

APPENDIX K

PRELIMINARY HAZARD ANALYSIS



Snapper Mineral Sands Project Environmental Assessment



SNAPPER MINERAL SANDS PROJECT
ENVIRONMENTAL ASSESSMENT

PRELIMINARY HAZARD ANALYSIS

FEBRUARY 2007
Project No. BMX-03-09\2.10
Document No. PHA-R01-F

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>	
K1	INTRODUCTION	K-1
	K1.1 OBJECTIVE AND SCOPE	K-1
	K1.2 STUDY METHODOLOGY	K-4
	K1.2.1 Risk Management Process	K-4
	K1.2.2 Risk Criteria	K-4
	K1.2.3 Qualitative Measures of Consequence, Likelihood and Risk	K-6
K2	SNAPPER MINE OVERVIEW	K-7
K3	HAZARD IDENTIFICATION	K-12
	K3.1 DESCRIPTION OF HAZARDOUS MATERIAL	K-12
	K3.1.1 Diesel	K-12
	K3.1.2 Backloaded MSP Process Waste	K-12
	K3.2 HAZARD IDENTIFICATION PROCESS	K-14
	K3.2.1 Snapper Mine Components	K-14
	K3.2.2 Incident Classes	K-14
	K3.2.3 Risk Treatment Measures	K-15
K4	RISK MANAGEMENT AND EVALUATION	K-16
K5	REFERENCES	K-16

LIST OF TABLES

Table K-1	Qualitative Measures of Probability
Table K-2	Qualitative Measures of Maximum Reasonable Consequence
Table K-3	Risk Ranking Table

LIST OF FIGURES

Figure K-1	Regional Location
Figure K-2	Snapper Mine (Year 1) and Ginkgo Mine (Years 3 to 5) Conceptual General Arrangements
Figure K-3	Risk Management Process
Figure K-4	Snapper Mine General Arrangement Year 1
Figure K-5	Snapper Mine General Arrangement Year 14
Figure K-6	Snapper Mine General Arrangement Post-Mining

ATTACHMENTS

Attachment KA	Snapper Mineral Sands Project Hazard Identification Table
---------------	---

K1 INTRODUCTION

The Snapper Mineral Sands Project (the Snapper Mine) involves the construction and operation of a mineral sands mine located approximately 10 kilometres (km) to the south-west of the existing Ginkgo Mineral Sands Project (the Ginkgo Mine) and approximately 170 km south of the Broken Hill Mineral Separation Plant (MSP) (Figure K-1). The Snapper Mine includes the development of the Snapper Mine mineral deposit, together with the extension/sharing of existing Ginkgo Mine infrastructure (Figure K-2).

This Preliminary Hazard Analysis (PHA) has been conducted as part of the Environmental Assessment (EA) to evaluate the hazards associated with the Snapper Mine in accordance with the general principles of risk evaluation and assessment outlined in the New South Wales (NSW) Department of Urban Affairs and Planning (DUAP) *Multi-Level Risk Assessment* (DUAP, 1999). This PHA also addresses the requirements of State Environmental Planning Policy (SEPP) No. 33 (Hazardous and Offensive Development) and has been documented in general accordance with *Guidelines for Hazard Analysis: Hazardous Industry Planning Advisory Paper No. 6* (DUAP, 1992a).

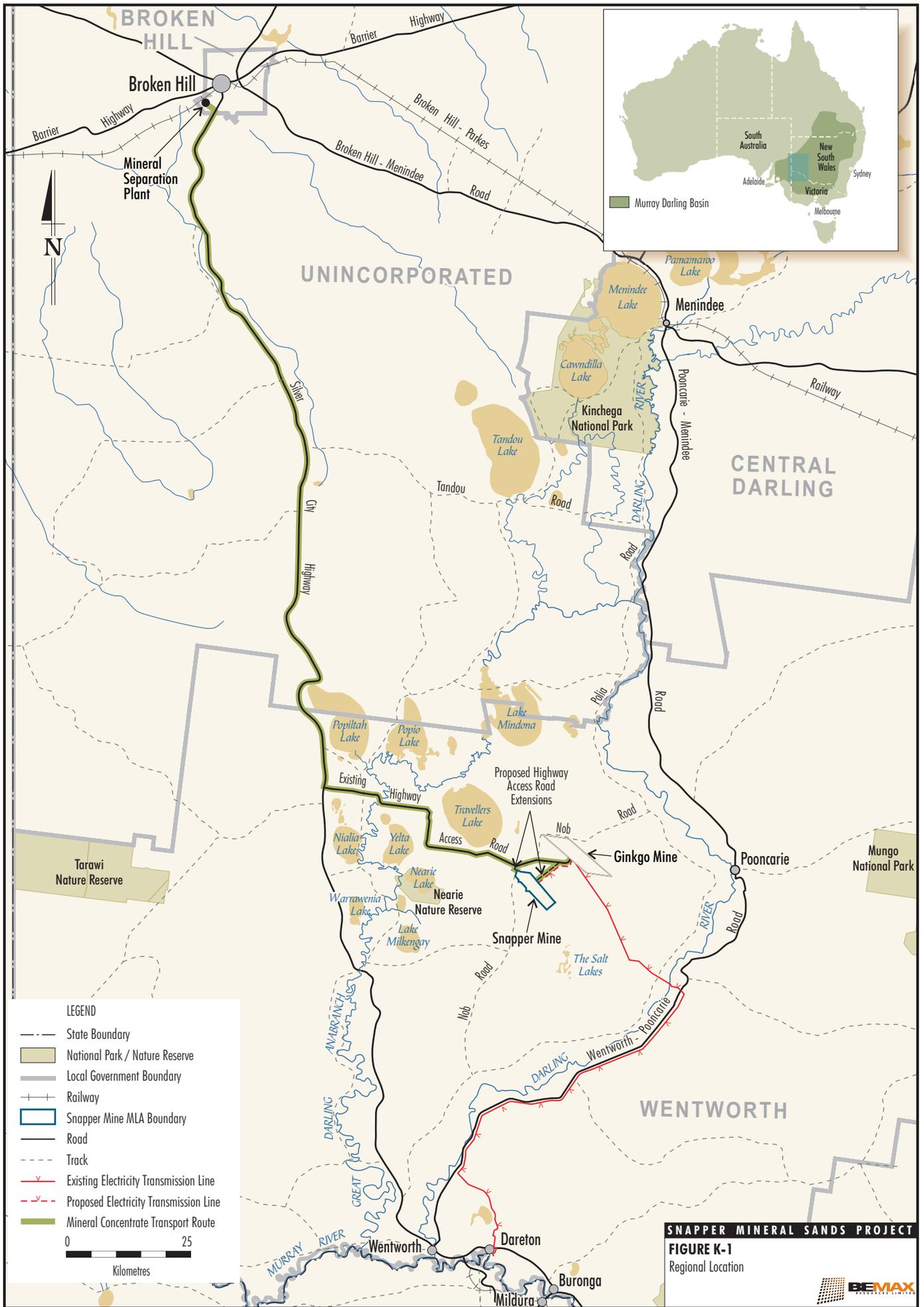
Assessed risks are compared to the qualitative risk assessment criteria developed in accordance with Australian Standard/New Zealand Standard (AS/NZS) 4360:2004 *Risk Management* (AS/NZS 4360). Further, this PHA considers the qualitative criteria provided in *Risk Criteria for Land Use Safety Planning: Hazardous Industry Planning Advisory Paper No. 4* (DUAP, 1992b).

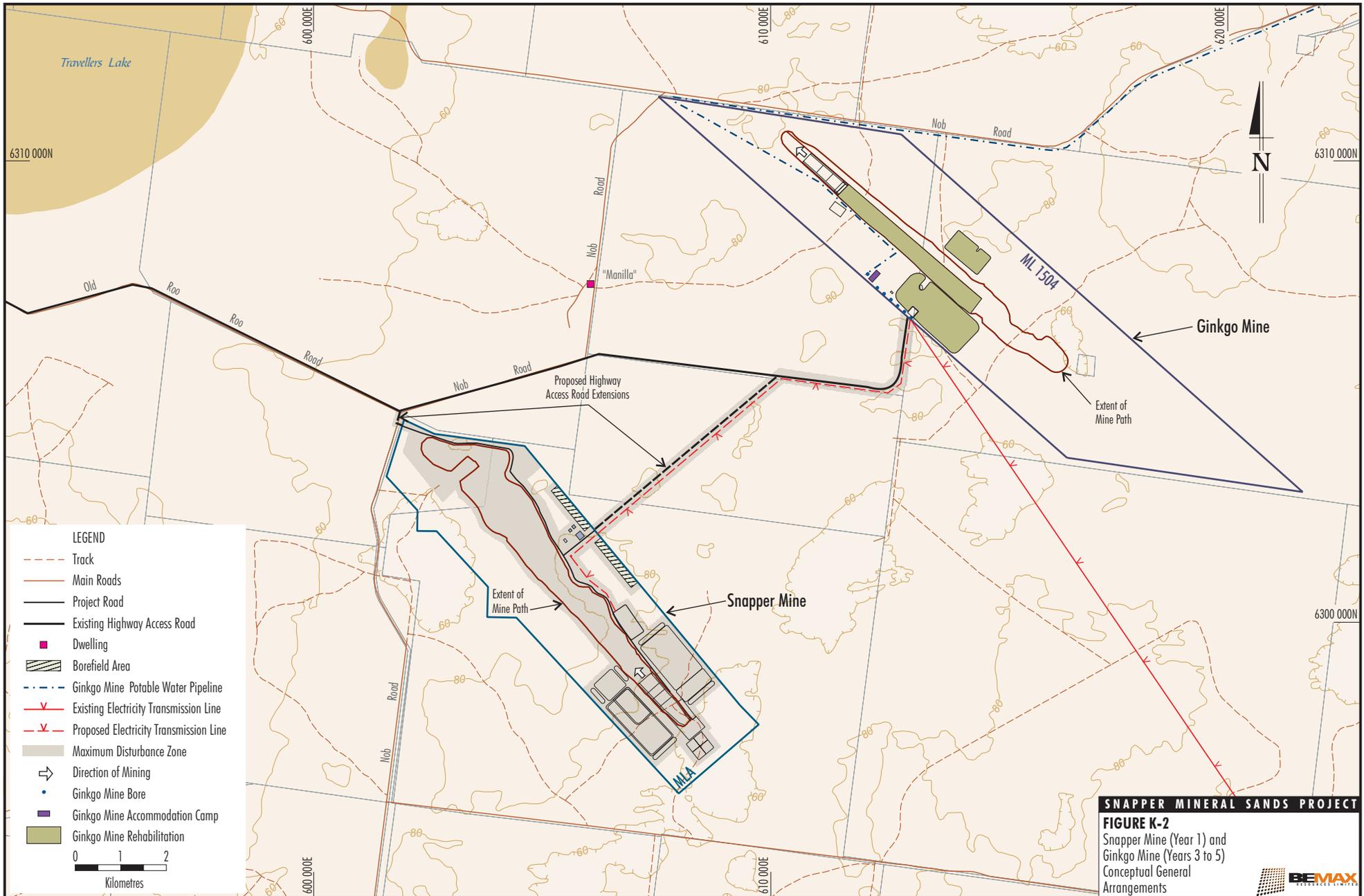
K1.1 OBJECTIVE AND SCOPE

The objective of this PHA is to identify the risks posed by the Snapper Mine to people, property and the environment and assess the identified risks using applicable qualitative criteria. This assessment considers off-site risks to people, property and the environment (in the presence of controls) arising from atypical and abnormal hazardous events and conditions (i.e. equipment failure, operator error and external events). The assessment does not consider risks to BEMAX employees or property.

This report should be read in conjunction with the following studies conducted for the EA:

- Hydrogeological Assessment (Golder Associates, 2007) (Appendix A).
- Road Transport Assessment (Traffix, 2007) (Appendix C).
- Fauna Assessment (Western Research Institute and Resource Strategies, 2007) (Appendix D).
- Flora Assessment (FloraSearch and Resource Strategies, 2007) (Appendix E).
- Noise Assessment (Holmes Air Sciences, 2007) (Appendix F).
- Air Quality Assessment (Holmes Air Sciences, 2007) (Appendix G).
- Rehabilitation Materials Assessment (BEMAX, 2007) (Appendix H).
- Process Waste Materials Assessment (BEMAX, 2007) (Appendix I).
- General Overview of Environmental Impacts (BEMAX, 2007) (Appendix L).





K1.2 STUDY METHODOLOGY

The methodology employed during the preparation of this PHA was as follows:

- Identify the hazards associated with the Snapper Mine.
- Examine the maximum reasonable consequence¹ of identified events.
- Qualitatively estimate the likelihood of events.
- Propose risk treatment measures.
- Qualitatively assess risks to the environment, members of the public and their property arising from atypical and abnormal events and compare these to applicable qualitative criteria.
- Recommend further risk treatment measures if considered warranted.
- Qualitatively determine the residual risk assuming the implementation of the risk treatment measures.

K1.2.1 Risk Management Process

This PHA has been undertaken with regard to the risk management process described in AS/NZS 4360. The risk management process is shown schematically on Figure K-3 and includes the following components:

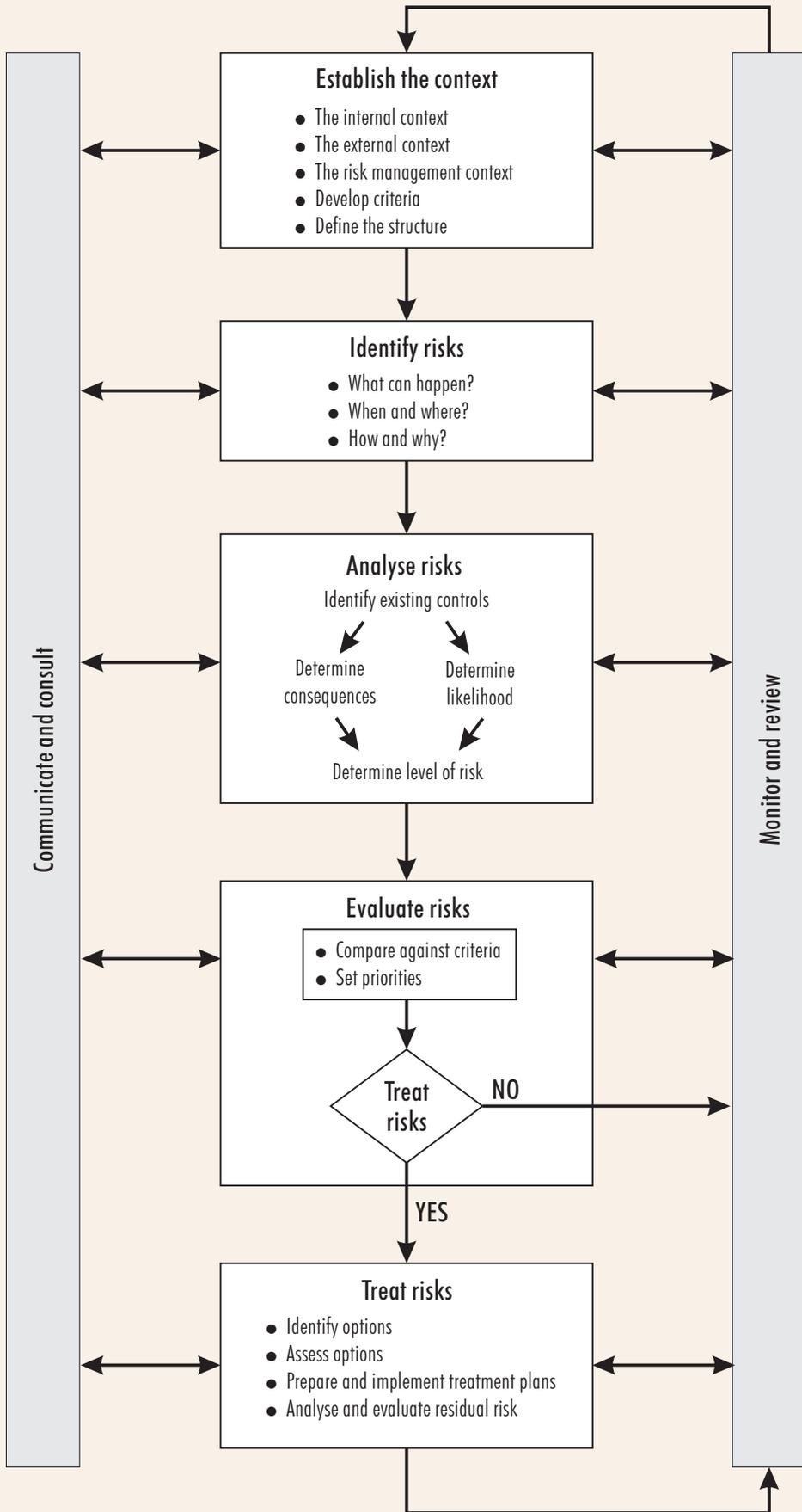
- establish the context (Section K1.2.3);
- identify risks (Section K3.2 and Attachment KA);
- analyse risks (Section K4 and Attachment KA);
- evaluate risks (Section K4 and Attachment KA); and
- treat risks (Section K3.2.3 and Attachment KA).

K1.2.2 Risk Criteria

This PHA considered the following qualitative criteria (summarised from DUAP, 1992b):

- (a) All 'avoidable' risks should be avoided. This necessitates investigation of alternative locations and technologies where applicable.
- (b) The risks from a major hazard should be reduced wherever practicable, irrespective of the value of the cumulative risk level from the whole installation.
- (c) The consequences (effects) of the more likely hazardous events should, where practicable, be contained within the boundaries of the installation.
- (d) Where there is an existing high risk from a hazardous installation, additional hazardous developments should not be allowed if they add significantly to that existing risk.

¹ Definition of Maximum Reasonable Consequence – The worst-case consequence that could reasonably be expected given the scenario.



Source: AS/NZS 4360: 2004 Risk Management

SNAPPER MINERAL SANDS PROJECT

FIGURE K-3
Risk Management Process



K1.2.3 Qualitative Measures of Consequence, Likelihood and Risk

To undertake a qualitative risk assessment it is useful to define (in a descriptive sense) the various levels of consequence of a particular event, and the likelihood (or probability) of such an event occurring. As noted in Section K1, risk assessment criteria were developed in accordance with AS/NZS 4360. AS/NZS 4360 allows the risk assessor to develop risk criteria during the *Establish the Context* phase.

In accordance with AS/NZS 4360, Tables K-1, K-2 and K-3 were reviewed as part of the *Establish the Context* phase. The tables were considered to be consistent with the specific objectives and context of the PHA.

Table K-1
Qualitative Measures of Probability

Event	Likelihood	Description	Probability
A	Almost Certain	Happens often	More than 1 event per month
B	Likely	Could easily happen	More than 1 event per year
C	Possible	Could happen and has occurred elsewhere	1 event per 1 to 10 years
D	Unlikely	Hasn't happened yet but could	1 event per 10 to 100 years
E	Rare	Conceivable, but only in extreme circumstances	Less than 1 event per 100 years

Source: Safe Production Solutions (2006)

Table K-2
Qualitative Measures of Maximum Reasonable Consequence

No.	People	Environment	Asset/Production
1	Multiple fatalities	Extreme environmental harm (e.g. widespread catastrophic impact on environmental values of an area)	More than \$500k loss or production delay
2	Permanent total disabilities, single fatality	Major environmental harm (e.g. widespread substantial impact on environmental values of an area)	\$100 to \$500k loss or production delay
3	Major injury or health effects (e.g. major lost workday case/permanent disability)	Serious environmental harm (e.g. widespread and significant impact on environmental values of an area)	\$50 to \$100k loss or production delay
4	Minor injury or health effects (e.g. restricted work or minor lost workday case)	Material environmental harm (e.g. localised and significant impact on environmental values of an area)	\$5 to \$50k loss or production delay
5	Slight injury or health effects (e.g. first aid/minor medical treatment level)	Minimal environmental harm (e.g. interference or likely interference to an environmental value)	Less than \$5k loss or production delay

Source: Safe Production Solutions (2006)

Combining the probability and consequence, Table K-3 provides a qualitative risk analysis matrix to assess risk levels.

**Table K-3
Risk Ranking Table**

Consequence	Probability				
	A	B	C	D	E
1	1 (H)	2 (H)	4 (H)	7 (M)	11 (M)
2	3 (H)	5 (H)	8 (M)	12 (M)	16 (L)
3	6 (H)	9 (M)	13 (M)	17 (L)	20 (L)
4	10 (M)	14 (M)	18 (L)	21 (L)	23 (L)
5	15 (M)	19 (L)	22 (L)	24 (L)	25 (L)

Notes: L – Low, M – Moderate, H – High
Rank numbering: 1 – highest risk; 25 – lowest risk

Legend – Risk levels:

	Tolerable
	ALARP – As low as reasonably practicable
	Intolerable

Source: Safe Production Solutions (2006)

Risk acceptance criteria for the Snapper Mine have been formulated following consideration of the *Hazardous Industry Planning Advisory Paper Number 4* (DUAP, 1992b) and AS/NZS 4360 guidelines, viz.:

Qualitative Risk Acceptance Criteria:

The risk posed by an event is at a level where the residual risk levels are considered tolerable, following consideration of the proposed risk mitigation and minimisation measures.

The hazard identification summary table (Attachment KA) illustrates the systematic application of the above criteria for the Snapper Mine.

K2 SNAPPER MINE OVERVIEW

Construction of the Snapper Mine would commence approximately between Years 3 to 5 of the Ginkgo Mine life. The mining operation would comprise the following:

- clearance of vegetation and stripping of soils on a campaign basis ahead of the advancing mine operation;
- overburden stripping, slurring and direct placement;
- predominantly dredge mining of ore by a conventional floating bucket wheel dredge located in the dredge pond;
- adjustment of dredge pond levels to maintain dredge access to the ore;
- supply of water from the borefields;
- disposal of water to the water disposal dam when lowering dredge pond levels;
- secondary mining of ore by conventional mobile equipment (i.e. dozers and/or scrapers), depositing ore in front of the dredge;
- ore concentration in the primary gravity concentration unit to produce heavy mineral concentrate (HMC);

- stockpiling of HMC;
- supply of desalinated water from the reverse osmosis (RO) plant for HMC salt washing;
- HMC separation via the Wet High Intensity Magnetic Separators (WHIMS) circuit either at the Snapper Mine or at the MSP, to produce three types of mineral concentrates (i.e. ilmenite-rich, leucoxene-rich and non-magnetic [rutile-rich and zircon-rich] concentrates);
- stockpiling of mineral concentrates;
- transport of HMC and/or mineral concentrates to the MSP;
- placement of wastes from the primary gravity concentration unit (i.e. sand residues) at the rear of the dredge pond as mining advances;
- treatment of process water to remove fines material (i.e. particles less than 53 microns in diameter);
- transport and placement of backloaded process waste from the MSP;
- replacement of overburden on top of sand residues; and
- staged replacement of soils and progressive rehabilitation.

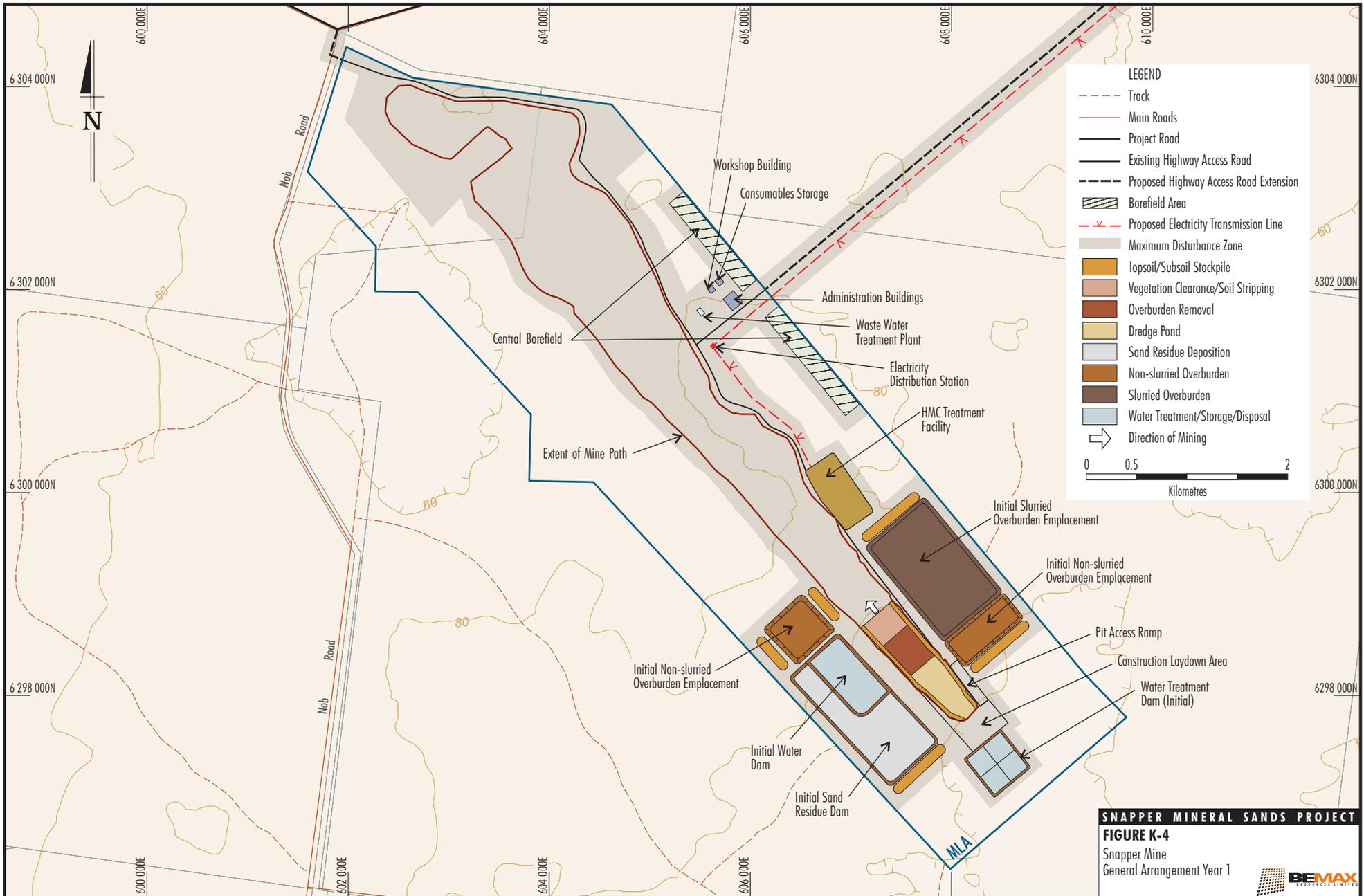
The combined development of the Snapper and Ginkgo Mines would maintain up to 650,000 tonnes per annum (tpa) feed rate of mineral concentrate to the MSP during the life of the two mines.

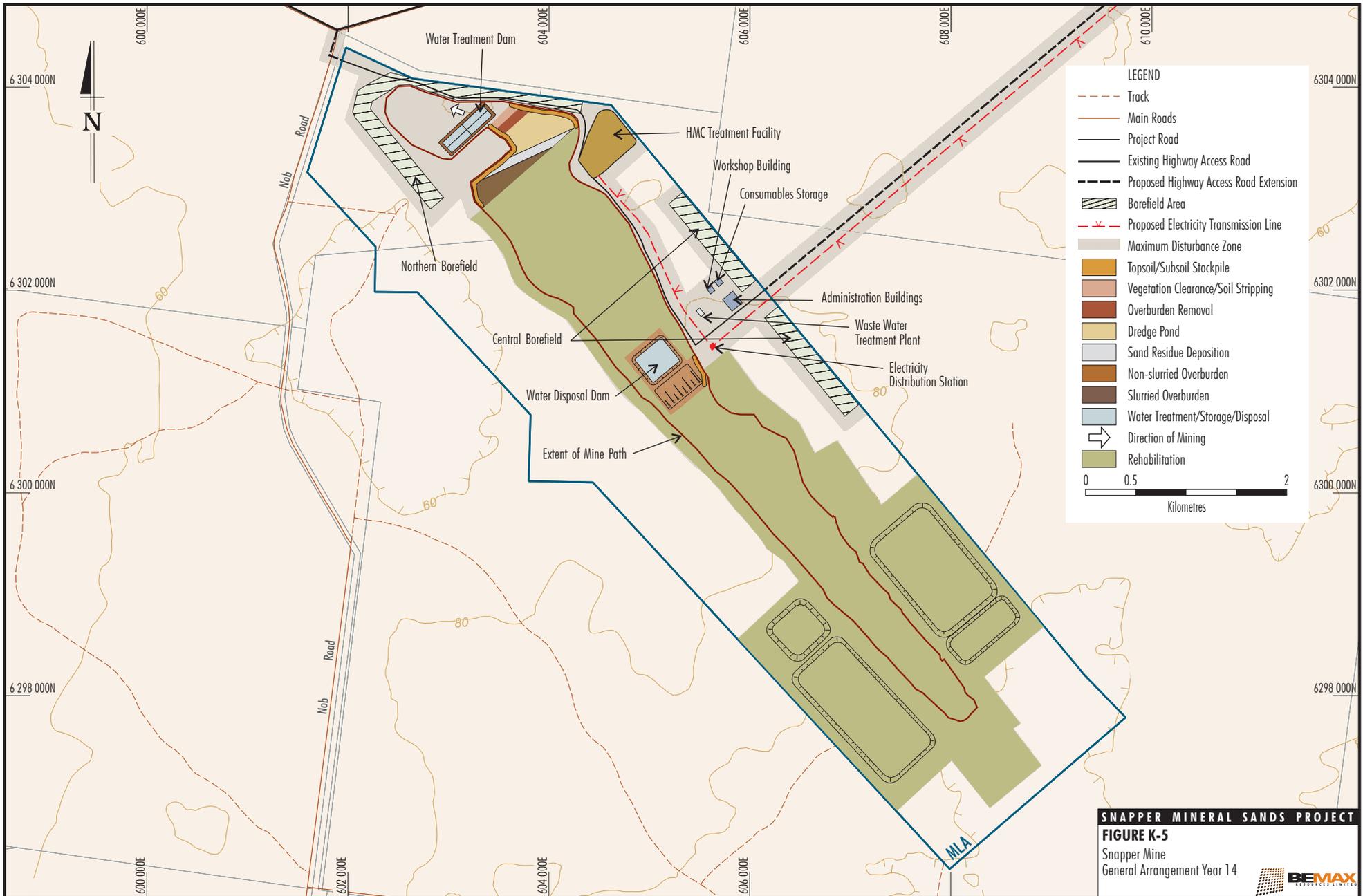
The general arrangement of the Mining Lease Application (MLA) area at Year 1, Year 14, and post-mining is shown on Figures K-4 to K-6.

The Snapper Mine has been designed to integrate with Ginkgo Mine ancillary infrastructure and facilities where practicable. For example, major ancillary infrastructure for the Snapper Mine comprises extensions/sharing of the existing Ginkgo Mine electricity transmission line (ETL), highway access road (HAR) and the Ginkgo Mine accommodation camp (Figure K-2).

The Snapper Mine area comprises the Snapper Mine Mining Lease Application (MLA) area and the ETL and HAR extensions (Figure K-2).

Due to the remote rural nature of the Snapper Mine, the existing Ginkgo Mine volunteer emergency response team (comprising BEMAX staff, employees and contractors) would attend to emergencies at the Snapper Mine. The team would provide rapid response to emergencies within the mine site and general Snapper Mine area. Training for the existing Ginkgo Mine volunteer emergency response team includes procedures for bushfire control, accident response, electrical emergencies, spill response and clean-up procedures. The emergency response team would be supported by a dedicated emergency response vehicle fitted with appropriate equipment.





K3 HAZARD IDENTIFICATION

K3.1 DESCRIPTION OF HAZARDOUS MATERIAL

The major potentially hazardous materials relevant to the Snapper Mine are limited to diesel and backloaded MSP process waste. A brief description of these materials is presented below.

The Snapper Mine would use a benign flocculant (e.g. Hi-TEX 82230) to treat process water. Approximately 2.3 tonnes (t) of flocculant would be used per month at the Snapper Mine operation during normal water treatment operations with higher doses (8 to 10 t per month) being used initially. The flocculant to be used (e.g. Hi-TEX 82230) would not be classified as hazardous according to the criteria of the National Occupational Health and Safety Commission (NOHSC), and is therefore not considered further in this report.

K3.1.1 Diesel

Diesel is classified as a combustible liquid by AS 1940:2004 *The Storage and Handling of Flammable and Combustible Liquids* (AS 1940) (Class C1) for the purposes of storage and handling but is not classified as a dangerous good by the criteria of the Australian Code for the Transport of Dangerous Goods by Road and Rail. In the event of a spill, diesel is damaging to soils and aquatic ecosystems and fires can occur if it is ignited (flash point 61.5°C) (BP Australia Pty Ltd [BP Aust], 2002).

Use of diesel at the Snapper Mine would be managed in accordance with the requirements of AS 1940 and the proposed use of diesel at the Snapper Mine does not include usage at elevated temperatures, therefore fires from conventional use are unlikely.

The risks associated with the Snapper Mine include diesel storage and usage. Diesel fuel storage at the Snapper Mine would comprise a 50,000 litre (L) tank located adjacent to the mineral concentrate stockpile. During construction a contractor would be employed to undertake the initial overburden stripping and replacement, prior to installation of the overburden slurring system. During this period, the contractor would require an additional temporary 50,000 L storage facility for diesel. This storage would be located adjacent to the Snapper Mine permanent diesel storage facility. Annual diesel usage should be up to approximately 4,000 L per year during operation and up to 4,750 L during the 15 month construction period.

K3.1.2 Backloaded MSP Process Waste

All heavy mineral sands orebodies contain traces of the naturally occurring radioactive elements uranium and thorium together with their decay products. The only mineral sands component that is significantly radioactive is monazite. Monazite is a radioactive material containing cerium, lanthanum and neodymium and is a source of the radioactive element thorium (BEMAX, 2006a).

Over the last 25 years the mineral sands industry has characterised radiation sources such as the mineral monazite. In some mineral sands projects, monazite is separated as a product stream. The Ginkgo and Snapper Mine deposits contain a very low level of monazite which is insufficient to warrant its commercial recovery. However, the monazite does concentrate in the zircon waste stream along with other minerals that have similar specific gravities, magnetic and conductivity properties (BEMAX, 2006a). Typically Australian mineral sands projects encounter monazite contents of less than 15% in the zircon waste stream and this would be an anticipated maximum for the Snapper Mine mineral concentrate.

Backloaded MSP process waste generated from the processing of Ginkgo and Snapper Mine ore would include:

- silica and quartz from the feed preparation circuit;
- monazite and silicate minerals from the ilmenite and leucoxene circuits;
- monazite and silicate materials from the zircon and other dry circuits; and
- ash waste by-product.

The maximum quantity of backloaded MSP process waste (from the processing of Ginkgo and Snapper Mines mineral concentrate) would be approximately 300,000 tpa.

The monazite fraction of the backloaded MSP process waste would determine its activity levels (BEMAX, 2006a). During minerals processing at the MSP, monazite concentrates in the zircon waste stream and to a lesser extent in the leucoxene and ilmenite waste streams. Based on Ginkgo Mine mineral concentrates (BEMAX, 2006a), the total activity of the zircon waste stream without mixing with other MSP process wastes or rejects is likely to be less than 450 Becquerels per gram (Bq/g).

The zircon waste stream would be blended with other MSP process waste streams. Based on Ginkgo Mine mineral concentrate (BEMAX, 2006a), this backloaded MSP process waste would have a total activity level of approximately 125 Bq/g during the early years of the MSP operations and increase to approximately 190 Bq/g during the latter years of the MSP operations. Prior to the handling of the zircon waste stream and the backloaded MSP process waste to be transported to the Snapper Mine, monitoring would be undertaken to confirm the specific activity of the waste. For the purposes of this assessment, the backloaded MSP process waste to be transported to the Snapper Mine is assumed to have similar properties to the Ginkgo Mine backloaded MSP process waste, in order to provide a conservative assessment of potential impacts.

The zircon waste stream and backloaded MSP process waste to be transported to the Snapper Mine would therefore be classified as *hazardous* wastes (i.e. total activity greater than 100 Bq/g) under the *Protection of the Environment Operations Act, 1997* (POEO Act) and *radioactive* under the *Radiation Control Act, 1990*.

The combustion of coal during the latter years of the MSP operations would produce an ash waste material. Ash would be expected as a waste by-product from the combustion of the black coal and brown coal briquettes. Quantities of ash from the brown coal briquettes should be minor due to the low inherent ash content of the briquettes (i.e. approximately 2%). The majority of solid ash waste would be produced by the combustion of the black coal. Prior to the commencement of backloading MSP process waste containing ash waste by-product, testwork would be undertaken to determine the composition of the ash waste material.

Although the backloaded MSP process waste would be classified as *hazardous* and *radioactive*, it should be noted that the heavy nature of monazite (specific gravity between 4.6 and 5.4 [DME, 1996]) reduces its susceptibility to suspension in both air and surface water. In addition, monazite is insoluble in water and, therefore, there should be no dissolution of radionuclides in surface water runoff (Radiation Advice & Solutions, 2006).

The management measures relevant to the backloaded MSP process waste are provided in the Process Waste Materials Assessment (Appendix I).

K3.2 HAZARD IDENTIFICATION PROCESS

The Snapper Mine hazard (or risk) identification summary table (Attachment KA) provides a summary of the potential risks and hazards identified for the Snapper Mine and a qualitative assessment of the risks posed.

K3.2.1 Snapper Mine Components

For the purposes of hazard identification and assessment, the Snapper Mine was subdivided into the following areas:

- dredge mining and mineral concentration;
- sand residue and overburden management;
- water management;
- concentrate haulage and waste backloading;
- diesel storage facilities;
- mine stores;
- concentrate stockpile/road train loading;
- consumables transport;
- electricity transmission; and
- external events.

K3.2.2 Incident Classes

The following generic classes of incident were identified:

- fire;
- explosion;
- leaks/spills;
- failure; and
- vehicle accident.

These incident classes were applied to the Snapper Mine component areas to identify scenarios for which treatment measures were developed.

K3.2.3 Risk Treatment Measures

A number of hazard treatment and mitigative measures would be described in management plans for the Snapper Mine, including the following:

- **Mining Operations Plan (MOP)** – the MOP would detail the proposed development and management of mining activities and associated progressive rehabilitation operations. Environmental controls and procedures required for compliance with lease conditions would be presented.
- **Site Water Management Plan (SWMP)** – the SWMP would include procedures that would be implemented to ameliorate potential groundwater impacts on surrounding land users, where applicable. The SWMP would include a site water balance, on-site water management measures (including erosion and sediment control) and a groundwater monitoring programme.
- **Landfill Environmental Management Plan (LEMP)** – the LEMP would describe the disposal activities relevant to the Snapper Mine and would be consistent with the *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (ARPANSA, 2005). The LEMP would also generally meet the environmental goals listed in *Environmental Guidelines: Solid Waste Landfills* (EPA, 1996).
- **Emergency Response Plan (ERP)** – This plan would provide emergency response objectives, site roles and responsibilities and a series of detailed response procedures for a range of potential emergencies.

The *Ginkgo Mineral Sands Mine and Broken Hill Mineral Separation Plant Transport of Hazardous Materials Plan* (BEMAX, 2006b) and the *Ginkgo Mineral Sands Mine and Broken Hill Mineral Separation Plant Traffic Code of Conduct* (BEMAX, 2006c) have been prepared for the Ginkgo Mine. These documents would be updated to include haulage activities relevant to the Snapper Mine prior to commencement of transport of hazardous materials to the Snapper Mine from the MSP.

In addition, the following hazard treatment measures would be adopted for the Snapper Mine:

- **Maintenance** – On-going and timely maintenance of all mobile and fixed plant and equipment in accordance with the manufacturer's recommended maintenance schedule, and consistent with the maintenance schemes required by relevant standards. Only vehicles permitted to carry dangerous goods would be used for transport of hazardous materials.
- **Staff Training** – Operators and drivers would be trained and (where applicable) licensed for their job descriptions. Only those personnel licensed to undertake skilled and potentially hazardous work would be permitted to do so.
- **Structures** – Mining and civil engineering structures would be constructed in accordance with applicable codes, guidelines and Australian Standards. Where applicable, BEMAX would obtain the necessary licences and permitting for engineering structures.
- **Diesel Storage** – The storage of diesel at the mine site and potable water supply pump station would be designed, constructed and operated in accordance with the requirements of AS 1940. This includes bunding of storages to contain 110% of the contents of the tank.
- **Site Emergency Response Team** – Selected BEMAX employees and/or contractors would be trained to respond to emergencies and spills within the Snapper Mine area. The emergency response team would be supported by a dedicated emergency response vehicle which would be equipped to provide fire control, spill clean-up and/or first aid capability as required.

K4 RISK MANAGEMENT AND EVALUATION

Attachment KA presents a qualitative assessment of risks associated with the construction and operation of the Snapper Mine. The assessment evaluates the risk of the Snapper Mine impacting on the environment, members of the public and their property. Hazard treatment measures have been proposed, where required, to produce a 'low' level of risk in accordance with the risk acceptance criteria described in Section K1.2.3. Proposed treatment measures are identified in Section K3.2.3.

K5 REFERENCES

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (2005) *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing*.

BEMAX (2006a) *Broken Hill Mineral Separation Plant Waste Management Plan*.

BEMAX (2006b) *Ginkgo Mineral Sands Mine and Broken Hill Mineral Separation Plant Transport of Hazardous Materials Plan*.

BEMAX (2006c) *Ginkgo Mineral Sands Mine and Broken Hill Mineral Separation Plant Traffic Code of Conduct*.

BP Australia Pty Ltd (BP Aust) (2002) *BP Ultra Low Sulphur Diesel Material Safety Data Sheet*. Middlesex.

Department of Minerals and Energy (DME) (1996) *Fact Sheet 10: Mineral Sands*.

Department of Urban Affairs and Planning (DUAP) (1992a) *Guidelines for Hazard Analysis: Hazardous Industry Planning Advisory Paper No. 6*.

Department of Urban Affairs and Planning (DUAP) (1992b) *Risk Criteria for Land Use Safety Planning: Hazardous Industry Planning Advisory Paper No. 4*.

Department of Urban Affairs and Planning (DUAP) (1999) *Multi-Level Risk Assessment*. Revised Edition.

Environmental Protection Authority (EPA) (1996) *Environmental Guidelines: Solid Waste Landfills*. New South Wales.

Radiation Advice & Solutions (2006) *Review of Waste Storage Facility at Bemax MSP, Broken Hill*.

Safe Production Solutions (2006) *Newcastle Coal Export Terminal Environmental Risk Assessment*.

ATTACHMENT KA
SNAPPER MINERAL SANDS PROJECT
HAZARD IDENTIFICATION TABLE

**Table KA-1
Snapper Mine Hazard Identification Table**

Project Component	Incident Type	Scenario	Proposed Preventative Measures	Likelihood ¹	Consequence ²	Risk ³
Construction	Leaks/Spills	Spill of diesel, oils, lubricants, solvents or construction materials leading to off-site impacts.	<ul style="list-style-type: none"> Contractors licensed and operate in accordance with Australian Standards and NSW Legislation. Supervision during construction. Inspection of containment structures and pipes. Fuel, oils and lubricants stored in accordance with Australian Standards and NSW Legislation. Spill response equipment and training. Site construction runoff control (drains and sumps). Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. Radio or telephone on mobile equipment. Trained operators and mechanics. 	C	4	Low (18)
	Fire	Mobile plant, fixed plant, human action, vehicle fire or fuel storage fire resulting in off-site impacts. Mobile plant, fixed plant, human action, vehicle fire or fuel storage fire resulting in off-site impacts (continued).	<ul style="list-style-type: none"> Contractors licensed and operate in accordance with Australian Standards and NSW Legislation. Development and maintenance of appropriate fire breaks. Environmental management plans relevant to construction. Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. Working area cleared and majority of equipment located below natural ground level. Radio or telephone on mobile equipment. Trained operators and mechanics. On board fire extinguishers. Site fire fighting capability and emergency response procedures. 	E	4	Low (23)
	Vehicle Accident	Vehicle accident on a public road due to construction activities associated with the mine.	<ul style="list-style-type: none"> Design of upgraded roads/intersections to appropriate standards and legislation. 	E	2	Low (16)

Table KA-1 (Continued)
Snapper Mine Hazard Identification Table

Project Component	Incident Type	Scenario	Proposed Preventative Measures	Likelihood ¹	Consequence ²	Risk ³
Construction	Leaks/Spills	Spill of diesel, oils, lubricants, solvents or construction materials leading to off-site impacts.	<ul style="list-style-type: none"> Contractors licensed and operate in accordance with Australian Standards and NSW Legislation. Supervision during construction. Inspection of containment structures and pipes. Fuel, oils and lubricants stored in accordance with Australian Standards and NSW Legislation. Spill response equipment and training. Site construction runoff control (drains and sumps). Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. Radio or telephone on mobile equipment. Trained operators and mechanics. 	C	4	Low (18)
	Fire	<p>Mobile plant, fixed plant, human action, vehicle fire or fuel storage fire resulting in off-site impacts.</p> <p>Mobile plant, fixed plant, human action, vehicle fire or fuel storage fire resulting in off-site impacts (continued).</p>	<ul style="list-style-type: none"> Contractors licensed and operate in accordance with Australian Standards and NSW Legislation. Development and maintenance of appropriate fire breaks. Environmental management plans relevant to construction. Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. Working area cleared and majority of equipment located below natural ground level. Radio or telephone on mobile equipment. Trained operators and mechanics. On board fire extinguishers. Site fire fighting capability and emergency response procedures. 	E	4	Low (23)
	Vehicle Accident	Vehicle accident on a public road due to construction activities associated with the mine.	<ul style="list-style-type: none"> Design of upgraded roads/intersections to appropriate standards and legislation. 	E	2	Low (16)

Table KA-1 (Continued)
Snapper Mine Hazard Identification Table

Project Component	Incident Type	Scenario	Proposed Preventative Measures	Likelihood ¹	Consequence ²	Risk ³
Dredge Mining and Primary Mineral Concentration	Fire	Vehicle or equipment fire due to leak or mechanical/electrical failure.	<ul style="list-style-type: none"> Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. Working area cleared and majority of equipment located below natural ground level. Radio or telephone on mobile equipment. Trained operators and mechanics. On board fire extinguishers. Site fire fighting capability and emergency response procedures. Water management strategies for pit areas to contain fire-water runoff. 	E	4	Low (23)
	Leaks/Spills	Diesel or lubricant spill from equipment.	<ul style="list-style-type: none"> Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. Radio or telephone on mobile equipment. Trained operators and mechanics. No bulk storage of diesel or lubricants within the mining area therefore limited potential spill volume. Spill response equipment and training. Water management strategies for mining areas to contain pit runoff. 	C	4	Low (18)
Sand Residue and Overburden Management	Fire	Vehicle or equipment fire due to leak or mechanical failure.	<ul style="list-style-type: none"> Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. Windrows and fire breaks maintained between existing vegetation and overburden areas where appropriate. Radio or telephone on mobile equipment, and on-board fire extinguishers. Trained operators and mechanics. Project fire fighting capability and emergency response procedures. Water management structures for operational areas to contain fire-water runoff. 	D	4	Low (21)

Table KA-1 (Continued)
Snapper Mine Hazard Identification Table

Project Component	Incident Type	Scenario	Proposed Preventative Measures	Likelihood ¹	Consequence ²	Risk ³
Sand Residue and Overburden Management (continued))	Leaks/Spills	Loss of sand residues and slurried overburden due to failure or accidental damage of residue pipeline to initial residue storage.	<ul style="list-style-type: none"> Sand residue and slurried overburden pipelines located within a bunded corridor to contain spills. The sand residue pipeline, residue dam and slurried overburden pipeline to the initial slurried overburden emplacement inspected daily while operational. Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. Water management structures for operational areas sized to contain sand residue slurried overburden runoff. 	E	4	Low (23)
	Failure	Slip or seismic event leads to loss of sand residues from the initial sand residue dam or slurried overburden from the initial slurried overburden emplacement.	<ul style="list-style-type: none"> Initial sand residue dam and initial slurried overburden emplacement designed to appropriate engineering standards. If applicable, dam design to be approved by the dam safety committee prior to construction. Sand residue dam and initial slurried overburden emplacement would be managed to maintain optimum freeboard. Earthmoving equipment available to contain and collect sand residue and slurried overburden material in the event of a spill. 	E	4	Low (23)
		Slip or seismic event leads to slump of sand residues or slurried overburden from the deposition area into the dredge pond working area.	<ul style="list-style-type: none"> Sand residues and slurried overburden managed to maintain stability of the residue and overburden mass. Any slump would be contained within the dredge pond – no loss to the surrounding environment. 	E	4	Low (23)

Table KA-1 (Continued)
Snapper Mine Hazard Identification Table

Project Component	Incident Type	Scenario	Proposed Preventative Measures	Likelihood ¹	Consequence ²	Risk ³
Water Management	Failure	Failure or overtopping of sediment control structures leads to dispersion of sediment from operational areas.	<ul style="list-style-type: none"> All diversion and containment structures designed to meet appropriate criteria. Sediment sumps pumped out after heavy rainfall events and cleaned out periodically to maintain storage capacity. Regular monitoring of structural integrity. 	D	4	Low (21)
		Failure of upslope water diversion structures.	<ul style="list-style-type: none"> Upslope diversion bunds engineered for peak flow events in accordance with appropriate criteria. In the event of diversion failure waters would be retained by the dredge pond or contained in the mine area. 	E	4	Low (23)
		Failure of the initial water dam due to structural failure or seismic event.	<ul style="list-style-type: none"> Water dam designed and constructed in accordance with standard engineering practice. If applicable, dam design to be approved by the dam safety committee prior to construction. Water dam would be managed to maintain optimum freeboard. In the event of dam failure, water would be retained by the dredge pond or contained in the mine area. 	E	4	Low (23)
	Leaks/Spills	Leak of saline process water from the pipeline or borefield.	<ul style="list-style-type: none"> Pipeline located within a bunded corridor to reduce the possibility of spills or accidental damage. The process water management system would operate on a pressure break system and would shutdown in the event of a pipeline rupture. Process water pipeline, borefield and water management structures regularly inspected for signs of wear or damage. 	E	4	Low (23)

Table KA-1 (Continued)
Snapper Mine Hazard Identification Table

Project Component	Incident Type	Scenario	Proposed Preventative Measures	Likelihood ¹	Consequence ²	Risk ³
Concentrate Haulage and Waste Backloading	Vehicle Accident	Road train accident involving a member of the public.	<ul style="list-style-type: none"> • Design and fabrication of double road trains or other RTA-approved vehicles (e.g. AB-triple vehicles) undertaken in consultation with the RTA. • Traffic control measures including those undertaken for the Ginkgo Mine: <ul style="list-style-type: none"> – signs on all public road approaches to the concentrate transport route to warn drivers of the presence of road trains and upcoming give way signs; – give way signs to allow road train right of way at intersections (except Silver City Highway); – road train speed limit on the concentrate transport route and Silver City Highway (100 km/hr); – warning signs on approach to the intersection of the Silver City Highway and the concentrate transport route; – maintenance of roadside vegetation to provide clear sight lines in all directions at concentrate transport route intersections with public roads; – road train operators would be trained to blast their horn and drive defensively on approach to intersections; – road trains would be weighed at a certified weighbridge prior to departure from the mine site; – a Road Safety Audit undertaken along the entire mineral concentrate haulage route; – on-going road surface maintenance monitoring would be undertaken in consultation with the RTA to assess road pavement conditions; and – a specifically designed intersection on the Silver City Highway at the intersection with the concentrate transport route. 	E	2	Low (16)

Table KA-1 (Continued)
Snapper Mine Hazard Identification Table

Project Component	Incident Type	Scenario	Proposed Preventative Measures	Likelihood ¹	Consequence ²	Risk ³
Concentrate Haulage and Waste Backloading (continued)	Vehicle Accident Leaks/Spills	Accident causing spillage of mineral concentrate.	<ul style="list-style-type: none"> Truck tubs are covered. Truck tubs are side tipping so no tailgate seals are present that could leak during transport. Traffic control measures in place as outlined above. Haul truck operator training. GPS transponder and/or radio in truck cabs for rapid emergency response. Mineral concentrate are solids and are not mobile. Concentrates could be effectively cleaned up with earthmoving equipment. 	D	4	Low (21)
		Accident causing spillage of backloaded MSP process waste materials.	<ul style="list-style-type: none"> Truck tubs are covered. Traffic control measures in place as outlined above. Haul truck operator training. GPS transponder and/or radio in truck cabs for rapid emergency response. Backloaded MSP process waste materials are solids and are not mobile. Backloaded MSP process waste could be effectively cleaned up with earthmoving equipment. 	D	4	Low (21)
		Loss of diesel from fuel tanks due to leak or accident.	<ul style="list-style-type: none"> Haul truck operator training. GPS transponder and/or radio in truck cabs for rapid emergency response. Road trains maintained according to a maintenance schedule. Trained mechanics. Emergency response procedures in place to respond to leaks and spills including assessment, clean-up and treatment procedures. 	D	4	Low (21)

Table KA-1 (Continued)
Snapper Mine Hazard Identification Table

Project Component	Incident Type	Scenario	Proposed Preventative Measures	Likelihood ¹	Consequence ²	Risk ³
Concentrate Haulage and Waste Backloading (continued)	Fire	Vehicle or equipment fire due to leak or mechanical failure.	<ul style="list-style-type: none"> Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. GPS transponder and/or radio in truck cabs for rapid emergency response. Trained operators and mechanics. On board fire extinguishers. Mineral concentrate and backloaded MSP process waste not flammable. 	E	4	Low (23)
Diesel Storage Facilities	Leaks/Spills	Spill, seismic event, leak, flood, accident or operator error causing loss of contaminant, land or water contamination.	<ul style="list-style-type: none"> Bunded storage facilities. Tanks and bunds would be constructed and operated in accordance with relevant Australian Standards. Emergency response procedures in place to respond to leaks and spills including assessment, clean-up and treatment procedures. Trained operators. Diesel storage tank would be located on an elevated structure to position the tank above recorded maximum flood levels and would be constructed to appropriate engineering standards. 	E	4	Low (23)
	Fire	Fire leads to emission of fumes and/or loss of containment.	<ul style="list-style-type: none"> Tanks and bunds would be constructed and operated in accordance with relevant Australian Standards. Control of ignition sources, administrative controls. Trained operators. Fire extinguishers. Earthmoving equipment for fire containment available. 	E	4	Low (23)

Table KA-1 (Continued)
Snapper Mine Hazard Identification Table

Project Component	Incident Type	Scenario	Proposed Preventative Measures	Likelihood ¹	Consequence ²	Risk ³
Mine Stores	Fire	Fire in store leads to toxic fumes or gases or land or water contamination.	<ul style="list-style-type: none"> Control of ignition sources, administrative controls. Trained operators. Earthmoving equipment for fire containment available. Fire-water runoff would be contained within water management structures. 	E	4	Low (23)
	Leaks/Spills	Seismic event, handling accident, operator error, failure of container.	<ul style="list-style-type: none"> Trained operators. Spills would be contained within water management structures. 	D	4	Low (21)
Concentrate Stockpile/Road Train Loading	Fire	Fire due to leak or mechanical failure.	<ul style="list-style-type: none"> Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. Trained operators and mechanics. Site fire extinguishers and hydrants. Site fire fighting capability and emergency response procedures. Earthmoving equipment for fire containment available. Water management structures would contain fire-water runoff. 	E	4	Low (23)
	Leaks/Spills	Diesel or lubricant spill from equipment.	<ul style="list-style-type: none"> Regularly maintained equipment in accordance with manufacturer's recommended maintenance schedule. Trained operators and mechanics. Water management structures would contain fire-water runoff. 	D	4	Low (21)

Table KA-1 (Continued)
Snapper Mine Hazard Identification Table

Project Component	Incident Type	Scenario	Proposed Preventative Measures	Likelihood ¹	Consequence ²	Risk ³
Consumable Transport	Vehicle Accident Leaks/Spills – Diesel Tanker	Accident and spill resulting in land or water contamination or fire.	<ul style="list-style-type: none"> Deliveries in accordance with standard supplier transportation procedures. Use of reputable suppliers and carriers. Radio or telephone in truck cabs. Site emergency response procedures including liaison with local emergency services. Moderate annual consumption due to electrical power supply for major plant items. 	D	3	Low (17)
	Vehicle Accident Leaks/Spills – Lubricants Waste Oil Transport	Accident and spill resulting in land or water contamination or fire.	<ul style="list-style-type: none"> Deliveries in accordance with standard supplier transportation procedures. Use of reputable suppliers and carriers. Radio or telephone in truck cabs. Site emergency response procedures including liaison with local emergency services. Moderate annual consumption due to electrical power supply for major plant items. 	D	3	Low (17)
	Vehicle Accident	Transport vehicle accident involving a member of the public.	<ul style="list-style-type: none"> As above. 	E	2	Low (16)
Electricity Transmission Line	Fire	Line fall leads to bushfire.	<ul style="list-style-type: none"> Electricity transmission line constructed to appropriate standards. Failure of the electricity supply at the mine site would initiate rapid response. Co-ordination of emergency response team with rural fire brigades if necessary. 	E	4	Low (23)

1 Refer to Table KA-2

2 Refer to Table KA-3

3 Refer to Table KA-4

**Table KA-2
Qualitative Measures of Probability**

Event	Likelihood	Description	Probability
A	Almost Certain	Happens often	More than 1 event per month
B	Likely	Could easily happen	More than 1 event per year
C	Possible	Could happen and has occurred elsewhere	1 event per 1 to 10 years
D	Unlikely	Hasn't happened yet but could	1 event per 10 to 100 years
E	Rare	Conceivable, but only in extreme circumstances	Less than 1 event per 100 years

Source: Safe Production Solutions (2006)

**Table KA-3
Qualitative Measures of Maximum Reasonable Consequence**

No.	People	Environment	Asset/Production
1	Multiple fatalities	Extreme environmental harm (e.g. widespread catastrophic impact on environmental values of an area)	More than \$500k loss or production delay
2	Permanent total disabilities, single fatality	Major environmental harm (e.g. widespread substantial impact on environmental values of an area)	\$100 to \$500k loss or production delay
3	Major injury or health effects (e.g. major lost workday case/permanent disability)	Serious environmental harm (e.g. widespread and significant impact on environmental values of an area)	\$50 to \$100k loss or production delay
4	Minor injury or health effects (e.g. restricted work or minor lost workday case)	Material environmental harm (e.g. localised and significant impact on environmental values of an area)	\$5 to \$50k loss or production delay
5	Slight injury or health effects (e.g. first aid/minor medical treatment level)	Minimal environmental harm (e.g. interference or likely interference to an environmental value)	Less than \$5k loss or production delay

Source: Safe Production Solutions (2006)

**Table KA-4
Risk Ranking Table**

Consequence	Probability				
	A	B	C	D	E
1	1 (H)	2 (H)	4 (H)	7 (M)	11 (M)
2	3 (H)	5 (H)	8 (M)	12 (M)	16 (L)
3	6 (H)	9 (M)	13 (M)	17 (L)	20 (L)
4	10 (M)	14 (M)	18 (L)	21 (L)	23 (L)
5	15 (M)	19 (L)	22 (L)	24 (L)	25 (L)

Notes: L – Low, M – Moderate, H – High
Rank numbering: 1 – highest risk; 25 – lowest risk

Legend – Risk levels:

	Tolerable
	ALARP – As low as reasonably practicable
	Intolerable

Source: Safe Production Solutions (2006)