SECTION 2

PROJECT DESCRIPTION

Snapper Mineral Sands Project
Environmental Assessment

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2 PROJECT DESCRIPTION

2.1 MINERAL DEPOSIT

The Murray Darling Basin is a large sedimentary basin covering approximately 300,000 km^2 extending across the borders of NSW, Victoria, Queensland and South Australia. The basin contains mineral sands deposits within the Loxton-Parilla Sands host unit, a sequence of weakly consolidated, near horizontally bedded sands that were deposited during marine transgressions and regressions in the Late Miocene to Late Pliocene period.

The Ginkgo and Snapper mineral deposits both occur within the Loxton-Parilla Sands host unit. Various sub-units of the Loxton-Parilla Sands are recognised. The Snapper mineral deposit consists of fine to medium grained quartz sands which are generally unconsolidated, well sorted and contain little clay. The deposit is overlain on average by 30 to 35 m of overburden, increasing at the northern end where the orebody dips to the north-west.

The Lower Loxton-Parilla Sands are overlain by the Mica Sands unit, which are fine to very fine micaceous sands. The Mica Sands are in turn covered by barren sand representing the Upper Loxton-Parilla Sands. The Shepparton Formation is a sandy clay unit overlying the Upper Loxton-Parilla Sands, which outcrops in places where the uppermost stratigraphic layer, the Woorinen Formation, is absent. The Woorinen Formation consists of very fine to coarse sand and silty sand, sandy clay and minor calcrete. The profile described above is shown conceptually in Figure 2-1.

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 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. The Snapper mineral deposit has been categorised into six domains. Domain 1 is a high grade lens that runs the full length of the deposit. This lens is characterised by good rutile values and relatively low zircon, and is thickest at the southern end of the deposit. Domain 2 is a deep, thin, high grade lens on the far western side of the deposit. Domain 3 represents the lower-grade material of the deposit and is characterised by high levels of titanium silicates. Domain 4 is a thin, discontinuous high grade lens on the western side of the deposit.

Domain 5 is the low grade material overlying Domain 4 and although a low-grade domain, has relatively high zircon levels. Domain 6 is a wide, high grade lens on the eastern side of the deposit, and is mineralogically the best domain in the deposit. These domains overlay unmineralised mica-rich, fine to very fine offshore sands. The geological domains described above are shown conceptually in Figure 2-1.

The reserve for the Snapper Mine comprises approximately 117 Mt of ore (measured and indicated), at an average grade of 5% heavy minerals (Section 1.1.2). This represents some 5.9 Mt of heavy minerals comprising the valuable components of ilmenite, leucoxene, rutile and zircon. Snapper Mine ore grades are especially high (typically 8 to 9% heavy minerals) in the early years of production.

Section 4.2.1 provides further discussion of geology relevant to the Hydrogeological Assessment.

2.2 GENERAL ARRANGEMENT

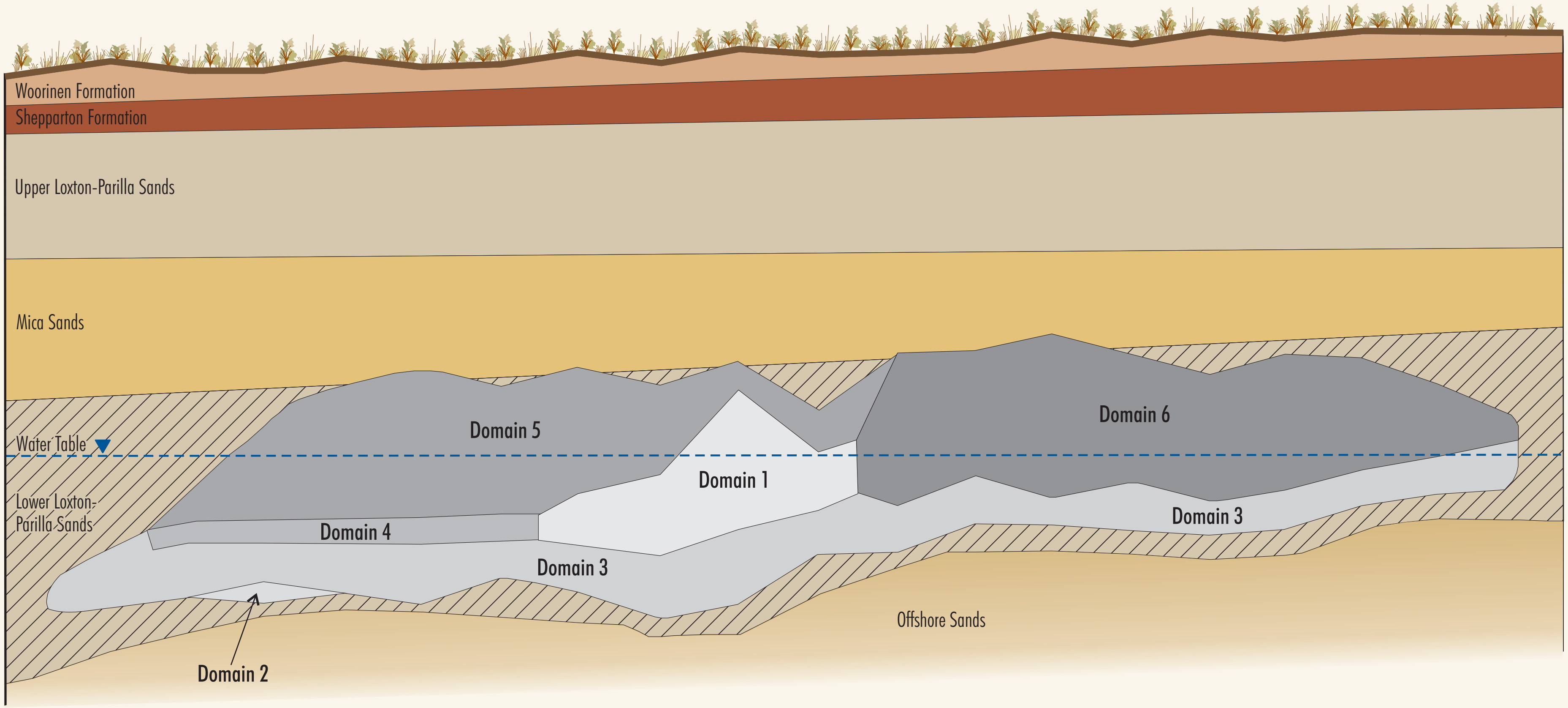
Dredge mining would be the primary method of mining and would involve the same method of mining as the Ginkgo Mine (i.e. conventional mineral sands dredge mining). Secondary mining of ore would occur simultaneous to dredge mining as required, and would be undertaken by conventional mobile equipment (i.e. dozers and/or scrapers) depositing ore in front of the dredge.

The Snapper Mine has been designed to integrate with Ginkgo Mine ancillary infrastructure and facilities as far as practicable. For example, ancillary infrastructure for the Snapper Mine comprises extensions/sharing of the existing Ginkgo Mine ETL and HAR and expansion of the Ginkgo Mine accommodation camp to accommodate Snapper Mine workers (Figure 1-2).

2.2.1 Mine Site

Major mine site components would include:

- floating dredge and primary gravity concentration unit for mining and primary minerals separation;
- borefields supplying water to the overburden slurrying facility, dredge pond, primary gravity concentration unit, water disposal dam and HMC treatment facility;



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Source: BEMAX, (2006)

SNAPPER MINERAL SANDS PROJECT

FIGURE 2-1

Conceptual Cross Section - Geological Domains of the Snapper Deposit

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- overburden slurrying and pumping system;
- RO plant to supply the salt washing facility and potable water;
- salt washing facility;
- WHIMS circuit;
- administration and workshop buildings (including ablutions);
- a wastewater (including sewage) treatment plant;
- laydown areas;
- roads and ETL;
- towers and stackers for stockpiling mineral concentrates;
- overburden, soil and mineral concentrate stockpiles;
- fuel and consumables storage facilities;
- initial water supply dam;
- initial sand residue dam;
- initial overburden emplacements;
- water treatment dams;
- water disposal dam; and
- other associated infrastructure, plant, equipment and activities.

The general arrangement of the mine site at Year 1, Year 14, and post-mining is shown on Figures 2-2 to 2-4.

2.2.2 Ancillary Infrastructure

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

- An approximate 10 km long 66 kV ETL from the Ginkgo Mine to the Snapper Mine (i.e. an extension of the existing ETL from the Ginkgo Mine substation) (Figure 1-2).
- Shared use of the existing mineral concentrate transport route (Figure 1-1). The HAR would be extended by approximately 1 km into the northern extent of the mine site and by approximately 6 km to the eastern side of the mine site (Figure 1-2).
- Shared use of the accommodation camp at the Ginkgo Mine, which would be expanded to accommodate Snapper Mine workers.

2.3 SNAPPER MINE CONSTRUCTION ACTIVITIES

Pre-construction Phase

Prior to commencement of construction earthworks, various pre-construction activities would be undertaken. These would include:

- design finalisation and the issue of tender documentation for key infrastructure components (e.g. electricity supply requirements, dredge and primary gravity concentration unit);
- development of environmental management plans (Section 4); and
- ordering long lead supply items.

General Construction Phase

The general construction phase would involve the installation and commissioning of surface facilities to allow access to the orebody and the commencement of mining. An approximate 15 month construction period would be expected.

Procedures for controlling surface disturbance would 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. Details of these management activities are provided in Sections 4.2.3 and 4.5.3.

Various contractors would be employed during the construction phase. Contractors would be required to operate in accordance with BEMAX's Environmental Policy (Section 1.2.2). Further, an environmental education programme would be included in contractor inductions.

Towards the end of the construction phase, surface infrastructure components would be tested and commissioned. This would involve the commissioning of the dredge, primary gravity concentration unit, overburden removal systems and water and sand residue management components.

An overview of activities scheduled to occur during the construction phase for the mine site and ancillary infrastructure is provided below.

A provisional construction schedule for the Snapper Mine is presented in Table 2-1.

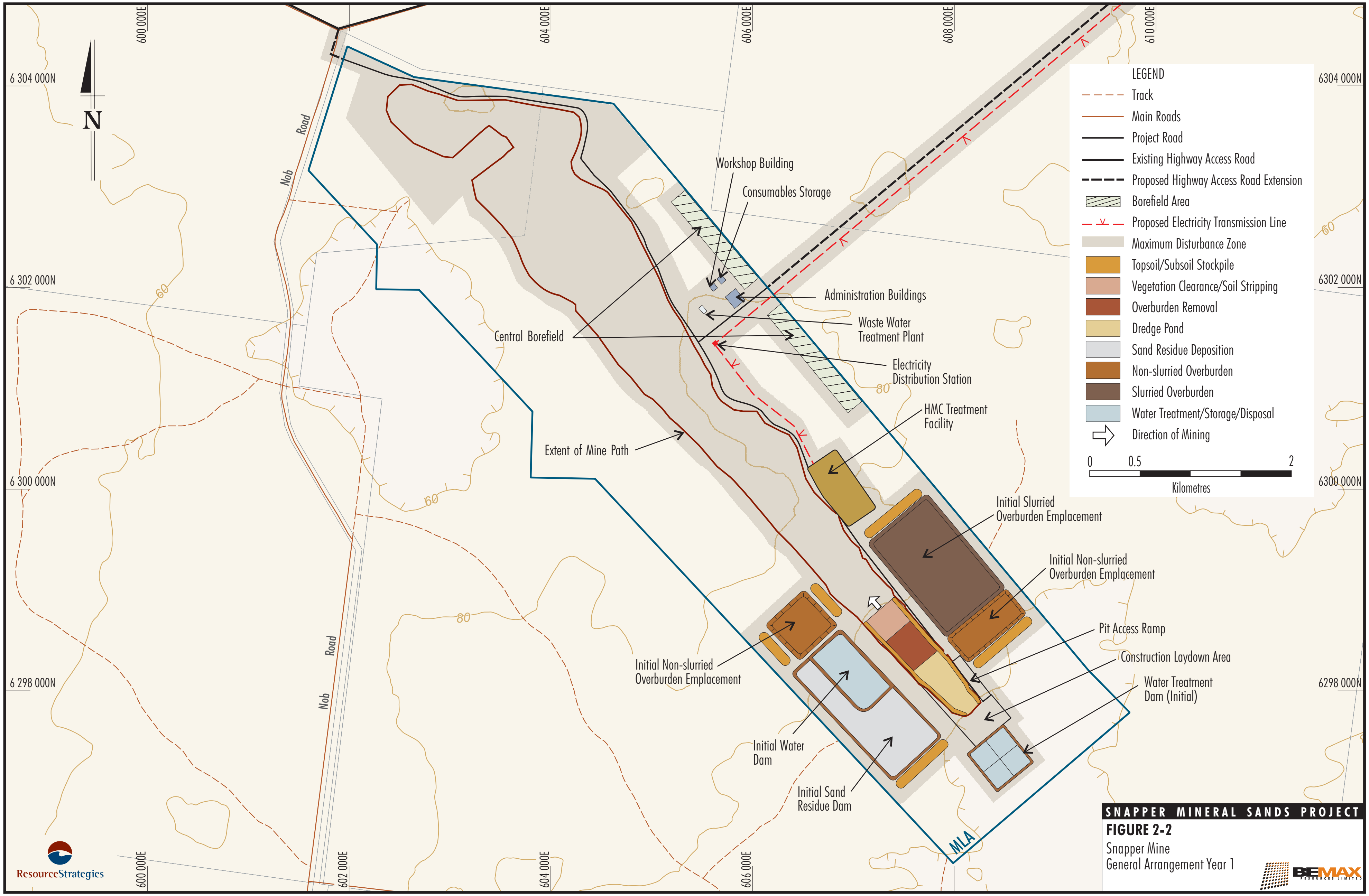

FIGURE 2-2
Snapper Mine
General Arrangement Year 1

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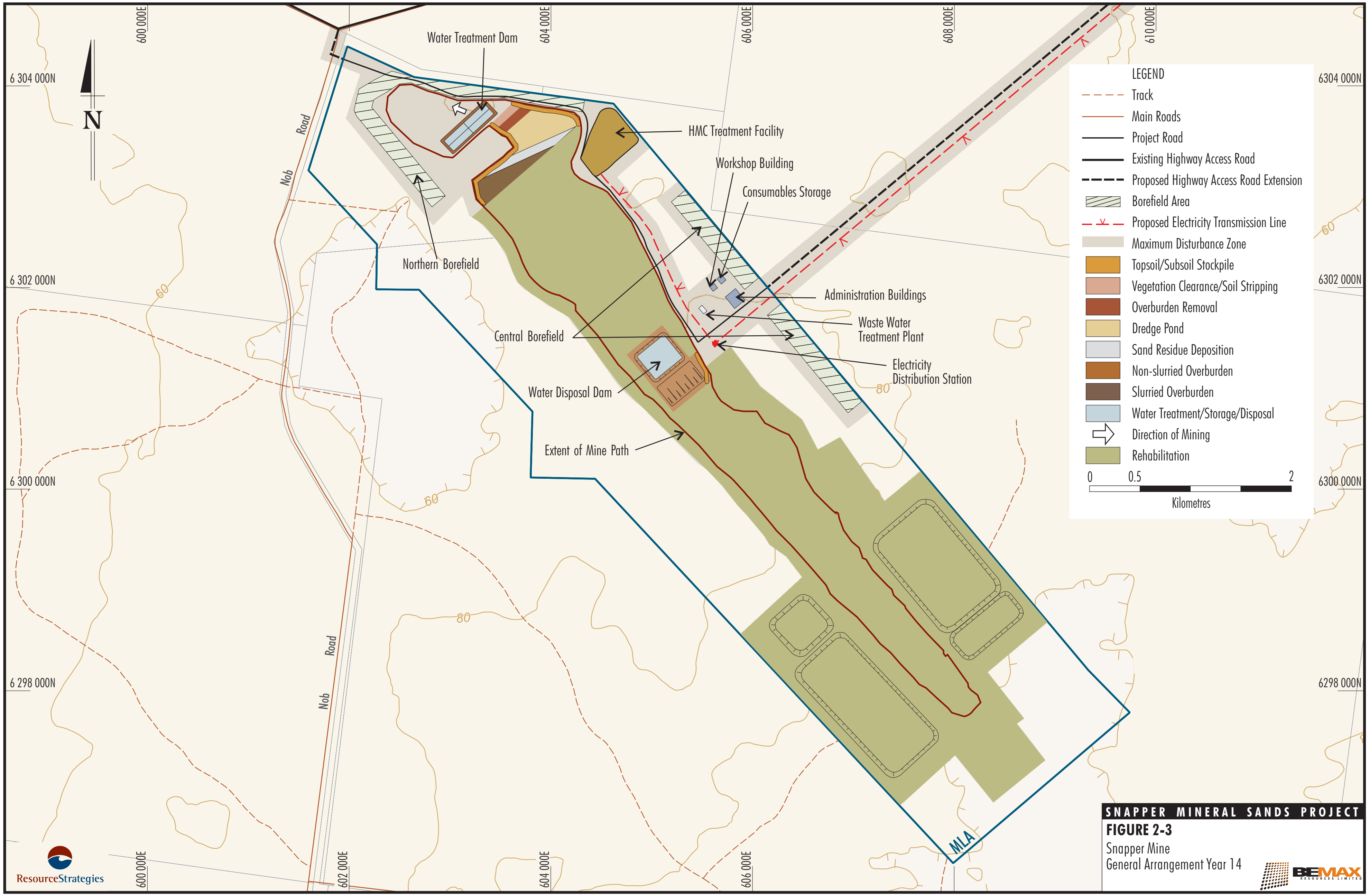

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FIGURE 2-3

Snapper Mine
General Arrangement Year 14

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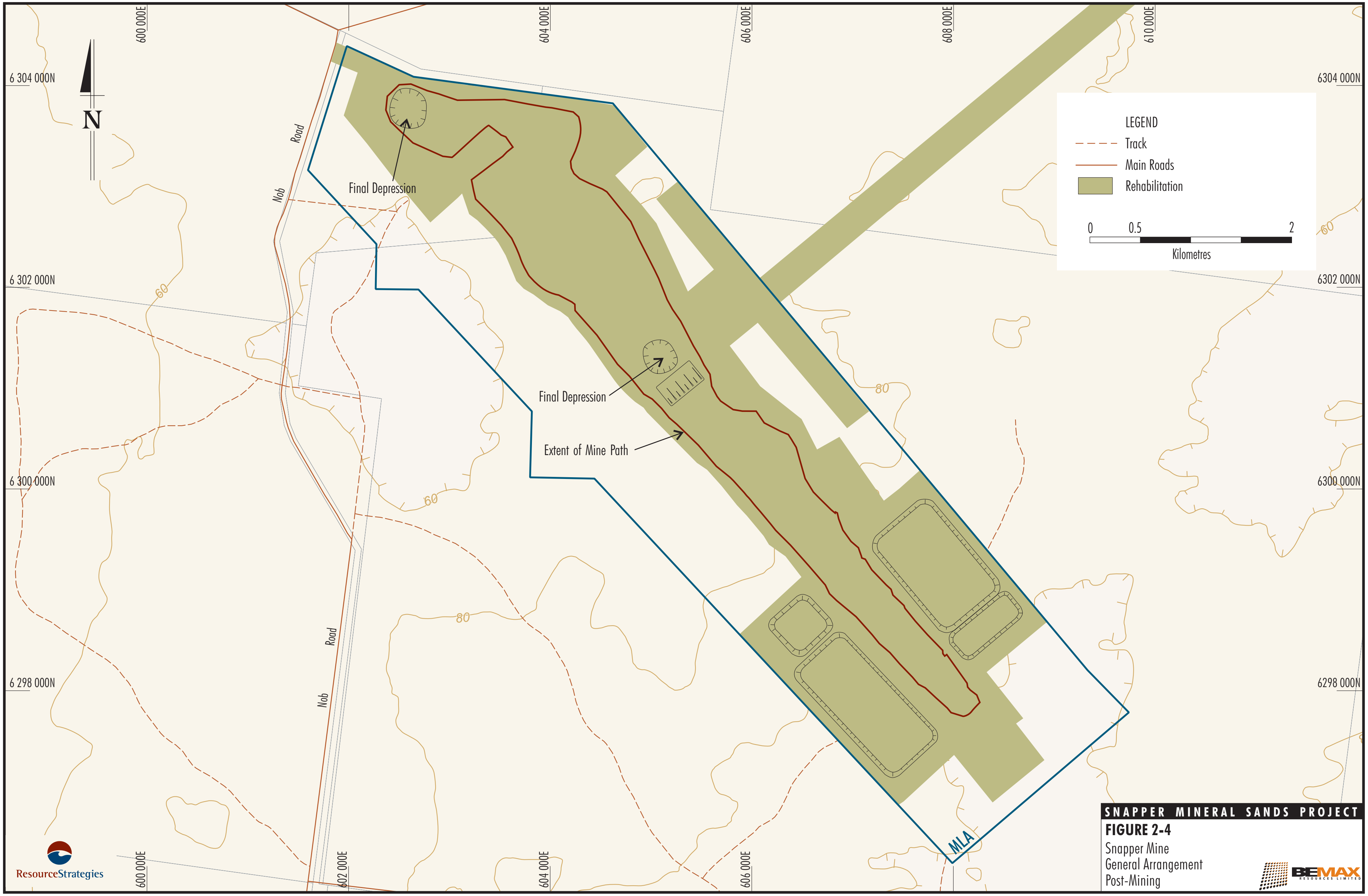

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FIGURE 2-4

Snapper Mine
General Arrangement
Post-Mining

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Table 2-1
Provisional Snapper Mine Construction Schedule

Activity	Snapper Mine Month															
	Pre-Cons	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Engineering Design																
Procurement of Major Items																
Expansion of Ginkgo Mine Accommodation Camp																
Access Road																
Roads																
Laydown Area																
Construction Pit																
Initial Overburden Emplacements																
Dredge and Primary Gravity Concentration Unit Design and Assembly																
Process Water Reticulation System																
Initial Sand Residue and Water Supply Dams																
Water Treatment Dam (Initial)																
ETL																
Overburden Removal																
Overburden Slurrying System																
Reverse Osmosis Plant																
Salt Washing Facility																
WHIMS																
Commissioning of the Dredge and Primary Gravity Concentration Unit																
Mineral Concentrate Production																

2.3.1 Mine Site

A description of the major construction activities at the mine site is provided below.

2.3.1.1 Vegetation Clearance and Soil Management

Campaign vegetation clearance and soil stripping of disturbance areas would be undertaken prior to the commencement of construction activities. Where practicable, soil stripping would be undertaken as a two pass operation to separate topsoil (containing higher levels of organic matter) from subsoil material which would be stockpiled in separate windrows. Where practicable, the top 5 to 10 centimetres (cm) of topsoil would be salvaged separately to the rest of the topsoil, to maintain the integrity of the cryptogamic soil crust and seed bank for rehabilitation.

2.3.1.2 Construction Pit

Subsequent to initial vegetation clearance, a 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 (see below). The initial pit would be developed by excavating some 3.5M cubic metres (m^3) of overburden using scrapers and dozers over an approximate six month period (Figure 2-2). This overburden would be used to construct initial water and sand residue dams, initial overburden emplacements and an initial water treatment dam adjacent to the mine path (Figure 2-2).

2.3.1.3 Dredge and Primary Gravity Concentration Unit

Construction of the dredge and primary gravity concentration unit would take approximately 15 months, with assembly occurring in the construction pit on a pad located approximately 1 m above the water table. The dredge and primary gravity concentration unit would be transported to the pad in component parts and assembled. When construction of these components is complete, the pad would be flooded with water from the initial water dam and the borefield to create a dredge pond (Section 2.7.2.1). This would enable the dredge and primary gravity concentration unit to be floated, ready to commence dredge mining.

2.3.1.4 Initial Water and Sand Residue Dams

An initial water dam would be constructed with overburden materials from the construction pit to store water pumped from the process water borefield during the construction period. The embankments and floor of the storage would be lined with clay to minimise water losses (Figure 2-5). The initial water supply and demand is described in Section 2.7.2.1.

An initial sand residue dam would be constructed to store residues that initially cannot be returned to the dredge pond behind the primary gravity concentration unit. The embankments and floor of the storage would be lined with clay to minimise water losses (Sections 2.4.6 and 4.4.3).

Figure 2-2 illustrates the location of the initial sand residue and water dams and Figure 2-5 provides conceptual construction detail of the dam embankments.

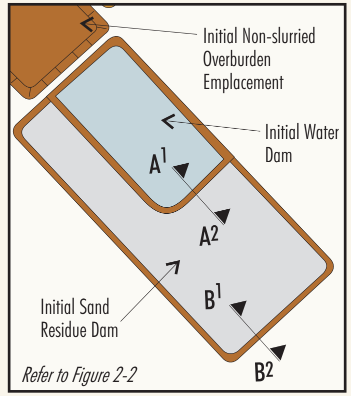
2.3.1.5 Initial Overburden Emplacements

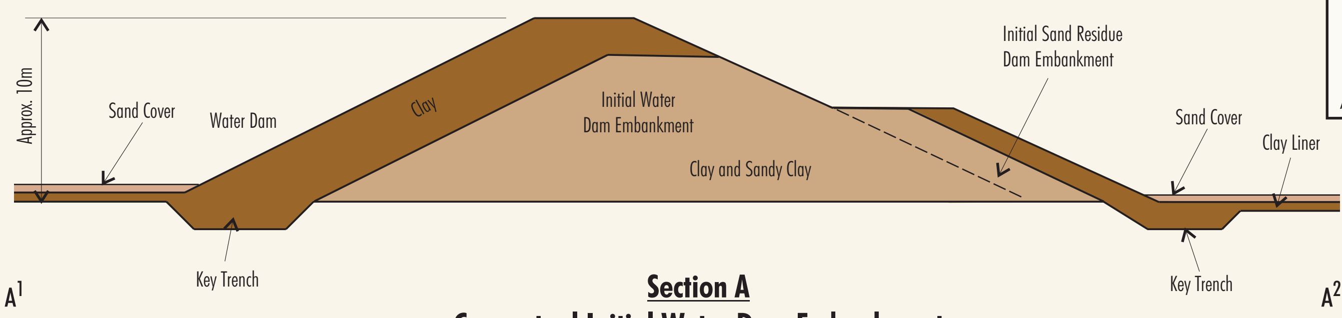
Three initial overburden emplacements would be constructed from overburden removed from the construction pit and stripped ahead of the dredge pond, namely an initial slurried overburden emplacement and two initial non-slurried overburden emplacements, one north and one south of the mine path (Figure 2-2).

The initial non-slurried overburden emplacements would store overburden materials which cannot be feasibly slurried. The embankments and floor of the initial slurried overburden emplacement would be lined with clay to minimise water losses (Sections 2.4.3 and 4.4.3).

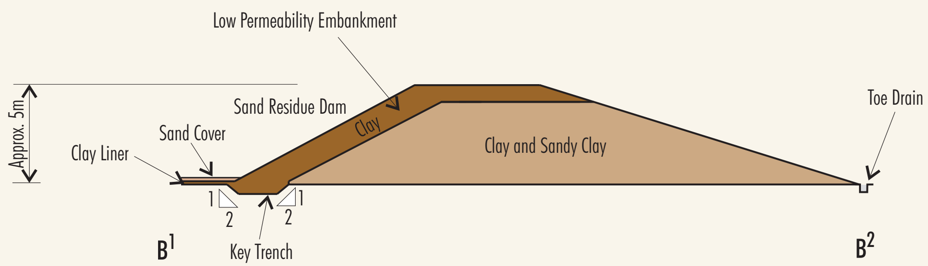
Construction of the initial non-slurried overburden emplacements would take place over a period of approximately three months. Removal of material (to construct the emplacements) from the area in front of the mine path would provide room to accommodate the installation of the overburden slurrying facility. Overburden stripping and emplacement construction during this initial period would be undertaken by a scraper fleet using conventional load, haul and paddock dumping techniques.

Rehabilitation of the initial slurried overburden emplacement would involve construction of a low permeability clay cap to minimise infiltration into the emplacement (Section 5.4.2).





Section A
Conceptual Initial Water Dam Embankment



Section B
Conceptual Initial Sand Residue Dam Embankment

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FIGURE 2-5

Initial Sand Residue Dam and Initial Water Dam - Conceptual Embankment Detail

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Figure 2-2 illustrates the location of the initial overburden emplacements and Figure 2-6 provides conceptual construction detail of the embankments of the initial slurried overburden emplacement.

2.3.1.6 RO Plant and Potable Water

The RO plant would be located at the HMC treatment facility for potable and process water requirements (Figure 2-2). Sections 2.7.2 and 2.7.3 describe process and potable water demand and supply.

2.3.1.7 Salt Washing Facility

The salt washing facility would be located at the HMC treatment facility (Figure 2-2).
Section 2.4.7.1 describes the requirement for this facility during operation.

2.3.1.8 WHIMS

The WHIMS would be located at the HMC treatment facility (Figure 2-2). Section 2.4.7.2 describes the requirement for the WHIMS during operation.

2.3.1.9 Water Treatment Dam

An initial water treatment dam south of the mine path (Figure 2-2) would be constructed to facilitate the removal of fines material which is collected in the process water from the primary gravity concentration unit through the dredging operation. The initial water treatment dam would comprise a series of clay-lined cells with walls approximately 4 m high. The cells would be used on a rotational basis to allow for continual treatment.

The initial water treatment dam would be decommissioned and rehabilitated as mining advances along the mine path.

As an alternative to the water treatment dam described above, process water containing the fines material may be pumped to purpose built cells within the deposited sand residue behind the dredge pond and treated in a similar manner. Section 2.7.4 describes the requirements for water treatment during operation.

2.3.2 Mineral Concentrate Transport Route

The haulage of mineral concentrate from the Ginkgo Mine to the MSP is currently undertaken by a haulage contractor operating a fleet of 55 tonnes (t) payload double road trains. Once the Snapper Mine is operational the haulage fleet and mineral concentrate transport route would be shared to truck mineral concentrate from both mines to the MSP. Either double road trains or other RTA-approved vehicles (e.g. AB-triple vehicles) would be used. BEMAX have an "in principle" agreement with the RTA to use AB-triple road trains. Such vehicles would be specially designed and constructed for the Ginkgo and Snapper Mines in consultation with the RTA.

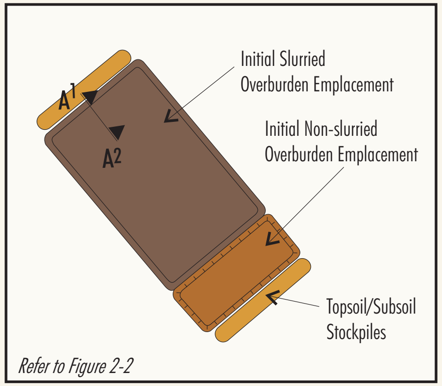
Road construction and upgrades (e.g. road intersection improvements) undertaken by BEMAX along the mineral concentrate transport route between the Ginkgo Mine and MSP have been designed and constructed to a standard appropriate for Class 12 triple road trains (although the use of vehicles larger than double road trains [e.g. AB-triple vehicles] would be subject to further consultation with the RTA, WSC and Broken Hill City Council [BHCC]).

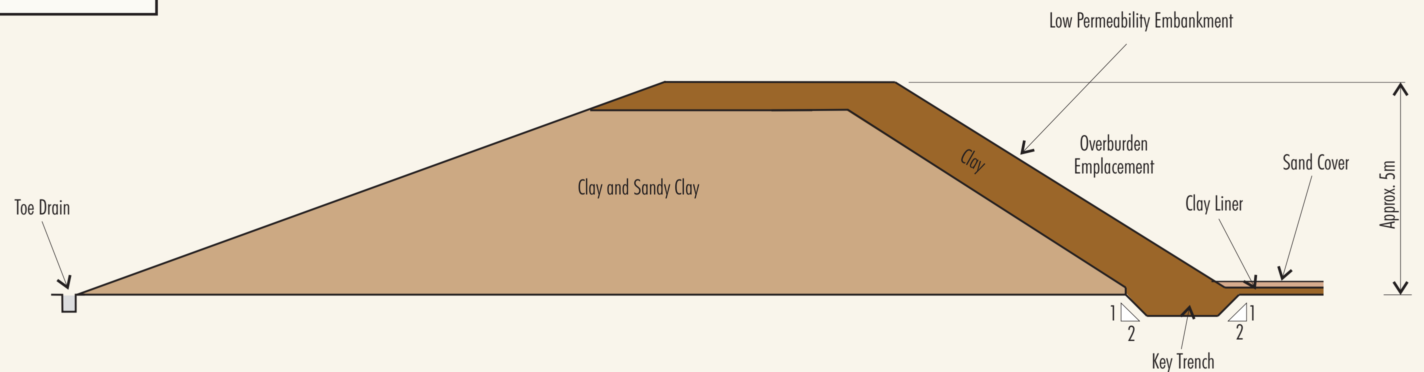
The HAR linking the Ginkgo Mine with the Silver City Highway comprises an unsealed road some 8 m wide. The HAR would be extended by approximately 1 km into the northern extent of the Snapper Mine site and by approximately 6 km to the eastern side of the mine site. These extensions would also be designed and constructed to the same standard as the existing HAR. No change to the geometry of existing intersections would be required to operate double road trains or AB-triple vehicles for the Snapper Mine.

2.3.3 ETL

The existing ETL to the Ginkgo Mine would be extended by approximately 10 km to service the power requirements of the Snapper Mine site (Figure 1-2).

The 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.





Section A
Conceptual Initial Slurried Overburden Emplacement Embankment

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FIGURE 2-6
Initial Slurried Overburden Emplacement - Conceptual Embankment Detail

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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. Easement requirements for the ETL would be negotiated with landholder(s) located along the route prior to construction, if required (Section 1.1.4 and Figure 1-3).

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 would include:

- survey and pegging of the ETL route and pole locations;
- installation of access gates (if required) in existing fences;
- supervised clearing of the ETL route and construction of access tracks/roads;
- digging of holes;
- fitting of poles with insulators etc. prior to standing;
- standing of poles;
- stringing/lifting and tensioning the electrical conductor and securing the conductors to the insulating posts at each pole; and
- rehabilitation of any significant disturbance areas.

An electricity distribution station would be located at the Snapper Mine site (Figure 2-2).

2.3.4 Construction Phase Transport Requirements

Transport activity during the approximate 15 month construction period would vary according to delivery requirements. Traffic would comprise light vehicles, heavy vehicles and a limited number of oversize vehicles. The potential impacts of this traffic on the local and regional road network and applicable impact mitigation measures are described in Section 4.8.

A number of overwidth, overheight or overweight heavy loads would be generated during the construction phase, however the number of these oversize loads would be relatively very small.

All such loads would be transported with the relevant permits, licences and escorts, as required by the regulatory authorities. The route for such oversize loads would be the same routes currently used for the Ginkgo Mine.

2.3.5 Accommodation Camp

An accommodation camp providing single quarters for up to 120 persons is located at the Ginkgo Mine site. The Ginkgo Mine accommodation camp currently comprises approximately 120 semi-demountable rooms, ablution and sewage facilities, laundry facilities, office, stores, kitchen and dining area as well as a wet mess and garden/recreation area.

The accommodation camp and associated services at the Ginkgo Mine site would be expanded to accommodate a total of approximately 350 persons (i.e. approximately 120 Ginkgo Mine operation workers, approximately 200 Snapper Mine construction workers and visitors). Following Snapper Mine construction, the camp would be reduced to accommodate approximately 250 persons including Ginkgo and Snapper Mine workers and visitors. The expansion of the camp would be undertaken within the currently approved area.

2.4 SNAPPER MINE OPERATION

2.4.1 Mining Method and Schedule

The Snapper mineral deposit is overlain on average by approximately 30 to 35 m of overburden, increasing at the northern end where the orebody dips to the north-west. This overburden overlies approximately 10 to 25 m of ore containing valuable heavy minerals. The standing water table lies at an average depth of 45 m below the ground level (or at an average RL of 34 m AHD).

The mining operation would comprise the following:

- clearance of vegetation and stripping of soils on a campaign basis ahead of the advancing mine operation;
- overburden stripping, slurrying and direct placement;
- predominantly dredge mining of ore by a conventional floating bucket wheel dredge located in the dredge pond;

- adjustment of dredge pond levels to maintain dredge access to the ore;
- supply of water from the borefields;
- disposal of water to the water disposal dam when lowering dredge pond levels;
- secondary mining of ore by conventional mobile equipment (i.e. dozers and/or scrapers), depositing ore in front of the dredge;
- ore concentration in the primary gravity concentration unit to produce HMC;
- stockpiling of HMC;
- supply of desalinated water from the RO plant for HMC salt washing;
- HMC separation via the WHIMS circuit either at the Snapper Mine or at the MSP, to produce three types of mineral concentrates (i.e. ilmenite-rich, leucoxene-rich and non-magnetic [rutile-rich and zircon-rich] concentrates);
- stockpiling of mineral concentrates;
- transport of HMC and/or mineral concentrates to the MSP;
- placement of wastes from the primary gravity concentration unit (i.e. sand residues) at the rear of the dredge pond as mining advances;
- treatment of process water to remove fines material (i.e. particles less than 53 microns in diameter);
- transport and placement of backloaded process waste from the MSP;
- replacement of overburden on top of sand residues; and
- staged replacement of soils and progressive rehabilitation.

Figures 2-7 and 2-8 provide plan and elevation illustrations of the mining process. Figure 2-9 provides a process flowsheet of the mining process. Further detail of the mining operation is provided in the following sections.

Mine Path

The Snapper Mine resource extends some 8 km in length and is up to approximately 1,200 m wide. An illustration of the mine path and conceptual cross-sections is provided on Figure 2-10.

Production Schedule

A provisional production schedule for the Snapper Mine life is provided in Table 2-2. The schedule for the Snapper Mine complements the schedule for the Ginkgo Mine (i.e. operation at the Snapper Mine would increase when ore grades at the Ginkgo Mine start to decline). The schedule shows the combined development of the Snapper and Ginkgo Mines and maximum annual production of approximately 650,000 tpa of concentrate. As shown in Table 2-2, the maximum rate of production from the Snapper Mine alone would be approximately 450,000 tpa.

The schedule presented in Table 2-2 provides for a conservative transport scenario (i.e. maximum road movements) whilst accounting for the maximum MSP capacity, haulage fleet capacities and travel times.

The Snapper and Ginkgo Mines would transport up to approximately 735,000 tpa of concentrate to the MSP after an initial period when ilmenite-rich concentrate would be stockpiled. Stockpiled ilmenite-rich concentrate would be transported when appropriate market conditions prevail.

2.4.2 Vegetation Clearance and Soil Management

Vegetation clearance and soil stripping would be undertaken on a campaign basis by a contractor. Stripping of topsoil to the appropriated depth would be guided by the landform type and depth to the carbonate layer to maximise topsoil recovery (Section 5.2.1).

Soils would be stockpiled along the margins of the mine path before being re-spread on rehabilitation areas. When climatic conditions are appropriate, soil stripping and rehabilitation works would be undertaken on a campaign basis and integrated as a single operation.

Where soils cannot be used directly in rehabilitation works, they would be stockpiled in windrows and seeded with suitable grass and legume species to maintain soil viability for future rehabilitation works. Windrows of subsoil and topsoil would be kept separate.

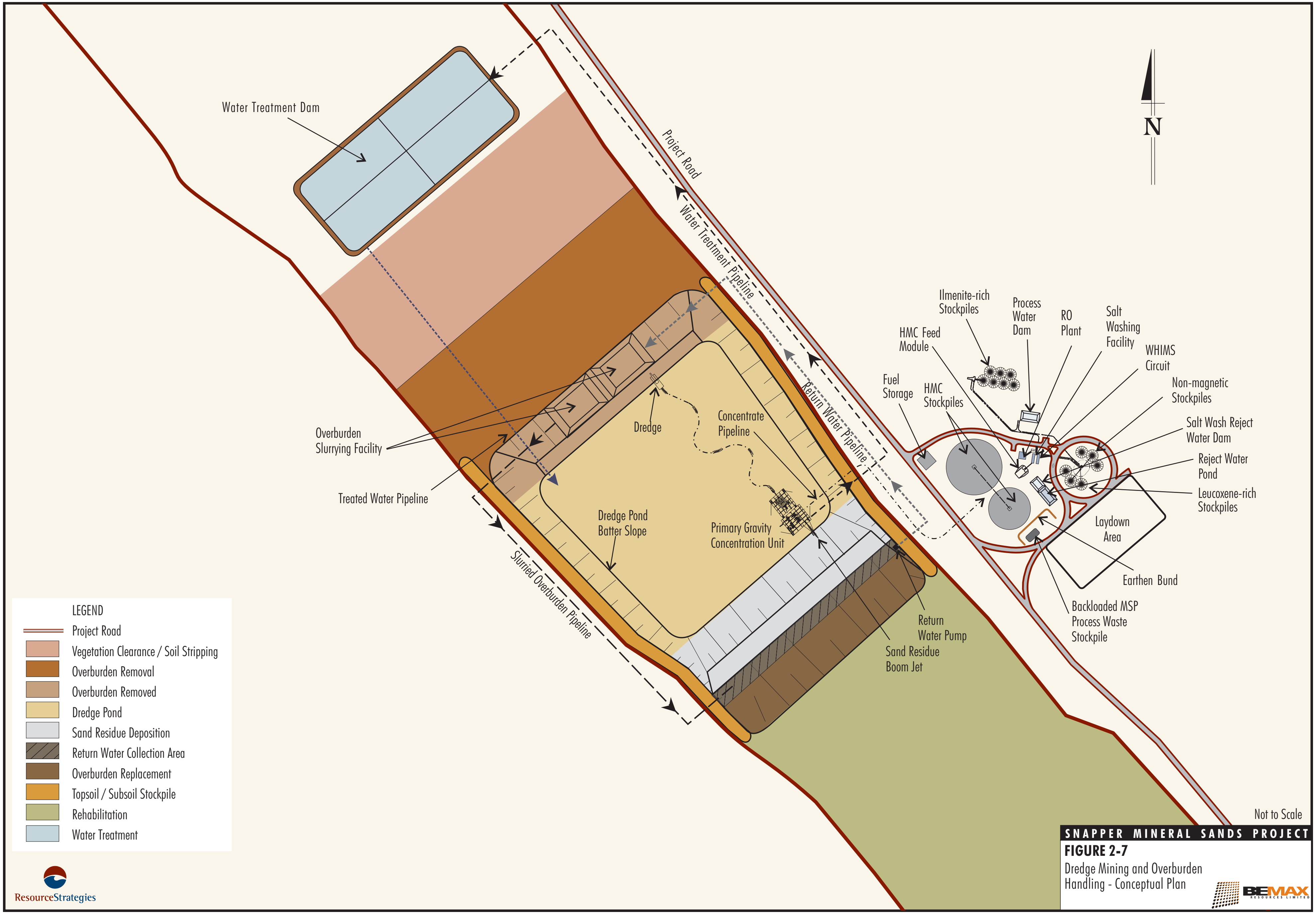

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FIGURE 2-7

Dredge Mining and Overburden Handling - Conceptual Plan

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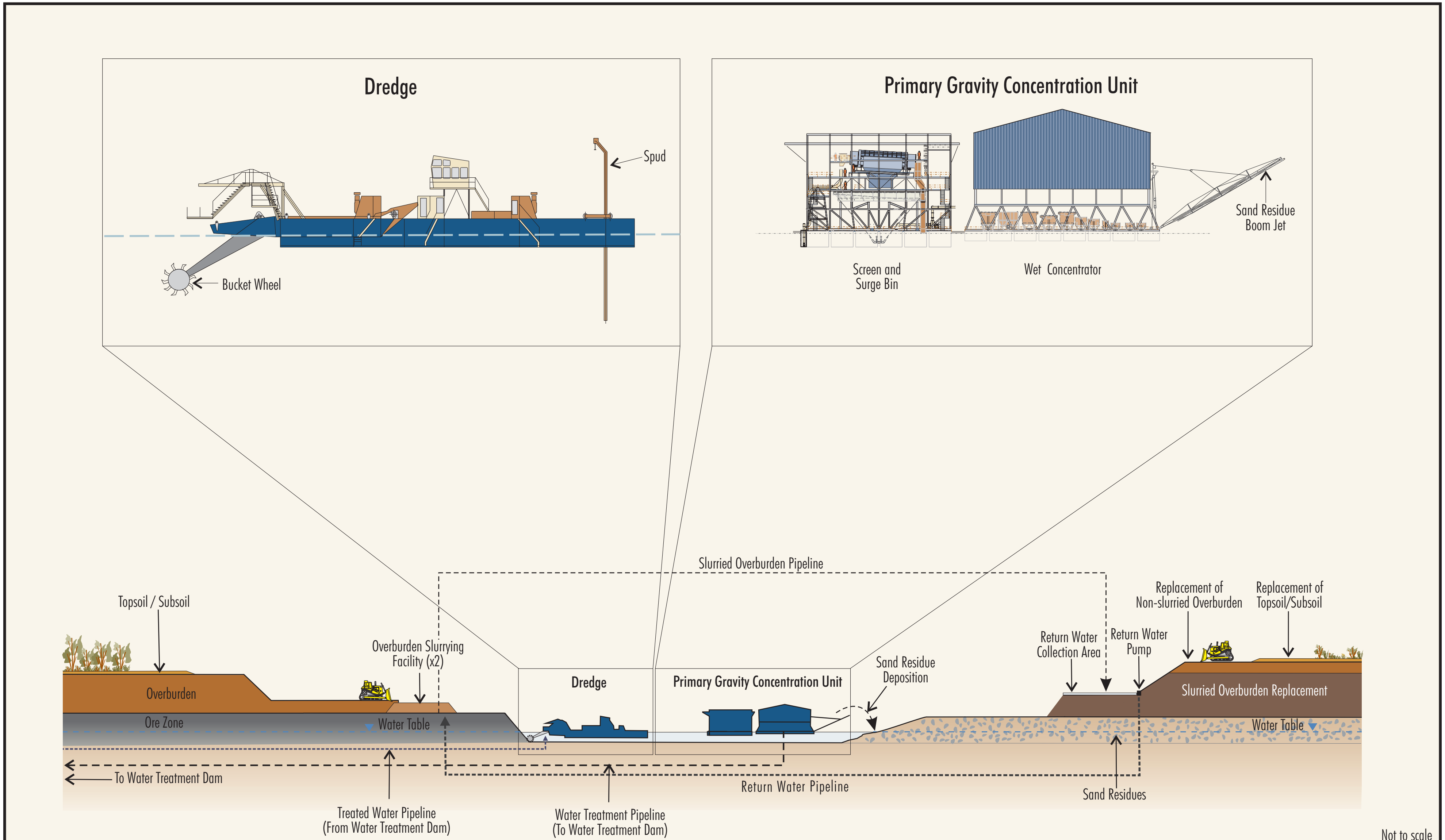

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FIGURE 2-8

Dredge Mining and Overburden Handling - Conceptual Section

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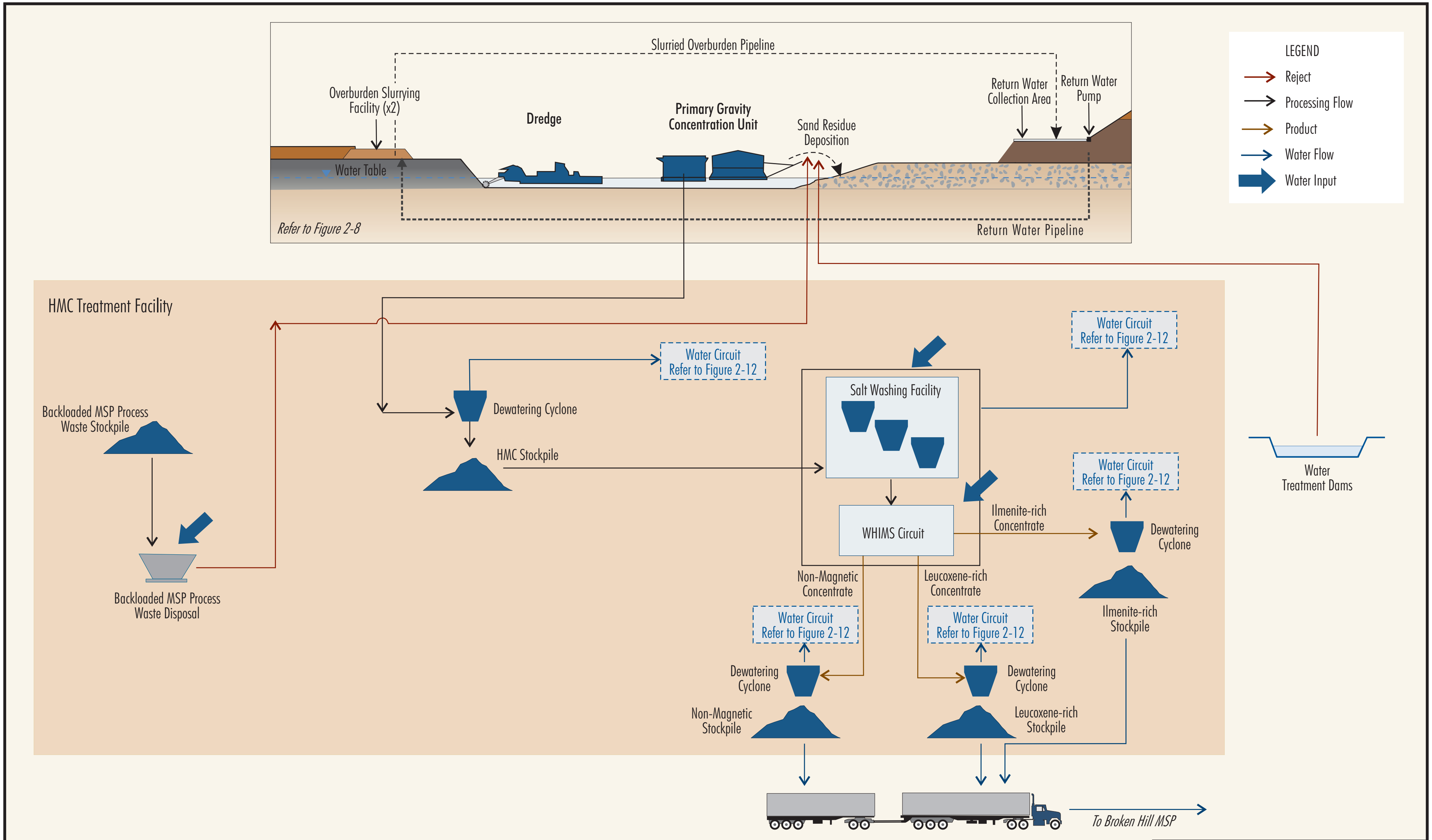

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FIGURE 2-9

Process Flowsheet

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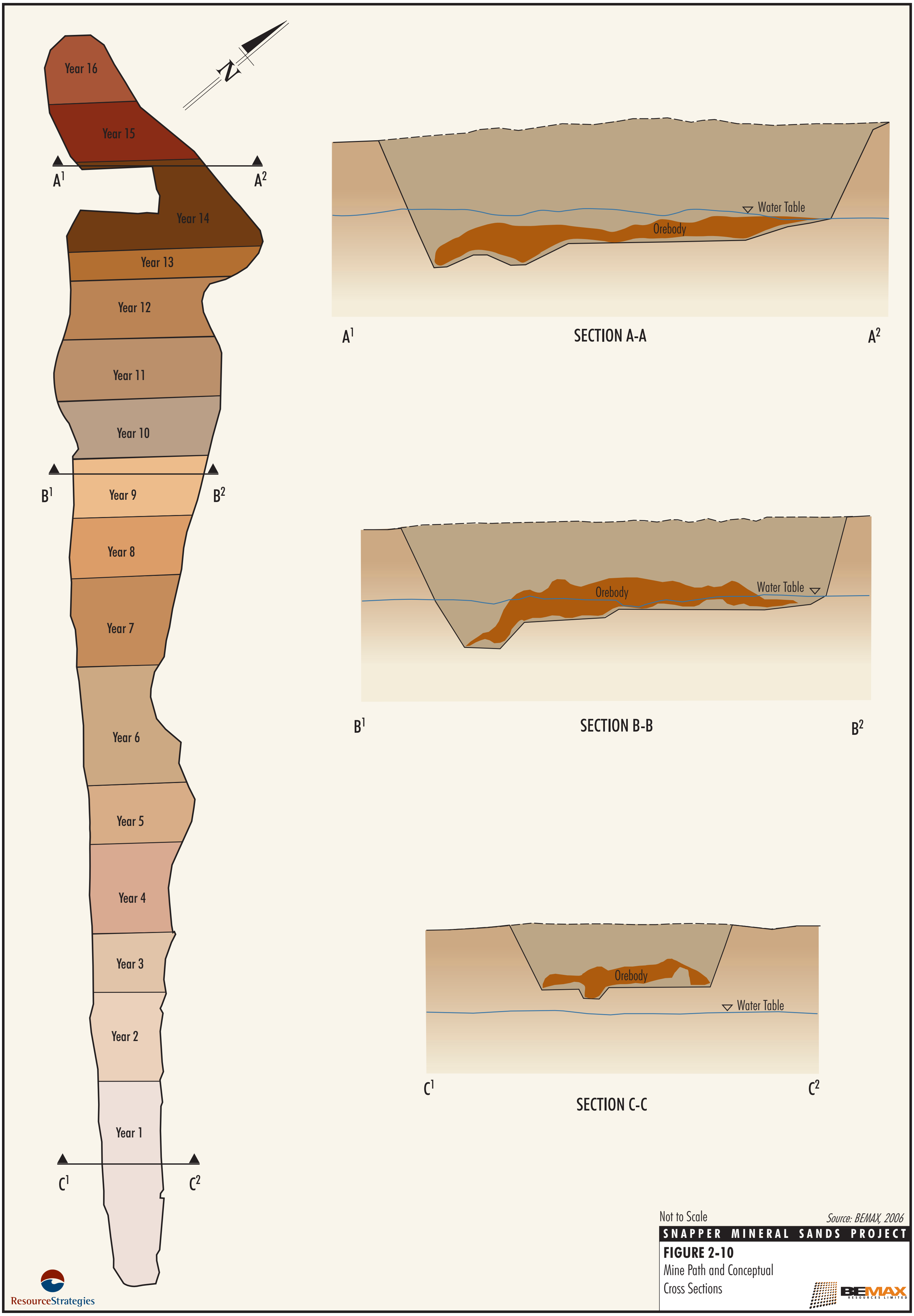

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Source: BEMAX, 2006

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FIGURE 2-10
Mine Path and Conceptual Cross Sections

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Table 2-2
Provisional Production Schedule*

Snapper Mine Development Year	Mineral Concentrate Production (kilotonne [kt])			Mineral Concentrate Transport (kt)
	Ginkgo Mine	Snapper Mine	Total	Total
-	500	0	500	350
-	550	0	550	385
Construction	475	0	475	333
1	375	250	625	444
2	300	350	650	464
3	200	450	650	735
4	200	450	650	735
5	200	450	650	735
6	250	400	650	735
7	250	400	650	735
8	250	400	650	735
9	250	400	650	735
10	200	400	600	685
11	200	375	575	660
12	200	350	550	609
13	200	350	550	550
14	150	275	425	425
15	0	275	275	275
16	0	250	250	250
Total	4,750	5,825	10,575	10,575

Source: Appendix G

* Production and transport rates are indicative only.

2.4.3 Overburden Replacement

The five major *in situ* overburden units in the Snapper Mine area are characterised in Appendix H. The overburden would be replaced by a combination of slurrying and conventional load and haul methods. Replacement of the majority of the overburden would be undertaken by feeding the overburden to an overburden slurrying facility in which it would be screened, slurried and then pumped via a slurry pipeline behind the dredge pond and placed on top of the sand residues from the primary gravity concentration unit. Replacement of non-slurried overburden would be undertaken by removing it using conventional earthmoving equipment and placement directly on top of the slurried overburden. The type and amount of overburden to be slurried would be dependent on its clay content. Rehabilitation of the mine path and other Snapper Mine landforms is discussed further in Section 5.

For the initial period during start-up, when there is insufficient area behind the dredge pond, slurried overburden would be deposited in the initial slurried overburden emplacement (Section 2.3.1.5 and Figure 2-2). During this initial period, non-slurried overburden would be placed in the initial non-slurried overburden emplacements (Section 2.3.1.5).

The water for the overburden slurrying facility would be sourced from the dredge pond and water draining from the deposited slurry (i.e. return water collection area). Further details on the water management associated with the overburden slurrying facility are provided in Section 2.7.2.

Seepage Controls

To minimise the potential for seepage from the initial slurried overburden emplacement, control measures would be implemented in accordance with the Hydrogeological Assessment (Appendix A). In summary, seepage management design measures would comprise those set out below:

- A clay liner which would be compacted to minimise seepage through the base of the emplacement. The clay liner would be covered with clean sand material (track rolled) to prevent cracking or drying out of the liner prior to deposition of slurried overburden.
- The low permeability embankment would be constructed of clay, sandy clay, gravely clay and selected stockpiled material and placed in layers (Figure 2-6). The embankment would be compacted with the moisture content at placement chosen to optimise the permeability outcome.
- A toe drain/trench would be constructed on the downstream face of the embankment to collect runoff and/or seepage (Figure 2-6).

2.4.4 Dredge Mining

Dredge mining has been selected as the most efficient method of mining the Snapper mineral deposit due to the location of the orebody with respect to the standing groundwater table, the presence of suitable groundwater resources for additional process requirements and the physical characteristics of the sands that make up the orebody.

The floating dredge would be approximately 50 m long, 10 m wide and have a draft of approximately 5 m (Figure 2-7). The dredge would mine the ore in a pond approximately 300 m long and as wide as the ore within the mine path. The dredge would consist of a rotating bucket wheel to cut/collect the ore and deposit it at the suction pipe inlet to the dredge pump. Geotechnical investigations indicate that the ore would be relatively free flowing and would form a slope of approximately 20 degrees (^{o}) below the water. The dredge would collect the ore from the base of this slope. The dredge pump would have a maximum throughput of approximately 1,000 tonnes per hour (tph) (solids).

The level of the dredge pond would vary according to the level of the existing groundwater table relative to the orebody. In order to maintain dredge access to the orebody and minimise dilution, the dredge pond level would be altered as required through water supply from the borefield (Section 2.7.2.1). Towards the northern end of the mine path, the orebody dips below the 20 m dredging range of the dredge's bucket wheel ladder. This would require the dredge pond to be lowered by approximately 10 m, by extracting water from the dredge pond and/or via the northern borefield (Figure 2-3), when mining occurs in this area. The excess water would be pumped to the water disposal dam, where it would seep back to the groundwater table (Section 2.7.2.1). Lowering of the groundwater table at the northern end before mining also facilitates the stripping of waste which lies below the present groundwater table level.

The rotating bucket wheel of the dredge would be located on a ladder that can be raised or lowered according to the depth of the orebody below the dredge pond level and to provide access for maintenance (Figure 2-8). Movement of the dredge within the pond would be achieved by a combination of winches and anchors for lateral movement and use of "spuds" for forward or backward movement within the pond. A spud is a tube that is lowered onto the base of the pond to provide a pivot point for dredge movement (Figure 2-8). The dredge would be semi-automated for swing control, pump speed, wheel rotation and swing winches and would require a single operator.

The dredge would pump ore slurry to the primary gravity concentration unit via a 200 m long pipeline located on a series of pontoons. The pontoons would also be used for access between the primary gravity concentration unit and the dredge. All slurry pumps and pipelines would be rubber-lined to resist abrasion.

A floating work barge would be located permanently in the dredge pond to carry out repairs to any floating equipment, change bucket wheel teeth as required and assist with maintenance activities.

2.4.4.1 Primary Gravity Concentration Unit

Primary separation of the valuable minerals would occur in a primary gravity concentration unit located behind the dredge within the pond (Figure 2-8). Figure 2-11 provides a schematic flowsheet of the primary mineral separation that would occur in the primary gravity concentration unit.

The dredge would deliver the ore slurry containing up to 45% solids to the primary gravity concentration unit (Figure 2-8). The ore feed material would comprise unconsolidated sands with a 2-3% very fine particle content (e.g. clays) and minimal oversize material. A screen above a surge bin within the unit would reject coarse material (> 3 millimetres [mm]), which would be returned to the pond to be covered later by sand residues. The surge bin would provide a buffer storage to maintain consistent feed rate and pulp density to the subsequent concentration circuits. Backloaded MSP process waste would be introduced to the sand residue stream at the surge bin. Section 2.6.2 contains further detail about the handling of backloaded MSP process waste.

The ore slurry would be transferred to a gravity separation circuit by pumps located in the bottom of the surge bin. Twin conventional gravity concentration circuits would separate valuable minerals from sand residues in spiral separators with the use of water sourced from the dredge pond.

The primary gravity concentration unit would be connected to the bank of the dredge pond by a pontoon bridge that would carry the mineral concentrate pipeline, water pipeline and provide access. All electrical power would be provided at either 22 kV or 11 kV through a trailing cable from a relocatable transformer on the bank of the dredge pond.

The primary gravity concentration unit would be manoeuvred in the pond in accordance with dredge movement and sand residue stacking requirements by four winches, one on each corner of the primary gravity concentration unit pontoon. The winch cables would be attached to anchors that would be periodically relocated in accordance with the unit's advance along the mine path.

Many of the unit's functions would be automatically controlled, however, mineral recovery and concentrate grade control would be determined by the unit operators who would use manual adjustment of the spiral concentrator settings to achieve optimum mineral recoveries.

The primary gravity concentration unit would produce a mineral concentrate comprising approximately 94% valuable heavy minerals. The mineral concentrate would principally contain ilmenite, leucoxene, rutile and zircon. The mineral concentrate recovered by the primary gravity concentration unit would be pumped as a slurry to the shore-based HMC treatment facility located adjacent to the mine path (Section 2.4.7).

2.4.5 Secondary Mining

Secondary mining of ore would be undertaken 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. This mining method would supplement dredge mining and involve relatively insignificant volumes of ore. Secondary mining would involve the use of conventional mobile equipment (i.e. dozers and/or scrapers) depositing ore in front of the dredge. Overburden removed utilising the secondary dozer push mining method would be replaced as described in Section 2.4.3.

2.4.6 Sand Residue Disposal

The dredge pond would be progressively enlarged until it reaches its design dimensions. During this period, the initial sand residue dam would be used to contain barren sand material that cannot be returned behind the dredge pond. This material would rapidly settle out and supernatant water would be returned to the dredge pond.

Once the dredge pond reaches design dimensions, sand residues would be stacked directly into the back of the dredge pond either through the sand residue boom jet located at the rear of the primary gravity concentration unit (Figure 2-8) or via a pipe along the pond surface.

Seepage Controls

The seepage control measures and monitoring for the initial slurried overburden emplacement (Section 2.4.3) would also be adopted for the initial sand residue dam.

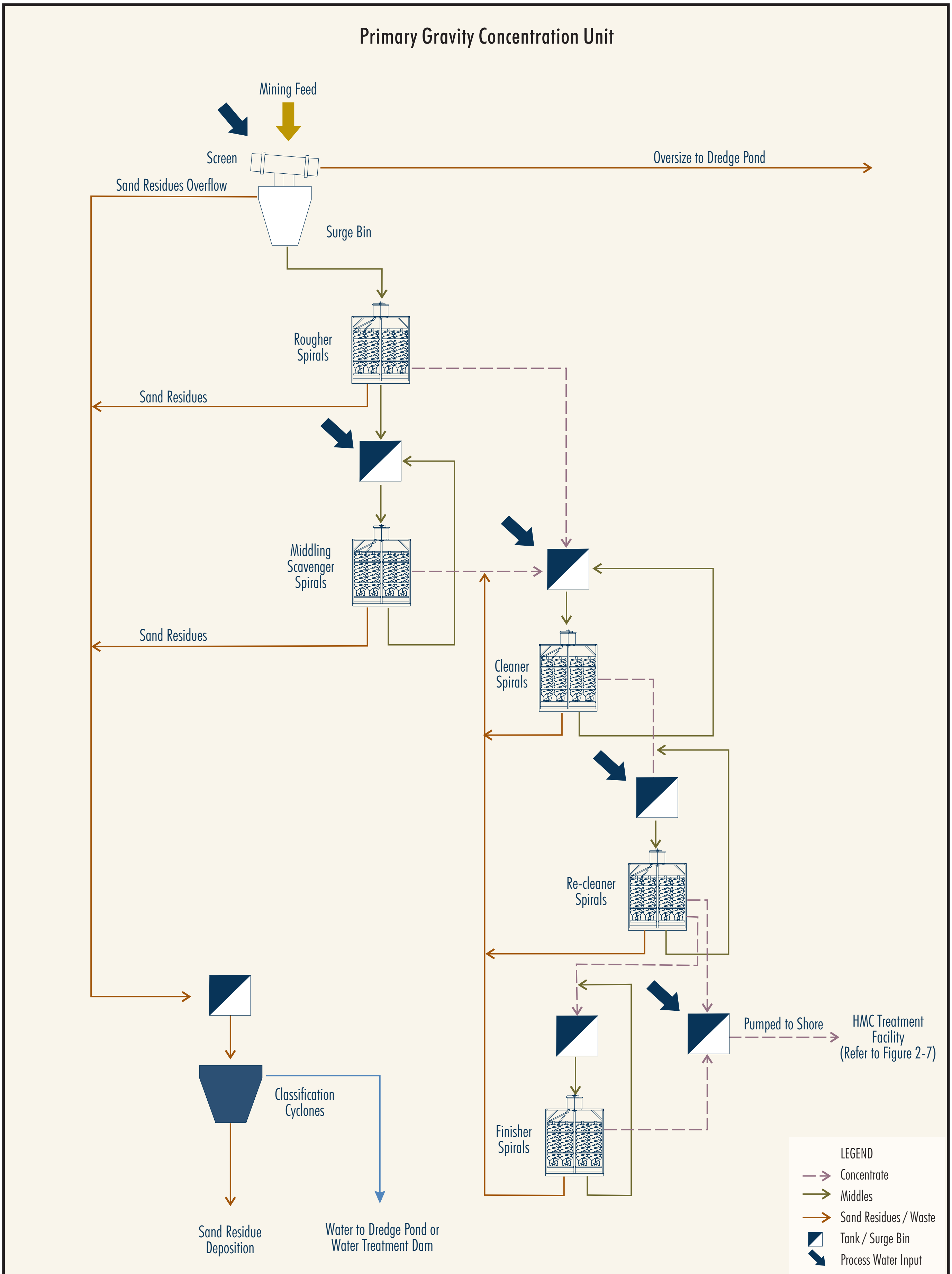

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FIGURE 2-11

Primary Gravity Concentration Unit - Process Flowsheet

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2.4.7 Mineral Concentrate Handling

The ore recovered by the primary gravity concentration unit would be pumped as a mineral concentrate slurry to the shore-based HMC treatment facility located adjacent to the mine path (Figures 2-2 and 2-9). In addition to the ilmenite-rich, leucoxene-rich and non-magnetic concentrate stockpiles, the HMC treatment facility would include (Figure 2-7):

- a salt washing facility;
- a WHIMS circuit; and
- a RO plant.

These components are described below.

2.4.7.1 Salt Washing Facility

Due to the saline nature of the groundwater at the Snapper Mine site (Appendix A), HMC pumped from the primary gravity concentration unit would have a high salt content. Residual salt in the HMC would inhibit the efficiency of subsequent separation which, in part, involves electrostatic separation. The mineral concentrate would therefore be washed with desalinated water (Section 2.4.7.3) prior to transport to and further processing at the MSP. The salt washing facility would be relocatable and positioned adjacent to the mine path (Figure 2-3).

The salt washing facility would utilise desalinated wash water provided by the RO plant (Section 2.4.7.3). Reject water from the salt washing facility would be contained within the salt wash reject water dam and subsequently used to produce a backloaded MSP process waste slurry, where required (Section 2.7). 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 (Figures 2-3 and 2-9).

2.4.7.2 WHIMS Circuit

Following salt washing (Section 2.4.7.1), the mineral concentrate would be pumped into the WHIMS circuit (Figure 2-9). WHIMS is the preliminary mineral concentrate treatment stage which separates the mineral concentrate into ilmenite-rich, leucoxene-rich and non-magnetic concentrates (containing rutile-rich and zircon-rich concentrate). The WHIMS circuit relies on magnetic separation and requires no chemical reagents. A WHIMS circuit is approved for the early years at the Ginkgo Mine and the latter years at the MSP. A WHIMS circuit would also be utilised at the Snapper Mine.

Water requirements for the WHIMS circuit are discussed in Section 2.7.

The WHIMS circuit would be located within the HMC treatment facility adjacent to the mine path (Figure 2-2).

Table 2-3 presents a summary of the major components associated with the WHIMS circuit.

Following separation through the WHIMS circuit on-site, ilmenite-rich, leucoxene-rich and non-magnetic concentrates would flow through product stackers to the mineral concentrate stockpile area. The leucoxene-rich and non-magnetic concentrates would then be transported to the MSP. The ilmenite-rich concentrate would be stockpiled and transported to the MSP during the latter years, or it would be transported for sale without further processing (depending upon prevailing market conditions), subject to relevant approvals being obtained.

Table 2-3
Summary of WHIMS Circuit Components

WHIMS Component	Function/Description
Magnetic Separators	Primary gravity separation of magnetic and non-magnetic materials using high intensity magnets.
De-watering Cyclones	De-watering of concentrates prior to stockpiling.

After: BEMAX (2001a)

2.4.7.3 *RO Plant*

A RO plant would supply desalinated water to the salt washing facility and WHIMS circuit, and potable water for the administration buildings (Figure 2-12). The borefields would supply water to the RO plant (Figure 2-3).

Water requirements for the RO plant are discussed in Section 2.7. 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.

2.4.8 Mineral Concentrate Transport

As stated in Section 2.3.2, the transport of mineral concentrate from the Ginkgo Mine site to the MSP is currently undertaken by a haulage contractor operating a fleet of 55 t payload double road trains. Mineral concentrate transport from the Ginkgo Mine to the MSP is being undertaken in accordance with the *Ginkgo Mineral Sands Mine and Broken Hill Mineral Separation Plant Traffic Code of Conduct* (Ginkgo Mine and MSP TCC) (BEMAX, 2006b) and the *Ginkgo Mineral Sands Mine and Broken Hill Mineral Separation Plant Transport of Hazardous Materials Plan* (Ginkgo Mine and MSP THMP) (BEMAX, 2006c). The haulage fleet and mineral concentrate transport route would be shared to truck mineral concentrate from the Ginkgo and Snapper Mines to the MSP. Either double road trains or other RTA-approved vehicles (e.g. AB-triple vehicles) would be used to transport mineral concentrate from the Snapper and Ginkgo Mines to the MSP. BEMAX have an "in principle" agreement with the RTA to use AB-triple road trains. Vehicles would be specially designed and constructed for the Snapper Mine in consultation with the RTA. The abovementioned Ginkgo Mine and MSP TCC and Ginkgo Mine and MSP THMP would be updated to include haulage activities relevant to the Snapper Mine prior to commencement of transport of materials between the Snapper Mine and the MSP.

Once the HMC is pumped ashore from the primary gravity concentration unit and treated through the salt washing facility and WHIMS, it would be transferred to the mineral concentrate stockpile area and dewatered to approximately 6% water content for subsequent haulage to the MSP for further treatment. Haulage vehicles would be loaded by a front end loader at the stockpile. Haulage trucks would be fitted with side tipping trays to minimise the potential for spillage. Loads would be covered by tarpaulin to minimise the potential loss of heavy minerals during transport.

During operation of the Snapper Mine, transport of mineral concentrate to the MSP would increase (beyond the existing number of trips from the Ginkgo Mine), given the increase from the approved concentrate haulage of 576,000 tpa for the Ginkgo Mine alone to the combined concentrate haulage of approximately 735,000 tpa from the Snapper Mine and Ginkgo Mine. The frequency of double road train movements would increase from approximately 26 trips per day (52 vehicle movements per day) to a maximum of approximately 37 trips per day (74 vehicle movements per day). If larger vehicle types (e.g. AB-triple haulage vehicles) are used, movement frequencies would be less.

The estimated haul profile to the MSP via the mineral concentrate transport route includes a six hour round trip and a requirement for up to approximately thirteen double road trains to be operating at any one time (based on approximately 37 trips per day). A proportion of the haulage vehicles would backload MSP process waste (Section 2.6.2) from the MSP to the Snapper Mine. Disposal of these wastes is discussed in Sections 2.6.2, 4.2.2 and 4.2.3.

Mineral concentrate haulage vehicles currently stop off the HAR in a designated truck stopping area to drop dust from wheels, prior to entering the Silver City Highway. This practice would continue for the life of the Snapper Mine or until the HAR is sealed.

2.4.9 Handling of Backloaded MSP Process Waste

The characteristics of the backloaded process waste from the MSP are described in Section 2.6.2.

Backloaded MSP process waste classified as hazardous under the *Protection of the Environment and Operations Act, 1997* (POEO Act) and the *Environmental Guidelines: Assessment Classification and Management of Liquid and Non-liquid Wastes* (DEC, 2004b) would be removed from the designated stockpile and placed in a hopper, mixed with wastewater from the salt washing facility, then transported to the primary gravity concentration unit via a slurry pipe, where it would be combined in a sump with sand residues from the spirals circuit. The combined sand residue and backloaded MSP process waste slurry would be deposited on the sand residue beach and/or with overburden and would be covered under a minimum of 10 m (up to 35 m) of overburden.

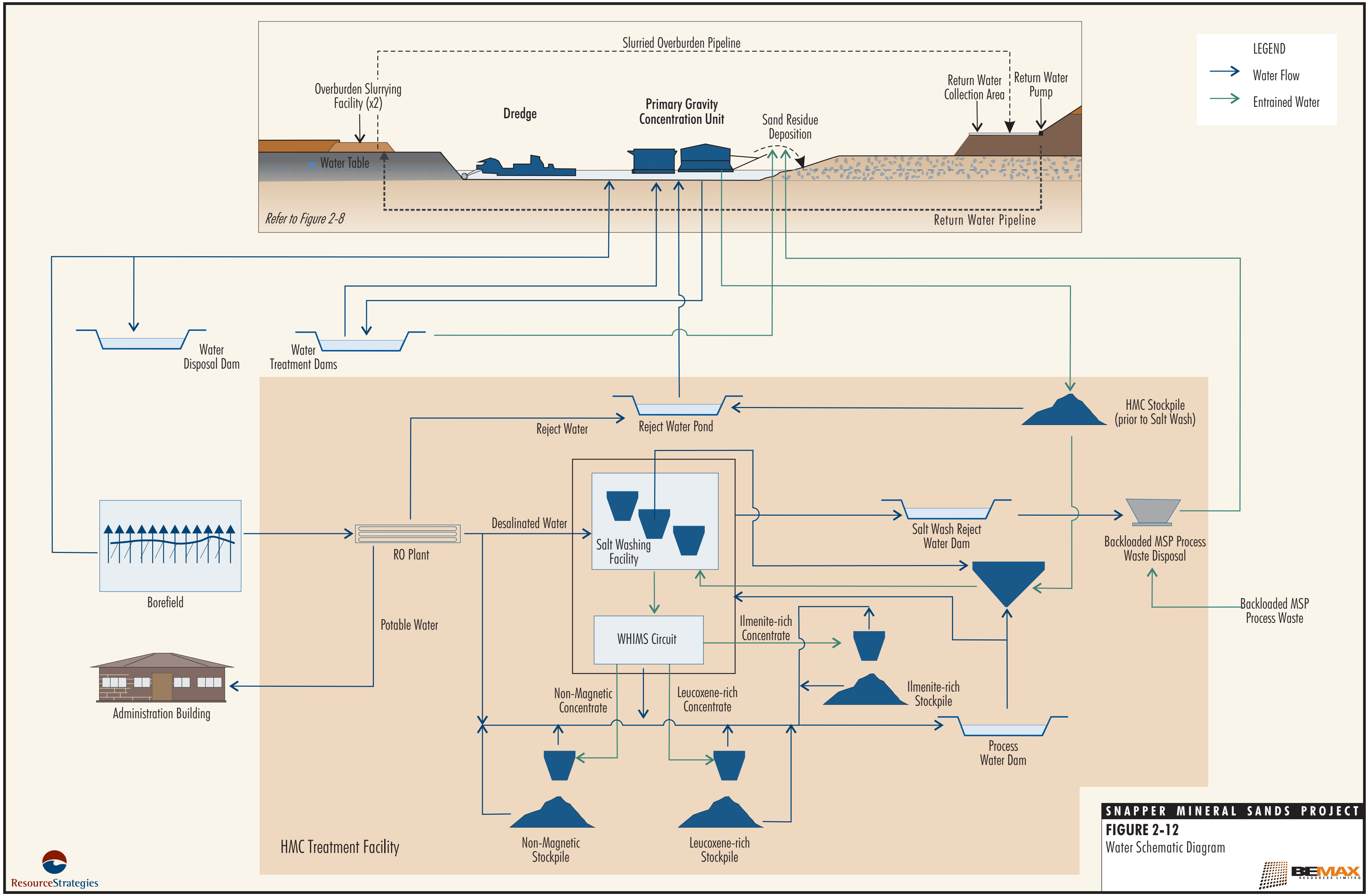

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FIGURE 2-12

Water Schematic Diagram

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Backloaded MSP process waste not classified as hazardous under the POEO Act and the *Environmental Guidelines: Assessment Classification and Management of Liquid and Non-liquid Wastes* (DEC, 2004b) would be removed from the designated stockpile and placed on the sand residue beach and/or with overburden and would be covered under a minimum of 10 m (up to 35 m) of overburden.

2.5 MOBILE EQUIPMENT

A provisional list of mobile equipment required at the mine site and for mineral concentrate transport over the Snapper Mine life is presented in Table 2-4. A similar operational mobile fleet would be utilised at the Ginkgo Mine. As stated in Section 2.4.8, the mineral concentrate haulage fleet (i.e. double road trains or other RTA-approved vehicles) would be shared between the Snapper and Ginkgo Mines.

2.6 MINE MATERIALS

2.6.1 Geochemical/Physical Characteristics

An evaluation of the physical and geochemical characteristics of each of the overburden units within the Snapper Mine path are provided in Appendix H. Appendix H presents the Acid Rock Drainage Assessment undertaken for overburden and ore samples collected during bulk ore sampling in September 2006. The geochemical properties of the sand residues would be essentially the same as the *in situ* ore.

A summary of the physical and geochemical characteristics of these materials is provided below.

Overburden

Overburden derived from the uppermost stratigraphic layers, the Woorinen and Shepparton Formations, have varying levels of soil conductivity, pH, boron and sodicity.

The older Loxton-Parilla Sands has three major recognized units – the Upper Loxton-Parilla Sands, Mica Sands and the Lower Loxton-Parilla Sands. These units have varying sodicity or Exchangeable Sodium Percentage (ESP) values (i.e. sodic to highly sodic) and generally high sulphur levels, neutral to slightly alkaline pH, negligible boron levels and moderate conductivity levels.

The Acid Rock Drainage Assessment (Appendix H) included 16 samples of overburden (four from the Woorinen formation; three from the Shepparton formation; five from the Upper Loxton-Parilla Sands; three from the Mica Sands [Loxton-Parilla Sands]; and one from the Lower Loxton-Parilla Sands). All of the overburden samples were classified as non-acid forming.

The five major overburden units mentioned above are further characterised in Appendix H. Appendix H also provides an assessment of the suitability of the overburden material for use in rehabilitation.

Ore and Sand Residues

The sand residues are the waste stream from the primary gravitational (i.e. physical) minerals separation process. The geochemical properties of the sand residues would be essentially the same as the *in situ* ore. The sand residues would be saline owing to the presence of entrained saline groundwater.

The Acid Rock Drainage Assessment (Appendix H) included one ore sample collected during bulk ore sampling. The sample analysed was classified as non-acid forming.

Appendix H provides an assessment of the suitability of the sand residue material for use in rehabilitation.

2.6.2 Backloaded MSP Process Waste

The backloaded MSP process waste is expected to have similar physical and chemical properties to the backloaded Ginkgo Mine MSP process waste. It is therefore assumed that the backloaded MSP process waste transported to the Snapper Mine would have approximately the same geochemical and radiation properties as the Ginkgo Mine backloaded MSP process waste.

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

Table 2-4
Provisional Equipment Fleet

Equipment	Primary Purpose	Number of Equipment	
		Construction	Operation
Backhoe	Miscellaneous works (e.g. roads, trenches, etc.)	1	1
Bobcat	Miscellaneous works (e.g. roads, trenches, etc.)	1	1
Bus	Transport of personnel between Snapper Mine and Ginkgo Mine accommodation camp	1	1
Crane	Maintenance/moving equipment	8	4
Dozer	Overburden excavation/replacement, secondary mining	7	7
Excavator	Overburden excavation/replacement	2	2
Front End Loader	Loading haulage vehicles/multi-purpose	1	3
Mobile Fuel Tank	Refuelling equipment	1	1
Stationary Genset (Diesel)	Back-up power generation	8	3
Grader	Overburden contouring, road grading	2	2
Multi-Purpose Service Vehicle	Servicing equipment	2	2
Light Vehicle	Transport of personnel	50	25
Lighting Tower	Diesel-generated floodlight	8	6
Scraper	Soil, overburden excavation/replacement and secondary mining	9	9
Scraper (Water Cart)	Dust suppression	1	1
Maintenance Truck	Maintenance	1	1
Overburden Slurrying System (Dozer Trap) (Feed conveyor, hopper and slurrying unit)	Slurrying overburden	0	2
Service Truck	Servicing equipment	3	3
Truck	Servicing excavators	6	0
Water Truck	Dust suppression	1	2
Garbage Truck	Compacting garbage	1	1
Forklift	Miscellaneous (e.g. movement of goods)	2	0
55 t Payload Double Road Trains (fleet shared with the Ginkgo Mine)	Mineral concentrate haulage	0	13
65 t Payload AB-Triple Vehicles (fleet shared with the Ginkgo Mine) (example fleet subject to approval)	Mineral concentrate haulage	0	11

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

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

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

The monazite fraction of the backloaded MSP process waste, which concentrates in the zircon waste stream, would determine the activity levels (i.e. a measure of radioactivity) of backloaded MSP process waste (BEMAX, 2006d).

Based on Ginkgo Mine mineral concentrate (BEMAX, 2006d), the total activity of the zircon waste stream, without mixing with other MSP process wastes or rejects is likely to be less than 450 becquerels per gram (Bq/g) and the backloaded MSP process waste would have a total activity level of approximately 125 Bq/g during the early years of MSP operation and increase to approximately 190 Bq/g during its latter years. Assuming similar physical and chemical properties to the Ginkgo Mine backloaded MSP process waste, the zircon waste stream and the backloaded MSP process waste transported to the Snapper Mine would be classified as hazardous wastes (i.e. total activity greater than 100 Bq/g) under the POEO Act and radioactive under the *Radiation Control Act, 1990* (RC Act).

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

The combustion of coal during the latter years of the MSP operation would produce an ash waste material which would also be backloaded although in relatively minor quantities. In accordance with MSP licence requirements, prior to the commencement of backloading MSP process waste containing ash waste by-product, testwork would be undertaken to determine the composition of the ash waste material.

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

The management measures relevant to the backloaded MSP process waste are provided in Section 4.2.3 and the Process Waste Materials Assessment (Appendix I).

The handling of the abovementioned process waste materials is described in Section 2.4.9.

2.7 WATER MANAGEMENT

The Snapper Mine water management system would contain and control waters generated from Snapper Mine development and operation areas, while diverting other runoff water around such areas.

The water management system would include permanent features that would continue to operate post–mining and temporary structures that would only be required until the completion of rehabilitation works.

The system would be progressively developed as the mine path progresses and water management requirements change over time. Further description and assessment of the water management system is provided in Section 4.5.3.

The Snapper Mine water management system would be based on the containment and re-use of mine site waters and on the control of sediment that may be potentially carried with runoff from disturbed areas such as the overburden emplacement areas prior to rehabilitation.

The key components of the strategy are:

- separation of undisturbed area runoff from disturbed area runoff;
- collection and re-use of surface runoff from disturbed areas (including mining areas and overburden replacement);
- design of evaporation/sediment sumps to contain runoff generated from a 1 in 20 year, 72 hour rainfall event;
- capture and on-site containment of potentially contaminated mine site waters; and
- priority re-use of captured and contained water for dust suppression or process requirements.

Water management for the Snapper Mine during operation would comprise control of runoff from disturbed areas (erosion and sediment control) and the provision and management of process and wastewater at the mine site.

2.7.1 Site Water Management and Erosion and Sediment Control

A Site Water Management Plan (SWMP) would be developed for the Snapper Mine prior to construction in consultation with the relevant authorities. The SWMP would include procedures that would be implemented to ameliorate potential groundwater impacts on surrounding land, where applicable. The SWMP would include a site water balance and on-site water management measures (including erosion and sediment control).

Surface water diversion bunds and drains would be sized to convey runoff generated by a 1 in 20 year, 72 hour critical duration storm event. Runoff from disturbed areas of the mine site would be channelled to evaporation/sediment sumps where practicable.

During mining, the dredge and primary gravity concentration unit would be located below the existing ground level. Water collected in this area would drain to the dredge pond, reducing the amount of water required to be extracted from the borefield.

Drainage from disturbance areas around the overburden stripping and overburden replacement operation would be directed to the evaporation/sediment sumps for containment. Waters collected in evaporation/ sediment sumps would be utilised for dust suppression at the mine site or allowed to evaporate.

Figure 2-13 provides an illustration of the typical key components of the water management system at the mine site during Year 1.

2.7.2 Process Water

The two borefields shown on Figures 2-2 and 2-3 would provide the water required for the Snapper Mine. Each bore in the borefields would be capable of producing up to either 10 L/s or 15 L/s, depending on their location (Appendix A).

The two borefields would supply process water to the following:

- dredge pond;
- primary gravity concentration unit via the dredge pond;
- overburden slurry system via the dredge pond;
- initial water dam;
- RO plant;
- salt washing facility and WHIMS circuit via the RO plant; and
- water disposal dam.

Process water would also be supplied to the dredge pond and overburden slurry system indirectly (i.e. via recycling of water).

Site Water Balance

A site water balance for the Snapper Mine was prepared by Golder Associates as a component of the Hydrogeological Assessment (Appendix A). The water balance considers the following inputs and outputs to the water management system:

- water required to fill the initial water dam;
- water required to flood the construction pit using initial water dam and borefield water;
- water required during deepening and extending the dredge pond to the required operation dimensions;
- dredge pond water level adjustments;
- water retained in the tailings sand residue and slurried overburden;
- water retained in fines;
- water consumed in the HMC treatment facility including that transported off-site; and
- water lost to evaporation.

During operation, the average groundwater requirement from the borefields would be approximately 165 L/s. The maximum water supply requirement from either borefield (370 L/s) would be pumped during Years 14 to 16.

2.7.2.1 Initial Water Demand and Supply

Water from the central borefield (Figure 2-2) would be used to fill the initial water dam during the final six months of construction at a rate of approximately 111 L/s. The water within the initial water dam, together with water from the borefield, would then be piped to flood the construction pit thereby creating the dredge pond ready for commencement of dredge mining.

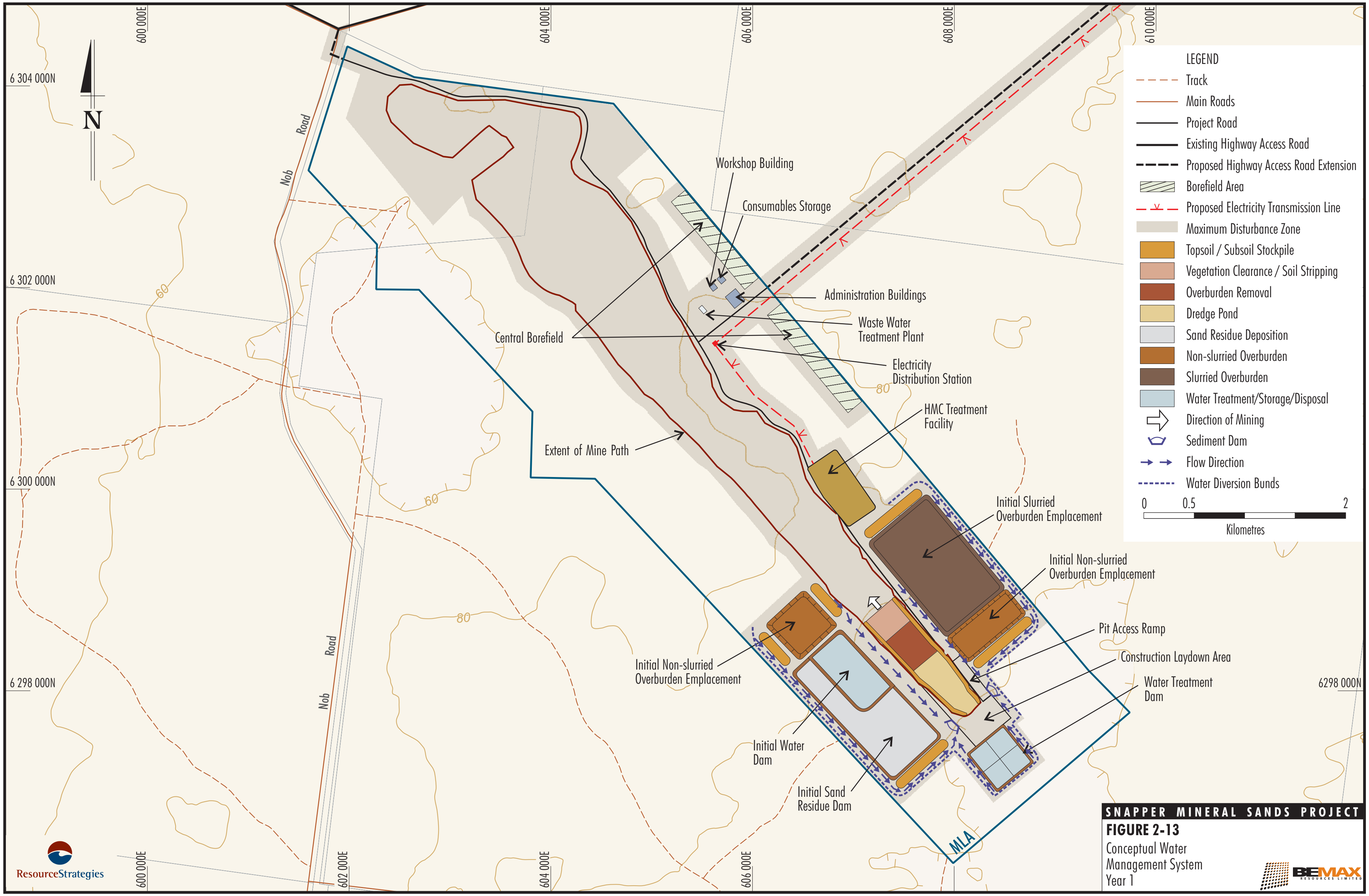

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FIGURE 2-13

Conceptual Water Management System Year 1

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In this initial period, water required to slurry the overburden would be sourced solely from the dredge pond until a sufficient volume of return water from slurried overburden runoff can be recycled via the return water pump and pipeline (Section 2.4.3). Supernatant water from the initial sand residue dam (Section 2.4.6) would be recycled to the dredge pond.

2.7.2.2 Operation Water Demand and Supply

The water flows (including entrained water flows [i.e. material containing water]) during operation are presented as a water schematic on Figure 2-12. The operation water demand would be incurred by (Appendix A):

- dredge pond water level adjustments and evaporation;
- water retained in the sand residue and slurried overburden above the initial moisture content;
- water retained in fines deposited above the water table; and
- water consumed in the HMC treatment facility including evaporation from concentrate stockpiles and water transported off-site.

These are described in the sub-sections below.

Dredge Pond Water Level Adjustments

The water demand associated with dredge pond water level adjustments would vary over the life of the mine according to the relative position of the dredge pond to the groundwater table (Appendix A).

While the dredge pond water level is required to be increased at various times along the mine path, the maximum increase in dredge pond water level is required during Years 1 and 2, when the dredge pond water level is required to be approximately 14.5 m above the existing water table. The maximum central borefield water demand is expected during the first year of mining operation (i.e. 328 L/s) when the dredge pond level would be raised by 14.5 m (Appendix A). The dredge pond water level would return to the natural groundwater level via seepage and water losses (Appendix A) allowing mining to proceed after dredge pond water level increases.

The dredge pond water level is required to be lowered by a maximum of approximately 10 m below the existing water table in the north of the mine path in Years 14, 15 and 16 in order to maintain dredge access to the orebody and to allow stripping of overburden below the present water table. The maximum water supply requirement from the northern borefield of 370 L/s would be pumped during these years (Appendix A). The excess water produced as a result of the reduction in the dredge pond elevation would be pumped to the water disposal dam and allowed to seep back to the groundwater table (Section 2.7.5). Water disposal is described further in Section 2.7.5.

The average estimated evaporative loss from the dredge pond represents approximately 3% of the total water losses or outputs listed above (Appendix A).

Entrained Water in Sand Residue and Slurried Overburden

The final moisture content of drained deposited sand residues and slurried overburden above the water table (by mass) is estimated to be approximately 10%. This is considered to be a conservative estimate of water losses from the deposited sand residues and slurried overburden since there would be additional drainage to groundwater over a period of several months to years following placement, as the moisture content of the material equilibrates towards the *in situ* moisture content of the surrounding material.

Entrained Water in Fines Material

The fines collected in the water treatment dams would include entrained water. The water treatment dams are further discussed in Section 2.3.1.9.

HMC Treatment Facility

As described in Section 2.4.7, slurried HMC from the primary gravity concentration unit would be piped to the HMC stockpile within the HMC treatment facility (Figure 2-12). The majority of water from the HMC stockpile would drain to a reject water pond and then return to the dredge pond. Water losses would be associated with evaporation from concentrate stockpiles and off-site transport of concentrate containing entrained water.

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 (Section 2.4.7.3) (Figure 2-12). The operation of the WHIMS circuit marginally increases the demand on the borefield (in the order of 12 L/s) as the majority of the water required for the WHIMS circuit would be recycled through dewatering of product materials. The HMC treatment facility (including the RO plant, salt washing facility and WHIMS circuit) would put a maximum demand on the borefield of approximately 80 L/s when the WHIMS circuit is operating, though a majority of this water (in the order of 60 L/s) would be returned as make-up water to the dredge pond via the reject water pond.

The RO plant would produce approximately 20 L/s of desalinated water for the salt washing facility and WHIMS circuit. Wastewater from the salt washing facility would be piped to the reject water pond for use when slurrying the backloaded MSP process waste (Section 2.4.9).

2.7.3 Potable Water

The RO plant would provide approximately <1 L/s potable water for the administration buildings and ablutions.

2.7.4 Water Treatment

Fines material would be dredged as a component of the ore. Fines material would be processed through the cyclone in the primary gravity concentration unit where it would be separated from the ore as a constituent of the process water through the cyclone overflow (Figure 2-11). Build-up of fines material in the process water results in inferior metallurgical performance and exacerbated deterioration of pumping equipment.

As described below, two alternative process water treatment locations are proposed for the separation of fines from the process water, namely water treatment dams or purpose built cells on the initial sand residue dam.

Water Treatment Dams

As described in Section 2.3.1.9, an initial water treatment dam would be constructed to facilitate the removal of fines material from the process water. In addition to the initial water treatment dam, subsequent water treatment dams would be constructed within the mine path adjacent to the operating dredge pond, either in front of or behind the dredge pond. The number of dams required would be dependent on the volumes and settling properties of the fines material encountered during dredging.

A flocculant (e.g. Hi-TEX 82230) would be added to the overflow water prior to it entering the water treatment dam to enhance particle coagulation and minimise settling times. Hi-TEX 82230 is an anionic flocculant which would break down into inert compounds during the settling process (NALCO, 2006a). Dosage testwork has concluded that the concentrated fines material would have a pH between 6.8 and 7 after treatment (NALCO, 2006b). Approximately 2.3 t of flocculant would be used each month at the Snapper Mine operation during normal water treatment.

After approximately 48 hours of settling time, approximately 50% of the process water would be decanted from the surface of the dam and returned to the dredge pond. The remainder would be lost to evaporation, minor seepage or retained with the fines material. After approximately seven days, the material would have compressed to approximately 15% of its original depth through evaporation and minor seepage and would exist as a thin layer of concentrated fines. After 14 to 21 days, the material would be collected and disposed of in the mine path area thereby re-establishing storage capacity.

The dams would be constructed with compartment cells which would be used on a rotational basis to allow for continual treatment and filled with process water to a depth of up to approximately 3 m.

If, despite the above measures, if accumulation of fines was to occur within the dredge pond, submersible pumps would be placed at the base of the dredge pond to remove any densely accumulated fines material. The material would be pumped directly to the water treatment dam, where it would undergo the same settling and disposal process as described above.

Initial Sand Residue Dam – Alternative Water Treatment Location

As an alternative to the water treatment dams described above, process water containing the fines material may be pumped to purpose built cells within the initial sand residue dam. This process water would also be dosed with a flocculant to promote the settling of suspended sediments. Similar to the water treatment dams, 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.

2.7.5 Water Disposal

The water disposal dam would be constructed within the mine path approximately in Year 7 (Figure 2-3). 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 slurried overburden and sand residues to allow vertical seepage to the groundwater table. The concept for the water disposal dam is shown on Figure 2-14. To reduce the dredge pond water level sufficiently to mine in Years 14, 15 and 16, water would be pumped to the water disposal dam from Year 12. On completion of mining and once the water disposal dam has drained, it would be decommissioned and rehabilitated.

2.8 INFRASTRUCTURE

2.8.1 Roads

As stated in Section 2.2.2, Snapper Mine traffic would share the existing 64 km HAR from the Ginkgo Mine to the Silver City Highway. The HAR would be extended by approximately 1 km in the north and 6 km in the east in order to service the Snapper Mine site (Figure 1-2). Other minor roads required for the Snapper Mine would include internal access roads at the mine site and maintenance tracks along the ETL route.

2.8.2 Electricity Distribution

As stated in Section 2.2.2, an approximate 10 km long 66 kV ETL would be constructed to extend the existing ETL from the Ginkgo Mine to the Snapper Mine. An electricity distribution station would be located at the mine site (Figure 2-2). 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.

2.8.3 Site Buildings

Buildings constructed at the mine site would be of demountable design and would be removed on closure of the operation.

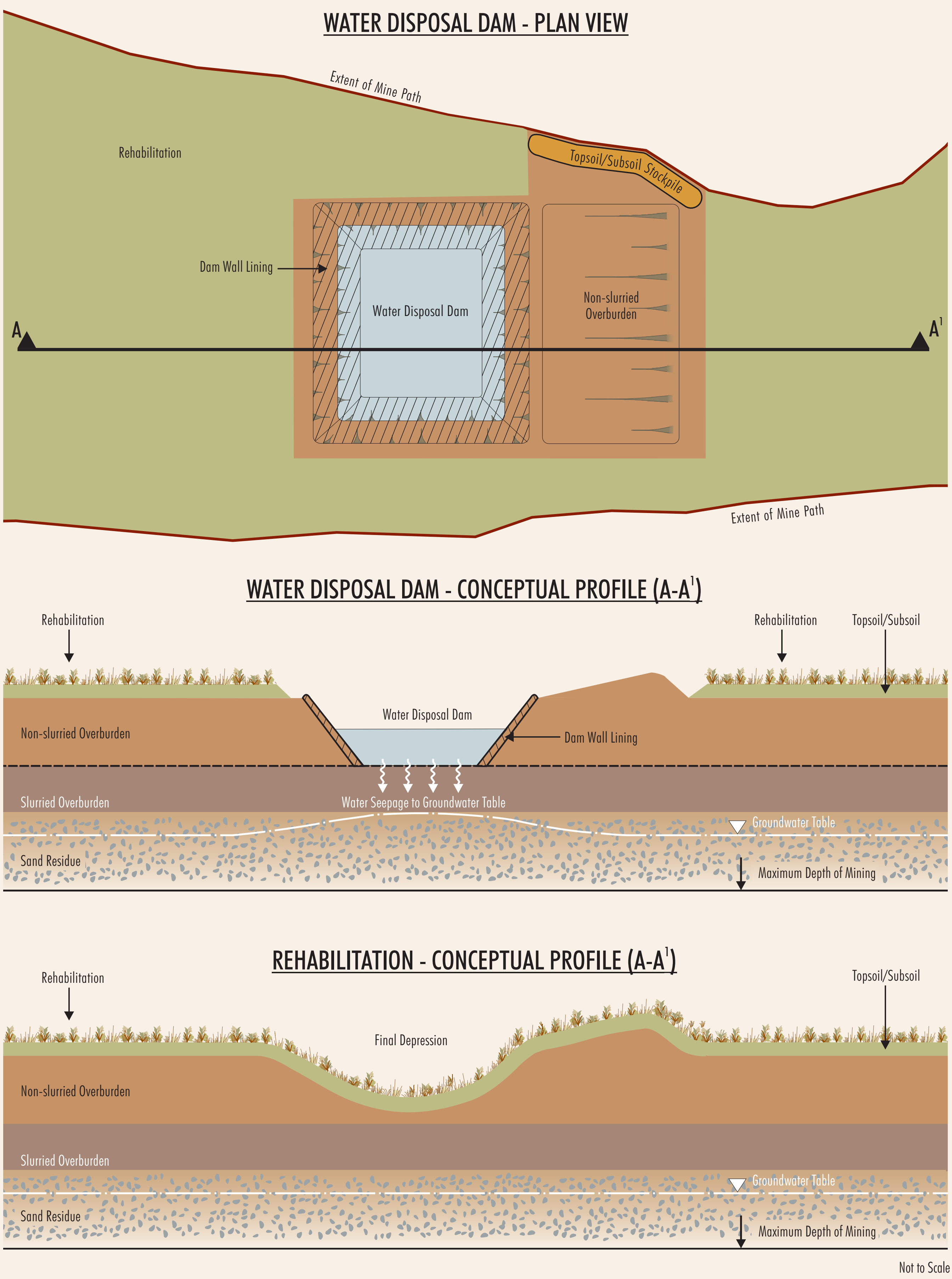
Pre-fabricated, modular administration and workshop buildings would be erected near the Snapper Mine road to the north-east of the mine path (Figure 2-2). The administration buildings would provide air conditioned offices and facilities for the majority of the administration and operation staff. A car park for employees and visitor parking would be provided adjacent to the building. Parking facilities would be constructed to meet the requirements of the WSC.

The workshop would provide for servicing of mobile equipment, dredge and primary gravity concentration unit components and storage of consumables. The building would be steel framed, metal clad and the maintenance offices would be air conditioned.

2.8.4 Diesel Storage

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.

Diesel storage at the mine site would comprise a permanent single diesel 50,000 litre (L) tank located adjacent to the mineral concentrate stockpile. During construction, a contractor would be employed to undertake the initial overburden stripping and replacement, prior to installation of the overburden slurrying system. During this period, the contractor would require an additional temporary 50,000 L storage facility for diesel. This storage would be located adjacent to the Snapper Mine permanent diesel storage facility.



SNAPPER MINERAL SANDS PROJECT

FIGURE 2-14

Water Disposal Dam Concept

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2.9 MANAGEMENT OF CONSUMABLES AND SITE SECURITY

2.9.1 Consumables

Due to the nature of the mining operation (i.e. no blasting required) and the very limited chemical requirements for water treatment and mineral concentration, consumables required for the Snapper Mine would be largely limited to fuels and lubricants.

Transportation

Any hazardous or dangerous goods required for the Snapper Mine would be transported in accordance with the appropriate regulations under the *Road and Rail Transport (Dangerous Goods) Act, 1997*. These regulations apply versions of the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (ADG Code) (DTRS, 1998).

Handling and Storage

Potentially hazardous goods used on-site for the Snapper Mine would generally be limited to fuels (i.e. diesel and petrol) and hydrocarbons (e.g. oil). Of these, diesel would be the only potentially hazardous material required in any significant quantity at the mine site.

Hydrocarbon storage facilities would be designed, located, constructed and operated in accordance with AS 1940-2004 *The Storage and Handling of Flammable and Combustible Liquids.*

Waste hydrocarbons would be collected and stored, before being removed by licensed waste transporters on a periodic basis.

The handling and management of waste classified as hazardous is discussed in Sections 2.4.8, 2.4.9 and 2.6.2.

Material Safety Data Sheets and Inventory Register

No chemical or hazardous material would be permitted on-site unless a copy of the appropriate Material Safety Data Sheet (MSDS) is available on-site or, in the case of a new product, it is accompanied by a MSDS.

All chemicals brought onto the Snapper Mine would be recorded in an inventory register which would identify the type of product, dangerous goods class, liquid class, hazchem class and the quantity held on-site. The inventory register would also identify the compatibility of materials and the emergency response procedures in the event of a spill.

2.9.2 Security

Public safety and security at the mine site would be maintained by restricting access to authorised personnel.

2.10 WORKFORCE AND OPERATIONAL HOURS

2.10.1 Construction Phase

The construction phase of the Snapper Mine would require a workforce averaging around 200 people with a maximum of approximately 250 employees required during the peak two to three months of construction activity.

Construction would be undertaken seven days per week, 24 hours per day. Employees would work on a shift basis with two 12 hour shifts worked in each 24 hour period (shifts starting 7.00 am and 7.00 pm). A proportion of the construction phase workforce would include workers who go on to form part of the operational workforce.

Both local and non-local workers would be employed during the construction of the Snapper Mine. As described in Section 2.3.5, the majority of the mine site construction workforce would be housed in the accommodation camp at the Ginkgo Mine.

2.10.2 Operation Phase

An operational workforce of approximately 110 employees would be anticipated. The employees would work on a shift basis with two 12 hour shifts worked in each 24 hour period (shifts starting 7.00 am and 7.00 pm).

Table 2-5 below lists the approximate number of employees required during operation, including BEMAX employees and contractors. It is expected that, on average, 80% of the positions created by the Snapper Mine would be filled from the Broken Hill, Wentworth Shire, Mildura and the Murray Darling and Far West Regions.

Table 2-5
Approximate Snapper Mine Employee Numbers During Operation

Snapper Mine Component	BEMAX Employees	Contractors	Total
Mine Site	35	60	95
Haulage	-	15	15
Total	**35**	**75**	**110**

Source: Appendix J