ResourceStrategies

Snapper Mineral Sands Mine & Ginkgo Mineral Sands Mine

April 2010 Modification Environmental Assessment

BEMAX RESOURCES LIMITED

BEMAX RESOURCES LIMITED

SNAPPER MINERAL SANDS MINE
AND
GINKGO MINERAL SANDS MINE

APRIL 2010 MODIFICATION
ENVIRONMENTAL ASSESSMENT

APRIL 2010
Project No. BMX-09-21
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1 INTRODUCTION

The Snapper Mineral Sands Mine (the Snapper Mine) and Ginkgo Mineral Sands Mine (the Ginkgo Mine) are located approximately 85 kilometres (km) north of Mildura and approximately 170 km to the south of the Broken Hill Mineral Separation Plant (the MSP) in western New South Wales (NSW) (Figures 1 and 2). BEMAX Resources Limited (BEMAX) is the proponent of the Snapper and Ginkgo Mines and the MSP.

Snapper Mine

In March 2007, BEMAX submitted a Project Application for the Snapper Mine to the Minister for Planning. The Project Application was accompanied by the Snapper Mineral Sands Project Environmental Assessment (the Snapper Mine EA) (BEMAX, 2007a). The Snapper Mine was granted Project Approval (06_0168) under Part 3A of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) by the Minister for Planning on 28 August 2007. Construction of the Snapper Mine commenced in August 2008. The Snapper Mine Project Approval (06_0168) has been modified on two occasions: June 2009 and December 2009.

Ginkgo Mine

In September 2001, BEMAX submitted a Development Application (DA) for the Ginkgo Mine to the Minister for Urban Affairs and Planning. The DA was accompanied by the Ginkgo Mineral Sands Project Environmental Impact Statement (BEMAX, 2001a) (the Ginkgo Mine EIS). The Minister for Urban Affairs and Planning issued Development Consent (DA 251-09-01) under Part 4 of the EP&A Act on 30 January 2002. The Ginkgo Mine was commissioned in 2005. The Ginkgo Mine Development Consent (DA 251-09-01) has been modified on seven occasions: September 2003, May 2005, April 2006, April 2007, December 2008, April 2009 and December 2009.

Proposed Modification

BEMAX is seeking approval to make the changes outlined herein to the currently approved Snapper and Ginkgo Mines (the Modification).

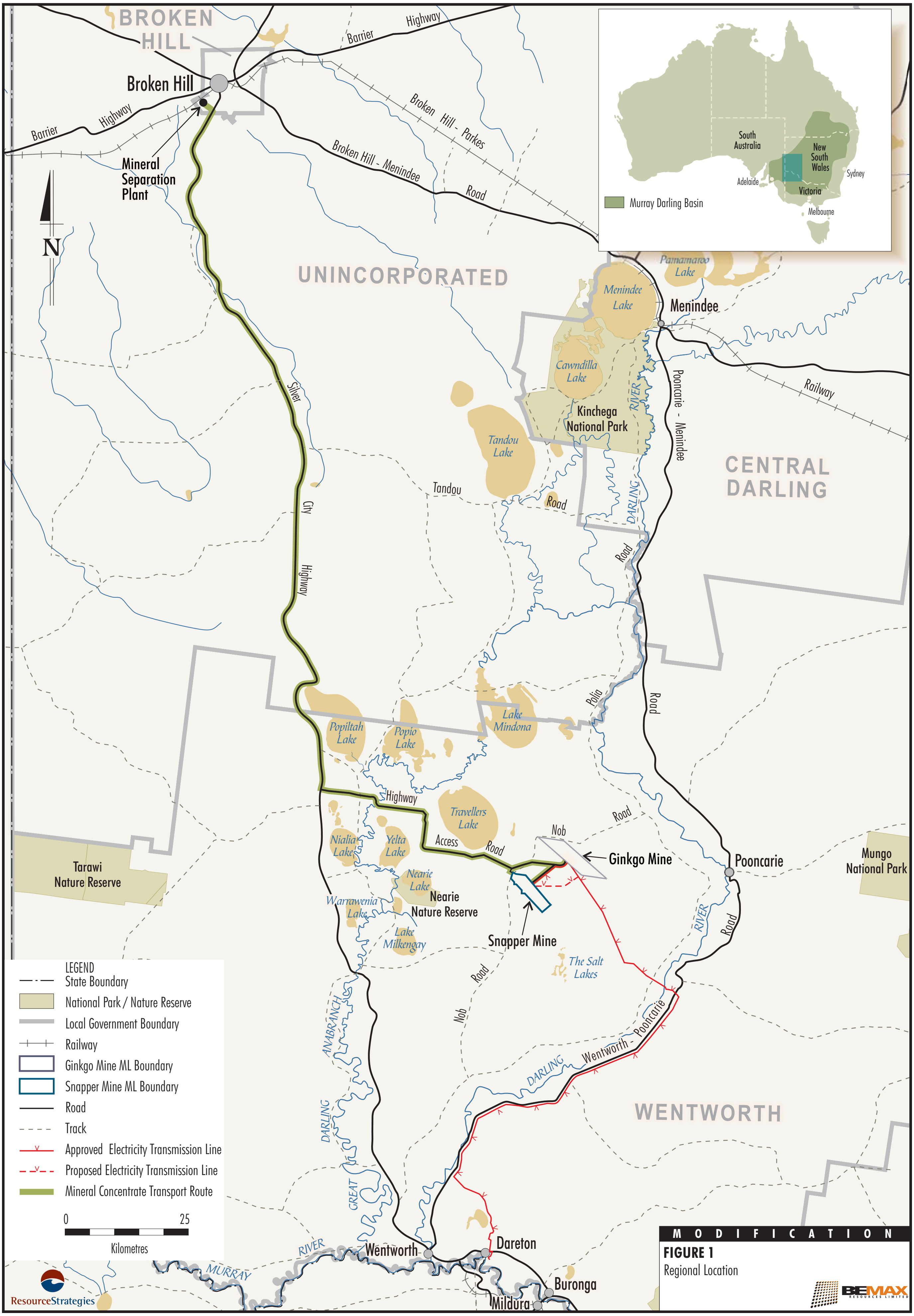
BEMAX has lodged applications to the Minister for Planning under Section 75W of the EP&A Act to modify the Ginkgo Mine Development Consent (DA 251-09-01) and Snapper Mine Project Approval (06_0168) for approval of the Modification.

This Environmental Assessment (EA) has been prepared in support of the modification applications and sets out the details of the Modification which is sought and an assessment of the potential environmental impacts of the Modification.

1.1 OVERVIEW OF THE MODIFICATION

The key aspects of the Modification to the Snapper Mine include:

- an increase in the total amount of ore mined from approximately 117 million tonnes (Mt) to approximately 122 Mt and a minor change to the extent of the mine path;
- an increase in the annual ore mining rate from approximately 8.2 million tonnes per annum (Mtpa) to approximately 9.1 Mtpa;
- a decrease in the total amount of mineral concentrates from approximately 5.9 Mt to approximately 5.2 Mt, as a result of decreased average ore grades;



MODIFICATION

FIGURE 1

Regional Location

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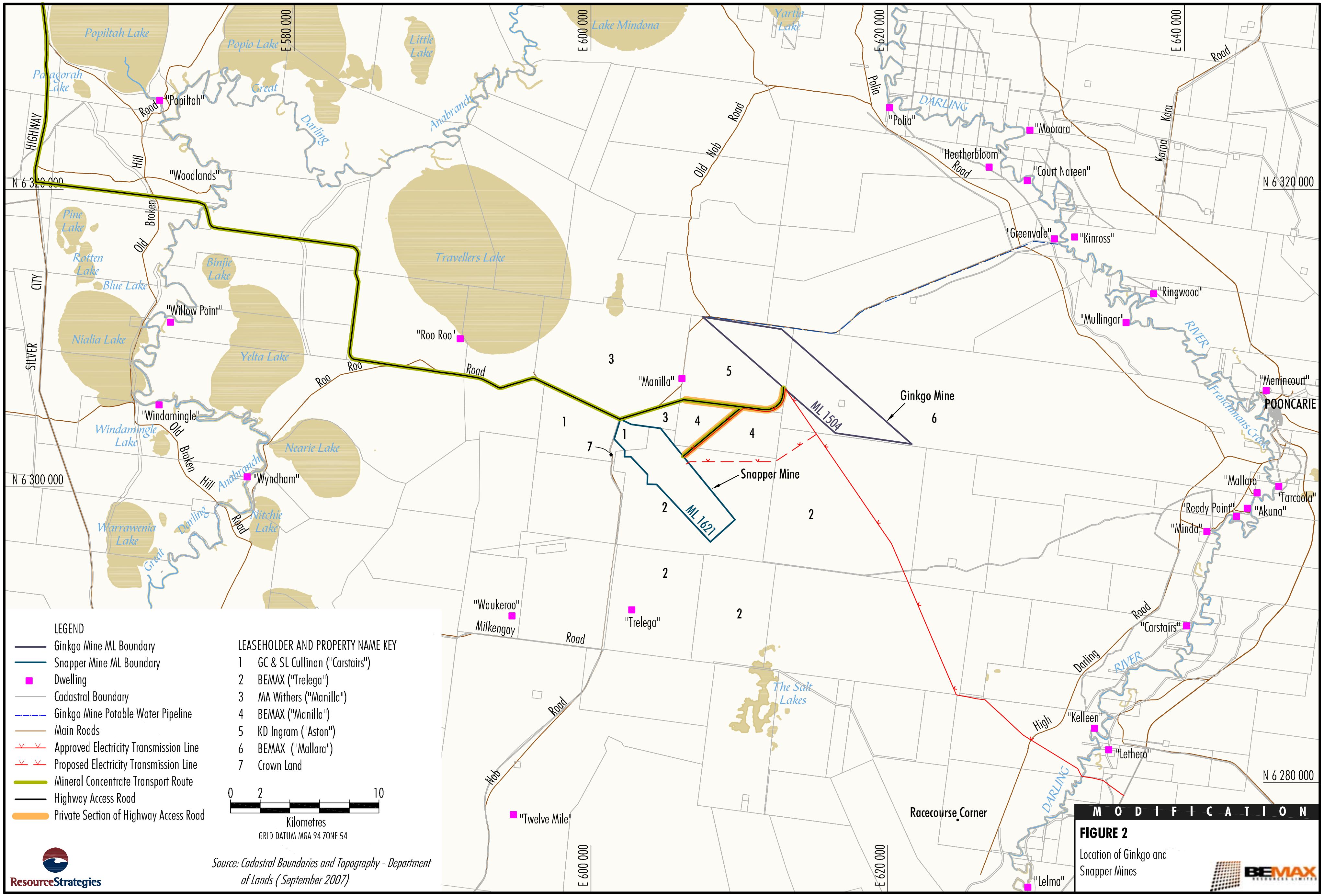

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- an increase in maximum annual mineral concentrate production rate from the Snapper Mine from approximately 450,000 tonnes per annum (tpa) to approximately 621,000 tpa;
- a decrease in the life of the Snapper Mine from approximately 16 years to approximately 15 years, to reflect the decrease in total amount of mineral concentrates and increase in maximum annual mineral concentrate production rate;
- a change to a double-pass mining operation commencing approximately 4 km from the southern end of the ore body (single-pass for approximately the initial six years, followed by double-pass for the remainder);
- an increase in operational mining areas (including: an increase in the active mining area; an increase in the area of the overburden emplacement from approximately 145 to 215 hectares (ha); an increase to the HMC treatment facility and soil stockpile areas; and addition of a temporary HMC stockpile area adjacent to the mine path);
- an increase in the final mine path landform height from approximately 2 to 4.5 metres (m) to approximately 10 m;
- use of an electric conveyor system and/or dry mine fleet for dry overburden replacement instead of overburden slurrying;
- a change in the alignment of the electricity transmission line (ETL) to the Snapper Mine;
- trucking of Heavy Mineral Concentrate (HMC) between the Snapper and Ginkgo Mines[1], dependent on the location of the HMC treatment facility, and treatment of Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa;
- an increase in processing rate capacity of the wet high intensity magnetic separator (WHIMS) circuit from approximately 450,000 tpa to approximately 844,000 tpa;
- an increase in the water supply capacity of the reverse osmosis (RO) plant;
- supply of groundwater from the deeper, higher yielding, saline Lower Olney Formation aquifer instead of the shallow saline Loxton-Parilla aquifer; and
- as a contingency for potential delays associated with the Snapper Mine dredge construction and commissioning, continued trucking of an additional approximate 2 Mt of high-grade ore from the Snapper Mine to the Ginkgo Mine (and associated activities) on a temporary basis (i.e. this approved activity would continue for an additional 12 months).

The key aspects of the Modification to the Ginkgo Mine include:

- an increase in the total amount of ore mined from approximately 128 Mt to approximately 145 Mt, as a result of an increased ore reserve;
- an increase to the life of the Ginkgo Mine from approximately 12 years to approximately 14 years, to reflect the increased ore reserve and a care and maintenance period;
- a decrease in the total amount of mineral concentrates from approximately 4.8 Mt to approximately 3.7 Mt, as a result of decreased average ore grades;
- trucking of HMC between the Ginkgo and Snapper Mines[1], dependent on the location of the HMC treatment facility and treatment of Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa; and

[1] The current temporary approved trucking between the Snapper and Ginkgo Mines involves the transport of high grade **ore**, **<u>not</u>** HMC. The proposed HMC transport between the mines would involve significantly less truck movements than ore transport.

- as a contingency for potential delays associated with the Snapper Mine dredge construction and commissioning, continued trucking of an additional approximate 2 Mt of high-grade ore from the Snapper Mine to the Ginkgo Mine (and associated activities) on a temporary basis (i.e. this approved activity would continue for an additional 12 months).

The increase to the life of the approved Ginkgo Mine (from approximately 12 years to approximately 14 years) reflects the ore increase and a care and maintenance period. The care and maintenance schedule would extend for an approximate 12 month period from the commencement of dredge mining at the Snapper Mine until favourable market conditions (i.e. in particular a favourable Australian/United States dollar exchange rate) prevail. During the course of the care and maintenance period, BEMAX's focus would be on activities at the Snapper Mine (i.e. commencement of dredge mining at the Snapper Mine targeting high-grade ore).

Since November 2009, detailed design information provided by the dredge manufacturer has triggered the requirement to increase the Snapper Mine dredge commissioning (and associated reliability testwork) period. Consequently, the Modification would include the continuation of the trucking of high-grade ore (and associated activities) for an additional 12 months, as a contingency whilst the dredge is being commissioned. Should the Snapper Mine dredge commissioning proceed without any issues, the continued trucking of the high-grade ore (and associated activities) would not be required. For assessment purposes, this EA assumes that these contingency activities would be required. This additional approximate 2 Mt of ore combined with the 2 Mt of ore for the November 2009 Modification (i.e. 4 Mt of ore in total) represents less than 3.3% of the total ore to be mined from the Snapper Mine (of a total of approximately 122 Mt) and less than 2.8% of the total ore to be mined from the Ginkgo Mine (of a total of approximately 145 Mt).

The proposed changes to the currently approved Snapper Mine and Ginkgo Mine development areas are shown on Figure 3.

Table 1 provides a summary comparison of the currently approved Snapper Mine and the Snapper Mine including the Modification (i.e. the modified Snapper Mine). As shown in Table 1, the proposed modification **does not** involve any change to the Snapper Mine for the following development components: concentrate transport to the MSP; backloaded MSP process waste management; site access; hours of operation; or employment.

Table 2 provides a summary comparison of the currently approved Ginkgo Mine and the Ginkgo Mine including the Modification (i.e. the modified Ginkgo Mine). As shown in Table 2, the proposed modification **does not** involve any change to the Ginkgo Mine for the following development components: concentrate transport to the MSP; overburden management; backloaded MSP process waste management; water supply; rehabilitation works; offset; site access; mine site electricity distribution; hours of operation; employment; or accommodation camp.

Section 4 describes the potential environmental impacts of the Modification and discusses how the environmental management and monitoring programmes at the Snapper and Ginkgo Mines would be applied to manage potential environmental impacts.

A detailed description of the proposed changes to the Snapper and Ginkgo Mines is provided in provided in Sections 2 and 3, respectively.

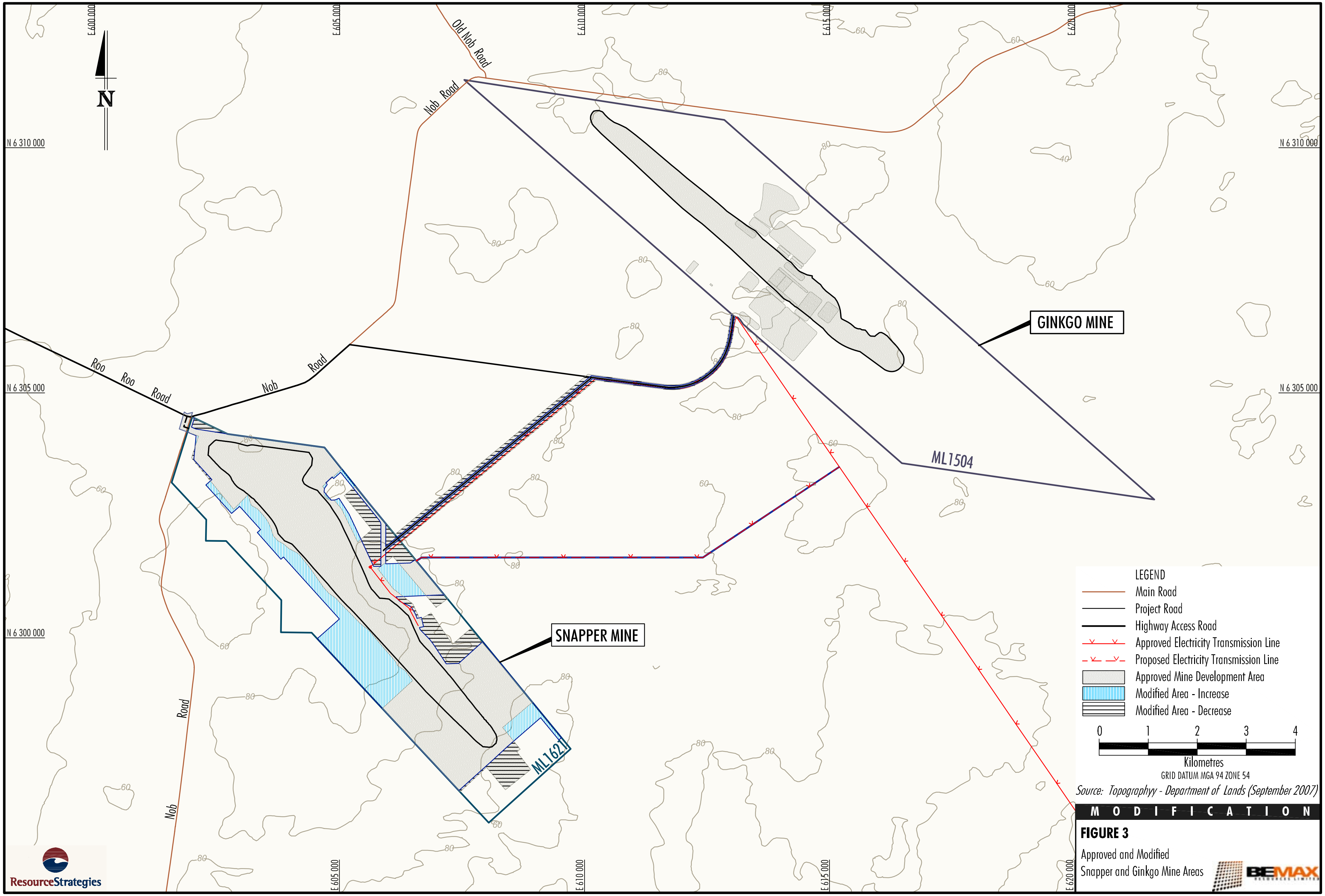

FIGURE 3
Approved and Modified Snapper and Ginkgo Mine Areas

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Table 1
Summary Comparison of Approved and Modified Snapper Mine

Development Component	Approved Snapper Mine[1]	Modified Snapper Mine[2]
Tenement	Mining operations conducted within mining lease (ML 1621).	No change.
Life of Mine	Life of mine of approximately 16 years.	Decreased life of mine to approximately 15 years, to reflect the decrease in total amount of mineral concentrates and increase in maximum annual mineral concentrate production rate.
Mining	Reserve of approximately 117 Mt of ore to be mined over the life of the mine. Mining of ore by predominantly dredge mining at approximately 8.2 Mtpa of ore. Secondary mining of ore is to be undertaken using conventional mobile equipment in various locations along the mine path where ore is located at levels well above the groundwater table such that dredge mining is not feasible. Approximately 2 Mt of Snapper Mine high-grade ore to be mined using secondary mining methods (i.e. dry mined) and transported to the Ginkgo Mine dredge, on a temporary basis (i.e. for approximately 12 months).	Increased ore reserve of approximately 122 Mt of ore to be mined over the life of the mine. Minor change to the extent of the mine path. Increased annual ore mining rate to approximately 9.1 Mtpa of ore, by predominantly dredge mining. Double-pass mining operation commencing approximately 4 km from the southern end of the ore body (single-pass for approximately the initial six years, followed by double-pass for the remainder of the mine life). Additional approximate 2 Mt of Snapper Mine high-grade ore to be mined using secondary mining methods (i.e. dry mined) and transported to the Ginkgo Mine, on a temporary basis (i.e. this approved activity would continue for an additional 12 months).
Mineral Concentration	Mineral concentration to be undertaken in a primary gravity concentration unit (comprising a screen, surge bin and wet concentrator). HMC produced to be either separated through the WHIMS circuit on-site or at the MSP. Mineral concentrates to be further separated and treated at the MSP. Approximately 5.9 Mt of mineral concentrates to be produced over the life of the mine. Maximum annual mineral concentrate production rate of approximately 450,000 tpa. Approximately 2 Mt of Snapper Mine high-grade ore to be concentrated in the Ginkgo Mine primary gravitation unit and separated in the Ginkgo Mine or MSP WHIMS circuit, on a temporary basis (i.e. for approximately 12 months).	Mineral concentration as per the approved Snapper Mine, with trucking of HMC between the Snapper and Ginkgo Mines, dependent on the location of the HMC treatment facility, and treatment of Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa. The proposed HMC transport between the mines would involve significantly less truck movements than ore transport. Decreased mineral concentrate production to approximately 5.2 Mt of mineral concentrates to be produced over the life of the mine, as a result of decreased average ore grades. Increased processing rate capacity of the WHIMS circuit from approximately 450,000 tpa to approximately 844,000 tpa. Additional approximate 2 Mt of Snapper Mine high-grade ore to be concentrated in the Ginkgo Mine primary gravitation unit and separated in the Ginkgo Mine or MSP WHIMS circuit, on a temporary basis (i.e. this approved activity would continue for an additional 12 months).

Table 1 (Continued)
Summary Comparison of Approved and Modified Snapper Mine

Development Component	Approved Snapper Mine[1]	Modified Snapper Mine[2]
Concentrate Transport to the MSP	Double road trains or other NSW Roads and Traffic Authority (RTA) approved vehicles (e.g. AB-triple vehicles) to be used to transport mineral concentrate from the Snapper Mine to the MSP via the mineral concentrate transport route.	No change.
Overburden Management	Replacement of the majority of deeper overburden to be undertaken by slurrying. Replacement of the majority of shallow overburden to be undertaken by conventional earthmoving equipment. Slurried overburden material to be covered by an appropriate depth of non-slurried material, to provide a suitable revegetation medium. Overburden from the initial dry mining to be placed within the approved initial non-slurried overburden emplacement.	Overburden would not be slurried. During start-up, overburden would be deposited in an overburden emplacement. The location of the overburden emplacement area would change from the northern side of the ML to the southern side. Following start-up, replacement of overburden would be undertaken by an overland conveyor system and/or dry mine fleet for dry overburden removal. Stripped overburden would be transported via the overland conveyor system and/or dry mine fleet and replaced over sand residues that have been deposited behind the floating plant.
Sand Residue Management	Sand residues from the primary gravity concentration unit to be placed in an initial sand residue dam for approximately the first six months of operation. For the remainder of the Snapper Mine life, sand residues to be stacked directly into the back of the dredge pond. A reduced amount (less than 2% reduction) of sand residues to be placed at the rear of the Snapper Mine dredge pond.	As per the approved Snapper Mine, with a reduced amount (less than 2% reduction) of sand residues to be placed at the rear of the Snapper Mine dredge pond.
Backloaded MSP Process Waste Management	Following transport from the MSP, backloaded MSP process waste to be placed in a designated stockpile at the mine site. Backloaded MSP process waste to be deposited on the sand residue beach and/or with overburden and covered under a minimum of 10 m (and up to 35 m) of overburden.	No change.
Water Supply	Water requirements to be supplied primarily by two borefields comprising approximately 30 bores (within the ML area) extracting water from the shallow saline Loxton-Parilla aquifer. The maximum water supply requirement from either borefield to be 370 litres per second (L/s), much of which is returned to the water table after use. Water to be recycled on-site (where practicable) to minimise the quantity of water extracted from the borefields.	As per the approved Snapper Mine, with water supply being sourced from a borefield comprising approximately three bores (within the ML area) extracting water from the deeper, higher yielding, saline Lower Olney Formation aquifer. Reduced maximum water supply requirement from the borefield to approximately 270 L/s, primarily as a result of the use of dry overburden replacement method. Increased water supply capacity of the RO plant as a result of the increased maximum annual mineral concentrate production rate.

Table 1 (Continued)
Summary Comparison of Approved and Modified Snapper Mine

Development Component	Approved Snapper Mine[1]	Modified Snapper Mine[2]
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.	As per the approved Snapper Mine, with a change to the height of final mine path landform.
Offset	An offset to be implemented to offset approximately 1,630 ha of native vegetation communities that would be removed by the Snapper Mine. The offset area to comprise of an enhancement area of approximately 5,220 ha.	Increased offset area to reflect the net increase of approximately 81 ha of native vegetation communities to be disturbed. The offset area would comprise of an enhancement area of approximately 5,470 ha.
Access	Snapper Mine traffic to share the existing 64 km Highway Access Road (HAR) from the Ginkgo Mine to the Silver City Highway. The HAR to be extended in two locations to access the Snapper Mine site. The access road within the ML is used for the transport of ore to the Ginkgo Mine.	No change.
Mine Site Electricity Distribution	A 10 km long 66 kilovolts (kV) ETL to be constructed to extend the existing ETL from the Ginkgo Mine to the Snapper Mine.	As per the approved Snapper Mine, with a change in alignment of the ETL to the Snapper Mine (Figure 3), in order to facilitate a more direct alignment of the ETL, reducing the associated disturbance area, construction costs and infrastructure requirements (i.e. number of poles and cable length).
Hours of Operation	24 hours per day, seven days per week.	No change.
Key Mobile Equipment	Backhoes, bobcats, cranes, dozers, excavators, front end loaders, graders, scrapers, overburden slurrying system, forklift, trucks and double road trains or AB-triple vehicles. 200 tonne (t) road trains would be used for ore transport on the private road section of the HAR between the Ginkgo and Snapper Mines, on a temporary basis (i.e. for approximately 12 months).	As per the approved Snapper Mine, with changes in equipment types and numbers to reflect changes to overburden and soil management and trucking using AB-triple vehicles or 200 t road trains for HMC transport on the private road section of the HAR between the Ginkgo and Snapper Mines, on a permanent basis, and for ore transport on that private road section, on a temporary basis (i.e. this approved activity would continue for an additional 12 months).
Employment	Construction workforce averaging around 200 people with a maximum of approximately 250 employees required during peak construction activity. Operational workforce of approximately 110 employees.	No change.

1 Approved Snapper Mine approved in August 2007 and modified in June 2009 and December 2009.
2 Proposed modification to the approved Snapper Mine.

Table 2
Summary Comparison of Approved and Modified Ginkgo Mine

Development Component	Approved Ginkgo Mine[1]	Modified Ginkgo Mine[2]
Tenement	Mining operations conducted within ML 1504.	No change.
Life of Mine	Life of mine of approximately 12 years.	Increased life of mine to approximately 14 years, to reflect the increased ore reserve and a care and maintenance period.
Mining	Reserve of approximately 128 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, moving up to approximately 24 Mtpa of overburden. Approximately 2 Mt of Snapper Mine high-grade ore to be fed through the Ginkgo Mine dredge, on a temporary basis (i.e. for approximately 12 months).	As per the approved Ginkgo Mine with increased ore reserve of approximately 145 Mt of ore to be mined over the life of the mine. Additional approximate 2 Mt of Snapper Mine high-grade ore to be fed through the Ginkgo Mine dredge, on a temporary basis (i.e. this approved activity would continue for an additional 12 months).
Mineral Concentration	Mineral concentration to be undertaken in a primary gravity concentration unit (comprising a screen, surge bin and wet concentrator). HMC produced would either be separated through the WHIMS circuit on-site or at the MSP. Concentrates would be further separated and treated at the MSP. Approximately 4.8 Mt of mineral concentrates to be produced over the life of the mine. Maximum annual mineral concentrate production rate of approximately 576,000 tpa. Approximately 2 Mt of Snapper mine high-grade ore to be concentrated in the Ginkgo Mine primary gravitation unit and separated in the Ginkgo Mine or MSP WHIMS circuit, on a temporary basis (i.e. for approximately 12 months).	Mineral concentration as per the approved Ginkgo Mine, with trucking of HMC between the Snapper and Ginkgo Mines, dependent on the location of the HMC treatment facility, and treatment of Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa . The proposed HMC transport between the mines would involve significantly less truck movements than ore transport. Decreased mineral concentrate production to approximately 3.7 Mt of mineral concentrates to be produced over the life of the mine, as a result of decreased average ore grades. Unchanged maximum annual mineral concentrate production rate. Additional approximate 2 Mt of Snapper Mine high-grade ore to be concentrated in the Ginkgo Mine primary gravitation unit and separated in the Ginkgo Mine or MSP WHIMS circuit, on a temporary basis (i.e. this approved activity would continue for an additional 12 months).
Concentrate Transport to the MSP	Double road trains would be used to transport mineral concentrate from the Ginkgo Mine to the MSP via the mineral concentrate transport route. Other vehicles may be used subject to obtaining relevant approvals.	No change.
Overburden Management	Replacement of overburden would be undertaken by an overland conveyor system. Stripped overburden would be transported via the overland conveyor system and replaced over sand residues that have been deposited behind the floating plant.	No change.

Table 2 (Continued)
Summary Comparison of Approved and Modified Ginkgo Mine

Development Component	Approved Ginkgo Mine[1]	Modified Ginkgo Mine[2]
Sand Residue Management	Sand residues from the primary gravity concentration unit would be placed in the extended initial sand residue dam for approximately the first nine months of operation. For the remainder of the Ginkgo Mine life, sand residues would return to the dredge pond behind the floating pond. Additional amount (less than 2% increase) of sand residues to be placed at the rear of the Ginkgo Mine dredge pond, from approximately 2 Mt of Snapper mine high-grade ore to be concentrated in the Ginkgo Mine primary gravitation unit, on a temporary basis (i.e. for approximately 12 months).	As per the approved Snapper Mine, with an additional amount (less than 2% increase) of sand residues to be placed at the rear of the Ginkgo Mine dredge pond.
Backloaded MSP Process Waste Management	In accordance with conventional practice, monazite from the Ginkgo deposit would be separated from the other heavy minerals at the off-site MSP, diluted with silica waste products and returned to the mine site for disposal above the groundwater table and under a minimum cover depth of 10 m of overburden. Following transport from the MSP, backloaded MSP process waste would be deposited in a designated stockpile at the mine site. Backloaded MSP process waste would be placed directly on the sand residue beach and/or with overburden and covered with overburden.	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 the borefield would be 128 L/s, much of which is returned to the water table after use. Water would be recycled on-site (where practicable) to minimise the quantity of water extracted from the borefields.	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.

Table 2 (Continued)
Summary Comparison of Approved and Modified Ginkgo Mine

Development Component	Approved Ginkgo Mine[1]	Modified Ginkgo Mine[2]
Offset	An offset to be implemented to offset approximately 521 ha of native vegetation communities that would be removed as a result of modifications to the Ginkgo Mine since May 2005. The offset would comprise of an enhancement area of approximately area of 521 ha.	No change.
Access	Ginkgo Mine traffic would use the 64 km HAR to the Silver City Highway. Realignments of the original HAR route would minimise impacts on leaseholder's pastoral activities. The access road within the ML would be used for the transport of ore from the Snapper Mine.	No change.
Mine Site Electricity Distribution	A main substation and 66 kV to 22 kV transformer would be located at the mine site. Power would be reticulated around the site at 22 kV. Each operating area would then have a re-locatable step-down substation located adjacent to the working area.	No change.
Hours of Operation	24 hours per day, seven days per week.	No change.
Key Mobile Equipment	Drill rig, bulldozers, electric loader, front end loader, cranes, grader, scrapers, dozers, trucks and double road trains or AB-triple vehicles. 200 t road trains would be used for ore transport on the private road section of the HAR between the Ginkgo and Snapper Mines, on a temporary basis (i.e. for approximately 12 months).	As per the approved Ginkgo Mine, with trucking using AB-triple vehicles or 200 t road trains for HMC transport on the private road section of the HAR between the Ginkgo and Snapper Mines, on a permanent basis, and for ore transport on that private road section, on a temporary basis (i.e. this approved activity would continue for an additional 12 months).
Employment	Operational workforce of some 100 employees.	No change.
Accommodation Camp	An accommodation camp located in the Mining Lease to accommodate Ginkgo and Snapper Mine workers and visitors.	No change.

[1] Approved Ginkgo Mine approved in January 2002 and modified in September 2003, May 2005, April 2006, April 2007, December 2008, April 2009 and December 2009.
[2] Proposed modification to the approved Ginkgo Mine.

1.2 LEGISLATIVE FRAMEWORK

The EP&A Act and *Environmental Planning and Assessment Regulation, 2000* (EP&A Regulation) set the framework for planning and environmental assessment in NSW.

Modifications of the Ginkgo Mine Development Consent (DA 251-09-01) and Snapper Mine Project Approval (06_0168) are sought under Section 75W of Part 3A of the EP&A Act.

Section 75W of the EP&A Act states:

75W Modification of Minister's Approval

(1) In this section:

Minister's approval *means an approval to carry out a project under this Part, and includes an approval of a concept plan.*

modification of approval *means changing the terms of a Minister's approval, including:*

(a) revoking or varying a condition of the approval or imposing an additional condition of the approval, and

(b) changing the terms of any determination made by the Minister under Division 3 in connection with the approval.

(2) The proponent may request the Minister to modify the Minister's approval for a project. The Minister's approval for a modification is not required if the project as modified will be consistent with the existing approval under this Part.

(3) The request for the Minister's approval is to be lodged with the Director-General. The Director-General may notify the proponent of environmental assessment requirements with respect to the proposed modification that the proponent must comply with before the matter will be considered by the Minister.

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

….

Accordingly, an approval granted by the Minister under Part 3A of the EP&A Act to carry out a project (i.e. for the Snapper Mine) may be modified under Section 75W.

In addition, Clause 8J(8) of the EP&A Regulation prescribes a certain type of development consent issued under Part 4 of the EP&A Act that may also be modified under Section 75W of the EP&A Act. Clause 8J(8) of the EP&A Regulation states:

8J Transitional Provisions

(8) For the purposes only of modification, the following development consents are taken to be approvals under Part 3A of the Act and section 75W of the Act applies to any modification of such a consent:

…

(c) a development consent granted by the Minister under Division 4 of Part 4 of the Act (relating to State significant development) before 1 August 2005…

The development consent, if so modified, does not become an approval under Part 3A of the Act.

The Development Consent for the Ginkgo Mine was granted by the Minister under Division 4 of Part 4 of the EP&A Act (relating to State significant development) that was in force before 1 August 2005. Accordingly, by operation of clause 8J(8) of the EP&A Regulation, the existing Ginkgo Mine Development Consent is taken to be an approval under Part 3A of the EP&A Act for the purposes of the Modification, and Section 75W of the Act applies to the Modification.

1.3 PROPOSED AMENDMENTS TO THE SNAPPER MINE PROJECT APPROVAL

Condition 2 of the Snapper Mine Project Approval (06_0168) states:

2. The proponent shall carry out the project generally in accordance with the:

(a) EA:

(b) statement of commitments;

(c) modification application 06_0168 Mod 1 and accompanying Environmental Assessment titles Bemax Resources Limited Snapper Mineral Sands Mine Offset Modification Environmental Assessment dated April 2009; and

(d) modification application 06_0168 Mod 2 and accompanying Environmental Assessment titled Bemax Resources Limited Ginkgo Mineral Sands Mine and Snapper Mineral Sands Mine November 2009 Modification Environmental Assessment dated November 2009; and

(e) conditions of this consent.

BEMAX seeks the following modification of Condition 2 of the Snapper Mine Project Approval (06_0168) (as underlined):

2. The proponent shall carry out the project generally in accordance with the:

(a) EA:

(b) statement of commitments;

(c) modification application 06_0168 Mod 1 and accompanying Environmental Assessment titles Bemax Resources Limited Snapper Mineral Sands Mine Offset Modification Environmental Assessment dated April 2009; and

(d) modification application 06_0168 Mod 2 and accompanying Environmental Assessment titled Bemax Resources Limited Ginkgo Mineral Sands Mine and Snapper Mineral Sands Mine November 2009 Modification Environmental Assessment dated November 2009; and

(e) modification application 06_0168 Mod 3 and accompanying Environmental Assessment titled Bemax Resources Limited Ginkgo Mineral Sands Mine and Snapper Mineral Sands Mine April 2010 Modification Environmental Assessment dated April 2010; and

(f) conditions of this consent.

Statement of Commitment (SOC) 4 of Appendix 4 of the Project Approval states:

A Flora and Fauna Offset will be implemented in the offset area (see Appendix 2). This offset area will:

(a) include an enhancement area (see table below): and

Area	***Description***	***Size (ha)***
Offset Area 1 and Offset Area 2 in Appendix 2	*Enhancement of existing areas of native vegetation communities through natural regeneration and management for conservation.*	*5,216*
	Total Minimum Area Conserved	*5,216*

Note: The offset shall be in addition to, and outside, the rehabilitated areas of the project disturbance area.

(b) contain the following vegetation communities:

- *Black Box Woodland;*
- *Black Oak-Rosewood-Wilga Woodland;*
- *Chenopod Mallee Woodland/Shrubland;*
- *Irregular Dune Mallee Shrubland;*
- *Bluebush Shrubland;*
- *Linear Dune Mallee Shrubland; and*
- *Austrostipa Grassland.*

BEMAX propose the following modification of SOC 4 of Appendix 4 of the Project Approval (as underlined):

A Flora and Fauna Offset will be implemented in the offset area (see Appendix 2). This offset area will:

(a) include an enhancement area (see table below): and

Area	***Description***	***Size (ha)***
Offset Area 1 and Offset Area 2 in Appendix 2	*Enhancement of existing areas of native vegetation communities through natural regeneration and management for conservation.*	*<u>5471</u>*
	Total Minimum Area Conserved	*<u>5471</u>*

Note: The offset shall be in addition to, and outside, the rehabilitated areas of the project disturbance area.

(b) contain the following vegetation communities:

- *Black Box Woodland;*
- *Black Oak-Rosewood-Wilga Woodland;*
- *Chenopod Mallee Woodland/Shrubland;*
- *Irregular Dune Mallee Shrubland;*
- *Bluebush Shrubland;*
- *Linear Dune Mallee Shrubland; and*
- *Austrostipa Grassland.*

1.4 PROPOSED AMENDMENTS TO THE GINKGO MINE DEVELOPMENT CONSENT

Condition 1.1 of the Ginkgo Mine Development Consent (DA 251-09-01) states:

1.1 Adherence to terms of DA, EIS, etc.

(a) The development is to be carried out generally in accordance with development application No. 251-09-01, and the EIS dated September 2001, prepared by Resource Strategies and certified in accordance with Section 78A(8) of the Act, and the following documentation:

(i) various additional information regarding the Neobatrachus pictus (N. pictus) assessment and management provided to the Department by Resource Strategies;

(ii) additional information provided to EPA by Resource Strategies, including the letter dated 25 October 2001 with the attached "Response to EPA Information Requests;"

(iii) additional information provided to DLWC by Resource Strategies, including the letter dated 22 October 2001;

(iv) additional information supplied by Resource Strategies to the Department of Planning in response to the issues raised in submissions received during the exhibition period for the project;

(v) the modification application MOD 14-3-2003 and accompanying Statement of Environmental Effects, dates February 2003 and prepared by Resource Strategies Pty Limited";

- *(vi) Statement of Environmental Effects in support of a Section 96(2) application for the Ginkgo Mineral Sands Project, dated January 2005, prepared by Resource Strategies Pty Ltd;*
- *(vii) Statement of Environmental Effects in support of a Section 96(1A) application for the Ginkgo Mineral Sands Project, dated 21 December 2005, prepared by Resource Strategies Pty Ltd;*
- *(viii) modification application MID-148-12-2006-I, and supporting Statement of Environmental Effects dated December 2006 and prepared by Resource Strategies Pty Ltd;*
- *(ix) modification application DA 251-09-01 Mod 5, and supporting letter dated 8 September 2008 and prepared by Bemax Resources Ltd;*
- *(x) modification application DA 251-09-01 Mod 6, and supporting letters dated 14 October 2008 and 23 February 2009, prepared by Bemax Resources Ltd;*
- *(xi) modification application DA 251-09-01 Mod 7, and supporting letter and Environmental Assessment dated 19 November 2009, prepared by Bemax Resources Ltd; and*
- *(xii) the conditions of this consent.*

BEMAX seeks the following modification of Condition 1.1 of the Ginkgo Mine Development Consent (DA 251-09-01) (as underlined):

1.1 Adherence to terms of DA, EIS, etc.

(a) The development is to be carried out generally in accordance with development application No. 251-09-01, and the EIS dated September 2001, prepared by Resource Strategies and certified in accordance with Section 78A(8) of the Act, and the following documentation:

- *(i) various additional information regarding the Neobatrachus pictus (N. pictus) assessment and management provided to the Department by Resource Strategies;*
- *(ii) additional information provided to EPA by Resource Strategies, including the letter dated 25 October 2001 with the attached "Response to EPA Information Requests;"*
- *(iii) additional information provided to DLWC by Resource Strategies, including the letter dated 22 October 2001;*
- *(iv) additional information supplied by Resource Strategies to the Department of Planning in response to the issues raised in submissions received during the exhibition period for the project;*
- *(v) the modification application MOD 14-3-2003 and accompanying Statement of Environmental Effects, dates February 2003 and prepared by Resource Strategies Pty Limited";*
- *(vi) Statement of Environmental Effects in support of a Section 96(2) application for the Ginkgo Mineral Sands Project, dated January 2005, prepared by Resource Strategies Pty Ltd;*
- *(vii) Statement of Environmental Effects in support of a Section 96(1A) application for the Ginkgo Mineral Sands Project, dated 21 December 2005, prepared by Resource Strategies Pty Ltd;*
- *(viii) modification application MID-148-12-2006-I, and supporting Statement of Environmental Effects dated December 2006 and prepared by Resource Strategies Pty Ltd;*
- *(ix) modification application DA 251-09-01 Mod 5, and supporting letter dated 8 September 2008 and prepared by Bemax Resources Ltd;*
- *(x) modification application DA 251-09-01 Mod 6, and supporting letters dated 14 October 2008 and 23 February 2009, prepared by Bemax Resources Ltd;*
- *(xi) modification application DA 251-09-01 Mod 7, and supporting letter and Environmental Assessment dated 19 November 2009, prepared by Bemax Resources Ltd; ~~and~~*

(xii) *modification application DA 251-09-01 Mod 8, and supporting letter and Environmental Assessment dated 27 April 2010, prepared by Bemax Resources Ltd; and*

(xiii) *the conditions of this consent.*

1.5 REASONS FOR THE MODIFICATION REQUEST

The Modification is required in order to increase the overall rate of mineral concentrate production and to improve the efficiency of BEMAX's operations in the Murray Darling region.

1.6 CONSULTATION

BEMAX has discussed the modification with the DoP prior to, and during the development of this EA.

BEMAX also consulted with Aboriginal community group members Noel Johnson and Ray Lawson of the Barkindji Elders Council. These representatives of the Barkindji Elders Council accompanied the Project archaeologist during the survey for the Aboriginal Cultural Heritage Assessment.

Consultation initiatives would continue throughout the EA assessment process and beyond, including:

- Ongoing discussions with key regulatory authorities.
- Continuing work with the Barkindji Aboriginal community regarding Aboriginal cultural heritage matters at the Snapper and Ginkgo Mines.
- Community consultation in accordance with the Ginkgo Mine Community Consultation Plan (CCP) (which is also relevant to the Snapper Mine). The procedure for receiving, investigating, responding to and reporting complaints received from the community would continue to operate, providing the local community with a method to register issues or complaints with respect to BEMAX mining activities.

2 DESCRIPTION OF THE MODIFICATION TO THE SNAPPER MINE

2.1 GENERAL ARRANGEMENT

2.1.1 Mine Site

The location of the following major mine site components would change as a result of the Modification:

- bores supplying water to the dredge pond, primary gravity concentration unit, water disposal dam and HMC treatment facility;
- HMC treatment facility (which includes: RO plant, salt washing facility, WHIMS circuit; laydown areas; towers and stackers for stockpiling mineral concentrates; mineral concentrate stockpiles; fuel and consumables storage facilities);
- administration and workshop buildings (including ablutions);
- wastewater (including sewage) treatment plant;
- sections of the internal access roads on the mine site and ETL;
- soil stockpiles;
- initial water dam;
- initial sand residue dam;
- overburden emplacement;
- water treatment dams; and
- water disposal dam.

In addition, the overburden slurrying and pumping system would be replaced by an overland conveyor system.

The Modification would also include a temporary mineral concentrate stockpile adjacent to the mine path.

The approved Snapper Mine general arrangement is shown on Figure 4. The general arrangement of the mine site at Years 1, 6 and 10 and post-mining is shown on Figures 5 to 8.

2.1.2 Ancillary Infrastructure

Ancillary infrastructure for the approved Snapper Mine comprises extensions to and sharing of existing Ginkgo Mine infrastructure, as outlined below.

ETL

The approved Snapper Mine includes an extension of the existing ETL from the Ginkgo Mine substation (Figure 3).

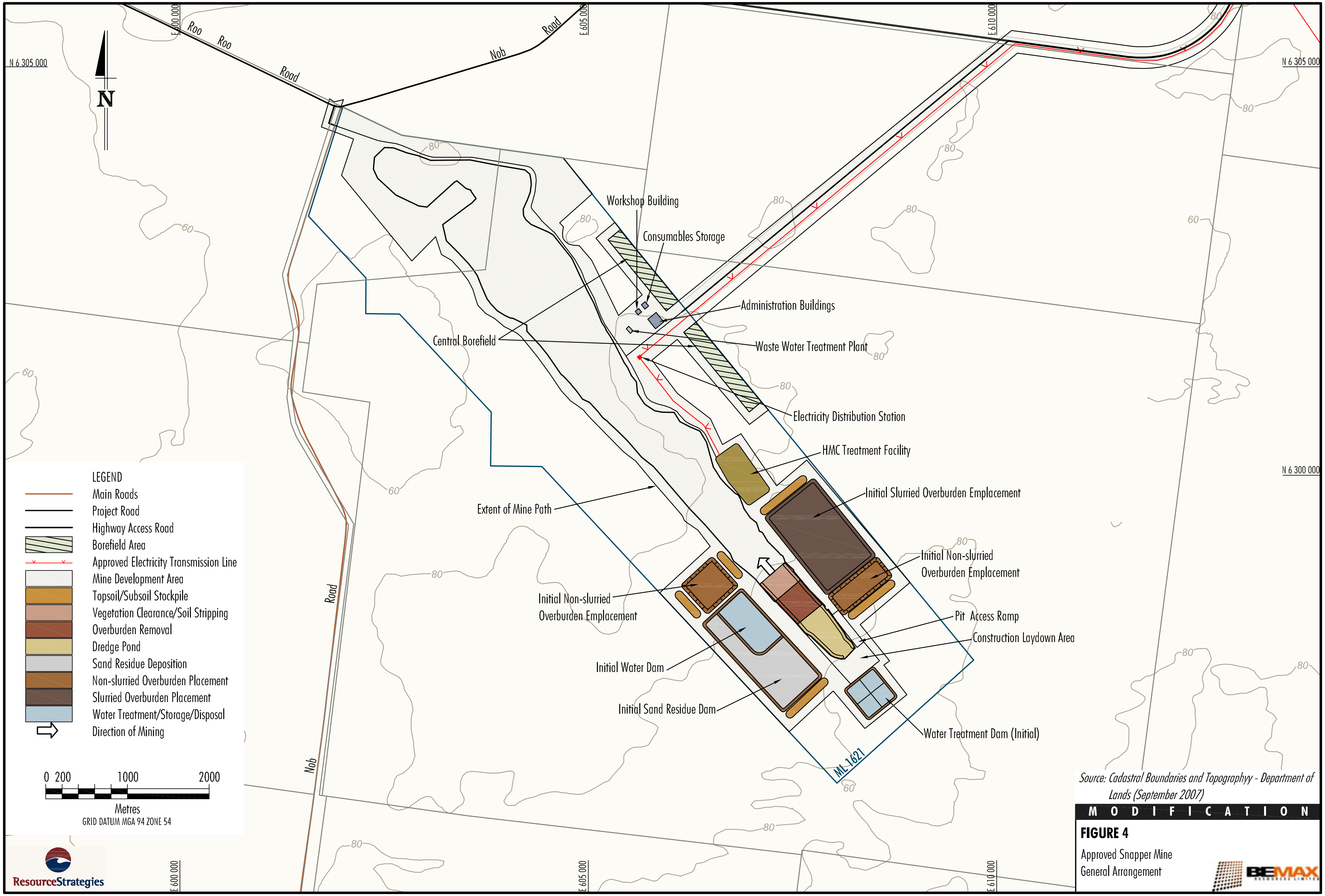
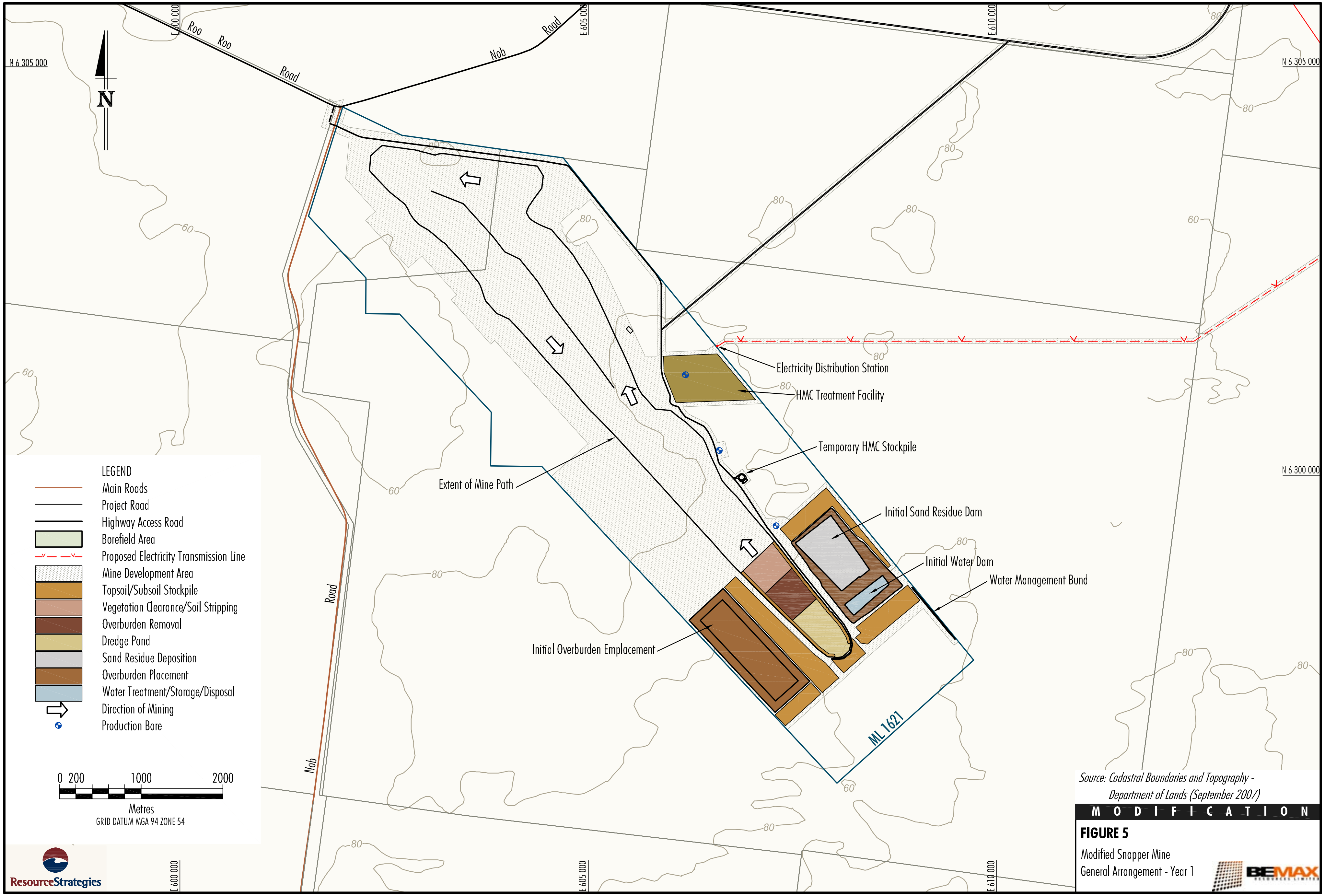


FIGURE 4
Approved Snapper Mine
General Arrangement

BMX-09-21_103A

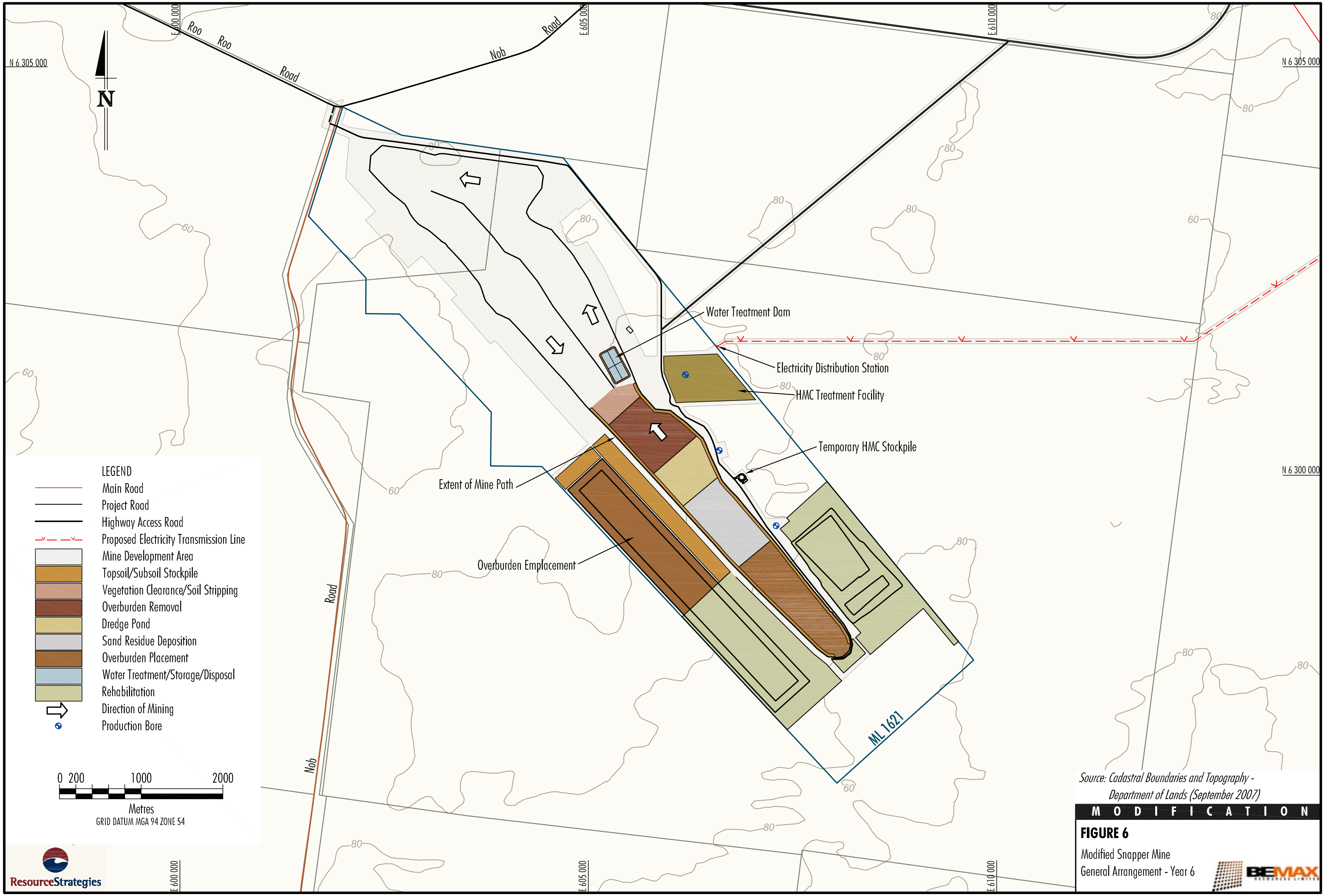


MODIFICATION

FIGURE 5

Modified Snapper Mine
General Arrangement - Year 1

BMX-09-21_104E



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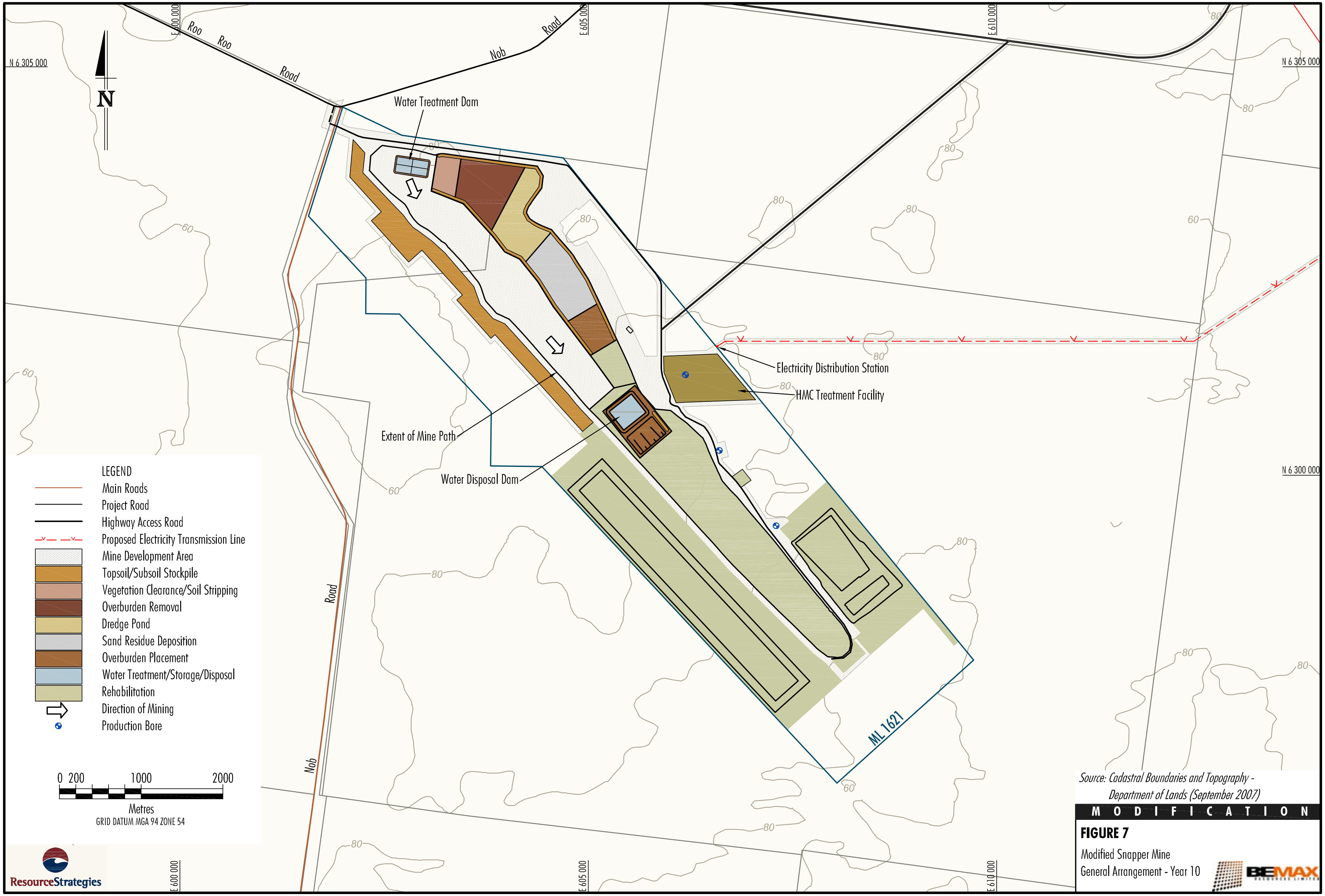
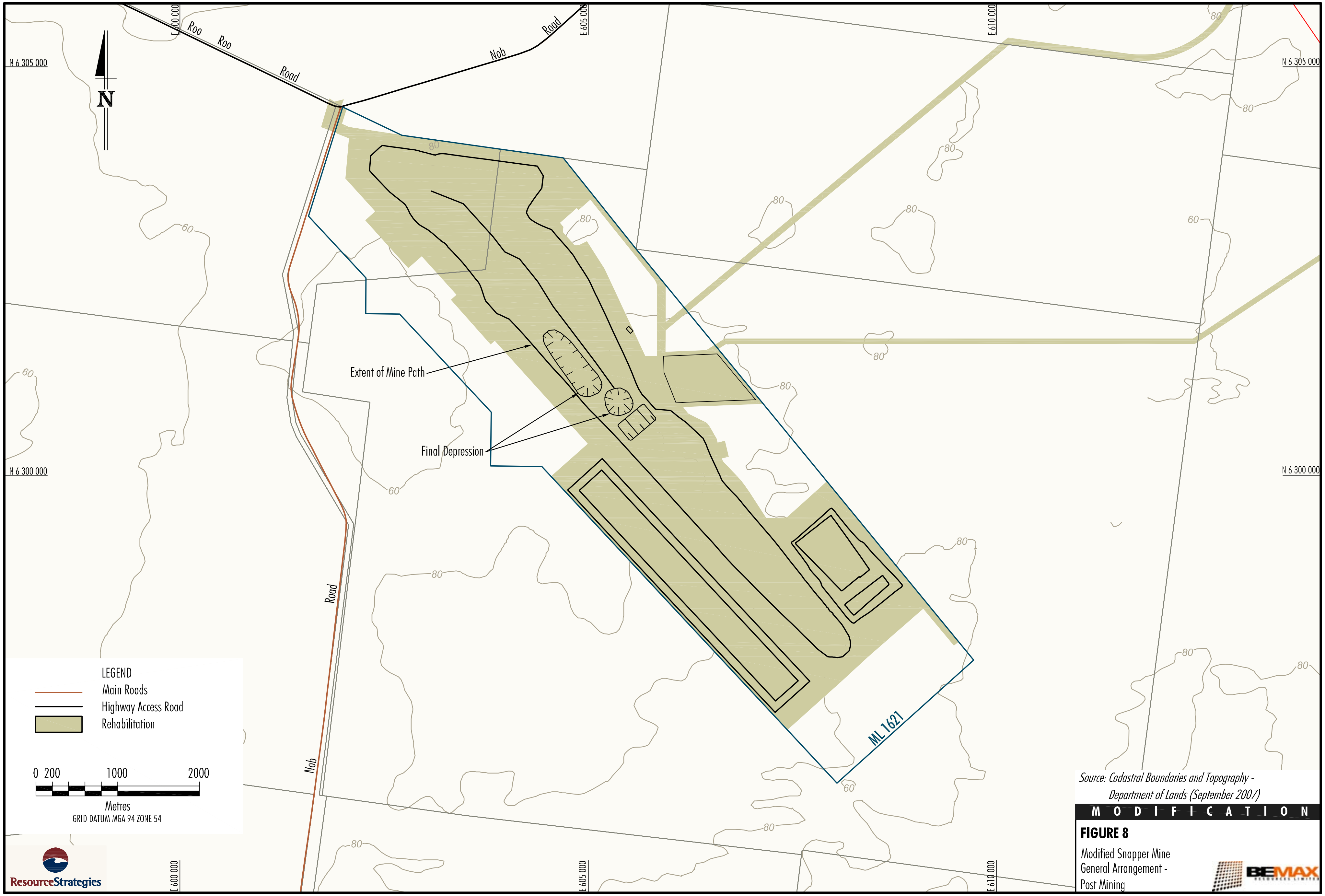


FIGURE 7

Modified Snapper Mine
General Arrangement - Year 10

BMX-09-21_113D



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The Modification would include a change to the alignment of the ETL in order to facilitate a more direct alignment of the ETL, reducing the associated disturbance area, construction costs and infrastructure requirements (i.e. number of poles and cable length). The modified ETL alignment is shown on Figure 3.

HAR

The approved Snapper Mine includes shared use of the existing mineral concentrate transport route and an extension of the HAR between the two mines (Figures 1 and 2). Construction of the extension of the HAR between the mines commenced in 2009.

The Modification would not change the mineral concentrate transport route or HAR.

Accommodation Camp

The approved Snapper Mine includes shared use of the accommodation camp at the Ginkgo Mine.

The Modification would not change the accommodation camp at the Ginkgo Mine.

2.2 SNAPPER MINE CONSTRUCTION ACTIVITIES

General construction at the Snapper Mine commenced in June 2008. Construction activities have not been continuous since that time. Subject to approval of the Modification, construction would be expected to be completed in late 2010.

The Modification would not change the existing procedures for controlling surface disturbance, which include management of vegetation removal, stripping and stockpiling of soil resources from surface disturbance areas and the installation of appropriate erosion and sediment control structures.

2.2.1 Mine Site

Vegetation Clearance and Soil Management

The Modification would not change the currently approved vegetation clearance or soil management methodologies during construction at the Snapper Mine.

Construction Pit

The Snapper Mine construction pit is currently being excavated.

As for the approved Snapper Mine, the construction pit would be excavated to an approximate Relative Level (RL) of 35 m Australian Height Datum (AHD), approximately 35 to 40 m below natural ground level, to allow the assembly of the dredge and primary gravity concentration unit.

As for the approved Snapper Mine, the initial pit would be developed by excavating some 3.5 million cubic metres (Mm^3) of overburden using scrapers and dozers over an approximate six month period. As for the approved Snapper Mine, this overburden would be used to construct initial water and sand residue dams and an overburden emplacement adjacent to the mine path (Figure 4).

Dredge and Primary Gravity Concentration Unit

The Modification would not change the construction activities relevant to the dredge and primary gravity concentration unit.

Initial Water and Sand Residue Dams

The locations of the initial water and sand residue dams would change to provide for more efficient access to water and placement of sand residues during the construction period. The locations of the modified initial water and sand residue dams would be swapped with the overburden emplacement. The proposed locations are shown on Figure 5.

The design and total area of these dams would also change to reflect detailed design parameters. As for the approved Snapper Mine, the embankments and floor of the modified initial water and sand residues dams would be lined with clay to minimise water losses. Figure 9 provides conceptual construction detail of the dam embankments.

Overburden Emplacement

Detailed mine planning has determined that the number and location of overburden emplacements should change in order to provide for more efficient placement of overburden during the construction period. The modified Snapper Mine would include a single overburden emplacement on the southern side of the mine path. A slurried overburden emplacement would no longer be required, given that overburden would not be slurried for the modified Snapper Mine.

The total area of the overburden emplacement would increase from approximately 145 ha to approximately 215 ha to allow for placement of overburden from a larger active mining area (Section 2.3.3).

The Modification would not increase the height of the overburden emplacement from the approved height of 20 m (BEMAX, 2007a). Batters would remain at an approximate 1:4 slope or an appropriate alternative determined by slope and erodibility investigations. The overburden emplacement would be progressively rehabilitated throughout the life of the mine.

Figures 5 and 6 illustrate the location of the modified overburden emplacement.

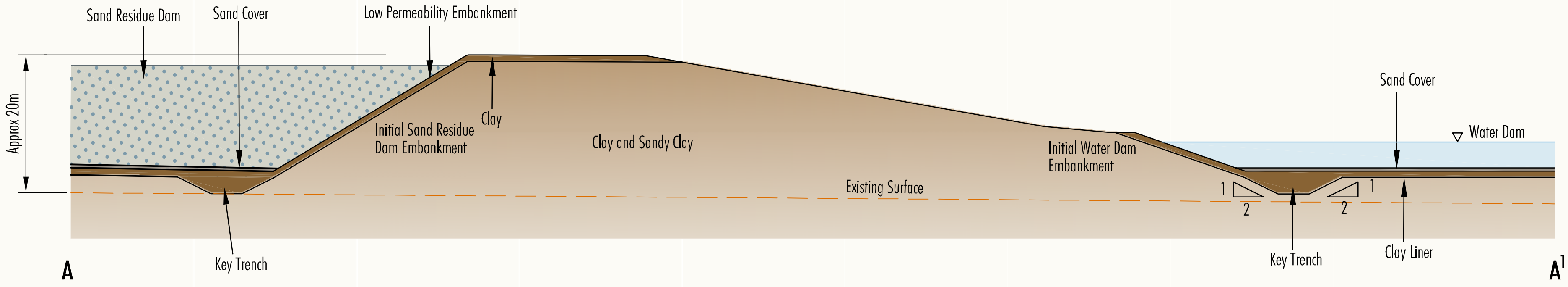
HMC Treatment Facility

The Modification would include the construction of a larger HMC treatment facility at the Snapper Mine, to accommodate an increase to the Snapper Mine mineral concentrate production rate and the treatment of Ginkgo Mine HMC. The modified HMC treatment facility would include a larger RO plant, salt washing facility, WHIMS circuit and mineral concentrate stockpiles. The location of the modified HMC treatment facility is shown on Figure 5.

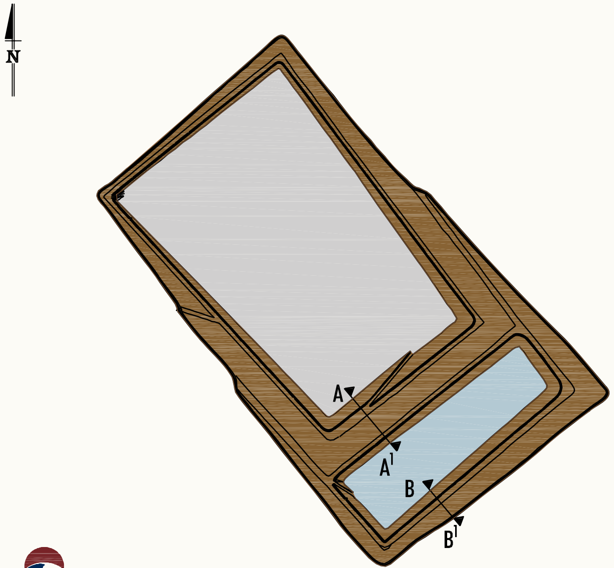
The Modification would also include the construction of a temporary HMC stockpile adjacent to the mine path, for stockpiling HMC prior to the completion of the HMC treatment facility at the Snapper Mine. The location of the temporary HMC stockpile is shown on Figure 5.

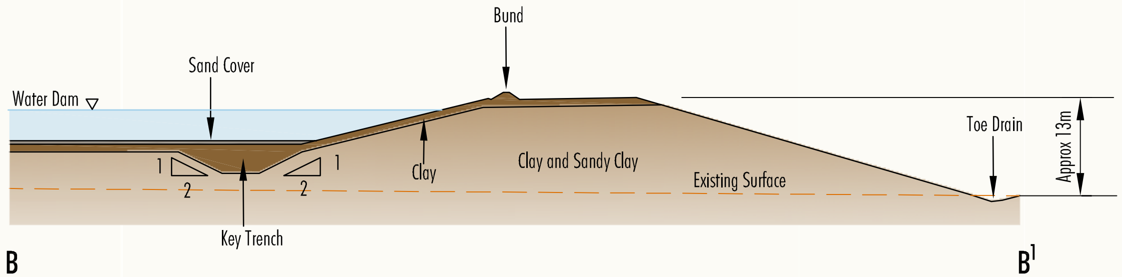
Initial Water Treatment Dam

The initial water treatment dam would not be required as part of the modified Snapper Mine. Water treatment cells would be constructed within the initial water dam for the treatment of water during construction.



Initial Sand Residue Dam





Initial Water Dam

Not to Scale

MODIFICATION

FIGURE 9
Modified Snapper Mine Initial Sand Residue Dam and Initial Water Dam - Conceptual Embankment Detail

BMX-09-21_108A

2.2.2 Mineral Concentrate Transport Route

The Modification would not change the mineral concentrate transport route or HAR.

2.2.3 ETL

As described in Section 2.1.2, the Modification would include a change to the alignment of the ETL in order to facilitate a more direct alignment of the ETL, reducing the associated disturbance area, construction costs and infrastructure requirements (i.e. number of poles and cable length). The modified ETL alignment is shown on Figure 3.

As for the approved Snapper Mine, the modified ETL would be based on a three conductor power pole (A-Frame Power Pole) with standing post insulators and steel construction (approximately 18 m high), or another industry standard design if required. A detailed design of pole spacing and conductor and insulator configurations would be determined by the power supplier as a component of an electrical load study and licence agreements.

The modified ETL would be located on BEMAX-held land, thereby removing the requirement for easements to be negotiated with other private landholders.

As for the approved Snapper Mine, ground disturbance for ETL construction would largely be limited to vegetation clearance of a 10 to 20 m wide corridor along the centreline of the alignment to allow for stringing of the overhead conductor and any additional clearance requirements for equipment stockpiles or vehicle access.

Construction activities (e.g. survey and pegging, etc.) would be the same as for the approved Snapper Mine.

Given the change in the alignment of the ETL, the location of the approved electricity distribution station at the Snapper Mine site would also change. The location of the modified electricity distribution station (immediately outside ML 1621) is shown on Figure 5.

2.2.4 Construction Phase Transport Requirements

The Modification would not change the construction phase transport requirements of the approved Snapper Mine.

2.2.5 Accommodation Camp

Shared use of the Ginkgo Mine accommodation camp would remain unchanged.

2.3 SNAPPER MINE OPERATION

2.3.1 Mining Method and Schedule

The Modification would not change the mining method of the approved Snapper Mine. Dredge mining would be the primary method of mining and would involve the same method of mining as the Ginkgo Mine (i.e. conventional mineral sands dredge mining). Secondary mining of ore would occur simultaneous to dredge mining as required, and would be undertaken by conventional mobile equipment (i.e. dozers and/or scrapers) depositing ore in front of the dredge.

Mine Path

The Modification would increase the total amount of ore mined from approximately 117 Mt to approximately 122 Mt. This increase would trigger a consequent minor change to the approved Snapper Mine path, as a result of detailed mine planning and resource modelling. The extent of the modified Snapper Mine path is shown on Figure 5.

Additionally, a double-pass mine plan would be introduced in Year 7, at approximately 4 km from the southern end of the ore body. A single pass mine plan would be retained until this time.

Detailed mine planning has identified the requirement to increase the volume of overburden to be placed off-path during the initial years. This increase is due to:

- the relatively small area behind the dredge pond during the initial years of mining;
- a flatter angle of deposition of sand residues and larger wet sand residue beach to allow for increased drying time (i.e. for safe placement of overburden as experienced at the Ginkgo Mine) and improved consolidation, which increases the active mining area (from approximately 1.6 to 3.4 km) and reduces the amount of area available behind the dredge pond for on-path overburden emplacement (i.e. overburden replacement cannot safely occur until adequate consolidation of the residues, consequently reducing the space available behind the dredge for on-path overburden replacement); and
- in combination with the above, a limited final on-path landform height triggers the requirement for off-path overburden placement.

The final landform height would increase from approximately 2 to 4.5 m to approximately 10 m Retention of the original elevation proposed for the backfilled mine path would increase the off-path overburden emplacement area because the off-path overburden emplacement elevation would not change. The backfilled mine path elevation has therefore been increased to minimise the off-path overburden area. The change to the final landform profile as a result of the double-pass mine plan and increased elevation is described in Section 4.2.2.

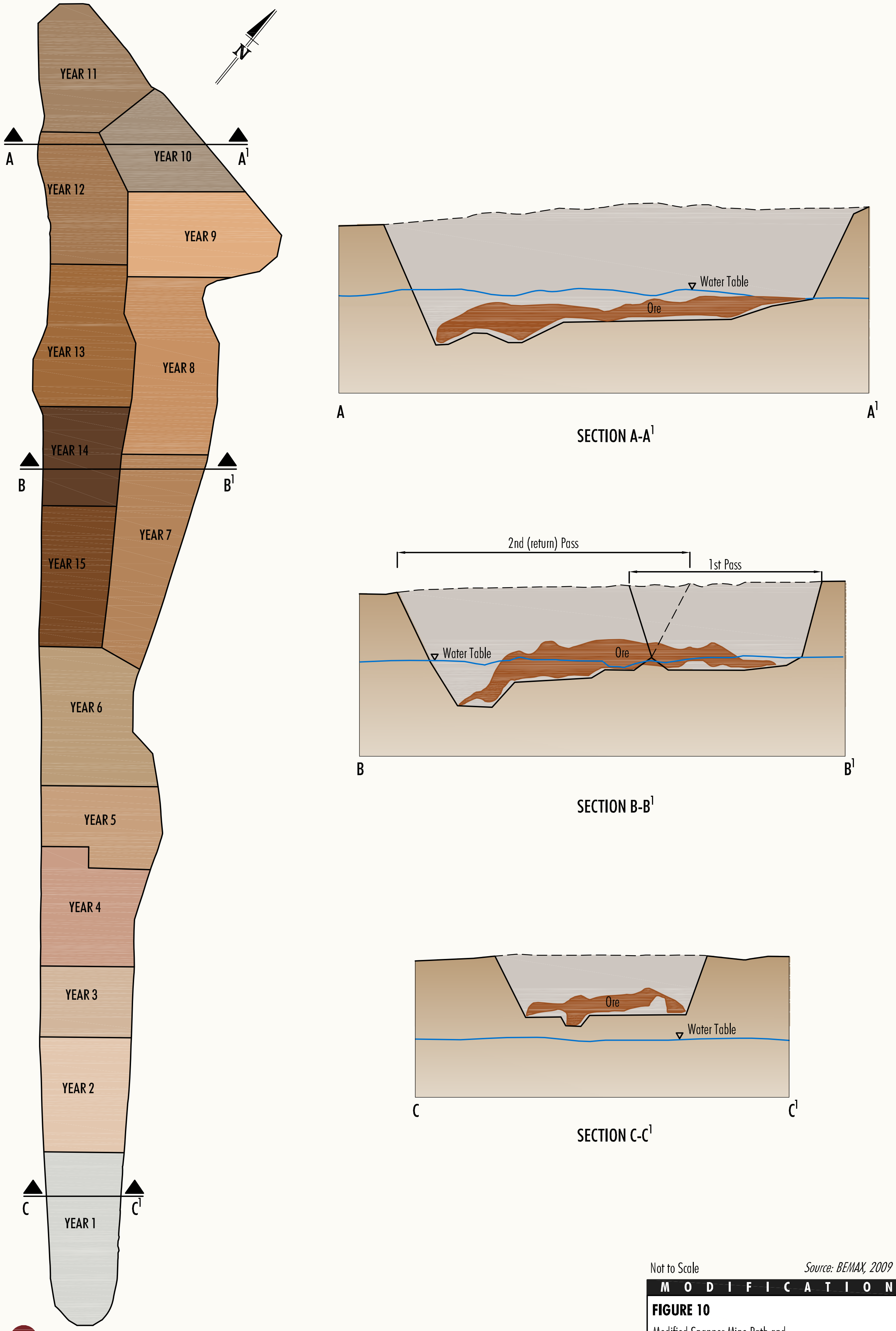
The height of the off-path overburden emplacement would remain unchanged at up to approximately 20 m.

An illustration of the modified Snapper Mine path and conceptual cross-section is provided on Figure 10. Figure 11 provides an illustration of the mining process for the modified Snapper Mine.

Production Schedule

As stated above, the Modification would increase the total amount of ore mined from approximately 117 Mt to approximately 122 Mt. Notwithstanding, the total amount of mineral concentrates to be produced from the Snapper Mine would decrease from approximately 5.9 Mt to approximately 5.2 Mt, as a result of decreased ore grades identified from detailed mine planning and resource modelling.

A provisional production schedule for the modified Snapper Mine life is provided in Table 3. The schedule shows the combined development of the Snapper and Ginkgo Mines and maximum annual mineral concentrate production of approximately 844,000 tpa, which is more than the approved combined maximum annual mineral concentrate production of approximately 650,000 tpa. As shown in Table 3, the maximum rate of mineral concentrate production from the Snapper Mine alone would be approximately 621,000 tpa, which is more than the approved maximum rate of mineral concentrate production of approximately 450,000 tpa. The increase in the maximum mineral concentrate production rate would be achieved by increasing the maximum annual mining rate from 8.2 to 9.1 Mtpa and increasing the capacity of the HMC treatment facility (Section 2.3.8).



ResourceStrategies

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Source: BEMAX, 2009

MODIFICATION

FIGURE 10

Modified Snapper Mine Path and Conceptual Cross Sections

BEMAX

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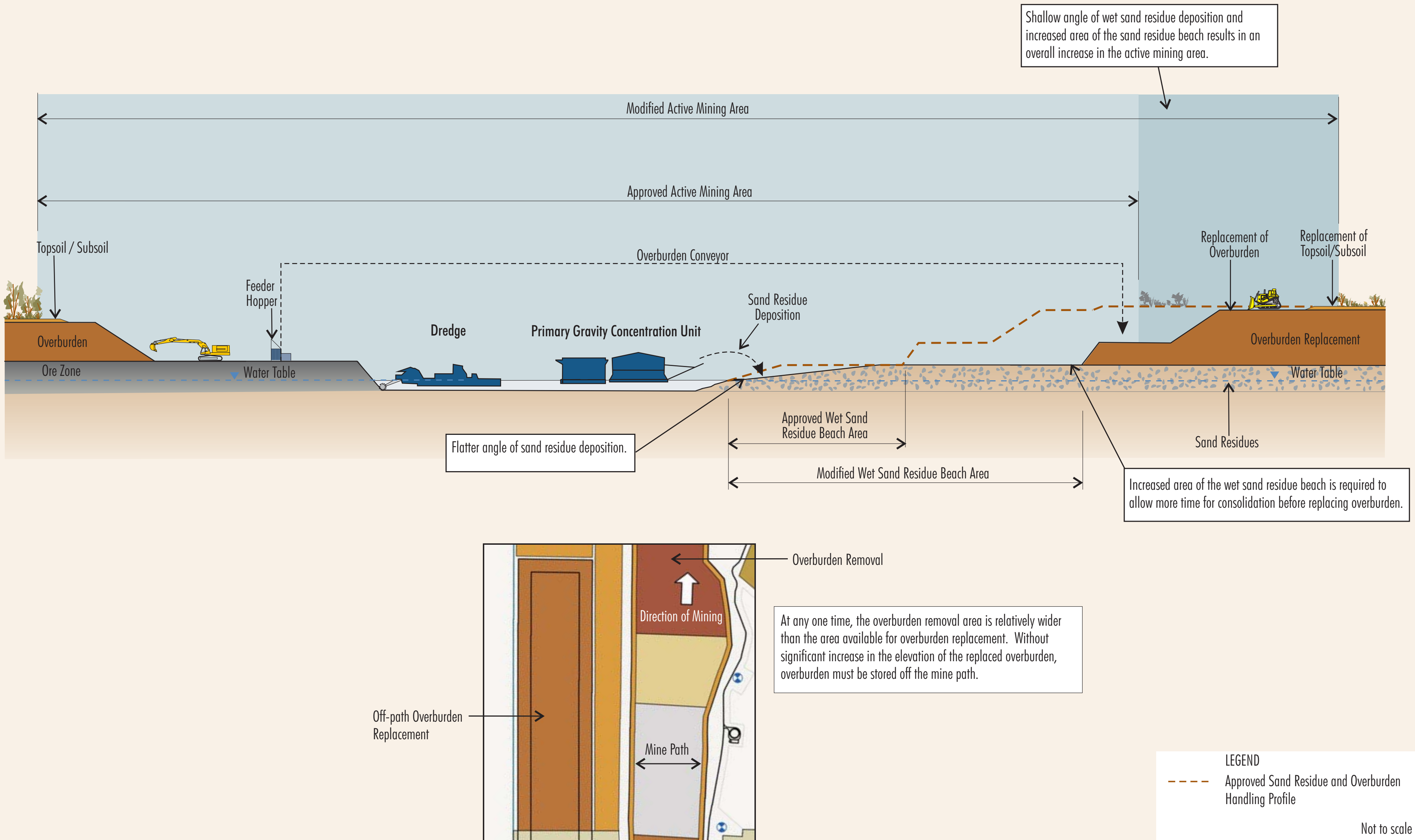


M O D I F I C A T I O N

FIGURE 11

Modified Snapper Sand Residue and Overburden Handling - Conceptual Section

BEMAX RESOURCES LIMITED

BMX-09-21_002E

Given the decrease in the total amount of mineral concentrates and increase in the maximum annual mineral concentrate production rate at the Snapper Mine, the life of the approved Snapper Mine would be reduced from approximately 16 years to approximately 15 years.

Table 3
Provisional Production Schedule – Modified Snapper and Ginkgo Mines

Calendar Year	Mine Development Year		Mineral Concentrate Production (kilotonne [kt])		
	Ginkgo Mine	Snapper Mine	Ginkgo Mine	Snapper Mine	Total
2005	Construction	-	-	-	-
2006	1	-	386	-	386
2007	2	-	491	-	491
2008	3	-	524	-	524
2009	4	Construction	394	-	394
2010	5	1	51	565[1]	616
2011	6	2	40[2]	421[2,3]	461[2]
2012	7	3	223	621	844
2013	8	4	213	488	701
2014	9	5	223	422	645
2015	10	6	301	449	750
2016	11	7	240	338	578
2017	12	8	185	240	425
2018	13	9	191	168	359
2019	14	10	200	175	375
2020	-	11	-	126	126
2021	-	12	-	210	210
2022	-	13	-	292	292
2023	-	14	-	357	357
2024	-	15	-	345	345
Total			3,662[2]	5,217[1,3]	8,879[2]

1 Approximately 565 kt of mineral concentrates would be produced at the Ginkgo Mine from Snapper Mine high-grade ore in 2010, approved as part of the November 2009 Modification.

2 Potential for approximately 130 kt of mineral concentrates to be produced from the Ginkgo Mine in 2011, should the high-grade ore transport contingency not be required. This production schedule assumes that this 130 kt of mineral concentrates would otherwise be produced later in the Ginkgo Mine life.

3 Approximately 421 kt of mineral concentrates would be produced at the Ginkgo Mine from Snapper Mine high-grade ore in 2011, assuming the high-grade ore transport contingency is required.

2.3.2 Vegetation Clearance and Soil Management

The Modification would not change the currently approved vegetation clearance or soil management methodologies during operations at the Snapper Mine.

2.3.3 Overburden Replacement

The modified Snapper Mine would include the use of an electric conveyor system and/or dry mine fleet for dry overburden removal, instead of overburden slurrying. This method of overburden replacement would be the same as that currently employed at the Ginkgo Mine.

Prior to dredge mining, the mine path would be stripped of overburden ahead of the dredge (Figure 11). The overburden would be dumped directly into a feeder hopper which would feed onto the overland conveyor system. Stripped overburden would be transported via the overland conveyor system and replaced over sand residues that have been deposited behind the floating plant.

The conveyor system would comprise approximately 1 to 3 km of belt conveyors and a mobile stacker conveyor. The conveyor feeder hopper would be periodically relocated to follow the stripping operation.

For the initial period during start-up, when there is insufficient area behind the dredge pond, overburden would be placed in the overburden emplacement. The increase in the total area required for the overburden emplacement is described in Sections 2.2.1 and 2.3.1.

2.3.4 Dredge Mining

The Modification would not change the currently approved dredge mining methods at the Snapper Mine.

2.3.5 Secondary Mining

Dry mining of ore was described in the Snapper Mine EA, which stated that "*secondary mining of ore would be undertaken using conventional mobile equipment in various locations along the mine path where ore is located at levels well above the groundwater table such that dredge mining is not feasible*".

As described in Section 1.1, the Modification would include the continuation of the trucking of high-grade ore (and associated activities) for an additional 12 months. This additional approximate 2 Mt of ore combined with the 2 Mt of ore for the November 2009 Modification would result in a total of 4 Mt of ore to be mined using secondary mining methods (i.e. dry mined) and trucked from the Snapper Mine to the Ginkgo Mine.

The transportation of this high-grade ore to the Ginkgo Mine is described in Section 2.3.6 and the concentration and separation of this ore is described in Section 3.5. Sections 3.6 and 3.7 described the placement of the resultant sand residues and waste characteristics and disposal, respectively.

2.3.6 High-Grade Ore Transport

As for the approved Snapper Mine, once extracted, the additional approximate 2 Mt of Snapper Mine high-grade ore would be trucked to the Ginkgo Mine along the private road section of the approved HAR (Figure 2), using 200 t road trains. The frequency of 200 t road trains transporting the Snapper Mine high-grade ore to the Ginkgo Mine along the private road would be a maximum of 2 trips per hour (4 vehicle movements per hour), as for the approved Snapper Mine.

2.3.7 Sand Residue Disposal

The Modification would not change the currently approved sand residue disposal methods at the Snapper Mine.

Additional sand residues would be produced at the Ginkgo Mine from processing of the high-grade ore from the Snapper Mine. The combined sand residues would be stacked directly into the back of the Ginkgo Mine dredge pond either through the sand residue boom jet located at the rear of the primary concentration unit or via a pipe along the pond surface.

This additional approximate 2 Mt of ore combined with the 2 Mt of ore for the November 2009 Modification (i.e. 4 Mt of ore in total) would result in a reduction of less than 2.7% of sand residues to be placed at the rear of the Snapper Mine dredge pond, given the grade of the ore (approximately 25 to 30% heavy minerals).

2.3.8 Mineral Concentrate Handling and Transport

As for the approved Snapper Mine, the ore recovered by the primary gravity concentration unit would be pumped as a concentrate slurry to the shore-based HMC treatment facility located adjacent to the mine path (Figure 12). Prior to the completion of the HMC treatment facility at the Snapper Mine, HMC would be stockpiled adjacent to the mine path in the temporary HMC stockpile and transported to the Ginkgo Mine HMC treatment facility.

Whilst a HMC treatment facility is approved for use at both the Snapper and Ginkgo Mines, BEMAX may delay the construction of the Snapper Mine HMC treatment facility or relocate the Ginkgo Mine HMC treatment facility to the Snapper Mine, depending on the results of further detailed mine planning.

The Modification would therefore include the trucking of HMC between the Snapper and Ginkgo Mines, dependent on the location of the HMC treatment facility. Consequential treatment of Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa, would be undertaken.

HMC would be trucked between the mines along the private road section of the approved HAR (Figure 2), using AB-triple vehicles or 200 t road trains.

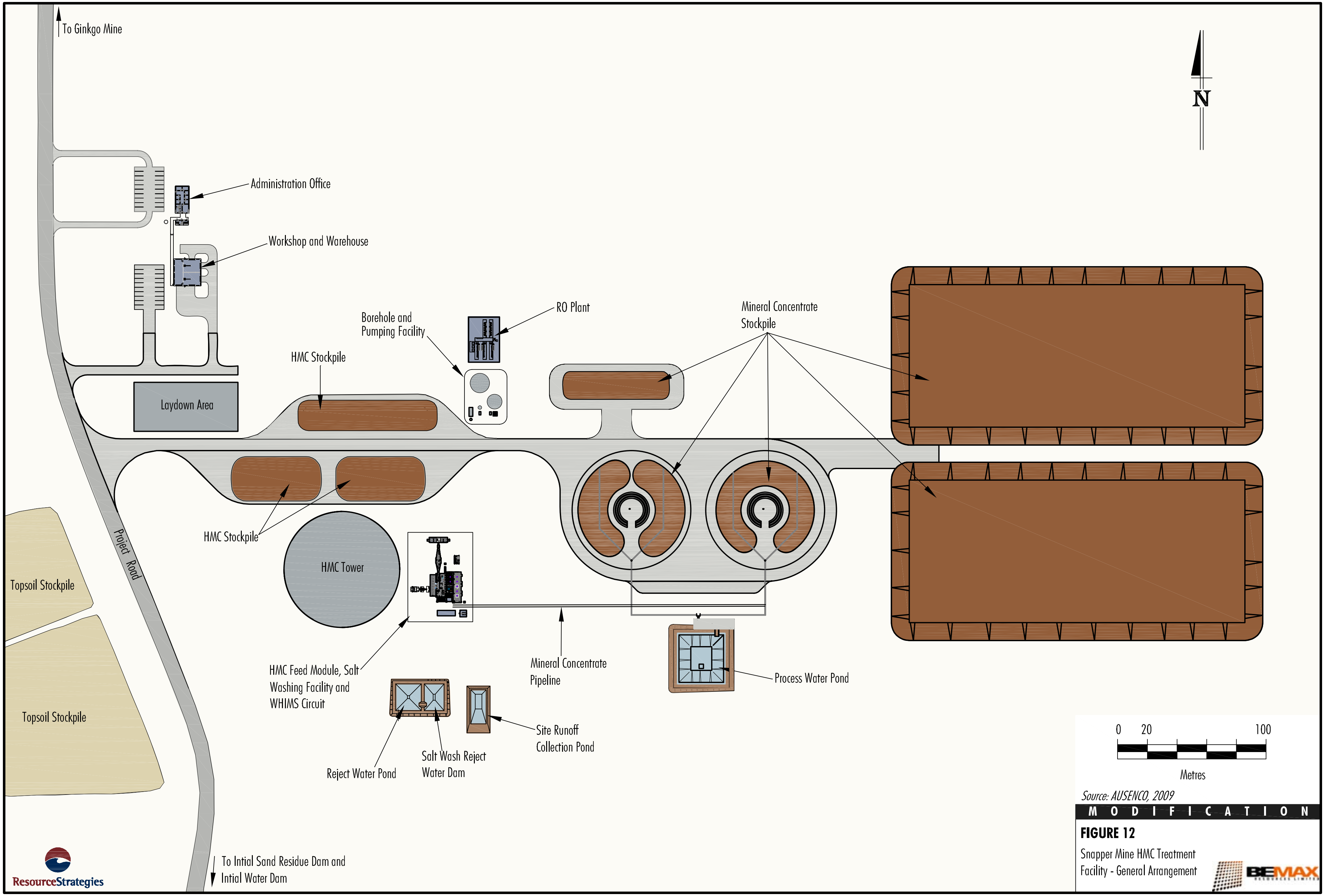
The frequency of AB-triple vehicles would be a maximum of 1 to 2 trips per hour (3 vehicle movements per hour). AB-triple vehicles would be used on the return trip from the MSP. For example, on the return from the MSP AB-triple vehicles would enter the Snapper Mine site at the northwest entrance and unload backloaded MSP process waste, then be loaded with HMC and transport that HMC to the Ginkgo Mine along the private road between the two mines. That is, the use of AB-triple vehicles would not involve an increase to the number of operational trucks – the AB-triple vehicles would “detour” on their return trip from the MSP and go via the private section of HAR between the two mines instead of the private section of the HAR to the east of Nob Road.

The frequency of 200 t road trains transporting the Ginkgo Mine HMC to the Snapper Mine along the private road would be a maximum of 1 trip every two hours (1 vehicle movement per hour).

The frequency of AB-triple vehicle or road train movements would be less than the frequency of road train movements along the private road approved (for transporting ore on a short-term basis) as part of the November 2009 Modification (which approved a maximum of 4 vehicle movements per hour) and also proposed to continue for an additional 12 months as part of the current Modification (Section 2.3.6). The proposed transport of HMC and HMC treatment waste would not occur at the same time as the transport of ore between the Snapper and Ginkgo Mines.

The Modification would include the construction of a larger HMC treatment facility at the Snapper Mine, to accommodate the increase in the maximum mineral concentrate production rate, as described in Section 2.2.1. The general arrangement of the modified HMC treatment facility is shown on Figure 12.

The characteristics of the HMC from the Ginkgo Mine are similar to that from the Snapper Mine. That is, the Ginkgo and Snapper mineral deposits both occur within the Loxton-Parilla Sands host unit and contain the same types of heavy minerals (i.e. ilmenite, leucoxene, rutile and zircon). The annual HMC required to be treated from the Ginkgo Mine would typically be approximately half that of the Snapper Mine (Table 3).



MODIFICATION

FIGURE 12

Snapper Mine HMC Treatment Facility - General Arrangement

BMX-09-21_107C

Mineral Concentrate Transport to the MSP

The Modification would not change the maximum combined concentrate haulage of approximately 735,000 tpa from the Snapper and Ginkgo Mines to the MSP. Therefore, there would be no change to the approved number or type of haulage vehicles transporting mineral concentrates to the MSP (or backloaded MSP process waste materials from the MSP to the Snapper and Ginkgo Mines).

As for the approved Snapper Mine, ilmenite-rich concentrate would be stockpiled during the initial period of mining operations. Stockpiled ilmenite-rich concentrate would be transported when appropriate market conditions prevail.

Salt Washing Facility

The capacity of the salt washing facility would be increased to accommodate the increase in maximum annual mineral concentrate production of the Snapper Mine and the treatment of Ginkgo Mine HMC.

As for the approved Snapper Mine, the salt washing facility would be relocatable and positioned adjacent to the mine path within the modified HMC treatment facility area (Figure 12). The salt washing facility would utilise desalinated wash water provided by the RO plant (described below). Reject water from the salt washing facility would be contained within the salt wash reject water dam. The amount of reject water would increase for the Modification given the increase in the throughput of the salt washing facility. As for the approved Snapper Mine, the reject water would be used to produce a backloaded MSP process waste slurry, where required. This slurry would be pumped to the primary gravity concentration unit where it would be combined with sand residues and deposited behind the primary gravity concentration unit (Figure 11).

WHIMS Circuit

Similar to the salt washing facility, the capacity of the WHIMS circuit would be increased from approximately 450,000 tpa to approximately 844,000 tpa to accommodate the increase in maximum annual HMC production of the Snapper Mine and the treatment of Ginkgo Mine HMC.

The WHIMS circuit separates the mineral concentrate into an ilmenite concentrate, a leucoxene concentrate, a non-magnetic concentrate (containing zircon and rutile) and waste products as part of the preliminary mineral concentrate treatment stage. The separation is achieved through magnetic, electrostatic and gravity separation methods without the need for any chemical reagents.

The increase in the capacity of the WHIMS circuit would be achieved through the addition of additional magnetic separators and de-watering cyclones. The modified WHIMS circuit would be located within the modified HMC treatment facility area (Figures 5 and 12).

RO Plant

The capacity of the RO plant would increase in order to supply the increased volume of desalinated water to the salt washing facility and WHIMS circuit. The potable water requirements for the administration buildings would not change.

The modified RO plant would be supplied by approximately three bores drawing water from the Lower Olney Formation aquifer. Water requirements for the RO plant are discussed in Section 2.6.

As for the approved Snapper Mine, wastewater from the RO plant would contain approximately 50,000 milligrams per litre (mg/L) of total dissolved solids (TDS) and would gravitate from the plant to the dredge pond.

2.3.9 Handling of Backloaded MSP Process Waste

As per the approved Snapper Mine, the backloaded MSP process waste would be placed in a designated stockpile at the mine site. The backloaded MSP process waste would be deposited on the sand residue beach and/or with overburden and covered under a minimum of 10 m (and up to 35 m) of overburden.

As for the approved Snapper Mine, the management measures for the handling of backloaded MSP process waste would provide for:

- the average concentration of radioactive material in the rehabilitated mine path (i.e. the landfilled mine path) to not exceed the average concentration of radioactive material in the original ore body;
- the radiation level of any material deposited in the mine path to not exceed 0.7 microGray per hour, measured 1 m vertically above the surface of the landfilled area; and
- no detectable increase from the natural background radiation level measured at the ground surface.

2.4 MOBILE EQUIPMENT

The Modification would not change the number or type of mobile equipment required for mineral concentrate transport relevant to the approved Snapper Mine.

Detailed mine planning since the Snapper Mine EA has identified the need to change the type and number of some of the equipment fleet for the Snapper Mine. The proposed changes primarily relate to changes to overburden excavation/replacement methodologies (i.e. use of an electric conveyor system and/or dry mine fleet for dry overburden removal, instead of overburden slurrying) and changes to the soil excavation/replacement methodologies (i.e. use of bucket scoops instead of scrapers, in order to reduce potential impact to the structure of replaced soil).

Table 4 lists the proposed equipment fleet for the modified Snapper Mine and provides a comparison with the provisional equipment fleet presented in the Snapper Mine EA.

Table 4
Modified Snapper Provisional Equipment Fleet

Equipment	Primary Purpose	Number of Equipment			
		Approved Snapper Mine		Modified Snapper Mine	
		Construction	Operation	Construction	Operation
Backhoe	Miscellaneous works (e.g. roads, trenches, etc.)	1	1	1	1
Bobcat	Miscellaneous works (e.g. roads, trenches, etc.)	1	1	1	1
Bucket Scoop	Removal and placement of topsoils	-	-	6	3
Bus	Transport of personnel between Snapper Mine and Ginkgo Mine accommodation camp	1	1	4	2
Crane	Maintenance/moving equipment	8	4	8	2
Dozer	Overburden excavation/replacement, secondary mining	7	7	4	7

Table 4 (Continued)
Modified Snapper Provisional Equipment Fleet

Equipment	Primary Purpose	Number of Equipment			
		Approved Snapper Mine		Modified Snapper Mine	
		Construction	Operation	Construction	Operation
Excavator	Overburden excavation/replacement	2	2	5	4
Front End Loader	Loading haulage vehicles/multi-purpose	1	3	1	3
Integrated Toolcarrier	Pipe laying, equipment transport	-	-	2	1
Mobile Fuel Tank	Refuelling equipment	1	1	4	2
Stationary Genset (Diesel)	Back-up power generation	8	3	7	2
Grader	Overburden contouring, road grading	2	2	3	2
Multi-Purpose Service Vehicle	Servicing equipment	2	2	3	1
Light Vehicle	Transport of personnel	50	25	53	22
Lighting Tower	Diesel-generated floodlight	8	6	8	6
Scraper	Soil, overburden excavation/replacement and secondary mining	9	9	1	1
Scraper (Water Cart)	Dust suppression	1	1	-	-
Telehandler	Equipment Handler and elevated-work platform			1	1
Maintenance Truck	Maintenance	1	1	1	1
Overburden Slurrying System (Dozer Trap) (Feed conveyor, hopper and slurrying unit)	Slurrying overburden	0	2	-	-
Service Truck	Servicing equipment	3	3	2	2
Dump Truck	Overburden Removing/Placement	6	0	9	8
Water Truck	Dust suppression	1	2	4	2
Garbage Truck	Compacting garbage	1	1	1	1
Forklift	Miscellaneous (e.g. movement of goods)	2	0	1	1
1-3 km Trunk Conveyor	Overland overburden conveyor	-	-	0	1
Overburden Feed Hopper	Transfer of overburden to the trunk conveyor	-	-	0	1

2.5 MINE MATERIALS

The modified Snapper Mine would mine the same five major overburden units and the same orebody as the approved Snapper Mine. The backloaded MSP process waste would be expected to have similar physical and chemical properties as for the approved Snapper Mine.

2.6 WATER MANAGEMENT

The supply of groundwater for the modified Snapper Mine would be sourced from the deeper, high yielding, Lower Olney Formation aquifer instead of the shallow, saline Loxton-Parilla aquifer. The Modification would see the number of required groundwater bores be reduced from approximately 30 bores to approximately three bores. The groundwater bores would be capable of producing up to approximately 100 to 120 L/s each. The borefield would supply process water to the: dredge pond; primary gravity concentration unit via the dredge pond; initial water dam; RO plant; salt washing facility and WHIMS circuit via the RO plant; and water disposal dam.

The approved initial water treatment dam shown on Figure 4 would not be required for the modified Snapper Mine. During the first few years of the mine life, process water containing the fines material would be pumped to purpose built cells within the initial water dam. This process water would be dosed with a flocculant to promote the settling of suspended sediments, as for the approved Snapper Mine.

Recoverable water would be returned to the dredge pond with the remaining fines material being managed as part of the overall sand residue management process.

The remainder of the water management measures would not change as a result of this modification and would continue to be implemented for the modified Snapper Mine as described in the Snapper Mine EA and the Snapper Mine Water Management Plan (BEMAX, 2008a).

Operational Water Demand and Supply

Additional groundwater balance modelling conducted by GEO-ENG (2010) has been undertaken to augment previous modelling conducted by Golder Associates (2007) and has determined a general reduction in water demand for the modified Snapper Mine. This reduction in water demand is primarily a result of the change from overburden slurrying to dry overburden replacement.

During operation, the average groundwater requirement from the borefield would reduce from approximately 165 L/s to approximately 98 L/s. The maximum water supply requirement from the borefield would reduce from approximately 370 L/s to approximately 270 L/s and would be pumped during approximately the first half of the mine life.

Notwithstanding the overall reduction in water demand, the Modification would involve a minor increase to the water demand associated with the increased mineral concentrate production rate.

The maximum water demand for the HMC treatment facility (including the RO plant, salt washing facility and WHIMS circuit) would increase from approximately 80 L/s to approximately 83 L/s . The majority of this water (in the order of 62 L/s) would continue to be returned as make-up water to the dredge pond via the reject water pond.

A proportion of the water sourced from the borefield for the HMC treatment facility would be desalinated in the RO plant prior to use in the salt washing facility and WHIMS circuit. The water demand of the WHIMS circuit would increase for the modified Snapper Mine from approximately 12 L/s to approximately 13 L/s. The majority of the water required for the WHIMS circuit would continue to be recycled through dewatering of product materials.

The water demand for the RO plant would increase from approximately 20 L/s to approximately 21 L/s of desalinated water for the salt washing facility and WHIMS circuit. Wastewater from the salt washing facility would continue to be piped to the reject water pond for use when slurrying the backloaded MSP process waste.

Water Disposal

The water disposal dam would be constructed within the mine path approximately in Year 6. The Modification would include a change to the location of the water disposal dam within the mine path to account for the change to the double-pass mining method (Figure 7). As per the approved Snapper Mine, the dam walls would be clay-lined to minimise lateral seepage. The base of the dam would not be clay-lined. Rather the base would overlay the permeable overburden and sand residues to allow vertical seepage to the groundwater table. To reduce the dredge pond water level sufficiently to mine in Years 9 to 12, water would be pumped to the water disposal dam from approximately Years 8 to 13. On completion of mining in the northern section of the mine path and once the water disposal dam has drained, it would be decommissioned and rehabilitated.

2.7 INFRASTRUCTURE

2.7.1 Roads

The Modification would not change the mineral concentrate transport route or HAR.

The Modification would include changes to minor roads, including the internal access roads at the mine site and maintenance tracks along the ETL route.

2.7.2 Electricity Distribution

As described in Section 2.1.2, the Modification would include a change to the alignment of the ETL in order to facilitate a more direct alignment of the ETL, reducing the associated disturbance area, construction costs and infrastructure requirements (i.e. number of poles and cable length). The modified ETL alignment is shown on Figure 3.

As described in Section 2.2.3, given the change in the alignment of the ETL, the location of the approved electricity distribution station at the Snapper Mine site would also change. The location of the modified electricity distribution station is shown on Figure 3.

As for the approved Snapper Mine, power would be reticulated around the site at 22 kV. Each operating area would then have a relocatable step-down substation located adjacent to the working area.

2.7.3 Site Buildings

The Modification would include changes to the locations of site buildings. The site buildings would be located within the area of the modified HMC treatment facility (Figures 5 and 12).

As for the approved Snapper Mine, buildings constructed at the mine site would be of demountable design and would be removed on closure of the operation.

2.7.4 Diesel Storage

The Modification would include a change to the location of diesel storage facilities. The diesel storage facilities would be located within the area of the modified HMC treatment facility (Figure 5).

As for the approved Snapper Mine, all diesel storage facilities would be constructed and operated in accordance with the requirements of Australian Standard (AS) 1940:2004 *The Storage and Handling of Flammable and Combustible Liquids* (AS 1940). Diesel would be supplied to the Snapper Mine by tankers.

2.8 MANAGEMENT OF CONSUMABLES AND SITE SECURITY

The Modification would not change the management measures (associated with transportation, handling and storage and material safety data sheets [MSDS] and inventory register) for consumables.

The Modification would not change the site security arrangements for the approved Snapper Mine.

2.9 WORKFORCE AND OPERATIONAL HOURS

The Modification would not change the workforce or operational hours for the approved Snapper Mine.

3 DESCRIPTION OF THE MODIFICATION TO THE GINKGO MINE

3.1 GENERAL ARRANGEMENT

The Modification would not result in any changes to the approved Ginkgo Mine general arrangement (Figure 13).

3.2 MINING METHOD AND SCHEDULE

The Modification would not change the mining method of the approved Ginkgo Mine.

The Modification would increase the total amount of ore mined from approximately 128 Mt to approximately 145 Mt.

The life of the approved Ginkgo Mine would increase from approximately 12 years to approximately 14 years, to reflect the ore increase and a care and maintenance period. The care and maintenance schedule would extend for an approximate 12 month period from the commencement of dredge mining at the Snapper Mine until favourable market conditions (i.e. in particular a favourable Australian/United States dollar exchange rate) prevail. During the course of the care and maintenance period, BEMAX's focus would be on activities at the Snapper Mine (i.e. commencement of dredge mining at the Snapper Mine targeting high-grade ore).

Notwithstanding the increase in the ore reserves, the total amount of mineral concentrates to be produced from the Ginkgo Mine would decrease from approximately 4.8 Mt to approximately 3.7 Mt, as a result of decreased ore grades identified from detailed mine planning and resource modelling.

The maximum rate of production from the Ginkgo Mine would remain unchanged from the approved maximum rate of production of approximately 576,000 tpa.

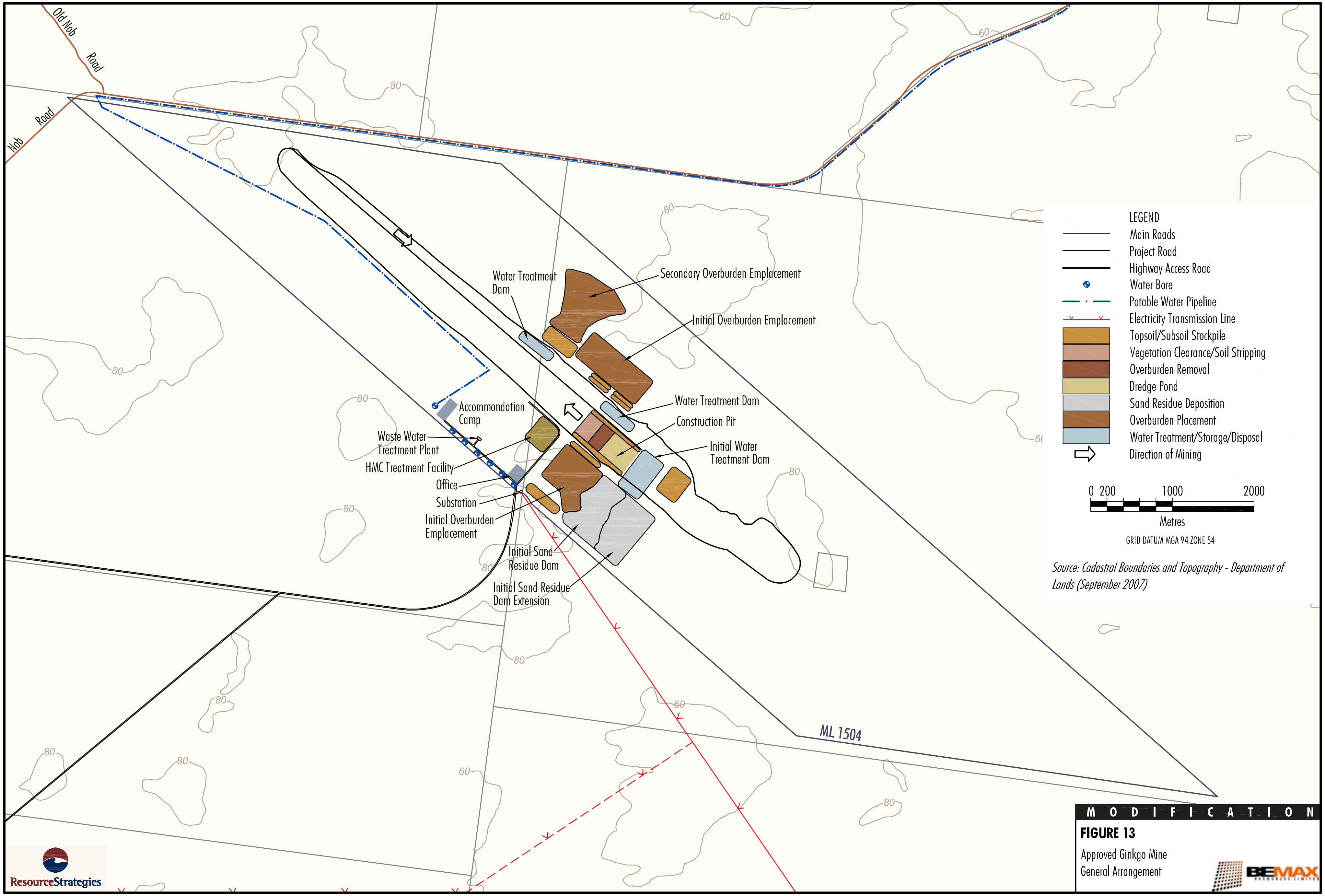
3.3 MINERAL CONCENTRATE HANDLING AND TRANSPORT

As described in Section 2.3.8, whilst a HMC treatment facility is approved for use at both the Snapper and Ginkgo Mines, BEMAX may delay the construction of the Snapper Mine HMC treatment facility or relocate the Ginkgo Mine HMC treatment facility to the Snapper Mine, depending on the results of further detailed mine planning.

The Modification would therefore include the trucking of HMC between the Snapper and Ginkgo Mines, dependent on the location of the HMC treatment facility. Consequential treatment of Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa, would be undertaken.

The HMC would be trucked between the mines along the private road section of the approved HAR (Figure 2), using AB-triple vehicles or 200 t road trains, as described in Section 2.3.8.

The characteristics of the HMC from the Ginkgo Mine are similar to that from the Snapper Mine. The annual HMC required to be treated from the Ginkgo Mine would typically be approximately half that of the Snapper Mine (Section 2.3.1).



MODIFICATION

FIGURE 13

Approved Ginkgo Mine
General Arrangement

Mineral Concentrate Transport to the MSP

The Modification would not change the maximum combined concentrate haulage of approximately 735,000 tpa from the Snapper and Ginkgo Mines to the MSP. Therefore, there would be no change to the approved number or type of haulage vehicles transporting mineral concentrates to the MSP.

As for the approved Snapper Mine, ilmenite-rich concentrate would be stockpiled during the initial period of mining operations. Stockpiled ilmenite-rich concentrate would be transported when appropriate market conditions prevail.

3.4 HIGH-GRADE ORE TRANSPORT

As described in Section 2.3.6, the frequency of 200 t road trains transporting the Snapper Mine high-grade ore to the Ginkgo Mine along the private road would be a maximum of 2 trips per hour (4 vehicle movements per hour), as for the approved Snapper Mine.

3.5 CONCENTRATION AND SEPARATION OF SNAPPER MINE HIGH-GRADE ORE AT THE GINKGO MINE

High-grade ore from the Snapper Mine would be deposited in front of the dredge at the Ginkgo Mine. The rotating bucket wheel of the dredge would collect both the high-grade ore from the Snapper Mine and ore from the Ginkgo Mine. The characteristics of the ore from the Snapper Mine are similar to that from the Ginkgo Mine.

The dredge would then deliver the combined Ginkgo and Snapper ore slurry to the primary concentration unit. The mineral concentrate would be pumped as a slurry to the shore-based HMC treatment facility located adjacent to the mine path. The mineral concentrate would be washed with desalinated water to remove residual salt, prior to the concentrate being separated through the WHIMS circuit at the Ginkgo Mine or at the MSP.

Mineral concentrate transport is described in Section 3.3.

3.6 SAND RESIDUE DISPOSAL

The Modification would not change the currently approved sand residue disposal methods at the Ginkgo Mine.

As described in Section 2.3.7, additional sand residues would be produced at the Ginkgo Mine from processing of the high-grade ore from the Snapper Mine. The combined sand residues would be stacked directly into the back of the Ginkgo Mine dredge pond either through the sand residue boom jet located at the rear of the primary concentration unit or via a pipe along the pond surface.

This additional approximate 2 Mt of ore combined with the 2 Mt of ore for the November 2009 Modification (i.e. 4 Mt of ore in total) would result in an increase of less than 2.6% of sand residues to be placed at the rear of the Ginkgo Mine dredge pond, given the grade of the ore (approximately 25 to 30% heavy minerals).

The characteristics of the sand residues from the Snapper Mine ore would be similar to that from the Ginkgo Mine. That is, sand residues would be saline owing to the presence of entrained saline groundwater (BEMAX, 2007a).

3.7 WASTE CHARACTERISTICS AND DISPOSAL

The characteristics of the waste from the treatment and processing of Snapper Mine ore would be similar to that from the processing of Ginkgo Mine ore.

The reject water from salt washing mineral concentrates derived from the Snapper Mine ore would be similar to that from washing of mineral concentrates derived from the Ginkgo Mine ore (i.e. there would be high levels of salt within the reject water). Reject water from the salt washing facility at the Ginkgo Mine would continue to be contained within the salt wash reject water dam and subsequently used to produce a backloaded MSP process waste slurry, where required. This slurry would be pumped to the primary gravitation unit where it would be combined with sand residues and deposited behind the primary gravity concentration unit.

The backloaded MSP process waste from the Snapper Mine would have approximately the same geochemical and radiation properties as the Ginkgo Mine backloaded MSP process waste (BEMAX, 2007a). The backloaded MSP process waste would be disposed of within either the Ginkgo or Snapper Mines, in accordance with the Environment Protection Licence (EPL) for each mine.

Condition L5.3 of the Ginkgo Mine EPL (No. L12264) permits "*waste generated outside the premises from the processing of mineral concentrates produced at the premises or the Snapper Mine*". Similarly, condition L5.3 of the Snapper Mine EPL (No. L12799) permits "*waste generated outside the premises from the processing of mineral concentrates produced at the premises or the Ginkgo Mineral Sands Project*".

4 ENVIRONMENTAL ASSESSMENT

4.1 METEOROLOGY

4.1.1 Existing Environment

A description of the existing meteorological environment relevant to the Modification is provided in the Snapper Mine EA.

4.1.2 Meteorological Monitoring

The automated meteorological monitoring station would continue to be operated at the Ginkgo Mine site to record temperature, relative humidity, net solar radiation, rainfall, wind speed, wind direction and sigma theta (the rate of change of wind direction).

Meteorological monitoring would continue to form a component of the environmental monitoring programmes for the Snapper and Ginkgo Mines.

4.2 LAND RESOURCES

4.2.1 Existing Environment

Topography and Landuse

The Snapper and Ginkgo Mine areas show limited relief and comprise generally flat to undulating sandplains covered by a combination of grasslands, low woodland and shrublands.

Elevations within the Snapper Mine ML area range from approximately 60 m AHD in the south-eastern and north-western ML area to approximately 80 m AHD in the centre of the ML area.

Elevations within the Ginkgo Mine ML area range from approximately 55 m AHD at a natural depression in the south-east of the ML area to approximately 85 m AHD in the northern ML area near Nob Road.

Landuse within the Ginkgo and Snapper Mine ML areas comprise of pastoral leasehold lands that are used for light intensity rangeland grazing.

Geology

The Snapper mineral deposit is a series of stacked beach deposits that dip at a shallow angle toward the north-west. The base of the deposit is generally flat and approximately 40 m to 50 m below the natural ground surface. The high grade core of the deposit within the mine path is approximately 6 km long and up to 700 m wide (BEMAX, 2007a).

The Ginkgo mineral deposit is a series of stacked beach accumulations of ilmenite, altered ilmenite, rutile and zircon that dip at a shallow angle toward the south-west. The deposit is approximately 14 km long and has a central high grade core approximately 6 km long and 400 m wide. The base of the deposit is approximately 60 m below the ground surface and is generally flat and well-defined. Mineralisation is well-defined on the south-western side of the deposit and generally diffuse to the north-east (BEMAX, 2001a).

Rural Land Capability and Agricultural Suitability

Rural Land Capability of the Snapper and Ginkgo Mine ML Areas

The rural land capability assessment has been conducted in accordance with the standard NSW eight class system. This system is based on the assessment of biophysical characteristics categorising land in terms of its general limitations such as erosion hazard, climate and slope. Land is classed based on the limitations to a particular type of landuse (Emery, 1985). The only class identified within the ML area is Class VI.

Class VI Capability is defined as:

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

Agricultural Suitability of the Snapper and Ginkgo Mine ML Areas

Agricultural suitability assessments were carried out for the Ginkgo Mine ML area (BEMAX, 2001a) and the Snapper Mine ML area (BEMAX, 2007a) in accordance with the five class system (Riddler, 1996), which classifies land according to its productivity for a wide range of agricultural activities. The only class identified within the Ginkgo and Snapper ML areas was Class IV.

Class IV agricultural suitability is defined as:

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

Climatic and physical limitations preclude the establishment of improved pastures on soils of the Snapper and Ginkgo Mine ML areas.

4.2.2 Potential Impacts

Snapper Mine

The Modification to the Snapper Mine has the potential to alter:

- topography and landscape features;
- soils and erosion potential; and
- soil properties due to contamination through the handling the disposal of backloaded MSP process wastes.

These potential impacts are described in the following subsections. Measures to mitigate these potential impacts are provided in Section 4.2.3.

Topography and Landscape Impacts

Changes to the existing topography that would result from the Modification to the Snapper Mine would include:

- a minor change to the extent of the mine path;
- increasing the final mine path landform height from approximately 2 to 4.5 m to approximately 10 m;
- increasing the area of the overburden emplacement from approximately 145 to 215 ha;
- changing the location of the initial sand residue dam and initial water dam;
- increasing the HMC treatment facility and soil stockpile areas; and
- other minor landform alterations associated with the construction of internal access roads and the modified ETL and erosion and sediment control measures.

In the context of the existing undulating topography of the Snapper Mine ML area (which ranges from approximately 60 m AHD to approximately 80 m AHD), the landform alterations outlined above represent a minor modification to the existing topography.

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

As described in Section 2.6, the initial water treatment dam (Figure 4) is no longer required and would therefore not contribute to the final landform.

Potential visual impacts associated with changes in topography are described in Section 4.3.2.

Soils and Erosion Potential

The potential soil and erosion-related impacts identified in the Snapper Mine EA that would be relevant to the modified Snapper Mine include:

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

The low rainfall and lack of defined drainage channels in the ML area limits the potential for fluvial erosion and sedimentation.

Land Use/Capability

The Modification would not change the land use for the approved Snapper Mine. The rehabilitation of the Snapper Mine landforms would target an agreed final land use following discussions with regulatory authorities and landholders. Final land use would be likely to include areas suitable for light intensity grazing as well as areas where stock exclusion may be preferred so as to enhance native flora and fauna habitat.

The Modification would change the location of the final depressions (at the location of the final dredge pond and water disposal dam) at the Snapper Mine. The final depressions would remain as permanent topographic basins, as for the approved Snapper Mine.

Land Contamination

As described in Section 2.2.1, the overburden for the modified Snapper Mine would no longer be slurried. The use of non-slurried overburden as a subsoil growth medium in rehabilitation would eliminate the potential impacts that were associated with the use of slurried overburden.

The Modification would include the trucking of HMC between the Snapper and Ginkgo Mines, dependent on the location of the HMC treatment facility, as described in Section 2.3.8. The Modification would therefore increase the potential for a truck accident (between the mines along the private road section of the approved HAR) to result in a spill of fuel.

The Modification would not change the potential impacts described in the Snapper Mine EA relevant to past land use, backloaded MSP process wastes, saline water or other potential land contamination risks.

Bushfire Hazard

The Modification would not change the potential bushfire impacts at the Snapper Mine. Fires moving on or off the mine area would present potentially serious impacts to surrounding pastoral properties and to Ginkgo and Snapper Mine personnel and equipment. The degree of potential impact would vary with climatic conditions (e.g. temperature and wind) and the quantity of available fuel (e.g. grasses and native vegetation).

Ginkgo Mine

The Modification would not change the potential impacts to land resources associated with the Ginkgo Mine, given that there would be no change to Ginkgo Mine landforms or disturbance areas.

4.2.3 Mitigation Measures and Management

Potential impacts to land resources at the Snapper and Ginkgo Mines are currently managed via implementation of measures included in the following:

- Snapper Mine Water Management Plan (BEMAX, 2008a);
- Snapper Mine Waste Management Plan (BEMAX, 2008b);
- Ginkgo Mine Bushfire Management Plan (BEMAX, 2005a);
- Ginkgo Mine Integrated Erosion and Sediment Control Plan (BEMAX, 2005b);
- Ginkgo Mine Land Management Plan (BEMAX, 2006a);
- Ginkgo Mine Landfill Environmental Management Plan (BEMAX, 2006b); and
- Ginkgo Mine Site Water Management Plan (BEMAX, 2006c).

These measures would continue to be implemented where relevant.

As described in Section 4.2.2, the use of non-slurried overburden as a subsoil growth medium in rehabilitation would eliminate the potential impacts that were associated with the use of slurried overburden. Therefore, the installation of seepage control measures (i.e. clay liners, low permeability embankments or toe drain/trenches) associated with the initial slurried overburden emplacement as outlined in the Snapper Mine EA and Snapper Mine WMP would not be required. The Snapper Mine WMP would be revised accordingly.

4.3 VISUAL CHARACTER

4.3.1 Existing Environment

The Snapper and Ginkgo Mines are located within an area of low hills, sand ridges, depressed open plains and playa plains. The area is characterised by Black Oak-Rosewood-Wilga Woodland, Bluebush Shrubland, Austrostipa Grassland, Chenopod Mallee Woodland/Shrubland and Irregular Dune Mallee Shrubland with comparatively small areas of Black Box Woodland and Turpentine Shrubland (BEMAX, 2007a).

Public viewpoints providing opportunity to view the Snapper and Ginkgo Mines are available along Nob Road and the HAR, although views are limited due to the low rolling topography and intervening vegetation. In addition, the number of potential viewers is limited due to the sparse settlement in the region and the low use of local public roads.

The "Manilla" homestead is the closest residence to the Snapper and Ginkgo Mines and is located within a slight topographical depression some 4 km away from the Snapper Mine ML boundary. Other properties within the proximity of the Snapper and Ginkgo Mines include the "Trelega" homestead (7 km south of the Snapper ML), the "Roo Roo" homestead (12 km north west of the Snapper ML) and the "Waukeroo" homestead (12 km south west of the Snapper ML).

The Snapper and Ginkgo Mines are the only significant artificial light sources in the remote rural area.

4.3.2 Potential Impacts

Snapper Mine

As for the approved Snapper Mine, the dredge mining operation would not generally be visible from any public viewpoints as the majority of activities would be undertaken below the natural ground level, although secondary mining would be utilised in various locations along the Snapper mine path and would be potentially visible for short periods where such mining is undertaken close to public vantage points.

The Snapper Mine EA identified three permanent landscape components that could present limited visual impacts to the viewscape from surrounding viewpoints, *viz*.:

- the overburden emplacement;
- the initial sand residue dam; and
- the initial water dam.

The Modification would alter the number and location of the overburden emplacements (i.e. proposed single overburden emplacement on the southern side of the mine path) and the location of the initial sand residue dam and the initial water dam (i.e. swapped with the overburden emplacement) (Section 2.2.1). The overburden emplacement would also increase in area from approximately 145 ha to approximately 215 ha (Section 2.2.1). However, the Modification would not increase the heights of these landforms as described in the Snapper Mine EA. Further, these landforms would be progressively rehabilitated throughout the life of the mine, as for the approved Snapper Mine.

As described in Section 2.3.1, the Modification would increase the final landform height of the backfilled mine path from approximately 2 to 4.5 m to approximately 10 m. Retention of the original elevation proposed for the backfilled mine path would increase the off-path overburden emplacement area because the off-path overburden emplacement elevation would not change. The backfilled mine path elevation has therefore been increased to minimise the off-path overburden area.

Public viewpoints providing opportunity to view these modified components would be available along Nob Road and the HAR. However, as for the approved Snapper Mine, the rolling topography, intervening vegetation and progressive revegetation of these landforms would limit potential impacts. In addition, the likely number of viewers would be limited due to the sparse settlement in the region and the low levels of public road use.

Night Lighting

The Modification would not change the number of lighting towers. Therefore, the nature of the night-lighting for the modified Snapper Mine would be of a similar intensity when compared to the approved Snapper Mine.

The Modification would not significantly change the locations where night-lighting is visible.

Ginkgo Mine

The Modification would not change the potential visual impacts associated with the Ginkgo Mine, given that there would be no change to Ginkgo Mine landforms, lighting or disturbance areas.

4.3.3 Mitigation Measures and Management

Visual Screening

As for the approved Snapper and Ginkgo Mines, the limited number of residences in the vicinity of the Snapper and Ginkgo Mine sites assists in limiting the potential impacts of the modified development. Given the distance to the nearest homestead ("Manilla") from the Snapper and Ginkgo Mine ML boundaries (approximately 4 km and 5 km from the Snapper and Ginkgo Mines respectively), the temporary nature of the accommodation camp and the proposed moderate elevation of the initial mine landforms, no specific visual impact mitigation measures are proposed.

Night Lighting

As for the approved Ginkgo and Snapper Mines, lighting would be directional and light shields would be used to minimise spill where practicable.

4.4 HYDROGEOLOGY

A Hydrogeological Assessment of the Modification was conducted by GEO-ENG (2010) and is presented in Appendix A.

4.4.1 Existing Environment

The hydrogeological setting for the Snapper and Ginkgo Mine areas is described in full in the Snapper Mineral Sands Project Hydrogeological Assessment (Golder Associates, 2007) and Appendix A and is summarised below.

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

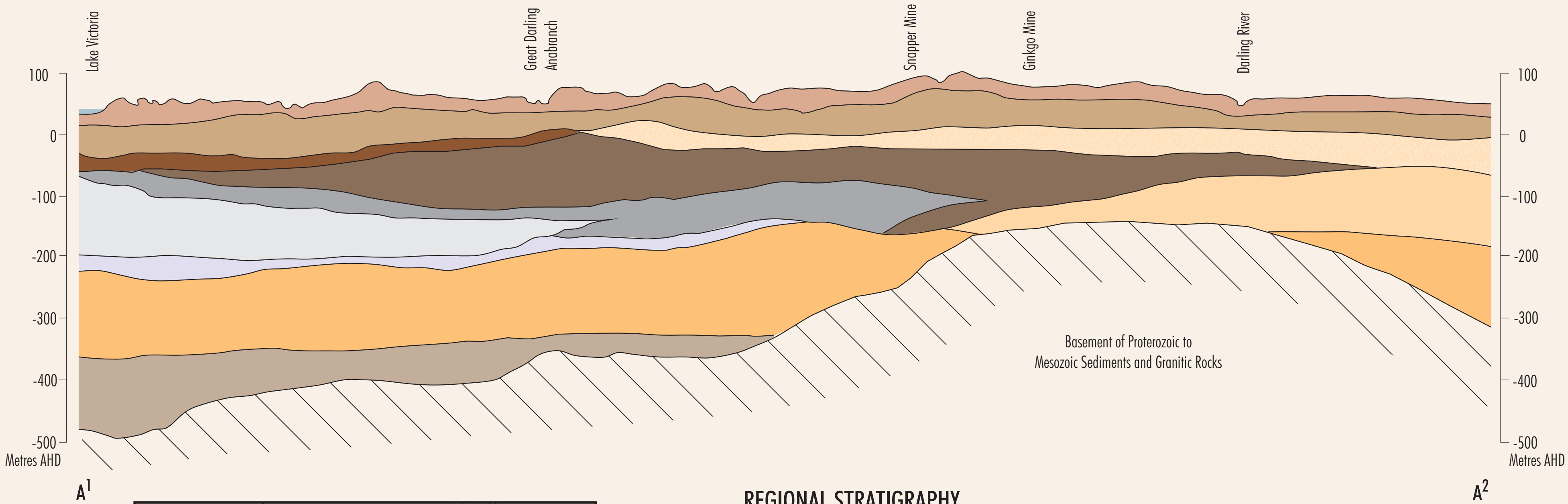
Saline aquifers within the Renmark Group have been mapped to include sand beds of the Upper, Middle and Lower Olney Formation and the basal Warina Sand (AGSO, 1993). The Snapper and Ginkgo ore bodies lie in the shallow, saline aquifer of the Loxton-Parilla Sands. Figure 14 provides a cross section of the regional stratigraphy at the Snapper Mine and Ginkgo Mine areas. At the Snapper and Ginkgo Mines, the Upper Olney Formation is indicated to be a thin zone of fine sand directly beneath and connected to the Loxton-Parilla Sands. The Middle Olney Formation is not well defined in the Snapper and Ginkgo Mine areas but is more significant to the north where it connects with both the Upper and Lower Olney Formations. The Lower Olney Formation and Warina Sand are located at approximately RL -170 m to RL -260 m beneath the Snapper Mine overlying pre-Tertiary bedrock, respectively. The Geera Clay Aquitard is approximately 130 m thick at the Snapper and Ginkgo Mines and separates the saline Upper and Lower Olney Formation units (Appendix A).

Groundwater monitoring results from the Ginkgo Mine and the Murray Basin Hydrogeological Map Series indicate salinities in excess of 35,000 mg/L for the shallow Pliocene Loxton-Parilla Sands aquifer and 14,000 mg/L to 35,000 mg/L for the deep Tertiary Lower Olney Formation/Warina Sand aquifer (Appendix A).

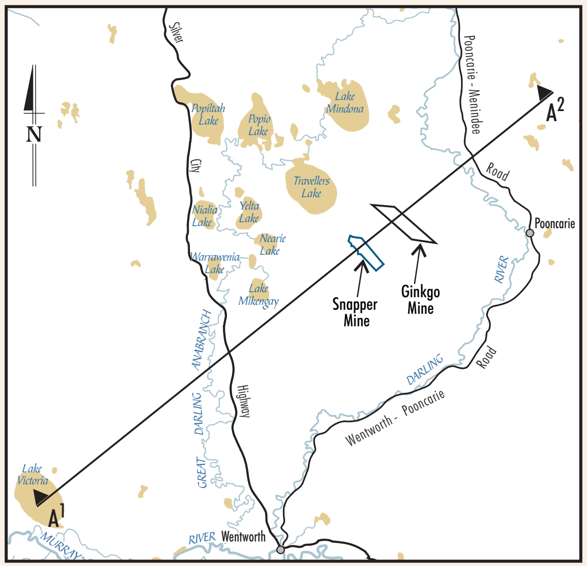
The groundwater flow in all aquifers is from recharge areas in the north and east to discharge areas in the south-west towards the Murray River and Lake Victoria. The groundwater gradient is very flat with a local gradient of about 1V:10,000H (Appendix A).

The Snapper and Ginkgo Mines are the only significant user of groundwater from the Loxton-Parilla aquifer in the vicinity of the mines (Appendix A). Recent regional groundwater level monitoring indicates little, if any, impact on the water level in regional bores since water extraction at the Ginkgo Mine began (BEMAX, 2009b).

The nearest farm bores, which exploit small freshwater lenses sitting on the saline water of the Loxton-Parilla Aquifer, are known as Chalky Well, Greenvale Well and Court Nareen Well. The freshwater lenses appear to be related to locations of concentrated infiltration due to topographic depressions. The nearest groundwater bore targeting the deeper Lower Olney Formation/Warina Sand aquifer is on the Popio Property about 45 km to the north-west of the Snapper Mine. Government records indicate it may be used for stock watering as the water quality improves in this direction (Appendix A).



REGIONAL STRATIGRAPHY



LEGEND

- Quaternary Sediments
- Loxton-Parilla Sands
- Bookpurnong Beds
- Upper Renmark Group
- Middle Remark Group
- Geera Clay
- Winnambool Formation
- Murray Group Limestone
- Ettrick Formation
- Lower Renmark Group
- Warina Sand

Not to Scale

Source: Golder Associates, 2001

MODIFICATION

FIGURE 14

Regional Stratigraphy

BEMAX RESOURCES LIMITED

BMX-09-21_003A

4.4.2 Potential Impacts

As described in Section 2.6, the supply of groundwater for the modified Snapper Mine would be sourced from the deeper, high yielding, Lower Olney Formation aquifer. By pumping this water to the dredge pond, the water from the Lower Olney Formation would be transferred to the shallow, saline Loxton-Parilla aquifer.

The Modification to the Snapper and Ginkgo Mines would potentially change the cumulative groundwater drawdown predictions presented in the Snapper Mine EA, groundwater supply to other groundwater users, groundwater quality and groundwater drawdown related impacts on regional hydrological features such as the Darling River and Great Darling Anabranch, Murray River, The Salt Lakes, Menindee Lakes, Great Darling Anabranch Lakes and Lake Victoria.

A cumulative transient groundwater model was developed by GEO-ENG (2010) as part of the Hydrogeological Assessment (Appendix A) to assess the impacts of the Modification on the above features. The model is based on the Golder Associates Hydrogeological Assessment (prepared for the Snapper Mine EA) with augmentation to provide more detail on the aquifer and aquitard parameters for the stratigraphical sequence below the Loxton-Parilla aquifer to reflect the proposal to draw water from the saline deeper Lower Olney. Model augmentation also included an updated water balance based on current mine water demand estimates. Appendix A includes details of the groundwater model set-up, hydrogeological parameters, groundwater requirements and calibration. Appendix A also provides a water balance for the modified Snapper and Ginkgo Mines.

Groundwater Drawdown Predictions

Figures 15 and 16 provide the cumulative groundwater drawdown predictions for the modified Snapper and Ginkgo Mines at the end of the Snapper Mine life, for the shallow saline Loxton-Parilla Sands aquifer and the deeper, higher yielding, saline Lower Olney Formation aquifer, respectively.

Modelling predicts that the maximum extent of groundwater drawdown would be reduced for the shallow Loxton Parilla Sands aquifer and an increased drawdown in the deeper Lower Olney Formation aquifer.

Because the modified design of the Snapper Mine utilizes the lower aquifer for its bore water supply the effect of mining on the upper aquifer is significantly reduced. A groundwater mound would form in the upper aquifer around Snapper Mine, offsetting most of the decline in this aquifer caused by Ginkgo Mine. The net result for the upper aquifer would be a smaller groundwater decline around Ginkgo Mine and a limited groundwater mound centred at Snapper Mine (Appendix A).

The maximum expected drawdown in the lower aquifer occurs at about Snapper Year 7, as after this time the groundwater pumping requirements decrease. Twenty years after mining is completed, there is estimated to be no measurable effect in the lower aquifer (Appendix A).

The implications of these drawdown predictions on regional hydrogeological features and other groundwater users are discussed below.

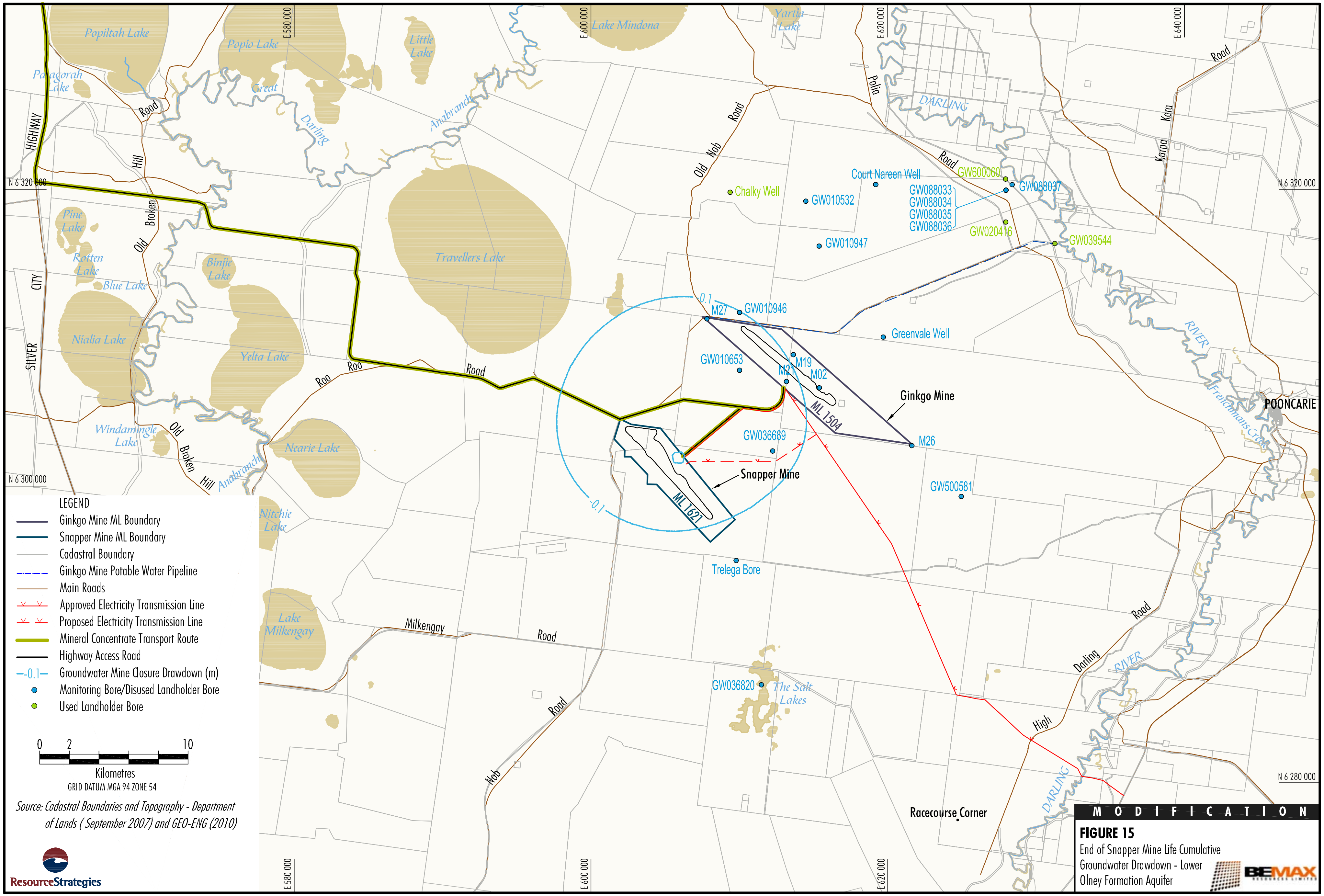


FIGURE 15
End of Snapper Mine Life Cumulative Groundwater Drawdown - Lower Olney Formation Aquifer

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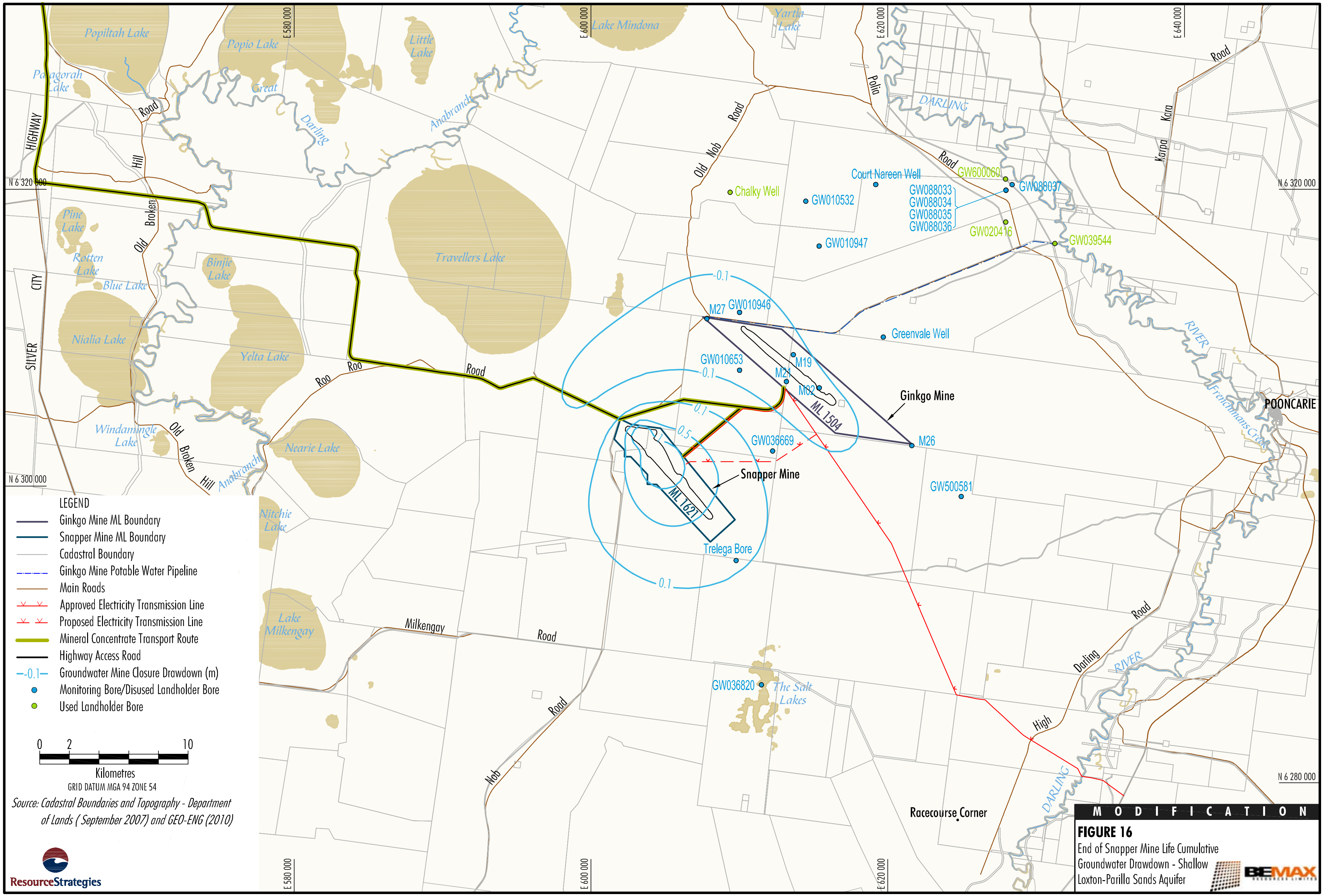

FIGURE 16
End of Snapper Mine Life Cumulative Groundwater Drawdown - Shallow Loxton-Parilla Sands Aquifer

BMX-09-21_116A

Other Groundwater Users

The nearest farm bores, which exploit small freshwater lenses immediately above the saline water of the Loxton-Parilla Aquifer, are known as Chalky Well, Greenvale Well and Court Nareen Well (currently disused). The freshwater lenses appear to be related to locations of concentrated infiltration due to topographic depressions. With the proposed reduction in use of the water from the Loxton-Parilla aquifer, these bores are predicted to experience a drawdown in the order of 5 cm which is less than the drawdown predicted for the Snapper Mine. Thus predicted drawdown would be unlikely to affect this supply (Appendix A).

Regional Hydrological Features

Based on groundwater modelling results for the Modification, the change in groundwater levels beneath local surface water features (Darling River, Darling Anabranch and associated lakes, The Salt Lakes, Lake Victoria and the Murray River), would not have any measureable effect on these features. The ultimate net effect of the Ginkgo and Snapper Mines on the regional groundwater system would be a small reduction of salt water flowing to the Murray River over the medium to long term (i.e. 50 to 100 years) (Appendix A).

Groundwater Quality

Groundwater from the deeper Lower Olney aquifer has lower TDS, than groundwater from the shallower Loxton-Parilla aquifer. Thus there would be a slight dilution of the dissolved salt in the upper aquifer around the Snapper Mine as a result of the Modification, given that water for the Snapper Mine will be drawn from the less saline deeper Lower Olney aquifer and transferred to the shallower Loxton-Parilla aquifer. This effect is not expected to be measureable at any groundwater bores or regional hydrological features (Appendix A).

Lateral Saline Seepage from Dams and Slurried Materials.

The Modification does not involve slurrying of overburden materials, therefore the Modification would result in a reduction in lateral saline seepage from slurried materials described in the Snapper Mine EA. The Modification is not expected to increase lateral seepage from dams above those levels predicted for the Snapper Mine EA, given that the design concepts and management measures relevant to the dams would remain unchanged.

4.4.3 Mitigation Measures and Management

Given the minimal environmental impact of the Modification to the Snapper and Ginkgo Mines, BEMAX would continue to implement the existing management measures and monitoring described in the Snapper Mine Environmental Monitoring Program and Borefield Impact Management Plan with additional groundwater depth and salinity monitoring in the Lower Olney Formation aquifer (Appendix A).

4.5 SURFACE WATER

4.5.1 Existing Environment

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

There are no well defined natural drainage channels within the ML areas of the Snapper and Ginkgo Mines. Overland flow does occur during prolonged rainfall events and surface waters accumulate in topographic depressions and then evaporate or seep to the groundwater table over time.

4.5.2 Potential Impacts

The potential hydrogeological impacts of the Modification on surface water features are described in Section 4.4.2.

Snapper Mine Area

As for the approved Snapper Mine, the potential impacts of the Snapper Mine on surface water systems are limited due to the distance of the mining activity from any significant surface water systems.

The Modification would not significantly change the potential for diesel or oil spills from mobile equipment and sediment or salt runoff to localised short-term water features during heavy rain.

Ginkgo Mine Area

The Modification would not change the potential surface water impacts associated with the Ginkgo Mine, given that there would be no change to Ginkgo Mine landforms or disturbance areas.

4.5.3 Mitigation Measures and Management

Potential impacts to surface water at the Snapper and Ginkgo Mines are currently managed via implementation of measures included in the following:

- Snapper Mine Water Management Plan (BEMAX, 2008a);
- Ginkgo and Snapper Mineral Sand Mines and Broken Hill Mineral Separation Plan Transport Management Plan (BEMAX, 2007c);
- Ginkgo Mine Integrated Erosion and Sediment Control Plan (BEMAX, 2005b); and
- Ginkgo Mine Site Water Management Plan (BEMAX, 2006c).

These measures would continue to be implemented where relevant.

4.6 ABORIGINAL CULTURAL HERITAGE

A Cultural Heritage Assessment was prepared for the Snapper Mine EA by Landskape (2007) which assessed potential Aboriginal cultural heritage impacts of the Snapper Mine. The Cultural Heritage Assessment included a survey of the Snapper Mine ML area and associated ETL and HAR extensions (Landskape, 2007).

An Archaeological and Cultural Heritage Assessment was prepared for the Ginkgo Mine EIS by Witter Archaeology (2001) which assessed potential Aboriginal cultural heritage impacts of the Ginkgo Mine. The Archaeological and Cultural Heritage Assessment included a survey of the Ginkgo Mine ML area and associated HAR, ETL and potable water pipeline.

As described in Section 2.2.3, the Modification would include a change to the alignment of the ETL in order to facilitate a more direct alignment of the ETL. A supplementary Aboriginal Cultural Heritage Assessment has therefore been prepared by Landskape (2010) to assess the potential impacts of the modified ETL on Aboriginal cultural heritage. This supplementary Aboriginal Cultural Heritage Assessment is included in Appendix B.

4.6.1 Existing Environment

Snapper Mine

Archaeological field surveys were undertaken for the Snapper Mine EA using both area survey and linear transect methodologies. Twenty-two Aboriginal archaeological sites (SN01-22) were identified as shown on Figure 17. Table 5 provides a summary of the physical characteristics of the sites and the location of the sites within the approved Snapper Mine area.

Table 5
Aboriginal Archaeological Sites within the Snapper Mine ML Area

Site Name	Physical Characteristics	Location (Figure 17)
SN01, SN11	Quarried silicified and ferruginized sandstone cobbles with associated silcrete artefacts.	Sandplains at the southern end of the Snapper Mine ML area.
SN02	Scatter of silcrete, chert and quartz artefacts with two associated *in situ* hearths of baked clay heat retainers.	Adjacent to a small ephemeral depression at the northern end of the Snapper Mine ML area.
SN03, SN05	Isolated finds of a silcrete scraper and fragment of a quartzite pestle/hammerstone.	Northern end of the Snapper Mine ML area.
SN04, SN06	Scattered baked clay heat retainers from eroded hearths.	
SN07	Scatter of silcrete and quartz artefacts with associated scattered calcrete hearthstones.	
SN08, SN10, SN12, SN13, SN14, SN15, SN17, SN18, SN19, SN21	Scatters of silcrete artefacts.	Southern end of the Snapper Mine ML area.
SN09, SN16	Isolated finds of silcrete artefacts.	
SN20, SN22	Quarried silcrete outcrops with associated scatters of silcrete artefacts.	

Source: Landskape, 2007

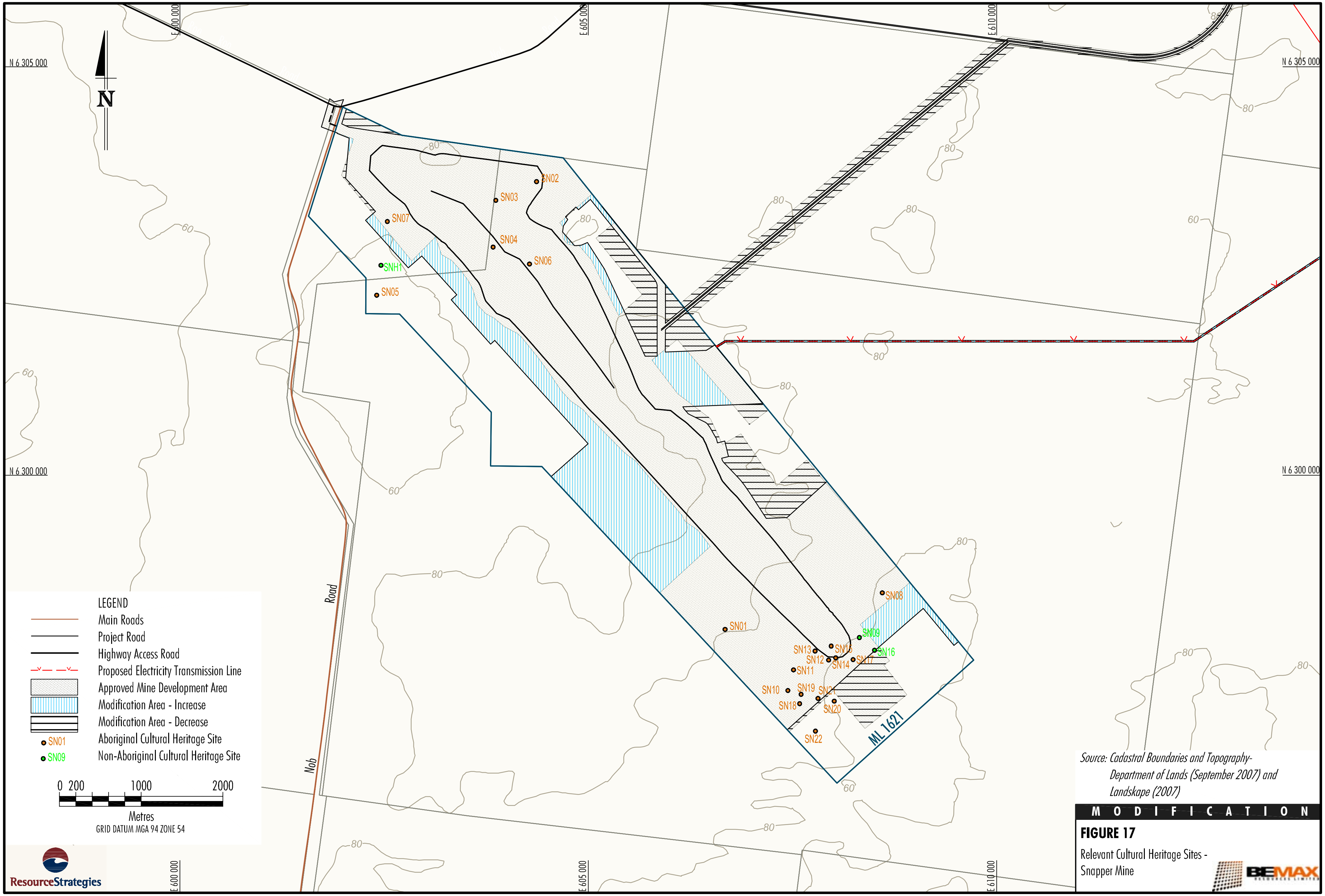

FIGURE 17
Relevant Cultural Heritage Sites - Snapper Mine

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Of the sites presented in Table 5, sites SN20 and SN22 were considered to be of moderate-to-high significance, with the remainder considered to be of low or low-to-moderate significance (Landskape, 2007).

Fieldwork conducted for the 2009 supplementary Aboriginal Cultural Heritage Assessment (Landskape, 2009) inspected the proposed corridor for the modified ETL using a pedestrian survey. No Aboriginal heritage sites or places were identified within the modified ETL corridor (Appendix B).

Ginkgo Mine

Archaeological field surveys of the Ginkgo Mine ML area were undertaken for the Ginkgo Mine EIS from the 25 April to 3 March 2001, with an additional day on 11 May 2001. The field survey was conducted using linear transects. Nine sites and 24 isolated finds (i.e. artefacts) were identified within the Ginkgo Mine ML area. Table 6 provides a summary of the physical characteristics of the sites.

Table 6
Aboriginal Archaeological Sites within the Ginkgo Mine ML Area

Site Number	Site Name	Site Type	Description
Gk-1	Dune Site	Camp Site	24 scattered artefacts and scattered oven stones
Gk-2	Cache Site	Camp Site	4 artefacts, 1 ochre, 1 mussell shell
Gk-3	Knoll Site	Camp Site	7 artefacts and 1 hearth
Gk-4	Waterhole Site	Camp Site	122 artefacts and 2 in situ fire places, 5 scattered hearths
Gk-5	Playa Site	Camp Site	73 artefacts, 2 scattered hearths
Gk-6	Lake Bottom Site	Camp Site	24 artefacts and 1 scattered hearth
Gk-7	Lake Edge Site	Camp Site	24 artefacts
Gk-8	Lunette Site	Camp Site	20 artefacts including a half muller
Gk-9	Quamby Site	Camp Site/ Quarry Site	An estimated 1,000 artefacts, 1 mortar, 1 hammerstone and an estimated 10 hearths

Source: BEMAX (2001a)

4.6.2 Potential Impacts

Snapper Mine

The potential impacts of the Modification on Aboriginal cultural heritage at the Snapper Mine would include the potential for direct and indirect impacts.

Direct Impacts

Nineteen Aboriginal cultural heritage sites were located within the original Snapper Mine disturbance area (BEMAX, 2007a). The Modification would avoid Aboriginal cultural heritage sites previously recorded within the Snapper Mine ML area (Figure 17).

No additional Aboriginal cultural heritage sites were located within the modified ETL corridor (Appendix B).

Therefore, the Modification would not change the potential direct impacts on Aboriginal heritage assessed for the approved Snapper Mine.

Indirect Impacts

The three Aboriginal cultural heritage sites located outside modified Snapper Mine disturbance area have the potential to be indirectly impacted in the absence of relevant mitigation measures. Potential indirect impacts to the sites could include the following:

- deposition of dust generated by mining;
- accidental disturbance by peripheral activities; and
- inappropriate visitation.

Ginkgo Mine

The Modification does not involve any additional surface disturbance at the Ginkgo Mine, therefore modification to the Ginkgo Mine would not impact on Aboriginal cultural heritage.

4.6.3 Mitigation Measures and Management

The mitigation and management measures for Aboriginal cultural heritage are described in the Snapper Mine Aboriginal Cultural Heritage Management Plan (ACHMP) (BEMAX, 2007c) and the Ginkgo Mine Barkandji Heritage Management Plan (BHMP) (BEMAX, 2004). The mitigation and management measures described in the ACHMP and BHMP would continue to be implemented for the modified Snapper and Ginkgo Mines.

4.7 NON-ABORIGINAL CULTURAL HERITAGE

A Cultural Heritage Assessment was prepared for the Snapper Mine EA by Landskape (2007) which assessed the potential non-Aboriginal cultural heritage impacts of the Snapper Mine. The Cultural Heritage Assessment included a survey of the Snapper Mine ML area and associated ETL and HAR extensions (Landskape, 2007).

A European Heritage Assessment was prepared for the Ginkgo Mine EIS by Witter Archaeology (2001) which assessed the potential European cultural heritage impacts of the Ginkgo Mine. The European Heritage Assessment included a survey of the Ginkgo Mine ML area and associated HAR, ETL and potable water pipeline (Witter Archaeology, 2001).

4.7.1 Existing Environment

Previously Recorded Non-Aboriginal Cultural Heritage Sites

Table 7 provides a summary of the non-Aboriginal cultural heritage sites previously recorded within the Snapper and Ginkgo Mine areas by Landskape (2007) and Witter Archaeology (2001), respectively.

Table 7
Previously Recorded Non-Aboriginal Cultural Heritage Sites

Site	ID	Type	Location
"Bluebush Tank"[1]	Eu-1	Tank, historic refuse dump	Ginkgo Mine ML area – outside approved disturbance area.
"Quamby Tank"[1]	Eu-2	Tank and windmill	Ginkgo Mine ML area – outside approved disturbance area.
Surveyor's Post[1]	Eu-3	Carved wooden post marking Western Lands Lease boundaries	HAR – within approved disturbance area.
"Greenvale"[1]	Eu-4	Homestead complex	Ginkgo potable water pipeline route – within approved disturbance area.
"Kertne Nob"[2]	SNH1	Outstation and Stockyard Ruin	Snapper Mine ML area – outside approved disturbance area.

Source: [1] Witter, 2001
[2] Landskape, 2007

The NSW State Heritage Inventory contains items listed by the Heritage Council under the *Heritage Act, 1977*. The Wentworth LEP also lists heritage sites within the Wentworth Shire.

The "Windamingle" homestead is the closest registered (NSW Heritage database) site to the Snapper Mine and is located approximately 33 km south-west of the Snapper and Ginkgo Mines (NSW Heritage Office, 2006) (Landskape, 2007).

The "Carstairs" homestead is listed as a heritage item (WSC, 1993, 2006) in the Wentworth Shire Heritage Study (WSC Heritage Item Number 103) (Hassell Planning Consultants, 1989; WSC, 1993) and is located approximately 30 km east of the Snapper and Ginkgo Mines (Landskape, 2007).

4.7.2 Potential Impacts

The Modification would avoid non-Aboriginal cultural heritage sites previously recorded within the Snapper and Ginkgo Mine areas (Table 7). Therefore, the Modification would not change the potential impacts on non-Aboriginal heritage assessed for the approved Snapper and Ginkgo Mines.

4.7.3 Mitigation Measures and Management

The mitigation and management measures described in the Snapper Mine EA and Ginkgo Mine EIS would continue to be implemented for the modified Snapper and Ginkgo Mines.

4.8 ROAD TRANSPORT

4.8.1 Existing Environment

Road Hierarchy

The main arterial road in the Snapper Mine area is State Highway No. 22 (Silver City Highway), which provides a sealed north-south route connecting Mildura to the south with Broken Hill in the north. State Road (SR) 68 provides a north-south arterial route to the east of the Ginkgo Mine, connecting the township of Wentworth with Pooncarie and Menindee in the north.

Local unsealed roads in the vicinity of the Snapper Mine include Old Roo Roo Road, and Nob Road, which provide unsealed east-west routes connecting the Silver City Highway with SR No. 68. The existing approved 64 km HAR from the Ginkgo Mine to the Silver City Highway comprises an unsealed road (including sections of Old Roo Roo and Nob Roads). The section of the existing approved HAR to the east of Nob Road is a private road maintained by BEMAX. Construction of the approved extension of the HAR between the mines was completed in early 2010. The construction of this approximate 6 km of private road to provide access between the mines was described in the Snapper Mine EA. This section of private road was constructed to the same specifications as the existing approved HAR, and is suitable for 200 t road trains, double road trains and AB-triple vehicles.

Mineral Concentrate Transport to the MSP

The Snapper and Ginkgo Mines presently use a fleet of 55 t payload double road trains to transport materials to and from the MSP via the HAR and Silver City Highway. Other vehicles may be used subject to obtaining relevant RTA and/or council approvals.

Temporary Ore Transport from Snapper Mine to Ginkgo Mine

BEMAX currently transport Snapper Mine high-grade ore from the Snapper Mine to the Ginkgo Mine using 200 t road trains, on a temporary basis (i.e. approximately 2 Mt over a period of approximately 12 months) (assessed as part of the November 2009 Modification).

No complaints have been received regarding traffic-related noise associated with this haulage between the two mines.

The Snapper Mine EA described the construction of approximately 6 km of private road between the Ginkgo and Snapper Mines (Figure 2), to provide access between the mines. This section of private road has been constructed to the same specifications as the existing approved HAR, which carries double road trains and AB-triple vehicles and is suitable for the larger 200 t road trains. The construction of this private road section of the HAR includes the installation of drainage culverts to maintain surface drainage flows, where appropriate.

A water truck sprays the private road section of the HAR to suppress dust, as required. Any areas that have been treated with saline dust suppression water that are not to be retained for alternative uses by the landholder would be rehabilitated. As previously described for the Snapper Mine, areas where saline water is applied as a dust suppressant would be tested prior to rehabilitation to determine the suitability of the surface materials as a revegetation medium. If necessary (i.e. where material is unsuitable), the affected surface materials would be disposed with sand residues within the mine paths.

4.8.2 Potential Impacts

Mineral Concentrate Transport to the MSP

The Modification would not increase the approved traffic movements from the Snapper and Ginkgo Mines to the MSP. Therefore, no impacts on the local and regional public road network would result from the Modification.

During the 2006, 2007 and 2008 reporting periods, no complaints were received regarding operations (including road transport) associated with the Ginkgo Mine (BEMAX, 2007b; 2008b; 2009b).

Transport of HMC between the Snapper and Ginkgo Mines

As described in Section 2.3.8, the Modification would include the trucking of HMC and HMC treatment waste between the Snapper and Ginkgo Mines, dependent on the location of the HMC treatment facility. HMC would be trucked between the mines along the private road section of the approved HAR (Figure 2), using AB-triple vehicles or 200 t road trains. The frequency of AB-triple vehicles would be a maximum of 1 to 2 trips per hour (3 vehicle movements per hour). AB-triple vehicles would be used on the return trip from the MSP. For example, on the return from the MSP AB-triple vehicles would enter the Snapper Mine site at the northwest entrance and unload backloaded MSP process waste, then be loaded with HMC and transport that HMC to the Ginkgo Mine along the private road between the two mines. That is, the use of AB-triple vehicles would not involve an increase to the number of operational trucks – the AB-triple vehicles would "detour" on their return trip from the MSP and go via the private section of HAR between the two mines instead of the private section of the HAR to the east of Nob Road. The frequency of 200 t road trains transporting HMC and HMC treatment waste between the Snapper and Ginkgo Mines along the private road would be a maximum of 1 trip every two hours (1 vehicle movement per hour). The frequency of AB-triple vehicle or road train movements would be less than the frequency of road train movements along the private road approved (for transporting ore on a short-term basis) as part of the November 2009 Modification (which approved a maximum of 2 trips per hour [4 vehicle movements per hour]). The proposed transport of HMC and HMC treatment waste would not occur at the same time as the transport of ore between the Snapper and Ginkgo Mines.

Temporary Ore Transport from Snapper Mine to Ginkgo Mine

As stated in Section 2.3.6, the frequency of 200 t road trains transporting the Snapper Mine high-grade ore to the Ginkgo Mine along the private road would be a maximum of 2 trips per hour (4 vehicle movements per hour), as for the approved Snapper Mine.

The Modification would not increase the approved traffic movements from the Ginkgo and Snapper Mines to the MSP. Therefore, no impacts on the local and regional public road network would result from the Modification.

During the 2006, 2007 and 2008 reporting periods, no complaints were received regarding operations (including road transport) associated with the Ginkgo Mine (BEMAX, 2007d; 2008c; 2009b).

4.8.3 Mitigation Measures and Management

The mitigation and management measures for road transport are described in the Ginkgo and Snapper Mineral Sand Mines and Broken Hill Mineral Separation Plant Transport Management Plan (TMP) (BEMAX, 2007b). The mitigation and management measures for road transport described in the TMP would continue to be implemented for the modified Ginkgo and Snapper Mines.

In addition, and as previously described in Section 4.8.1, a water truck would spray the private road section of the HAR to suppress dust, as required. Any areas that have been treated with saline dust suppression water that are not to be retained for alternative uses by the landholder would be rehabilitated. Areas where saline water is applied as a dust suppressant would be tested prior to rehabilitation to determine the suitability of the surface materials as a revegetation medium. If necessary (i.e. where material is unsuitable), the affected surface materials would be disposed with sand residues within the mine paths.

4.9 FLORA

A detailed flora assessment was prepared by FloraSearch and Resources Strategies (2007) for the Snapper Mine EA (BEMAX, 2007a), generally in accordance with the Draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

This Section provides a description of the existing environment relating to flora (Section 4.9.1), an assessment of the potential impacts of the Modification on flora (Section 4.9.2), flora mitigation, management and monitoring (Section 4.9.3) and offset measures (Section 4.9.4).

4.9.1 Existing Environment

The landuse in the surrounding area is predominantly livestock grazing of on Perpetual Western Land Leases. A total of 145 vascular plant species were identified within the Snapper Mine area, of which 111 are native (FloraSearch and Resources Strategies, 2007).

FloraSearch undertook flora surveys in ML 1621 and along the HAR extension in autumn and spring 2006 (FloraSearch and Resources Strategies, 2007). The surveys involved quadrat sampling, spot sampling, transects, targeted surveys for threatened flora species and vegetation community mapping.

During the surveys, seven plant communities were identified (Figure 18). Five of the vegetation communities (1 to 5) are considered to represent the original native climax vegetation communities of the South Olary Plain. Vegetation communities 6 and 7 are considered to be secondary vegetation communities resulting from removal of the original tree cover by pastoral landholders to promote grass (FloraSearch and Resources Strategies, 2007).

In spring 2009, FloraSearch (2009) undertook similar detailed flora surveys in the Snapper Mine Offset Area 2, which is located approximately 2 km east of the Snapper Mine (Figure 18). Vegetation communities similar to those identified in ML 1621 are mapped within the Offset Area 2. A total of 66 vascular plant species were identified within Offset Area 2, of which 59 are native (FloraSearch, 2009).

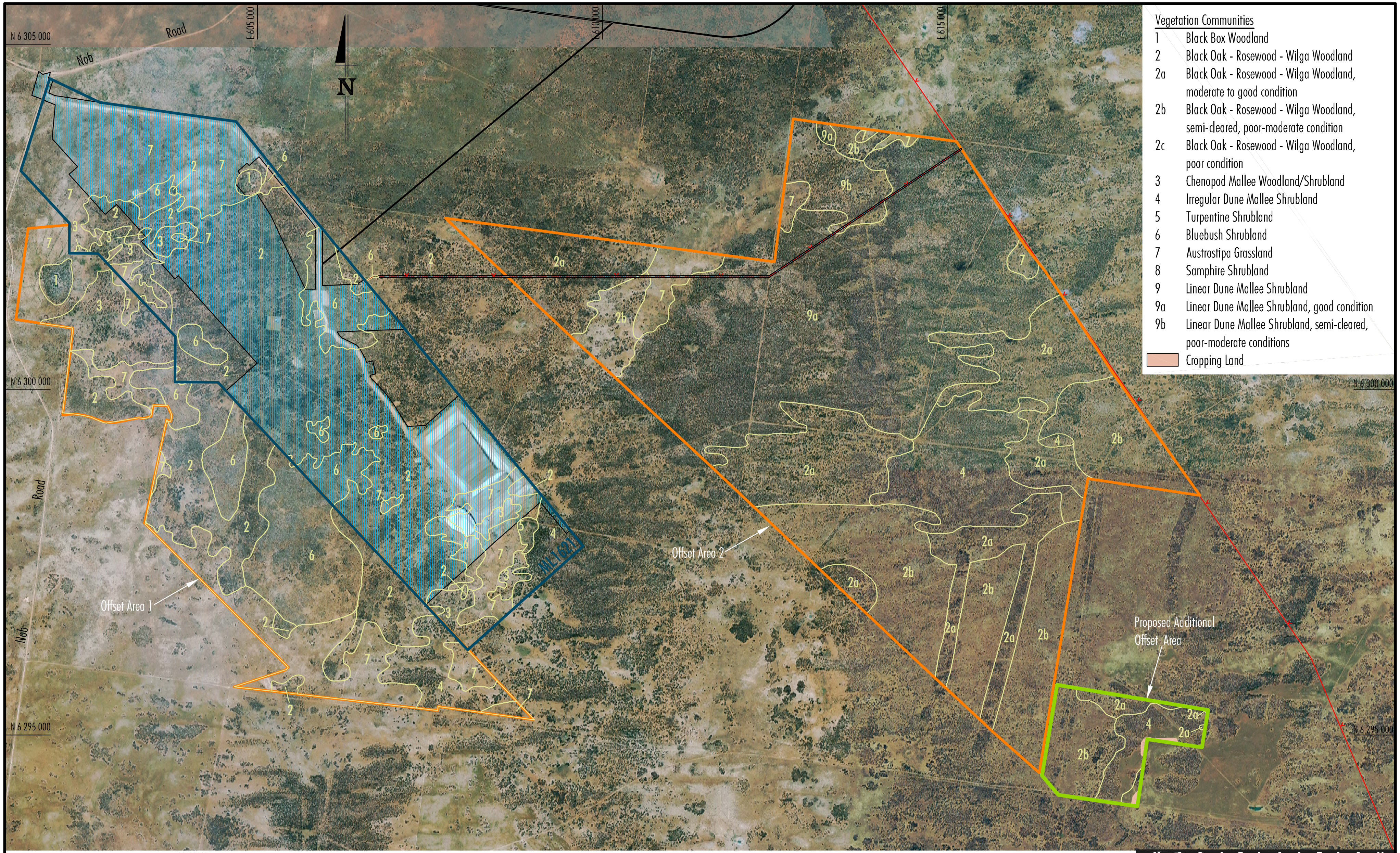
In addition to the above baseline flora surveys, pre-clearance flora surveys have been undertaken in ML 1621 by Ogyris (2009).

No threatened flora species, populations or ecological communities listed under the TSC Act or EPBC Act have been identified in ML 1621 or Offset Area 2 (FloraSearch, 2009; Ogyris, 2009; FloraSearch and Resources Strategies, 2007).

One noxious weed (DPI, 2010) was recorded in ML 1621, namely Horehound (*Marrubium vulgare*), by FloraSearch and Resources Strategies, 2007. This species was also recorded during the surveys of the Offset Area 2 (FloraSearch, 2009). There has been no additional noxious weed species for the Wentworth Shire (Department of Primary Industries [DPI], 2010) recorded in the Modification area since the Snapper Mine EA.

4.9.2 Potential Impacts

The following sub-sections identify the potential impacts of the Modification on flora. The measures to avoid, mitigate and offset potential impacts are provided in Section 4.9.3.



LEGEND

Snapper Mine ML Boundary

Modified Snapper Mine Areas

Existing Electricity Transmission Line

Proposed Electricity Transmission Line

0 1 2

Kilometres

GRID DATUM MGA 94 ZONE 54

Source: Bemax (2009); Department of Lands (September 2007); FloraSearch (2007); FloraSearch and Resource Strategies (2007) and FloraSearch (2009)

ResourceStrategies

MODIFICATION

FIGURE 18

Snapper Mine and Offset Vegetation Communities

BEMAX

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Direct Impacts - Vegetation Clearance

The Modification would result in a change to the areas approved to be cleared and approximately 81 ha of additional vegetation clearance (Table 8).

Table 8
Vegetation Clearance

Vegetation Community		Approved Snapper Mine Disturbance Area (ha) [1]	Modification Disturbance Area (ha) [2]	Net Modification Disturbance Area (ha)
1	Black Box Woodland	0	1	1
2	Black Oak-Rosewood-Wilga Woodland	1,075	1,045	-30
3	Chenopod Mallee Woodland/Shrubland	30	40	10
4	Irregular Dune Mallee Shrubland	0	5	5
5	Turpentine Shrubland	0	0	0
6	Bluebush Shrubland	200	200	0
7	*Austrostipa* Grassland	325	410	85
8	Samphire Shrubland	0	0	0
9	Linear Dune Mallee Shrubland	0	10	10
	TOTAL AREA	**1,630**	**1,711**	**81**

1 BEMAX (2007a)

2 Areas are based on vegetation mapping shown on Figure 18

The same vegetation communities approved to be disturbed are proposed to be disturbed for the modified Snapper Mine, along with three additional communities, namely, Black Box Woodland (Vegetation Community 1), Irregular Dune Mallee Shrubland (Vegetation Community 4) and Linear Dune Mallee Shrubland (Vegetation Community 9) (Table 8). Although not previously proposed to be disturbed, large areas of these vegetation communities occur within the current offset area, i.e. 24 ha, 428 ha and 1703 ha, respectively (Section 4.9.4).

Black Oak-Rosewood-Wilga Woodland (Vegetation Community 2) and *Austrostipa* Grassland (Vegetation Community 7) are related communities as the *Austrostipa* Grassland has been created as a result of past clearing of Black Oak-Rosewood-Wilga Woodland. The modified Snapper Mine would result in 30 ha less clearance of Black Oak-Rosewood-Wilga Woodland and an increase of 85 ha of *Austrostipa* Grassland (Section 4.9.4).

As previously described in the Snapper Mine EA (BEMAX, 2007a), ground disturbance for ETL construction would largely be limited to vegetation clearance of a 10 to 20 m wide corridor to allow for stringing of the overhead conductor and any additional clearance requirements for equipment stockpiles or vehicle access. Based on a 20 m wide clearance corridor, the modified ETL would, conservatively, involve the clearance of approximately 20 ha of the following communities outside ML 1621:

- approximately 9 ha of Linear Dune Mallee Shrubland (including 7 ha in good condition [Vegetation Community 9a] and 2 ha in semi-cleared poor condition [Vegetation Community 9b]);
- approximately 4.5 ha of Black Oak-Rosewood-Wilga Woodland (including 4 ha in moderate to good condition [Vegetation Community 2a] and 0.5 ha in semi-cleared poor condition [Vegetation Community 2b]);
- approximately 0.5 ha of Bluebush Shrubland (Vegetation Community 6); and
- approximately 5 ha of *Austrostipa* Grassland (Vegetation Community 7).

The change in alignment of the ETL minimises its length and would be located in Offset Area 2. Vegetation clearance along the modified ETL would be minimised where practicable using techniques such as selective clearing (i.e. minimising vegetation clearance to higher midstorey and upperstorey vegetation).

Indirect Impacts

Indirect impacts on flora were assessed as part of the Snapper Mine EA (BEMAX, 2007a) including the potential for introduced flora and fauna species, detrimental effects of salt water on revegetation, airborne salts and dust.

Potential impacts associated with introduced flora and fauna are not likely to change as a result of the Modification since the additional disturbance areas are largely adjacent to approved disturbance areas. BEMAX currently manage introduced flora and fauna in accordance with the FFMP (BEMAX, 2007e).

The Snapper Mine EA described the potential for entrained water within slurried overburden to migrate upwards in the soil profile via capillary rise and airborne salts to occur once slurried materials dry. The modified Snapper Mine does not propose overburden slurrying and therefore would remove this potential impact (Section 2.3.3).

Threatened Flora Species, Population or Ecological Communities

As previously stated, no threatened flora species, populations or ecological communities listed under the TSC Act or EPBC Act have been identified in the Modification, despite multiple surveys (FloraSearch, 2009; FloraSearch and Resources Strategies, 2007).

A review of the DECCW (2010a), SRBG (2010) and NSW Government (2010) databases was undertaken to identify any additional threatened flora species records since 2007. There were no additional nearby records. The preliminary and final determinations of the NSW Scientific Committee (DECCW, 2010b) were also reviewed for any additional listing of flora species which may occur in the Modification area. There were no newly listed flora species relevant to the Modification area.

While approximately 2 km of the modified ETL, has not been previously surveyed for threatened flora species, there is a low likelihood that any threatened flora species occur in the proposed corridor as no threatened species have been recorded in adjacent similar habitat type in a similar condition, despite surveys. The vegetation in this area comprises of Black Oak-Rosewood-Wilga Woodland (Vegetation Community 2) and Bluebush Shrubland (Vegetation Community 6).

4.9.3 Mitigation Measures and Management

The potential flora impacts resulting from the approved Snapper Mine are currently managed via the implementation of existing management protocols, plans and programs, including the following:

- Flora and Fauna Management Plan (FFMP) (BEMAX , 2007e);
- Vegetation Clearance Protocol (VCP);
- Threatened Species Management Protocol (TSMP);
- grazing management;
- control of introduced flora species;
- vegetation monitoring;
- dust suppression;
- bushfire risk management;
- vehicular traffic management; and
- rehabilitation/revegetation of the disturbance areas.

These are described below.

Flora and Fauna Management Plan

The FFMP (BEMAX, 2007e) details flora and fauna impact avoidance and mitigation measures. The FFMP includes measures to be undertaken during construction and operation, including a VCP, TSMP, grazing management, control of introduced flora species, control of introduced animal species, vegetation monitoring and bushfire management.

Vegetation Clearance Protocol

A VCP has been developed to minimise the removal/modification of flora species and their habitats. Key components of the VCP which apply to flora include the delineation of areas to be cleared of remnant vegetation. Vegetation clearance along the modified ETL would be minimised, where practicable, using techniques such as selective clearing (i.e. minimising vegetation clearance to higher midstorey and upperstorey vegetation).

Threatened Species Management Protocol

A TSMP has been prepared to facilitate the management and minimisation of potential impacts on threatened species. Key components of the TSMP which apply to flora include site observations/ surveys, threatened species management strategies and reporting.

In the event that any threatened flora species are recorded in this area during pre-clearance surveys, BEMAX would manage the impacts in accordance with the existing TSMP.

Grazing Management

As proposed for the approved Snapper Mine, appropriate fencing has been used to prevent the uncontrolled entry of livestock within the progressive work and rehabilitation areas for the life of the mine.

Control of Introduced Flora Species

Control measures are implemented at the approved Snapper Mine to minimise the occurrence of weeds. Control measures include the mechanical removal of identified weeds and/or the application of approved herbicides in authorised areas.

Vegetation Monitoring

A photographic monitoring programme would be developed to assess the performance of the rehabilitation areas and monitor the health of the vegetation surrounding the mine path and initial overburden emplacement.

Dust Suppression

Dust suppression is undertaken on the Snapper Mine roads within ML 1621.

Bushfire Risk Management

The potential for a change in the frequency of fires due to the Snapper Mine has been reduced through implementation of the Emergency Response Plan.

Vehicular Traffic Management

To reduce the potential for vehicular related vegetation disturbance, the number of roads constructed for the Snapper Mine has been minimised and employees and contractors have been instructed to only use the Snapper Mine roads.

Rehabilitation/Revegetation of the Disturbance Areas

As for the approved Snapper Mine, the disturbance areas associated with the modified Snapper Mine would be progressively rehabilitated and revegetated as mining proceeds and infrastructure is decommissioned. The revegetation programme provides for the selective planting of species characteristic of the vegetation communities cleared. Rehabilitation and revegetation would be progressive and would aim to re-establish vegetation across the disturbance areas.

4.9.4 Offset

The approved Snapper Mine offset area includes the Offset Area 2 and a proportion of the approved Offset Area 1[2] (Figure 18). The approved Snapper Mine offset area is located on the Trelega Property which is a perpetual Western Lands Lease, leased to BEMAX.

2 The existing Offset Area 1 has an area of 1,579 ha. This includes 521 ha which represents the approved Ginkgo Mine offset and 1,058 ha which represents part of the approved Snapper Mine offset.

Plate 1 – Snapper Mine Offset Area

The *Snapper Mineral Sands Mine Offset Modification Environmental Assessment* (BEMAX, 2009a) described how the Approved Snapper Mine offset area was designed to maintain or improve biodiversity values. The vegetation communities within the approved Snapper Mine disturbance area and approved Snapper Mine offset are quantified in Table 9.

Table 9
Approved Snapper Mine Offset

Vegetation Community[1]		Approved Snapper Mine Disturbance Area (ha)	Approved Snapper Mine Offset Area (ha)
1	Black Box Woodland	0	24
2	Black Oak-Rosewood-Wilga Woodland	1,075	2,020
3	Chenopod Mallee Woodland/Shrubland	30	136
4	Irregular Dune Mallee Shrubland	0	428
6	Bluebush Shrubland	200	331
7	Austrostipa Grassland	325	574
9	Linear Dune Mallee Shrubland	0	1,703
	TOTAL AREA	**1,630**	**5,216**

Source: BEMAX (2009a)

1 The numbering of vegetation communities is consistent with the EA.

It is proposed that the approved Snapper Mine offset area is increased by 255 ha for the modified Snapper Mine, as the Modification would result in a net increase of approximately 81 ha of vegetation clearance (Table 10).

Table 10
Proposed Additional Offset Area#

Proposed Modification Disturbance	Proposed Additional Offset Area
1 ha of Black Box Woodland 10 ha of Chenopod Mallee Woodland/Shrubland 5 ha of Irregular Dune Mallee Shrubland 85 ha of Austrostipa Grassland 10 ha of Linear Dune Mallee Shrubland	95 ha of Irregular Dune Mallee Shrubland 160 ha of Black Oak-Rosewood-Wilga Woodland
111 ha*	**255 ha**

* This is the increase in vegetation clearance, the net increase is only 81 ha since 30 ha of Black Oak-Rosewood-Wilga Woodland which was originally proposed to be cleared would not be cleared for the modified Snapper Mine.

\# Areas are based on vegetation mapping shown on Figure 18

The proposed addition to the offset area is located adjacent to the approved Snapper Mine offset area (Figure 18) and would increase the overall size of the offset to approximately 5,471 ha. The proposed offset is justified given:

- 136 ha of Chenopod Mallee Woodland/Shrubland is already conserved in the approved Snapper Mine offset area (Table 9), and the modified Snapper Mine would result in the total clearance of only 40 ha of this community (Table 8).
- The clearance of 85 ha of *Austrostipa* Grassland would be offset with 160 ha of Black Oak-Rosewood-Wilga Woodland which is a better conservation outcome, as Black Oak-Rosewood-Wilga Woodland is the climax community of the *Austrostipa* Grassland.
- 1,703 ha of Linear Dune Mallee Shrubland is already conserved in the approved Snapper Mine offset area (Table 9), and the modified Snapper Mine would result in the total clearance of only 10 ha of this community (Table 10).
- 24 ha of Black Box Woodland is already conserved in the approved Snapper Mine offset area (Table 9), and the modified Snapper Mine would result in the total clearance of only 1 ha of this community (Table 10).
- Although the Mallee communities (namely, the Chenopod Mallee Woodland/Shrubland, Irregular Dune Mallee Shrubland and Linear Dune Mallee Shrubland) are already well represented in the approved Snapper Mine offset area (Table 9), an additional 95 ha of Irregular Dune Mallee Shrubland is proposed to be included in the offset area (Table 10).

The flora and fauna characteristics of the proposed additional offset area were described by FloraSearch (2009) and Cenwest Environmental Services (2009), respectively. The Linear Dune Mallee Shrubland community on linear sand dunes that occupies about a quarter of the approved Snapper Mine offset area is considered to be in good condition, despite some thinning and periodic burning (FloraSearch, 2009). The Black Oak – Rosewood – Wilga Woodland has areas in moderate to good condition (FloraSearch, 2009). The Irregular Dune Mallee Shrubland is considered to be in poor to moderate condition, due to more extensive clearing, thinning and grazing than for the Linear Dune Mallee Shrubland (FloraSearch, 2009). These vegetation communities provide moderate to good fauna habitat (Cenwest Environmental Services, 2009)

As stated in the Snapper Offset Modification EA (BEMAX, 2009a), the following measures would be implemented as part of the Snapper Mine offset area:

- fencing to exclude grazing;
- incremental destocking;
- removal of unnecessary fencing;
- erosion control;
- signage of the offset area;
- revegetation of unnecessary access tracks;
- animal pest control;
- weed management;
- fire management;
- threatened species management;
- security of artificial water sources;
- vehicle access management; and
- an environmental induction for employees and contractors.

Table 11 provides a reconciliation of the proposed additional offset area against the DECCW (2009) offset principles.

Table 11
Reconciliation of the Proposed Offset against the DECCW Offset Principles

DECCW Offset Principles (DECCW, 2009)	Description of How the Proposed Offset Addresses the DECCW Offset Principles
Impacts must be avoided first by using prevention and mitigation measures.	Impact avoidance and mitigation measures are provided in Section 4.9.3 and include measures such as weed and pest control measures. The offset area is proposed to address remaining impacts (e.g. vegetation/habitat removal).
All regulatory requirements must be met.	BEMAX are required to meet all statutory requirements. The offset area is not proposed to substitute other licence/approval requirements.
Offsets must never reward ongoing poor performance.	The proposed conservation area provides an appropriate offset against residual flora and fauna impacts associated with the Modification and is not proposed to reward past performance.
Offsets will complement other government programs.	The proposed offset compliments the current reserve system in NSW by providing long-term security and management of a significant area of vegetation/habitat. BEMAX recognise the conservation benefit in increasing the area of existing conserved areas. The proposed offset area adjoins the existing offset area.
Offsets must be underpinned by sound ecological principles.	The proposed offset area is underpinned by sound ecological principles such as increasing the size of existing patches of vegetation/habitat.
Offsets should aim to result in a net improvement in biodiversity over time.	Increased security would be provided for the proposed offset area in perpetuity through change of purpose of the relevant Western Lands Lease land to reflect conservation purposes. The security of the proposed offset area would facilitate an ecological gain from the protection from other land use practises (e.g. current grazing).
Offsets must be enduring. They must offset the impact of the development for the period that the impact occurs.	Increased security would be provided for the proposed offset area in perpetuity through change of purpose of the relevant Western Lands Lease land to reflect conservation purposes.
Offsets should be agreed prior to the impact occurring.	The offset area is proposed as part of the Project. The implementation of the offset area is likely to be a condition of Project approval.
Offsets must be quantifiable. The impacts and benefits must be reliably estimated.	The proposed offset area is quantified in Table 10.
Offsets must be targeted.	The proposed offset area was designed to target similar vegetation which would be impacted by the Project.
Offsets must be located appropriately.	The proposed offset area is located an appropriate distance from the Project as to benefit the local populations of flora and fauna which would be impacted by the Project. The proposed offset area is located in the same CMA sub-region and LGA as the Project.
Offsets must be supplementary.	The implementation of the proposed offset is beyond existing requirements, in that the proposed offset area is not subject to an existing conservation agreement.
Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.	The implementation of the offset area is likely to be a condition of Project approval.

4.10 FAUNA

A fauna assessment was prepared by Western Research Institute and Resource Strategies (2007) for the Snapper Mine EA (BEMAX, 2007a), generally in accordance with the Draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

This section provides a description of the existing environment relating to fauna (Section 4.10.1), an assessment of the potential impacts of the Modification on fauna (Section 4.10.2), fauna mitigation, management and monitoring (Section 4.10.3) and offset measures (Section 4.10.4).

4.10.1 Existing Environment

A number of fauna surveys have been carried out in recent years in the general locality of the Modification. A review of these studies was undertaken as part of this assessment and included the following baseline surveys:

- Cenwest Environmental Services (2009) *Trelega North Fauna Survey and Assessment*;
- Western Research Institute (2007) *Trelega Property Fauna Survey and Assessment*;
- Western Research Institute and Resource Strategies (2007) *Snapper Mineral Sands Project – Fauna Assessment*;
- Resource Strategies (2003) *Ginkgo Mineral Sands Project - Supplementary Flora and Fauna Assessment*; and
- Mount King Ecological Surveys (MKES) (2001) *Ginkgo Mineral Sands Project – Fauna Assessment*.

In addition, pre-clearance fauna surveys have been undertaken in ML 1621 by Ogyris (2009).

Three major fauna habitat types have been identified in the Modification area (Cenwest Environmental Services, 2009; Western Research Institute and Resource Strategies, 2007):

- Mixed Woodland - characterised by sparse Black Oak (*Casuarina pauper*) woodland approximately 8-10 m in height with a mid-storey of Rosewood (*Alectryon oleifolius* subsp. *canescens*) and Wilga (*Geijera parvifolia*) approximately 4 to 5 m in height with a moderately dense shrub layer of Bluebush (*Maireana* spp.) up to 1 m in height. This habitat type also includes a small area of Black Box.
- Open Grassland/Shrubland with Scattered Trees - characterised by scattered Bluebush shrubland and grassland, large bare areas.
- Mallee Shrubland - characterised by open Mallee to approximately 6 m in height.

All three habitat types have a medium to a high level of degradation due to pastoral land management practices.

Table 12 provides a list of threatened fauna species which were recorded in ML 1621 in 2007 (Western Research Institute and Resource Strategies, 2007), additional threatened fauna species recorded in ML 1621 since 2007 (Ogyris, 2009), and additional fauna species recorded in the Offset Area 2 (Cenwest Environmental Services, 2009).

A review of the DECCW (2010a), Birds Australia (2010), Australian Museum (2010), DEWHA (2010) and DEC (2010) databases was also undertaken to identify additional threatened fauna species records since 2007. There were no additional nearby records. The preliminary and final determinations of the NSW Scientific Committee (DECCW, 2010b) were also reviewed for any additional listing of threatened fauna species which may occur in the Modification area. There were no newly listed threatened fauna species.

Table 12
Threatened Fauna Species Recorded in the ML 1621 or Offset Area 2

Scientific Name	Common Name	Conservation Status[1]		Previously Located in the Project Area and Immediate Surrounds[8]
		TSC Act	EPBC Act	
Recorded in ML 1621 in 2007				
Tiliqua occipitalis	Western Blue-tongued Lizard	V	-	A
Cacatua leadbeateri	Major Mitchell's Cockatoo	V	-	A, B, C
Melanodryas cucullata	Hooded Robin	V	-	A, C
Chalinolobus picatus	Little Pied Bat	V	-	A, B, C
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	A
Additional Fauna Recorded in ML1621 Since 2007				
Diplodactylus elderi	Jewelled Gecko	V	-	B,C
Hamirostra melanosternon	Black-breasted Buzzard	V	-	C
Nyctophilus timoriensis	Greater Long-eared Bat *(South-eastern form)*	V	V	C
Vespadelus baverstocki	Inland Forest Bat	V	-	B, C
Additional Fauna (to that listed above) Recorded in Offset Area 2				
Diplodactylus stenodactylus	Crowned Gecko	V	-	B
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V	-	B

1 Conservation Status under the TSC Act and EPBC Act (current as of January 2010) E – Endangered, V – Vulnerable.

A Western Research Institute and Resources Strategies (2007)

B Cenwest (2009)

C Ogyris (2009)

4.10.2 Potential Impacts

The following sub-sections identify the potential impacts of the Modification on fauna. The measures to avoid and mitigate potential impacts are provided in Section 4.10.3.

Habitat Removal/Modification

The Open Grassland/Shrubland with Scattered Trees broad fauna habitat type is the most prevalent habitat in the Modification area (85 ha). In addition, approximately 25 ha of Mallee Shrubland would also be cleared for the Modification.

The modified Snapper Mine no longer require clearance of 30 ha of the Mixed Woodland broad fauna habitat type which was proposed to be cleared for approved Snapper Mine, although it is recognised that the modified Snapper Mine would result in the disturbance to approximately 1 ha of Black Box Woodland in this broad fauna habitat type. As described in Section 4.9.4, approximately 24 ha of Black Box Woodland is already conserved in the approved Snapper Mine offset area (Table 9), and the modified Snapper Mine would result in the total clearance of only 1 ha of this community (Table 10).

'Clearing of Native Vegetation', 'Bushrock Removal' and 'Removal of Dead Wood and Dead Trees' are key threatening processes listed under the TSC Act which are relevant to the approved and modified Snapper Mine.

Indirect Impacts

Indirect impacts relevant to fauna which were assessed as part of the Snapper Mine EA (BEMAX, 2007a) include the creation of barriers to fauna movement, introduced flora and fauna species, fauna and noise, fauna and artificial lighting, vehicular traffic movements, bushfire risk, infection of frogs by amphibian chytrid.

The potential for impacts associated with introduced flora and fauna is not likely to change as a result of the Modification, since the additional disturbance areas associated with the Modification are largely adjacent to approved disturbance areas and BEMAX manage introduced flora and fauna in accordance with the FFMP (BEMAX, 2007e).

The Modified Snapped Mine would not create any additional barriers to fauna movement and would not significantly increase potential indirect fauna impacts associated with noise, artificial lighting, bushfire risk or infection of frogs by amphibian chytrid fungus.

Vehicular traffic movements between the Ginkgo and Snapper Mines would increase, and this may increase the potential for animal vehicle strike.

Threatened Fauna Species

The threatened fauna species listed in Table 13 were subject to detailed assessment in the *Snapper Mine Fauna Assessment* (Western Research Institute and Resource Strategies, 2007).

While, four previously unrecorded threatened fauna species have been recorded in ML 1621 during pre-clearance survey since the *Snapper Mine Fauna Assessment* (Western Research Institute and Resource Strategies, 2007), namely the Jewelled Gecko, Black-breasted Buzzard, Greater Long-eared Bat (south-eastern form) and Inland Forest Bat (Ogyris; 2009) (Table 12), the fauna assessment undertaken by Western Research Institute and Resource Strategies (2007) for the approved Snapper Mine considered that all of the species were likely to occur in ML 1621, and the potential impacts on the species were assessed as part of the approved Snapper Mine.

Table 13 provides an excerpt from the threatened species assessment in the *Snapper Mine Fauna Assessment* (Western Research Institute and Resource Strategies, 2007) and an evaluation as to whether the assessment is still applicable to the modified Snapper Mine considering:

- the habitat removal/modification required for the modified Snapper Mine; and
- threatened species records in the general area, including records since 2007 (Table 12).

Table 13 demonstrates that the threatened species assessments made in the *Snapper Mine Fauna Assessment* (Western Research Institute and Resource Strategies, 2007) are relevant to the modified Snapper Mine.

Further to the above, the Snapper Mine was referred under the EPBC Act (BEMAX, 2007a), and it was decided that the Snapper Mine was not a controlled action (July, 2007). The referral considered the potential occurrence of the Greater Long-eared Bat in the Snapper Mine area.

Table 13
Threatened Fauna Species Assessment

Species	Assessment in the Snapper Mine Fauna Assessment (Western Research Institute and Resource Strategies, 2007)	Is the Assessment Applicable to the Modified Snapper Mine?
Painted Burrowing Frog (*Neobatrachus pictus*)	It is possible that a local population of the Painted Burrowing Frog could utilise potential habitat resources within the Snapper Mine area given records of the species approximately 10 km north-east of the ML area (MKES, 2001). However, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species (if the species were to occur in the Snapper Mine area).	Yes
Jewelled Gecko (*Diplodactylus elderi*)	It is possible that a local population of the Jewelled Gecko could utilise potential habitat resources within the Snapper Mine area, given that this species was recorded by MKES (2001). The Jewelled Gecko is restricted to Spinifex (*Triodia* spp.) habitat on red soils, usually in association with mallee woodlands (Sadlier *et al*., 1996 in DEC, 2006). While Mallee Shrubland occurs within the ML area and associated infrastructure areas, only a small portion would be cleared/modified for the Snapper Mine.	Yes. Since the EA, the Jewelled Gecko was recorded within habitat in the Snapper Mine area and surrounds by Ogyris (2009), however, a small portion of habitat for this species would be cleared/modified for the Snapper Mine. The VCP would be continued for the Modified Snapper Mine.
Crowned Gecko (*Diplodactylus stenodactylus*)	It is possible that a local population of the Crowned Gecko could utilise potential habitat resources within the Snapper Mine area given MKES (2001) indicates this species has been locally recorded. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species (if the species were to occur in the Snapper Mine area)	Yes. A small portion of mallee habitat in which this species was recorded (Cenwest Environmental Services, 2009) would be impacted by the modified ETL. The other portion of the habitat occurs within the offset area.
Marble-faced Delma (*Delma australis*)	It is possible that a local population of the Marble-faced Delma could occur in the Snapper Mine area given the occurrence of marginal potential habitat resources within the species range, however it is unlikely that a local population of the Marble-faced Delma occurs within the Snapper Mine area given the lack of records nearby (despite targeted surveys). Therefore, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Wedgesnout Ctenotus (*Ctenotus brooksi*)	It is possible that a local population of the Wedgesnout Ctenotus could utilise potential habitat resources within the Snapper Mine area given this species may have been previously recorded by MKES (2001). Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species (if the species were to occur in the Snapper Mine area).	Yes
Slender Mallee Blue-tongued Lizard (*Cyclodomorphus melanops elongatus*)	It is possible that a local population of the Slender Mallee Blue-tongue Lizard could occur in the Snapper Mine area given the occurrence of marginal potential habitat resources within the species range, however it is unlikely that a local population of the Slender Mallee Blue-tongue Lizard occurs given the lack of records near the Snapper Mine area (despite targeted surveys). Therefore it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Western Blue-tongued Lizard (*Tiliqua occipitalis*)	Known habitat resources for the Western Blue-tongued Lizard occur within the Snapper Mine area given this species was recorded in habitat consisting of open grassland/shrubland with scattered trees within the ML area. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Malleefowl (*Leipoa ocellata*)	It is possible that a local population of the Malleefowl could occur in the Snapper Mine area given the occurrence of potential habitat resources within the species range, however it is unlikely that a local population of the Malleefowl occurs given the lack of records near the Snapper Mine area (despite targeted surveys). Therefore it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Grey Falcon (*Falco hypoleucos*)	It is possible that a local population of the Grey Falcon could utilise potential habitat resources within the Snapper Mine area given this species was recorded by MKES (2001) during fauna surveys of the Ginkgo Mine and infrastructure. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species (if the species were to occur in the Snapper Mine area)	Yes

Table 13 (Continued)
Threatened Fauna Species Assessment

Species	Assessment in the Snapper Mine Fauna Assessment (Western Research Institute and Resource Strategies, 2007)	Is the Assessment Applicable to the Modified Snapper Mine?
Square-tailed Kite (*Lophoictinia isura*)	It is possible that a local population of the Square-tailed Kite could utilise potential habitat resources within the Snapper Mine area given this species was recorded by MKES (2001) during fauna surveys of the Ginkgo Mine and infrastructure. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species (if the species were to occur in the Snapper Mine area)	Yes
Black-breasted Buzzard (*Hamirostra melanosternon*)	It is possible that a local population of the Black-breasted Buzzard could utilise potential habitat resources within the Snapper Mine area. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species (if the species were to occur in the Snapper Mine area).	Yes. Since the EA, the Black-breasted Buzzard was recorded by Ogyris (2009), however it is considered unlikely that the Snapper Mine would affect the lifecycle of the species
Bush Stone-curlew (*Burhinus grallarius*)	It is possible that a local population of the Bush Stone-curlew could occur in the Snapper Mine area given the occurrence of potential habitat resources within the species range, however it is unlikely that a local population of the Bush Stone-curlew occurs given the lack of records near the Snapper Mine area (despite targeted surveys). Therefore it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Shy Heathwren (*Calamanthus cautus*)	It is possible that a local population of the Shy Heathwren could occur in the Snapper Mine area given the occurrence of potential habitat resources within the species range, however it is unlikely that a local population of the Shy Heathwren occurs given the lack of records near the Snapper Mine area (despite targeted surveys). Further, the pastoral leaseholder of the land within the ML area has indicated that the Mallee within the Snapper Mine area has been frequently and recently (2005) burnt, which reduces the likelihood that the species would utilise the potential habitat. Given the above it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Chestnut Quail-thrust (*Cinclosoma castanotus*)	It is possible that a local population of the Chestnut Quail-thrush could occur in the Snapper Mine area given the occurrence of potential habitat resources within the species range, however it is unlikely that a local population of the Chestnut Quail-thrush occurs given the lack of records near the Snapper Mine area (despite targeted surveys). Therefore it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Striated Fieldwren (*Calamanthus fuliginosus*)	It is possible that a local population of the Rufous Fieldwren could occur in the Snapper Mine area given the occurrence of potential habitat resources within the species range, however it is unlikely that a local population of the Rufous Fieldwren occurs given the lack of records near the Snapper Mine area (despite targeted surveys). Therefore it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Major Mitchell's Cockatoo (*Cacatua leadbeateri*)	It appears likely that a local population of the Major Mitchell's Cockatoo occasionally utilises known habitat resources within the Snapper Mine area given this species was recorded within the ML area as well as flying overhead. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*)	A local population of the Hooded Robin (south-eastern form) appears to utilise known habitat resources within the Snapper Mine area given this species was recorded within the MLA. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Grey-crowned Babbler (*Pomatostomus temporalis temporalis*)	It is possible that a local population of the Grey-crowned Babbler (eastern subsp.) could utilise potential habitat resources within the Snapper Mine area given this species was recorded by MKES (2001) during fauna surveys of the Ginkgo Mine and infrastructure. It is considered unlikely that the Snapper Mine would affect the lifecycle of the species given (if the species were to occur in the Snapper Mine area).	Yes

Table 13 (Continued)
Threatened Fauna Species Assessment

Species	Assessment in the Snapper Mine Fauna Assessment (Western Research Institute and Resource Strategies, 2007)	Is the Assessment Applicable to the Modified Snapper Mine?
Black-eared Miner (*Manorina melanotis*)	It is possible that a local population of the Black-eared Miner could occur in the Snapper Mine area given the occurrence of potential habitat resources within the species range, however it is unlikely that a local population of the Black-eared Miner occurs given the lack of records near the Snapper Mine area (despite targeted surveys). Therefore it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Redthroat (*Pyrrholaemus brunneus*)	It is possible that a local population of the Redthroat could utilise potential habitat resources within the Snapper Mine area given local records of the species in the Birds Australia (2006) database. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species (if the species were to occur in the Snapper Mine area).	Yes
Eastern Long-eared Bat (south-eastern form) (*Nyctophilus timoriensis*)	It is possible that a local population of the Eastern Long-eared Bat could utilise potential habitat resources within the species range. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species (if the species were to occur in the Snapper Mine area).	Yes. Since the EA, the Eastern Long-eared Bat was recorded by Ogyris (2009), however it is considered unlikely that the Snapper Mine would affect the lifecycle of the species. The VCP would be continued for the Modified Snapper Mine.
Little Pied Bat (*Chalinolobus picatus*)	It appears likely that a local population of the Little Pied Bat occasionally utilises known habitat resource within the Snapper Mine area given this species was recorded within the ML area. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes
Inland Forest Bat (*Vespadelus baverstocki*)	It is possible that a local population of the Inland Forest Bat could utilise potential habitat resources within the Snapper Mine area given this species was recorded by MKES (2001) during fauna surveys of the Ginkgo Mine and infrastructure. Although, it is considered unlikely that the Snapper Mine would affect the lifecycle of the species (if the species were to occur in the Snapper Mine area).	Yes. Since the EA, the Inland Forest Bat was recorded by Ogyris (2009), however it is considered unlikely that the Snapper Mine would affect the lifecycle of the species. The VCP would be continued for the Modified Snapper Mine.
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	It appears likely that a local population of the Yellow-bellied Sheathtail-bat occasionally utilises known habitat resource within the Snapper Mine area given this species was recorded proximal to the ML area. It is considered unlikely that the Snapper Mine would affect the lifecycle of the species.	Yes

4.10.3 Mitigation Measures and Management

The potential flora and fauna impacts resulting from the approved Snapper Mine are currently managed via the implementation of existing management protocols, plans and programs, including the following:

- FFMP (BEMAX , 2007e);
- VCP;
- TSMP;
- control of introduced fauna species;
- bushfire risk management;
- Painted Burrowing Frog Monitoring;
- vehicular traffic management;
- site induction; and
- rehabilitation/revegetation of the disturbance areas.

These are described below.

Flora and Fauna Management Plan

The FFMP is outlined in Section 4.9.3.

Vegetation Clearance Protocol

As described in Section 4.9.3, a VCP has been implemented to minimise the removal/modification of fauna species and their habitats. Key components of the VCP which apply to fauna include the delineation of areas to be cleared of remnant vegetation, a pre-clearance survey, identification of fauna management strategies and specific procedures for vegetation clearance. Further, vegetation clearance would be timed to minimise disturbance to potential roosting/breeding activities of fauna, where practicable.

Vegetation clearance along the modified ETL would been minimised, where practicable, using techniques such as selective clearing (i.e. minimising vegetation clearance to higher midstorey and upperstorey vegetation).

Threatened Species Management Protocol

As stated in Section 4.9.3, a TSMP has been prepared and implemented to facilitate the management and minimisation of potential impacts on threatened species. Key components of the TSMP which relate to fauna include site observations/surveys, threatened species management strategies and reporting.

Control of Introduced Animal Species

A clean, rubbish-free environment is kept to discourage scavenging and reduce the potential for further colonisation of the study area by non-endemic fauna (e.g. introduced rodents and foxes). The introduction of animals on to the site is prohibited. Domestic pets are not allowed at the mine site.

In addition, control measures have been developed to minimise the occurrence of declared pests (e.g. Rabbits) and other introduced animal species (e.g. Red Fox). These include cat trapping and fox baiting. Animal pest control is undertaken by a licensed contractor.

Bushfire Risk Management

Bushfire risk management is described in Section 4.9.3.

Painted Burrowing Frog Monitoring

The Snapper Mine EA (BEMAX, 2007a) described how monitoring for the Painted Burrowing Frog is conducted by a suitably qualified person(s) following heavy rain (>25 mm in 24 hours). Frog populations can be particularly sensitive to the introduction of infectious pathogens such as the chytrid fungus. To reduce the likelihood of spreading infection, the Painted Burrowing Frog monitoring is conducted in accordance with the guidelines for the collection, handling and transport of amphibians.

Vehicular Traffic Management

The number of roads constructed for the Snapper Mine has been minimised, employees and contractors have been instructed to only use the Snapper Mine roads, speed limits have been imposed on vehicles using roads and tracks, and signposting has been installed to remind personnel of the danger of vehicles to wildlife. Vehicle speed has also been restricted to 50 km/hour on all roads inside ML 1621 and the section of road where the HAR crosses the Great Darling Anabranch.

Site Induction

An environmental education programme is included in employee and contractor inductions.

Rehabilitation/Revegetation of the Disturbance Areas

The rehabilitation and revegetation of the disturbance areas is described in detail in Section 5.

4.10.4 Offset

The offset for the modified Snapper Mine is described in Section 4.9.4.

4.11 NOISE

A Noise Assessment for the modified Snapper and Ginkgo Mines was undertaken by PAE Holmes (2010a) (Appendix C).

4.11.1 Existing Environment

Noise Management and Monitoring Regime

Noise management at the Snapper and Ginkgo Mines is described in the Ginkgo Mineral Sands Project Noise Management Plan (Ginkgo Mine NMP) (BEMAX, 2005c) and the Snapper Mine Noise Monitoring Programme (Snapper Mine NMP) (BEMAX, 2008e) included in the Snapper Mineral Sands Mine Environmental Monitoring Program (Snapper Mine EMP) (BEMAX, 2008f).

Noise monitoring has been carried out at residences in the vicinity of the mines and along the HAR on a regular basis since the commencement of Ginkgo Mine construction, in accordance with the Ginkgo Mine NMP and results are reported in the Ginkgo Mine Annual Environmental Management Reports (AEMRs) (BEMAX, 2007d; 2008c; 2009b). The monitoring results show that both operational and traffic noise levels have been below the applicable DECCW criteria at the closest residences to the Ginkgo Mine and HAR (i.e. the Woodlands and Manilla homesteads) since the commencement of Ginkgo Mine construction (BEMAX, 2007d; 2008c; 2009b).

During the 2006, 2007 and 2008 reporting periods, no complaints were received regarding operational or traffic-related noise associated with the Ginkgo Mine (BEMAX, 2007d; 2008c; 2009b).

Operational Noise

The Snapper Mine EA noise assessment by Holmes Air Sciences (2007a) included an assessment of the potential cumulative impacts from the operation of the Snapper and Ginkgo Mines. The closest residence to both mines is the Manilla homestead, which is located approximately 4 km and 5 km from the Snapper and Ginkgo Mines respectively. The Holmes Air Sciences (2007a) assessment modelled all Snapper Mine plant items operating concurrently to simulate the overall maximum energy equivalent (i.e. $L_{Aeq[15minute]}$) intrusive noise level. The Holmes Air Sciences (2007a) assessment concluded that noise levels from the Snapper Mine at the Manilla homestead would be approximately 29.5 A-weighted decibels (dB[A]) (under inversion conditions and including the effects of wind), which is below the 35 dB(A) intrusive noise criterion. The assessment described that the cumulative noise impacts would be limited by distance and would be small (Holmes Air Sciences, 2007a).

Road Transport Noise – Mineral Concentrate Transport to the MSP

The Snapper Mine EA noise assessment also included an assessment of potential traffic noise at residences along the HAR between the Snapper and Ginkgo Mines and the Silver City Highway (Figure 2). This included an assessment of the potential traffic noise from the maximum combined concentrate haulage from the Ginkgo and Snapper Mines (i.e. approximately 3 vehicle movements per hour]). The closest residence (i.e. the Woodlands homestead) is approximately 800 m from the HAR (and approximately 40 km from the private road section of the HAR relevant to the Modification). Due to the distance of the closest residence to the HAR, no exceedances of the applicable criteria were predicted (Holmes Air Sciences, 2007a).

Road Transport Noise – Transport of Ore between the Snapper and Ginkgo Mines

BEMAX currently transport Snapper Mine high-grade ore from the Snapper Mine to the Ginkgo Mine using 200 t road trains, on a temporary basis (i.e. approximately 2 Mt over a period of approximately 12 months) (assessed as part of the November 2009 Modification).

No complaints have been received regarding traffic-related noise associated with this haulage between the two mines.

4.11.2 Potential Impacts

Operational Noise

Snapper Mine

As described in Section 2.4, detailed mine planning since the Snapper Mine EA has identified the need to change the type and number of some of the equipment fleet for the Snapper Mine. The proposed changes primarily relate to changes to overburden excavation/replacement methodologies (i.e. use of an electric conveyor system and/or dry mine fleet for dry overburden removal, instead of overburden slurrying) and changes to the soil excavation/replacement methodologies (i.e. use of bucket scoops instead of scrapers, in order to reduce potential impact to the structure of replaced soil).

Table 4 lists the proposed equipment fleet for the modified Snapper Mine and provides a comparison with the provisional equipment fleet presented in the Snapper Mine EA.

Appendix C provides a quantitative assessment for potential noise impacts for the modified Snapper Mine, by calculating the overall fleet sound power levels for the approved and modified Snapper Mine. Noise modelling was not conducted given that the previous assessment shows that noise levels at all receptors are likely to be low and well within the DECCW assessment criteria (Appendix C). The sound power levels for the existing and proposed construction and operational fleet are provided in Table 14.

Table 14
Total Fleet Sound Power Levels

Sound Power Level (dB[A])			
Construction		**Operations**	
Approved Snapper Mine	**Modified Snapper Mine**	**Approved Snapper Mine**	**Modified Snapper Mine**
124.4	125.2	126.0	125.2

Source: After Appendix C.

The total sound power level for the modified Snapper Mine construction fleet would be 0.8 dB(A) higher than the currently approved construction fleet (Appendix C). The sound power level for the modified Snapper Mine operational fleet would however be 0.8 dB(A) lower than the currently approved construction fleet (Appendix C).

For both construction and operation, the proposed activities would not be significantly different to that of the approved Snapper Mine in regard to the potential for increased noise impact at receptors due to the prevailing weather conditions, equipment location and individual siting of plant items (Appendix C).

Ginkgo Mine

The proposed modifications to the Ginkgo Mine would not affect noise impacts and would not add to previously predicted noise levels (Appendix C).

The maximum rate of production from the Ginkgo Mine would remain unchanged from the approved maximum rate of production of approximately 576,000 tpa and there would be no changes to the existing fleet. Therefore there would be no change to the existing noise emissions from the Ginkgo Mine (Appendix C).

Road Transport Noise – Mineral Concentrate Transport to the MSP

The proposed modifications to the Snapper and Ginkgo Mines would not change the maximum combined concentrate haulage of approximately 735,000 tpa from the Snapper and Ginkgo Mines to the MSP in Broken Hill. Therefore, there would be no change to the approved number or type of haulage vehicles transporting mineral concentrates to the MSP (or backloaded MSP process waste materials from the MSP to the Snapper and Ginkgo Mines). Given the above, transport noise impacts associated with the transport of mineral concentrates to the MSP would not change as a result of the modification (Appendix C).

Road Transport Noise – Transport of Ore and HMC between the Snapper and Ginkgo Mines

The frequency of road trains transporting ore between the mines along the private road section of the approved HAR would continue at the same frequency as approved as part of the November 2009 Modification (which approved a maximum of 4 vehicle movements per hour). The frequency of AB-triple vehicles or road trains transporting HMC between the mines along the private road section of the approved HAR would be less than for ore.

These vehicle movements would be additional to the existing vehicle movements transporting mineral concentrate from the Ginkgo Mine to the MSP along other sections of the HAR and would be a source of noise emissions.

Assuming a maximum of 4 x 200 t road train vehicle movements per hour along the private section of the HAR, there would be an average of 1 vehicle movement along the HAR during any 15-minute period. Over this 15-minute period, the additional noise from this vehicle is unlikely to significantly increase the overall sound power level of the 42 fleet items assessed for the Modification noise assessment by PAE Holmes (2010a) (Appendix C).

Given that the increase in potential noise from the additional vehicle movements is unlikely to be significant when compared to the potential noise from the mining operations, the potential noise from the Modification would be unlikely to cause an exceedance of the applicable criteria (Appendix C).

4.11.3 Mitigation Measures and Management

The mitigation and management measures for noise are described in the Ginkgo Mine NMP and Snapper Mine NMP included in the Snapper Mine EMP. The mitigation and management measures for noise described in the Ginkgo Mine NMP and Snapper Mine NMP would continue to be implemented for the modified Ginkgo and Snapper Mines.

4.12 AIR QUALITY

An Air Quality Impact Assessment was undertaken by PAE Holmes (2010b) and is attached as Appendix D.

4.12.1 Existing Environment

Air Quality Management Regime

Air quality management at the Snapper and Ginkgo Mines is described in the Snapper Mine Air Quality Monitoring Programme (Snapper Mine AQMP) (BEMAX, 2008g) and the Ginkgo Mineral Sands Project Air Quality Management Plan (Ginkgo Mine AQMP) (BEMAX, 2005d), respectively.

During the 2006, 2007 and 2008 reporting periods, no complaints were received regarding operations (including traffic-related dust) associated with the Ginkgo Mine (BEMAX, 2007d; 2008c; 2009b).

Air Quality Criteria

Dust Deposition

The DECCW amenity criteria for dust deposition seeks to limit the maximum increase in the mean annual rate of dust deposition from a new development to 2 grams per square metre per month (g/m^2/month) and total dust deposition (i.e. including background air quality) to 4 g/m^2/month (Appendix D).

Concentrations of Suspended Particulate Matter

Exposure to suspended particulate matter can lead to health and amenity impacts. The likely risk of these impacts depends on a range of factors including the size, chemical make-up and concentration of the particulate matter and the general health of the person (NSW Health and NSW Minerals Council, 2006).

Such particles (referred to as total suspended particles [TSP]) are typically less than 50 micrometres (µm) in size and can be as small as 0.1 µm. Fine particles less than 10 µm are referred to as PM_{10}. Details of the air quality criteria for concentrations of suspended particulate matter are provided in Table 15.

Table 15
Air Quality Assessment Criteria for Suspended Particulate Matter Concentrations

Pollutant	Criterion/Goal	Agency
TSP Matter	90 µg/m^3 (annual mean)	NHMRC
PM_{10}	50 µg/m^3 (24-hour average – maximum)*	DECCW assessment criterion
	30 µg/m^3 (annual mean)	DECCW assessment criterion

Source: After Appendix D.

* Modified Snapper Mine or Ginkgo Mine only emissions.

Snapper Mine EA Assessment

The Snapper Mine EA air quality assessment by Holmes Air Sciences (2007b) included an assessment of the potential cumulative impacts from the operation of the Snapper and Ginkgo Mines. The closest residence to both mines would be the Manilla homestead, which is located approximately 4 km and 5 km from the Snapper and Ginkgo Mines respectively. The Holmes Air Sciences (2007b) assessment concluded that cumulative air quality impacts would be limited by these distances and that air quality emissions from the two mines would be below the project-specific criteria at all nearby residences. Table 16 summarises the model predictions for the closest residence, Manilla homestead, as described in Holmes Air Sciences (2007b). Results show the contribution of dust emissions from the Snapper Mine as well as the cumulative effect of other dust sources, including the Ginkgo Mine, as estimated from the monitoring data.

Table 16
Air Quality Predictions at Manilla Homestead

Air Quality Parameter	Year 14 Operation	Year 14 Operation with Background	Air Quality Criteria
Predicted maximum 24-hour average PM_{10} concentrations (µg/m^3)	34	*	50
Predicted annual average PM_{10} concentrations (µg/m^3)	2.7	24.5	30
Predicted annual average TSP concentrations (µg/m^3)	2.9	56.9	90
Predicted annual average dust deposition (g/m^2/month)	0.06	2.46	2 (4 – cumulative)

Source: Holmes Air Sciences, 2007b

PM_{10} – particulate matter less than 10 microns in size

TSP – total suspended particulates

µg/m^3 – micrograms per cubic metre

g/m^2/month – grams per square metre per month

* Refer to Snapper Mine EA (Holmes Air Sciences, 2007b) for discussion regarding background concentrations. Notwithstanding that there are days when the Snapper Mine plus background concentration could exceed the relevant criterion, Holmes Air Sciences (2007b) assessed the potential for the Snapper Mine to be the cause of the exceedance to be very low.

Air Quality Monitoring Results

Air quality monitoring has been carried out at residences in the vicinity of the Snapper and Ginkgo Mines and along the HAR on a regular basis since the commencement of Ginkgo Mine construction, in accordance with the Ginkgo Mine AQMP and is reported in the Ginkgo Mine AEMRs (BEMAX, 2007d; 2008c; 2009b). The monitoring results show that the majority of the monitoring locations have reported an annual average dust deposition level below the DECCW's cumulative dust deposition criterion (Appendix D). Further, during the 2006, 2007 and 2008 reporting periods, no complaints were received regarding operations (including traffic-related dust) associated with the Ginkgo Mine (BEMAX, 2007d; 2008c; 2009b).

4.12.2 Potential Impacts

Dust Deposition and Suspended Particulates

Snapper Mine

<u>Modelling Scenario</u>

Year 2 and Year 9 represent the 'worst-case' scenarios for modified Snapper Mine operations (Appendix D). These scenarios assume that overburden would be replaced by a dry mine fleet, whereas any potential air quality impacts would be less when if using an electric conveyor system.

Year 2 was chosen for assessment as operations during this year would occur in the south closest to private receptor Trelega. Dispersion modelling was not conducted for operations at the Snapper Mine during Year 2 as dust impacts at Trelega are likely to be small and well within the DECCW assessment criteria (Appendix D).

Year 9 was chosen for dispersion modelling and assessment as this year would have the highest amount of overburden moved during operations in the north of the mine path (i.e. closest to private receptor Manilla) (Appendix D).

<u>Dust Deposition</u>

Modified Snapper Mine only incremental increases in annual average dust deposition were not predicted to exceed the applicable 2 g/m^2/month DECCW amenity criterion at any receiver (Appendix D).

Annual average dust deposition due to the modified Snapper Mine plus the assumed background level (2.4 g/m^2/month) was also not predicted to exceed the applicable 4 g/m^2/month DECCW amenity criterion at any receiver (Appendix D).

<u>Suspended Particulates</u>

Annual average TSP (modified Snapper Mine plus background) concentrations modelled were not predicted to be above the DECCW assessment criterion of 90 µg/m^3 at any receiver (Appendix D).

Predicted annual average PM_{10} (modified Snapper Mine plus background) concentrations were not predicted to exceed the 30 µg/m^3 DECCW assessment criterion at any receiver (Appendix D).

Modified Snapper Mine only predicted 24-hour PM_{10} concentrations modelled were not predicted to be above the 50 µg/m^3 DECCW assessment criterion at any privately-owned receivers (Appendix D).

Contours showing the predicted modified Snapper Mine-only maximum 24-hour average PM_{10} emissions are provided on Figure 19.

Ginkgo Mine

As described in Section 4.12.1, Holmes Air Sciences (2007b) modelled the cumulative effects of the Ginkgo Mine with Snapper Mine operations. Holmes Air Sciences (2007b) concluded that, due to the prevailing weather conditions, there would be no change to the maximum 24-hour average PM_{10} predictions at the Manilla and Trelega homesteads when emissions from the Ginkgo Mine were included. Similarly, inclusion of the Ginkgo Mine emissions with the Snapper Mine emissions would have a small effect on annual average PM_{10}, TSP and dust deposition levels at the Manilla and Trelega homesteads (Holmes Air Sciences, 2007b).

The modified Ginkgo Mine would not affect air quality impacts and would not add to previously predicted concentrations (Appendix D). Given the above, operations from the Ginkgo Mine would not affect dust impacts arising from the proposed modification at the Ginkgo Mine and are not assessed further (Appendix D).

Road Transport Emissions

The proposed modification would not change the maximum combined concentrate haulage from the Snapper and Ginkgo Mines to the MSP. Therefore there would be no change to the approved number or type of haulage vehicles transporting mineral concentrates to the MSP, and therefore no change to potential air quality emissions (Appendix D).

The frequency of road trains transporting ore between the mines along the private road section of the approved HAR would continue at the same frequency as approved as part of the November 2009 Modification (which approved a maximum of 4 vehicle movements per hour). The frequency of AB-triple vehicles or road trains transporting HMC between the mines along the private road section of the approved HAR would be less than for ore.

These vehicle movements would be additional to the existing vehicle movements transporting mineral concentrate from the Ginkgo Mine to the MSP along other sections of the HAR and would be a source of dust emissions.

Given the frequency of road train movements along the private road section of the HAR for ore transport (i.e. a maximum of 4 vehicle movements per hour) and the distance to the closest residence, Manilla homestead (i.e. 4 km), it is unlikely that the modification would result in adverse air quality impacts at the Manilla homestead or other nearby residences (Appendix D).

Greenhouse Gas Emissions

An assessment of the Snapper Mine greenhouse gas emissions was conducted as part of the Snapper Mine EA (BEMAX, 2007a). The assessment estimated the total lifetime (including construction) Scope 1 emissions to be approximately 0.23 Mt $CO_{2\text{-e}}$ with Scope 2 and Scope 3 emissions estimated to be approximately 0.37 Mt $CO_{2\text{-e}}$ and 1.1 Mt $CO_{2\text{-e}}$ respectively. The total lifetime full fuel cycle (i.e. Scopes 1, 2 and 3) emissions from the Snapper Mine was estimated to be approximately 1.7 Mt $CO_{2\text{-e}}$, which is an average of approximately 0.98 Mt $CO_{2\text{-e}}$ per year over the life of the mine, including construction.

The greenhouse gas calculations were updated for the Modification using emissions factors from the National Greenhouse Accounts (NGA) Factors (2009). Table 17 provides a categorical breakdown of the supplementary assessment.

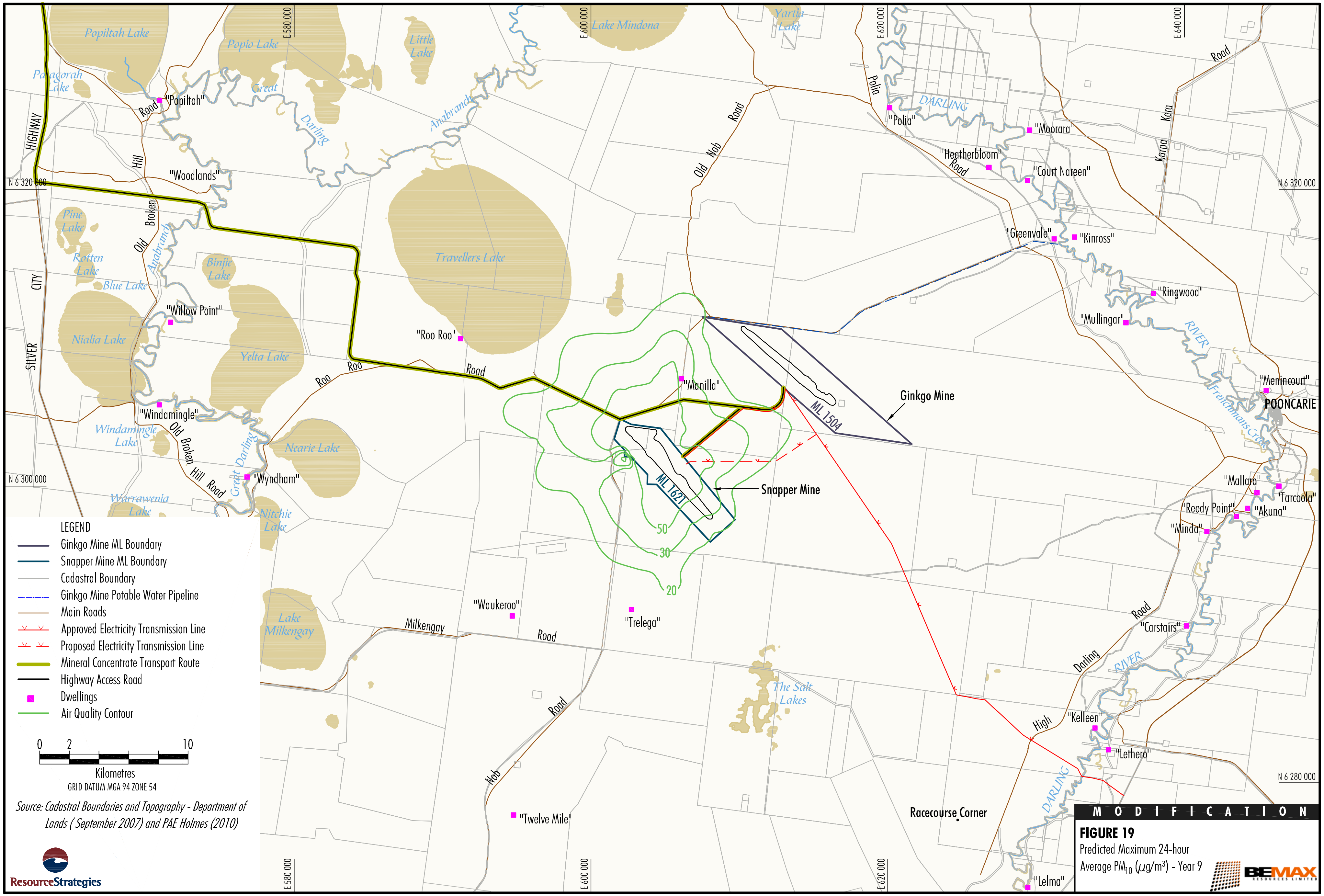

FIGURE 19
Predicted Maximum 24-hour Average PM_{10} ($\mu g/m^3$) - Year 9

BMX-09-21_117A

Table 17
Summary of Estimated CO_2-e Emissions

Project Component	Emissions (t CO2-e)			
	Direct Emissions	Indirect Emissions		Full Fuel Cycle
	Scope 1	Scope 2	Scope 3	
Construction - Diesel	12,816	NA	972	13,788
Construction – Electricity	NA	11,125	2,250	13,375
Operations – Diesel	84,429	NA	6,402	90,830
Operations – Electricity	NA	298,109	60,292	358,401
Mineral Concentrate Haulage to the MSP	69,589	NA	5,276	74,866
Mineral Concentrate Haulage between Ginkgo and Snapper Mines	785	NA	59	844
Ore Haulage (Temporary) between Ginkgo and Snapper Mines	3,370	NA	258	3,628
Employee Commute to and from the Snapper Mine	NA	NA	27,314	27,314
Deliveries to the Snapper Mine	NA	NA	50,546	50,546
Business Travel	NA	NA	113	113
MSP Operations	NA	NA	791,131	791,131
Rail Transport of Mineral Product from the MSP to Port Adelaide	NA	NA	112,990	112,990
Total	**170,989**	**309,234**	**1,057,603**	**1,537,826**

The total lifetime (including construction) Scope 1 emissions from the Modification is estimated to be approximately 0.17 Mt CO_{2-e}, with the Scope 2 and Scope 3 emissions estimated to be approximately 0.3 Mt CO_{2-e} and 1.06 Mt CO_{2-e}, respectively. The total lifetime full fuel cycle emissions from the Modification is estimated to be approximately 1.54 Mt CO_{2-e}, which is an average of approximately 0.96 Mt CO_{2-e} per year over the life of the mine, including construction.

The Modification would see the total lifetime (including construction) full fuel cycle emissions reduce from those estimated in the Snapper Mine EA (BEMAX, 2007a) by approximately 9%.

4.12.3 Mitigation Measures and Management

Dust Deposition and Suspended Particulates

The mitigation and management measures for air quality are described in the Ginkgo Mine AQMP and Snapper Mine AQMP included in the Snapper Mine EMP. The mitigation and management measures for air quality described in the Ginkgo Mine AQMP and Snapper Mine AQMP would continue to be implemented for the modified Ginkgo and Snapper Mines.

Greenhouse Gas Emissions

The mitigation and management measures for greenhouse gas emissions at the Snapper Mine will be described in the Snapper Mine Project Energy Savings Action Plan, to be prepared in accordance with the Snapper Mine Project Approval (06_0168). The Snapper Mine Energy Savings Action Plan will be prepared prior to commencement of operations at the Snapper Mine. BEMAX would also implement the mitigation and management measures described in the Snapper Mine Energy Savings Action Plan relevant to the Modification for the Ginkgo Mine.

4.13 SOCIO-ECONOMICS

As described in Section 2.3.1, the Modification would reduce the life of the approved Snapper Mine from approximately 16 years to approximately 15 years, given the decrease in the total amount of mineral concentrates and increase in the maximum annual mineral concentrate production rate at the Snapper Mine. The shorter Snapper Mine life would therefore reduce the number of years (by one) in which the mine would contribute to the regional economy (i.e. reduced contribution to: direct and indirect regional output or business turnover; direct and indirect regional value added; household income; and direct and indirect jobs).

As described in Section 3.2, the Modification would increase the life of the approved Ginkgo Mine from approximately 12 years to approximately 14 years, reflecting the ore increase and care and maintenance period. The care and maintenance schedule would extend for an approximate 12 month period from the commencement of dredge mining at the Snapper Mine until favourable market conditions (i.e. in particular a favourable Australian/United States dollar exchange rate) prevail. During the course of the care and maintenance period, BEMAX's focus would be on activities at the Snapper Mine (i.e. commencement of dredge mining at the Snapper Mine targeting high-grade ore). The contribution of the Ginkgo Mine to the regional economy would be minimal during the care and maintenance period (i.e. for approximately 12 months), but would again become significant during the re-start and for the remainder of the life of the mine.

Notwithstanding the changes to the extent of the mine lives, the modified Snapper and Ginkgo Mines would continue to provide significant economic and employment benefits provided by the approved mines. The Ginkgo Mine currently employs some 100 operational personnel, with the Snapper Mine employing some 250 constructional personnel reducing to 110 during the operational mine life. These levels of employment would continue for the life of the modified Snapper and Ginkgo Mines. The majority of these employees (approximately 80%) would continue to be sourced from the local area.
The operation of the Ginkgo and Snapper Mines would continue to result in the collection of royalties and taxes by the State of NSW and the Commonwealth Government

BEMAX continues to make numerous financial sponsorship and in-kind support to a variety of local schools, sporting groups, annual events, charity groups and community groups (BEMAX, 2008d).

BEMAX also continues to work with the Barkindji Aboriginal community regarding Aboriginal cultural heritage matters at the Ginkgo and Snapper Mines.

Community consultation would continue to be provided in accordance with the Ginkgo Mine CCP (which is also relevant to the Snapper Mine). The procedure for receiving, investigating, responding to and reporting complaints received from the community, would continue to operate, providing the local community with a method to register issues or complaints with respect to BEMAX mining activities.

4.14 HAZARD AND RISK

4.14.1 Existing Measures

The following analyses, systems and plans have been completed and relevant hazard prevention and mitigation measures implemented for the Ginkgo and Snapper Mines:

- Ginkgo Mineral Sands Project Preliminary Hazard Analysis (Ginkgo Mine PHA) (Resource Strategies Pty Ltd, 2001);
- Ginkgo Mineral Sands Project Safety Management System (Ginkgo Mine SMS) (BEMAX, 2005e);
- Snapper Mineral Sands Project Preliminary Hazard Analysis (Snapper Mine PHA) (BEMAX, 2007f); and
- Ginkgo and Snapper Mines and MSP TMP (which includes a Traffic Code of Conduct and Transport of Hazardous Materials Measures).

4.14.2 Hazard Identification and Risk Assessment

The Modification would not introduce any new hazardous materials to the Ginkgo and Snapper Mines. The transport of HMC and mineral concentrates to the MSP would continue to occur along the transport routes previously assessed for the Snapper and Ginkgo Mines.

As described in Section 2.3.8, the frequency of AB-triple vehicles or road trains transporting HMC between the mines along the private road section of the approved HAR (a maximum of 3 vehicles movements per hour) would be less than the frequency of road train movements along the private road approved (for transporting ore on a short-term basis) as part of the November 2009 Modification (which approved a maximum of 4 vehicle movements per hour).

As described in Section 2.3.6, the frequency of road trains transporting ore between the mines along the private road section of the approved HAR would continue at the same frequency as approved as part of the November 2009 Modification (which approved a maximum of 4 vehicle movements per hour). These road train movements would continue for an additional 12 months (approximately), beyond that approved as part of the November 2009 Modification.

The introduction of an electric conveyer system and/or dry mine fleet at the Snapper Mine would enable overburden to be transported to the initial overburden emplacement area without the need for it to be screened and slurried. The electric conveyer system and/or dry mine fleet would therefore eliminate the potential risks associated with saline slurried overburden described in the EA.

Overall, the Modification would not increase the number of potential impact mechanisms to the environment, public and public property, and their associated consequences and likelihoods, to the extent that risk levels would increase from those previously assessed in the Ginkgo and Snapper Mine PHAs. Subsequently, there would be no increase to the overall PHA risk assessment findings as a result of the Modification.

4.14.3 Mitigation Measures and Management

The hazard prevention and mitigation measures outlined in the analyses, systems and plans described above would continue to be implemented for the modified Ginkgo and Snapper Mines.

5 REHABILITATION

The Modification would not significantly alter the rehabilitation approved by the Ginkgo Mine Development Consent and described in the Ginkgo Mine EIS and relevant supporting documentation (i.e. letters, Statement of Environmental Effects and Environmental Assessments) that accompanied various modifications made to the Ginkgo Mine Development Consent.

The Modification would not significantly alter the rehabilitation approved by the Snapper Mine Project Approval and described in the Snapper Mine EA. Additional disturbance areas would be required to be rehabilitated however the rehabilitation principles and objectives to be adopted for theses areas would not change.

Principles to be implemented in the rehabilitation programme for both the Snapper and Ginkgo Mines would include:

- preservation of existing vegetation and landforms where practicable;
- progressive campaign-based rehabilitation;
- passive drainage and flow diversion structures where required;
- where appropriate, the use of authorised hybrid cover crops to provide initial erosion protection on newly prepared (i.e. topsoiled) landforms prior to the establishment of long-term native vegetation;
- revegetated landforms to be contiguous with existing vegetation where practicable;
- fencing and/or bunding to selectively exclude livestock from rehabilitation areas;
- flexible rehabilitation concepts to allow for adjustments, based on investigations, to improve the programme; and
- annual rehabilitation programmes and budgets to be approved by site management.

Rehabilitation objectives include:

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

Treatment of Snapper Mine High-Grade Ore at the Ginkgo Mine

In the process of stripping and replacing materials within the mine paths, some increase in the volume of these materials (i.e. swell) would be expected due to an increase in the number and size of pore (air) spaces between particles. It is estimated that the replaced materials would swell by approximately 7 to 10% (BEMAX, 2001a). As a result, a slight increase in elevation of the backfilled mine path is expected. Over time, there would be some further minor settlement of the landform and the net result would be a slightly mounded landform along the alignment of the mine path.

This additional approximate 2 Mt of ore combined with the 2 Mt of ore for the November 2009 Modification (i.e. 4 Mt of ore in total) would result in a reduction of less than 2.7% of sand residues to be placed at the rear of the Snapper Mine dredge pond and less than 1% of the total volume of overburden and sand residues backfilled within the Snapper Mine path, given the grade of the ore (approximately 25 to 30% heavy minerals). Accordingly, the reduction in sand residues would have a negligible effect on the final landform at the Snapper Mine.

The change to sand residue volumes would also represent less than 2.6% of the total sand residues produced at the Ginkgo Mine and approximately 1% of the total volume of overburden and sand residues backfilled within the Ginkgo Mine path. Accordingly, the additional sand residues would have a negligible effect on the final landform at the Ginkgo Mine. The characteristics of the sand residues from the Snapper Mine ore would be similar to that from the Ginkgo Mine. That is, sand residues would be saline owing to the presence of entrained saline groundwater (BEMAX, 2007a).

There would be no other changes to the rehabilitation approved by the Ginkgo Mine Development Consent and described in the Ginkgo Mine EIS and relevant supporting documentation (i.e. letters, Statement of Environmental Effects and Environmental Assessments) that accompanied various modifications made to the Ginkgo Mine Development Consent.

Modifications to the rehabilitation plan detailed below in Sections 5.1 to 5.6 are therefore relevant to the Snapper Mine.

5.1 REHABILITATION MATERIALS

In accordance with the objective to develop landforms generally consistent with the surrounding landscape, the Modification would continue to use materials which are suitable as growth media for revegetation species that reflect the *in situ* properties (i.e. primary root zone [PRZ] soil properties).

A Rehabilitation Materials Assessment was conducted as part of the Snapper Mine EA to analyse and assess the suitability of a range of materials that would continue to be used for the rehabilitation of the modified Snapper Mine. The assessment included characterisation of the:

- surficial soil resources (i.e. the topsoil and subsoil to a depth of approximately 2 m) occurring within the study area to determine their suitability as rehabilitation growth media; and
- overburden materials within the study area to determine their suitability as rehabilitation growth media.

The Rehabilitation Materials Assessment also included a Saline Slurried Overburden Risk Assessment, which identified the risks associated with the rehabilitation and revegetation of the Snapper Mine site relevant to the use of saline slurry in the overburden emplacements.

As described in Section 2.2.1, the overburden for the modified Snapper Mine would no longer be slurried. The use of non-slurried overburden as a subsoil in rehabilitation growth media would eliminate the potential hazards that were associated with the use of slurried overburden.

The backloaded MSP process waste would continue to be disposed at the modified Snapper Mine in accordance with the management and mitigation measures outline in the Process Waste Materials Assessment (BEMAX, 2007a), prepared for the Snapper Mine EA.

5.2 CLIMATIC VARIATION AND REVEGETATION ACTIVITIES

The Snapper Mine is located within a persistently arid climatic zone (BEMAX, 2007a). While the average annual rainfall is typically distributed uniformly throughout the year, variability is greater during summer and autumn.

The majority of the modified Snapper Mine revegetation works would continue to be scheduled to commence with direct seeding in late February and planting of tubestock following winter rainfall in June. Additional revegetation works continue to be undertaken on a campaign basis at any time during the year when climatic conditions are favourable.

The revegetation programme at the modified Snapper mine would continue to use endemic plant species as outlined in the Snapper Mine EA.

5.3 REHABILITATION OF ML DISTURBANCE AREAS

5.3.1 General Rehabilitation Practices and Measures

The materials handling, plant species selection, rehabilitation investigations, studies and trials conducted at the modified Snapper Mine would be undertaken in accordance with the Snapper Mine EA.

Erosion and Sediment Control

The low rainfall and lack of defined drainage channels in the ML area limits the potential for fluvial erosion and sedimentation. On-site water management measures including erosion and sediment control would continue to be in accordance with the Snapper Mine Water Management Plan (BEMAX, 2008a).

5.3.2 Description of Landforms

The final landform design concepts presented below include consideration of the issues associated with the progressive development of the final landform over the modified Snapper Mine life, drawing on relevant experience from the Ginkgo Mine.

Final landform construction would be based on objectives for long-term stability, general consistency with the surrounding landscape and suitability for a final landuse determined in consultation with relevant landholders and regulatory authorities.

At the completion of mining, the final landform within the mine path would include two final depressions (associated with the final dredge pond and water disposal dam) (Figure 8). Mine planning would minimise the size of the final depressions.

Mine Path

The Modification would include a change to the final landform profile along the alignment of the mine path, with the final elevation increased from approximately 4 m to approximately 10 m over the pre-existing landform. Over time, there would be some further minor settlement of the landform and the net result would be a mounded landform along the alignment of the mine path.

The Modification would introduce a double-pass mine plan in Year 7, approximately 4 km from the southern end of the orebody (Section 2.3.1). The single mine path would be progressively rehabilitated and backfilled during the first seven years. Double mine pass areas would be progressively backfilled although final landform shaping and revegetation would not occur until the secondary mine pass and backfill has occurred.

Overburden Emplacement

As described in Section 2.2.1 detailed mine planning has identified the requirement to increase the volume of overburden to be placed off-path during the initial years of mining.

Slurried overburden would no longer form part of the rehabilitated mine materials profile, given that overburden would not be slurried for the modified Snapper Mine. The use of an electric conveyor system and/or dry mine fleet would be used as an alternative for slurried overburden removal. Accordingly, the installation of seepage control measures (i.e. clay liners, low permeability embankments or toe drain/trenches) associated with the initial slurried overburden emplacement as outlined in the Snapper Mine EA would not be required.

The total area of the overburden emplacement would increase from approximately 145 ha to approximately 215 ha to allow for placement of overburden from a larger active mining area (Section 2.2.1).

The height of the overburden emplacement (i.e. 20 m) described in the Snapper EA would remain unchanged. Batters would remain at an approximate 1:4 slope or an appropriate alternative determined by slope and erodibility investigations. The overburden emplacements would continue to be covered with soil materials (e.g. subsoil and topsoil) to an appropriate depth, as per the Snapper Mine EA.

Initial Water Treatment Dam

As mentioned in Section 2.6, the initial water treatment dam (Figure 4) is no longer required and would therefore not contribute to the final landform.

Water Treatment Dam

In accordance with the Snapper Mine EA the water treatment dams constructed within modified Snapper Mine path would continue to be pushed down and rehabilitated as part of the rehabilitation of the mine path.

Water Disposal Dam

As mentioned in Section 2.6, the water disposal dam would be constructed within the mine path approximately in Year 6; the location of the water disposal dam would be altered to account for the modified double-pass mining method.

The water disposal dam would be decommissioned and rehabilitated following the cessation of mining, as described in the Snapper Mine EA.

Final Dredge Pond Depression

The final dredge pond would be located at the southern end of the double-pass mine plan at the cessation of mining (Figure 8). The volume of the final dredge pond and surrounding pit would approximate the volume of overburden material that was removed during construction of the initial starter pit (i.e. approximately 34 Mm^3).

As per the Snapper Mine EA, the final dredge pond would be partially backfilled with overburden material pushed down from the pit walls and from the final overburden emplacement area to a level some 2 m to 4 m above the local groundwater table.

The saline materials would be covered using the same cover strategy as for sand residues outlined in the approved Snapper Mine EA, resulting in the formation of a final depression similar in nature to the localised topographic depressions that occur in the region.

Snapper Mine Roads

As per the Snapper Mine EA, it is anticipated that the mine roads within the modified Snapper Mine area would be retained for use by landholders following the cessation of mining, subject to consultation with relevant landholders during closure planning.

During the modified Snapper mine life, selected roads would continue to be watered with saline groundwater to minimise dust emissions in accordance with the Snapper Mine Water Management Plan (BEMAX, 2008a).

ML Area Infrastructure

Hardstand areas would continue to be subject to dust suppression watering in accordance with the Snapper Mine Water Management Plan (BEMAX, 2008a)

As per the Snapper Mine EA, stockpiled rehabilitation media would be applied as necessary and stabilised, with revegetation being undertaken with suitable endemic plant species.

Infrastructure located in the ML area that would be removed following the cessation of mining would be consistent with those detailed in the Snapper Mine EA.

5.4 HAR AND ETL REHABILITATION

As per the Snapper Mine EA, it is anticipated that sections of the ETL and HAR would be retained for alternative use by landholders or other interested parties following cessation of mining, subject to consultation with landholders and regulatory agencies during closure planning.

Following the change in alignment of the ETL, rehabilitation objectives would be consistent with those outlined in the Snapper Mine EA.
It is anticipated that the disturbance associated with the construction of linear Snapper Mine infrastructure would be limited in extent and specific revegetation activities would not be required. Natural regrowth of surrounding vegetation would be allowed and encouraged.

Options for the ETL following cessation of the Snapper Mine, remain consistent with those outlined in the Snapper Mine EA.

5.5 REHABILITATION MONITORING

The modification to the Snapper Mine would not alter the rehabilitation monitoring programme developed as part of the approved Snapper Mine to assess the performance of the rehabilitation areas. Monitoring results along with the monitoring site locations, parameters and frequencies would continue to be reviewed annually through the AEMR process. Information collected from monitoring would be incorporated into rehabilitation strategies.

Radiation monitoring at the modified Snapper Mine would be continue in accordance with the approved Snapper Mine Waste Management Plan (BEMAX, 2008b)

5.6 LONG-TERM PROTECTION AND MANAGEMENT MEASURES

The long-term security of a landholding which may result from the comprehensive offset strategy is described in the Snapper Mine EA.

Upon cessation of mining operations, it would be expected that tenure of the mining lease would be maintained by BEMAX until such time as the relevant statutory requirements are achieved (e.g. fulfilment of mining lease conditions). BEMAX would then seek to relinquish the Snapper Mining Lease.

Long-term protection and management measures for the modified Snapper Mine (following cessation of mining operations) would be consistent with those outlined in the Snapper Mine EA.

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APPENDIX A

SNAPPER AND GINKGO MINES

HYDROGEOLOGICAL ASSESSMENT

BEMAX Resources Limited

Section 75W Modification

Snapper & Ginkgo Mines – Hydrogeological Assessment

Pooncarie, NSW

GEO-ENG Report 9015C March 2010

GEO-ENG

9015C MDR
5 March 2010

Mr Joe Bannister
Development Manager
BEMAX Resources Limited
PO Box 15164
City East QLD, 4002

RE: Snapper & Ginkgo Mines – Hydrogeological Assessment

Dear Joe,

Please find following an assessment of the potential local and regional hydrogeological impacts of the proposed modification to the Snapper and Ginkgo Mines.

If you have any questions about this report or other issues, please contact me on 07 3711 5530 or 0423 200 355.

Sincerely yours,

Mark Robertson MASc, CPEng. RPEQ
GEO-ENG

Executive Summary

Bemax Resources Limited is planning to modify their existing approved plans for Ginkgo and Snapper Mines to optimize the use of the identified mineral resource, while minimizing environmental impacts.

Groundwater investigations have indicated that a more efficient groundwater supply can be achieved from a deep aquifer compared to a borefield in the shallow aquifer as was previously proposed.

A new groundwater model has been developed to more accurately represent the effects of the mining, while also incorporating new geological data and changes to the mine plans, including the change to a deeper groundwater bore supply.

The results of the new modelling confirm that the originally designed thirty shallow bores can be replaced with three deep bores, with a reduction in groundwater aquifer effects.

The maximum and average estimated water supply demands, and water disposal requirements, have reduced significantly due to the planned mine modifications.

The potential mining effect on the shallow aquifer groundwater levels around the mine are reduced by the modified design. Changing from shallow to deep bores at Snapper Mine would create a groundwater mounding in the shallow aquifer at Snapper Mine, which would offset some of the drawdown due to the Ginkgo Mine, resulting in a smaller impact at nearby shallow farm bores and The Salt Lakes.

Groundwater drawdowns in the deep aquifer are limited to the local area and will not effect any beneficial use of this water.

The will be no measureable effect on any surface water features in the region.

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1.0 Introduction

The Snapper and Ginkgo Mines are located in far western New South Wales (NSW); approximately 40 km west of Pooncarie. Mineral sands are mined at both operations, from which the concentrate is trucked to a mineral separation plant in Broken Hill. The Ginkgo Mine was approved in 2002 and commissioned in 2005. The Snapper Mine was approved in 2007 with construction commencing in 2009.

A hydrogeological assessment was prepared by Golder Associates in 2007 for the Snapper Mine. [1] It assessed the hydrogeological impacts of the Snapper Mineral Sands Project and included a detailed description of the existing hydrogeological environment at the Snapper Mine. This report builds on this previous work and provides an assessment of the potential hydrogeological impacts of the modification to the Snapper and Ginkgo Mines (the proposed modification), including supply of groundwater from the deeper, higher yielding, saline Lower Olney Formation / Warina Sand aquifer instead of the shallow saline Loxton-Parilla Sands aquifer.

2.0 Scope

GEO-ENG was commissioned by BEMAX Resources Limited (Bemax) to investigate an alternative groundwater supply for the Snapper Mineral Sands Project and to prepare a cumulative (i.e. Snapper and Ginkgo Mines) assessment of the potential local and regional hydrogeological impacts.

The objectives of this hydrogeological assessment include the following:

- characterise the existing hydrogeological regime in the vicinity of the Snapper and Ginkgo Mines;
- characterise the alternative groundwater supply aquifer (i.e. the Lower Olney Formation / Warina Sand aquifer) at the Snapper Mine;
- assess the water requirements for the Snapper and Ginkgo Mines (e.g. raise and lower the water in the dredge pond) using a mine-scale model and develop a mine water balance;
- revision of the regional groundwater model for assessment of the sustained water availability and potential cumulative impacts of the Snapper and Ginkgo Mines, including potential impacts to other groundwater users and hydrological features such as The Salt Lakes, Darling River, Darling Anabranch and associated lakes and the Murray River; and
- development of measures to manage, mitigate and/or avoid impacts.

3.0 Dredge Mining Groundwater Effects

Dredge mining of the Snapper and Ginkgo heavy mineral sand strand-line deposits requires the development and maintenance of an artificial dredge pond, which may

1. Golder Assoicates, *Snapper Mineral Sands Project Environmental Assessment Report, Appendix A—Hydrogeological Assessment*, March 2007, Report # 06613504/016.

vary above or below the natural groundwater table level according to the relative position of the orebody. Tailings[2] is placed in off-path locations (i.e. in a purpose-built dam for an initial period) which is clay-lined to isolate stored water from the groundwater table, and in the mining void behind the dredge pond (which will create a groundwater mound and return water to the water table aquifer).

Water for mineral processing and pond level raising is provided by bores located at the Snapper and Ginkgo Mines. At Ginkgo Mine the bores are located in the shallow water-table aquifer (Loxton-Parilla Sands aquifer), while at Snapper Mine the bores would pump from a deep aquifer (Lower Olney Formation/ Warina Sand), which is isolated from the shallow water-table aquifer.

The water balances of the Snapper and Ginkgo Mines are dominated by groundwater seepage into or out of the dredge pond, losses to the ground from the tailings placement and water transferred to or from the dredge pond to make adjustments to its level or size. Some water is lost through evaporation which varies throughout the year and is dependent on the area of pond and saturated sands. Minor losses occur via the residual moisture in the mineral taken off-site, dust-suppression spraying and office, camp and workshop use. Potable water for sand washing and human consumption is produced by a reverse-osmosis plant, with the reject brine being pumped to the dredge pond.

To lower the pond level, excess water must be pumped from the dredge pond to disposal location in the tailings for infiltration.

4.0 Modification Summary

BEMAX is proposing to modify the currently approved Snapper and Ginkgo Mines. The proposed general arrangement of the modified Snapper Mine is shown on Figure 1.

The key hydrogeological aspects of the modification relating to the Snapper Mine would include the following:

- supply of groundwater from three deep bores in the higher-yielding, saline Lower Olney Formation / Warina Sand aquifer instead of the previously proposed thirty shallow bores in the saline Loxton-Parilla Sands aquifer;
- an increase in processing rate capacity of the wet high intensity magnetic separator (WHIMS) circuit;
- an increase in the water supply capacity of the reverse osmosis (RO) plant, with the water demand increasing from 80 l/s to 83 l/s;

[2] Tailings is equivalent to the term 'sand residue' which is used in BEMAX approval documentation under the *Environmental Planning and Assessment Act, 1979*, including the Snapper Mine and Ginkgo Mine Modification Environmental Assessment to which this report is appended.

- a change to a double-pass mining operation commencing approximately 4 km from the southern end of the ore body (single-pass for approximately the initial six years, followed by double-pass for the remainder);
- use of an electric conveyor system and/or dry mine fleet for dry overburden replacement instead of overburden slurrying;
- swapping the location of the initial overburden emplacement with the initial tailings and initial water dam;
- an increase in the size of the active mining area as a result of the requirement to increase the volume of overburden to be placed off-path during the initial years of mining to allow a consistent final landform height;
- an increase in the maximum final landform height from approximately 4.5 m to approximately 10 m; and
- a decrease in the life of the Snapper Mine from approximately 16 years to approximately 15 years.

The key hydrogeological aspect of the modification relevant to the Ginkgo Mine is an increase to the life of the Ginkgo Mine from approximately 12 years to approximately 14 years. The general arrangement of the approved Ginkgo Mine is shown on Figure 2.

5.0 Existing Environment

5.1 Hydrogeological Setting

A number of large scale ridges and basins (likely fault bounded blocks) form the pre-Tertiary basement profile, over which the relatively flat lying Tertiary and Quaternary sediments of the Murray Basin have formed.[3]

Specific groundwater information is provided by the Murray Basin Hydrogeological Map Series,[4] which indicate the general geometry of the various aquifers and aquitards, based on a sparse distribution of drillholes. Groundwater monitoring results from the Ginkgo Mine and the Map Series also indicate salinities in excess of 35,000 mg/l for the shallow Pliocene Loxton-Parilla Sands aquifer and 14,000 mg/l to 35,000 mg/l for the deep Tertiary Lower Olney Formation / Warina Sand aquifer, in the region of interest.[4,5]

The regional stratigraphy of the Snapper and Ginkgo area is shown on Figure 3 and is described below.

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3. Brown, C.M. and Stephenson, A.E., *Geology of the Murray Basin, Southeastern Australia*. Bureau of Mineral Resources, Australia. Bulletin 235, 1991.
4. Australian Geological Survey Organisation, *Murray Basin Hydrogeological Map Series*, 1993.

5 BEMAX Resources Ltd, *Snapper Mineral Sands Project Environmental Assessment*, 2007.

The Snapper and Ginkgo ore bodies lie in the shallow, saline aquifer of the Loxton-Parilla Sands. Saline aquifers within the underlying Renmark Group have been mapped to include sand beds of the Upper, Middle and Lower Olney Formation and the basal Warina Sand.[4] At the mine sites the Upper Olney Formation is indicated to be a thin zone of fine sand directly beneath and connected to the Loxton-Parilla Sands.[6] The Middle Olney Formation is not well defined in the local mine area but is more significant to the north where it connects with both the Upper and Lower Olney Formations.[4] The Lower Olney Formation and Warina Sand are located at about RL -170 m to RL -260 m beneath the mine site overlying pre-Tertiary bedrock.[7] The Geera Clay Aquitard is approximately 130 m thick at the mine site and separates the saline Upper and Lower Olney Formation units.[7]

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

Deep drilling by Bemax and re-interpretation of existing government drilling logs has identified that the Lower Renmark Aquifer (including the Warina Sand) is quite thick in the Snapper/Ginkgo area and thus will have a much higher transmissivity than previously modelled. Accordingly, this aquifer was selected as the preferred water supply source due to its higher yields.

5.2 Regional Hydrological Features

Regional and local hydrological features of relevance to the proposed modification are described below:

Darling River - The Darling River is surrounded by a fresh to brackish groundwater lens (alluvial lens)[8]. The Darling River provides some local fresh water recharge to groundwater systems, however, the level of connection and rate of flux between the alluvial system and the underlying deeper groundwater system is considered to be low.[8]

Menindee Lakes – The Menindee Lakes are natural lakes with man-made weirs to raise their level for water storage. The lakes provide local fresh water recharge to the Loxton-Parilla aquifer.[8]

Great Darling Anabranch - The Great Darling Anabranch normally consists of a series of pools and occasionally floods. Similar to the Darling River, the Great Darling Anabranch is surrounded by a fresh to brackish groundwater lens (alluvial lens).[8] It is

6. BEMAX, Exploration Drilling Database – Pooncarie Region.

7. GEO-ENG, *Deep Bore DPB-02 Commissioning*, Snapper Mine Site, 7005(N2), 2009.

8 Commonwealth Scientific and Industrial Research Organisation (CSIRO) Land and Water. *Salinity Impact Assessment. Appendix K of Darling Anabranch Environmental Impact Assessment for Stock and Domestic Pipeline and Reinstatement of Environmental Flows*, 2004.

expected that periods of high flow in the Great Darling Anabranch would result in some limited contribution to the underlying deeper groundwater systems; however, due to the intermittent nature of these events and the lack of significant connection between surface and deeper systems, this contribution is likely to be lower than that from the Darling River.[8]

Great Darling Anabranch Lakes - The lakes adjacent to the Great Darling Anabranch are gentle deflation basins that are normally dry but do receive water when the Great Darling Anabranch is in periods of high flow,[9] or from localised rain. Occasional wet surface conditions in the lakes would provide small intermittent recharge to the deeper underlying saline groundwater.[8]

The Salt Lakes - Locally, loss from the Loxton-Parilla aquifer occurs via evaporation at The Salt Lakes, 8 km south of the Snapper Mining Lease (ML) area. There is no permanent surface water in The Salt Lakes, with the groundwater table being at a shallow depth below ground level. The surface salt crusting in low-lying parts of The Salt Lakes indicates upward movement of saline groundwater by capillary action driven by evaporation.[8] A number of similar salt pans are found at distances of 40 to 100km to the south-west and west of the mine site, where groundwater loss occurs due to evaporation, resulting in a crust of salt at the surface.[4]

Localised Freshwater Lenses - In addition to the above, isolated freshwater lenses also occur below localised topographic depressions in the region. This generally occurs in topographically enclosed basins where rainfall runoff is concentrated and recharges shallow groundwater. Low salinity recharge in these areas tends to form a localised freshwater lens over the denser more saline groundwater. An example of this is located at Chalky Well to the north-east of Ginkgo Mine.[8]

Lake Victoria – Lake Victoria is a shallow freshwater lake adjacent to the Murray River, approximately 100 km to the south-west of Snapper Mine. It is managed as off-river storage by the Murray Darling Basin Commission, with an embankment around its extent to increase storage capacity.[10] Groundwater seeps from the base of the lake into the shallow aquifer and towards the Murray River. Given the lakes distance from the mine sites, any groundwater effect from the mining operation would be negligible.

Murray River – At its closest point, the Murray River is approximately 74 km south of the Snapper Mine Site at Mildura, Vic. In this section of the river, the water levels are controlled by a series of locks resulting in a range of effects including groundwater inflow and outflow from the river, depending on the local gradient.[11] Saline groundwater flow from the Loxton-Parilla, and other shallow aquifers, enters the river along much of its length increasing the salinity load which eventually reaches South Australia. The effect of groundwater changes at the Snapper and Ginkgo Mine sites

9 Earthtech, *Darling Anabranch Environmental Impact Statement for Stock and Domestic Pipeline and Reinstatement of Environmental Flows*. Department of Infrastructure, Planning and Natural Resources, NSW.

10. Murray Darling Basin Commission. *Lake Victoria,* www2.mdbc.gov.au/rmw/river_murray_system/lake_victoria.html.

11. Brodie, R.S., *The Lower Darling Regional Steady State Groundwater Flow Model*, Australian Geological Survey Organization, Canberra, 1998/19.

would be negligible over this distance, with a small reduction in salt recharge to the river over the medium term.

6.0 Groundwater Modelling

To improve the accuracy of the groundwater assessment, a moving-pond groundwater model has been used by GEO-ENG to calculate water balance volumes on a mine scale with small time-increments, while also being able to provide regional scale groundwater level changes. This model is based on the earlier regional groundwater model created by Golder Associates.[1,12]

The modified groundwater model was built using a 3-D Finite Element Groundwater Modelling software package (FEFLOW).[13] A series of EXCEL spreadsheets were set up to create inputs for the varying groundwater sources and sinks at monthly intervals, allowing parameters to vary linearly over the period.[14]

The extent of the model is similar to that defined by Golder Associates and uses similar boundary conditions. The same regional geological data was used to define the geometry of the geological layers, with additional information provided from mineral sand exploration drilling information to better define the variability of the upper aquifer. The thickness of the Lower Renmark Group Aquifer was also adjusted based on the Bemax deep-drilling information.

6.1 Model Set-up

Five layers were used in the model, with the upper aquifer(s) being subdivided into 3 layers. Layer 1 includes the water table aquifers including shallow Quaternary sediments, the Shepparton Formation and the majority of the Loxton-Parilla Sands. Layer 2 was used to delineate the higher permeability surf-zone of the Loxton-Parilla Sands, and Layer 3 represented the Upper Olney fine-grained sands of the Renmark Group, which is directly connected to the Loxton-Parilla Sands. By increasing the subdivision of the upper aquifer, the interaction of the mining dredge pond with the high permeability surf zone, which varies in elevation by over 30 m across the Snapper Mine site, can be better simulated.

Layer 4 represents the low-permeability Geera Clay and similar units, which forms an aquitard over much of the region but pinches out to the north, where it is replaced by the middle Renmark Group Layers, and to the south, where it is replaced by the Murray Group Limestone. Layer 5 defines the lower aquifer, including the Lower Olney Formation and the Warina Sand of the Renmark Group.

External boundary conditions from the previous groundwater model were recreated in the new model.[1]

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12. Golder Associates*, Re-Run of Regional Groundwater Model, Snapper Mineral Sands Project.*, 19 September 2008. Project # 087616009001.
13. Diersch, H.-J.G., *FEFLOW: Finite Element Subsurface Flow & Transport Simulation System*, DHI-WASY GmbH, Berlin, 2005.
14. The previous modelling utilized average results over periods of up to 1 year.

6.2 Hydrogeological Parameters

Hydrogeological parameters were based on those determined by Golder Associates.[1] The Specific Yield for the water table aquifers was increased to 0.15 (compared to 0.10 as used by Golder Associates[1]) to improve the transient calibration of the model. Uniform hydraulic conductivity was used in each geological unit, as there is insufficient data to define regional variability, and the mining effects are insensitive to changes in the far-field. Transmissivities will vary across the region, as a result of the varying layer thickness determined from the regional hydrogeological maps.[4]

Table 1 – Ginkgo and Snapper Mine Hydrogeological Parameters

	Layer	K	Anisotropy	SY	Ss
1	Quaternary Sediments / Shepparton / Loxton-Parilla	$1x10^{-4}$ m/s	0.25	0.15	
2	Surf Zone	$5x10^{-4}$ m/s	0.20	0.15	0.0001
3	Upper Olney	$1x10^{-5}$ m/s	0.33	0.15	0.0001
4a	Geera Clay	$1x10^{-7}$ m/s	0.5		0.001
4b	Middle Renmark Group	$3.5x10^{-4}$ m/s	0.06		0.0001
4c	Murray Group Limestone	$3.5x10^{-4}$ m/s	0.06		0.0001
5	Lower Olney / Warina Sand	$3.5x10^{-4}$ m/s	0.06		0.0001

As the moving-pond model is able to directly simulate the effects of the mine pond and tailings, a number of the assumptions and parameters used in the previous modelling are not necessary. Table 2 provides the required water balance parameters for the modified Snapper Mine modelling.

Table 2 – Ginkgo and Snapper Mine Water Balance Parameters

Parameter	Ginkgo	Snapper
Tailings density	1.6 t/m^3	1.6 t/m^3
HMC bulk density	3.1 t/m3	3.1 t/m3
Evaporation rate over all open water and active tailings areas	100% of Mildura Pan Evaporation Rate	100% of Mildura Pan Evaporation Rate
Maximum potable water requirements	1.7 l/s	0.8 l/s
Maximum water supply to RO plant (limitation to bore supply range)	41 l/s	83 l/s

6.3 Moving Pond Simulation

To simulate the effect of the moving dredge pond and tailings, the mining progress was subdivided into monthly increments to define the location and elevation of the dredge pond and tailings.[15] The mine path was subdivided into small triangular elements (maximum length of about 40 m), and each mine path node was given a Cauchy-type flow boundary associated with a sequence of water levels and control functions to mimic the passing of the pond and tailings. A total of almost 1000 time-varying functions were applied to about 4700 nodes to simulate the mining progress. The bores and infiltration of excess water back into the mine path was simulated using Well-type cells.

As previously stated, the proposed modification to the Snapper Mine would involve a change to a double-pass mining operation commencing approximately 4 km from the southern end of the ore body (single-pass for approximately the initial six years, followed by double-pass for the remainder). The proposed modification to the Ginkgo Mine would involve an increase to the life of the Ginkgo Mine from approximately 12 years to approximately 14 years, to reflect changes to the mine path design.

6.4 Groundwater Bores

The groundwater supply at Snapper has been altered from a shallow aquifer borefield, to three deep bores in the higher yielding Lower Olney / Warina Sand aquifer. Each of the deep bores would be capable of producing up to approximately 100 l/s to 120 l/s each, however, the pumping infrastructure is planned to limit the total flow from the bores to 270 l/s, reduced from the previously designed capacity of 370 l/s.

Because the Snapper bores are located in a separate aquifer from the mining pond, the design pumping rates over the life of the mining can be calculated directly from the mine water requirements, without any secondary feedback. This is advantageous in the modelling process, as there is a large variation in water demand over the life of mine. Ginkgo bores on the other hand have a limited capacity (~85 l/s in total) and have a direct effect on water levels in the Ginkgo mine pond. Within the model the Ginkgo bores are simulated for future times as being either fully on (when there is high demand), or at minimal flow rate for the RO plant, when there is excess water.

6.5 Calibration

The model was initially calibrated under steady state conditions to match the groundwater levels determined by the Golder Associates model and against regional water bore levels. Subsequent transient calibration (which was not available to the previous model) was carried out against approximately 4.5 years of groundwater monitoring data around the Ginkgo Mine Site (Appendix A). The calibration indicates a good representation of the effect of dredge mining on the upper aquifer.

6.6 Model Controls

Historic and planned dredge pond water levels, pond sizing, tailings placement elevations and rates, and mineral processing quantities were determined at monthly increments, for the life of the operations. Within the groundwater model, calculations were carried out at time steps internally determined to achieve convergence with data

15. Mine planning data, current as of November 2009, was used for the design. Previous modelling had applied a net water balance at the location of the bores, based on estimates of pond gains and tailings losses.

being reported every 10 days. Groundwater pumping and disposal was iteratively matched after each model run to the water surplus/deficit for each mine and re-input into the model to obtain a near zero net water balance.

Water disposal locations were chosen to minimize the interference with the dredge pond, assuming water would be infiltrated into the aquifer in zones within the tailings areas.

7.0 Water Balance Results

The resulting water balance graphs (Appendix B) indicate bore and dewatering requirements for each mine. Seepage in and out are obtained from the groundwater model. Fixed water demands (mineral processing water, potable water, dust suppression) were provided by Bemax. The resulting surplus/deficit (s/d) determines bore and dewatering requirements. Bore pumping is also limited by available bore yields and fixed requirements for mineral processing. The model was iteratively run to maintain a cumulative water balance near to zero.

Given the variable nature of hydrogeological parameters, the indicated results should be accurate to about +/- 20%. Changes to the mining operation in the placement of tailings, pond levels or mining advance rates can cause significant variations beyond this to the water balance, and the model can be rerun to assess any planned variations.

For the modified Snapper design, the average groundwater usage from the Snapper Mine Bores reduces from approximately 165 l/s to approximately 98 l/s. The maximum rate of dewatering disposal is also reduced from 370 l/s to 130 l/s.

The reduced water demand is due to: 1) a change to a dry method for overburden removal, 2) less vertical changes to the pond level in the modified model, and 3) a more accurate accounting for the effect of the water from the tailings recharging the groundwater.

The maximum water supply requirements for the modified Ginkgo Mine would remain unchanged and continue to be sourced from the six bores in the Loxton-Parilla Sand aquifer.

8.0 Hydrogeological Impact Assessment

8.1 Regional Contours

Contours showing the change in groundwater levels at 7 years and at the end of Snapper Mining are shown in Appendix C, for both the upper and lower aquifers, to compare directly to the previous modelling results. As can be seen the lateral impact of mining on groundwater levels is limited to a diameter of about 18 km in the upper aquifer and about 28km in the lower aquifer (0.1 m contours). Significant changes in water level, greater than 0.5 m, are restricted to diameters of about 9 km.

Table 3 provides a comparison with the previously modelled results.

Table 3 – Groundwater Drawdown Modelling Results Comparison

Time	Maximum Diameter Extent of 0.5 m GDW Contour (km)			
	2007 Golder Model	2009 GEO-ENG		
	Shallow (drawdown)	Shallow (drawdown)	Shallow (rise)	Deep (drawdown)
Snapper Year 7	21.5	4	8	6
Snapper mine closure (Year 14.8)	27	0	9	0.6
20 years post-mine closure	19	0	0	0.0

8.2 Shallow Aquifer Effects

The previous calculated contours and the results from the current model are significantly different in the shallow aquifer because the current model shows both groundwater mounding and groundwater drawdowns, spread along the mine path in the shallow water-table aquifer. The previous model applied the net groundwater usage at the bore locations only and thus only showed a groundwater decline centred around the borefields.[16]

Because the modified design of the Snapper Mine utilizes the lower aquifer for its bore water supply the effect of mining on the upper aquifer is significantly reduced. A groundwater mound will form in the upper aquifer around Snapper Mine, offsetting most of the decline in this aquifer caused by Ginkgo Mine. The net result for the upper aquifer is a smaller groundwater decline around Ginkgo Mine and a limited groundwater mound centred at Snapper Mine.

In the upper aquifer the shape of the drawdown contours varies as the mine moves, with a maximum groundwater mounding centred around the middle of Snapper Mine at the end of mining (Year 4.8). The maximum groundwater drawdown in the upper aquifer also varies, with a maximum extent of about 4 km centred around the Ginkgo Mine at Year 7 of the Snapper Mining (12 years after the start of mining at Ginkgo Mine).

The nearest farm bores, which exploit small freshwater lenses sitting on the saline water of the Loxton-Parilla Aquifer, are known as Chalky Well and Greenvale Well. The freshwater lenses appear to be related to locations of concentrated infiltration due to topographic depressions. These bores are predicted to experience a drawdown in the order of 5 cm which is less than the drawdown predicted for the 2007 Snapper Mineral Sands Project Environmental Assessment and is considered unlikely to affect supply.

16. Note that in the figures presented in the hydrogeological assessment, groundwater drawdowns are shown as negative values, while groundwater mounding is positive (opposite of the way it was presented by Golder Associates).

The results from the groundwater modelling indicate reduced regional groundwater effects as a result of the proposed modification compared to the previous assessment,[5] (i.e. reduced drawdown of the Loxton-Parilla Sands aquifer and associated potential impacts such as potential drawdown of the Salt Lakes).

8.3 Deep Aquifer Effects

The maximum expected drawdown in the lower aquifer occurs at about Snapper Year 7, as after this time the groundwater pumping requirements decrease. Twenty years after mining is completed, there is estimated to be no measurable effect in the lower aquifer.

The nearest groundwater bore targeting the deeper Lower Olney Formation / Warina Sand aquifer is on the Popio Property about 45 km to the north-west of the Snapper Mine. Government records indicate it may be used for stock watering as the water quality improves in this direction.[4] There is expected to be no observable drawdown effect on the Popio well as a result of the proposed modification. There will be no measureable effect at any discharge locations (Murray River) for the deep aquifer, as a result of the proposed modification.

8.4 Surface Waters

Based on modelling results and experience to date at the Snapper Mine and Ginkgo Mine, the change in water levels beneath local surface water features (Darling River, Darling Anabranch and associated lakes, The Salt Lakes, Lake Victoria and the Murray River), will be very small and will not have any measureable effect on these features.

The ultimate net effect of the Ginkgo and Snapper Mines on the regional groundwater system will be a small reduction of salt water flowing to the Murray River over the medium to long term (50-100 years).

8.5 Change in Water Quality

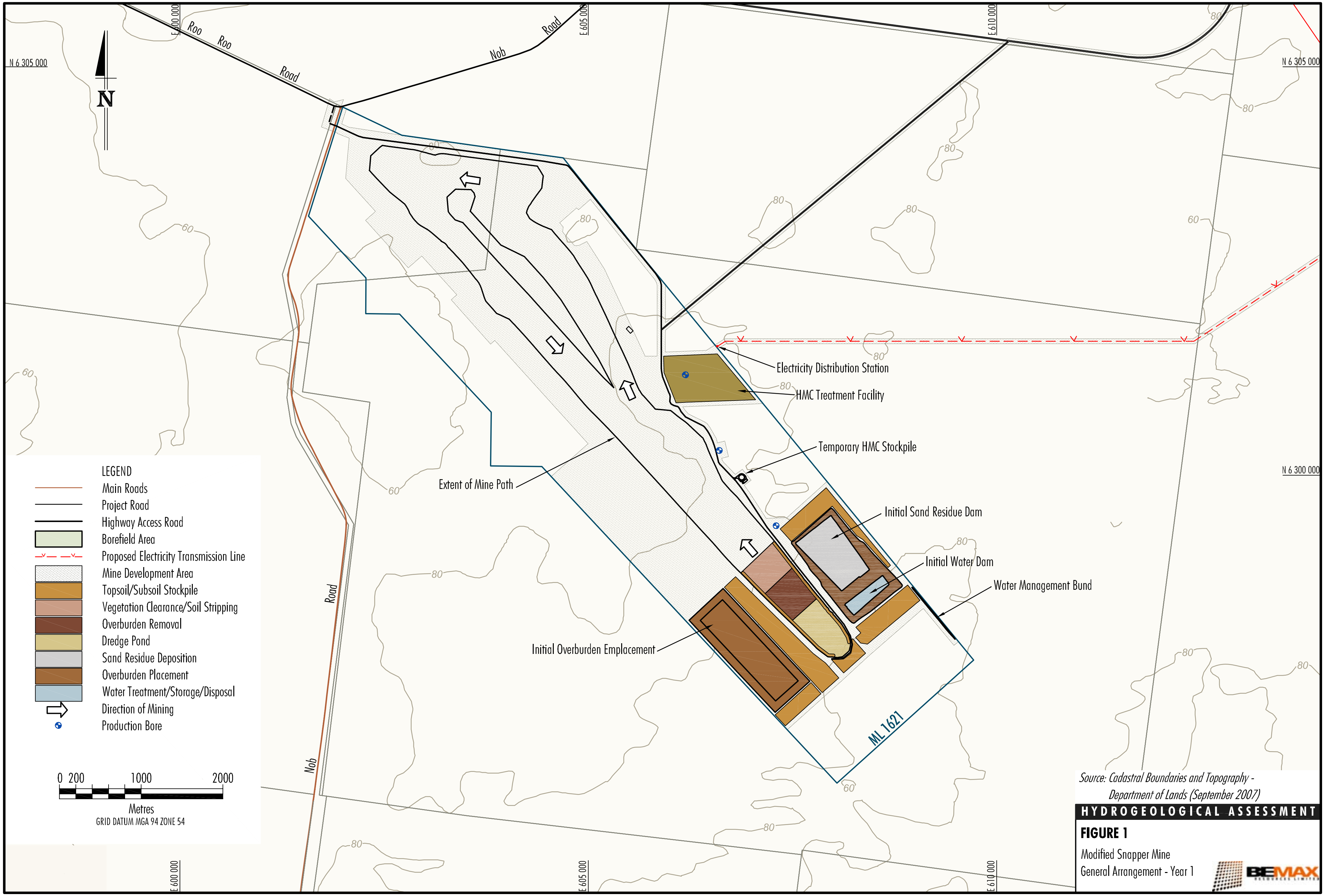
The water drawn from the Lower Olney/Renmark Aquifer has lower total dissolved solids (TDS), than water measured in the upper Loxton-Parilla Aquifer. Thus there will be a slight dilution of the dissolved salt in the upper aquifer around the Snapper Mine as a result of the proposed modification. This change will eventually migrate south over about 100 years. This effect is not expected to be measureable at any receiving environment.

9.0 Conclusion and Recommendations

The results from the groundwater modelling indicate minimal groundwater impacts including reduced regional groundwater effects compared to the previous assessment,[1] (i.e. reduced drawdown of the Loxton-Parilla Sands aquifer and associated potential impacts such as potential drawdown at Chalky Well or the Salt Lakes) as a result of the proposed modification to the Snapper and Ginkgo Mines.

Given the minimal environmental impact of the proposed modification to the Snapper and Ginkgo Mines, it is recommended that Bemax continue the existing management measures and monitoring described in the Snapper Mine Environmental Monitoring Program and Borefield Impact Management Plan with additional groundwater depth and salinity monitoring in the Lower Olney Formation / Warina Sand aquifer.

GEO-ENG



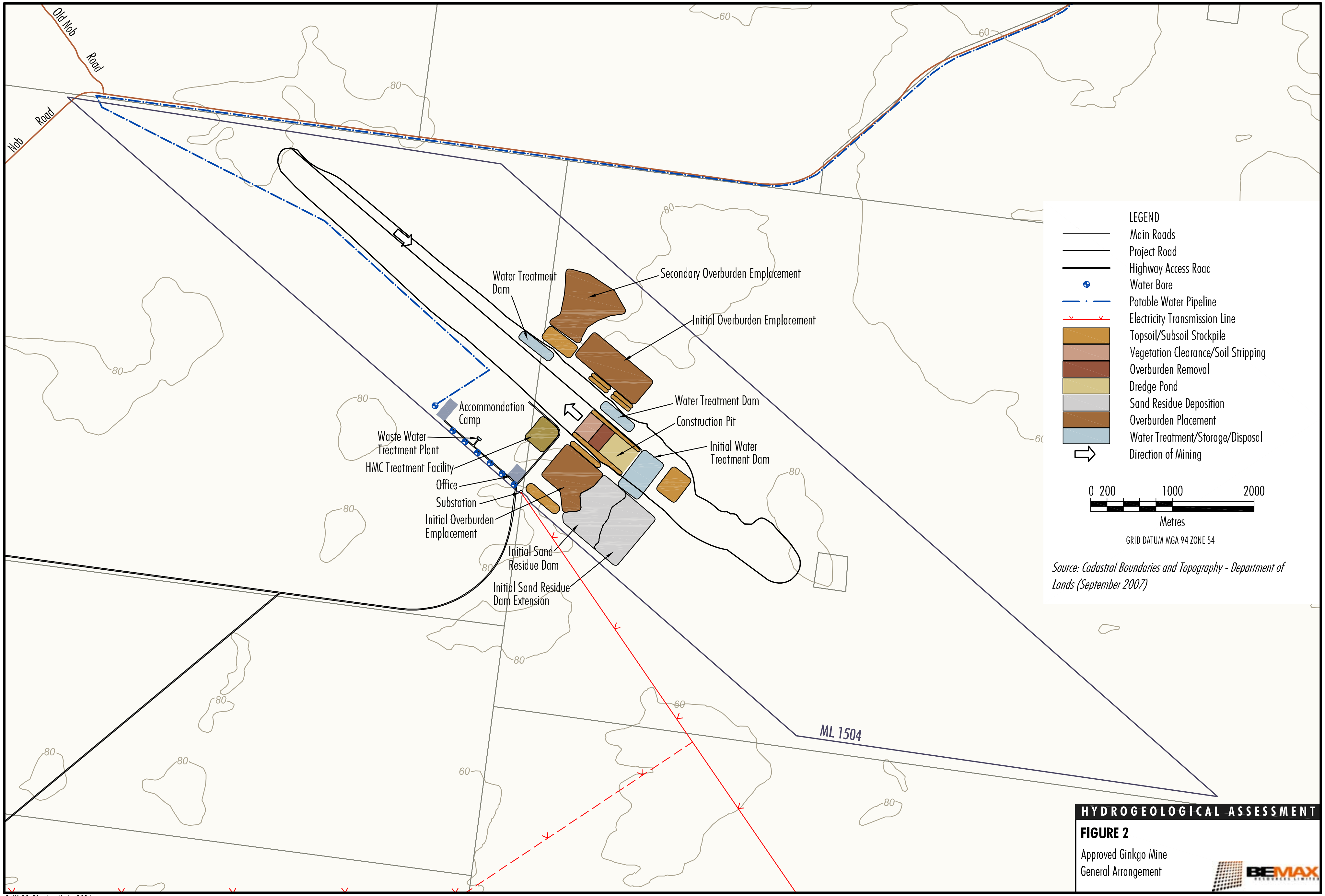
Source: Cadastral Boundaries and Topography - Department of Lands (September 2007)

HYDROGEOLOGICAL ASSESSMENT

FIGURE 1

Modified Snapper Mine
General Arrangement - Year 1

BMX-09-21_App Hydro 101A

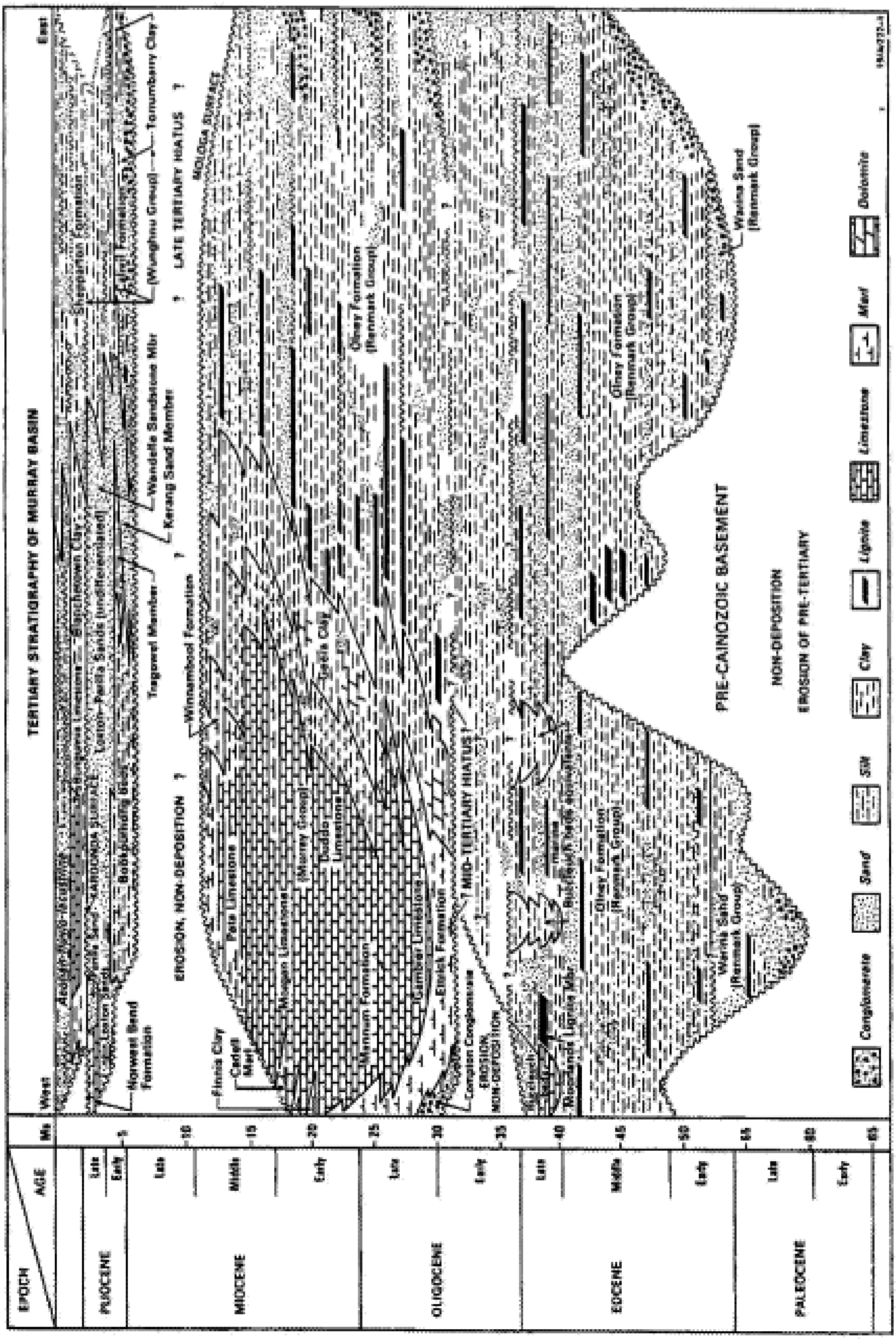


HYDROGEOLOGICAL ASSESSMENT

FIGURE 2

Approved Ginkgo Mine General Arrangement

BMX-09-21_App Hydro 101A



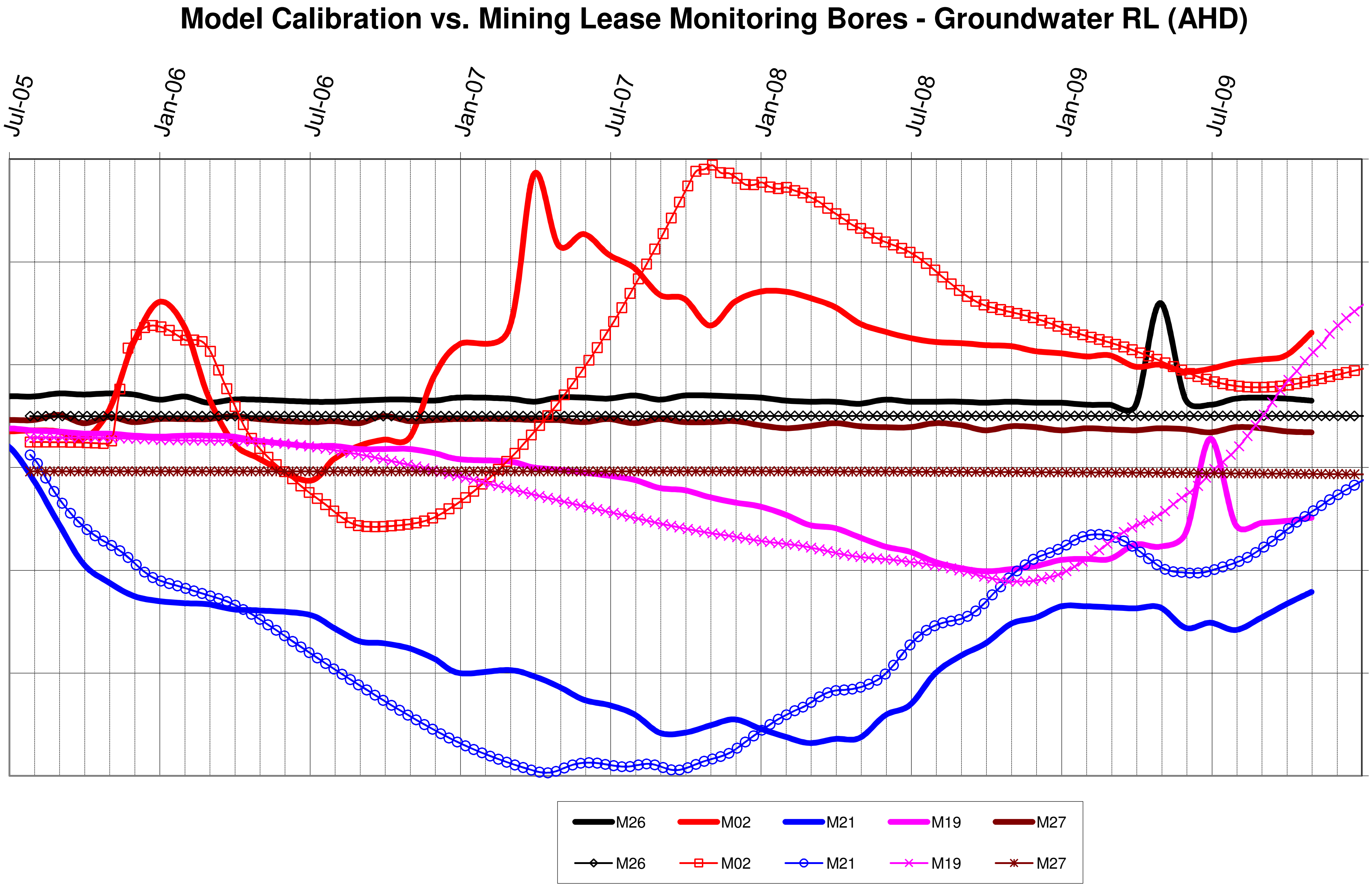
Tertiary Stratigraphy of the Murray Basin (from Brown & Stephenson, 1991)[3]

Appendix A

Model Calibration

Thick Lines – Measured Data

Symbols– Model Data

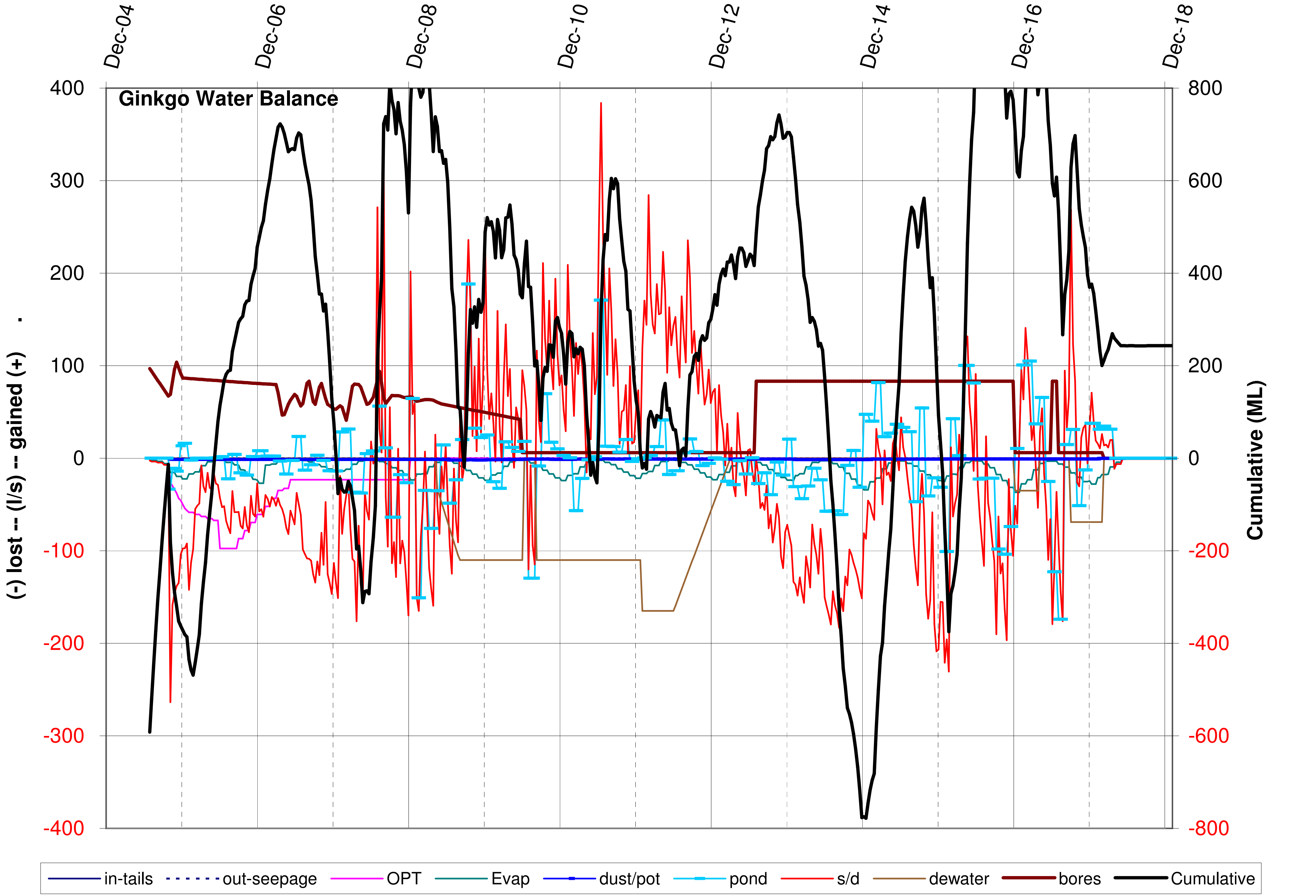


Model Calibration vs. Mining Lease Monitoring Bores - Groundwater RL (AHD)
Jul-05
Jan-06
Jul-06
Jan-07
Jul-07
Jan-08
Jul-08
Jan-09
Jul-09
37.5
36.5
35.5
34.5
33.5
32.5
31.5
RL (mAHD)
M26
M02
M21
M19
M27
M26
M02
M21
M19
M27

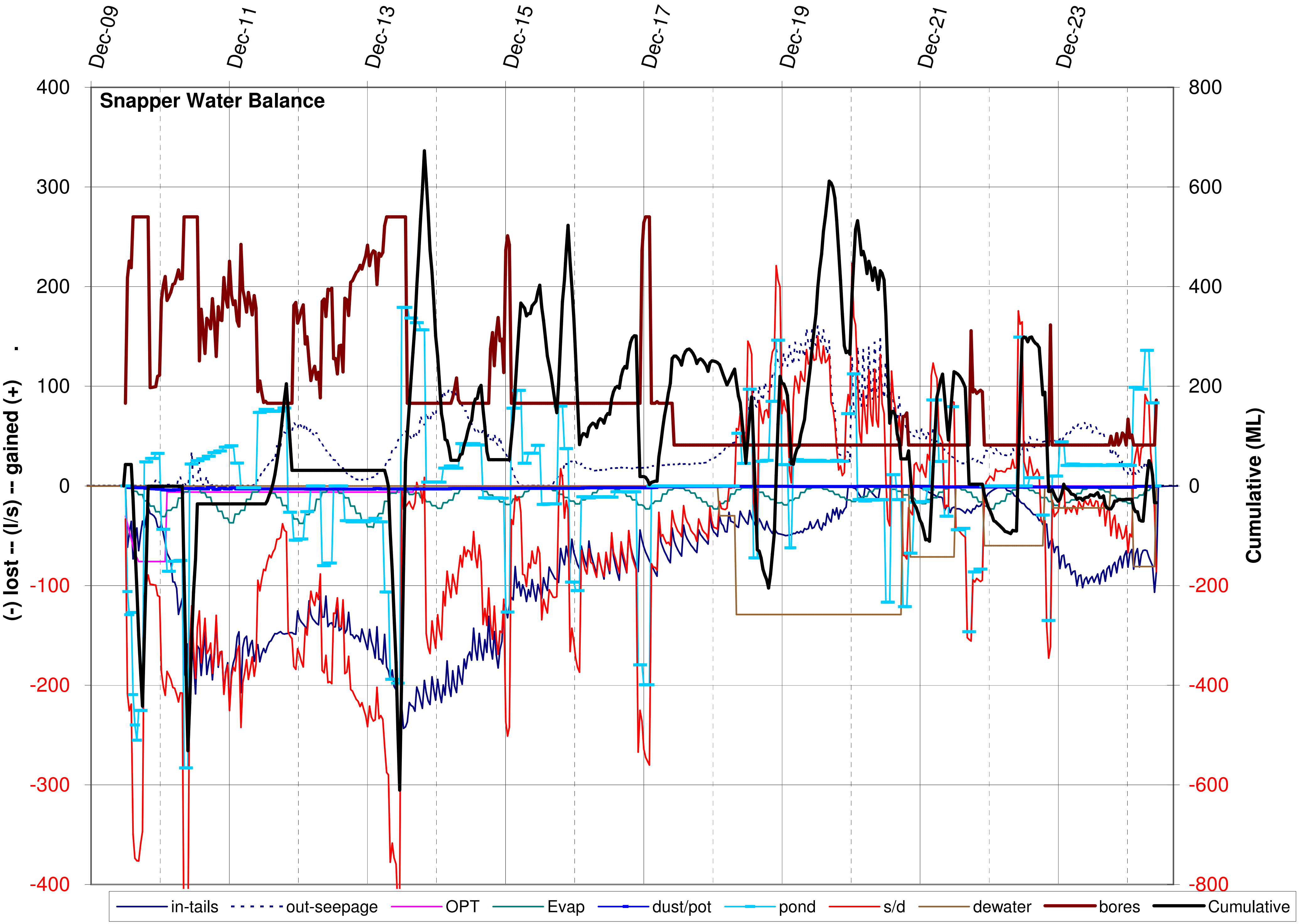
Appendix B

Mine Water Balances

Key	
In-tails	Groundwater flux into aquifer (primarily tailings, but also pond loss, where pond is above natural water table level)
Out- Seepage	Groundwater flux out of aquifer (primarily seepage into dredge pond where pond is lower than natural water table, seepage may also occur in low areas of tailings)
OPT	Off-path tailings. Water lost from aquifer into lined storage dams
Evap	Evaporation. Average values for Pooncarie Station multiplied by wet areas (dredge pond, slimes dams, wet tailings)
dust/pot	Water used for dust suppression on haul roads and for potable water purposes
pond	Water flux required to raise or lower the dredge pond
s/d	Surplus/Deficit of water balance before applying bores and dewatering
dewater	Water pumped to disposal areas for infiltration back into aquifer
Bores	Water pumped from bores
Cumulative	Cumulative water balance for mine.



Ginkgo Water Balance
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18
400
300
200
100
0
-100
-200
-300
-400
800
600
400
200
0
-200
-400
-600
-800
(-) lost -- (l/s) -- gained (+)
Cumulative (ML)
in-tails
out-seepage
OPT
Evap
dust/pot
pond
s/d
dewater
bores
Cumulative



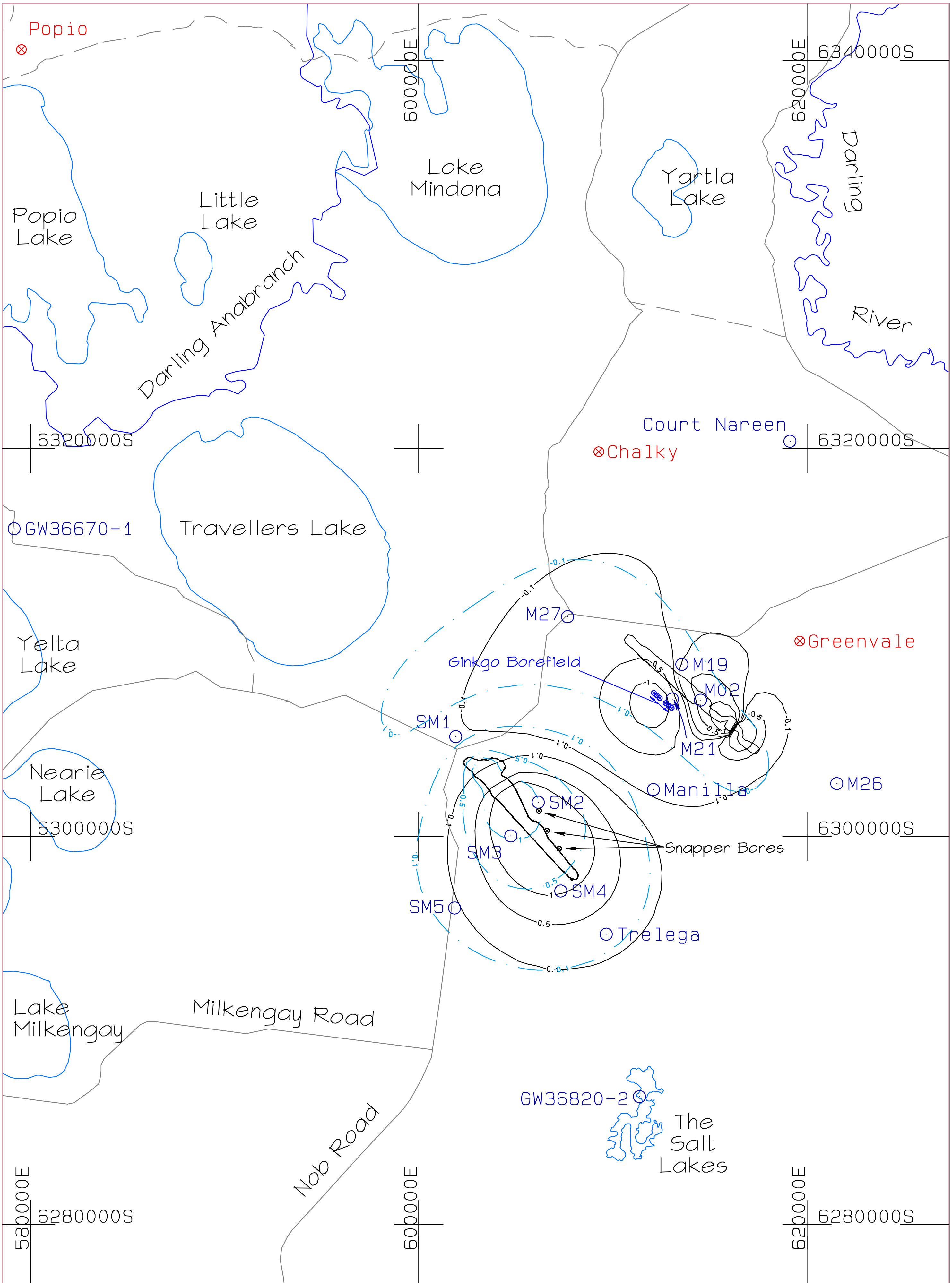
Snapper Water Balance
Dec-09
Dec-11
Dec-13
Dec-15
Dec-17
Dec-19
Dec-21
Dec-23
400
300
200
100
0
-100
-200
-300
-400
800
600
400
200
0
-200
-400
-600
-800
(-) lost -- (l/s) -- gained (+)
Cumulative (ML)
in-tails
out-seepage
OPT
Evap
dust/pot
pond
s/d
dewater
bores
Cumulative

Appendix C

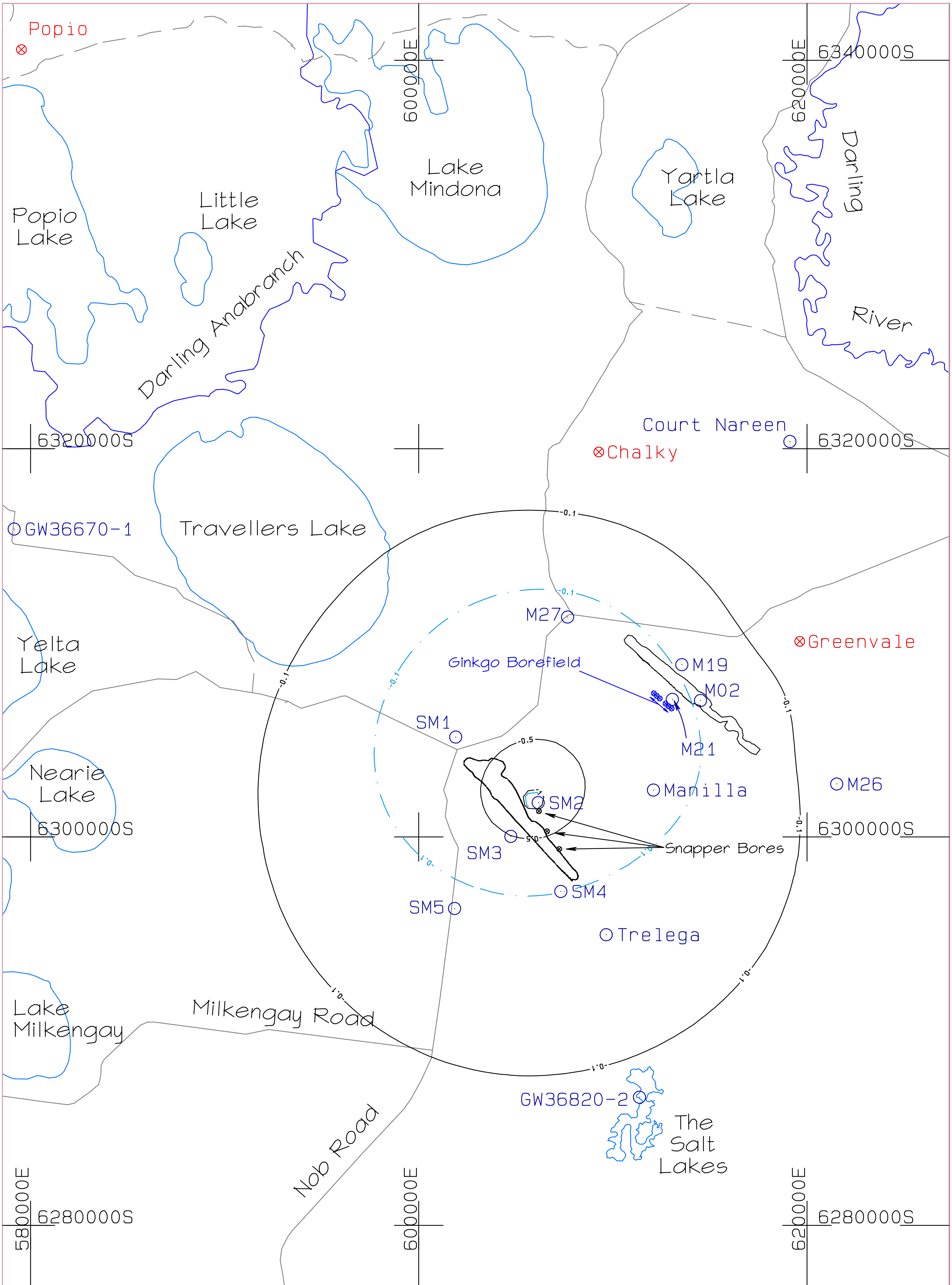
Regional Groundwater Effects

Contours of groundwater drawdown are negative

Contours of groundwater mounding are positive



19.5 x 26.41	Note: Contours of Groundwater Change (+) increase (-) drawdown. Intervals: 0.1, 0.5, 1, 5 (m)	North	Bemax Resources Snapper & Ginkgo Mines		Upper Aquifer Contours
	——— Jun 2017 - 7 Yrs from start of Snapper — · — Apr 2025 - End of Mining at Snapper	Monitoring Point Farm Bore	Surveyed: BEMAX	Plotted: Mar 5 2010	Design: GEO-ENG
			Contour int: N/A	DATUMS: Hor: GDA Ver: A.H.D.	A4 - 1 : 250000
			File No.: C:\FeFlow\S&G\import+export\Plots\159\S&GContoursDD.pro		



19.5 x 26.41	Note: Contours of Groundwater Change (+) increase (−) drawdown. Intervals: 0.1, 0.5, 1, 5 (m)	North	Bemax Resources Snapper & Ginkgo Mines	Lower Aquifer Contours

——— Jun 2017 - 7 Yrs from start of Snapper — · — Apr 2025 - End of Mining at Snapper	⊙ Monitoring Point ⊗ Farm Bore	Surveyed: BEMAX	Plotted: Mar 5 2010	Design: GEO-ENG	Contour int: N/A	DATUMS: Hor: GDA Ver: A.H.D.	A4 - 1 : 250000

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APPENDIX B

SNAPPER MINE MODIFICATION

ABORIGINAL CULTURAL HERITAGE ASSESSMENT

Snapper Mine Modification

Aboriginal Cultural Heritage Assessment

Report to BEMAX Resources Limited

22 February 2010

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Snapper Mine Modification

Aboriginal Cultural Heritage Assessment

Report to BEMAX Resources Limited

22 February 2010

Landskape

Natural and Cultural Heritage Management

a division of M.L. Cupper Pty Ltd

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Executive Summary

BEMAX Resources Limited (BEMAX) proposes to modify the Snapper Mine (herein referred to as *the Modification*) approximately 35 kilometre (km) west of Pooncarie in southwestern New South Wales (NSW). The Snapper Mine was granted Project Approval on 28 August 2007 and the Mining Lease (ML 1621) was approved on 10 July 2008.

The potential impacts on Aboriginal cultural heritage associated with the Snapper Mine were assessed in the Snapper Mineral Sands Project Environmental Assessment (the Snapper Mine EA), which included a cultural heritage assessment. The cultural heritage assessment included an assessment of potential impacts to Aboriginal cultural heritage within the areas of the highway access road and electricity transmission line extensions. The Modification disturbance areas would avoid Aboriginal cultural heritage sites within ML 1621. The potential impact to Aboriginal cultural heritage within ML 1621 is therefore not considered in this report.

In order to assess the potential impact of the Modification on Aboriginal cultural heritage places, items and values resulting from the proposed change to the alignment of the ETL, Landskape was engaged by BEMAX to conduct a cultural heritage assessment of the modified ETL corridor.

The key objectives of the cultural heritage study were to:

- locate and record any Aboriginal cultural heritage places or items within the modified ETL corridor (i.e. the approximately 9.5 km ETL alignment [35 metre corridor]) and assess their significance;
- determine the potential impacts of the modified ETL on cultural heritage; and,
- devise options in consultation with the community for mitigating potential impacts of the modified ETL on cultural heritage.

No items or places of Aboriginal cultural heritage significance were recorded in the corridor proposed for the ETL.

This assessment shows that the nature of the potential impacts of the Modification remains unchanged from those identified in the Snapper Mine EA and the mitigation measures proposed in the Snapper Mine EA can be implemented to minimise these potential impacts.

Based on the results of this cultural heritage assessment and consultation with representatives of the Barkindji Aboriginal community it is recommended that:

- the general mitigation strategies detailed in the Snapper Mine EA and Aboriginal Cultural Heritage Management Plan (ACHMP) be implemented;
- if any previously unidentified Aboriginal cultural heritage places or items are encountered during the course of the Modification works within the corridor of the modified ETL, they should be managed in accordance with the general mitigation strategies detailed in the Snapper Mine EA and ACHMP; and,
- if human skeletal remains are encountered during the course of the Modification works, all work in that area must cease. Remains must not be handled or otherwise disturbed except to prevent further disturbance. If the remains are thought to be less than 100 years old the Police or the State Coroners Office (tel: 02 9552 4066) must be notified. If there is reason to suspect that the skeletal remains are more than 100 years old and Aboriginal, the proponent should contact the NSW Department of Environment, Climate Change and Water's Environmental Line (tel: 131 555) for advice.

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1 Introduction

BEMAX Resources Limited (BEMAX) proposes to modify the Snapper Mine (herein referred to as *the Modification*) approximately 35 kilometres (km) west of Pooncarie in southwestern New South Wales (NSW) (Figure 1). The Snapper Mine was granted Project Approval on 28 August 2007 and Mining Lease (ML1621) was approved on 10 July 2008.

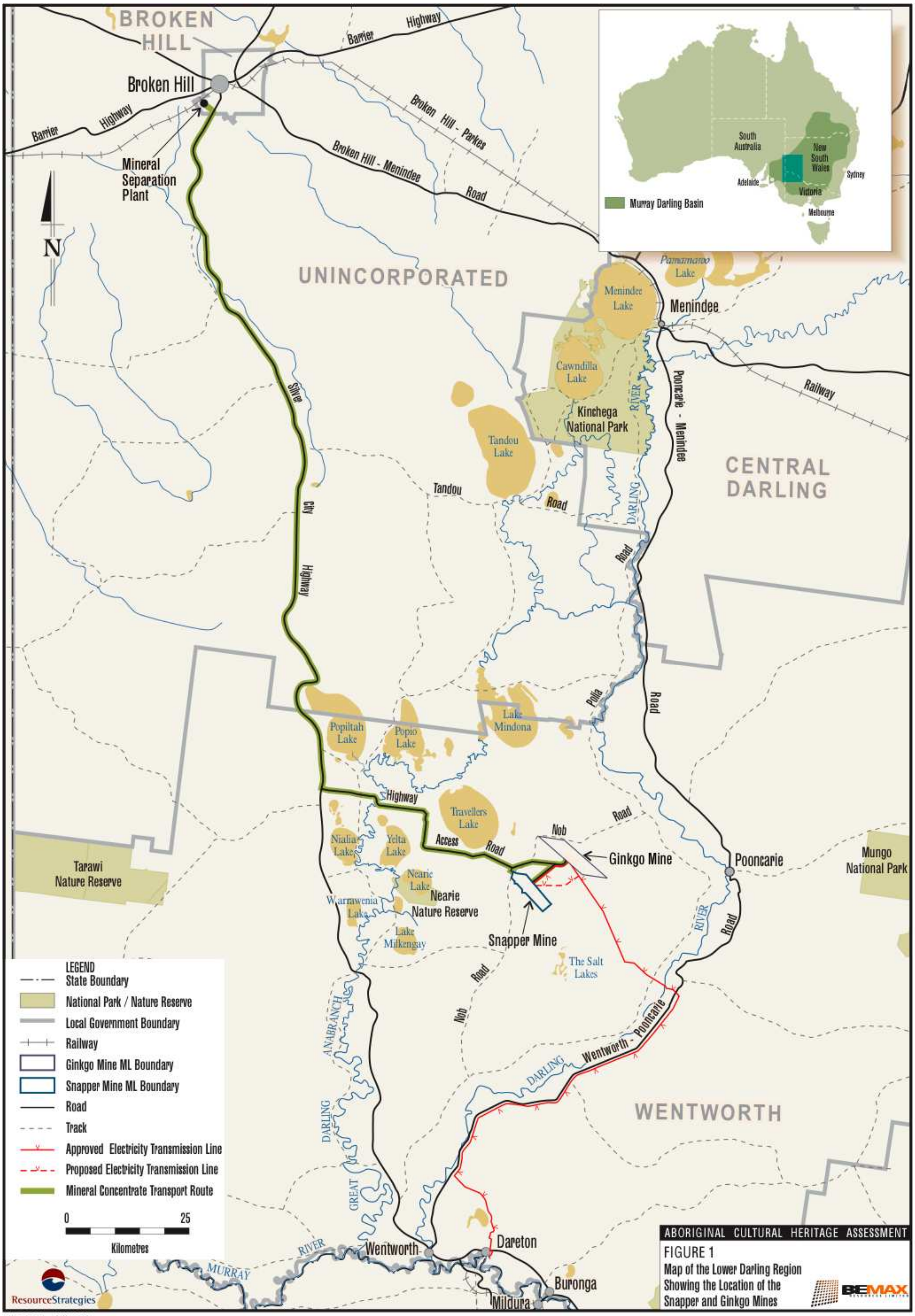
The potential impacts on Aboriginal cultural heritage associated with the Snapper Mine were assessed in the Snapper Mineral Sands Project Environmental Assessment (the Snapper EA) (BEMAX 2007a), which included a cultural heritage assessment (Cupper 2007). The cultural heritage assessment included an assessment of potential impacts to Aboriginal cultural heritage within ML 1621 and within the areas of the highway access road and electricity transmission line extensions.

The potential impacts on Aboriginal cultural heritage associated with the Modification relate to changes to the disturbance area within ML 1621 and the change to the alignment of the approved ETL to the Snapper Mine. The Modification disturbance areas would avoid Aboriginal cultural heritage sites within ML 1621. The potential impact to Aboriginal cultural heritage within ML 1621 is therefore not considered in this report.

In order to assess the potential impact of the Modification on Aboriginal cultural heritage places, items and values resulting from the proposed change to the alignment of the ETL, Landskape was engaged by BEMAX to conduct a supplementary cultural heritage assessment of the modified ETL corridor.

The key objectives of the cultural heritage study were to:

- locate and record any Aboriginal cultural heritage places or items within the modified ETL corridor (i.e. the approximately 9.5 km ETL alignment [35 metre corridor]) and assess their significance;
- determine the potential impacts of the modified ETL on cultural heritage; and,
- devise options in consultation with the community for mitigating potential impacts of the modified ETL on cultural heritage.



ABORIGINAL CULTURAL HERITAGE ASSESSMENT
FIGURE 1
Map of the Lower Darling Region Showing the Location of the Snapper and Ginkgo Mines

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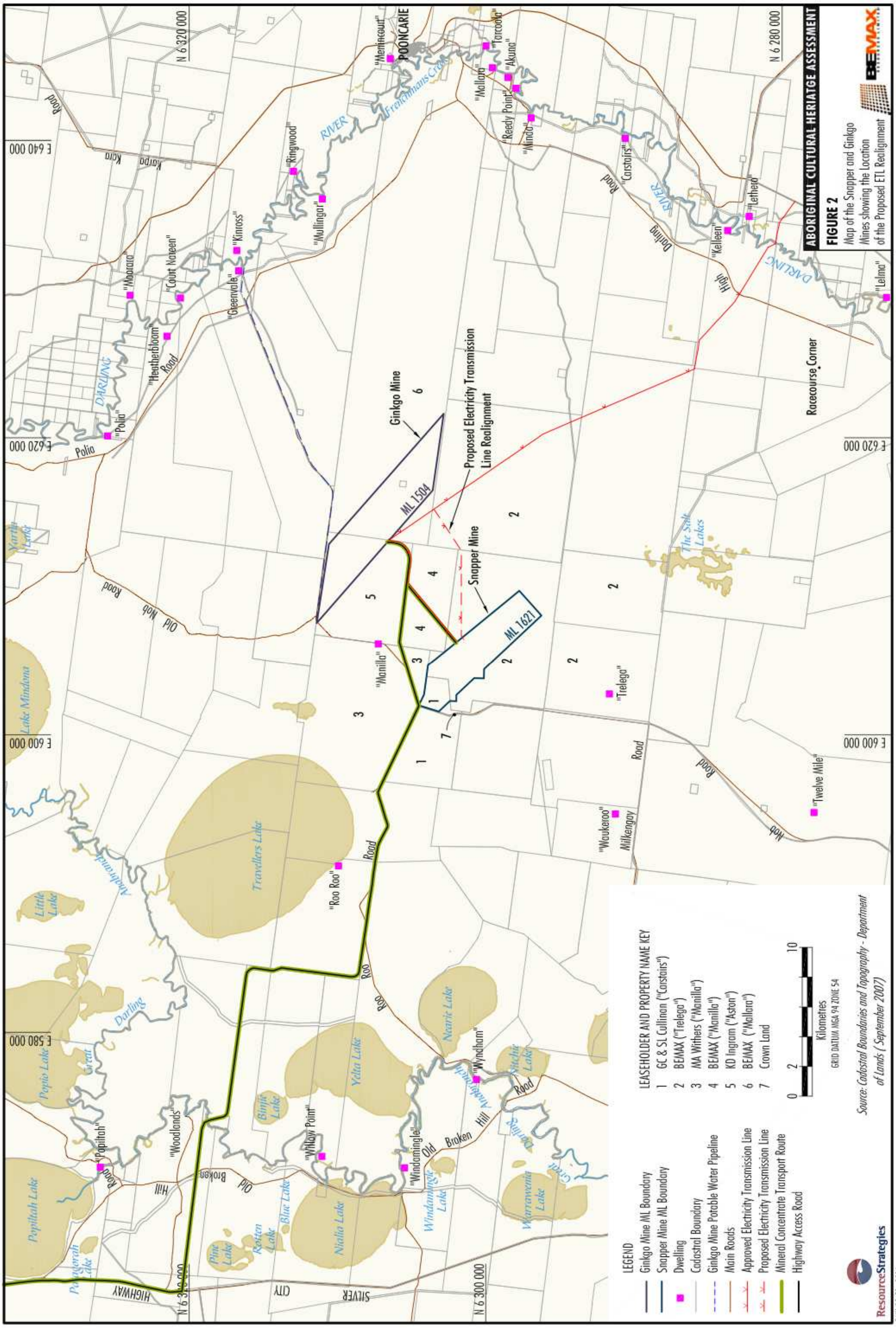
ABORIGINAL CULTURAL HERIATGE ASSESSMENT
FIGURE 2
Map of the Snapper and Ginkgo Mines showing the Location of the Proposed ETL Realignment
LEGEND
Ginkgo Mine ML Boundary
Snapper Mine ML Boundary
Dwelling
Cadastral Boundary
Ginkgo Mine Potable Water Pipeline
Main Roads
Approved Electricity Transmission Line
Proposed Electricity Transmission Line
Mineral Concentrate Transport Route
Highway Access Road
LEASEHOLDER AND PROPERTY NAME KEY
1 GC & SL Cullinan ("Carstairs")
2 BEMAX ("Telega")
3 MA Withers ("Manilla")
4 BEMAX ("Manilla")
5 KD Ingram ("Aston")
6 BEMAX ("Mallara")
7 Crown Land
Kilometres
GRID DATUM MGA 94 ZONE 54
Source: Cadastral Boundaries and Topography - Department of Lands (September 2007)
Ginkgo Mine
Snapper Mine
ML 1504
ML 1621
Proposed Electricity Transmission Line Realignment
POONCARIE
Racecourse Corner
Travellers Lake
Lake Mindona
SILVER CITY HIGHWAY
ResourceStrategies
BMX-09-21_101A

Preparation of this report involved collation of relevant archaeological and environmental information and the use of aerial photographs and topographic and geomorphic maps to identify areas likely to contain archaeological sites. Fieldwork was undertaken on 20 and 21 August 2009 by archaeologist Matt Cupper with the assistance of Barkindji Elders Council members Noel Johnson and Ray Lawson.

1.1 Legislative Background

The Snapper Mine was approved by the Minister for Planning on 28 August 2007 under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) as a Major Project. The EP&A Act recognizes the need to protect the cultural and natural heritage of NSW and provides for planning before development to determine the likely impact of an activity on the environment.

Section 75U of the EP&A Act outlines the authorisations that do not apply to approved Part 3A projects. Under Section 75U permits and consents under Sections 87 and 90 of the *National Parks and Wildlife Act 1974* do not apply.

2 Modification Description and Potential Impacts

2.1 Modification Description

The key aspects of the Modification to the Snapper Mine include:

- an increase in the total amount of ore mined from approximately 117 million tonnes (Mt) to approximately 122 Mt and a minor change to the extent of the mine path;
- an increase in the annual ore mining rate from approximately 8.2 million tonnes per annum (Mtpa) to approximately 9.1 Mtpa;
- a decrease in the total amount of mineral concentrates from approximately 5.9 Mt to approximately 5.2 Mt, as a result of decreased average ore grades;
- an increase in maximum annual mineral concentrate production rate from the Snapper Mine from approximately 450,000 tonnes per annum (tpa) to approximately 621,000 tpa of Heavy Mineral Concentrate (HMC);
- a decrease in the life of the Snapper Mine from approximately 16 years to approximately 15 years, to reflect the decrease in total amount of mineral concentrates and increase in maximum annual mineral concentrate production rate;
- a change to a double-pass mining operation commencing approximately 4 km from the southern end of the ore body (single-pass for approximately the initial six years, followed by double-pass for the remainder);
- an increase in the active mining area;
- an increase in the final mine path landform height from approximately 2 to 4.5 metres (m) to approximately 10 m;
- an increase in the area of the initial overburden emplacement from approximately 145 hectares (ha) to approximately 215 ha;
- swapping the location of the initial overburden emplacement with the initial sand residue and initial water dam;
- use of an electric conveyor system and/or supplementary dry mine fleet for dry overburden replacement instead of overburden slurrying;
- a change in the alignment of the ETL from the Ginkgo Mine to the Snapper Mine;
- trucking of Heavy Mineral Concentrate (HMC) between the Snapper and Ginkgo Mines, dependent on the location of the HMC treatment facility, and treatment of

Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa;

- an increase to the HMC treatment facility and soil stockpile areas;
- addition of a temporary HMC stockpile area adjacent to the mine area;
- an increase in processing rate capacity of the wet high intensity magnetic separator circuit from approximately 450,000 tpa to approximately 621,000 tpa;
- an increase in the water supply capacity of the reverse osmosis plant; and,
- supply of groundwater from the deeper, higher yielding, saline Lower Olney Formation aquifer instead of the shallow saline Loxton-Parilla aquifer.

As described in Section 1, the Modification disturbance areas would avoid Aboriginal cultural heritage sites within ML 1621. The potential impact to Aboriginal cultural heritage within ML 1621 is therefore not considered in this report.

The focus of this report is therefore the proposed change in the alignment of the ETL from the Ginkgo Mine to the Snapper Mine (Figures 1 and 2).

Ground disturbance for ETL construction would be largely limited to a corridor of up 35 m width to allow for stringing of the overhead conductor and any additional clearance requirements for equipment stockpiles or vehicle access (as for the approved ETL described in the Snapper Mine EA). The modified ETL corridor would be approximately 9.5 km long.

The proposed route of the ETL realignment would traverse degraded open woodland and low open shrublands of Western Lands perpetual leasehold property (leased by BEMAX), Trelega Station, between the existing Ginkgo Mine ETL and the Snapper Mine. Current land use in this proposed corridor is conservation (i.e. within BEMAX's vegetation offset area) and low intensity sheep and cattle grazing (i.e. outside BEMAX's vegetation offset area).

2.2 Flexibility of Design

The proposed ETL realignment has been identified as the preferred corridor based on the existing disturbance corridor of a fence and access track and the proximity to the Snapper Mine and existing ETL. There is flexibility within the design of the modified ETL with respect to the power pole spacing to avoid any potential disturbance of Aboriginal cultural heritage places or items that may be identified during construction.

2.3 Identification of Direct and Indirect Impacts

Development of the modified ETL would involve surface disturbance of grazing properties and a fenceline and access track. These areas have generally been previously disturbed by pastoral activities, which have included clearing of the original woodland vegetation along the fence and track.

Direct impacts of the modified ETL include the drilling of holes for power poles and a 3 m wide unmade access track beneath the line. Trees and tall shrubs would also be cleared and/or trimmed within a direct impact corridor of up to approximately 35 m total width.

Indirect impacts for the proposed development include possible temporary access tracks and temporary machinery parking areas. Construction personnel involved with the project would be trained in procedures to recognise and avoid disturbance to cultural heritage places and items. This includes restricting construction activities to designated work areas and access corridors.

3 Environmental Context

The study area is located in the Lower Darling region of the Murray Basin. It lies within an area bounded to the east by the Lower Darling River and to the west by the Great Anabranch of the Darling. The surface geology of the region is mostly aeolian (wind-blown) sediments, while underlying sequences within the basin were deposited by shallow seas and lakes over the past 60 million years (Brown and Stephenson 1991).

The modified ETL would be located in dunefields and sandplains some 30 km northwest of the Darling River (Figure 1). The modified ETL would traverse the Trelega land system (Soil Conservation Service 1985, 1991) for almost all of its length, with approximately 100 m of the modified ETL route within the Overnewton land system. The features of these land systems are provided below:

- *Trelega: level to slightly undulating sandplains and swales of loamy solonised brown soils. Aligned low dunes and low rises of deep brownish sands and calcareous red earths; relief to 3 m. Moderate to dense belah, scattered wilga, mallee and rosewood; dense to scattered pearl and black bluebushes; abundant porcupine grass on dunes; short grasses and forbs.*
- *Overnewton: extensive slightly undulating sandplain with isolated sandy hummocks and depressions; relief to 5 m. Sandplains of calcareous loams and sandy loams with moderately dense clumps of belah, rosewood, scattered bluebush and inedible shrubs. Areas of deep brownish sands with white cypress pine or nelia. Abundant short grasses and forbs throughout.*

The modified ETL corridor has been previously disturbed by pastoral activities.. Vegetation includes degraded belah (*Casuarina pauper*) — rosewood (*Alectryon oleifolius*) — wilga (*Geijera parvifolia*) low-open woodlands, mallee *Eucalyptus* spp. tall shrublands and black and pearl bluebush (*Maireana pyramidata — Maireana sedifolia*) low-open shrublands.

4 Cultural Heritage Context

4.1 Introduction

Some of the earliest evidence of human occupation of Australia comes from southwestern NSW (Bowler *et al*. 1970, 2003, Thorne *et al*. 1999, Cupper and Duncan 2006, Olley *et al*. 2006). Stone artefacts found at Lake Mungo in the Willandra Lakes region, about 100 km to the east of the Project area, have been dated to between 46,000 to 50,000 years ago (Bowler *et al*. 2003). The burials of a male and female at Lake Mungo are 42,000 years old (Olley *et al*. 2006, cf. Thorne *et al*. 1999). People were also at nearby Lake Menindee from 45,000 years ago (Cupper and Duncan 2006) and Lake Victoria from 21,000 years ago (Gill 1973).

Aboriginal people of the Barkindji language group occupied the Lower Darling region at the time of first contact with Europeans (Sturt 1833, 1984 [1844-6], Mitchell 1839, Eyre 1985 [1842], Krefft 1865). This language group comprised people who spoke the sub-dialects Barindji, Barkindji, Danggali, Maraura and Wiljakali (Allen 1974, Tindale 1974, Hardy 1976). These tribes shared similar language and kinship systems, notably the division of members into matrilineal moieties (two-part social classification) known as Mukwara (wedge-tailed eagle) and Kilpara (raven) (Blows 1995).

The Barkindji were hunter-fisher-gatherers and appear to have had a semi-sedentary lifestyle. Early accounts by the European explorer Gerard Krefft (1865) suggest that the Barkindji lived along the Lower Darling and Murray Rivers during the warmest months of the year, with people moving away from the rivers into the dunefields to collect food after winter rains.

The material record of this occupation is preserved in the archaeological sites of the Lower Darling region, most of which date to the period since the last Ice Age (after around 18,000 years ago) (Hope 1981, Balme and Hope 1990, Balme 1995). All that remains at many of these sites are flakes of stone debris from the making and resharpening of stone tools. These were made both at Aboriginal open habitation areas (campsites) or special activity areas such as stone knapping sites. As well as being the sites of manufacture and maintenance of stone implements, open habitation areas usually contain evidence of domestic and other activities such as cooking and food preparation. Campfires or oven hearths are common, marked by calcrete, baked clay, ferricrete, sandstone and silcrete heat retaining stones or hearthstones and charcoal. Organic remains consist of burnt animal bones, emu and aquatic bird eggshell and freshwater mussel shell.

4.2 Types of Cultural Heritage Sites

The types of cultural heritage site previously recorded in the Lower Darling region and which might therefore be expected to occur within the proposed disturbance corridor are described below.

4.2.1 Stone Artefact Scatters

Scatters of stone artefacts exposed at the ground surface are one of the most commonly occurring types of archaeological site in the region. The remains of fire hearths may also be associated with the artefacts. In rare instances, sites that were used over a long period of time may accumulate sediments and become stratified. That is, there may be several layers of occupation buried one on top of another.

Stone artefact scatters are almost invariably located near permanent or semi-permanent water sources (Hope 1982). Local topography is also important in that stone artefact scatters tend to occur on level, well-drained ground elevated above the local water source. In southwestern NSW they are commonly located on river terraces and along creek-lines and also around the margins of lakes, swamps and claypans.

4.2.2 Hearths

Hearths consist of lumps of burnt clay or stone cobble hearthstones. Sometimes ash and charcoal are preserved. Other materials found in hearths include animal bone, freshwater mussel shell, emu eggshell and stone artefacts. Hearths probably represent the remains of cooking ovens, similar to those described in ethnographic accounts by Major Thomas Mitchell (1839) (see also Coutts *et al*. 1979). These were lined with baked clay nodules and stone cobbles, possibly to retain heat. Hearths may be isolated or occur in clusters and may be associated with open campsites or middens. They are often located in dune swales, particularly on claypans, near soaks and on floodplain terraces.

4.2.3 Freshwater Shell Middens

Shell middens are deposits of shell and other food remains accumulated by Aboriginal people as food refuse. In inland NSW these middens typically comprise shells of the freshwater lacustrine mussel *Velesunio ambiguus* or the freshwater riverine mussel *Alathyria jacksoni*. Freshwater middens are most frequently found as thin layers or small patches of shell and often contain stone or bone artefacts and evidence of cooking. Such sites are relatively common along the Murray and Darling Rivers and their associated lakes and tributaries.

4.2.4 Earth Mounds

Earth mounds may have been used by Aboriginal people as cooking ovens or as campsites. They are common along the Murray River and in the Western District of Victoria. Originally they appear to have ranged from 3 to 35 m in diameter and from 0.5 to 2 m in height. Today, however, they may be difficult to recognize because of the effects of ploughing, grazing and burrowing rabbits. Earth oven material, stone artefacts, food refuse and the remains of hut foundations have been exposed in excavated earth mounds.

4.2.5 Stone Quarries

Quarries are locations where Aboriginal people obtained raw material for their stone tools or ochre for their art and decoration. Materials commonly used for making flaked stone tools include chert, silcrete, quartz and quartzite. Stone sources are not common in southwestern NSW. Silcrete outcrops are the most abundant and have been noted at a number of locations in the Lower Darling region, particularly at topographic low points of the landscape such as abandoned lakebeds and playa floors (e.g. Hope 1998, Witter 2001, Cupper 2003a, 2003b). Chert is found exposed in cliffs incised by the Murray River in South Australia. Most other stone in the Lower Darling region was probably sourced via long-distance trade links with the Olary and Barrier Ranges and the southeastern Australian Highlands.

4.2.6 Modified Trees

Slabs of bark were cut from trees by Aboriginal people and used for a variety of purposes including roofing shelters and constructing canoes, shields and containers. Scars also resulted from the cutting of toeholds for climbing trees to obtain honey or to capture animals such as possums. In southwestern NSW river red gums and black box are the most commonly scarred species. The classification of modified trees as natural, European or Aboriginal is often problematic. However, if the scar is Aboriginal the tree must now be more than ~150 years old.

4.2.7 Stone Arrangements, Ceremonial Rings and Ceremony and Dreaming Sites

Stone arrangements range from cairns or piles of rock to more elaborate arrangements such as stone circles or standing slabs of rock held upright by stones around the base. Some stone arrangements were used in ceremonial activities whilst others may represent sacred or totemic sites. Other features associated with the spiritual aspects of Aboriginal life are those now called 'ceremony and dreaming' sites. These can be either stone arrangements or natural features such as rock outcrops, which may be associated with initiation ceremonies or the activities of ancestral creators.

4.2.8 Burials

Aboriginal burial grounds may consist of a single interment or a suite of burials. Burials tend to be in areas of sandy soil that were easy to dig and above floodwaters. Burials are frequently located in source-bordering sand dunes, sand ridges, lunettes and levees along watercourses (Bonhomme 1990, Hope 1993). Knowledge of Aboriginal burial grounds is best sought from local Aboriginal communities.

4.3 Previously Identified Aboriginal Cultural Heritage in the Study Area

According to the NSW Department of Environment, Climate Change and Water (DECCW) Aboriginal Heritage Information Management System (AHIMS) site database, **no Aboriginal archaeological sites have previously been recorded in the corridor proposed for the ETL.** There are five registered Aboriginal archaeological sites within approximately 2 km of the modified ETL corridor (Table 1). These sites are isolated finds of silcrete stone artefacts (AHIMS site numbers 39-3-0054 — 0058) recorded by Cupper (2003a) during a cultural heritage assessment of an ETL route servicing the Ginkgo Mine. The closest of these isolated finds are about 1 km north of the modified ETL.

Table 1. Previously recorded Aboriginal cultural heritage sites near the modified ETL corridor.

AHIMS site number	Type	GDA94 (Zone 54) mE	GDA94 (Zone 54) mN
39-3-0054	Isolated find of stone artefacts	614620	6304110
39-3-0055	Isolated find of a stone artefact	614070	6304970
39-3-0056	Isolated find of stone artefacts	614380	6304690
39-3-0057	Isolated find of stone artefacts	614520	6304460
39-3-0058	Isolated find of stone artefacts	614790	6304070

5 Project Design and Survey Methodology

This heritage survey and assessment was conducted in accordance with the *Guidelines for Archaeological Practice in Aboriginal Heritage Management* (NSW National Parks and Wildlife Service 1997).

5.1 Site Predictive Model

Previous archaeological studies indicate that the most frequently recorded Aboriginal sites in southwestern NSW are open habitation areas represented by stone artefact scatters and often hearths (NSW DECCW AHIMS site database). Shell middens, trees modified by Aboriginal people and burials are also represented in the archaeological record. Based on these observations of archaeological site types and their distribution and landscape setting, the following predictive model of site locations within the proposed realigned infrastructure corridor can be proposed:

- **Stone artefacts** and **hearth sites** are possible within the modified ETL corridor, although unlikely given the absence of nearby water sources.
- The chance of encountering **quarry sites** is low due to the general absence of suitable rock outcrop. However, they have been noted elsewhere in the area (e.g. Witter 2001, Cupper 2003a, 2003b, 2007).
- Similarly, despite the presence of **stone arrangements** in southwestern NSW, the general dearth of stone in the region means that the chances of encountering this site type are low. Stone arrangements tend to occur on level ground, often on elevated landforms such as floodplain terraces.
- **Modified trees** are highly improbable, because black box and river red gum trees, the taxa typically scarred by Aboriginal people, are absent in the study area.
- **Shell middens** also very unlikely, as they are usually found near permanent water sources, as are **burial sites**.

5.2 Field Methodology

5.2.1 Logistics

Fieldwork was undertaken on 20 and 21 August 2009 by archaeologist Matt Cupper with the assistance of Barkindji Elders Council members Noel Johnson and Ray Lawson. BEMAX Environmental Officer Michael Priest also present in the field to explain the proposed developments to the local Aboriginal community representatives.

The archaeologist and Aboriginal representatives also inspected a previously proposed Highway Access Road (HAR) realignment with a pedestrian survey. This HAR realignment is no longer proposed to be constructed as part of the Modification.

5.2.2 Survey Methods

The archaeologist and Aboriginal representatives inspected the modified ETL corridor with a pedestrian survey whereby team members walked abreast along the modified ETL corridor. Survey members were approximately 10 m apart and due to the openness of the landscape it was possible to identify likely site locations from at least 10 m and deviate to make closer inspections.

The team examined the ground surface for archaeological traces such as stone artefacts, hearths, hearthstones, shells, bones and mounds, and also mature eucalypt trees for evidence of Aboriginal scarring. Particular attention was paid to areas with high ground surface visibility such as along the graded fenceline and vehicle track and in scalds and deflation hollows. Due to wind, vehicular and stock erosion, most of the study area had excellent conditions of surface visibility, and as a consequence, coverage was very high.

5.2.3 Access to Survey Areas and Weather Conditions

Access was available to the entire length of the modified ETL corridor. Weather conditions during the survey were fine.

5.3 Survey Coverage Data

5.3.1 Conditions of Visibility

Conditions of ground surface visibility will affect how many sites are located. Visibility may also skew the results of a survey. If, for example, conditions of ground surface visibility vary dramatically between different environments, then this in turn will be reflected in the numbers of sites reported for each area. The area with the best visibility may be reported as having the most sites (because they are visible on the ground) while another area with less visibility but perhaps more sites will be reported as having very little occupation. It is important therefore to consider the nature of ground surface visibility as part of any archaeological investigation.

Conditions of ground surface visibility were typically around 80% (Table 2, Figure 3). These excellent conditions of visibility were mainly due to the fact that the ground surface was widely exposed by erosion by stock and vehicular traffic, scalding and wind deflation and grass and herbaceous plant growth was sparse.

Table 2. Visibility conditions of the proposed realigned ETL corridor.

Landscape setting	Vegetation	Visibility (%)	Exposures	Survey method
1 Trelega land system	Mallee eucalypts, belah, wilga, rosewood, bluebush, salt bush, grasses	80	Vehicle tracks, fencelines, scalds, gullies, animal tracks, deflation hollows	Pedestrian
2 Overnewton land system	Mallee eucalypts, rosewood, bluebush, salt bush, grasses	80	Vehicle tracks, fencelines, scalds, gullies, animal tracks, deflation hollows	Pedestrian

5.3.2 Coverage Analysis

Coverage analysis is a useful measurement to allow cultural resource managers to assess surveys from adjacent areas and it also allows some meaningful calculation of the actual sample size surveyed. The *actual* or *effective* area surveyed by a study depends on the conditions of ground surface visibility. Conditions of surface visibility are affected by vegetation cover, geomorphologic processes such as sedimentation and erosion rates and the abundance of natural rock that may obscure the remains of cultural activities.

Approximately 21% of the surface area of the modified ETL corridor was inspected on foot, with an effective coverage of 17% (Table 3). Very high coverage was achieved given the narrow width of the survey corridor, the intensive nature of the field inspection and the excellent conditions of surface visibility.

Table 3. Effective coverage of the modified ETL corridor.

Landscape setting	Area	Visibility	Coverage		Effective coverage	
	(m^2)	(%)	(m^2)	(% area)	(m^2)	(%)
1 Trelega land system	329,000	80	69,090	21	55,272	17
2 Overnewton land system	3,500	80	1,200	34	960	27
Total	332,500		70,290	(21%)	56,232	(17%)

Figure 3. Section of the modified ETL corridor showing the excellent conditions of ground surface visibility.

6 Results

No Aboriginal archaeological sites were located in the modified ETL corridor. This negative result does not mean that Aboriginal people did not occupy this area, nor that ground surface visibility was inadequate. Rather, it is attributable to the fact that study area is not near any natural drainage lines or depressions, which tended to be the focus of past Aboriginal occupation. Moreover, archaeological surveys for small, linear developments only rarely encounter Aboriginal cultural heritage sites.

Scarred trees were not identified because of the absence of suitable trees. Quarry sites are also definitely not represented in the study area as rock outcrop is lacking. Landforms such as lunettes or source-bordering sand dunes that might contain sensitive sub-surface archaeological material such as burials do not occur in the proposed development corridor. The sediments of the study area had been well enough exposed by prior track and fenceline grading activities, vehicular and stock traffic and wind and water erosion to determine that no archaeological material was present on the surface or buried beneath the soil.

7 Aboriginal Concerns

Aboriginal people of the Lower Darling region of southwestern New South Wales are concerned about any development that might impact upon Aboriginal sites on land that is traditionally theirs. All land has high cultural significance for individual Aboriginal people and for the Aboriginal community collectively. It should also be noted that any development upon, or disturbance of land is contrary to principal Aboriginal beliefs regarding land, its values and its inherent cultural significance.

Liaison with the local Aboriginal people involved consultation with Barkindji Elders Council members Noel Johnson and Ray Lawson, who accompanied the archaeologist in the field over two days.

The Barkindji community is particularly concerned about the preservation of Aboriginal archaeological sites. However, the Aboriginal community representatives who inspected the modified ETL corridor expressed no objections to the proposed developments proceeding because they are not envisaged to impact upon cultural heritage places or items.

8 Recommendations

This assessment shows that the nature of the potential impacts of the Modification remains unchanged from those identified in the Snapper Mine EA and the mitigation measures proposed in the Snapper Mine EA can be implemented to minimise these potential impacts.

Based on the results of this cultural heritage assessment and consultation with representatives of the Barkindji Aboriginal community it is recommended that:

- the general mitigation strategies detailed in the Snapper Mine EA and Aboriginal Cultural Heritage Management Plan (ACHMP) (BEMAX 2007b) be implemented.
- if any previously unidentified Aboriginal cultural heritage places or items are encountered during the course of the Modification works within the corridor of the modified ETL, they should be managed in accordance with the general mitigation strategies detailed in the Snapper Mine EA and ACHMP; and,
- if human skeletal remains are encountered during the course of the Modification works, all work in that area must cease. Remains must not be handled or otherwise disturbed except to prevent further disturbance. If the remains are thought to be less than 100 years old the Police or the State Coroners Office (tel: 02 9552 4066) must be notified. If there is reason to suspect that the skeletal remains are more than 100 years old and Aboriginal, the proponent should contact the NSW Department of Environment, Climate Change and Water's Environmental Line (tel: 131 555) for advice.

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APPENDIX C

SNAPPER AND GINKGO MINES

NOISE ASSESSMENT

27 April 2010

BEMAX Resources Limited
PO Box 15164
CITY EAST QLD 4002

Attn: Joe Bannister

RE: SNAPPER & GINKGO MINES MODIFICATION – NOISE IMPACT ASSESSMENT

Dear Joe,

Please find below our assessment of the potential noise impacts of proposed modifications to the Snapper and Ginkgo Mines.

1 INTRODUCTION

BEMAX Resources Limited (BEMAX) is the proponent of the Snapper and Ginkgo Mines located in western New South Wales (NSW) (see **Figure 1.1**). BEMAX is seeking approval for the modifications under Section 75W of the *Environmental Planning and Assessment Act* (EP&A Act).

PAEHolmes (formerly Holmes Air Sciences [HAS]) prepared noise impact assessments for the Ginkgo and Snapper Mines in 2001 and 2007, respectively (see **HAS, 2001** and **HAS, 2007**). This study will rely on these previous assessments in order to assess potential noise impacts at nearby private receptors arising from the proposed modifications. This study:

- Reviews previous Snapper and Ginkgo Mine noise assessments and adopts background noise data/rating background levels (RBLs) as appropriate;
- Reviews the mining fleet used in the original assessments and associated sound power levels;
- Reviews proposed modified mining fleet and associated sound power levels;
- Assesses the predicted intrusive noise emissions for worst case construction and operation scenarios, based on increase/decrease in sound power levels; and
- Conducts an assessment of the changes, with reference to the previous Snapper and Ginkgo Mine noise assessments.

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BRISBANE

GOLD COAST

TOOWOOMBA

A PEL COMPANY

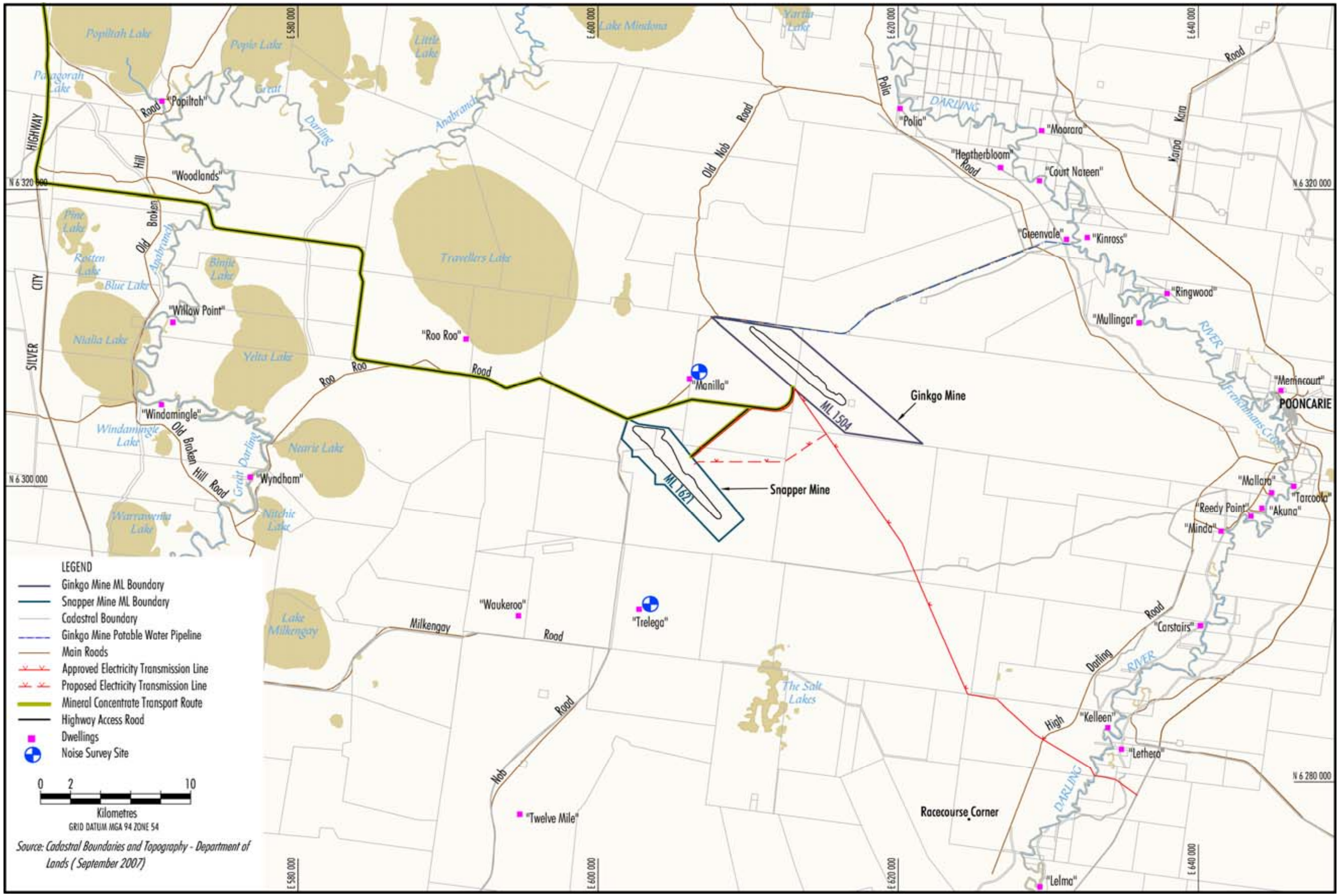

Figure 1.1: Location of the Snapper and Ginkgo Mines

2 OVERVIEW OF MODIFICATION

2.1 Snapper Mine

The key aspects of the Modification to the Snapper Mine include:

- an increase in the total amount of ore mined from approximately 117 million tonnes (Mt) to approximately 122 Mt and a minor change to the extent of the mine path;
- an increase in the annual ore mining rate from approximately 8.2 million tonnes per annum (Mtpa) to approximately 9.1 Mtpa;
- a decrease in the total amount of mineral concentrates from approximately 5.9 Mt to approximately 5.2 Mt, as a result of decreased average ore grades;
- an increase in maximum annual mineral concentrate production rate from the Snapper Mine from approximately 450,000 tonnes per annum (tpa) to approximately 621,000 tpa;
- a decrease in the life of the Snapper Mine from approximately 16 years to approximately 15 years, to reflect the decrease in total amount of mineral concentrates and increase in maximum annual mineral concentrate production rate;
- a change to a double-pass mining operation commencing approximately 4 km from the southern end of the ore body (single-pass for approximately the initial six years, followed by double-pass for the remainder);
- an increase in operational mining areas (including: an increase in the active mining area; an increase in the area of the overburden emplacement from approximately 145 to 215 hectares (ha); an increase to the HMC treatment facility and soil stockpile areas; and addition of a temporary HMC stockpile area adjacent to the mine path)
- an increase in the final mine path landform height from approximately 2 to 4.5 metres (m) to approximately 10 m;
- use of an electric conveyor system and/or dry mine fleet for dry overburden replacement instead of overburden slurrying;
- a change in the alignment of the electricity transmission line (ETL) to the Snapper Mine;
- trucking of Heavy Mineral Concentrate (HMC) between the Snapper and Ginkgo Mines[1], dependent on the location of the HMC treatment facility, and treatment of Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa;
- an increase in processing rate capacity of the wet high intensity magnetic separator (WHIMS) circuit from approximately 450,000 tpa to approximately 844,000 tpa;
- an increase in the water supply capacity of the reverse osmosis (RO) plant;
- supply of groundwater from the deeper, higher yielding, saline Lower Olney Formation aquifer instead of the shallow saline Loxton-Parilla aquifer; and
- continued trucking of an additional approximate 2 Mt of high-grade ore from the Snapper Mine to the Ginkgo Mine on a temporary basis (i.e. this approved activity would continue for an additional 12 months), feeding the ore through the Ginkgo Mine dredge, concentration and separation through the Ginkgo Mine primary gravitation unit and Ginkgo Mine or MSP WHIMS circuit and placement of the sand residues at the Ginkgo Mine.

1 The current temporary approved trucking between the Snapper and Ginkgo Mines involves the transport of high grade ore, not HMC. The proposed HMC transport between the mines would involve significantly less truck movements than ore transport.

2.2 Ginkgo Mine

The key aspects of the Modification to the Ginkgo Mine include:

- an increase in the total amount of ore mined from approximately 128 Mt to approximately 145 Mt, as a result of an increased ore reserve;
- an increase to the life of the Ginkgo Mine from approximately 12 years to approximately 14 years, to reflect the increased ore reserve and a care and maintenance period;
- a decrease in the total amount of mineral concentrates from approximately 4.8 Mt to approximately 3.7 Mt, as a result of decreased average ore grades;
- trucking of HMC between the Ginkgo and Snapper Mines[1], dependent on the location of the HMC treatment facility and treatment of Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa; and
- continued trucking of an additional approximate 2 Mt of high-grade ore from the Snapper Mine to the Ginkgo Mine on a temporary basis (i.e. this approved activity would continue for an additional 12 months), feeding the ore through the Ginkgo Mine dredge, concentration and separation through the Ginkgo Mine primary gravitation unit and Ginkgo Mine or MSP WHIMS circuit and placement of the sand residues at the Ginkgo Mine.
- Existing environment

2.3 Noise

Background noise surveys to characterise and quantify the acoustical environment in the area surrounding the Snapper and Ginkgo Mines were conducted between 25 August 2006 and 7 September 2006 (**HAS, 2007**). The effect of existing operational noise emissions from the Ginkgo Mine were captured by these noise surveys. These background noise surveys involved the positioning of two unattended noise loggers at the two nearest receptors, the Manilla and Trelega homesteads (see **Figure 1.1**). A full description of the noise survey methodology is provided in **HAS** (**2007**).

The analysis of the noise monitoring results at Trelega and Manilla homesteads are summarised in **Table 3.1** and **Table 3.2**, respectively.

The data show that ambient noise levels in the vicinity of the Snapper and Ginkgo Mines are usually very low (i.e. less than 30 A-weighted Decibels [dB(A)]). Most of the recorded low levels are determined by the lower threshold of sensitivity of the instrument known as the noise floor.

Table 2.1: Unattended Background Noise Environment at Trelega

Date (at end of monitoring session)	Assessment Background Level Daytime (dB[A])+	Evening (dB[A])+	Night-time (dB[A])+
25 August 2006	24.6	24.8	
26 August 2006	24.8	24.8	25.1
27 August 2006	25.5	24.7	25.5
28 August 2006	25.9	24.9	26.2
29 August 2006	26.3	24.8	26.3
30 August 2006	25.8	24.6	25.8
31 August 2006	25.8	24.7	25.8
1 September 2006	27.5	24.6	27.5
2 September 2006	26.9	25.9	26.9
3 September 2006	37.7	24.9	37.7
4 September 2006	26.4	25.2	26.4
5 September 2006	26.1	24.8	26.1
6 September 2006	42.6*	35.7	25.7
Median	**26.1**	**24.8**	**26.3**

* Excluded because wind speed above 5 m/s in accordance with the INP procedure.

+ Note the quieter levels are clearly determined by the instrument noise floor.

Table 2.2: Unattended Background Noise Environment at Manilla

Date (at end of monitoring session)	Assessment Background Level Daytime (dB[A])+	Evening (dB[A])+	Night-time (dB[A])+
25 August 2006	29.6	24.5	-
26 August 2006	24.7	24.5	24.5
27 August 2006	25.2	24.6	24.6
28 August 2006	27.8	24.5	25.1
29 August 2006	26.5	24.6	24.6
30 August 2006	25.5	24.5	24.7
31 August 2006	25.7	24.6	24.6
1 September 2006	26.1	24.5	24.5
2 September 2006	26.9	24.6	24.5
3 September 2006	35.5	24.5	24.5
4 September 2006	25.2	24.4	24.4
5 September 2006	24.3	24.3	24.6
6 September 2006	44.4*	38.1	25.1
Median	**26.1**	**24.5**	**24.6**

* Excluded because wind speed above 5 m/s in accordance with the INP procedure.

+ Note the quieter levels are clearly determined by the instrument noise floor

The RBL is the median value of all the Assessment Background Levels (ABLs) derived over the day, evening and night-time periods. It is important to note that all the derived RBLs are less than 30 dB(A). Where the RBL is found to be less than 30 dB(A) the RBL is set to 30 dB(A), in accordance with the *Industrial Noise Policy* (EPA, 2000) procedure. The RBL for the Snapper Mine would therefore be 30 dB(A).

2.4 Meteorology

The Snapper Mine noise assessment (**HAS, 2007**) used meteorological data collected from the Gingko Mine meteorological station in its modelling. As there was only 84% data recovery from one continuous year, these real-world observations were applied in The Air Pollution Model (TAPM) to provide a more accurate representation of meteorology at the site. Meteorological data between April 2005 and April 2006 were used in the 2007 assessment and have been used in this assessment for consistency.

Figure 3.1 presents the annual and seasonal windroses prepared from the hourly meteorological data as used in the Snapper Mine noise assessment (**HAS, 2007**). It can be seen from **Figure 3.1** that, annually, the most common winds are from the south or the north. In summer the winds are generally from the south while in winter the winds are typically from the north. Autumn and spring winds exhibit a mix of both summer and winter patterns. On an annual basis there are 8.9% calms and the annual average wind speed is 2.4 m/s.

More recent meteorological data from the Ginkgo Mine meteorological station have been provided. Data from years 2007, 2008 and 2009 have been reviewed to provide a comparison with the 2005/2006 Ginkgo Mine with TAPM dataset used in the previous modelling (**HAS, 2007**). The results show that the dataset used in the modelling is representative of actual meteorological conditions at the mine site.

Figure 3.2 presents the annual and seasonal windroses for the Ginkgo Mine meteorological station for years 2007, 2008 and 2009. When compared with the 2005/2006 data (see **Figure 3.1**), the annual wind patterns are very similar with dominant winds from southern directions and slighter winds from the north. Summer patterns in all years are similar with winds predominantly from the south and autumn and spring winds varying between north and south directions. Winter wind patterns in 2007 however are more prominent from the southern direction when compared with the other years being predominately from the north. The annual percentages of calms are similar throughout the datasets but slightly higher in the 2007, 2008 and 2009 data, which ranged from 11.6 to 14.9 m/s.

3 ENVIRONMENTAL NOISE CRITERIA

3.1 On-site Noise

The assessment procedure for assessing the potential impacts of industrial noise sources in NSW is set out in the INP. The INP assessment procedure for industrial noise sources has two components:

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

3.2 Intrusive Noise Criterion

The intrusiveness criterion is met if the $L_{Aeq(15minute)}$ is less than or equal to the RBL plus 5 dB(A), where the RBL is determined from monitoring data following the INP procedures discussed in **Section 2.3**. As discussed in **Section 2.3**, the RBL is 30 dB(A), thus the intrusive noise criterion for the Snapper and Ginkgo Mines would be 35 dB(A). This is the intrusive noise criterion that will be used in the current assessment for day, evening and night periods.

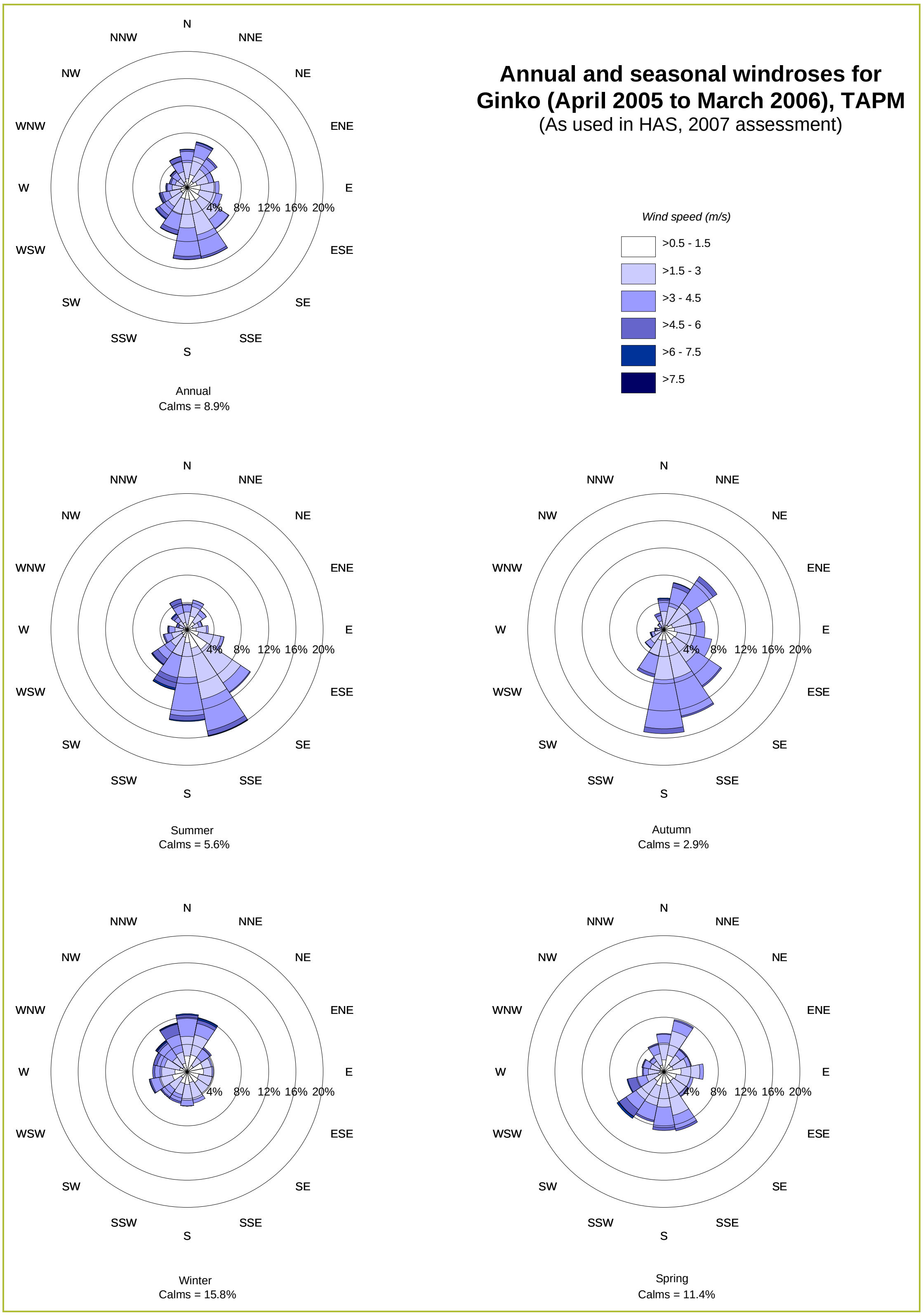

Figure 3.1: Annual and Seasonal Windroses for the Ginkgo Mine (TAPM), April 2005 – March 2006

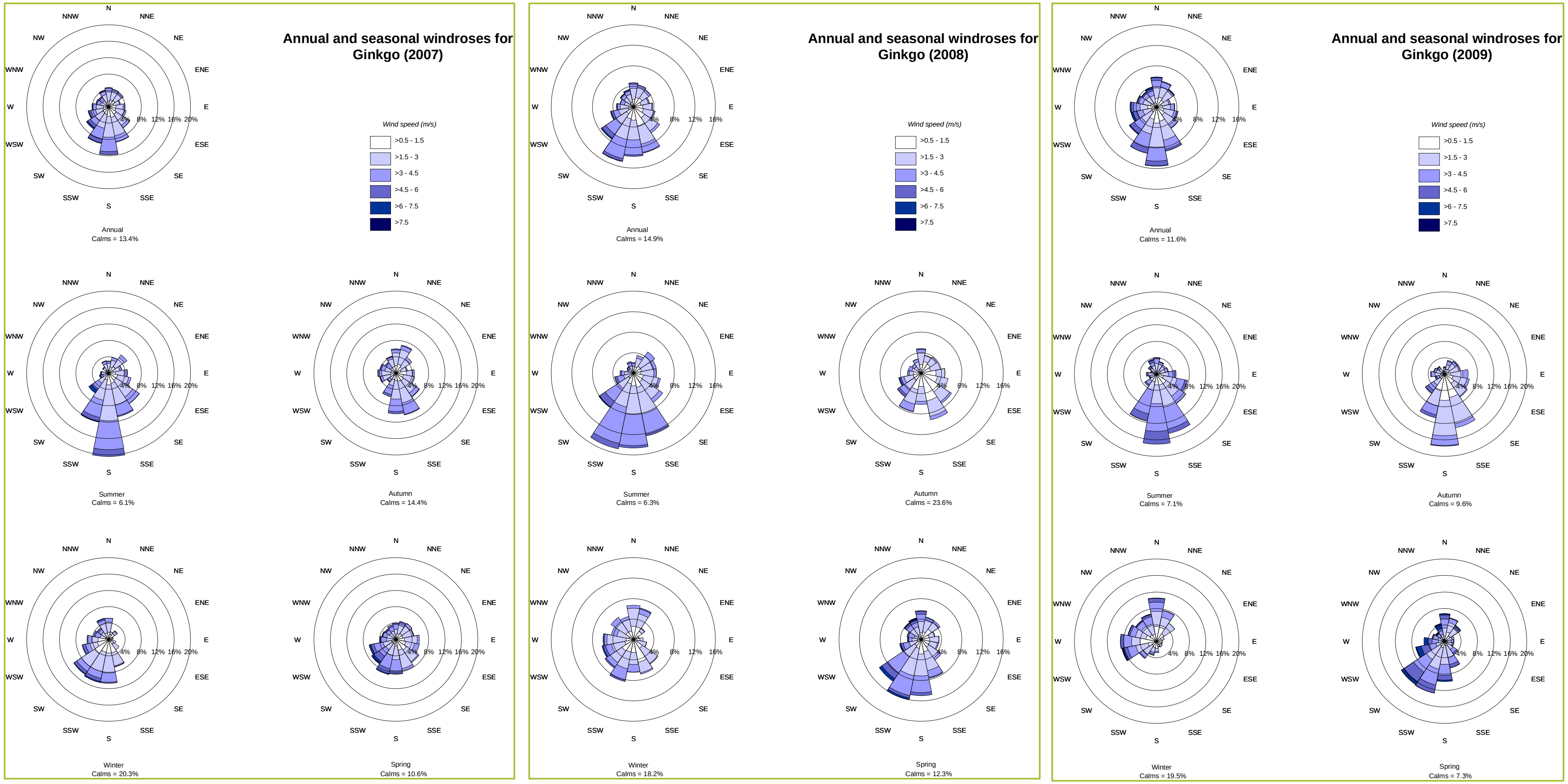

Figure 3.2: Annual and Seasonal Windroses for the Ginkgo Mine (2007, 2008 and 2009)

3.3 Amenity Noise Criteria

The INP-based acceptable and recommended maximum noise amenity criteria for the Snapper Mine locality are summarised in **Table 3.1**.

Table 3.1: Recommended LAeq Noise Amenity Levels from Industrial Noise Sources

Receiver Type	Indicative Noise Amenity Area	Time of Day1	Recommended LAeq Noise Level dB(A)	
			Acceptable	Recommended Maximum
Residence	Rural	Day (7.00 am to 6.00 pm)	50	55
		Evening (6.00 pm to 10.00 pm)	45	50
		Night (10.00 pm to 7.00 am)	40	45

Source: EPA (2000)

[1] For Sundays and Public Holidays, Day is 8.00 am to 6.00 pm, Evening is 6.00 pm to 10.00 pm and Night is 10.00 pm to 8.00 am.

When compared to the amenity noise criteria identified in **Table 3.1**, it can be seen that the intrusive noise criterion (i.e. 35 dB[A]) is the most stringent of the criteria that need to be satisfied. Provided that the Snapper and Ginkgo Mines are predicted to result in L_{Aeq} levels (over the relevant averaging period) of less than 35 dB(A) then impacts would fall within the acceptable range required by the INP.

4 OVERVIEW OF PREVIOUS NOISE ASSESSMENTS

4.1 Ginkgo Mine

A noise assessment was conducted for the Ginkgo Mine in 2001 (**HAS, 2001**). The assessment applied a conservative approach that predicted noise levels at the nearest residence could be up to a level of $L_{Aeq\ (15\ minute)}$(dB(A)) noise levels up to 29 dB(A).

4.2 Snapper Mine

A noise impact assessment was previously conducted for the Snapper Mine in 2007 (**HAS, 2007**). Year 1 (construction) and Year 14 represented the 'worst-case' scenarios given that mining operations during these years would be closest to the nearest private receptors (i.e. Manilla and Trelega).

Table 4.1 presents the noise model results as predicted in the Snapper Mine assessment (**HAS, 2007**). Noise levels were predicted to be highest at Manilla during Year 14 operations.

Table 4.1: 2007 Snapper Mine Noise Assessment Modelling Results

Receptor	Construction	Year 14 Operation	*Noise Criteria*
Predicted $L_{AEQ\ (15\ minute)}$(dB(A)) – Neutral conditions			
Manilla	8	21	*35*
Trelega	10	3	
Predicted $L_{AEQ\ (15\ minute)}$(dB(A)) – Inversion Conditions			
Manilla	19	28	*35*
Trelega	*22*	*14*	

Source: **HAS, 2007**

4.3 Off-site Transport Noise

Off-site transport noise was assessed for both Snapper and Ginko Mines in 2007 (**HAS, 2007**).

The calculated noise levels for existing and proposed total vehicles (i.e. existing vehicles plus heavy vehicles associated with the development of the Snapper Mine) along the Silver City Highway are presented in **Table 5.2**.

Table 4.2: 2007 Predicted Existing and Total Vehicle Noise (Weekdays) – Silver City Highway

Distance to Receiver (m)	Existing Vehicles $L_{Aeq(1hour)}$	Total Vehicles including Vehicles Associated with Snapper* $L_{Aeq(1hour)}$
10	62.6	63.3
50	52.6	53.4
100	49.7	50.4
1,000	39.7	40.3

* Existing traffic levels plus Snapper Mine haulage vehicles.

A comparison of existing noise levels was made with the proposed total noise emissions and this showed that existing noise levels would not increase by more than approximately 0.8 dB(A) for locations within 10 m of the Silver City Highway, along the proposed transport haul route, which would not be discernable (**HAS, 2007**).

5 ASSESSMENT METHODOLOGY

5.1 Snapper Mine - Construction and Operational Noise

This study provides a quantitative assessment for potential noise impacts for the modified Snapper Mine, by calculating the overall fleet sound power levels for the approved Snapper Mine fleet, as previously modelled and comparing this to the sound power levels for the modified Snapper Mine fleet.

Noise modelling was not conducted given the minor difference in sound power levels, the minor change in location of sources and also as the previous assessment shows that noise levels at all receptors are likely to be low and well within the DECCW assessment criteria.

5.2 Ginkgo Mine - Construction and Operational Noise

As stated in **Section 3.1**, background noise surveys for the Snapper Mine were undertaken during Year 1 of Ginkgo Mine operation. During Year 1 of operation, the Ginkgo Mine was approximately 5 km from where it would be closest to the Manilla homestead (which would occur in approximately Years 5 to 7 of the Ginkgo Mine). Assessment using the noise survey results incorporating Year 1 of Ginkgo Mine operation would be relevant since the Ginkgo Mine would be further away (to the south-west) from the Manilla homestead when the Snapper Mine is at its closest point to this receptor (i.e. Year 14 of Snapper Mine operation). Further, the existing ABLs are well below the Ginkgo Mine intrusive noise limit of 35 dB(A).

Further to this, the proposed modifications to the Ginkgo Mine (see **Section 2.2**) would not affect noise impacts and would not add to previously predicted noise levels. **Table 6-1** outlines these proposed modifications and their effect on noise.

Table 5.1: Proposed Modifications to the Ginkgo Mine and Effect on Noise

Proposed Modification to the Ginkgo Mine	Effect on Noise
Operations An increase in the total amount of ore mined	Notwithstanding the increase in the total amount of ore mined, the maximum rate of production from the Ginkgo Mine would remain unchanged from the approved maximum rate of production of approximately 576,000 tpa and there would be no changes to the existing fleet. Therefore there would be no change to the existing noise emissions from the Ginkgo Mine.
Operations An increase in mine life by two years	The increase in mine life extends the mining period but would not impact on noise emissions during operations.

Based on the discussion above, operations from the Ginkgo Mine would not affect noise impacts arising from the proposed modifications at the Ginkgo Mine and are not assessed in detail further.

6 EQUIPMENT FLEET

Table 7.1 outlines the proposed changes to the equipment fleet relevant to this noise assessment, i.e. the plant with potential to contribute to noise levels at receptors. **Table 7.1** shows that whilst some equipment would be added, other equipment would be removed. There are no changes proposed to the Ginkgo Mine fleet relevant to this noise assessment.

Table 6.1: Proposed Changes to Equipment Fleet Numbers – Snapper Mine

Equipment	Construction			Operation		
	Approved Modelled Mine Fleet	Modified Modelled Mine Fleet	Change	Approved Modelled Mine Fleet	Modified Modelled Mine Fleet	Change
Backhoe	1	1	0	1	1	0
Bucket Scoop	0	6	6	0	3	3
Dozer	7	4	-3	7	7	0
Excavator	2	5	3	2	4	2
Front End Loader	1	1	0	3	3	0
Grader	2	3	1	2	2	0
Lighting Tower	8	8	0	6	6	0
Scraper	9	1	-8	9	1	-8
Dump Truck	6	9	3	0	8	8
Water Truck	1	4	3	2	2	0
Overburden Slurrying System (Dozer Trap) (Feed conveyor, hopper and slurrying unit)	0	0	0	2	0	-2
Total numbers	**37**	**42**	**5**	**34**	**37**	**3**

From **Table 6.1** it can be seen that an additional 5 plant items may potentially contribute to noise emissions from the construction activity, and an additional 3 plant items may potentially contribute to noise emissions from operational activity.

Note that actual modelled fleet numbers (**HAS, 2007**) are slightly less than the total approved fleet numbers as plant will be serviced and repaired, and thus not continuously operational.

For this study, a conservative approach was applied to calculate fleet sound power levels and all noise relevant fleet items (see **Table 6.1**) were included in total fleet calculations.

The spectral sound power levels for the equipment fleet relevant to the noise assessment are provided in **Attachment 1**.

7 ASSESSMENT OF IMPACTS

7.1 Snapper Mine - Construction and Operation

The total sound power levels for the existing and proposed construction and operational fleet are provided in **Table 7.1**.

Table 7.1: Total Fleet Sound Power Levels

Total Fleet Sound Power Level (dB(A))					
Construction			Operation		
Approved Mine	Modified Mine	Change	Approved Mine	Modified Mine	Change
124.4	125.2	0.8	126.0	125.2	-0.8

Table 7.1 shows that the total fleet sound power level from construction activity is predicted to be 125.2 dB(A). This represents an increase of 0.8 dB(A) over the level modelled in **HAS** (**2007**). The total fleet sound power level during operational activity is 125.2 dB(A). This represents a decrease of 0.8 dB(A) over the level modelled in **HAS** (**2007**).

For both construction and operation, there is little difference in between the approved and modified total fleet sound power levels. Also, there is unlikely to be any significant difference in the manner in which noise from the site propagates into the environment as a result of the modification given that the prevailing weather conditions, equipment location and individual siting of plant items would be similar.

Table 8.2 presents the predicted noise levels from the modified Snapper Mine (under neutral and inversion conditions) at the nearest receptors, the Manilla and Trelega homesteads.

Table 7.2: Estimated Modified Snapper Mine Noise Levels

Receptor	Construction	Operation	*Noise Criteria*
Predicted $L_{AEQ\ (15\ minute)}$(dB(A)) – Neutral conditions			
Manilla	9	20	*35*
Trelega	11	2	
Predicted $L_{AEQ\ (15\ minute)}$(dB(A)) – Inversion Conditions			
Manilla	20	27	*35*
Trelega	*23*	*13*	

Table 7.2 shows that predicted noise levels would be up to 27 dB(A) at Manilla homestead (or at least 8 dB(A) below the applicable criteria).

7.2 Ginkgo Mine – Construction and Operation

As stated in **Section 6.2**, background noise surveys for the Snapper Mine were undertaken during Year 1 of Ginkgo Mine operation. During Year 1 of operation, the Ginkgo Mine was approximately 5 km from where it would be closest to the Manilla homestead (which would occur in approximately Years 5 to 7 of the Ginkgo Mine). Assessment using the noise survey results incorporating Year 1 of Ginkgo Mine operation would be relevant since the Ginkgo Mine would be further away (to the south-west) from the Manilla homestead when the Snapper Mine is at its closest point to this receptor (i.e. Year 14 of Snapper Mine operation). Further, the existing ABLs are well below the Ginkgo Mine intrusive noise limit of 35 dB(A).

Further to this, the proposed modification to the Ginkgo Mine (see **Section 2.2**) would not affect noise impacts and would not add to previously predicted noise levels. **Table 6-1** outlines the proposed modification and its effect on noise.

7.3 Transport

Mineral Concentrate Transport to the Mineral Separation Plant

The proposed modifications to the Snapper and Ginkgo Mines would not change the maximum combined concentrate haulage of approximately 735,000 tpa from the Snapper and Ginkgo Mines to the MSP in Broken Hill. Therefore, there would be no change to the approved number or type of haulage vehicles transporting mineral concentrates to the Mineral Separation Plant (MSP) (or backloaded MSP process waste materials from the MSP to the Snapper and Ginkgo Mines). Given the above, transport noise impacts associated with the transport of mineral concentrates to the MSP would not change as a result of the modification.

Ore and HMC Transport between the Mines

The frequency of road trains transporting ore between the mines along the private road section of the approved HAR would continue at the same frequency as approved as part of the November 2009 Modification (which approved a maximum of 4 vehicle movements per hour).

The frequency of road trains transporting HMC between the mines along the private road section of the approved HAR would be would a maximum of 3 vehicle movements per hour.

Assuming a maximum of 4 transport vehicle movements per hour along the private section of the HAR, there would be an average of 1 vehicle movement along the HAR during any 15-minute period. Over this 15-minute period, the additional noise from a single transport vehicle is unlikely to significantly affect the noise levels experienced at any of the receptors, or to significantly contribute to the overall sound power level of the 42 fleet items assessed (see **Table 7.1**).

As the potential noise from vehicle movements is unlikely to be significant alone or in combination with the potential noise from the mining operations, the potential noise from the Modification would remain unlikely to cause an exceedence of the applicable criteria.

8 CONCLUSIONS

This study has assessed the potential noise impacts associated with the proposed modifications to the Snapper and Ginkgo Mines. A quantitative assessment was used to assess the potential for noise impact at sensitive receptors by reference to previous detailed modelling studies.

The area is remote and sparsely populated with the closest residence, the Manilla homestead, located approximately 4 km from the mining sites.

It is concluded that adverse noise impacts above DECCW criteria would be unlikely at nearest private receptors under either neutral or inversion conditions.

9 REFERENCES

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Holmes Air Sciences (HAS) (2007)
"Noise Assessment: Snapper Mineral Sands Project" Prepared for BEMAX Resources Limited by Holmes Air Sciences, Suite 2B, 14 Glen Street, Eastwood, NSW 2122. January 2007.

ATTACHMENT 1

MINE FLEET SOUND POWER LEVELS

Table A1: Sound Power Levels (dB(A)) for the Snapper Mine Fleet

Equipment	Frequency (Hz)								Total PWL (dB(A))
	63	125	250	500	1,000	2,000	4,000	8,000	
Backhoe	92	96	100	112	111	110	101	94	116
Bucket Scoop	90	97	108	105	107	103	98	93	113
Dozer	88	93	106	101	103	99	94	89	109
Excavator	88	93	106	101	103	99	94	89	109
Front End Loader	88	93	106	101	103	99	94	89	109
Grader	92	96	100	112	111	110	101	94	116
Lighting Tower	68	88	88	96	94	97	92	82	102
Scraper	90	97	108	105	107	103	98	93	113
Dump Truck (Cat 740)	70	77	81	92	96	94	89	84	100
Water Truck	70	77	81	92	96	94	89	84	100
OB Slurry	68	88	88	96	94	97	92	82	102
Dredge	80	85	91	97	91	92	92	1	100
Primary Concentrator	78	86	87	84	89	82	89	42	95

APPENDIX D

SNAPPER AND GINKGO MINES

AIR QUALITY ASSESSMENT

23 April 2010

BEMAX Resources Limited
PO Box 15164
CITY EAST QLD 4002

Attn: Joe Bannister

RE: SNAPPER & GINKGO MINES MODIFICATION – AIR QUALITY IMPACT ASSESSMENT

Dear Joe,

Please find below our assessment of the potential air quality impacts of proposed modifications to the Snapper and Ginkgo Mines.

1 INTRODUCTION

BEMAX Resources Limited (BEMAX) is the proponent of the Snapper and Ginkgo Mines located in western New South Wales (NSW) (see **Figure 1.1**). BEMAX is seeking approval for the modifications under Section 75W of the *Environmental Planning and Assessment Act* (EP&A Act).

PAEHolmes (formerly Holmes Air Sciences [HAS]) prepared air quality impact assessments for the Ginkgo and Snapper Mines in 2001 and 2007, respectively (see **HAS** [**2001**] and **HAS** [**2007**]). This study adopts the same modelling and assessment approach as that taken in these previous assessments to assess potential air quality impacts at nearby private receptors arising from the proposed modifications. This study:

- Reviews the prevailing meteorological conditions in the area;
- Reviews recent ambient air quality data;
- Conducts an assessment of potential air quality impacts by adopting the same approach taken in the previous Snapper and Ginkgo Mine air quality assessments; and
- Presents the expected emissions from the Snapper and Ginkgo Mines and compares the predicted dust concentrations with the relevant air quality criteria.

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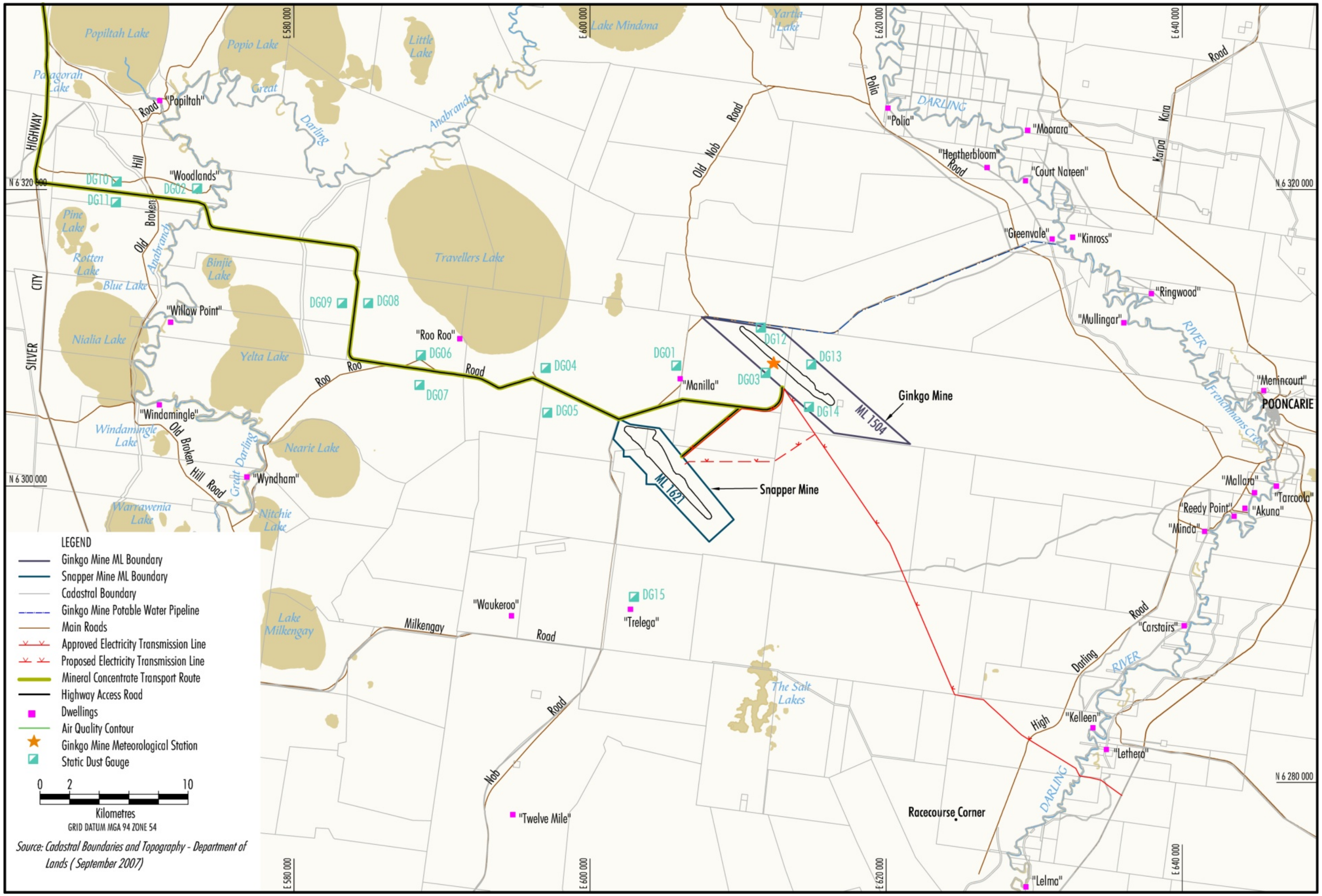


Figure 1.1: Location of the Snapper and Ginkgo Mines

2 OVERVIEW OF MODIFICATION

2.1 Snapper Mine

The key aspects of the Modification to the Snapper Mine include:

- an increase in the total amount of ore mined from approximately 117 million tonnes (Mt) to approximately 122 Mt and a minor change to the extent of the mine path;
- an increase in the annual ore mining rate from approximately 8.2 million tonnes per annum (Mtpa) to approximately 9.1 Mtpa;
- a decrease in the total amount of mineral concentrates from approximately 5.9 Mt to approximately 5.2 Mt, as a result of decreased average ore grades;
- an increase in maximum annual mineral concentrate production rate from the Snapper Mine from approximately 450,000 tonnes per annum (tpa) to approximately 621,000 tpa;
- a decrease in the life of the Snapper Mine from approximately 16 years to approximately 15 years, to reflect the decrease in total amount of mineral concentrates and increase in maximum annual mineral concentrate production rate;
- a change to a double-pass mining operation commencing approximately 4 km from the southern end of the ore body (single-pass for approximately the initial six years, followed by double-pass for the remainder);
- an increase in operational mining areas (including: an increase in the active mining area; an increase in the area of the overburden emplacement from approximately 145 to 215 hectares (ha); an increase to the HMC treatment facility and soil stockpile areas; and addition of a temporary HMC stockpile area adjacent to the mine path)
- an increase in the final mine path landform height from approximately 2 to 4.5 metres (m) to approximately 10 m;
- use of an electric conveyor system and/or dry mine fleet for dry overburden replacement instead of overburden slurrying;
- a change in the alignment of the electricity transmission line (ETL) to the Snapper Mine;
- trucking of Heavy Mineral Concentrate (HMC) between the Snapper and Ginkgo Mines[1], dependent on the location of the HMC treatment facility, and treatment of Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa;
- an increase in processing rate capacity of the wet high intensity magnetic separator (WHIMS) circuit from approximately 450,000 tpa to approximately 844,000 tpa;
- an increase in the water supply capacity of the reverse osmosis (RO) plant;
- supply of groundwater from the deeper, higher yielding, saline Lower Olney Formation aquifer instead of the shallow saline Loxton-Parilla aquifer; and
- continued trucking of an additional approximate 2 Mt of high-grade ore from the Snapper Mine to the Ginkgo Mine on a temporary basis (i.e. this approved activity would continue for an additional 12 months), feeding the ore through the Ginkgo Mine dredge, concentration and separation through the Ginkgo Mine primary gravitation unit and Ginkgo Mine or MSP WHIMS circuit and placement of the sand residues at the Ginkgo Mine.

[1] The current temporary approved trucking between the Snapper and Ginkgo Mines involves the transport of high grade ore, not HMC. The proposed HMC transport between the mines would involve significantly less truck movements than ore transport.

2.2 Ginkgo Mine

The key aspects of the Modification to the Ginkgo Mine include:

- an increase in the total amount of ore mined from approximately 128 Mt to approximately 145 Mt, as a result of an increased ore reserve;
- an increase to the life of the Ginkgo Mine from approximately 12 years to approximately 14 years, to reflect the increased ore reserve and a care and maintenance period;
- a decrease in the total amount of mineral concentrates from approximately 4.8 Mt to approximately 3.7 Mt, as a result of decreased average ore grades;
- trucking of HMC between the Ginkgo and Snapper Mines[1], dependent on the location of the HMC treatment facility and treatment of Ginkgo Mine HMC at the Snapper Mine and disposal of Ginkgo Mine HMC treatment waste at the Snapper Mine, and vice versa; and
- continued trucking of an additional approximate 2 Mt of high-grade ore from the Snapper Mine to the Ginkgo Mine on a temporary basis (i.e. this approved activity would continue for an additional 12 months), feeding the ore through the Ginkgo Mine dredge, concentration and separation through the Ginkgo Mine primary gravitation unit and Ginkgo Mine or MSP WHIMS circuit and placement of the sand residues at the Ginkgo Mine.

3 EXISTING ENVIRONMENT

3.1 Dispersion Meteorology

The Snapper Mine air quality assessment (**HAS, 2007**) used meteorological data collected from the Gingko Mine meteorological station in its modelling. As there was only 84% data recovery from one continuous year and the Department of Environment Climate Change and Water's (DECCW) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005) require 90% data recovery, this data was input into The Air Pollution Model (TAPM) as real-world observations to provide a more accurate representation of meteorology at the site. Meteorological data between April 2005 and April 2006 were used in the 2007 assessment and have been used in this assessment for consistency.

Figure 3.1 presents the annual and seasonal windroses prepared from the hourly meteorological data as used in the Snapper Mine air quality assessment (**HAS, 2007**). It can be seen from **Figure 3.1** that, annually, the most common winds are from the south or the north. In summer the winds are generally from the south while in winter the winds are typically from the north. Autumn and spring winds exhibit a mix of both summer and winter patterns. On an annual basis there are 8.9% calms and the annual average wind speed is 2.4 m/s.

More recent meteorological data from the Ginkgo Mine meteorological station have been received from BEMAX. Data from years 2007, 2008 and 2009 have been reviewed to provide a comparison with the 2005/2006 Ginkgo Mine with TAPM dataset used in the previous modelling (**HAS, 2007**). The results show that the dataset used in the modelling is representative of actual meteorological conditions at the mine site.

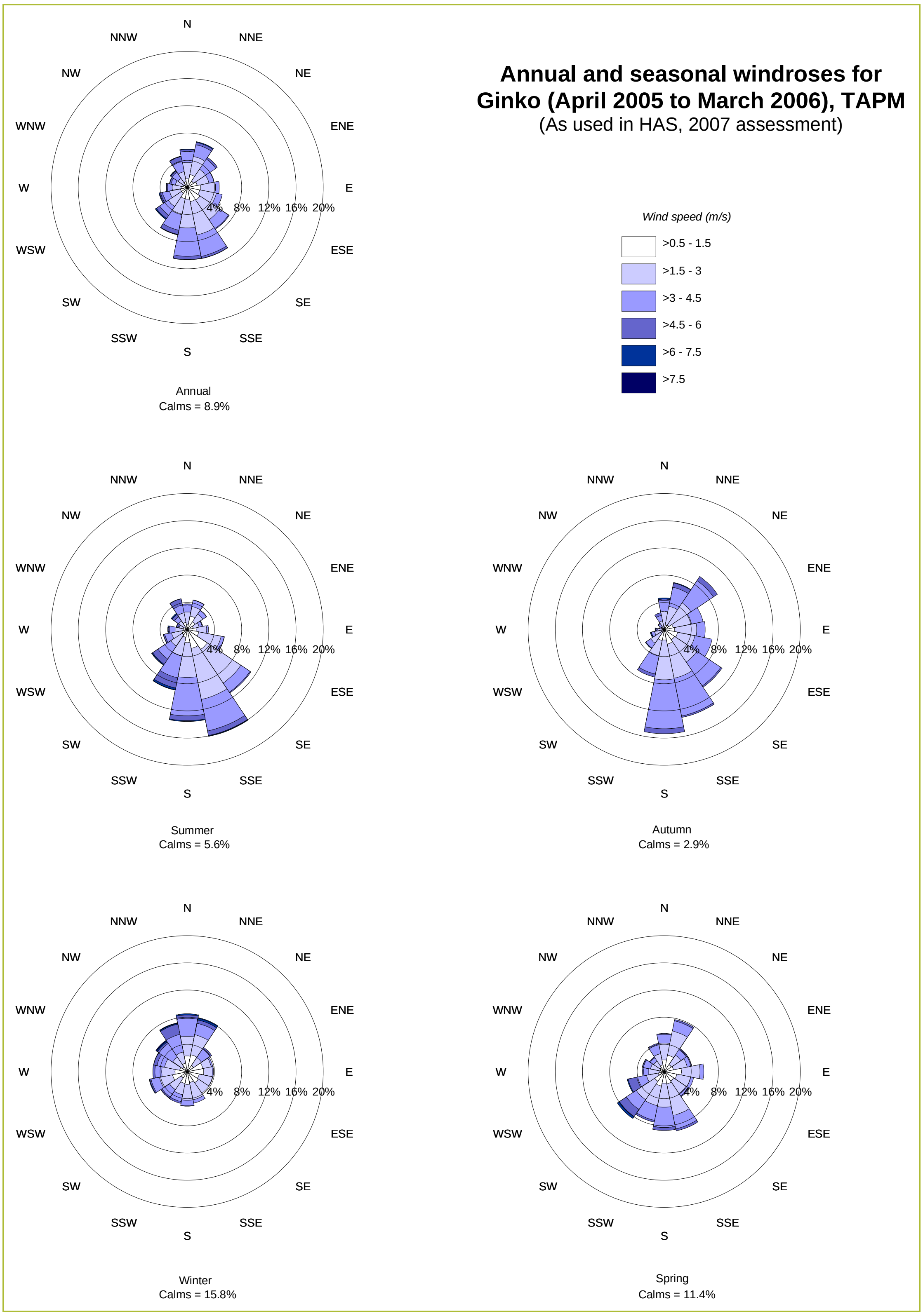


Figure 3.1: Annual and Seasonal Windroses for the Ginkgo Mine (TAPM), April 2005 – March 2006

Figure 4.1 presents the annual and seasonal windroses for the Ginkgo Mine meteorological station for years 2007, 2008 and 2009. When compared with the 2005/2006 data (see **Figure 3.1**), the annual wind patterns are very similar with dominant winds from southern directions and slighter winds from the north. Summer patterns in all years are similar with winds predominantly from the south and autumn and spring winds varying between north and south directions. Winter wind patterns in 2007 however are more prominent from the southern direction when compared with the other years being predominately from the north. The annual percentages of calms are similar throughout the datasets but slightly higher in the 2007, 2008 and 2009 data, which ranged from 11.6 to 14.9 m/s.

4 EXISTING AIR QUALITY

Dust deposition is monitored by BEMAX in the area surrounding the Ginkgo and Snapper Mines. There are however, no long-term measurements of total suspended particulate matter (TSP) or particulate matter less than 10 microns (PM_{10}) concentrations at the site.

4.1 Dust Deposition

Figure 1.1 shows the location of the 15 dust deposition gauges surrounding the Snapper and Ginkgo Mines. Data collected from the gauges are summarised below in **Table 4.1**. These measurements include all background sources relevant to the location, including any contribution which may occur from the Ginkgo Mine (which commenced construction and operation in 2004 and 2005, respectively) and the Snapper Mine (which commenced construction in 2008).

Table 4.1: Annual Average Dust Deposition ($g/m^2/month$) Data surrounding the Snapper and Ginkgo Mines

Dust Deposition Gauge	2004	2005	2006	2007	2008	2009
DG01 - Manilla Homestead	1.6	1.6	1.1	1.3	2.7	3.3
DG02 - Woodlands Homestead	1.4	1.1	0.9	1.1	3.0	2.4
DG03 - Ginkgo Camp	-	1.6	0.9	1.2	2.8	3.3
DG04 - Manilla HAR	0.7	1.5	1.9	2.8	**4.6**	3.7
DG05 - Carstairs HAR	-	0.8	1.4	2.6	**4.6**	4.0
DG06 - Roo Roo South HAR	-	1.4	2.2	2.6	**5.9**	**6.7**
DG07 - Willow Point HAR	-	1.5	2.2	3.6	**5.6**	**5.6**
DG08 - Roo Roo North HAR	-	1.3	2.1	3.4	**4.5**	3.9
DG09 - Woodlands East HAR	-	0.6	1.7	2.1	3.5	2.7
DG10 - Woodlands West HAR	-	-	1.9	1.3	2.5	1.8
DG11 - Springwood HAR	-	-	1.3	1.8	2.9	3.1
DG12 - North Lease Fence	-	-	1.7	1.3	2.4	3.6
DG13 - East Lease Fence	-	-	1.2	0.9	3.6	2.8
DG14 - Nob Rd Lease Boundary	-	-	1.5	1.1	2.4	3.7
DG15 - Trelega Homestead	-	-	-	-	-	2.3
Average Over All Data						2.4

Note: Results above the relevant criterion are shown in bold.

HAS (2007) adopted 2.4 grams per square metre per month ($g/m^2/month$) as the background dust deposition rate. This background dust deposition rate was based on the highest annual average dust deposition recorded at the time (from a dust gauge on the Ginkgo Mine in 2006). **HAS (2007)** considered this background concentration to be conservative and in reality, background concentrations were expected to be significantly less.

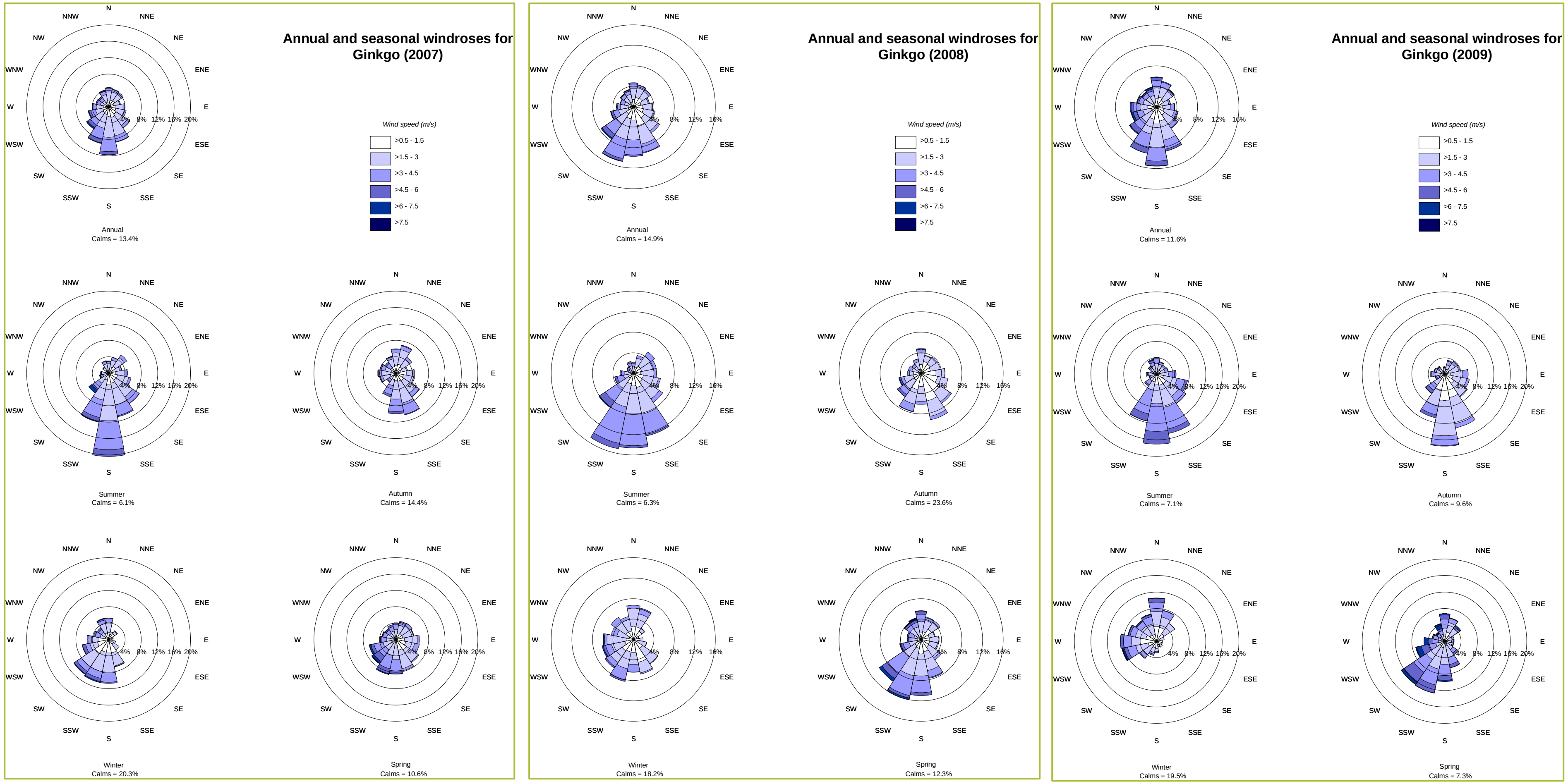


Figure 4.1: Annual and Seasonal Windroses for the Ginkgo Mine (2007, 2008 and 2009)

The data in **Table 4.1** shows that that the majority of the monitoring locations have reported an annual average dust deposition level below the DECCW's 4 g/m^2/month dust deposition criterion. DG4 to DG8 have recorded dust deposition levels above the criterion in 2008. These high annual averages are the result of unusually high readings in September which are most likely due to extensive dust storms experienced over NSW during this time (**Bureau of Meteorology, 2010**). DG6 and DG7 also recorded annual average levels above the criteria in 2009 which are also most likely the result of dust storms between September and December 2009 (**BEMAX, 2010**).

It should be noted that these short term dust storm events can significantly increase the annual average dust deposition results and therefore the annual average dust deposition rates for these years would overestimate the typical dust deposition levels in the area.

The average dust deposition level over all data is 2.4 g/m^2/month (see **Table 4.1**), which is below the DECCW assessment criterion and is the same as the background dust deposition level adopted in the **HAS** (**2007**) assessment.

4.2 Dust Concentration

HAS (**2007**) adopted the following background concentrations for the Snapper and Gingko Mines:

- Annual average background TSP - 54 µg/m^3; and
- Annual average background PM_{10} - 22 µg/m^3.

These background concentrations were derived in **HAS** (**2007**) from the highest annual average dust deposition recorded at the time (i.e. 2.4 g/m^2/month). **HAS** (**2007**) considered these background concentrations to be conservative and in reality, background concentrations were expected to be significantly less.

For the purpose of this study, background levels derived for the **HAS** (**2007**) air quality assessment will be used for consistency.

5 OVERVIEW OF PREVIOUS AIR QUALITY ASSESSMENT

5.1 Ginkgo Mine

An air quality assessment was conducted for the Ginkgo Mine in 2001 (**HAS, 2001**). Year 10 represented the 'worst-case' scenario as operations in this year would be closest to private receptor Manilla.

Table 5.1 presents the model results as predicted in the Ginkgo Mine assessment (**HAS, 2001**). Predictions with background levels are shown in parentheses.

Table 5.1: 2001 Ginkgo Mine Air Quality Assessment Modelling Results for Manilla

Pollutant	Year 10 operations – Manilla	Air Quality Criteria
24-hour average PM_{10} (µg/m^3)	6	50
Annual average PM_{10} (µg/m^3)	0.5 (10.5)	30
Annual average TSP (µg/m^3)	0.5 (25.5)	90
Annual average dust deposition (g/m^2/month)	0.02 (2.02)	2 (4 - cumulative)

Source: **HAS, 2001**

Note: Predictions with background levels are shown in parentheses.

24-hour average PM_{10} concentrations from the Ginkgo Mine at Manilla were predicted to be 6 micrograms per cubic metre (µg/m³) which is well below the DECCW assessment criterion of 50 µg/m³. Annual average PM_{10}, TSP and dust deposition predictions were well below their respective assessment criteria.

5.2 Snapper Mine

As described in **Section 1**, an air quality assessment was conducted for the Snapper Mine in 2007 (**HAS, 2007**). Year 1 (construction) and Year 14 represented the 'worst-case' scenarios given that mining operations during these years would be closest to the nearest private receptors (i.e. Manilla and Trelega).

Table 5.2 presents the maximum 24-hour average PM_{10}, annual average PM_{10}, annual average TSP and annual average dust deposition model results as predicted in the assessment (**HAS, 2007**). 24-hour average PM_{10} concentrations were predicted to be highest at Manilla during Year 14 operations at 34 µg/m³. All pollutants were predicted to be below their respective DECCW assessment criteria.

Table 5.2: 2007 Snapper Mine Air Quality Assessment Modelling Results

Receptor	Construction	Year 14 Operation	Air Quality Criteria
Predicted maximum 24-hour average PM_{10} concentrations (µg/m³)			
Manilla	11	34	50
Trelega	11	7	
Predicted annual average PM_{10} concentrations (µg/m³) (Predictions with background are shown in parentheses)			
Manilla	1.5 (23.5)	2.7 (24.5)	30
Trelega	0.9 (22.9)	0.6 (22.6)	
Predicted annual average TSP concentrations (µg/m³) (Predictions with background are shown in parentheses)			
Manilla	1.5 (55.5)	2.9 (56.9)	90
Trelega	0.9 (54.9)	0.6 (54.6)	
Predicted annual average dust deposition (g/m²/month) (Predictions with background are shown in parentheses)			
Manilla	0.02 (2.42)	0.06 (2.46)	2 (4 - cumulative)
Trelega	0.02 (2.42)	0.01 (2.41)	

Source: **HAS, 2007**

The **HAS (2007)** assessment modelled the cumulative effects of the Ginkgo Mine with Snapper Mine operations and due to the prevailing weather conditions, concluded that there would be no change to the maximum 24-hour average PM_{10} predictions when dust emissions from the Ginkgo Mine were included. Similarly, inclusion of the Ginkgo Mine emissions with the Snapper Mine emissions would have a small effect on annual average PM_{10}, TSP and dust deposition levels at the Manilla and Trelega homesteads.

The **HAS (2007)** assessment described that there would, on occasions, be exceedances of 50 µg/m³ criterion at all residential properties in the area due to non-mine related sources of particulate matter, such as bushfires or dust storms.

From the available dust monitoring data, **HAS (2007)** conservatively estimated that average background PM_{10} concentrations would be around 22 µg/m³ (although, in reality, the background levels are likely to be significantly less). It was predicted that if background concentrations are below this level on the day when the maximum impact from the Snapper Mine occurs, compliance with the 50 µg/m³ criterion would be anticipated. However, if background levels are above 22 µg/m³ then concentrations from the Snapper Mine plus the background may exceed the 50 µg/m³ criterion.

For the majority of the year the contribution of the Snapper Mine to 24-hour average PM_{10} concentrations was predicted to be less than 5 µg/m^3. There were three days in the modelled year when the 24-hour average PM_{10} concentration was predicted to be above 28 µg/m^3. On this basis, the potential for the Snapper Mine to be the cause of exceedances of the 50 µg/m^3 was considered to be very low.

6 ASSESSMENT METHODOLOGY

6.1 Snapper Mine Operations

For the purposes of impact assessment, the proposed operations during Year 2 and Year 9 represent the 'worst-case' scenarios for modified Snapper Mine operations. As discussed in **Section 2.1**, two options exist for overburden movement for the modified Snapper Mine; an electric conveyor system or use of a dry mine fleet. These scenarios assume that overburden would be replaced by a dry mine fleet, whereas any potential air quality impacts would be significantly less when if using an electric conveyor system.

Year 2 was chosen for assessment as operations at that time would occur in the south closest to private receptor Trelega (see **Figure 1.1**). Dispersion modelling was not conducted for operations at the Snapper Mine during Year 2 as dust impacts at Trelega are likely to be small and well within the DECCW assessment criteria. Notwithstanding the above, a brief qualitative assessment is provided for Year 2 operations (see **Section 8.2**).

Year 9 was chosen for dispersion modelling and assessment as this year would have the highest amount of overburden moved during operations in the north of the mine path (i.e. closest to private receptor Manilla). Private receptor Manilla (approximately 4 km away) is also situated in the direction of the predominant southerly wind.

6.2 Ginkgo Mine Operations

As described in **Section 5.2**, the **HAS (2007)** assessment modelled the cumulative effects of the Ginkgo Mine with Snapper Mine operations. **HAS (2007)** concluded that, due to the prevailing weather conditions, there would be no change to the maximum 24-hour average PM_{10} predictions at the Manilla and Trelega homesteads when emissions from the Ginkgo Mine were included. Similarly, inclusion of the Ginkgo Mine emissions with the Snapper Mine emissions would have a small effect on annual average PM_{10}, TSP and dust deposition levels at the Manilla and Trelega homesteads.

Further to this, the proposed modification to the Ginkgo Mine (see **Section 2.2**) would not affect air quality impacts and would not add to previously predicted concentrations. **Table 6.1** outlines these proposed modifications and their effect on air quality.

Table 6.1: Proposed Modification to the Ginkgo Mine and Effect on Air Quality

Proposed Modification to the Ginkgo Mine	Effect on air quality
Operations An increase in the total amount of ore mined	Notwithstanding the increase in the total amount of ore mined, the maximum rate of production from the Ginkgo Mine would remain unchanged from the approved maximum rate of production of approximately 576,000 tpa and there would be no changes to the existing fleet. Therefore there would be no change to the existing air quality emissions from the Ginkgo Mine. As the ore is in a slurry form and is extracted through a dredge pond, the moisture content is very high and would therefore not produce dust impacts. For this reason, dust impacts from ore extraction were not modelled in the previous Snapper and Ginkgo air quality assessments (**HAS, 2001** and **2007)** and do not require consideration here.
Operations An increase in mine life by two years	The increase in mine life extends the mining period but would not impact on 24-hour or annual dust deposition and TSP results.

Based on the discussion above, operations from the Ginkgo Mine would not affect dust impacts arising from the proposed modification at the Ginkgo Mine and are not assessed further.

7 REVISED EMISSIONS ESTIMATES

7.1 Snapper Mine Operations – Year 2

Trelega is located approximately 7 km south of the Snapper Mine (see **Figure 1.1**). TSP emissions for Year 2 have been estimated and are provided below in **Table 7.1**.

Table 7.1: Estimated dust emissions from the Snapper Mine (Year 2)

ACTIVITY	TSP emissions for Year 2 (kg/y)
Bucket Scoop/Scraper loading, transporting and unloading topsoil	25,460
Dozers stripping overburden	101,250
Loading haul trucks	2,198
Haul trucks transporting overburden	458,913
Emplacement at overburden dumps	2,198
Dozers on overburden areas	134,999
Grading roads and open areas	21,566
Wind erosion from topsoil stockpiles	378,432
Wind erosion from overburden dumps	490,560
Wind erosion from disturbed area around mine	164,688
Wind erosion from product stockpiles	24,528
Total	**1,804,792**

The estimated total annual emission of TSP for Year 2 operations is approximately 1,800 tonnes.

7.2 Snapper Mine Operations – Year 9

The most significant dust generating activities proposed for the Snapper Mine in Year 9 have been identified and the estimated dust emissions applied in the modelling are presented below in **Table 7.2**.

Table 7.2: Estimated dust emissions from the proposed modification to the Snapper Mine (Year 9)

ACTIVITY	TSP emissions for Year 9 (kg/y)
Bucket Scoop/Scraper loading, transporting and unloading topsoil	27,885
Dozers stripping overburden	101,250
Loading haul trucks	4,552
Haul trucks transporting overburden	1,629,016
Emplacement at overburden dumps	4,552
Dozers on overburden areas	134,999
Grading roads and open areas	21,566
Wind erosion from topsoil stockpiles	248,083
Wind erosion from overburden dumps	90,403
Wind erosion from disturbed area around mine	115,632
Wind erosion from product stockpiles	24,528
Total	**2,402,466**

The hauling of overburden material by haul trucks is the most significant dust generating activity that would occur at the site.

The estimated total annual emission of TSP for Year 9 operations is approximately 2,400 tonnes.

7.3 Emission Estimate Summary

The estimated total annual emission of TSP for Year 2 operations is approximately 1,800 tonnes. Although there is less overburden moved in Year 2 than Year 9 (see **Section 7.2**), the overburden stockpile areas are larger, therefore increasing potential wind erosion emissions. Nevertheless, the total estimated annual emission of TSP for Year 2 is lower than that of Year 9.

Figure 3.1 shows that on an annual basis, the predominant wind direction is from the south. As Trelega is located to the south of the Snapper Mine, winds are unlikely to transport significant amounts of dust from the Snapper Mine to this receptor.

As Manilla is located approximately 4 km north of the Snapper Mine and is situated in the direction of the predominantly southerly wind, Year 9 operations would produce higher dust impacts than the other years and thus if compliance is achieved in Year 9, it would be expected to be achieved in all other years.

Therefore, dispersion modelling (see **Section 8**) focuses on Year 9 rather than Year 2.

8 ASSESSMENT OF IMPACTS

8.1 Snapper Mine Operations

Table 8.1 presents a summary of the Year 9 predicted concentrations at each of the nearby private receptors due to the operations of the Snapper Mine alone. Modelling results for Year 9 show no exceedances of the DECCW criteria at any of the private receptors.

Figure 8.1 presents a plot of the predicted maximum 24-hour average PM_{10} concentrations for operations at the Snapper Mine in Year 9. As annual average modelling results are well below the criteria, only the 24-hour PM_{10} concentration plot has been presented in this study.

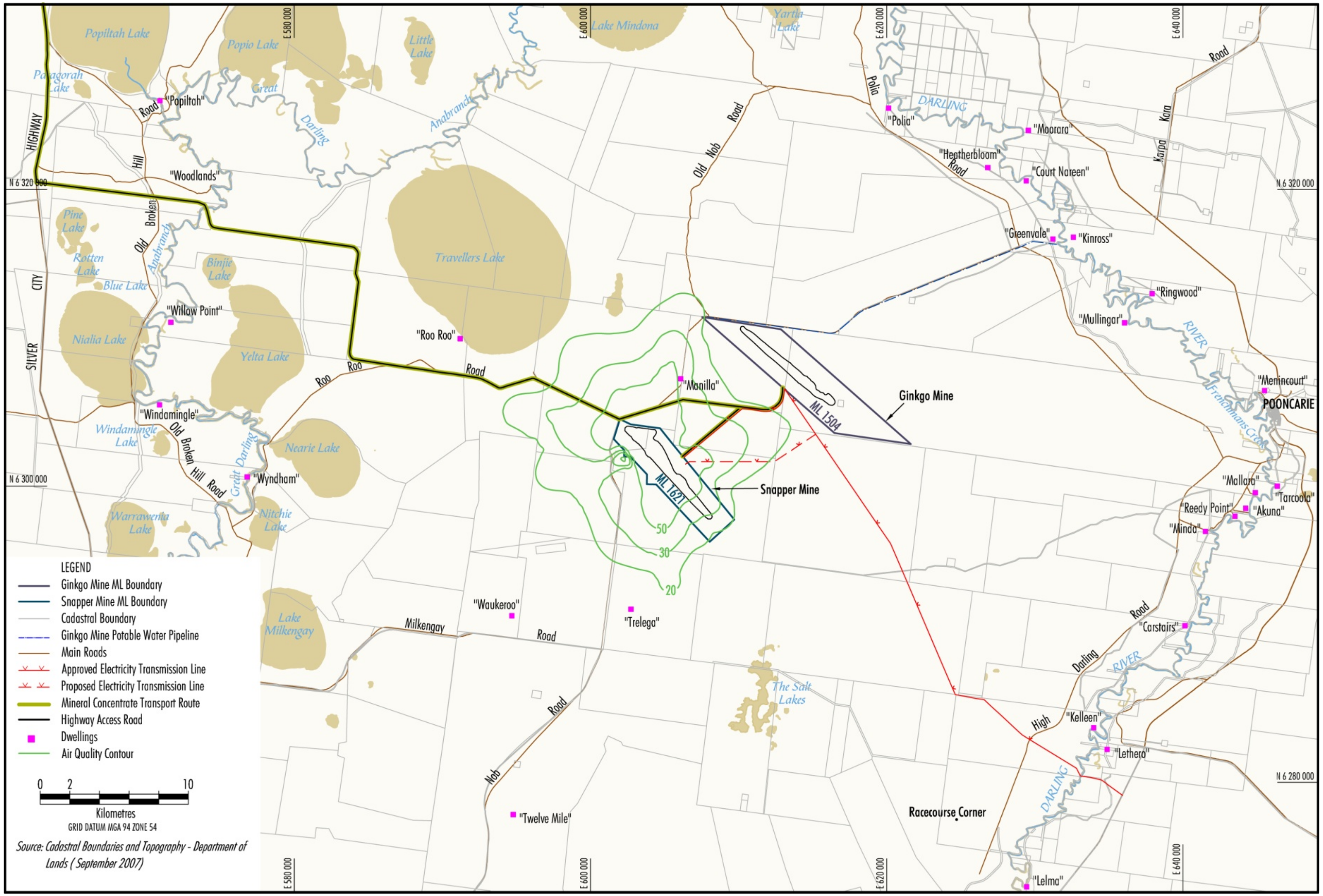


Figure 8.1 : Predicted 24-hour Average PM_{10} Concentrations due to Emissions from the Project alone in Year 9

Table 8.1: Year 9 – Predicted PM_{10} and TSP Concentrations and Dust Deposition Levels due to the Snapper Mine

Receptor	Year 9 Operations	Air Quality Criteria
Predicted Maximum 24-hour average PM_{10} concentrations (µg/m³) (Refer to Section 8.4.3 for cumulative assessment)		
Manilla	48	50
Trelega	12	
Predicted annual average PM_{10} concentrations (µg/m³) (Predictions with background are shown in parentheses)		
Manilla	5 (27)	30
Trelega	1 (23)	
Predicted annual average TSP concentrations (µg/m³) (Predictions with background are shown in parentheses)		
Manilla	6 (60)	90
Trelega	1 (55)	
Predicted annual average dust deposition (g/m²/month) (Predictions with background are shown in parentheses)		
Manilla	0.13 (2.5)	2 (4 - cumulative)
Trelega	0.02 (2.4)	

8.2 Ginkgo Mine Operations

As described in **Section 6.2**, the **HAS (2007)** assessment modelled the cumulative effects of the Ginkgo Mine with Snapper Mine operations. **HAS (2007)** concluded that, due to the prevailing weather conditions, there would be no change to the maximum 24-hour average PM_{10}, annual average PM_{10}, TSP and dust deposition levels predictions at the Manilla and Trelega homesteads when emissions from the Ginkgo Mine were included.

Further to this, the proposed modification to the Ginkgo Mine (see **Section 2.2**) would not affect air quality impacts and would not add to previously predicted concentrations (see **Section 6.2**). **Table 6.1** outlines these proposed modifications and their effect on air quality.

8.3 Road Transport

The proposed modification would not change the maximum combined concentrate haulage from the Snapper and Ginkgo Mines to the Mineral Separation Plant (MSP). Therefore there would be no change to the approved number or type of haulage vehicles transporting mineral concentrates to the MSP, and therefore no change to potential air quality emissions.

The frequency of road trains transporting ore between the mines along the private road section of the approved HAR would continue at the same frequency as approved as part of the November 2009 Modification (which approved a maximum of 4 vehicle movements per hour). The frequency of AB-triple vehicles or road trains transporting HMC between the mines along the private road section of the approved HAR would be less than for ore.

These vehicle movements would be additional to the existing vehicle movements transporting mineral concentrate from the Ginkgo Mine to the MSP along other sections of the HAR and would be a source of dust emissions.

Given the frequency of road train movements along the private road section of the HAR for ore transport (i.e. a maximum of 4 vehicle movements per hour) and the distance to the closest residence, Manilla homestead (i.e. 4 km), it is unlikely that the modification would result in adverse air quality impacts at the Manilla homestead or other nearby residences.

8.4 Cumulative Assessment

8.4.1 Introduction

As discussed in **Section 6.2** cumulative dust impacts from the modified Ginkgo Mine are negligible and therefore will not be included in a cumulative assessment with the Snapper Mine. There are however existing levels of background dust (e.g. agricultural activities, bushfires, dust storms) that need to be considered in a cumulative assessment with predictions from the Snapper Mine.

8.4.2 Annual average TSP, PM_{10} and Dust Deposition Cumulative Predictions

Annual average PM_{10}, TSP and dust deposition predictions from the modified Snapper Mine operations on its own, are well below the assessment criteria and are not expected to be exceeded when background levels are considered (see **Table 8.1**).

For the purpose of this study, the following background levels derived for the **HAS** (**2007**) air quality assessment will be used for consistency (see **Section 4**):

- Annual average background TSP - 54 $\mu g/m^3$;
- Annual average background PM_{10} - 22 $\mu g/m^3$; and
- Annual average background dust deposition - 2.4 g/m^2/month.

These background concentrations were derived in **HAS** (**2007**) from the highest average of deposited dust recorded at the time (from a dust gauge on the Ginkgo Mine in 2006). These background concentrations were considered by **HAS** (**2007**) to be conservative and in reality, background concentrations are likely to be significantly less.

More recently, the average of all dust deposition data has been recorded at 2.4 g/m^2/month (see **Table 4.1**), the same as the assumed background in **HAS** (**2007**). As noted in **Section 4.1**, this average has been influenced by the presence of regional dust storms in recent years and is also considered to overestimate the typical dust levels in the area.

When these background levels are added to predictions at Manilla and Trelega, all predicted annual average TSP, PM_{10} and dust concentrations comply with the DECCW's air quality criteria (see **Table 8.1**).

8.4.3 24-hour PM_{10} Cumulative Predictions

It is not possible to accurately predict cumulative 24-hour average PM_{10} concentrations using dispersion modelling (without daily background emissions data). However, a risk analysis can be provided to show the spread of concentrations at private receptors and assess the likelihood of concentrations exceeding the 24-hour average PM_{10} assessment criterion. This analysis has only been provided for Manilla only as 24-hour PM_{10} concentrations for Trelega would be well below the assessment criterion.

Figure 8.2 presents a plot showing the spread of predicted 24-hour PM_{10} concentrations from the modified Snapper Mine across the modelled year for Manilla.

Figure 8.3 presents a histogram showing the frequency (or number of days) of predicted PM_{10} 24-hour average concentrations from the modified Snapper Mine at Manilla in Year 9. The histogram shows that there are much higher proportions of lower concentrations (i.e. 80% of concentrations are less than 10 $\mu g/m^3$).

Figure 8.4 presents a graph showing the top ten 24-hour average PM_{10} concentrations from the modified Snapper Mine predicted at Manilla. The graph clearly shows a significant decrease in concentrations below the highest predicted concentration.

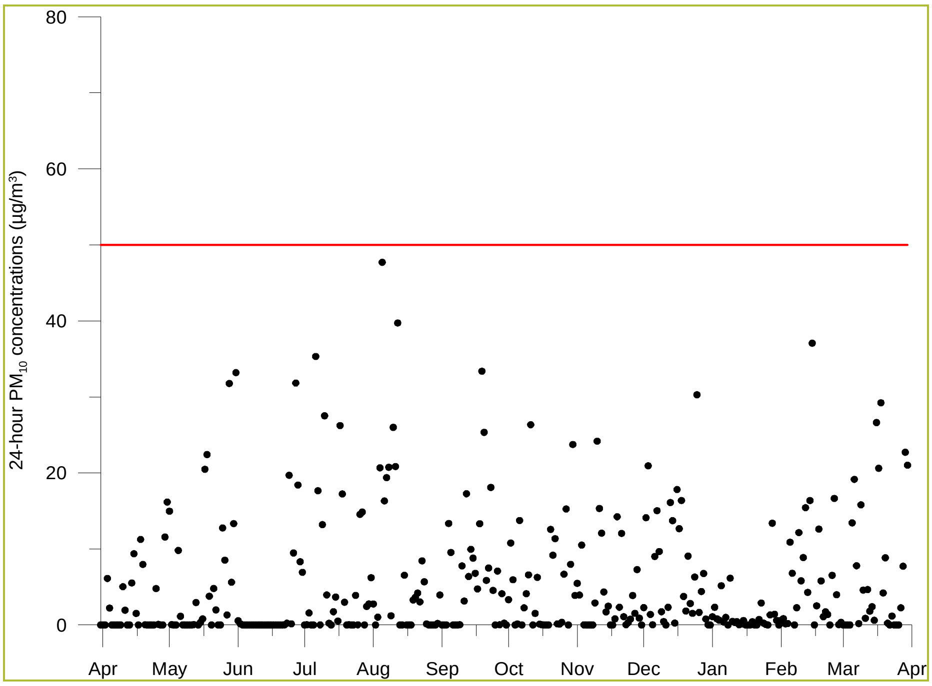
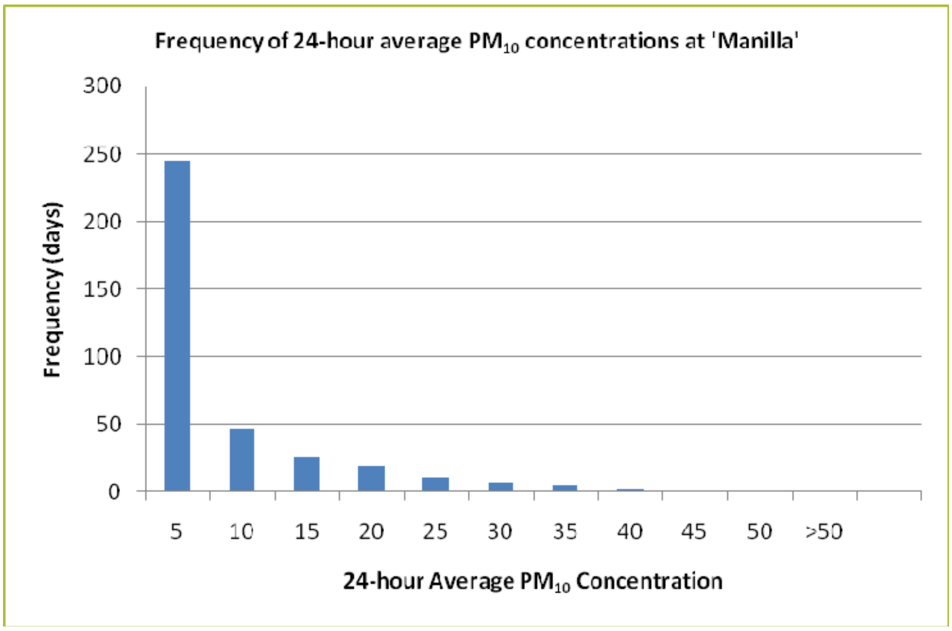


Figure 8.2: Predicted 24-hour PM_{10} Concentrations at Manilla in Year 9



N.B: The horizontal axis represents groups of PM_{10} 24-hour concentrations e.g. '5' includes concentrations between 0µg/m³ and 5µg/m³.

Figure 8.3: Frequency of 24-hour average PM_{10} Concentrations at Manilla in Year 9

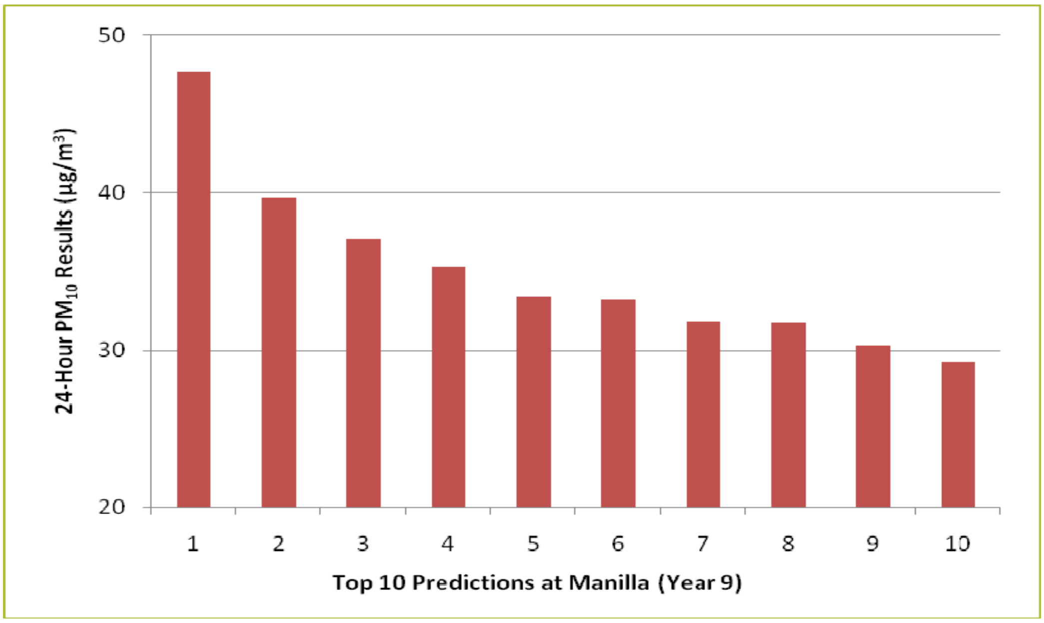


Figure 8.4: Top 10 24-hour Average PM_{10} Concentrations at Manilla in Year 9

As described in **Section 8.4.2**, the conservatively estimated background PM_{10} concentrations would be approximately 22 µg/m^3 (although, in reality, the background levels are likely to be significantly less). **HAS** (**2007**) predicted there would be 3 days when the 24-hour average PM_{10} concentration for the Snapper Mine was predicted to be above 28 µg/m^3 (see **Section 5.2**).

24-hour average PM_{10} concentrations for the modified Snapper Mine are predicted to be above 28 µg/m^3 on ten days in the modelled year (see **Figure 8.4**). For the majority of the year (80% of the time) the contribution of the modified Snapper Mine to 24-hour average PM_{10} concentrations is predicted to be less than 10 µg/m^3. There are only 5 days per year where the 24-hour average PM_{10} concentration from the modified Snapper Mine at Manilla is greater than 33.2 µg/m^3 and there are no days where the concentrations at Manilla exceed 50 µg/m^3.

As noted in **Section 4.1**, dust storm events can significantly increase the annual average dust deposition levels, and therefore the annual average dust deposition (or derived PM_{10} concentrations) would overestimate the typical levels in the region. There would, on occasions, be exceedances of the 50 µg/m^3 criterion at all residential properties in the area due to non-mine related sources of PM_{10}, such as dust storms and bushfires.

9 CONCLUSIONS

This study has assessed the air quality impacts associated with the proposed modifications to the Snapper and Ginkgo Sand Mines located in western NSW. Dispersion modelling and a qualitative assessment were used to assess the impact of dust emissions on the local air quality. The area is remote and sparsely populated with the closest residence, the "Manilla" homestead, located approximately 4 km from the mining sites.

It is concluded that adverse air quality impacts above DECCW criteria would be unlikely at nearest private receptors due to the proposed modifications at the Snapper and Ginkgo Mines. PM_{10} concentrations arising from sources not related to the mines, such as bushfires and dust storms, may result in elevated short-term levels on occasions. However, there is a low risk of elevated 24-hour average PM_{10} concentrations exceeding the DECCW assessment criteria at nearest private receptors.

The cumulative effects of dust emissions from the Ginkgo and Snapper Mines, are considered to be small and would not change the conclusions presented above.

10 REFERENCES

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