

# Development Proposal and Environmental Management Plan (DPEMP) Nelson Bay River Magnetite Mine

Prepared for: Shree Minerals

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transport infrastructure | community infrastructure | industrial infrastructure | climate change



Images of Nelson Bay River mine site

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## Volume 1 of 2 – Main Report

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## Table of Contents

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### Volume 1 of 2 - Main Report

Foreword .....	i
Executive Summary .....	iii
1. Introduction.....	1
2. Proposal Description.....	3
2.1 Location.....	3
2.2 Description .....	5
2.3 Hydrogeological conditions .....	11
2.4 Waste rock.....	23
2.5 Waste rock dump .....	28
2.6 Acid generation potential .....	31
2.7 Geochemical sampling program .....	33
2.8 Analytical program .....	36
2.9 Tailings.....	46
2.10 Estimated amounts of pyritic waste material.....	46
2.11 Management of pyritic material .....	54
2.12 Acidic water management .....	57
2.13 Tailings management .....	58
2.14 Mine infrastructure.....	61
2.15 Disturbance footprint .....	62
2.16 Pit water, stormwater and site drainage .....	64
2.17 Product transport.....	65
2.18 Construction.....	67
2.19 Off-site infrastructure .....	69
2.20 Technical and management alternatives .....	70
3. The Existing Environment.....	71
3.1 Planning aspects .....	71
3.2 Use and Zone .....	71
3.3 Arthur Pieman Conservation Area .....	73
3.4 Environmental aspects.....	74
3.5 Climate.....	77
3.6 Catchments.....	77
3.7 Project water monitoring .....	78
3.8 Land systems .....	86
3.9 Land capability .....	86
3.10 Land tenure and land values.....	86
3.11 Wilderness values.....	87
3.12 Flora .....	93
3.13 Fauna .....	99
3.14 Aboriginal cultural heritage .....	103
3.15 Historic heritage.....	104
3.16 Socio-economic aspects .....	104
3.17 Alternative sites .....	106
4. Potential emissions and their management .....	108
4.1 Air emissions .....	108
4.2 Liquid discharges .....	112
4.3 Groundwater .....	126
4.4 Noise emissions .....	129
4.5 Solid and controlled waste.....	132
4.6 Dangerous goods.....	137
5. Potential ecological impacts and their management .....	140
5.1 Existing conditions .....	140
5.2 Performance requirements .....	141
5.3 Vegetation communities .....	141


5.4	Threatened flora .....	143
5.5	Weeds .....	150
5.6	Plant pathogens.....	150
5.7	Fauna .....	150
6.	Avoidance and mitigation measures .....	163
6.1	Vegetation clearing .....	163
6.2	Plant hygiene measures .....	163
6.3	Threatened flora protection .....	163
6.4	Masked owl nests .....	164
6.5	Quoll and devil dens and habitat .....	164
6.6	Roadkill .....	168
6.7	Devil facial tumour disease .....	169
6.8	Assessment of effects.....	170
6.9	Commitments .....	170
6.10	Marine and coastal .....	171
6.11	Greenhouse gases and ozone depleting substances.....	171
6.12	Heritage.....	177
6.13	Land use and development .....	179
6.14	Visual effects.....	180
6.15	Socio-economic issues .....	182
6.16	Health and safety issues.....	183
6.17	Hazard analysis and risk assessment .....	183
6.18	Fire risk .....	185
6.19	Infrastructure and off-site ancillary facilities .....	189
6.20	Environmental management systems.....	189
6.21	Cumulative and interactive effects.....	189
6.22	Traffic impacts.....	190
7.	Monitoring and Review .....	191
8.	Decommissioning and Rehabilitation.....	198
9.	Commitments .....	199
10.	Summary of key assessed risks.....	207
11.	Summary of management plans to be prepared .....	213
12.	Conclusions.....	214

## Volume 2 of 2 - Appendices

Appendix A	Conceptual mine layouts showing staging
Appendix B	Conceptual mine pit cross-sections
Appendix C	Conceptual processing plant design
Appendix D	Hydrogeological report
Appendix E	Preliminary processing flowsheet for high grade hematite
Appendix F	Preliminary processing flowsheet for low grade hematite
Appendix G	Preliminary magnetite processing flowsheet
Appendix H	Water management staging
Appendix I	Waste rock accounting analytical results
Appendix J	K-NAG test interpretive report
Appendix K	Pit section potential acid forming (PAF) zones
Appendix L	PAF waste rock estimation
Appendix M	Traffic impact assessment
Appendix N	Conceptual mine elements and Arthur Pieman Conservation Area
Appendix O	Water quality monitoring database
Appendix P	Flora and fauna assessment
Appendix Q	Giant freshwater crayfish report
Appendix R	Roadkill and headlight survey data
Appendix S	Mine closure plan

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Authorised by:   
Name

Date: 28 November 2011



## Foreword

This Development Proposal and Environmental Management Plan (DPEMP) has been prepared to support a development application by Shree Minerals to the Circular Head Council. Council will refer the DPEMP to the Environment Protection Authority for assessment.

The application is for the development and operation of new magnetite and hematite extraction and processing activities near Nelson Bay River, off Wuthering Heights Road, approximately 7 km northeast of Temma in northwestern Tasmania.

The proposed operations will be located on Crown Land. A mining lease application has been submitted to Mineral Resources Tasmania.

The purpose of this DPEMP is to provide:

- Supporting documentation to the development application to the Circular Head Council;
- A basis for the Circular Head Council and the Board of the Environment Protection Authority to consider the planning and environmental aspects of the proposal;
- A basis for the conditions under which any approval can be given; and
- A source of information for interested individuals and groups to gain an understanding of the proposal.

The DPEMP has been prepared according to the Board of the Environment Protection Authority's (EPA) *General Guidelines for the preparation of a Development Proposal and Environmental Management Plan for Level 2 activities and 'called in' activities, May 2010* and the EPA's *Guidelines for the preparation of a Development Proposal and Environmental Management Plan for Shree Minerals - Nelson Bay River Magnetite Mine, Nelson Bay River, Tasmania, May 2011*.

The DPEMP guidelines were developed by the Board of the EPA based on the information supplied by the proponent in a Notice of Intent (NOI) submitted 23 March 2011 in accordance with the Board of the EPA NOI guidelines and the requirements of Section 27B of the *Environmental Management and Pollution Control Act 1994*.

A referral was submitted in February 2011 to the Department of Sustainability, Environment, Water, Population and Communities [DSEWPC] under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA). The Minister determined in March 2011 that the action was a controlled action requiring assessment using an environmental impacts statement under Part 8 of the EPBCA. The EIS will be assessed separately to this DPEMP under the Commonwealth's EIS process.

The development application will be advertised by the Circular Head Council in the Advocate newspaper and the DPEMP will be available for public scrutiny at:

- Circular Head Council offices in Smithton;
- The Environment Protection Authority's internet site; and
- The Department of Primary Industries, Parks, Water and Environment library in Hobart,

for a period of 42 days following the formal newspaper advertisement of the application. The calculation of this 42 day period does not include public holidays or the period between Christmas Day and New Year's Day, inclusive.

Any member of the public may submit a representation on the proposal, describing their comments and/or objections.

Representations must be in writing and lodged within the statutory period with:

The General Manager  
Circular Head Council  
PO Box 348  
SMITHTON TAS 7330.

Council will consider the development application in accordance with its obligations under the *Land Use Planning and Approvals Act 1993* and the *Environmental Management and Pollution Control Act 1994*.

Because the proposed activity is deemed a Level 2 activity under Schedule 2 of the *Environmental Management and Pollution Control Act 1994*, the Board of the Environment Protection Authority (the Board) will assess the potential environmental impacts and conditions for the proposed activity in accordance with the *Environmental Management and Pollution Control Act 1994*. The EPA has advised that the assessment will be undertaken as a class 2C, the highest assessment class.

The environmental conditions from the Board's assessment will be forwarded to Circular Head Council for inclusion in the permit, if and when Council approves the proposed activity.

Any persons who made written representations on the proposal will be notified by the Board of its decision. Persons aggrieved by a decision to approve the development, or by the conditions or restrictions of the permit, may appeal to the Resource Management and Planning Appeal Tribunal (the Tribunal). The applicant, Shree Minerals, may also appeal a refusal of the proposal by the Board or Council, or appeal the conditions or restrictions imposed by the Board or Council.

Appeals must be lodged in writing within 14 days of Council's decision. The Tribunal will hear appeals. The Tribunal will independently reassess the proposal, and either confirm, overturn or modify the decision and/or the permit conditions and restrictions.

A Forest Practices Plan (FPP) will not be developed for the proposal. An FPP is no longer required by the Forest Practices Authority, due to amendments to the *Forest Practices Regulations 2007* dated 25 November 2009. The land use permit will approve the vegetation clearance once issued by the Circular Head Council.



## Executive Summary

Shree Minerals is proposing to develop a new magnetite and hematite mine and mineral processing operation on Crown Land adjacent to Nelson Bay River, off Wuthering Heights Road, approximately 7 km northeast of Temma in northwest Tasmania. The project area is well served by existing State and Forestry Tasmania roads.

Metallurgical testwork of the Nelson Bay River magnetite ( $\text{Fe}_3\text{O}_4$ ) resource has returned magnetite concentrates >69% with low aluminium oxide, phosphorus sulphur and silica dioxide. The resource is ideally suited for the production of marketable concentrate for either heavy media markets or pellet production.

The current mine plan is to target approximately 4 Mt of this resource over a 10 year period. Targeting of the rest of the resource will be developed while the initial 4 Mt is being mined. The global resource could provide up to 30 years of mining at 400,000 tpa.

The project will provide significant economic and social benefits at the local and regional scale.

Contractors will be responsible for in-pit operations. The contractors will provide all the equipment and personnel for the in-pit mining and transport activities. The processing operations will be staffed by Shree personnel.

It is anticipated that this proposal will provide jobs for the next 10 years, with a potential future increase in the workforce if throughput rates are increased or alternative onsite mining areas are developed.

The construction of the processing plant and infrastructure will cost approximately \$15 M and \$5 M respectively. It is expected that construction will be undertaken by a local contractor(s), thereby benefiting the local community.

The mine will be only marginally visible from short sections of Rebecca and Temma Roads up to mid-mine life but from longer and more numerous sections in later mine life. In both cases, the visibility is driven by the waste rock dump. Other elements (plant and pits) have no significant visibility. The increased visibility of the rock dump toward the later stages of mining is due to it being higher than would otherwise be necessary because of the decision to confine its footprint to the eastern side of West Creek, so as to provide for a Fauna Habitat Protection Zone.

The potential visual impact of the rock dump from public roads in the later years of the mine life will be reduced by early and progressive rehabilitation of the dump batters, particularly on the southern and western sides. As vegetation takes hold, the rock faces will become covered and as trees become established the lines of the dump benches will be visually broken up. The appearance the dump from the roads, which are approximately 3 to 4 kilometres away, is therefore not expected to become obtrusive or significantly diminish the landscape quality.

With its planned processing and export activities, economic modelling estimates that operating full capacity the project would employ 125 full time employees (by the company and/or through contractors), with many more employed indirectly because of flow-on effects, and result in a business turnover of approximately \$70 to \$88 million per annum for a total of approximately \$1.5 billion over the project life.

North western Tasmania has a diverse range of wealth generating industries, including agricultural production and processing, forestry and forest processing, mining, specialized manufacturing and nature and culture based tourism. Despite this, the prosperity of the region is lower than the national average. The recent closure of several important manufacturing facilities has further reduced the resilience of the economy of this area.

This development will assist the region to progress towards a more resilient future as a key component of regional Australia, with improved social equity and quality of life within its community.

Shree proposes to extract magnetite and hematite ore by open cut mining.

The magnetite ore body is the main target of the proposed operation. This ore body, which is located close to Nelson Bay River, will be extracted by developing a pit ("main pit") to a depth of approximately 225 m (-145 m RL). The ore will be beneficiated in an on-site processing plant prior to road transport to the port of Burnie (or Port Latta) on the north coast of Tasmania.

In addition to the main pit, there is also an extended near-surface oxidised ore body, comprising direct shipping quality (Direct Shipping Ore, DSO) hematite. This ore will be extracted by shallow excavation ("DSO pit") to a depth of approximately 35 to 40 m down-dip (60 to 65 RL) and transported directly to the port, with the only beneficiation likely to be crushing and screening.

The DSO pit will be mined before the deep magnetite pit. DSO extraction will be by shovel and truck open cut mining. Ore extraction from the main pit will be by drill and blast, shovel and truck open cut mining.

The DSO ore (hematite) will require crushing and screening only. Processing of the magnetite ore will involve crushing and grinding, followed by dry magnetic separation and regrinding, then wet magnetic separation and filtering and finally drying of the transportable product.

The processing plant will have a maximum annual water requirement of 1.8 Mm<sup>3</sup>, comprising approximately 1.7 Mm<sup>3</sup> of recycled water and 0.1 Mm<sup>3</sup> of make-up water.

The DSO pit is expected to make approximately 0.1 Mm<sup>3</sup> of water per year (mean rainfall year), which will be enough to supply the make-up water needs, obviating the need for any extraction from Nelson Bay River. Additional makeup water will also be available from dewatering of the main pit. The available amount will progressively increase as the main pit deepens, up to an estimated 0.4 Mm<sup>3</sup> per year (mean rainfall year) at full development.

The mine will have a central acid neutralisation plant, to which all significant mine water streams will be directed, to allow acid neutralisation if necessary.

Water from pit dewatering will be pumped to the acid neutralisation plant and then to the recycle dam or to the East Creek discharge. The expected DSO dewatering rate is approximately equal to the process water make-up needs. Dewatering from the main pit would be excess to this, and the excess would be discharged to East Creek. In an average year at full pit development, the main pit dewatering rate is estimated to be 0.4 Mm<sup>3</sup>/a. The average annual flow of Nelson Bay River is in the order of 40 Mm<sup>3</sup>.

The additional contribution to the Nelson Bay River flow from the main pit dewatering will therefore be less than 1% in an average year. However, in a dry year the discharge of mine water would be more significant. As the pit deepens, pit water inflows will become more driven by the deeper regional aquifer, which will largely be independent of short term fluctuations in rainfall. Surface waters, including Nelson Bay River, on the other hand will respond to day to day changes in rainfall and the river flow could be very

low during particularly dry periods. If pit water continued to be discharged at a relatively constant rate, during dry times the discharge could dominate the flow in the river. For this reason, a variable flow discharge regime that adjusts to creeks and river conditions will be implemented.

Based on current mine plans, approximately 0.7 and 11.0 Mm<sup>3</sup> of waste rock will be removed from the DSO and main pits respectively. This total waste rock volume of 11.7 Mm<sup>3</sup> will require approximately 14 Mm<sup>3</sup> of dump space, based on an assumed waste rock bulking factor of 1.2.

It is anticipated that the majority of the waste rock will be transferred to the waste rock dump, but a significant amount may be used for construction of the following, subject to acceptable chemical and/or geotechnical properties:

- Tailings dam; use would be spread over the life of the mine
- Bund wall/drain diversion along the western and north western sides of the waste rock dump
- Sedimentation dams
- Mine roads and standing areas
- Recirculation and make-up dams
- Construction pads for the process plant.

Some of the waste rock will contain pyritic material and is therefore potentially acid forming (PAF). PAF rock will be disposed of in the DSO pit in an encapsulated cell, and then temporarily above the DSO pit if and when the DSO void becomes full. On mine closure, the excess PAF material will be relocated into the main pit. Both pits will be flooded on closure, thereby preventing oxidation of the PAF rock and the generation of acid.

The current JORC confirmed DSO resource provides a 40 m deep DSO pit with an approximate volume of 0.9 Mm<sup>3</sup>. Based on the current estimates of PAF rock volumes, the DSO could take approximately 50% of the estimated 1.7 PAF Mm<sup>3</sup> of PAF rock volumes over the life of the mine, allowing for clay linings and final water cover. However, strong exploration indications are that the ultimate DSO pit will extend to approximately 60 m in depth. This has the potential to provide a DSO pit volume of approximately 1.1 to 1.2 Mm<sup>3</sup>, which could take about 65% to 70% of the anticipated PAF rock.

Because of the generally veinlet nature of the pyrite dissemination and because the drill holes are biased toward siltstone material, which is more likely to contain pyrite, the amount of PAF rock may be less than current estimates, meaning that the DSO pit volume may in fact be sufficient for all PAF waste. The actual PAF quantities will become evident as mining proceeds and projections of the likely total amount will become progressively more refined over the first several years of operations.

If the actual PAF rock production rates and the actual DSO pit volume lead to a mid-mine-life (year 5) projection that the pit volume will not be sufficient for the last few years of mining then the PAF storage will be raised above the DSO pit.

The basic structure of the cell will be similar to that used in the DSO pit but, rather than making use of the pit walls, the raised cell will be constructed within a wall constructed from NAF rock. Drainage off the dump will be directed into a sump void that will be retained and water collected in this sump will continue to be pumped out as before.

This same approach would be adopted as a contingency response for the unlikely situation that a significantly greater amount of PAF rock is found than is expected, which could lead to the DSO pit's PAF storage capacity being filled earlier in the mine life than anticipated.

This temporary dump will be managed until mining finishes, at which time it will be demolished, with the rock being trucked to the edge of the main pit where a safe chute arrangement will be constructed. The PAF rock will be pushed through the chute into the pit. The excess PAF rock will therefore become flooded with a permanent cover of water as the main pit fills because of the cessation of dewatering.

With the above strategies, all PAF rock will be managed throughout the mine's operations to minimise the potential for acid generation and on mine closure all PAF rock will be submerged under a permanent cover of water (whether in the DSO pit or in the main pit), thereby providing permanent protection against acid generation.

Non-acid forming (NAF) rock will be placed in a rock dump located on the eastern side of West Creek, located to avoid the loss of riparian habitat. Drainage from the rock dump will flow westwards towards West Creek. This drainage will be intercepted before it reaches the creek by a collection drain that will be constructed parallel to the creek and at least 30 m away from it (so protecting the riparian habitat). The collection drain will terminate at its northern (downstream) end in a sediment settling basin, which will be off-stream. The basin overflow will discharge into the adjacent creek.

Process tailings will be permanently stored and managed in a dedicated tailings dam.

The tailings dam will be clay-lined. Clay is available on site but the resource has not been quantified. Clay requirements for the lining and wall core are in the order of 0.5 Mm<sup>3</sup>. If on site resources prove to be inadequate, supplementary clay will be imported from a licensed commercial clay pit. Clay will be compacted to achieve a permeability of less than  $1 \times 10^{-9}$  m/s. The tailings will provide additional sealing as they consolidate over time.

The design of the tailings dam will require approval from the Tasmanian Assessment Committee on Dam Construction and will need to satisfy the design standards of the Australian National Committee on Large Dams (ANCOLD).

The tailings dam will be located near the head of West Creek. Location on the creek line reduces the volume of the dam wall but, more importantly, facilitates permanent flooding of the dam following mine closure.

The headwaters of the creek above the tailings dam will be diverted around the dam using a cut-off drain. The drain will be constructed with a top-up flow weir to allow creek water to flow into the tailings dam to maintain a constant water cover over the tailings, during both operations and after mine closure. A permanent water cover over the tailings dam will prevent oxidation of pyritic material in the tailings and hence prevent acid formation.

Free tailings water will be recycled by decant into the process plant's recycle dam and tailings water alone would not lead to the tailings dam overflowing. However, if rainwater fills the dam to overflowing, that overflow will discharge to an off-stream sediment settling basin, which will also have a return to the recycle dam. If the recycle dam itself fills to overflowing, excess water will be discharged to East Creek, via the acid neutralisation treatment plant if the pH is below the treatment threshold of pH 7. Both the tailings dam collection basin and the recycle dam will need to have provision for emergency overflows (to West and East Creeks respectively) but such overflows would only occur in extreme weather events.

The mine will have basic support infrastructure including parking, workshops, change rooms, ablutions, security, first aid rooms, a crib room, an office, a diesel powered generator, communications, storage buildings and areas, and domestic wastewater treatment facilities. All buildings will be transportable and all entrances, car ports and access paths between buildings will be covered.

One or more sea containers will be used as lockup tool and parts stores.

The compound will include storage for chemicals, paints and fuel oils. An explosive magazine will be located at an appropriate distance from the plant area.

Potable water will be sourced from rainfall and stored in rainwater tanks.

Sewage will be collected for treatment in an on-site Aerated Wastewater Treatment System (AWTP) or similar. Treated effluent will be discharged into the recycle dam.

Power will be supplied by diesel powered generators. It is estimated that the total energy demand for the site, excluding mine dewatering pumps, will be approximately 2 MW. Mine dewatering pumps will be trailer mounted mobile units powered by diesel engines. By separating the power requirements of the pumps from the rest of the mine's infrastructure, the need for unnecessary oversizing of the diesel generator will be obviated, along with the need to connect an electrical supply from the surface substation to the pit floor.

The diesel generator station will be located centrally to all operations. To handle high starting loads of high inertia equipment such as the crusher and conveyor systems, the power capacity will need to be 500 KVA to be provided by two parallel 250 KVA units.

Power will be fed from the diesel alternator sets by a cable to a low voltage motor control centre in a substation building adjacent to the generator shed, which will be an open-sided, flat roofed steel structure.

All processing infrastructure will be on-site. The only off-site infrastructure used will be the State road network for product transport to Burnie port (or Port Latta), although it is possible that unprocessed ore could alternatively be sold to an existing licensed processor for processing, subject to commercial agreements.

Product transport from the 150,000 tonnes pa operating mine will require approximately 40 truck movements a day (i.e. 20 loads per day). This is based on a nominal five day week but, subject to the transport contract, trucking may occur 7 days a week. During year 1, while the DSO pit is operating, the transport task will be approximately 350,000 tonnes pa (assuming a ROM recovery rate of 90%).

The site is located on the southern side of the Nelson Bay River, which flows northwest and west to the Southern Ocean at Nelson Bay, and is located wholly within the Nelson Bay River catchment. For the purposes of this project the PEV of Nelson Bay River catchment will be assumed to be: *A: Protection of Aquatic Ecosystems (i) Protection of pristine or nearly pristine ecosystems.*

There will be no direct discharges from the mine to Nelson Bay River.

The total disturbance footprint for the principal elements of the mine is approximately 152 ha. A portion of this footprint intersects the Arthur-Pieman Conservation Area but the intersection area is only 0.014% of the total Conservation Area. The prescriptions for mining activities contained in the Arthur-Pieman Conservation Area Management Plan will be achieved through the commitments and subsequent approval of the activity in accordance with this DPEMP. Likewise, the Natural Zone general aims are furthered by the implementation of this DPEMP.

Because of the very small proportion of land lost (0.014%) and the fact that the loss occurs on the edge of the APCA, it is anticipated that a compensatory offset will not be required.

No vegetation community listed under Schedule 3A of the *Tasmanian Nature Conservation Act 2002* or the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) occurs within or adjacent to the study area.

Two threatened vascular plant species were recorded from the study area: *Epacris curtisiae* - northwest heath - and *Prasophyllum pulchellum* - pretty leek-orchid - listed under the schedules of the *Threatened Species Protection Act 1995*. *Prasophyllum pulchellum* is also listed under the *Environment Protection and Biodiversity Conservation Act 1999*. However, neither of these species was recorded from any of the potential disturbance areas associated with the mine.

Potential impacts on threatened fauna warranting mitigation measures are:

- Wedge-tailed eagle: There is a potential impact from increased roadkill risk when feeding on roadkill due to the increase in road traffic because of the mine.
- Masked owl: There is a potential impact on nesting owls from vegetation clearing if it occurs during the nesting season.
- Spotted-tailed quoll: There is a potential impact on shelter dens from vegetation clearing at any time and potential impact on breeding dens if clearing occurs during the breeding season. There is a potential impact from increased roadkill risk when crossing roads or when feeding on roadkill due to the increase in road traffic because of the mine. Based on conservative (high) assumptions about quoll densities on the site, clearing of vegetation for the mine could displace up to 1 quoll. Without mitigation, product transport could increase the quoll roadkill on the region's roads by 0.6 every year but 1.6 in year 1. Confining product transport to daylight hours would reduce these risks to 0.1 and 0.3 kills per year respectively.
- Tasmanian devil: There is a potential impact on shelter dens from vegetation clearing at any time and potential impact on breeding dens if clearing occurs during the breeding season. There is a potential impact from increased roadkill risk when crossing roads or when feeding on roadkill due to the increase in road traffic because of the mine. Based on conservative (high) assumptions about devil densities on the site, clearing of vegetation for the mine could displace up to 1 to 2 devils. Without mitigation, product transport could increase the devil roadkill on the region's roads by 3 per year (and 8 in year 1). Confining product transport to daylight hours would reduce these risks to 0.6 and 1.6 kills per year respectively.

A summary of the key risks assessed for the mine proposal is provided in the following table. As shown in the table, avoidance and mitigation measures reduce all potential impacts to a level of non-significance.



The Nelson Bay River mine will therefore be developed and operated without significant impact on the environment.

Matter	Risk assessed	Residual significance
<b>Surface and groundwater</b>		
Impact on quality	<p>Construction and operation of the mine could impact on the quality of surface water through mine site discharge of surface and groundwater.</p> <p>During construction, temporary settlement basins and silt fencing will be used and final runoff will be directed to naturally vegetated gently sloping land to natural drainage lines.</p> <p>All surface water will be recycled. Any excess water that will need to be discharged will be passed through permanent sedimentation ponds and dissipation drains prior to discharge to local drainage lines at approved locations.</p> <p>Tailings will be stored in a facility with a compacted clay lining to reduce the possibility of seepage to groundwater.</p>	Not significant
<b>Biological values of Nelson Bay River</b>		
Direct impact on river habitat	<p>Sediment loss to Nelson Bay River could result in loss of habitat, displacement of aquatic animals and impact on fish gills and respiration.</p> <p>The use of temporary settlement basins and silt fencing during construction and permanent settlement basins and water recycling will ensure that there is no sediment loss to Nelson Bay River.</p>	Not significant
Change to the ephemeral nature of East Creek	A constant discharge of mine water to East Creek could change it from an ephemeral stream to a permanent stream and the creek biota could change accordingly. To avoid these impacts, the discharge of water will to the extent practicable mimic an ephemeral stream, with water held back from discharge for extended periods when the creek is dry.	Not significant
Acid drainage to natural streams	Acid discharges from mines can cause mortality across a wide range of macroinvertebrate species. Similarly, macroinvertebrate community composition, abundance and diversity all show significant reductions with low pH discharges. Fish can also be excluded from affected reaches. Acid generation prevention and treatment measures are a fundamental basis of the mine plan and operations.	Not significant
<b>Acid drainage</b>		
DSO pit capacity	The DSO pit may not have a sufficiently large volume to accommodate all pyritic waste material - temporary storage may be required pending closure of the main pit	Not significant
DSO pit storage	Pyritic material stored in the DSO pit will be covered with water on mine closure	Not significant
Temporary storage of PAF waste rock	Temporary storage of pyritic material in separate encapsulation cells with appropriate drainage controls above the DSO pit. There may be some acid drainage from this dump but this will be collected within the pit to be managed as part of the pit water.	Not significant
Main pit storage	On mine closure, all pyritic material in the temporary storage cells above the DSO pit will be pushed into the main pit and eventually covered with water.	Not significant

Matter	Risk assessed	Residual significance
Discharge to Nelson Bay River	The minimisation of the risk of acid drainage to surface waters is the fundamental intent of the mining and water management strategy. The mine plan, the separation of NAF and PAF material, the provision of a centralised neutralisation plant, the regular and routine acid accounting testing regime, the alkalinity dosing of tailings, the flooding of the tailings dam on closure, the storage of PAF material in or above the DSO pit with covering at a frequency determined by its reactivity, and the flooding of all PAF waste rock on mine closure are all designed to avoid the formation in the first instance and ultimately the discharge of acid water. The risk of an acid discharge to Nelson Bay River is therefore not significant.	Not significant
<b>Waste rock dump</b>		
Long term stability	The dump could become unstable, resulting in partial failure. Geotechnical assessment of the foundation materials, construction of the dump within the established safe slope parameters and timely rehabilitation will ensure safe long term stability.	Not significant
<b>Tailings storage facility</b>		
Failure of dam walls	Long term failure of the tailings storage facility walls. Construction of the dam to ANCOLD standards will ensure that the facility will withstand a 1 in 10,000 year storm event.	Not significant
Water cover drying out	On mine closure, the creek upstream of the tailings dam will be partially redirected to ensure that the tailings dam retains a long term cover of water to prevent oxidation of any pyritic material in the tailings.	Not significant
<b>Threatened orchids</b>		
Direct disturbance or loss of individual plants	Targeted surveys (undertaken in the spring of 2010) found no threatened orchid plants within the mine lease area. Orchids do not always flower in every year and it is conceivable that individual plants could emerge in other flowering years. However, whether and where individual plants might occur some unknown time in the future can only be speculative and cannot be the basis for development planning or decision making.	Not significant
Direct disturbance or loss of populations	Targeted surveys (undertaken in the spring of 2010) found no threatened orchid plants within the mine lease area but it is conceivable that orchid populations could emerge in other flowering years.  Although it is conceivable that populations of threatened orchid species might appear within non-preferred habitat, these occurrences would be incidental and by definition would be within areas that are not optimal.  Protection of the species will best be achieved by protecting optimal habitat because it is that habitat that is most likely to contain sustainable populations.  The protection of wet heathland is therefore the design objective of the mine. Protecting this habitat provides the best assurance against minimising the loss of populations of threatened orchid species, irrespective of whether particular populations may or may be found within the habitat in any particular seasonal survey.	Not significant



Matter	Risk assessed	Residual significance
Direct physical disturbance of loss of habitat	<p>Within the vicinity of the mine, the wet heathland is the habitat most likely to be preferred by any threatened orchid species that exist in the area. The mine footprint will require the clearance of 4.2 ha of wet heathland patches (to the east of West Creek) but will entirely protect a very much larger area of wet heathland that lies in the western part of the lease (west of West Creek).</p> <p>Relative to the wider region, the 4.2 ha lost represents only 1.2% of the total wet heathland mapped by Tasveg as occurring within a 5 km radius of the lease. In fact, the site survey indicates that the vegetation mapped by Tasveg as buttongrass moorland to the west of the mine site is actually wet heathland, meaning that the 1.2% figure is probably a significant overestimate of the actual proportion of wet heathland in the region that would be lost due to the mine.</p>	Not significant
Altered fire regimes	<p>Fire can have positive and negative effects on orchids. Orchids often flower 1 to 3 years after a fire. On the other hand fires could kill orchids if they are too intense.</p> <p>The mine will actively manage its operations to minimise the risk of fire starting on the mine site and it will also actively suppress any fires that do nevertheless start or that encroach upon it from outside.</p> <p>The net effect of these management measures is that there is unlikely to be a significant change to the historical fire regime. This is a conservative, small change approach. Local orchid populations may, in fact, actually benefit from an increased fire frequency. However, unless Shree Minerals is specifically requested by the EPA Director on behalf of DPIPWE to undertake prescribed burning within its lease, the small change approach will be implemented.</p>	Not significant
Spread of weeds	<p>The spread of weeds and also plant diseases (such as Phytophthora) is highly undesirable irrespective of their potential impact on threatened orchid species and active weed and disease management measures will therefore be implemented at the mine. Indeed, they have already been implemented during the exploration phase.</p> <p>Equipment, machinery and vehicle inspection, washdown and disinfection procedures will be implemented and enforced for anything coming to the mine from a site where it has been exposed to disturbed soil.</p> <p>These measures will continue throughout the life of the mine.</p>	Not significant
Genetic effects of small population size	<p>Genetic effects, if any, arising from small population sizes would be a factor intrinsic to the existing gene pools and distributions of the various orchid species.</p> <p>If these effects do exist, the most appropriate way to mitigate against adverse consequences would be to protect the core habitat of each species. As described above, this means protecting the wet heathland, which is achieved by the mine design.</p> <p>There is no significant potential for the mine to influence the genetic characteristics of the orchids or to exacerbate any inherent genetic risks if indeed such risks exist in the first instance.</p>	Not significant

Matter	Risk assessed	Residual significance
Loss of mycorrhizal fungus	<p>Mycorrhizal fungus associations with orchids are known to be easily compromised by weed invasion, edge effects due to altered land use, changes to soil chemistry, changes to organic content and changes to hydrology. The task for the mine therefore becomes one of ensuring that its activities do not cause any of these changes.</p> <p>Weed management measures will minimise the risk of weed invasion to the mine site itself and therefore consequential weed invasion of the wet heathlands in the western part of the lease.</p> <p>The mine design by intent creates a clear separation buffer between the mine footprint and the wet heathland in the western part of the lease. That buffer will exclude any edge effects because the mine footprint and the heathlands will not share a contiguous boundary.</p> <p>There is no identifiable causal relationship between the presence of the mine in the eastern part of the mine lease and the soil chemistry or organic of the wet heathland in the western part. Any mooted of some possible unknown relationship could only be speculative at best, and without scientific basis.</p> <p>The remaining potential impact of the mine on mycorrhizal fungus associations with orchids is a change to the hydrology of the soil where those associations take place. The wet heathland (the preferred habitat of the orchids) in the western part of the lease is well away from the mine pits and will be at the extreme margins of the water table depression that will occur from pit dewatering. More importantly, the wet heathland is a groundwater recharge area. The heathland soil does not derive its water from the underlying groundwater but rather from precipitation from above. Even if it did occur, any lowering of the watertable below the heathland (which at most would be marginal anyway) could therefore not change the soil water regime and therefore could not affect mycorrhizal fungus associations.</p>	Not significant
Loss of pollinators	<p>Many orchids (but not all - some are self-pollinating) rely on insects for pollination. Loss of pollinator habitat could therefore impact on orchids by reducing their pollination rates.</p> <p>However, regardless of which particular vegetation community might be preferred by particular orchid pollinators, the maximum percentage loss of any given vegetation community within a 5 km radius of the mine is less than 3%.</p>	Not significant
<b>Wedge-tailed eagle</b>		
Nest disturbance	<p>The survey area has a low probability of containing eagle nests as most of the mature eucalypts within the study area have been badly fire damaged. The nearest known eagle nest is approximately 1.8 km to the north east of the study area (nest id 971500). A helicopter-based search failed to locate any other nests.</p>	Not significant
Roadkill	<p>An increase of traffic volume to and from the proposed mine site could potentially result in a higher incidence of road kill or injury to individual birds as they feed on any carcasses of wildlife killed by traffic. However, roadkill minimisation measures and the removal of any roadkill from mine roads and Wuthering Heights Road will mitigate this risk.</p>	Not significant

Matter	Risk assessed	Residual significance
<b>Masked owl</b>		
Nest loss due to vegetation clearing	<p>There is a potential impact on nesting owls from vegetation clearing if owls use any of the old trees on the site for nesting and clearing occurs during the nesting season.</p> <p>However, preclearance surveys will take place immediately before each stage of clearing to identify any nesting habitat trees currently in use by masked owls. A temporary 50 metre buffer will be established around any such nests during the clearing operations. Only after the nest has been confirmed to be vacated will the vegetation clearing be completed.</p>	Not significant
<b>Spotted-tailed quoll</b>		
Displacement by vegetation clearing	Based on conservative (high) assumptions about quoll densities on the site, clearing of vegetation for the mine could displace up to 1 quoll. However, the area cleared will not be significant relative to the movement range of quolls or the large area of surrounding vegetation.	Not significant
Den loss due to vegetation clearing	<p>There is a potential impact on quolls from vegetation clearing if any maternal dens are present and occupied and clearing occurs during the denning season.</p> <p>However, preclearance surveys will take place immediately before each stage of clearing to identify any maternal dens currently in use by quoll. A temporary 50 metre buffer will be established around any such dens during the clearing operations. Only after the den has been confirmed to be vacated will the vegetation clearing be completed.</p> <p>New denning opportunities will be created within a Fauna Habitat Protection Zone to the west of the mine footprint by constructing numerous windrows of cleared vegetation piles. Materials for the creation of the windrows will be sourced from the forest materials cleared for the waste rock dump and tailings dam and will include large trees placed specifically to create suitable denning hollows and to create good fauna shelter.</p>	Not significant
Roadkill	<p>An increase of traffic volume to and from the proposed mine site could potentially result in a higher incidence of quoll road kill. However, this risk will be mitigated through a number of measures.</p> <p>The speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour. This is the critical stopping distance for avoiding roadkill at night but will be applied throughout the day also as a conservative measure.</p> <p>Mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily). The roadkill will be moved at least 40 m from the edge of the road verge.</p> <p>Product transport will be restricted to daylight hours. Without this restriction, product transport could increase the quoll roadkill on the region's roads by 0.6 every year (and 1.6 in year 1). Confining product transport to daylight hours will reduce these risks to 0.1 and 0.3 kills per year respectively.</p>	Not significant
<b>Tasmanian devils</b>		
Displacement by vegetation clearing	Based on conservative (high) assumptions about devil densities on the site, clearing of vegetation for the mine could displace up to 2 devils. However, the area cleared will not be significant relative to the movement range of devils or the large area of surrounding vegetation.	Not significant

Matter	Risk assessed	Residual significance
Den loss due to vegetation clearing	<p>There is a potential impact on devils from vegetation clearing if any maternal dens are present and occupied and clearing occurs during the denning season.</p> <p>However, preclearance surveys will take place immediately before each stage of clearing to identify any maternal dens currently in use by devils. A temporary 50 metre buffer will be established around any such dens during the clearing operations. Only after the den has been confirmed to be vacated will the vegetation clearing be completed.</p> <p>New denning opportunities will be created within a Fauna Habitat Protection Zone to the west of the mine footprint by constructing numerous windrows of cleared vegetation piles. Materials for the creation of the windrows will be sourced from the forest materials cleared for the waste rock dump and tailings dam and will include large trees placed specifically to create suitable denning hollows and to create good fauna shelter.</p>	Not significant
Roadkill	<p>An increase of traffic volume to and from the proposed mine site could potentially result in a higher incidence of devil road kill. However, this risk will be mitigated through a number of measures.</p> <p>The speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour. This is the critical stopping distance for avoiding roadkill at night but will be applied throughout the day also as a conservative measure.</p> <p>Mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily). The roadkill will be moved at least 40 m from the edge of the road verge.</p> <p>Product transport will be restricted to daylight hours. Without this restriction, product transport could increase the devil roadkill on the region's roads by 3 every year (and 8 in year 1). Confining product transport to daylight hours will reduce these risks to 0.6 and 1.6 kills per year respectively.</p>	Not significant

# 1. Introduction

Shree Minerals Limited is proposing to develop a magnetite/hematite mine near Nelson Bay River in north western Tasmania.

Shree Minerals is an ASX listed mineral exploration company (ASX: SHH) with an interest in a diversified portfolio of exploration tenements located in Tasmania. Shree is well supported by cornerstone investors, ASX listed coal producer Gujarat NRE Coking Coal Limited (ASX: GNM) and China Alliance Holdings Group Limited, a Chinese investment group.

The Company's 100% owned Nelson Bay River Project is its most advanced exploration target and has significant iron resources estimated as per the *Australasian Code for Reporting of Mineral Resources and Ore Reserves* (the 'JORC Code' or 'the Code') guidelines. Shree holds a number of other prospective exploration licences including Sulphide Creek (gold), Mt Bertha (iron, copper-gold, and magnesite) and Mt Sorell (base metals).

This Development Proposal and Environmental Management Plan (DPEMP) has been prepared to support an application by Shree Minerals Limited for assessment of a mining operation under LUPAA and EMPCA. It has been prepared in accordance with the following documents:

- *General Guidelines for the Preparation of a Development Proposal and Environmental Management Plan (DPEMP Guidelines)*
- *DPEMP Project Specific Guidelines for Nelson Bay River Magnetite Mine* (provided by the EPA on 18 May 2011, following submission of an NOI on 23 March 2011).

The project specific guidelines identified the following five key issues as requiring consideration in the DPEMP:

- Surface and groundwater quality
- Acid mine drainage, waste rock/tailings dam management
- Biological values of Nelson Bay River
- Threatened flora and fauna
- Closure strategy.

An EPBC referral of the project has been submitted under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* on 15 February 2011. A referral decision from the Minister, Department of Sustainability, Environment, Water, Population and Communities (SEWPAC), dated 17 March 2011 advised that the project will be assessed using an environmental impact statement (EIS) under sections 101 to 105 of the EPBC Act. The assessment will not be under the accredited State assessment process but will be a separate Commonwealth process and will be undertaken in parallel with the State DPEMP assessment process.

Metallurgical testwork of the Nelson Bay River magnetite ( $\text{Fe}_3\text{O}_4$ ) resource has returned magnetite concentrates >69% with low aluminium oxide, phosphorus sulphur and silica dioxide. The resource is ideally suited for the production of marketable concentrate for either heavy media markets or pellet production.

The present resource estimate, reported according to the JORC Code, is based on information from 24 diamond holes, with a combined length of 2,513 m. The global iron resource estimate is 12.7 Mt at 36.1% Fe including magnetite resources and goethite-hematite resources.

The current mine plan is to target approximately 4 Mt of this resource over a 10 year period. Targeting of the rest of the resource will be developed while the initial 4 Mt is being mined. The global resource could provide up to 30 years of mining at 400,000 tpa.

## 2. Proposal Description

### 2.1 Location

The location of the mining lease application area is shown in Figure 1.

It is located approximately 4 km east of Couta Rocks, in north western Tasmania. Couta Rocks has the nearest sensitive receptors (habitable buildings). Approximate distances from the lease boundary to other sensitive receptor areas are: 4 km south to farmsteads; 7 km southwest to Temma; 10 km north west to Arthur River; 15 km south east to Balfour and 20 km north east to Roger River.

Road access from the Arthur River township direction (northwest) is via Temma and Rebecca Roads and then Wuthering Heights Road. Road access from the Roger River township direction (northeast) is via Blackwater Road and the Rebecca Link Road and then Wuthering Heights Road.

Wuthering Heights Road is a frequently used forestry road, which leads past a Forestry Tasmania gravel quarry to forestry plantations, which lie on the northern and eastern side of Nelson Bay River.

Local access to the resource site is via the end of a forestry spur road and then a newly upgraded local access road that leads to the baseline access road, as shown on Figure 2.



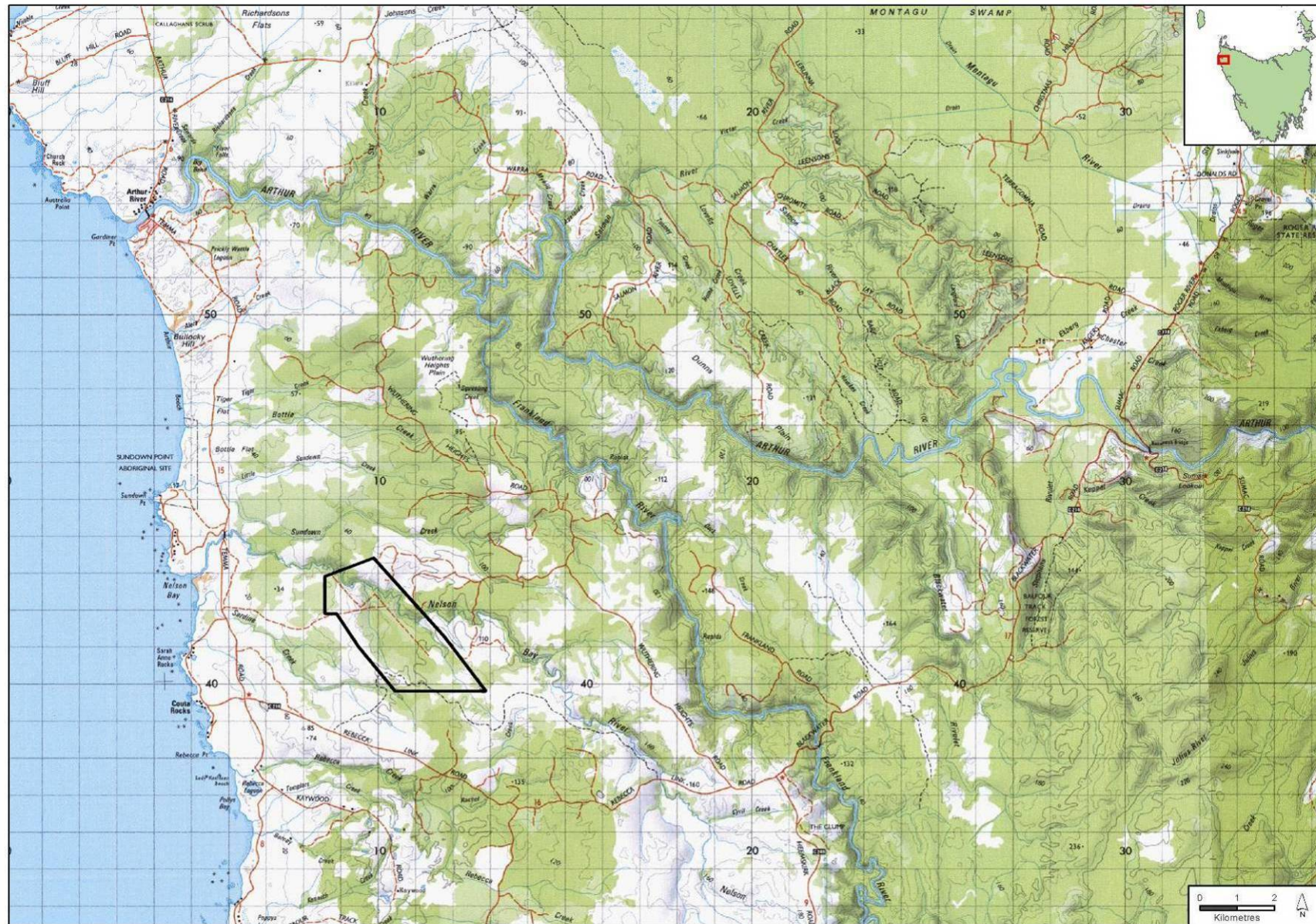


Figure 1: Local area map of proposed mine site (proposed lease boundary shown)



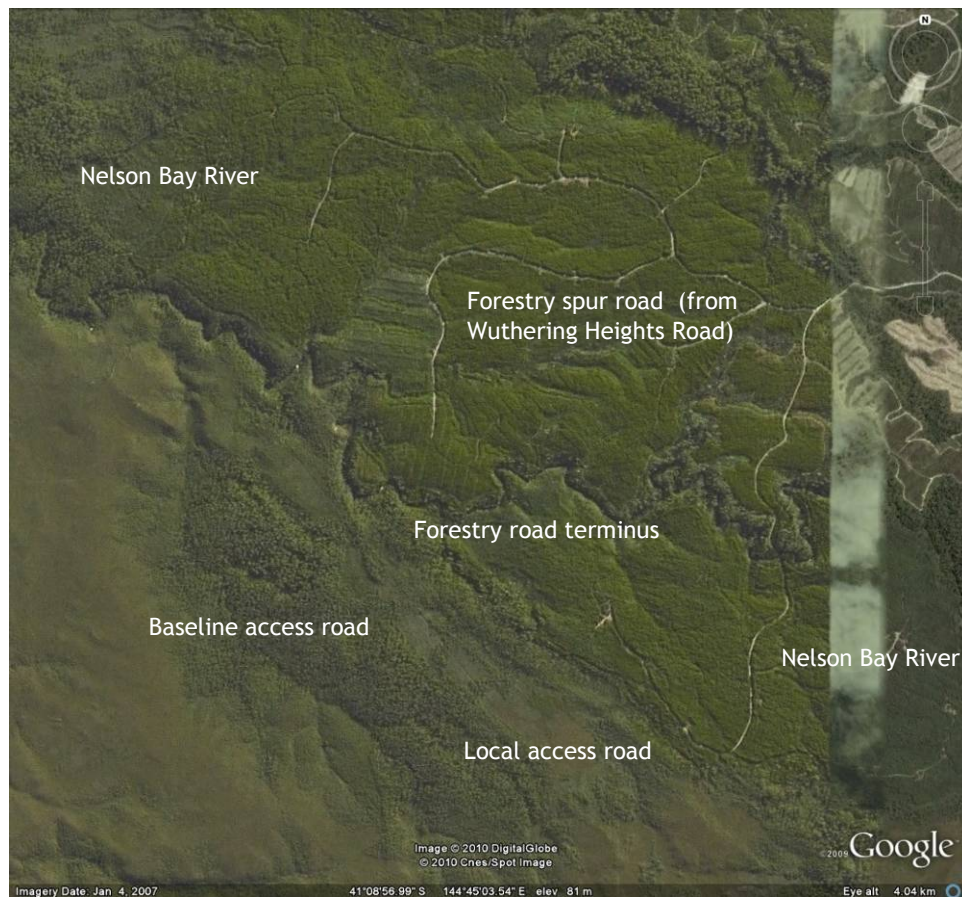


Figure 2: Existing local access to resource area (scale: width of image 4.5 km)

## 2.2 Description

### 2.2.1 General

Shree Minerals Limited proposes to extract magnetite and hematite ore by open cut mining.

#### *Mining*

The magnetite ore body is the main target of the proposed operation. This ore body, which is located close to Nelson Bay River, will be extracted by developing a pit (“main pit”) to a depth of approximately 225 m (-145 m RL). The ore will be beneficiated in an on-site processing plant prior to road transport to the port of Burnie (or Port Latta) on the north coast of Tasmania.

The top 30 m of the magnetite pit is beneficiable oxide ore with an expected 90% ROM recovery. The magnetite ROM recovery is expected to be 95%.

In addition to the main pit, there is also an extended near-surface oxidised ore body, comprising direct shipping quality (Direct Shipping Ore, DSO) hematite. This ore will be extracted by shallow excavation (“DSO pit”) to a depth of approximately 35 to 40 m down-dip (60 to 65 RL) and transported directly to the port, with the only beneficiation likely to be crushing and screening.

The DSO pit will be mined before the deep magnetite pit. Currently the mining limit for this pit will be 40 m downdip from the surface, with ROM recovery expected to be 90%. Further exploration during mining may extend the depth of this mining limit.

It is expected that the full DSO pit and the upper 20 m (oxidised layers) of the main pit will be free-dig mining, requiring no blasting. Blasting is only anticipated in the main pit, below the free-dig horizon.

### *Processing*

The magnetite processing plant will be constructed south of the main ore body, close to the access point to the mine site.

The DSO ore (hematite) will require crushing and screening only. Processing of the magnetite ore will involve crushing and grinding, followed by dry magnetic separation and regrinding, then wet magnetic separation and filtering and finally drying of the transportable product. The magnetite metallurgical recovery is expected to be 36%.

### *Production*

It is anticipated that production will commence with extraction of oxide ore (hematite) from the DSO pit in year 1, followed by production from the main pit during years 2 to 10 of the operation.

Oxide ore (hematite) will be produced from the main pit in year 2 and the first three months of year 3. Thereafter, all production from the main pit will be magnetite ore. The expected mine life for the combined DSO/main pit operation is 10 years.

Anticipated ore and concentrate production rates are summarised in Table 1.

Table 1: Anticipated mine life ore and concentrate production rates

Year	Annual ore production	Cumulative ore mined	Oxide ore <sup>1</sup>	Magnetite ore	Concentrate	Product shipped out
	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
1	394,181	394,181	~355,000 <sup>2</sup>	-	-	~355,000
2	384,372	778,553	~346,000 <sup>3</sup>	-	~242,000	~242,000
3	407,034	1,185,588	~36,000	366,331	~156,000	~156,000
4	400,551	1,586,139	-	400,551	~150,000	~150,000
5	396,848	1,982,987	-	396,848	~150,000	~150,000
6	381,561	2,364,547	-	381,561	~150,000	~150,000
7	383,107	2,747,655	-	383,107	~150,000	~150,000
8	426,805	3,174,459	-	426,805	~150,000	~150,000
9	386,981	3,561,440	-	386,981	~150,000	~150,000
10	274,636	3,836,076	-	274,636	~150,000	~150,000

<sup>1</sup> ROM recovery rate is expected to be 90% of production rate

<sup>2</sup> Production from DSO pit

<sup>3</sup> Production from main pit and thereafter for subsequent years

### *Future development*

Subject to further exploration work that will be undertaken as the mining proceeds, a second stage of the mine could extend this life by targeting additional parts of the resource. This would be the subject of a separate mine plan and environmental approval.

## **2.2.2 Mine setting**

### *Resource*

The resources at the site consist of approximately 1.0 km in strike length of hematite-goethite mineralisation within an ultramafic dyke, with magnetite resources extending over approximately 400 m of this strike length. Recent ground magnetic surveys, however, indicate that the mineralised strike length may be in excess of 2.3 km. Mineralisation remains open along strike and at depth.

The magnetite ore, which occurs beneath the beneficiable oxide zone at the northern end of the deposit, lies within the ultramafic dyke that outcrops at the surface. The dyke strikes generally northwest-southeast, dips to the southwest at an angle around 65°, and is typically 10 m to 40 m thick. As the floor of the ultramafic dyke is considered to be competent, no significant groundwater inflows are anticipated.

The open pit ore body has been defined by ground magnetic interpretation, surface mapping and twenty-two cored drill holes. The oxide ore body is currently closed approximately 100 m to the south of the main body of drilling.

The northern limit to open pit mining is constrained by the proximity of the Nelson Bay River. The river is some 10 m wide and occurs to the east and north of the deposit. The deposit is interpreted to extend some 100 m to the north to the other side of the river but this extension has not been included in the ore body. In addition to imposing mining limits, the proximity of the river places constraints on the location of out-of-pit waste dumps.

### *Overburden*

The overburden consists of Proterozoic sediments dipping to the east at angles around 60° to 70°. The topography is gently undulating between 90 m to 100 m above sea level. A variable layer of peat generally occurs at the surface.

Depth to base of weathering for the waste sediments is typically 20 m to 25 m whereas the oxidized dyke base of weathering extends beyond 40 m.

### *Potential mine stability*

The dipping hanging wall and footwall sediments observed at site and in the core appear to be very competent with no obvious problems for mining. The bedding, dipping into the footwall and the observed contact of the dyke with the sediments indicate a competent footwall rock unit which can contain a footwall ramp for the mining operations.

The hanging wall waste/ore zone boundary appears to be defined by a hanging wall shear which should provide a good physical and visual separation between the waste sediments and the dyke. A second hanging wall shear was observed within the dyke with the significant magnetite ore occurring between this second shear and the footwall of the dyke.

### *Resource dilution*

The dyke footwall waste sediment boundary appeared in the core to be indurated. This may require special attention during mining to minimise the occurrence of loss and dilution at the contact.

### *Potential acid drainage*

Some areas of pyrite were observed in the core that could lead to potential acid drainage problems in the waste rock dump. This material will require appropriate treatment including encapsulation.

### *Mine location*

The proposed mine site has been selected because it will result in the most efficient exploitation of the known mineral resource in this particular area. Mining of the resource as proposed by Shree Minerals will result in the minimisation of mineral resource loss during mining operations and also any long term sterilisation of the resource.

The proposed location of the mine pits and associated processing facilities has been identified as the most suitable location and no viable alternative sites have been identified.

### *Mine layout*

A conceptual mine layout is provided in Figure 3, which shows the end of mine (10 year) footprint. Staging footprints (1, 5 and 10 years) are provided in Appendix A. Cross sections of the mine pits are provided in Appendix B. The landscape of the mine site is shown in Figure 4.

The layout is aligned from southeast to northwest, reflecting the underlying resource lineaments. Two creeks cross the mine site and these also have a southeast to northwest alignment. The creeks are un-named and for convenience will be referred to as West Creek and East Creek. The mine pits lie between these creeks and the mine infrastructure has been designed to also lie between them, so avoiding any significant loss of riparian habitat.

The vegetation between the creeks is largely *Eucalyptus nitida* and *obliqua* forest and western wet scrub, none of which are threatened communities. This will need to be progressively cleared for the mine. Sensitive wet heathland lies to the west of West Creek. The confinement of the mine infrastructure between the creeks means that there will be no impacts on this heathland.

The pits will be located at the northwestern end of the mine site. The waste rock dump will commence at the northwestern end and progressively grow to the southeast.

The proposed waste rock dump location has been chosen because it provides the most compact mine footprint, the shortest haul distances and it avoids incursion on significant vegetation to the west. In addition, a waste rock dump in this proposed location would be less visible from Rebecca and Temma Roads than one located on the heathland to the west.

The proposed location of the ore processing facilities is approximately 1.2 km southeast of the pit, close to the access point to the mine site.

A conceptual design of the processing plant is provided in Appendix C.



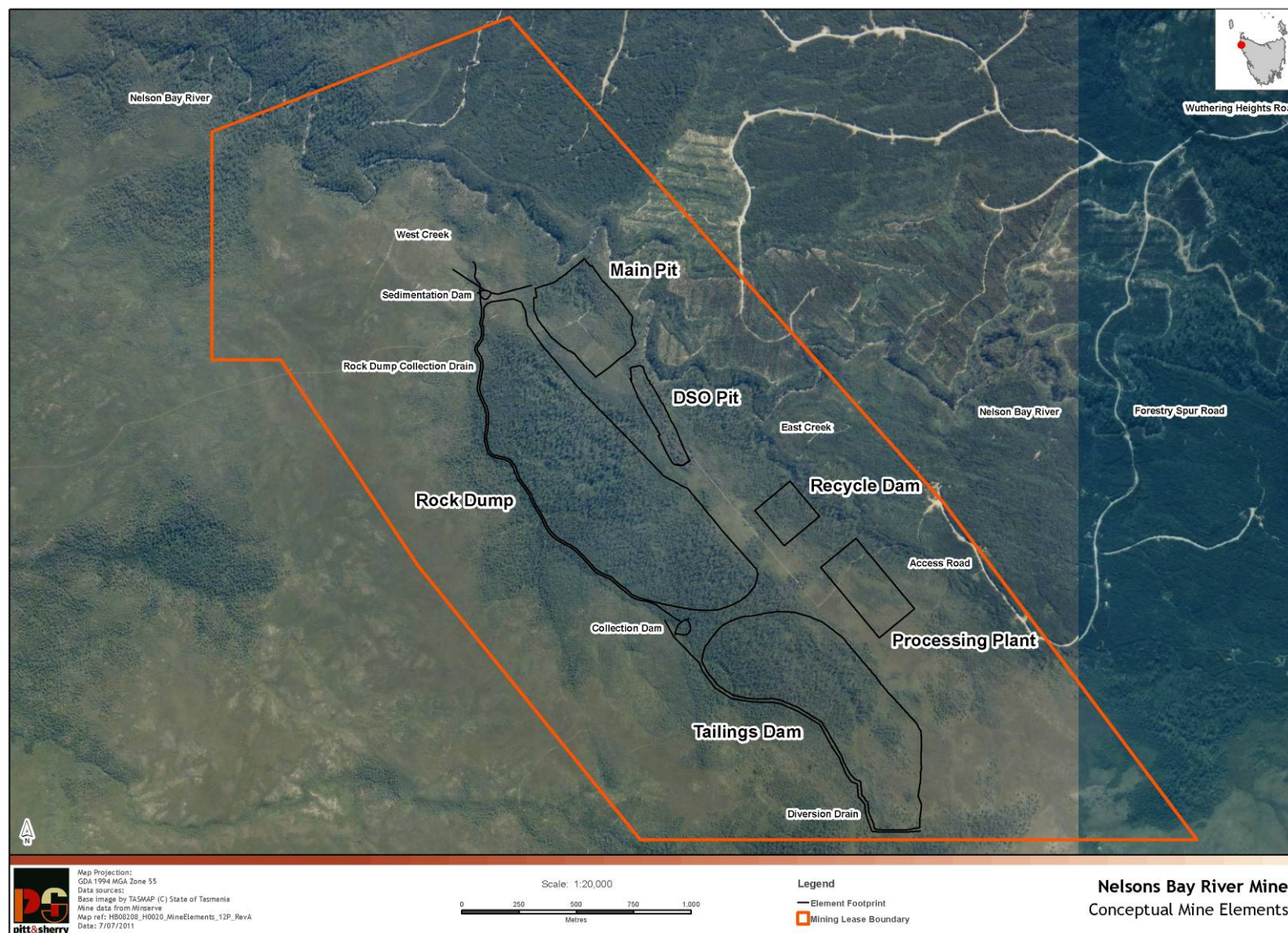


Figure 3: Principal mine elements (end-of-mine life footprint)





Figure 4: Landscape of the mine site

Several potential sites were considered for the proposed location of the tailings dam. The proposed site is considered to be the most suitable location because:

- The site is close to the proposed site for the process plant
- The site has suitable topography; it is relatively flat lying, thus minimising topographical constraints on storage volume
- The expected local clay resource in the area will facilitate construction of the facility (but, if local clay reserves are inadequate, additional clay will be imported from a licensed commercial supplier).

The tailings facility will be operated to recycle decant water into the beneficiation process via a recycle storage dam. Excess tailings dam water (from incident rainfall, will be sent to a central treatment plant, for neutralisation if necessary, prior to discharge to East Creek.

Both the tailings dam's overflow/seepage basin and the water recycle dam will need to have provisions for overflows, which will be to West Creek and East Creek respectively.

In the case of the basin, West Creek runs for approximately 2 km before it reaches Nelson Bay River. In the case of the recycle dam, East Creek runs for approximately 500 m before it reaches the river. There will be no direct discharges to the Nelson Bay River.

## 2.3 Hydrogeological conditions

A hydrogeological report<sup>1</sup> has been prepared by William C. Cromer Pty Ltd and is provided in Appendix D.

The mine site and environs are located on a coastal surface dissected by a dendritic drainage system. The surface is at elevations of about 80 - 100 m ASL near the proposed open pits, and on average slopes gently west at about 1°.

Climatic data from the nearest meteorological stations are shown in Table 2. The mean annual rainfall at Temma (approximately 7 km southwest of the mine site) is 1300 mm. Annual evapotranspiration (ET) at Smithton Airport totalled 945 mm and 988 mm for 2009 and 2010 respectively, and exceeded mean monthly rain from November to March.

Effective annual rain (mean rain less ET for the period April to October) at the mine site is therefore estimated to be approximately 570 mm.

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<sup>1</sup> Cromer, W. C. (2011). *Hydrogeological report, Proposed Nelson Bay River Magnetite Mine*. (Unpublished report for Shree Minerals Ltd. by William C. Cromer Pty. Ltd.).

Table 2: Climatic summary for Temma and Smithton airport Bureau of Meteorology stations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temma rainfall (mm)													
Mean	57	58	74	106	135	152	166	152	123	100	85	81	1300
Highest	134	186	221	219	283	238	278	266	217	213	166	245	1745
Lowest	8	7	14	31	50	60	56	39	48	34	14	3	929
Smithton airport evapotranspiration (ET; mm)													
2009	160	111	80	62	43	24	30	55	69	102	73	136	945
2010	154	127	105	63	44	29	27	44	64	91	109	131	988
Effective rain (mean rain less ET)													
2010	-97	-69	-31	43	91	123	139	108	59	9	-24	-50	572

The surface streams include Nelson Bay River and its tributaries West Creek and East Creek, and, in separate catchments to the southwest and north, Sardine Creek and Sundown Creek respectively.

Near the mine site, Nelson Bay River has cut through the coastal surface to base levels between 40 and 50 m ASL, so the local relief is up to 50 m and hillsides are steep.

The approximate surface water catchment areas of West and East Creeks are 320 ha and 270 ha respectively. The estimated mean annual discharges of West and East Creeks to Nelson Bay River are about 1650 ML and 1400 ML respectively.

Catchments (and groundwater and surface water sampling stations) are shown in Figure 5.



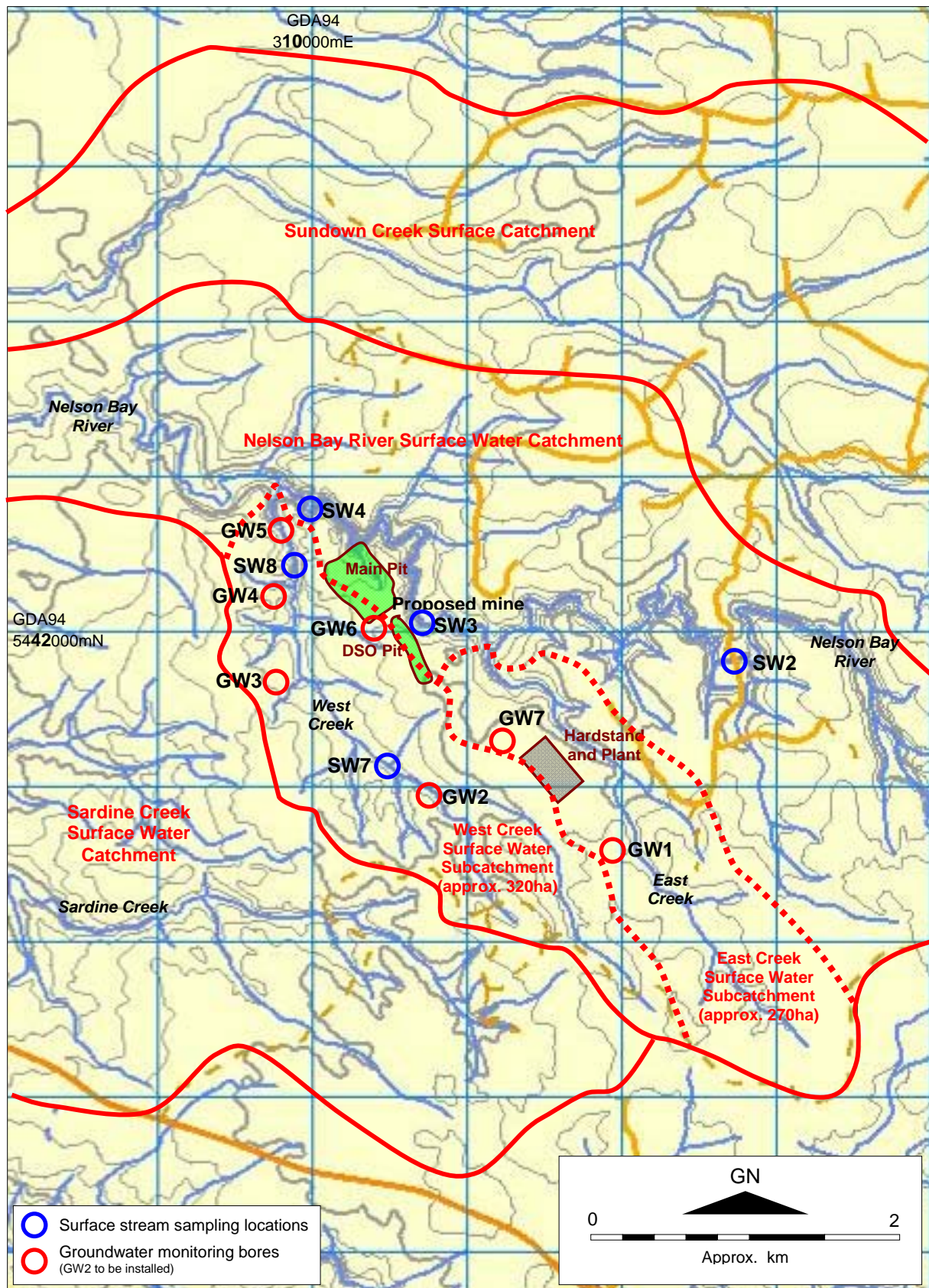


Figure 5: Surface water catchments near the proposed Nelson Bay River Mine. Mining operations will be contained within the Nelson Bay River catchment. Source: [wwthelist.tas.gov.au](http://wwthelist.tas.gov.au)

Based on general hydrogeological principles, the geology of the district, and a review of drill core photographs, the rocks and ores of the mine site and environs are regarded as fractured, hard-rock, unconfined aquifers. In such an environment, effective rain (precipitation less evapotranspiration) flows overland to surface streams, or infiltrates through the unsaturated zone to the water table.

Shallow water less than a metre or so from the ground surface was recorded from bores GW5 and GW7 (see Figure 17 in section 3.7.2 for locations). The former is in the lower reaches of West Creek, and the latter on almost flat, poorly drained ground. The remaining bores recorded water tables between about 5 and 10 m below ground.

A conceptual hydrogeological model for the mine site is shown in Figure 6.

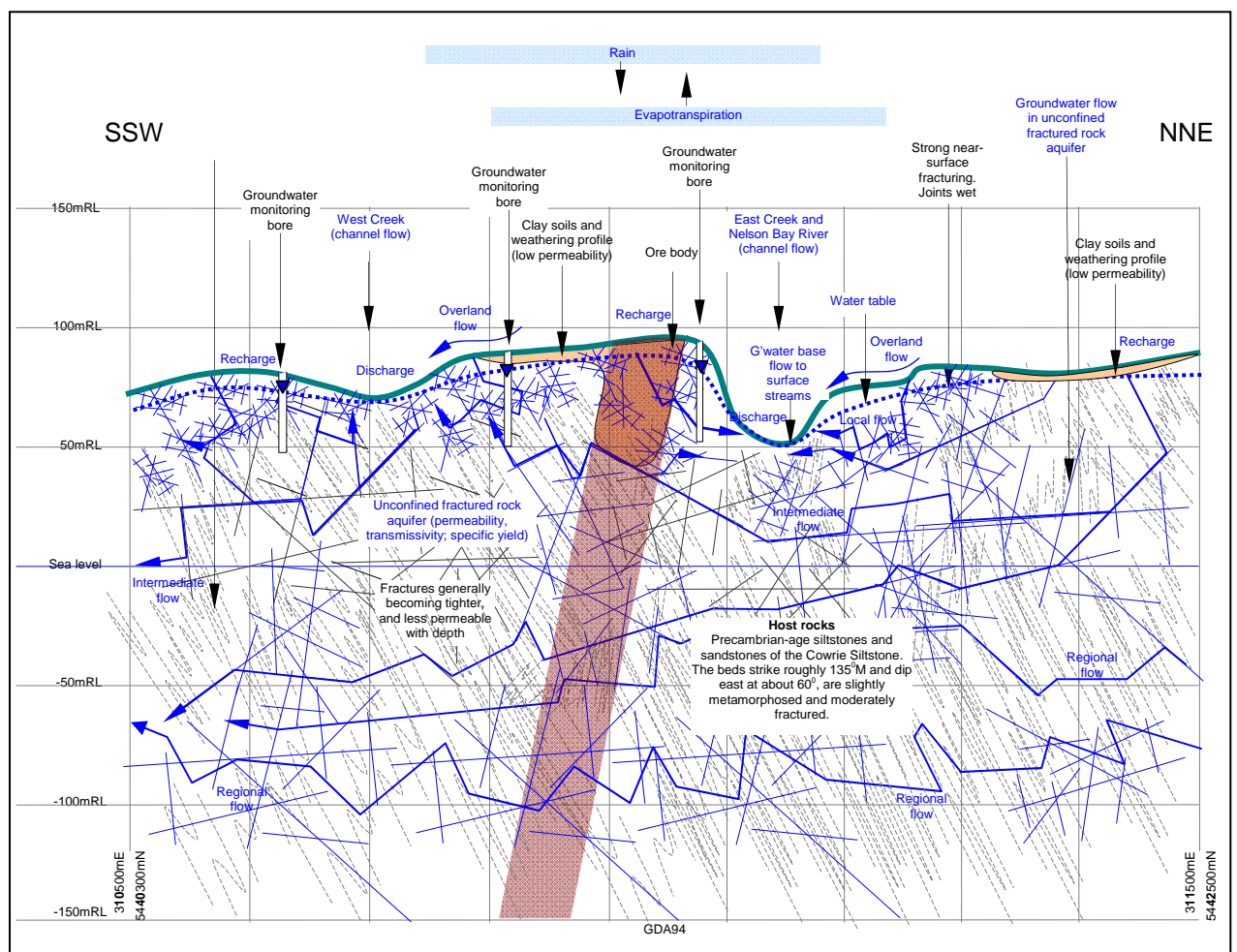


Figure 6: Conceptual hydrogeological model for the mine site (vertical exaggeration approximately 5)



The key features of the model are:

- No distinctive basement rocks but at depth overburden pressure will increasingly tend to close joints and other openings and at an intermediate-scale or regional-scale constitute a lower boundary to the groundwater system.
- The steeply easterly-dipping Cowrie Siltstone which constitutes a fractured rock aquifer. Fracturing is expected to be relatively intense at and near the surface, becoming less intense with depth. Permeability and specific yield are expected to be variable, but generally decreasing with depth. Groundwater moves only through the fractures, which separate essentially dry rock. (Other secondary porosity development might include vuggy dissolution zones in carbonates within the Cowrie Formation).
- The steeply west-dipping mineralised zone, which is locally oxidised and weathered, and probably of lower permeability, near the surface.
- Fault zones, where present, may be more permeable than the country rock and the ore bodies.
- A regional water table is expected to be a subdued replica of the land surface, and intersect the land surface along drainage lines, at least in wet periods.

Near-surface groundwater flow is controlled by local systems, where flow lines are steep (equipotential lines are gently inclined) and recharge and discharge occur on hills and intervening valleys respectively. Such conditions are likely to extend beneath the level of West and East Creeks.

At increasing depths, flow becomes intermediate and then regional in scale, with equipotential lines steepening to near-vertical, and flow lines almost horizontal.

Figure 7 is a variation of Figure 6 showing conceptual effects of mine pit dewatering on the water table towards the end of open cut operations.

Conceptual groundwater inflows (using the Theis equation) to the mine pits are provided in Table 3.

Dewatering the Main Pit, and to a lesser extent the shallower DSO Pit, will lower (“drawdown”) the water table in their vicinity, and if pumping is continued for a sufficiently long period, a near steady state condition will emerge where the lowering of the water table will cease. If pumping is stopped, the water table will rise.

Drawdown is greatest at pit and decreases radially away from it. The area of influence of a pumped bore or pit is contained within the radial distance to the point beyond which groundwater levels are unaffected by pumping.

Estimates for area of influence are provided in Table 4, based on assumed aquifer hydraulic conductivity and storativity and the final drawdown in the pit or bore.

An overlay of the distribution of wet heathland<sup>2</sup> on the surface drainage system in the area west of West Creek shows the habitat to be almost wholly located on a broad, gently-sloping interfluve in a groundwater recharge area. In this area groundwater beneath the heathland flows away from the heathland, not towards it, and groundwater therefore makes no contribution to the soil water of the heathland.

The heathland plants are shallow rooted species in peaty soil. Their soil water will be fed from above by rainfall, not from the water table below.

Dewatering of the pits during mining will lead to a drawdown of the water table in areas surrounding the pits. The effect diminishes with increasing distance from the pits.

Depending on the period and extent of dewatering, the area of influence of the pit drawdowns may extend beneath the margins of the wet heathland west of West Creek.

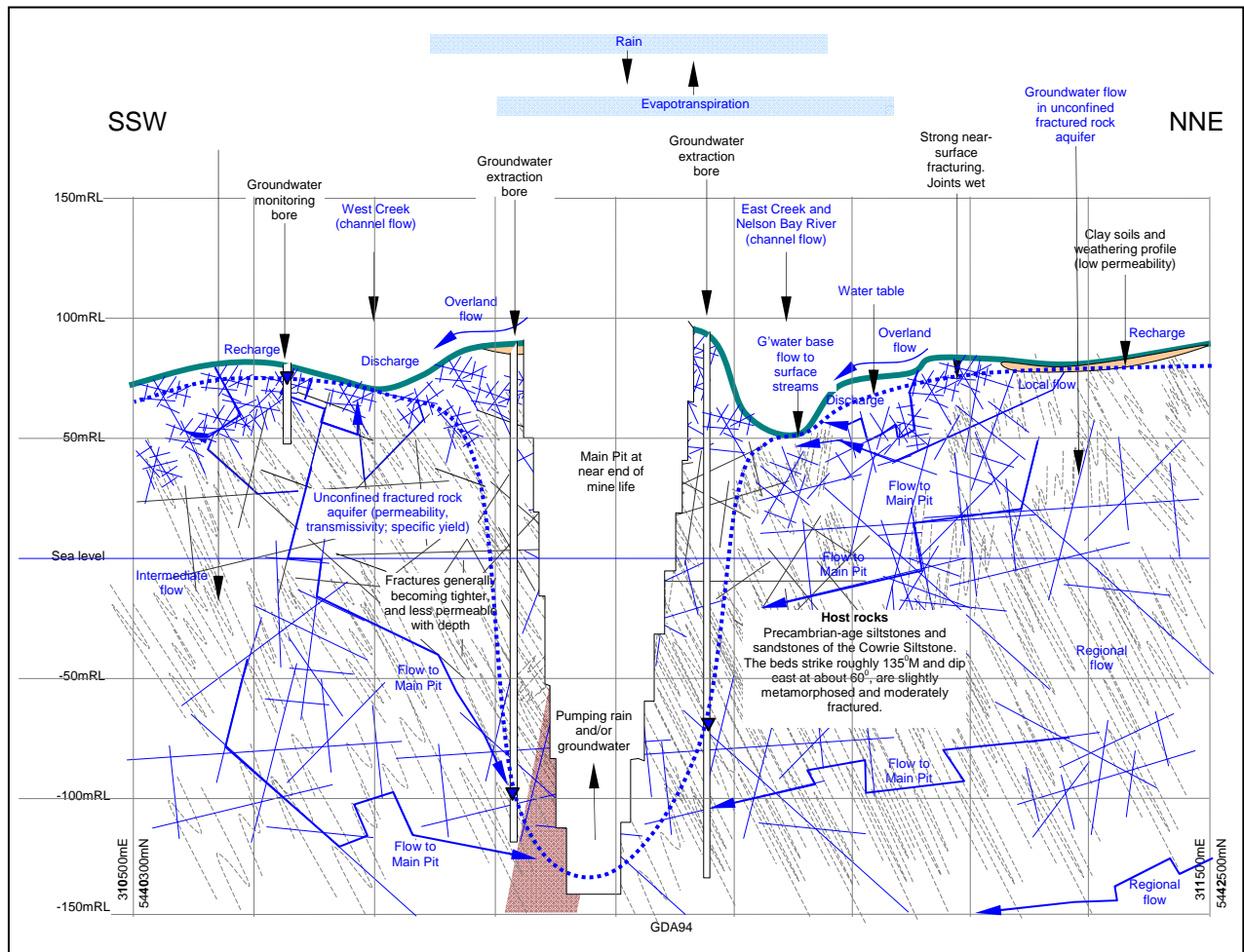


Figure 7: Conceptual hydrogeological model for the effects of pit dewatering (vertical exaggeration approximately 5)

<sup>2</sup> See Figure 2 of *Flora and Fauna Habitat Assessment: Nelson River - Shree Minerals Mine & Infrastructure Proposal*. Unpublished report for Shree Minerals by North Barker Ecosystem Services, 22 March 2001. (Appendix N)

Table 3: Estimates of groundwater inflow to the main and DSO pits assuming two values of hydraulic conductivity (Hy)

	Inflow (L/s)	Inflow (ML/yr)
Main pit (Hy = 0.1)	25	800 +/- 50%
Main pit (Hy = 0.05)	14	400 +/- 50%
DSO pit (Hy = 0.1)	8	300 +/- 50%
DSO pit (Hy = 0.05)	4	100 +/- 50%

Table 4: Estimates of groundwater areas of influence for near steady state dewatering of the Main and DSO pits assuming two values of hydraulic conductivity (Hy)

	Inflow (L/s)	Radius of influence (m)
Main pit (Hy = 0.1)	25	1200 +/- 20%
Main pit (Hy = 0.05)	14	800 +/- 20%
DSO pit (Hy = 0.1)	8	800 +/- 20%
DSO pit (Hy = 0.05)	4	350 +/- 20%

However, as stated, the wet heathland is in a groundwater recharge area, not a discharge area, and its soil water is therefore not dependent on the underlying water table. The heathland plants are shallow rooted species reliant on soil water from infiltrating rainfall, not from the underlying water table.

There is therefore no significant likelihood of the wet heathland soil water, and hence the ecosystems dependent on it, including threatened orchid species<sup>3</sup>, being affected by the dewatering of the mine pits.

Although dewatering of the pits will remove groundwater that otherwise would have flowed into Nelson Bay River, all but the 0.1 Mm<sup>3</sup>/a that will be used as process make-up water will be returned to Nelson Bay River upstream of the pits (see Figure 8 in section 2.3.3). The mean annual flow of Nelson Bay River is 46 Mm<sup>3</sup> (Figure 8), so the make-up water lost from the river is only 0.2% of the river's mean annual flow. There will therefore be no significant impact on river flows downstream from the mine.

### 2.3.1 Mining Methods

Mining will be from two pits: the DSO (shallow) pit and the main (deep) pit, the locations of which are shown in Appendices A and B.

#### *DSO pit*

DSO extraction will be by shovel and truck open cut mining. After removal of overburden, the DSO will be stripped in approximately 5 m flitches over lengths of a few hundred metres. Overburden will go to the waste rock dump.

DSO will be hauled to the crushing and screening plant, which will be constructed at the processing plant site.

<sup>3</sup>Mine dewatering is expected to have no impact on soil water conditions at and in the vicinity of the recorded location for the pretty leek orchid (*Prasophyllum pulchellum*) because the location is not only in a groundwater recharge area but is also outside the estimated area of influence of pumping.

*Main (magnetite) pit*

Ore extraction from the main pit will be by drill and blast, shovel and truck open cut mining. The upper 20 m of the resource is expected to be amenable to free-dig extraction; blasting is likely to be required at lower depths.

The ore will be removed in horizontal slices with a hydraulic excavator in backhoe mode loading rear dump trucks situated on the bench below. Pit ramps will be at 1 in 10 grade. At a nominal pit depth of 225 m, this means that more than 2 km of ramps will be required to access the bottom of the pit, which will preclude in-pit dumping of waste rock. All waste rock (apart perhaps from the final flitch) will therefore need to go to a separate out-of-pit waste rock dump.

*Estimated mining quantities*

Estimated mining quantities, strip ratios and years of production for the DSO and main pits are shown in Table 5, and annual waste rock material and ore production figures are shown in Table 6. Based on the current resource information, a mine life of 10 years is anticipated.

Table 5: Mining quantities

Item	Total volume m <sup>3</sup>	Specific gravity t/m <sup>3</sup>	Tonnes	Strip ratio m <sup>3</sup> /t	Strip ratio t/t	Years of production
<b>DSO pit</b>						
Total pit volume	857,895					
Ore volume	131,394	3.0	394,181	1.44	3.74	1
Waste	726,512	2.6	1,888,931			
<b>Magnetite pit</b>						
Total pit volume	11,904,082					
Oxide ore	141,692	3.0	425,075			1.25
Magnetite ore	815,357	3.7	3,016,820			7.75
Total ore	957,049		3,441,895	3.15	8.52	
Waste	10,947,033	2.6	28,462,286			
<b>Both pits</b>						
Total volume	12,761,977					
Total ore	1,278,692	3.0	3,836,076	2.97	8.00	10.0
Total waste	11,666,866	2.6	30,333,852			

NOTE: it is not possible to get these figures to exactly balance because they are based, in part, on assumptions (%'s, etc)

Table 6: Annual waste rock material and ore production

Year	Cumulative material movement	Annual movement	Cumulative waste mined	Annual waste	Cumulative ore mined	Annual ore mined
	bcm	bcm	bcm	bcm	tonnes	tonnes
1	857,895	857,895	726,512	726,512	394,181	394,181
2	2,745,686	1,887,791	2,486,237	1,759,726	778,553	384,372
3	4,795,962	2,050,276	4,415,268	1,929,031	1,185,588	407,034
4	7,342,161	2,546,199	6,853,503	2,438,234	1,586,139	400,551
5	9,140,369	1,798,208	8,544,743	1,691,241	1,982,987	396,848
6	10,334,245	1,193,876	9,635,772	1,091,029	2,364,547	381,561
7	11,794,887	1,460,643	10,993,152	1,357,379	2,747,655	383,107
8	12,372,891	578,004	11,456,114	462,963	3,174,459	426,805
9	12,665,436	292,544	11,644,351	188,237	3,561,440	386,981
10	12,761,977	96,541	11,666,866	22,515	3,836,076	274,636

### 2.3.2 Haulage of ore and waste rock

Ore and waste rock will be hauled out of the pits to the natural ground surface along ramped roads. Haulage will be by 30 - 35 t rear dumps or articulated trucks.

Ramps for the shallow DSO pit will be simple and will move along the DSO resource as excavation proceeds along the resource. Ramps for the main pit will move down as the pit deepens.

Ore will be taken to the processing plant via a haul road to be constructed. The haulage distance from the DSO pit to the crushing and screening plant will be approximately 1 km.

The out-of-pit haulage distance from the main pit to the processing plant will be approximately 2 km. The within-pit haulage distance will progressively increase to about 2 km when the main pit reaches maximum depth.

PAF waste rock will be taken to the DSO pit for encapsulated disposal. In the event that the DSO pit has insufficient capacity, excess PAF rock will be stored in encapsulation cells above the DSO pit. This excess material will be disposed of in the main pit on mine closure.

The majority of the NAF waste rock will be taken to the NAF waste rock dump. Potential other uses for waste rock are discussed in section 2.4.

### 2.3.3 Ore processing

The conceptual design for the processing plant is provided in Appendix C.

#### *Hematite*

There are two distinct grade material areas contained within the Nelson Bay River hematite deposit. Higher grade material occurs in the DSO pit and lower grade material occurs above the magnetite ore in the main pit.

The higher grade material will be prepared as a direct shipping ore (DSO), the processing of which will simply be: mine, crush and screen.

The lower grade hematite above the main pit is too low in iron and high in silica to be blendable with the higher grade material for direct shipping. This material will require beneficiation.

The preliminary flowsheets for high and low grade hematite are provided in Appendices E and F respectively.

### *Magnetite*

Magnetite (and low grade hematite) ore will be processed at a plant to be located approximately 1.2 km southeast of the pit (see Figure 3).

Metallurgical test work has shown that the ore is readily able to be concentrated using simple processing. Coarse dry magnetic separation followed by wet magnetic separation has demonstrated a recoverable magnetite with an Fe grade greater than 69.0% and  $\text{SiO}_2 < 1.6\%$ ,  $\text{Al}_2\text{O}_3 < 0.05\%$ ,  $\text{S} < 0.1\%$  and  $\text{P} < 0.01\%$ .

A preliminary magnetite processing plant flow sheet is provided in Appendix G.

420,000 tpa of ROM ore will be crushed in the primary jaw crusher. The primary crushed ore is conveyed to the secondary screens for screening. Typically the material would be screened at 40 mm; however, this needs to be confirmed with testwork to be undertaken during detailed design.

The oversize (+40 mm) ore from the secondary screen is conveyed to the secondary cone crushers. The crushed product is conveyed back to the secondary screens.

The secondary screen undersize (-40.0 mm) ore is conveyed to a buffer stockpile ahead of the high pressure grinding rolls (HPGRs). The purpose of the stockpile is to disengage the crushing and grinding sections, which have different operating availabilities.

Ore is removed from the stockpile by under ore feeders and conveyed to a series of bins to feed the three lines of HPGRs.

The HPGR ground ore is screened at 3 mm. This size is to be confirmed with further testwork. The oversize is recycled to combine with the fresh feed and reprocessed through the HPGRs. The undersize (-3 mm) is slurried with water and pumped to the first stage of magnetic separation, the rougher wet low intensity magnetic separators (RW LIMS).

The RW LIMS separate the -3 mm ground product into magnetic concentrates (cons) and non-magnetic tailings (tails) streams. The tails are pumped to the tails thickener, reducing the amount to be further ground by ball mills. The rougher cons are re-slurried with water and pumped to the ball mills. Grinding balls are added on an as need basis.

The ground material discharged from the ball mills is screened to remove ball scats and other oversize detritus with the undersize pumped (with additional process water added if required) to derrick screens for screening at 106  $\mu\text{m}$ . This yields an estimated screen undersize product, P80 of ~75  $\mu\text{m}$ . The oversize (+106  $\mu\text{m}$ ) is recycled to the ball mills for regrinding.



The -106  $\mu\text{m}$  pulp is pumped to the secondary LIMS for further magnetic concentration and then is reslurried and pumped to the cleaner wet LIMS for final magnetic concentration. The secondary wet LIMS units separate the -106  $\mu\text{m}$  ground product into mags (cons) and non-mags (tails) streams.

The cleaner wet LIMS concentrate, analysing ~68% Fe with other specified materials being within the required concentrate product specification, are repulped with process water and pumped to the concentrate thickener for partial dewatering.

The thickener underflow at 65%w/w solids is pumped to the concentrate filter. Filtered concentrate is stored in the concentrate storage shed before transportation to the shipping port via road.

The secondary wet LIMS and cleaner wet LIMS non-mag tails are pumped to the tailings thickener, combining with the rougher LIMS non-mag tails, and thickened and pumped to the tailings storage facility.

The tailings thickener overflow and concentrate thickener overflow flow by gravity to the recycle water dam for use in the operations.

Flocculent concentrations in the tailings are not expected to be too high because the flocculent molecules are tied up with the solids, making floccs. Any concentration of the flocculate, being fed to the thickeners, once it is diluted with the ore slurry, is expected to be of the order of grams per tonne of solution (including the material used to form the floccs). The vast majority of this material will remain with the solids in the tailings dam.

The mass balance of the magnetite processing plant indicates that there will be a significant loss of water to the tailings dam (22.7 tph to the dam and 11.4 tph returning), a recovery of about 50% by the tailings facility. Although this figure is high, it is considered to be reasonable, given the high rainfall and low evaporation rates of western Tasmania. As the discharge stream is almost the same as the fresh water input (12.1 tph), a bleed off stream has not been allowed for at this stage.

The basic mass balance for the magnetite process, provided in Appendix G, is summarised in Table 7.

Table 7: Basic mass balance summary for magnetite flowsheet

Magnetite processing stream data	HPGR fresh feed	Rougher concentrate	Secondary concentrate	Cleaner concentrate	Filtered concentrate
Solid (tph)	53.3	32.2	22.6	19.2	19.2
Water (tph)	1.4	21.5	15.0	12.8	2.1
% solids (w/w)	97.5	60.0	60.0	60.0	90.0
Fe %	40.9	54.1	61.8	68.2	68.2
SiO <sub>2</sub> %	22.6	18.7	10.7	4.7	4.7

### *Water requirements*

The concentrator is expected to be available for 7,884 hours per year. The process flowsheet (Appendix G) shows a process water requirement of 219.6 tph, giving a maximum annual requirement of approximately 1.8 Mt of process water, i.e. 1.8 Mm<sup>3</sup>. This water will be a combination of recycled water and fresh make-up water.

As shown in the flowsheet, the water balance is 207.5 tph of return process water and 12.1 tph of fresh make-up water, i.e. 1,636,000 m<sup>3</sup> of recirculated water and 95,000m<sup>3</sup> of fresh make-up water per year. The estimated mine water budget is shown in Figure 8.

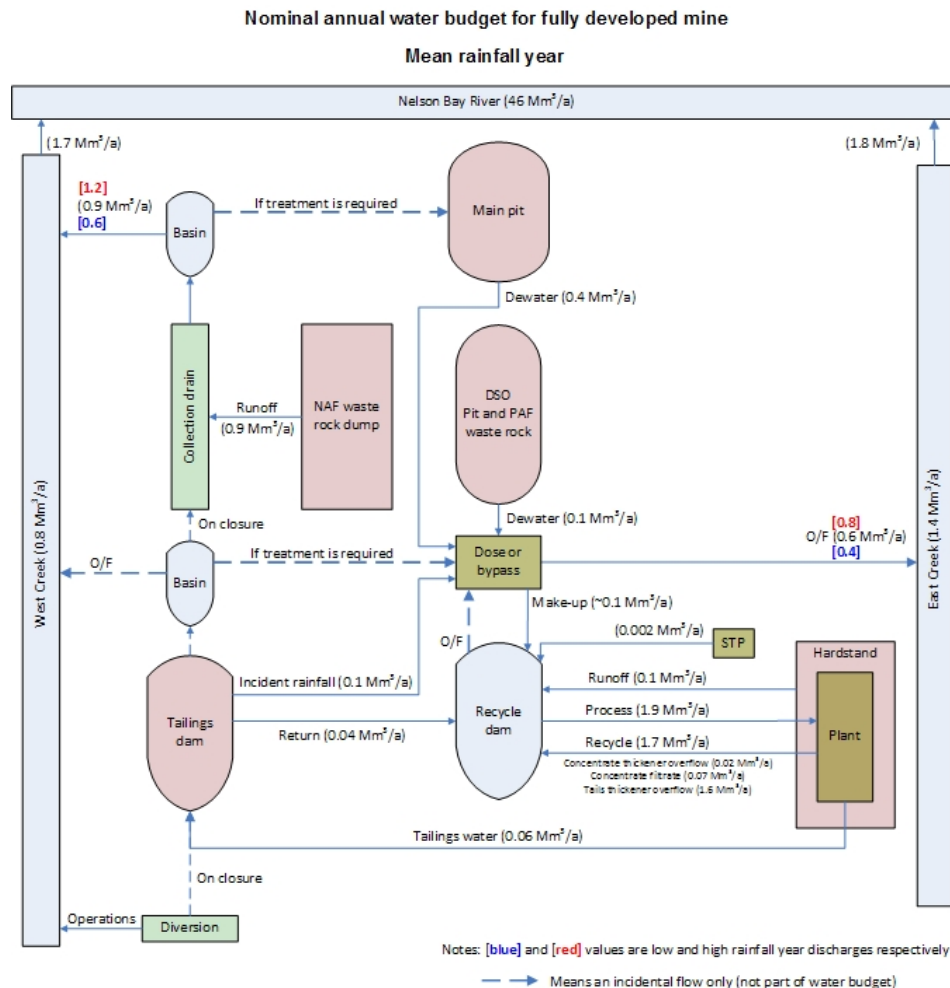


Figure 8: Nominal annual water budget for fully developed mine (mean rainfall year)

Normal practice is to have dam storage capacity for 2-4 weeks of the annual requirement. This equates to 136,500 m<sup>3</sup> of recirculated water and 8,000 m<sup>3</sup> of fresh water for one month's capacity.

The recycle water will be held in a dedicated dam, to be constructed near the processing plant. This dam will receive the decant from the tailings dam and its sedimentation basin. Make-up water will be supplied to the recycle dam from the DSO pit, which will accumulate its own water after the completion of mining, and from the main pit dewatering.

The DSO pit is expected to make approximately 100,000 m<sup>3</sup> of water per year, which will be enough to supply the make-up water needs, obviating the need for any extraction from Nelson Bay River.

Additional makeup water will also be available from dewatering of the main pit. The available amount will progressively increase as the main pit deepens, up to an estimated 400,000 m<sup>3</sup> per year at full development.

Assuming a 5 m deep dam, the recirculation dam footprint area would be 165 m x 165 m. The proposed location of this dam will be to the north of the processing plant (Appendix A).

Water management will evolve through various stages as the mine develops. This staging is shown in Appendix H.

## 2.4 Waste rock

### 2.4.1 Disposal requirements

The ore body has a steep dip (65°) and a limited strike length (600 m). As a result, it will not be possible to undertake any backfilling of mined areas with waste rock whilst the main pit is operational. All waste rock from the main pit and DSO pit must therefore be transferred to an out-of-pit dump(s).

Based on current mine plans, approximately 0.7 and 11.0 Mm<sup>3</sup> of waste rock will be removed from the DSO and main pits respectively. This total waste rock volume of 11.7 Mm<sup>3</sup> will require approximately 14 Mm<sup>3</sup> of dump space, based on an assumed waste rock bulking factor of 1.2.

The approximate anticipated production of waste rock material over the proposed mine life is shown in Table 8.

Table 8: Waste rock production

Year	DSO Pit	Main Pit	Cumulative
	Waste rock m <sup>3</sup>	Waste Rock m <sup>3</sup>	Waste Rock m <sup>3</sup>
1	726,512	-	726,512
2	-	1,759,726	2,486,237
3	-	1,929,031	4,415,268
4	-	2,438,234	6,853,503
5	-	1,691,241	8,544,743
6	-	1,091,029	9,635,772
7	-	1,357,379	10,993,152
8	-	462,963	11,456,114
9	-	188,237	11,644,351
10	-	22,515	11,666,866
Total	726,512	11,020,903	11,666,866

It is anticipated that the majority of the waste rock will be transferred to the waste rock dump, but a significant amount may be used for construction of the following, subject to acceptable chemical and/or geotechnical properties:

- Tailings dam; use would be spread over the life of the mine
- Bund wall/drain diversion along the western and north western sides of the waste rock dump
- Sedimentation dams

- Mine roads and standing areas
- Recirculation and make-up dams
- Construction pads for the process plant.

## 2.4.2 Waste rock material

Waste rock material will consist of:

- The country rock: predominantly quartz sandstone with lesser amounts of grey laminar bedded siltstone, of the Proterozoic Rocky Cape Group (Cowrie Siltstone)
- Some oxidised ore that is not of sufficiently high iron concentration for direct shipment
- Ultramafic dyke material
- Thermally metamorphosed sediments: dyke-country rock contact material (skarn).

Although early indications were that there was no significant pyrite or other sulphides in the ore and waste rock, subsequent analyses have indicated that the waste rock material will contain some pyritic material.

## 2.4.3 Waste rock dump location

The proximity of the pit to the Nelson Bay River limits the availability of adjacent areas for waste rock dumps.

The proposed location of the waste rock dump, which has an approximate footprint of 70 ha, is shown in Appendix A. This location provides for the most compact mine footprint and the shortest waste rock haul distances. It also avoids any impact on significant vegetation further to the west, including the extensive population of the rare (TSPA) heath *Epacris curtisiae* and a discrete population of the endangered (TSPA) and critically endangered (EPBCA) orchid *Prasophyllum pulchellum*.

A dump in this location would lie to the immediate west of both the main pit and the DSO pit, and would take advantage of natural drainage gullies, minimising visibility from the Rebecca and Temma Roads.

The alternative location for the rock dump, which would need to be on the wet heathland further to the west, is problematic. That location is on a broad, flat ridge lying between the Nelson Bay River and the Sardine Creek catchments and contains an extensive population of the rare (TSPA) heath *Epacris curtisiae* and a discrete population of the endangered (TSPA) and critically endangered (EPBCA) orchid *Prasophyllum pulchellum*.

## 2.4.4 Rock dump and drainage design rationale

Waste rock management is described in detail in section 2.4.5. The rationale for the development of the integrated water and waste rock management is described here.

Waste rock will be separated into potentially acid forming (PAF) and non-acid forming (NAF). PAF waste rock will be encapsulated in clay inside the DSO pit. In the event that the DSO pit has insufficient capacity, excess PAF rock will be stored in encapsulation cells above the DSO pit. This material will be disposed of in the main pit on mine closure.

NAF waste rock not required for tailings dam and other mine site construction purposes will be disposed of in a separate waste rock dump situated on natural ground.

The initial concept design described in the Project Description, and used to scope the project's flora and fauna surveys, included a waste rock dump that straddled West Creek that runs through the proposed lease area into Nelson Bay River. The tailings dam would be located near the head of this creek.

The initial design also included a site cut-off drain that ran along the full length of the western edge of the mine site. In its northern half, the location of this drain largely followed the boundary between wet heathland to the west and the *Eucalyptus nitida* and *obliqua* forest to the east (where the dump would be located). The flora studies found that the wet heathland was suitable habitat for *Epacris curtisiae* and threatened orchids (*Prasophyllum pulchellum*). A design objective for the project therefore became to protect that wet heathland habitat. With this objective established, further orchid surveys were unwarranted because the orchid habitat itself will be protected and the precise locations of individual populations of orchids are therefore of no consequence.

The potential risks to orchid habitat are direct physical impact from ground disturbance and changes to the hydrology of the wet heathland. With the original dump and cut-off drain layout, there would have been some marginal disturbance to the fringes of the habitat near the northern end of the cut-off drain. This disturbance would not be a significant impact on the habitat as a whole but it would nevertheless be contrary to the design objective.

The cut-off drain lay down-gradient from the heathland. Surface water would have run from the heathland to the drain (not the other way around) and the presence of the drain could therefore not have affected heathland soil water unless it was very close. For most of the length of the cut-off drain, the drain lay well away from the heathland and it could not have impacted on the heathland's hydrology. However, in the northernmost sections of the drain, where it intersected with the fringes of the heathland, the presence of the drain could have lead to a local draw-down of soil water from the adjacent heathland because of its vertical incision into the soil horizons. Like the marginal direct physical disturbance, this local impact would not have been significant for the *Epacris* and orchid habitat as a whole but it would nevertheless be contrary to the design objective.

The initial concept design for the rock dump to straddle West Creek would also have had the obvious direct impact of the loss of the creek's riparian habitat. On the other hand, by taking advantage of the gully topography, the final height of the dump could be lower, so reducing its potential visibility from tourist roads at its full volume. In addition to these competing concerns, covering the creek with a rock dump would have required a flow-through rock dump or a creek diversion, both of which raise engineering and management complexities.

To avoid these impacts and complexities, the location of the NAF rock dump has therefore been shifted from its original concept position to now be located entirely on the eastern side of West Creek. This revised location avoids the loss of the creek's riparian habitat. The move also negates the requirement for the full site cut-off drain on the western side of the creek and therefore removes the potential impacts of the drain on *Epacris* and orchid habitat. The disadvantage of the move is that it reduces the available area of the dump's footprint and therefore increases the final height of the dump. However, much of the waste rock appears to be suitable to be crushed and sold for beneficial reuse as, for example, commercial road base. The final volume of the rock dump is therefore unlikely to be as large as the theoretical maximum volume, meaning that the potential visibility concerns are diminished.

PAF waste rock will be identified at the mine working face and will be directed for disposal within the DSO pit where it will be encapsulated in clay. This will minimise the risk of acid formation and the in-pit location will provide a secondary security should any acid leakage occur. On mine closure, the DSO pit will be flooded, so providing permanent protection against acid formation. Excess PAF rock stored in encapsulation cells above the main pit will be disposed of in the main pit on mine closure. This pit will also be flooded on mine closure, also providing permanent protection against acid formation.

NAF waste rock will be stored in a separate dump to the west of the DSO pit. Drainage from the rock dump will flow westwards towards West Creek. This drainage will be intercepted before it reaches the creek by a collection drain that will be constructed parallel to the creek and at least 30 m away from it (so protecting the riparian habitat). The dump will grow southwards as mining proceeds and the collection drain will grow with it. The final length of the collection drain will therefore only need to be as long as is required by the size of the dump. The more waste rock that is taken off site for beneficial reuse (eg. for road base), the smaller the dump and the shorter the drain. The collection drain will terminate at its northern (downstream) end in a sediment settling basin, which will be off-stream. The basin overflow will discharge into the adjacent creek.

Although no PAF waste rock will knowingly be taken to this dump, the dump design with its collection drain directing seepage to a collection dam provides a mechanism to collect and treat any acid drainage that unexpectedly does emerge.

As an additional security measure against unexpected acid drainage, appropriate sections of the collection drain could be lined with acid neutralising rock, selected from the waste rock and supplemented if and as necessary by dolomite or limestone brought onto site. Existing dolomite supplies are available along the product transport route and dolomite could be brought back to the site economically by back filling ore transport trucks. This would only need to be a temporary neutralisation measure because any acid generation in the NAF dump would be incidental and short term. Lined drains are effective over the short term but become armoured and ineffective over the longer term.

To complement the modifications to the initial concepts of the rock dump and cut-off drain, the location of the tailings dam has also been modified by moving it northwards towards the rock dump. The tailings dam will be located near the head of West Creek. Location on the creek line reduces the volume of the dam wall but, more importantly, facilitates permanent flooding of the dam following mine closure. The headwaters of the creek above the tailings dam will be diverted around the dam using a cut-off drain. The drain will be constructed with a top-up flow weir to allow creek water to flow into the tailings dam to maintain a constant water cover over the tailings (apart from the beaching area), during both operations and after mine closure. A permanent water cover over the tailings dam will prevent oxidation of pyritic material in the tailings and hence prevent acid formation.

Free tailings water will be recycled by decant into the process plant's recycle dam and tailings water alone would not lead to the tailings dam overflowing. However, if rainwater fills the dam to overflowing, that overflow will discharge to an off-stream sediment settling basin, which will also have a return to the recycle dam. If the recycle dam itself fills to overflowing, excess water will be discharged to East Creek, via the acid neutralisation treatment plant if the pH is below the treatment threshold of pH 7. Both the tailings dam collection basin and the recycle dam will need to have provision for emergency overflows (to West and East Creeks respectively) but such overflows would only occur in extreme weather events.



Depending on the rate of growth of the rock dump and hence its collection drain, either before or at mine closure the overflow from the tailings dam collection basin will be redirected to the rock dump collection drain.

## 2.4.5 Waste rock management

### *Inert material*

The majority of NAF waste rock material will be disposed of in the NAF waste rock dump but variable amounts, subject to suitability of lithology and mineral content, will be used for the following:

- Construction of the tailings dam, including the various lifts in the dam wall that will be required over the life of the mine
- Mine site road construction
- Construction of the berm wall around the waste rock dump.

There is also the potential for NAF waste rock to be crushed and sold off-site for road base material.

### *Potential acid forming material*

At DSO break-ground (within the first 6 months into the project), further exploratory drilling of the DSO and oxidised ore in the main pit will be undertaken and samples will be subjected to kinetic testing, including free draining column leach or humidity cell tests.

In year two, further exploration drilling of the main pit magnetite resource will be undertaken (while the overlying oxidised ore is being mined) and these samples will also be subjected to static and kinetic testing.

Throughout the mine's life, regular static and kinetic testing will be undertaken of pit wall material and in advance of mining if exploration drilling of new areas is conducted.

The existing block model for PAF material in both the DSO and main pits will be progressively refined as mining proceeds and this, together with regular geological inspections and active grade control at the mine face, will allow PAF material to be identified and separately managed to NAF material.

All PAF (and UC) waste rock will be disposed of within special encapsulation cell(s) within the DSO pit. In the event that the DSO pit has insufficient capacity, excess PAF rock will be stored in encapsulation cells adjoining the main pit. This material will be disposed of in the main pit on mine closure.

No PAF or UC material will be disposed of to the NAF rock dump.

## 2.5 Waste rock dump

### 2.5.1 Dump stability

No site-specific geotechnical investigations of the waste rock dump site have been undertaken at this stage. This will be undertaken as part of detailed mine planning.

#### *Dump construction*

The dump will be constructed by end tipping of waste rock from benches about 30 m high. It is anticipated that this dumped material will form a slope of about 35° from the horizontal. These temporary slopes will then be reshaped to the final design slopes for the dump.

#### *Slope stability*

The stability of the dump slopes will be critically dependent on the following factors:

- The angle of the slope
- The properties of the materials (particularly the shear strength) within both the dump and the materials underlying the dump (rock, subsoil, etc)
- Groundwater elevations within the dump and the dump foundations.

The shear strength of uncompacted dump materials can be approximated by the rill angle of the waste material.

The major unknown factors (that will impact on dump stability) at this stage are:

- The nature and properties of materials underlying the proposed dump area
- The groundwater conditions that will exist within the dump as it is constructed.

However, the conditions (both materials and water) near the toe of the final slope will usually determine slope stability. The conditions distant from the toe are usually not so critical.

#### *Dump subsurface conditions*

Based on information gained from the exploration drilling program, it is anticipated that relatively strong materials, such as highly weathered to moderately weathered rock, lie at shallow depths. Such materials are likely to have higher shear strength than the dumped waste rock and should, therefore, provide an adequate foundation.

As the topsoil, subsoil and peat layers are potentially weaker than the dump material, they will be removed for storage prior to the commencement of dumping. The storage location is shown on the layout plans in Appendix A. All this material will be beneficially reused on the site, for example for dump cover and rehabilitation works.

### *Typical waste rock material*

Based on the proposed method of mining (drill, blast and excavation), it is anticipated that the waste rock will consist of:

- Dominantly sandstone, with a maximum size of about 500 mm and a platy/cubic shape, with at least 50% of this material expected to be greater than 75 mm in size
- Some skarn with similar shape and size characteristics as the sandstone
- A small percentage of siltstone with a maximum size of 300 mm x 300 mm, angular in shape, and with at least 25 % of this material greater than 75 mm in size.
- A variable percentage of weathered sandstone and some siltstone.

This waste rock material, as dumped, is therefore expected to consist of a variety of sizes, ranging from cobble and small boulder size down to gravel, sand and clay sizes.

End dumping of this material will result in sorting of the material into steeply dipping layers of the order of  $35^{\circ}$  from the horizontal. The larger material will generally move further downslope, with the finer material filling the interstices between the coarser particles. The majority of these layers are likely to be of high permeability relative to the underlying bedrock.

On the basis of the anticipated rill angles that will be formed on the dump, the shear strength of the waste rock dump is expected to be of the order of  $35^{\circ}$ . That is, the waste rock surface is expected to stabilise at a slope of about  $30^{\circ}$  -  $35^{\circ}$  from the horizontal.

### *Stability of individual batters*

The individual batters between benches are expected to be stable to angles up to  $30^{\circ}$  in an uncompacted state, due to the relatively high friction angle of the waste rock.

The final batter height/berm width configuration is likely to be governed by a combination of environmental management requirements and geotechnical constraints. However, factors such as erodibility and revegetation of slopes may reduce the maximum slope angle from the anticipated  $30^{\circ}$  "geotechnical limit".

Currently it is proposed to construct the dump with a 1 in 4 slope ( $14^{\circ}$ ), thereby allowing for a considerable safety factor in relation to the potential geotechnical constraints.

### *Dump foundations*

Prior to the commencement of waste rock dumping, all soft material such as topsoil, subsoil and peat layers will be removed.

The toe of the dump, which will be 40 m from the nearest creek and 10 m from the proposed collection drain, will be keyed into the base of the slope to provide long term dump stability.

Effective drainage will be established at the toe of the dump to eliminate the possibility of a "wet" slide (flow of failed material), although the waste rock material is likely to be far too coarse for this to be of serious concern.

A properly engineered drainage system will provide the best assurance of long term safe performance of the waste rock dump, long after the mine site is abandoned. It is anticipated that this drainage network will consist of subsoil drains beneath the fill to collect any infiltration, combined with surface drains to minimise infiltration of the dump by surface water.

Surface drains will also be installed to prevent runoff from adjacent areas spilling over onto the dump, and the final dump surface will be shaped so that rainfall is quickly shed.

### *Settlement*

It is anticipated that there will be some long term consolidation of the fill material through compaction of the material under its own weight.

Any compaction of the waste rock as it is dumped, such as would result from increased trafficking associated with smaller vertical lifts, would minimise long term consolidation. Compaction is not, however, considered necessary to ensure slope stability.

Settlement of the waste rock may cause some local slumping, particularly in the short term, but this is not expected to pose a risk to the stability of the dump.

## 2.5.2 Waste rock dump drainage control

Design of the waste rock dump will include a drainage collection and control system (refer mine layout, Appendix A).

An appropriately designed collection drain will be constructed along the western side of the waste rock dump to collect all drainage off the dump surface and any seepage from within the dump.

All the drainage and seepage collected by drain will be directed to a sedimentation dam, shown in the mine layout in Appendix A.

Construction of this drainage collection and control system will ensure that there is no movement of surface drainage or seepage from the waste rock dump area to West Creek.

Operational controls will ensure that no PAF or UC material will be disposed of in the NAF dump, so acid drainage from this dump is unlikely. If signs of acid runoff occur, however, water from the sedimentation dam will be pumped back into the main pit, from where it will in turn be pumped with the main pit's dewater to the acid neutralisation treatment plant.

Closeout rehabilitation of the dump could establish low vegetation commensurate with the wet scrub of surrounding areas.

While the location of the dump will require the clearing of *Eucalyptus nitida* and *obliqua* forest, this community is not of high significance and it has been subject to fire damage in the recent past. An alternative location for the rock dump, which would need to be on the wet heathland further to the west, is problematic. That location is on a broad, flat ridge lying between the Nelson Bay River and the Sardine Creek catchments.

Wet heathland has a high probability of containing threatened orchid and heath species (see section 3.12.1)

The vegetation community in the preferred location of the dump is not of conservation significance and surveys have found no threatened species in this area (see section 3.12.2). Also, the drainage catchment is relatively small and the tailings dam and the rock dump will be in the same catchment, whereas the alternative location for the dump would split these two over two catchments. A single catchment means that tailings dam and rock dump water management can be an integrated system, as shown in Figure 8 and Appendix H.

## 2.6 Acid generation potential

### 2.6.1 Pyrite content

The resource contains pyrite in varying proportions, as shown in Figure 9.

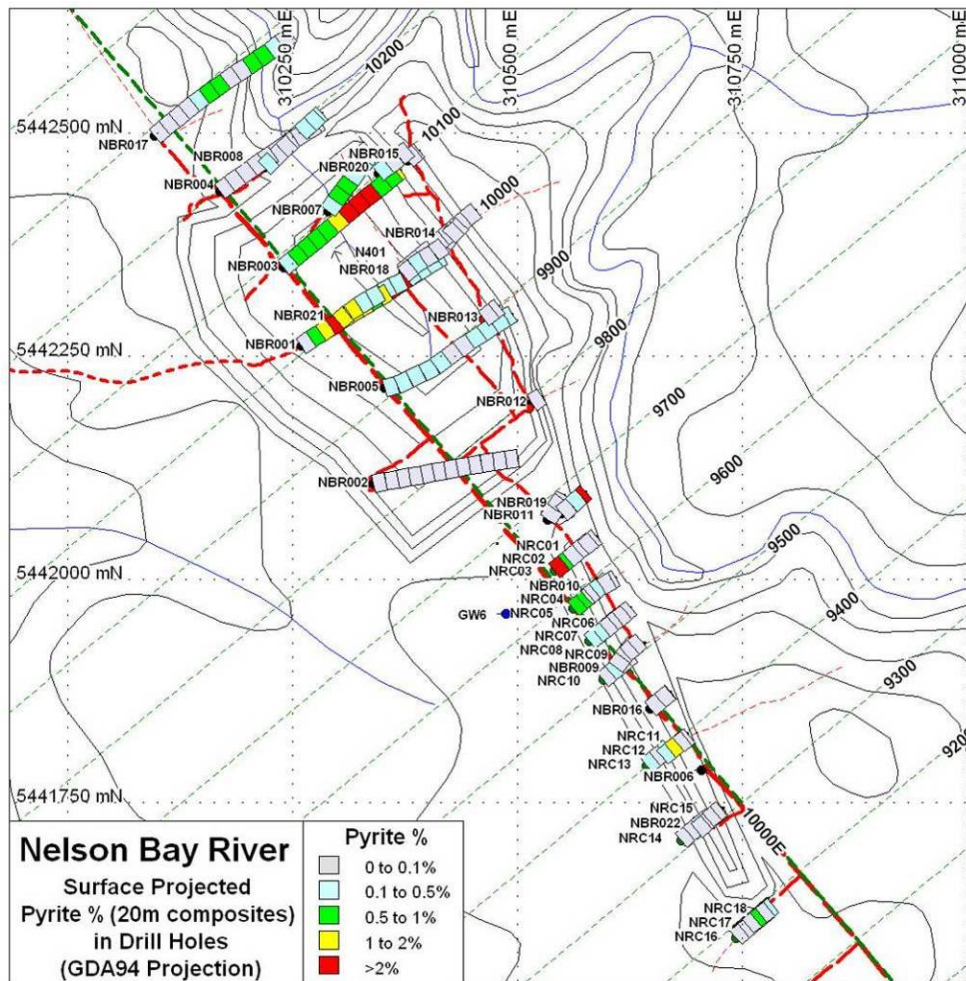


Figure 9: Pyrite content observed in drill holes

The core samples indicate that the occurrence of pyrite is not strata bound but occurs along fractures, joints and faults, with encrustations and veins having pinch and swell of varying size. Occurrence and concentration will, therefore, be hard to predict.

The waste rock is quartz sandstone with lesser amounts of grey laminar bedded siltstone. The occurrence of pyrite in the bulk of the waste rock is most commonly <0.5%, occurring in disseminated and to a lesser extent veinlet form.



As shown in the cored distributions in Figure 9, pyrite content varies considerably. It has a relatively high concentration near the 10100 m grid line (hole NBR003) but is more typically <1%. Strong pyrite zones will be readily visually identified and set aside for encapsulation.

Pyrite in waste rock, which is mostly quartz sandstone with lesser amounts of grey laminar bedded siltstone, is more commonly <0.5% as disseminated and, to a lesser extent, veinlet form. Strong (to ~15% in spots by visual assessment although only ~3% by sample analysis) disseminated pyrite is evident in association with pervasive silica alteration locally, being most prevalent west of the magnetite ore on sections 10000 & 10100N (hole NBR003). Disseminated and veined sulphide is also evident within skarn in both the footwall and hanging wall. This illustrates the variability in the distribution of pyrite, which is more likely to be found in discrete localised occurrences.

Skarn also often bears significant chalcopyrite, which can also be visually delineated and separated for disposal as PAF material.

The key sulphide mineralisation styles are:

- Disseminated most commonly within pervasive silica zones (e.g. hanging wall in deposit centre)
- Sulphide veinlets and fracture fill
- Quartz - sulphide veining
- Disseminated sulphide in skarn
- Overall, pyrite is noted from 29% of the total metres drilled at NBR.

The principal lithologies are:

- Siltstones
- Sandstones
- Skarn
- Goethite hematite
- Magnetite.

## 2.6.2 Potential acid drainage

In order to determine the potential for acid drainage to occur at the mine site, as a result of mining operations, it is necessary to understand the following:

- How much of the waste rock will be:
  - Potentially acid forming (PAF)
  - Non acid forming (NAF)
  - Acid consuming (ACM)
- Where each of these types of rock is likely to occur (in relation to the mining plan)
- When each of these types is likely to be produced over the mine life (eg continuously, specific periods in the mining operation, etc)
- How readily / easily these materials will be able to be identified in the pits
- The likely timing and exposure of potentially acid forming materials
- The likely pyritic content of the tailings.

## 2.7 Geochemical sampling program

Detailed sampling and analysis has been undertaken to investigate the acid generation potential of the waste rock material. This has consisted of three programs:

- Composite sampling on holes NBR018 and NBR22, undertaken in 2010
- A more detailed program, undertaken in June 2011, on geological drill hole logs from the whole drill hole dataset, excluding the recent NBR012A to 014A metallurgical holes; appropriate samples were selected from these holes
- A round of K-NAG kinetic testing, undertaken in September 2011, on representative samples (holes NRC08, NRC13 and NRC17) from the DSO pit.

Analytical results have been interpreted in accordance with the AMIRA International ARD Test Handbook<sup>4</sup>.

The AMIRA decision tree is shown in Figure 10.

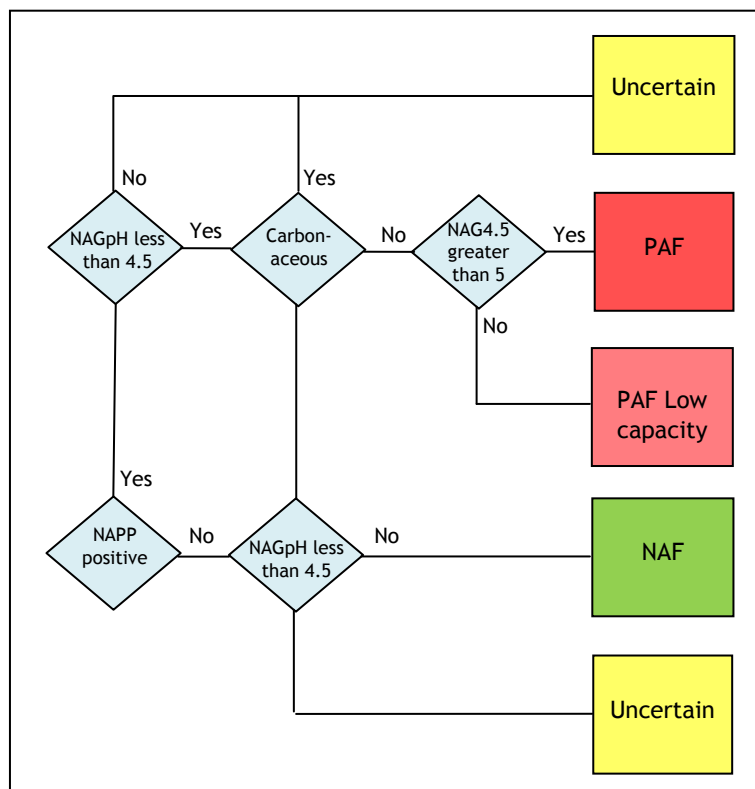


Figure 10: Sample acid classification decision tree (AMIRA)

<sup>4</sup> AMIRA International (May 2002) *ARD Test Handbook Project P387A Prediction & Kinetic Control of Acid Mine Drainage*.

## 2.7.1 2010 program

Sample intervals and rock type are shown in Table 9.

Table 9: Sample intervals and rock type for composite pyrite sample

Sample Number	Sample Interval (m)	Lithology
Drill hole NBR018		
367048	3.0 - 3.5	Laminated siltstone / minor sandstone
367049	6.6 - 7.1	
367050	10.0 - 10.5	
367051	16.0 - 16.5	Quartz vein
367052	23.0 - 23.5	Fine grained sandstone
367053	26.0 - 26.5	Fine grained sandstone
367054	32.9 - 33.4	Siltstone and fine grained sandstone
367055	36.8 - 37.3	Fine grained sandstone and siltstone
367056	45.3 - 45.8	Sandstone with minor siltstone
367057	49.0 - 49.5	Siltstone with minor sandstone
Drill hole NBR022		
367058	5.2 - 5.7	Siltstone
367059	9.0 - 9.5	Quartz sand
367060	13.7 - 14.2	Fault breccia; clay; sandstone, siltstone, skarn clasts
367061	20.0 - 20.5	Fault breccia zone; siltstone, sandstone, gossanous ironstone, pervasive silica
367062	21.7 - 22.2	
367063	26.3 - 26.8	
367064	28.5 - 29.0	

A composite sample for analysis was made, consisting of ten samples from NBR018 (from 3.0 - 49.5 m) and seven samples from NBR0222 (from 5.2 - 29.0 m). Borehole NBR018 was chosen because it is located in the region of highest pyrite content (the area between 10000 and 10100N) compared with the lower levels experienced elsewhere. The analytical report, summarised below, is contained in Appendix I.

This composite sample is therefore considered to represent the 'worst case' situation, with overall pyrite levels likely to be generally somewhat lower.

## 2.7.2 2011 program

This program sampled drillholes from four key sections along the strike of the Magnetite Resource zone, to a depth within the confines of the modelled open cut, and three drillholes within the DSO resource vicinity. The sampling aimed to assess the spectrum of key lithologies and alteration types.

Core samples of 0.5 m were collected from various lithologies and alteration types and a photo and brief description were recorded for each sample. Each sample was at least 0.5 kg, the minimum sample weight required to undertake the required analyses. Details of the samples are shown in Table 10.

Table 10: Sample intervals and lithology

Sample Number	Net Mass (g)	Drill Hole	Sample Depth (m)	Lithology
45398	703.7	NRC08	28.0 - 29.0	Siltstone
45410	678.7	NRC08	39.0 - 40.0	Skarn
45524	720.0	NRC10	32.0 - 33.0	Quartz vein
45692	677.1	NRC13	42.0 - 43.0	Quartz vein
45694	586.7	NRC13	44.0 - 45.0	Medium grained sandstone
45764	721.7	NRC14	50.0 - 51.0	Siltstone
45769	719.4	NRC14	55.0 - 56.0	Siltstone
45760	483.5	NRC14	46.0 - 47.0	Siltstone
45949	463.0	NRC17	39.0 - 40.0	Skarn
520901	1125.1	NBR007	21.63 - 22.13	Siltstone
520902	1977.9	NBR007	85.5 - 86	Siltstone / sandstone
520903	1845.0	NBR003	22 - 22.5	Siltstone
520904	1528.8	NBR003	58.5 - 59	Siltstone
520905	1508.8	NBR003	79.5 - 80	Siltstone
520906	1043.8	NBR003	110.1 - 110.6	Siltstone
520907	1552.9	NBR021	7.6 - 8.1	Sandstone
520908	1378.5	NBR021	27.7 - 28.2	Sandstone
520909	1751.0	NBR021	45.2 - 45.7	Sandstone
520910	1517.7	NBR021	63 - 63.5	Siltstone
520911	1635.8	NBR021	84.95 - 85.45	Siltstone / fine grained sandstone
520912	860.1	NBR021	105.2 - 105.7	Siltstone
520913	845.7	NBR021	181.85 - 182.35	Sandstone
520914	1376.3	NBR005	35.5 - 36	Siltstone
520915	776.9	NBR005	95.9 - 96.4	Siltstone
520916	914.8	NBR005	137.9 - 138.4	Fine grained sandstone
520917	747.5	NBR021	53.9 - 54.4	Siltstone
520918	1503.3	NBR002	14.9 - 15.4	Siltstone
520919	1582.8	NBR002	50.3 - 50.8	Siltstone
520920	621.4	NBR002	77 - 77.5	Sandstone
520921	889.5	NBR002	93.6 - 94.1	Siltstone
520922	857.1	NBR002	124.5 - 125	Siltstone
520923	819.1	NBR002	169.5 - 170	Siltstone
520924	1010.1	NBR002	180.8 - 181.3	Siltstone
520925	769.0	NBR009	31.8 - 32.3	Siltstone
520926	914.4	NBR016	35 - 35.5	Sandstone
520927	880.3	NBR022	46.2 - 46.7	Sandstone
520928	844.1	NBR001	41 - 41.5	Siltstone

Sample Number	Net Mass (g)	Drill Hole	Sample Depth (m)	Lithology
520929	936.0	NBR001	115.5 - 116	Siltstone
520930	823.4	NBR001	161 - 161.5	Siltstone
520931	575.3	NBR001	189.3 - 190	Skarn

The representative samples were selected, briefly logged and photographed. Most samples are from within relatively little weathered core, with sparse samples from partially oxidised near surface sampling. Sample selection was based partly on the basis of mineralogy / character and partly considered the variation down each hole. Sampling primarily tried to encompass areas that would be included within the modelled pit. This included some sampling from the immediate footwall to the magnetite within shallower level holes.

Core overall was in good condition and had not experienced more than superficial surface oxidation.

The strongest pyrite alteration is associated with pervasive silicification in fine to medium grained sandstone in the hanging wall on section 10000N. Within the laminated bedded fine grained sandstone and siltstones, pyrite is disseminated within chlorite flecks / patches and is significantly weaker when compared to the more strongly silicified zones. Here pyrite reaches up to 1% but mostly <0.5%. Further SE on section 9900 (hole NBR005), similar disseminated pyrite on fine grained sandstone interbeds is significantly reduced, comprising trace overall in the top 115 m of NBR005 but locally forming concentrations to 1% over short intervals (<5 m).

Skarn intervals worth sampling were sparse, with widths being narrow and the core commonly faulted and broken.

### 2.7.3 Carbonate acid neutralisation potential

There is no specific mention of carbonaceous sediment in the drill logs. A few zones of recognised carbonate veining were identified during the sampling program but overall quartz - carbonate veins (eg. NBR007 from 17.3 to 17.8 m) form a very small volume that is unlikely to contribute significantly to acid neutralisation potential. Furthermore, the NBR007 interval cited above is narrower than a likely minimum mining unit size.

Although extensive HCL (10%) testing of various lithologies was undertaken, no carbonate was identified.

## 2.8 Analytical program

The aim of the analytical program was to enable the determination of (as required by the Project Specific Guidelines):

- The occurrence and quantities of the acid and non acid forming materials and acid consuming materials
- The acid generating capacity of the ore
- The acid generating potential of the tailings
- The extent of element enrichment and leaching potential in waste rock and the potential for enrichment and leaching in tailings
- The identification of elements and concentrations that may be of concern based on background levels.



The analytical program consisted of the following:

1. TCLP (Toxicity Characteristic Leaching Procedure)
2. Acid Base Accounting & Net Acid Producing Potential, including:
  - Sulphur Suite (Total S, Sulphide)
  - MPA (Maximum Potential Acidity)
  - ANC (Acid Neutralising Capacity)
  - NAP (Net Acid Production)
  - NAG/NAGpH (Net Acid Generation)
  - K-NAG (24 hour kinetic Net Acid Generation)
  - pH / EC Test
  - Standard Metals Suite (incl. As, Cd, Cu, Cr, Hg, Pb, Ni, Sb & Zn).

All analytical work associated with this program was undertaken by SGS Metallurgical Services, a NATA registered laboratory based in Perth.

## 2.8.1 Analytical results

The full analytical results, summarised in Table 11 and Table 12, are included in Appendix I.

### *Static net acid generating potential tests*

The results of the static tests for acid generation potential are provided in Table 11.

### *Element enrichment and leaching potential in waste rock*

TCLP analysis results are shown in Table 12.

Table 11: Acid accounting analytical results

Sample	Drill Hole	Total S (%)	MPA (kg/tH <sub>2</sub> SO <sub>4</sub> )	ANC (kg/t H <sub>2</sub> SO <sub>4</sub> )	NAPP (kg/t H <sub>2</sub> SO <sub>4</sub> )	NAGpH	NAG <sub>4.5</sub> (kg/t H <sub>2</sub> SO <sub>4</sub> )	Geochem Class
2010 Analytical Program								
10638 Composite	NBR018	0.7	21	3	18	3.0	9.7	PAF
10638 / MB - 74198 Tailings composite*		0.121	3.5	11	<0	6.4	<0.5	NAF
2011 Analytical Program								
NBR07 non-mags (tailings)	NBR007	1.36	42	77	-36	5.8	<0.5	NAF
NBR08 non-mags (tailings)	NBR008	1.98	61	70	-11	4.8	<0.5	NAF
NBR021 non-mags (tailings)	NBR021	1.06	32	75	-43	6.3	<0.5	NAF
45398	NRC08	0.044	1.3	<1.0	0	5.6	<0.5	UC
45410	NRC08	0.275	8.4	<1.0	8	3.6	2.2	PAF Low Capacity
45524	NRC10	0.116	3.6	<1.0	4	4.3	<0.5	PAF Low Capacity
45692	NRC13	1.98	61	3.5	56	2.5	27	PAF
45694	NRC13	0.331	10	1.4	8	5.2	<0.5	UC
45764	NRC14	0.266	8.1	<1.0	7	3.6	2.0	PAF Low Capacity
45769	NRC14	0.402	12	<1.0	12	3.3	3.7	PAF Low Capacity

Sample	Drill Hole	Total S (%)	MPA (kg/tH <sub>2</sub> SO <sub>4</sub> )	ANC (kg/t H <sub>2</sub> SO <sub>4</sub> )	NAPP (kg/t H <sub>2</sub> SO <sub>4</sub> )	NAGpH	NAG <sub>4.5</sub> (kg/t H <sub>2</sub> SO <sub>4</sub> )	Geochem Class
45760	NRC14	0.16	4.9	1.6	3	4.1	<0.5	PAF Low Capacity
45949	NRC17	1.03	32	<1.0	30	2.9	10	PAF
520901	NBR007	0.04	0.96	3.2	-2	4.2	<0.5	UC
520902	NBR007	0.02	0.56	4.3	-4	6.6	<0.5	NAF
520903	NBR003	3.09	93	<1.0	92	2.3	49	PAF
520904	NBR003	0.65	18	1.9	16	2.8	13	PAF
520905	NBR003	0.67	19	2.0	17	2.8	14	PAF
520906	NBR003	0.78	24	2.2	22	2.7	17	PAF
520907	NBR021	0.07	2.1	1.2	1	3.8	1.0	PAF Low Capacity
520908	NBR021	0.71	21	<1.0	20	2.7	17	PAF
520909	NBR021	0.08	2.4	1.4	1	4.0	1.0	PAF Low Capacity
520910	NBR021	0.28	8.4	1.2	7	3.2	5.0	PAF
520911	NBR021	0.52	14	<1.0	14	3.0	10	PAF
520912	NBR021	0.03	0.87	2.0	-1	5.4	<0.5	NAF
520913	NBR021	<0.005	<0.25	2.3	-2	4.5	<0.5	NAF
520914	NBR005	0.13	3.2	1.7	1	3.6	2.1	PAF Low Capacity
520915	NBR005	0.43	12	1.6	10	3.0	9.1	PAF
520916	NBR005	0.09	2.5	4.3	-2	4.7	<0.5	NAF
520917	NBR021	0.75	21	<1.0	20	2.7	17	PAF
520918	NBR002	<0.005	<0.25	3.2	-3	5.6	<0.5	NAF

Sample	Drill Hole	Total S (%)	MPA (kg/tH <sub>2</sub> SO <sub>4</sub> )	ANC (kg/t H <sub>2</sub> SO <sub>4</sub> )	NAPP (kg/t H <sub>2</sub> SO <sub>4</sub> )	NAGpH	NAG <sub>4.5</sub> (kg/t H <sub>2</sub> SO <sub>4</sub> )	Geochem Class
520919	NBR021	0.09	2.5	4.7	-2	4.3	<0.5	UC
520920	NBR021	<0.005	<0.25	4.4	-4	6.2	<0.5	NAF
520921	NBR021	0.85	25	5.4	19	2.8	16	PAF
520922	NBR021	0.03	0.54	3.8	-3	5.4	<0.5	NAF
520923	NBR021	0.1	2.9	3.8	-1	5.2	<0.5	NAF
520924	NBR021	0.21	6.3	3.4	3	3.6	2.3	PAF
520925	NBR009	<0.005	<0.25	1.0	-1	6.5	<0.5	NAF
520926	NBR016	0.02	0.51	1.8	-1	6.4	<0.5	NAF
520927	NBR022	0.11	3.3	3.8	0	4.3	<0.5	PAF Low Capacity
520928	NBR001	0.46	11	<1.0	10	3.1	7.6	PAF
520929	NBR001	0.09	2.6	3.0	0	4.5	<0.5	PAF Low Capacity
520930	NBR001	0.14	3.6	5.2	-2	4.2	0.5	UC
520931	NBR001	0.56	17	11	6	5.0	<0.5	UC

\*The tailings composite comprised all non-magnetics (non-ore) from the Davis tube testing program for samples between depths 51.6 and 77.4 m from NBR018

Table 12: Toxicity characteristic leaching procedure - metals

Sample	Drill Hole	pH TCLP (after 18 hrs)	Hg (mg/L)	As (mg/L)	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Ni (mg/L)	Zn (mg/L)
LOR			0.0005	0.02	0.001	0.005	0.005	0.02	0.005	0.005	0.005	0.01
2010 Analytical Program												
10638 Composite	NBR018	5.1	<0.0005	<0.020	0.001	<0.005	0.15	nd	0.088	nd	0.065	0.06
10638 / MB - 74198 Tailings composite		5.0	<0.0005	0.036	0.001	<0.005	0.69	2.6	<0.005	13	0.058	0.87
2011 Analytical Program												
NBR07 non-mags (tailings)	NBR007	5.0	<0.0005	<0.020	<0.001	<0.005	0.15		<0.005		0.16	0.26
NBR08 non-mags (tailings)	NBR008	5.1	<0.0005	<0.020	<0.001	<0.005	0.078		<0.005		0.028	0.16
NBR021 non-mags (tailings)	NBR021	5.0	<0.0005	<0.020	<0.001	<0.005	0.10		<0.005		0.062	0.23
45398	NRC08	4.9	<0.0005	<0.020	<0.001	0.13	0.014		<0.005		0.032	0.11
45410	NRC08	4.9	<0.0005	<0.020	0.001	0.051	0.014		<0.005		0.14	0.45
45524	NRC10	4.9	<0.0005	<0.020	0.001	0.022	2.3		0.007		0.071	0.22
45692	NRC13	5.0	<0.0005	<0.020	<0.001	0.14	<0.005		0.015		0.051	0.21
45694	NRC13	4.9	<0.0005	<0.020	<0.001	0.036	0.008		0.005		0.028	0.20



Sample	Drill Hole	pH TCLP (after 18 hrs)	Hg (mg/L)	As (mg/L)	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Ni (mg/L)	Zn (mg/L)
LOR			0.0005	0.02	0.001	0.005	0.005	0.02	0.005	0.005	0.005	0.01
45764	NRC14	4.9	<0.0005	<0.020	<0.001	0.013	<0.005		0.010		0.030	0.21
45769	NRC14	5.0	<0.0005	<0.020	<0.001	0.025	0.092		0.23		0.051	0.20
45760	NRC14	4.9	<0.0005	<0.020	<0.001	0.0185	0.007		0.016		0.024	0.22
45949	NRC17	4.9	<0.0005	<0.020	0.001	0.054	0.25		0.11		0.16	0.88
520901	NBR007	5.0	<0.0005	<0.020	<0.001	0.007	0.005		<0.005		0.046	0.01
520902	NBR007	5.0	<0.0005	<0.020	<0.001	0.037	<0.005		0.16		0.008	0.02
520903	NBR003	4.9	<0.0005	<0.020	<0.001	0.010	0.079		0.009		0.13	0.06
520904	NBR003	4.9	<0.0005	<0.020	<0.001	<0.005	<0.005		<0.005		0.066	0.01
520905	NBR003	5.0	<0.0005	<0.020	<0.001	0.008	0.096		<0.005		0.047	0.03
520906	NBR003	5.0	<0.0005	<0.020	<0.001	0.009	0.008		0.040		0.022	0.01
520907	NBR021	4.9	<0.0005	<0.020	<0.001	0.043	0.032		0.028		0.018	0.03
520908	NBR021	4.9	<0.0005	<0.020	0.001	0.089	0.021		0.019		0.14	1.5
520909	NBR021	4.9	<0.0005	<0.020	<0.001	0.14	0.021		0.024		0.012	0.03
520910	NBR021	4.9	<0.0005	<0.020	<0.001	0.005	0.026		0.034		0.031	0.05
520911	NBR021	4.9	<0.0005	<0.020	<0.001	0.013	0.016		0.017		0.10	0.02
520912	NBR021	4.9	<0.0005	<0.020	<0.001	0.008	0.007		0.008		0.007	0.01
520913	NBR021	5.0	<0.0005	<0.020	<0.001	0.22	<0.005		0.050		0.015	0.02
520914	NBR005	4.9	<0.0005	<0.020	<0.001	<0.005	0.011		0.12		0.031	0.02

Sample	Drill Hole	pH TCLP (after 18 hrs)	Hg (mg/L)	As (mg/L)	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Pb (mg/L)	Mn (mg/L)	Ni (mg/L)	Zn (mg/L)
LOR			0.0005	0.02	0.001	0.005	0.005	0.02	0.005	0.005	0.005	0.01
520915	NBR005	4.9	<0.0005	<0.020	<0.001	<0.005	0.036		0.025		0.080	0.05
520916	NBR005	5.0	<0.0005	<0.020	0.001	0.035	<0.005		4.4		0.012	0.02
520917	NBR021	4.9	<0.0005	<0.020	<0.001	0.007	0.020		<0.005		0.085	0.02
520918	NBR002	4.9	<0.0005	<0.020	<0.001	0.006	<0.005		<0.005		0.009	0.04
520919	NBR021	5.0	<0.0005	<0.020	<0.001	0.011	<0.005		0.034		0.018	0.03
520920	NBR021	5.0	<0.0005	<0.020	<0.001	0.070	0.025		0.017		0.015	0.03
520921	NBR021	5.0	<0.0005	<0.020	<0.001	0.015	0.10		0.035		0.072	0.05
520922	NBR021	5.0	<0.0005	<0.020	<0.001	0.007	0.054		<0.005		0.021	0.02
520923	NBR021	5.0	<0.0005	<0.020	<0.001	0.005	0.051		0.027		0.028	0.02
520924	NBR021	5.0	<0.0005	<0.020	<0.001	0.010	0.006		0.010		0.023	0.01
520925	NBR009	5.0	<0.0005	<0.020	<0.001	0.027	0.009		0.035		0.005	<0.01
520926	NBR016	5.0	<0.0005	<0.020	<0.001	<0.005	0.37		0.87		0.027	0.03
520927	NBR022	5.0	<0.0005	<0.020	<0.001	0.019	0.005		0.036		0.060	0.02
520928	NBR001	4.9	<0.0005	<0.020	<0.001	0.016	0.062		<0.005		0.16	0.04
520929	NBR001	5.0	<0.0005	<0.020	<0.001	0.008	0.011		0.028		0.027	0.01
520930	NBR001	5.0	<0.0005	<0.020	<0.001	0.010	0.016		0.021		0.010	0.02
520931	NBR001	5.0	<0.0005	<0.020	0.001	<0.005	0.017		<0.005		0.011	0.13

LOR = Level of Reporting

No detectable levels of mercury, arsenic or cadmium were found in the waste rock samples analysed but there were variable levels of chromium (<0.005 - 0.22 mg/L), copper (<0.005 - 2.3 mg/L), lead (<0.005 - 4.4 mg/L), nickel (0.005 - 0.16 mg/L) and zinc (<0.01 - 1.5 mg/L).

### *Kinetic net acid generating potential tests*

K-NAG tests were conducted on samples 45410, 45692 and 45949, which are from the DSO pit. The K-NAG profiles for these samples are shown in Figure 11, Figure 12 and Figure 13 respectively.

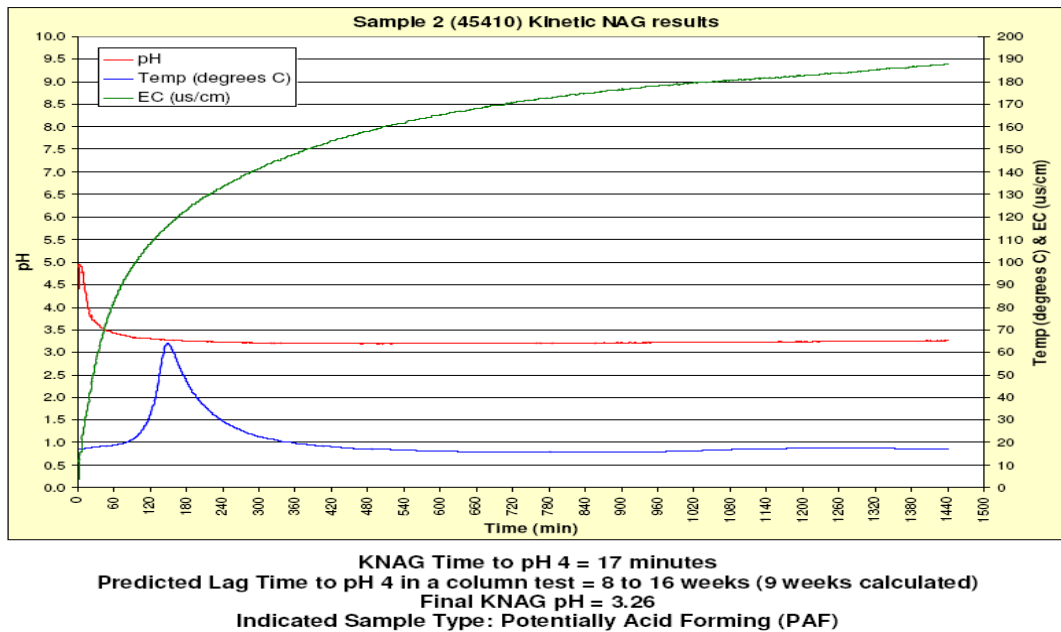


Figure 11: Kinetic NAG profile for sample 45410

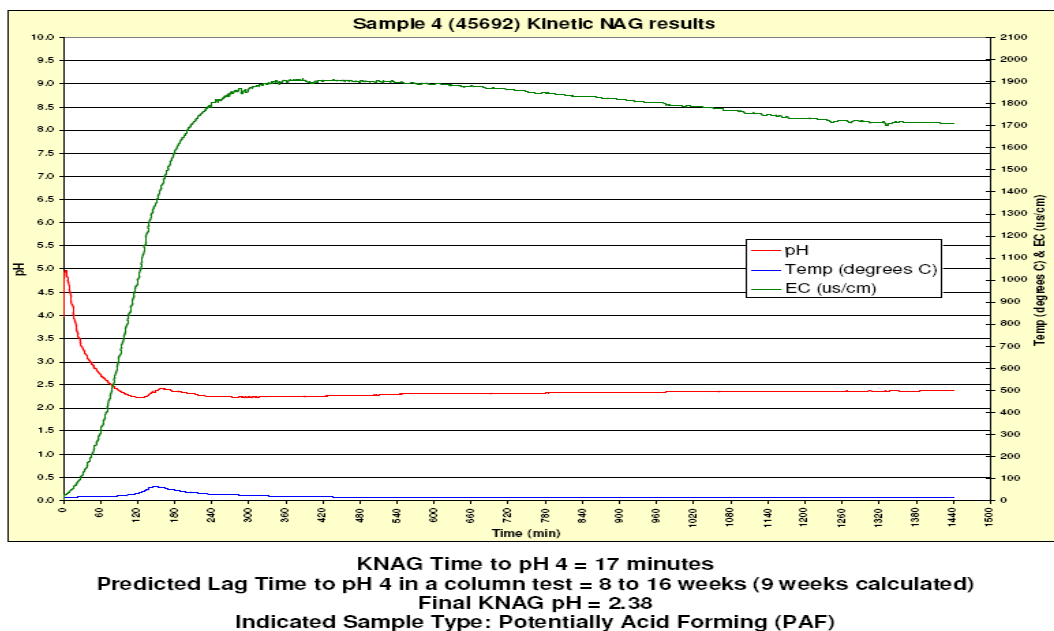


Figure 12: Kinetic NAG profile for sample 45692

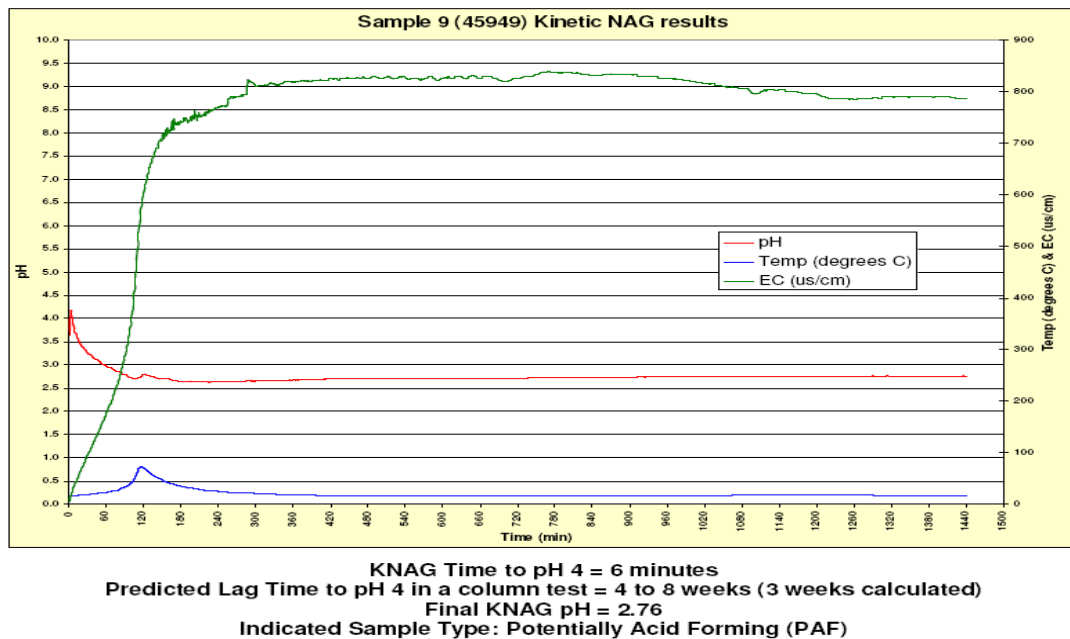


Figure 13: Kinetic NAG profile for sample 45949

The K-NAG test is qualitative rather than quantitative but it nevertheless provides an indication of the likely rate at which waste rock may produce acid conditions when exposed to air. This will guide the management of waste rock, particularly the frequency at which the PAF waste rock dump should be covered with a sealing layer to minimise air and water ingress.

The K-NAG tests were conducted on samples taken near the ore body, at depths of approximately 40 m below the surface. The DSO ore is hematite, which is oxidised, and the overburden above it is therefore likely to be even more highly oxidised. The K-NAG test results can nevertheless be conservatively applied to determine appropriate management approaches for PAF material found in the DSO pit.

The SGS interpretive report on the K-NAG tests is provided in Appendix J.

The K-NAG profiles for all three samples show a sharp temperature spike indicative of oxidation. Coincident with these temperature spikes are reductions in pH and these reductions show no signs of recovery, which is consistent with the lack of significant neutralising capacity within the waste rock.

All the tested samples indicated significant potential to generate acid drainage, with rapid onset of acid production predicted. The predicted lag time to the onset of acid conditions was 8 to 16 weeks for samples 45410 and 45692 and 4 to 8 weeks for sample 45949.

The K-NAG tests show that PAF rock from the DSO pit will need to be regularly covered with low permeability, clayey soil to minimise the risks of acidification. An initial cover frequency of fortnightly will be adopted but this will be adjusted if and as necessary based on the results of regular monitoring of dump run-off, which will pick up early signs of emerging acidity.

## 2.9 Tailings

All tailings samples were classified as NAF (non-acid forming).

The acid and neutralising potentials of the tailings samples are shown in Table 13.

Siderite and carbonate (calcite) are considered to be the sources of alkalinity in the test samples. In practice, however, siderite does not provide a neutralising role due to secondary reactions that negate its net neutralising capacity.

Table 13: Acid accounting results for tailings samples

Sample	Total S %	CaCO <sub>3</sub> %	ANC/NP kg H <sub>2</sub> SO <sub>4</sub> /t	NAG Total oxidisable sulphur kg H <sub>2</sub> SO <sub>4</sub> /t
NBR07	1.36	7.9	77	41
NBR08	1.98	7.1	70	59
NBR018	0.121	1.1	11	3.5
NBR021	1.06	7.6	75	32

Under the AMIRA protocol, NAF samples with a total sulphur content of more than 2% and an ANC/MPA ratio of less than 1.5 should be subjected to further evaluation. However, none of the tailings samples exceed these criteria.

The tailings are unlikely to be a source of acid drainage but they will nevertheless be managed on the conservative assumption that they do contain PAF material.

Comparison of TCLP results (Table 12) for the tailings samples against those of the waste rock and ore samples show no suggestion of significant element enrichment in the tailings.

## 2.10 Estimated amounts of pyritic waste material

### 2.10.1 Pyritic waste estimation

The amount of PAF material in the main and DSO pits was estimated by Shree Minerals' consulting geologist, Robert Reid. This estimation was then supplemented with block modelling by Hellman & Schofield PL, as described in section 2.10.3.

The accuracy of the estimation of pyritic waste material is constrained by the fact that exploratory drilling targets the resource rather than the non-resource material surrounding it. Drill directions are oriented relative to the resource and the areal coverage of drilling follows the apparent areal extent of the resource.

In addition to these biases, for practical and economic reasons analytical testing needs to be restricted to representative samples from the drill cores and cannot test every section of every core.

Despite these constraints and limitations, the information from the analysed samples can be used to build a model of the pyrite distribution as if it was a "resource", using the same principles and procedures as are used for resource modelling, as described below.

### *Main (magnetite) pit*

Pyrite distribution was modelled on a sectional basis, generating shells to define polygons for >0.5% pyrite. This was undertaken with reference to PAF classified rocks and to a lesser extent the distribution of lithology and pervasive silica alteration. The latter is a key control on disseminated pyrite distribution, which is commonly better developed within more porous coarser grained sandstone beds and interbeds within siltstone. The sections are included in Appendix K.

Bedding is known to have a consistent strike of approximately 130TN / -45 to 55E dip within outcrop and orientated core, particularly in the north of the prospect area. This orientation is notably sub-parallel to drill hole dip in many cases, making interpretation of pyrite distribution controlled by stratabound pervasive silicification difficult. In the proposed pit area, sectional interpretation shows dip of strata to be a little shallower; for example, on section 10000N an apparent dip of -35 degrees is indicated (Appendix K).

An approximate outline and contours for the final planned pit was generated from mine plans, with a pit DTM subsequently created allowing approximate pit profiles to be overlain on the sections, enabling clearer interpretation.

Sections spaced at 100m through the magnetite zone are presented in Appendix K. A consistent geological interpretation across all sections extending from 9800 to 10100mN was generated, considering down hole lithologies, long core axis angles and surface mapping.

ARD rock classification was displayed in conjunction with visually estimated pyrite (%) to aid sectional interpretation with >0.5% pyrite (PAF) zones extended to the pit boundary and stopped at the approximately 12 to 15 m base of oxidation. The boundaries for PAF rock are approximate.

The PAF outlines are partly based upon the premise that pervasive silica - disseminated pyrite alteration emanates from the mineralisation hosting fault zone and pervades along permeable zones in the enclosing sediments. This it seems is primarily within the siltstone dominated units with possibly somewhat less acid generation potential from the coarser more silicified sandstone beds.

A basic sectional “pre-resource” was calculated using a two dimensional inverse distance weighted interpolator (power 2) for PAF rock (>0.5% pyrite). This was based upon 100 m spaced sections (+/-50m section envelope), assuming an average specific gravity of 2.7 g/cm<sup>3</sup> from 21 drill core determinations (Table 14).

Samples were classified (section 2.8.1) as NAF, PAF, PAF Low Capacity and UC (Table 15). Comparison of this classification to the logged pyrite portions shows a consistent relationship between pyrite presence (>=0.5%) and PAF classification.

Table 14: Specific gravity determinations for Nelson Bay River drill core

Rock type	Specific gravity (SG) (g/cm <sup>3</sup> )
Hornfels	2.82
Fine grained sandstone	2.63
Sandstone undifferentiated	2.72
Siltstone	2.70
Average (20) samples	2.71



Table 15: Relationship of lithology and geochemical classification

Sample Number	Drill Hole	Sample Depth (m)	Description	Class
45398	NRC08	28.0 - 29.0	lht bn & gn, semi-trans qvn(25), sil fg sst & slst, FeO(w)	NAF
45410	NRC08	39.0 - 40.0	gn msv skarn(60) - perv sil(40) overprint, dss cg py(1%)-cpy(?)	PAF Low Capacity
45524	NRC10	32.0 - 33.0	crm & lht bn, st & milky qvn(90), sil sed(10)	PAF Low Capacity
45692	NRC13	42.0 - 43.0	gn & crm, milky qvn(40), dgn skarn(30, m), sil-serp(30), dss cg py	PAF
45694	NRC13	44.0 - 45.0	AA, qvn(10)	UC
45760	NRC14	46.0 - 47.0	lht gn, perv sil(m) over fg qsst(80), relict lam bdd slst & fg sst(20)	PAF Low Capacity
45764	NRC14	50.0 - 51.0	gn, skarn(m) over sil(m) lam bdd slst & fg sst	PAF Low Capacity
45769	NRC14	55.0 - 56.0	gn & red/bn, AA sil(m/s) lam bdd seds, milky qvn(20)	PAF Low Capacity
45949	NRC17	39.0 - 40.0	dgn, skarn(90, s) dss cg py(5%) cpy(tr), sil(w) but strong in few siliceous frags	PAF
520901	NBR007	21.63 - 22.13	thin bedded grey slst	UC
520902	NBR007	85.5 - 86	lam bedded slst & fg q-sst	NAF
520903	NBR003	22 - 22.5	weakly weathered grey / cream irregular lam bedded slst, ch(w, flecks), dss py (0.5%)	PAF
520904	NBR003	58.5 - 59	grey lam bdd slst with oxidised bn flecks after chlorite / sulphide?, minor straight sil veinlets on fractures with perv sil(vw)	PAF
520905	NBR003	79.5 - 80	lam bedded slst, very weak FeOxidised exterior	PAF
520906	NBR003	110.1 - 110.6	grey lam bdd slst, py(1% overall)-ch blebs / flecks (w, -1% overall), perv sil(w/m)	PAF
520907	NBR021	7.6 - 8.1	cream perv sil(m/s) - dss fg py(0.5%) sandstone	PAF low capacity
520908	NBR021	27.7 - 28.2	cream strongly leached and pitted likely after pyrite, perv sil(m/s) relict sst	PAF
520909	NBR021	45.2 - 45.7	cream perv sil(m/s) - dss fg py(0.5%), sparse ch flecks(vw) sandstone; sil-vnlets(w) on straight	PAF low capacity

Sample Number	Drill Hole	Sample Depth (m)	Description	Class
			fractures	
520910	NBR021	63 - 63.5	grey lam bdd slst with py dss(0.5%) within ch(vw) patches/flecks, with sil-py-ch veining on straight fracs(w, <0.5%)	PAF
520911	NBR021	84.95 - 85.45	grey lam bedded fg sst and slst, dss py(1%) with ch(vw) flecks on silicified crm fg sst interbeds. Perv sil(w)	PAF
520912	NBR021	105.2 - 105.7	grey lam bdd fg sst and slst	NAF
520913	NBR021	181.85 - 182.35	grey mottled sil(w/m) - ch(w) pervasive alteration within thin bdd fg/mg sst.	NAF
520914	NBR005	35.5 - 36	grey lam bdd fg sst & slst	PAF low capacity
520915	NBR005	95.9 - 96.4	grey lam bdd slst & fg sst	PAF
520916	NBR005	137.9 - 138.4	grey perv sil(w/m) - ch(vw) altered fg sst with slst interbeds	NAF
520917	NBR021	53.9 - 54.4	grey lam bdd slst & fg sst, py(0.5%) dss within ch(vw) flecks	PAF
520918	NBR002	14.9 - 15.4	grey lam bdd slst and fg sst, weathered(w)	NAF
520919	NBR002	50.3 - 50.8	grey lam bdd slst and fg sst, weathered(w)	UC
520920	NBR002	77 - 77.5	crm / grey perv sil(w/m) over fg q-sst with minor laminar beds bearing weak slst.	NAF
520921	NBR002	93.6 - 94.1	grey lam bdd fg sst and minor slst, perv sil(w/m), ch (w) flecks, dss Py?	PAF
520922	NBR002	124.5 - 125	grey lam bdd fg sst and minor slst; ox dss py?(0.5%)	NAF
520923	NBR002	169.5 - 170	lht bn lam bdd fg sst and minor slst, perv sil(m), brown FeOxidised surface(w)	NAF
520924	NBR002	180.8 - 181.3	grey mostly fg q-sst with sparse slst lam interbeds, perv sil(w/m)	PAF
520925	NBR009	31.8 - 32.3	grey thin bdd slst and fg q-sst, sparse pits after py?(0.5%)	NAF
520926	NBR016	35 - 35.5	crm / grey perv sil(w/m) over fg/mg q-sst	NAF
520927	NBR022	46.2 - 46.7	pale green perv sil(m) with	PAF low capacity

Sample Number	Drill Hole	Sample Depth (m)	Description	Class
			speckled chlorite(w/m) overprinting fg/mg q-sst, sparse relict surface pits after py?	
520928	NBR001	41 - 41.5	grey and pgn lam bdd slst and minor fg q-sst. Weak pgn FeO stained exterior. Sparse ch flecks(vw) and relict cubic Py pits(0.5%)	PAF
520929	NBR001	115.5 - 116	grey lam bdd slst and minor fg q-sst. Dss py(1%) mostly in fg sst interbeds and locally weakly framboidal / rounded appearing. Perv sil(vw), Fresh no oxidn	PAF low capacity
520930	NBR001	161 - 161.5	grey lam bdd slst and minor fg q-sst. Dss py(<1%), perv sil(w) Fresh no oxidn	UC
520931	NBR001	189.3 - 190	brown oxidised (m) silicified(m) dgn skarn; half core sample,	UC

There was minor overlap between pyrite bearing and NAF classified samples. ARD classification from the 2010 and 2011 sampling is plotted on sections (Appendix K). Strong silicification with 0.5% disseminated pyrite (NBR021), interestingly returned a PAF Low capacity classification (Table 15).

This result is low regardless of sulphide content presumably because the stronger pervasive silicification protects the pyrite from oxidation. It appears that more siltstone dominated pyrite bearing samples are PAF classified when compared to sandstone and pervasive silica altered samples. This may simply be a relict of lesser availability of sandstone samples, related to drill hole distribution.

The pyrite within siltstone appears to be more readily oxidisable by comparison to that of often higher concentrations encapsulated within pervasive silicification, a result seemingly at odds intuitively. This relationship appears to hold in the central 10000N to 10100N area (holes NBR001, NBR003, NBR021), whereas both principal lithologies are variably classified outside this zone, particularly on 9800N (hole NBR002).

The majority of the significant PAF rock is in the northern half of the pit (e.g. hole NBR003) on sections 10000 and 10100mN (Table 15). The volume and tonnes of PAF within each section are shown in Table 16 (section 2.10.3).

Twenty five percent of the tonnage calculated for 10100mN was removed from the waste rock estimation calculations as an approximation to account for what will not be mined from the 100 m wide modelled zone that intersects the NE pit wall. The same consideration was not applied to 9800mN, at the south eastern pit end, since expansion of the inferred PAF zone toward 9900mN will approximately accommodate a tonnage equivalent to that not planned for mining.

*DSO pit*

The acid rock drainage potential of the proposed DSO pit area was investigated through 12 samples, taken from drill holes NRC08, NRC10, NRC13, NRC14, NRC17, NBR009, NBR 022 and NBR 016.

Silicified sandstone from the hanging wall in NBR009 and NBR016 were NAF classified, whilst siltstone in the footwall in NBR022 returned PAF Low Capacity. Considering that these holes are relatively short and near the surface, a large proportion of the upper part of the holes was oxidised and weathered and therefore not appropriate for sampling. This is generally in line with the observed zonation of PAF to NAF classified samples extending from the core PAF classified Main Magnetite Pit to the south west.

At greater depths, PAF Low capacity material was found in the hanging wall in holes NRC08, NRC10, NRC13, NRC 14 and NRC17, principally in association with quartz veins, which form a zone of ~5 to 7 m in thickness but which locally reach 13 m on 9400mN. Pyrite distribution in the quartz veins is, not unexpectedly, sporadic and unpredictable. Quartz veining is often pyrite barren but also commonly bears variable pyrite of up to 5% tenor, but reaching 60% in one example (see below). The sulphidic portions of quartz veining should be readily visually selected for encapsulation.

The DSO pit area was modelled to encompass >55% FeO material, with the pit outline being based upon -65 to -70° north eastern and -45 to -50° (bedding parallel) south western pit walls planned for the magnetite pit. Consequently some elevated pyrite zones did not require evaluation since they were found to lie outside the pit margins. Some examples follow. Immediately north of the proposed pit, section 9650N bears significant coarse grained aggregated pyrite in quartz veining visually amounting to ~60% over 1 m, within a zone of 4 m @ ~20% pyrite in NRC03. Similarly, on 9600mN some potentially pyrite bearing quartz veining lies outside the potential pit boundary and extends to surface within the oxidised - pyrite depleted zone. Neither of these high pyrite areas will be mined.

Comparatively small sulphidic zones of potential importance with regard to ARD potential were identified on sections 9550, 9400 and 9200mN (Appendix K). Pyrite “resources” contained within these zones are shown in Table 16. Sectional envelopes were defined as +/- 12.5 m on 50 m (9550mN) and +/-50 m on 100 m (9200 & 9300mN) spaced sections, which likely provides a generous tonnage assessment given the observed erratic pyrite distribution in quartz veins. An SG of 2.7 g/cm<sup>3</sup>, similar to the sediments, was considered valid (quartz = 2.65 g/cm<sup>3</sup>).

## 2.10.2 Sampling results

The outcomes of the sampling were as follows:

- A poorly constrained “pre-resource” ~4.5Mt @ 1.01% pyrite was inferred for (>0.5% pyrite) PAF rock in the main pit, with a comparatively small ~40kt @ 2.99% pyrite modelled for the DSO pit.
- The majority of the significant PAF rock is shown to be in the northern half of the main pit on sections 10000 and 10100mN. Pervasive silica, primarily located within more porous sandstone appears to encapsulate elevated pyrite concentrations, resulting in some NAF classifications for this material, whereas the disseminated pyrite within the less altered siltstones is more often classified as PAF.

- PAF distribution and character is uncertain, partly since most drilling is sub-parallel to hole dip and actual distribution will become evident during mining.
- Pyrite is mostly erratically distributed within hanging wall quartz veins in the DSO pit area but should be readily visually identified during planned mining.

### 2.10.3 Anticipated quantities of acid forming materials

The potential amounts of pyritic waste rock material have been estimated on the basis of the analytical results and the estimated percentages of the various lithologies. The approximate anticipated quantities of pyritic material are shown in Table 16.

Table 16: Estimated amounts of potentially acid forming PAF

Section (mN)	Pyrite %	Estimated pyritic volume m <sup>3</sup>	PAF (tonnes)
<b>Main (magnetite) Pit</b>			
10100	1.00	407,500	1,100,250
10000 <sup>1</sup>	1.27	812,600	2,194,000
<i>incl. Zone 1</i>	<i>1.37</i>	<i>750,741</i>	<i>2,026,750</i>
<i>incl. Zone 2</i>	<i>0.08</i>	<i>61,852</i>	<i>167,000</i>
9900	0.05	321,850	869,000
9800	<0.05	120,000	324,000
<b>Total PAF</b>	<b>1.01*</b>	<b>1,661,950</b>	<b>4,487,250</b>
<b>DSO Pit</b>			
9550	2.97	2,724	7,355
<i>incl. Zone 1</i>	<i>6.00</i>	<i>1,005</i>	<i>2,713</i>
<i>incl. Zone 2</i>	<i>1.20</i>	<i>1,719</i>	<i>4,642</i>
9400	3.47	10,299	27,807
9300	0.60	1,074	2,900
9200	2.06	2,356	6,360
<b>Total PAF</b>	<b>2.99*</b>	<b>13,729</b>	<b>37,067</b>
<b>Both pits</b>			
Main pit	1.01*	1,661,950	4,487,250
DSO pit	2.99*	13,729	37,067
<b>Total PAF</b>		<b>1,675,679</b>	<b>4,524,317</b>
		<b>PAF rock as % of total material mined<sup>3</sup></b>	
Main pit		14.0%	
DSO pit		1.6%	

\* Weighted average

<sup>1</sup> Section 1000N comprises two zones, zone 1 and zone 2 of 2,026,750 and 167,000 tonnes respectively.

<sup>2</sup> Section 9550N comprises two zones, zone 1 and zone 2 of 2,713 and 4,642 tonnes respectively.

<sup>3</sup> Total mining quantities are given in Table 5

### *Block modelling of PAF rock*

Shree Minerals commissioned Hellman & Schofield PL to undertake block modelling estimations of PAF waste rock. The Hellman & Schofield report is provided in Appendix L.

Hellman & Schofield created a block model with a minimum block size of 5 x 20 x 10 m (X, Y, Z) from which they estimated pyrite volumes. The block model was consistent with the current resource model. Hellman & Schofield's model was based on the actual pit design shape whereas Reid's model used a simplified pit shape.

Hellman & Schofield's estimates for pyrite volumes in the main and DSO pits are provided in Table 17 and Table 18 respectively.

Table 17: Estimates of pyritic material in the main pit (0.5% pyrite cut-off)

Lode	Volume (m <sup>3</sup> )	Pyrite %
Siltstone	1,507,020	1.5
Skarn	164,729	2.68
Total	1,671,749	1.64

Table 18: Estimates of pyritic material in the DSO pit (0.5% pyrite cut-off)

Lode	Volume (m <sup>3</sup> )	Pyrite %
Quartz vein	12,951	2.15
Total	12,951	2.15

The Hellman & Schofield estimates of pyritic material are slightly higher than the Reid estimates for the main pit and slightly lower than the Reid estimates for the DSO pit. The differences are attributed to the more accurate pit shape model used by Hellman & Schofield and are not considered to be significant.

The Hellman & Schofield review supports the PAF waste rock estimates described in Table 16.

### *Anticipated timing and exposure of potentially acid forming materials*

The potential amounts of pyritic waste material and anticipated periods of removal over the first half (5 years) of the mine's life are summarised in Table 19. As described in section 2.11, at that time the remaining available volume for PAF disposal into the DSO pit will be reviewed.



Table 19: Pyritic waste rock - anticipated volumes and likely removal times during the first half of mine operations

Year	DSO Pit m <sup>3</sup>	Main Pit m <sup>3</sup>	Both Pits m <sup>3</sup>	Cumulative m <sup>3</sup>
1	14,000	-	14,000	14,000
2	-	24,000	24,000	38,000
3	-	135,000	135,000	173,000
4	-	346,000	346,000	519,000
5	-	309,000	309,000	828,000

The above estimates were calculated through conservative interpretations of available drilling data. However, because the pyrite is predominantly associated with quartz veins, which by nature are sporadic and irregular, the estimates are unavoidably uncertain. The estimates will be progressively refined during mining as more exploratory holes are drilled and the pits are opened up. This additional refinement work will begin with the commencement of operations.

## 2.11 Management of pyritic material

The waste rock from the high pyrite areas of the resource (both for the main pit and for the DSO pit) will require management to minimise acid generation. This management will involve identification, appropriate emplacement, encapsulation and drainage control, and monitoring.

It is anticipated that the high pyrite zones will be readily visually identified in the pit walls. These zones will be marked out for separate removal from the pit, and the material set aside for encapsulation within a specifically designed cell within a section of the completed DSO pit.

In addition to this visual separation of high pyrite material, regular acid accounting analysis in accordance with the AMIRA procedures (see Figure 10 in section 2.7) will be undertaken of all samples taken as part of routine grade control, including from blasting drill holes. Any material not classified as NAF (ie. classified as PAF, PAF Low capacity or UC) will be separated for encapsulation in the DSO pit. Regular routine testing of samples prior to blasting and/or material removal will be critical to the beneficiation process, which will rely on precise grade control for optimal efficiency. The incorporation of acid accounting testing with the routine grade control testing will ensure that no significant quantities of non-NAF material go to the NAF dump.

As described in section 2.8.1, K-NAG testing predicted that reactive PAF material could generate acid conditions within 4 to 8 weeks. This material will therefore be covered on a fortnightly basis to preclude these conditions forming. Depending on the results of routine K-NAG tests, for particularly reactive material this may be supplemented by mixing alkaline material (brought onto site from a commercial supplier) with highly reactive PAF material.

The DSO pit is the preferred location for disposal of any potentially acid forming material as it would provide the most secure location, precluding any long term acid drainage from the site. Flooding of the pit on mine closure would provide the added security of a water cover.

Magnetite mining in the main pit will not commence until the DSO pit mining has been completed. However, the oxidised ore overlying the main pit magnetite

will be mined prior to DSO completion because that may need blending with DSO ore to satisfy market requirements. Because only oxidised ore would be mined from the main pit during this overlap period, there would be minimal PAF waste rock generated. What little there may be during this brief period would be stored in the DSO pit.

ALL DSO pit PAF material will be managed inside the DSO pit from the outset. There will be no requirement for temporary storage of DSO PAF material outside the pit as it is being opened up. In the unlikely event that DSO material is uncovered early in the life of the pit, when it has only a limited void volume available, a bench will be left within the pit on which to temporarily store this early material (in an encapsulated cell) until the void has been expanded sufficiently to allow that material to be moved to its permanent location in the pit.

DSO and main pit PAF rock material will be encapsulated within cell(s) specially designed and constructed so that oxidation of the pyritic material will be slowed down, water ingress to the material reduced (preferably prevented if possible), and any drainage from the material readily controlled and treated.

The basic cell design for the disposal of pyritic material will consist of cells with clay lined floors and walls (clay lined containment bunds). Clay will be compacted to achieve a permeability of less than  $1 \times 10^{-9}$  m/s. Periodically the material within the cells will be capped with clay or compacted crushed NAF rock that will act as a barrier to air and water ingress, before the introduction of additional pyritic material. This will produce a 'sandwich type' structure, as shown in the conceptual cell design (Figure 14).

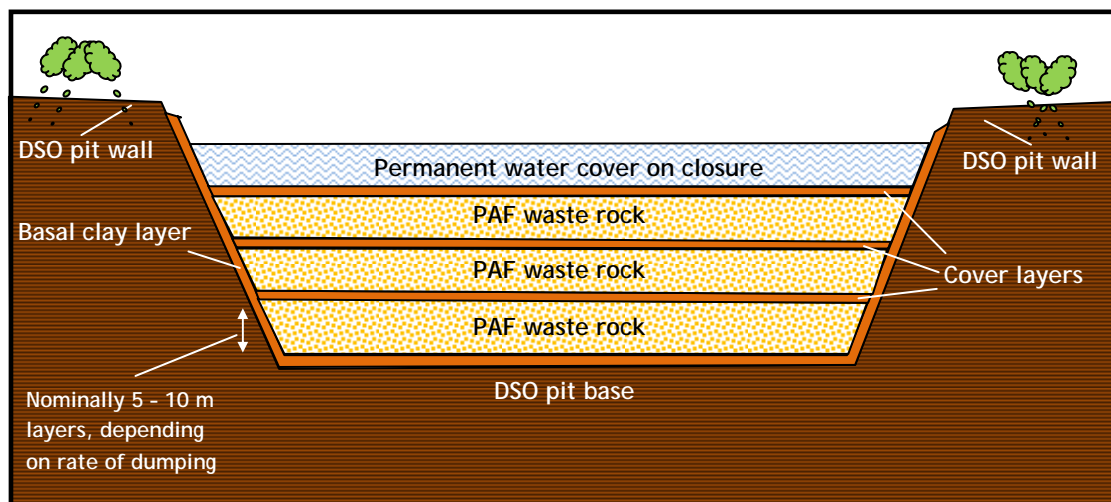


Figure 14: Schematic arrangement for disposal of potentially acid forming waste rock in DSO pit

The choice of material (clay or crushed NAF rock) for any particular cover layer will be an operational decision based on the reactivity of that particular PAF material, the frequency of covering, and the opportunity cost of using clay, which might be better applied elsewhere, relative to the cost of treating any drainage. By design, the PAF material is stored within the DSO pit and any drainage would be collected and could be treated if required and if it was cost effective relative to the cost of clay. Also, the successive layering of PAF material and cover material will progressively inhibit oxygen infiltration to progressively deeper layers, diminishing the need to use clay as the primary cover material. The phreatic zone will also steadily rise over time and the cells

will progressively come to lie within the saturated zone, which will further inhibit oxidation.

These cover layers will be successively replaced by overlying layers and are not intended to be a final impermeable capping - the final 'capping' will be a permanent water cover. The cover layers therefore will not be engineered clay caps designed to achieve a particular impermeability criterion but rather covers in the order of 0.5 to 1 m thick to inhibit oxygen and rainfall penetration while the next layer of material is being laid above.

Clay for covering will be sourced from within the mine disturbance footprint in the first instance but will be supplemented if and as required by clay sourced from approved commercial clay pits in the surrounding region.

The proposed management measures for potential acid forming material will ensure that any oxidation of pyritic material will be minimised and any acid drainage produced will be controlled to the maximum possible extent.

The current JORC confirmed DSO resource provides a 40 m deep DSO pit with an approximate volume of 0.9 Mm<sup>3</sup> (Table 5). Based on the current estimates of PAF rock volumes (Table 16), the DSO could take approximately 50% of the estimated 1.7 PAF Mm<sup>3</sup> of PAF rock volumes over the life of the mine, allowing for clay linings and final water cover. However, strong exploration indications are that the ultimate DSO pit will extend to approximately 60 m in depth. This has the potential to provide a DSO pit volume of approximately 1.1 to 1.2 Mm<sup>3</sup>, which could take about 65% to 70% of the anticipated PAF rock.

Because of the generally veinlet nature of the pyrite dissemination and because the drill holes are biased toward siltstone material, which is more likely to contain pyrite, the amount of PAF rock may be less than current estimates, meaning that the DSO pit volume may in fact be sufficient for all PAF waste. The actual PAF quantities will become evident as mining proceeds and projections of the likely total amount will become progressively more refined over the first several years of operations.

If the actual PAF rock production rates and the actual DSO pit volume lead to a mid-mine-life (year 5) projection that the pit volume will not be sufficient for the last few years of mining then the PAF storage will be raised above the DSO pit as a temporary dump.

The basic structure of the cell will be similar to that shown in Figure 14 but, rather than making use of the pit walls, the raised cell will be constructed within a wall constructed from NAF rock. Drainage off the dump will be directed into a sump void that will be retained and water collected in this sump will continue to be pumped out as before.

Because these temporary cells will be above ground, they would not be accessible to the rising phreatic zone within the DSO pit and could therefore not become enveloped within a saturated zone like the deeper cells. The risk of oxidation of PAF material within the above ground cells is therefore greater and because of this these cells will be covered with clay rather than NAF rock. The risk of oxidation of PAF material in these cells having commenced before the material is relocated into the main pit for flooding will therefore be minimised.

This same approach would be adopted as a contingency response for the unlikely situation that a significantly greater amount of PAF rock is found than is expected, which could lead to the DSO pit's PAF storage capacity being filled earlier in the mine life than anticipated.

This temporary above-pit dump will be managed until mining finishes, at which time it will be demolished, with the rock being trucked to the edge of the main pit where a safe chute arrangement will be constructed. The PAF rock will be pushed through the chute into the pit. The excess PAF rock will therefore become flooded with a permanent cover of water as the main pit fills because of the cessation of dewatering.

With the above strategies, all PAF rock will be managed throughout the mine's operations to minimise the potential for acid generation and on mine closure all PAF rock will be submerged under a permanent cover of water (whether in the DSO pit or in the main pit), thereby providing permanent protection against acid generation.

If acid is formed due to rain runoff from the exposed rock in the operating PAF cell, it will safely accumulate in the DSO pit before being pumped to the recycle dam via the neutralisation plant for neutralisation if necessary) for process make-up water.

Flooding the PAF rock dump inside the DSO pit on mine closure will provide permanent protection against oxidation and hence acid generation. This generation will be passive and would commence naturally when pit dewatering ends.

## 2.12 Acidic water management

The primary management approach (described above) will be to prevent the generation of acid drainage by encapsulation of PAF material during operations and permanent flooding on mine closure.

During operations, however, it is possible that highly reactive PAF rock, if it occurs, could generate acidic water before there has been time for that rock to be encapsulated. This is an unlikely scenario, because regular testing of waste rock samples will be routinely conducted to alert operators to the uncovering of highly reactive material, thereby enabling them to encapsulate it quickly. Nevertheless, contingency plans include the provision for treating acidic water.

All water from the main and DSO pits, which will include runoff from the PAF water rock dumps, and from the tailings dam will be pumped to the recycle dam via an acid neutralising treatment plant (see the schematic arrangement provided earlier in Figure 8) where it can be neutralised if necessary before being discharged to East Creek or being sent to the recycle dam for process make-up water. Treatment will occur if the water's pH is less than a quality threshold (pH of 7).

Regular monitoring of the discharges to East Creek will be used to confirm that pH levels of at least 7 are also accompanied by dissolved metal concentrations that are not significantly greater than their respective Nelson Bay River Water Quality Objectives. If this monitoring suggests a higher threshold pH is more appropriate, that will be adopted.

The neutralisation plant will be a proprietary system, which will be selected as part of detailed design.

The discharge from the plant will be via a sludge settling pond or thickener tank(s), designed to suit the chosen treatment plant's configuration.

The sludge pond/tank(s) will be used to detain the treated water to ensure complete oxidation (so that precipitation does not occur subsequent to

discharge) and to settle out unstable metal hydroxide precipitates from the supernatant, so that precipitates are not discharged with the treated water.

Periodically, the pond/tank(s) will be desludged and the sludge will be deposited within the PAF rock dump inside the DSO pit immediately prior to the addition of a dump cover layer. The PAF cell will therefore retain the sludges *in situ* and they, together with the rock within the PAF dump, will be permanently flooded on mine closure.

By design, the NAF dump should receive no PAF material. However, as discussed in section 2.5.2, if signs of acid runoff occur water from that dump's sedimentation dam will be pumped back into the main pit, from where it will in turn be pumped with the main pit's dewater to the acid neutralisation treatment plant.

## 2.13 Tailings management

### *Tailings production rate*

The weighted average recovery of saleable product for the mine is expected to be 36% across the resource.

The DSO ore will generate no tailings.

Processing of the magnetite ore and the lower quality hematite ore from the main pit will generate tailings.

At the planned production rate of 150,000 tpa of concentrate, 400,000 tpa of ore will be processed, generating 250,000 tpa of dry tailings, equivalent to a volume of approximately 140,000 m<sup>3</sup>pa or 1.4 Mm<sup>3</sup> over the mine life.

As the tailings discharged from the process plant will be approximately 70% solids, the total settled wet volume of tailings will be approximately  $1,400,000 \text{ m}^3 / 0.7 = 2,000,000 \text{ m}^3$  over the life of the mine or 200,000 m<sup>3</sup>pa (140,000 m<sup>3</sup>/0.7).

Testing on tailings derived from exploration cores shows that they are likely to be non-acid forming (see section 2.9). However, the sporadic occurrence of pyrite in quartz veins means that there is some potential for potentially acid forming material to be discharged in the tailings stream. As a conservative protection measure, surplus neutralising capacity will be added to the tailings stream prior to deposition in the tailings dam.

The amount of acid neutralising material to be added will be initially determined by detailed static and kinetic laboratory testing once tailings production commences. Thereafter, the tailings stream will be tested daily for pH and acid generating potential as it emerges from the processing plant. For this in-stream testing it is planned to use calcium as a surrogate for neutralising potential and total sulphur as a surrogate for acid potential but these details will be further informed by the laboratory testing. The relative amounts of the surrogates will be used to determine the amount of alkalinity to be added to the tailings prior to their deposition in the tailings dam so that the deposited tailings have a surplus alkalinity. Periodically, further laboratory testing of the tailings will be undertaken to check (and adjust if necessary) the calibration of the surrogates.

The addition of surplus alkalinity to the tailings stream means that the tailings could not become acidic and they will also hold a residual alkalinity.

### *Tailings storage*

The process tailings will be permanently stored and managed in a dedicated tailings dam (see Appendix A).

Tailings will be discharged from the processing plant (also shown in Appendix A) and deposited onto the dam water using an open pipe or spigots, until a beach is formed. The water level will be controlled using a decant tower or overflow channel weir, installed in or near the dam wall, to keep the level low enough to give optimum beaching and hence consolidation of the tailings.

The water level will be controlled to optimise detention time to ensure adequate solids/liquid separation.

The decant from the tailings dam will be pumped back to the recycled water dam (via the neutralisation plant) and hence to the processing plant.

### *Tailings storage dam requirements*

The tailings dam will need to have at least a volume capacity of 200,000 m<sup>3</sup> plus freeboard available each year at full production to allow for the settling and dewatering of the tailings. The conceptual footprint area of the tailings dam is approximately 40 ha.

### *Tailings storage dam design*

The tailings storage dam wall will be constructed in compacted 2 m lifts of graded crushed material sourced from pit overburden material, based on current understanding of the potential nature of this overburden material. The toe of the dam is expected to be at 90 m RL, with a final height of 115 m RL.

The dam wall will have an external slope of 1 in 2.5, an internal slope of 1 in 2 and a width at the top of 6 m. The internal slope of the wall may be steepened to a slope up to 1 in 1.5, subject to detailed design.

The dam wall will require approximately 1 Mm<sup>3</sup> of material, based on the current design, and will be constructed of selected graded crushed NAF material sourced from pit overburden material, based on current understanding of the potential nature of this overburden material. It will be constructed in stages of compacted lifts, which would be undertaken as demand requires.

The ore processing does not include chemical processing and the tailings will not have high toxicity that might otherwise require a synthetic liner.

The tailings dam will be clay-lined. Clay is available on site but the resource has not been quantified. Clay requirements for the lining and wall core are in the order of 0.5 Mm<sup>3</sup>. If on site resources prove to be inadequate, supplementary clay will be imported from a licensed commercial clay pit. Clay will be compacted to achieve a permeability of less than  $1 \times 10^{-9}$  m/s. The tailings will provide additional sealing as they consolidate over time.

The principal environmental concern is unoxidised pyritic residues. These have the potential to generate acid on oxidation. This risk will be mitigated by dosing the tailings to achieve a surplus alkalinity as they emerge from the processing plant and by maintaining a water cover over the tailings (apart from the tailings beach) during operations and after mine closure.

A collection dam will be constructed below the dam to collect any seepage and provide a water sampling point for any such seepage. Collected water will be returned to the recycle dam (via the neutralisation plant).



The design of the tailings dam will require approval from the Tasmanian Assessment Committee on Dam Construction and will need to satisfy the design standards of the Australian National Committee on Large Dams (ANCOLD)<sup>5</sup>. As part of the detailed dam design process, a societal risk assessment will be undertaken to examine the risk of human fatalities from a catastrophic dam failure. Because of the absence of human habitation in the Nelson Bay River catchment, the exposed population would be very low, and would probably be confined to road traffic on Temma Road, several kilometres downstream from the mine site. Nevertheless, the ANCOLD standards are likely to require a design failure probability of 1 in 10,000 years or less.

Catastrophic failure of the tailings dam will therefore be a very low (1 in 10,000 year) probability. If, despite this, failure did nevertheless happen to occur during operations, tailings would flow and be deposited in West Creek and remedial action would be undertaken. On mine closure, the tailings dam overflow would be connected to the waste rock dump collection drain. A post-closure tailings dam failure would result in tailings being deposited in the collection drain. Given the design standard for the dam, both of these scenarios are extremely unlikely events.

A geotechnical investigation of the dam site will be undertaken as part of the detailed mine planning.

### *Decant water*

The decant from the tailings dam will be fed into the recycling dam and then pumped back to the processing plant to recycle process water.

Because of the shortfall of recycling water relative to the total process water needs (requiring makeup water), there is not expected to be a need for any routine discharge of tailings dam decant. However, if rainfall onto the tailings dam leads to an excess, this will be discharged either to the collection basin below the tailings dam or to the recycled water dam. Any overflow from these dams would discharge to West Creek and East Creek respectively. Because of the tailings alkalinity dosing (see section 2.13), the tailings decant water, and hence any overflow to West Creek) would not be acidic. The discharge to East Creek, which could be subject to acidic inputs from pit water, will be via the acid neutralisation treatment plant, where it would be neutralised if the pH falls below the treatment threshold of pH 7.

If, for some unlikely reason, the decant water is temporarily not suitable or available for recycling back to the process plant, there is more than sufficient pit water to make up the shortfall. As shown in Figure 8, even in a dry year the expected excess of pit water is 0.4 Mm<sup>3</sup>/a, which exceeds the 0.04 Mm<sup>3</sup>/a expected from decant recycling by an order of magnitude.

### *Water cover*

The tailings dam will be constructed towards the head of West Creek. West Creek will be diverted around the dam. However, a top-up weir will be constructed at the diversion point to allow creek water to be redirected into the dam in order to maintain a permanent water cover. This arrangement will remain in place after mine closure.

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<sup>5</sup> ANCOLD (November 2010) *Guidelines on Planning, Design, Construction, Operation and closure of Tailings Dams*.

The total catchment area of the tailings dam and its upstream feed from West Creek is approximately 70 ha. The surface area of the tailings dam itself is approximately 40 ha. The mean annual effective rainfall (rainfall minus evaporation) at the mine site is 570 mm (see Table 2 in section 2.3). With a catchment to dam area ratio of approximately 70:40, i.e. 1.75:1, the mean effective rainfall onto and into the tailings dam is therefore approximately 1 m, which will ensure a mean depth of permanent water cover of at least 1 m.

The lowest annual rainfall likely to be experienced at the mine site is approximately 900 mm, equivalent to the annual evapotranspiration rate (Table 2). Even in drought years there will therefore be no net evaporation from the tailings dam, and a permanent water cover depth of at least 1 m is therefore readily attainable.

A water cover will be maintained over the tailings during operations, apart from the active beaching area which will need to be exposed to assist with the consolidation of newly deposited tailings.

The water cover will provide an additional level of security, on top of the pH adjustment of the tailings, to prevent the tailings dam becoming acidic and hence prevent the dissolution of metals contained within the tailings material. Tailings discharge water is therefore not expected to have any significant toxicity.

## 2.14 Mine infrastructure

A number of stockpiles will be maintained on site (in addition to the waste rock dump), namely:

- Topsoil stockpiles (for rehabilitation)
- Crushed material stockpile (eg. for road surfacing)
- Waste rock stockpile (eg. for building tailings dam walls)
- The ROM stockpile.

Topsoil will be recovered during the construction of the open pit, the waste dump areas and the access roads and will be stockpiled for future rehabilitation works.

The mine will have basic support infrastructure including parking, workshops, change rooms, ablutions, security, first aid rooms, a crib room, an office, a diesel powered generator, communications, storage buildings and areas, and domestic wastewater treatment facilities. All buildings will be transportable and all entrances, car ports and access paths between buildings will be covered.

The workshops will include provision for welding, vehicle maintenance, fitting and machining.

One or more sea containers will be used as lockup tool and parts stores.

The compound will include storage for chemicals, paints and fuel oils. An explosive magazine will be located at an appropriate distance from the plant area.

Potable water will be sourced from rainfall and stored in rainwater tanks.

Sewage will be collected for treatment in an on-site Aerated Wastewater Treatment System (AWTP) or similar. Treated effluent will be discharged into the recycle dam.

Power will be supplied by diesel powered generators. It is estimated that the total energy demand for the site, excluding mine dewatering pumps, will be approximately 2 MW. Mine dewatering pumps will be trailer mounted mobile units powered by diesel engines. By separating the power requirements of the pumps from the rest of the mine's infrastructure, the need for unnecessary oversizing of the diesel generator will be obviated, along with the need to connect an electrical supply from the surface substation to the pit floor.

The diesel generator station will be located centrally to all operations. To handle high starting loads of high inertia equipment such as the crusher and conveyor systems, the power capacity will need to be 500 KVA to be provided by two parallel 250 KVA units.

Power will be fed from the diesel alternator sets by a cable to a low voltage motor control centre in a substation building adjacent to the generator shed, which will be an open-sided, flat roofed steel structure.

The layout of the mine site is shown in the staging diagrams in Appendix A. Figure 15 shows the details of the plant and stockpiling area.

## 2.15 Disturbance footprint

Key features of the project include:

- DSO pit: a shallow excavation to a depth of approximately 40 m down-dip (60 to 65 m RL)
- Main pit: an open cut pit to an ultimate depth of approximately 225 m (-145m RL)
- Processing plant: an on-site processing plant with ROM pad
- Waste dump: an out of pit storage area for NAF waste rock
- Tailings storage dam: a process tailings storage area
- Support infrastructure: a range of facilities essential for mine operation and management.

The total disturbance footprint for the principal elements of the mine is approximately 152 ha. The footprint areas of the various components are shown in Table 20.

Table 20: Disturbance footprint of principal mine elements

Component	Area (ha)
DSO pit	3.6
Main pit	13.5
Waste dump	70.1
Processing plant and ROM pad	8.0
Process water dams	4.0
Tailings dam	41.7
Sediment dams	1.0
Cut-off drains and bunds	2.1
Access and haul roads	9.0
Total	152

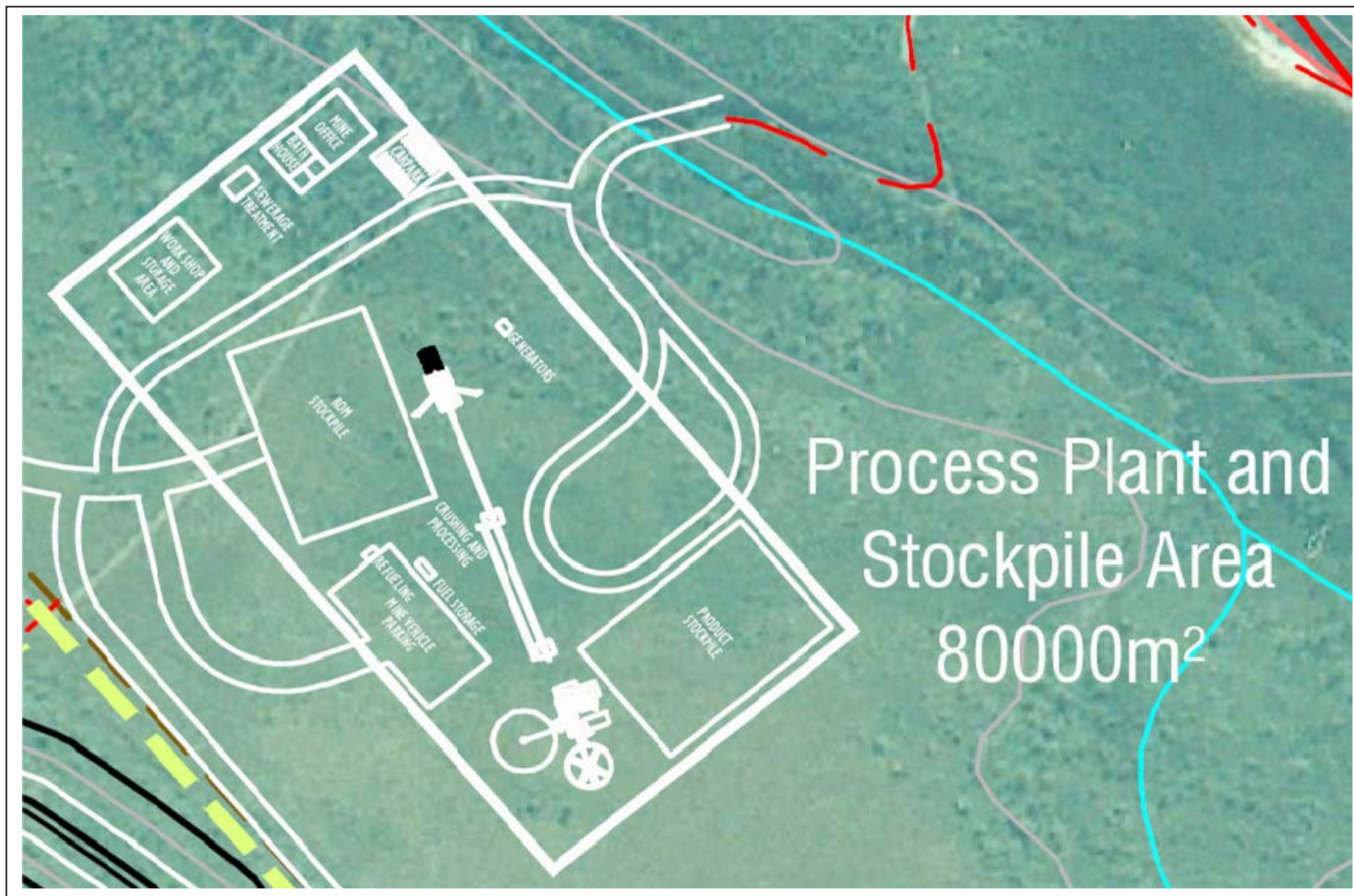


Figure 15: Schematic arrangement of processing plant and stockpiling area (see Appendix A for wider layout context)



## 2.16 Pit water, stormwater and site drainage

Mine water management will ensure that no contaminated surface water or groundwater is discharged to Nelson Bay River.

### *Surface water diversions*

Cut-off drains and bunds will be constructed to divert water away from the pits (both the DSO pit and main pit), waste rock dump, tailings dam and processing plant site. This diverted water will not be subject to contamination and therefore will be directed into natural drainage lines, through energy dissipation structures as necessary to minimise erosion risk.

### *Pit water*

Water from pit dewatering will be pumped to the acid neutralisation plant and then to the recycle dam or to the East Creek discharge. The expected DSO dewatering rate is approximately equal to the process water make-up needs. Dewatering from the main pit would be excess to this, and the excess would be discharged to East Creek (see Appendix H).

The additional contribution to the Nelson Bay River flow from the main pit dewatering will therefore be less than 1% in an average year. However, in a dry year the discharge of mine water would be more significant. As the pit deepens, pit water inflows will become more driven by the deeper regional aquifer, which will largely be independent of short term fluctuations in rainfall. Surface waters, including Nelson Bay River, on the other hand will respond to day to day changes in rainfall and the river flow could be very low during particularly dry periods. If pit water continued to be discharged at a relatively constant rate, during dry times the discharge could dominate the flow in the river. For this reason, a variable flow discharge regime that adjusts to creeks and river conditions will be implemented.

If acid is formed due to rain runoff from the exposed rock in the operating PAF cell inside the DSO pit, it will safely accumulate in the DSO pit before being pumped to the neutralisation plant.

It is possible that any exposed PAF rock in the main pit wall will oxidise and generate acid through rain runoff or groundwater discharge over that part of the pit face. Pit water will be pumped to the central treatment plant, where it can be neutralised if necessary, prior to discharge to East Creek (or to the recycle dam for make-up water).

### *Processing plant*

Site runoff from the processing plant hardstand, which may be subject to hydrocarbon contamination, will be diverted into an oil and grease separator, prior to pumping to the recycle dam. Treated effluent from the facility's wastewater (sewage) treatment plant will also be sent to the recycling dam.

### *Tailings dam*

A discharge to West Creek could occur from any overflow from the tailing dam's collection dam.

An overflow is unlikely because water from this dam will be recycled to the process plant. If there was nevertheless an overflow, the alkalinity dosing of the tailings and the permanent water cover of the tailings dam (apart from the beach) would prevent the overflow from becoming acidic or high in dissolved metals.

### *Rock dump*

NAF material will be separated at source from PAF material, as described in section 2.11. NAF rock will be taken to the NAF waste rock dump; PAF rock will be stored in the DSO pit and ultimately flooded in the DSO and main pits.

A discharge to West Creek could occur from the NAF rock dump's collection drain sedimentation basin.

Runoff from the rock dump into its collection drain would be at low risk of acidification and hence metal dissolution because the rock dump will comprise NAF material.

If there was nevertheless some incidental acid formation, water would be pumped from the basin to the main pit and hence to the neutralisation plant for treatment.

## 2.17 Product transport

Product will be transported to the Port of Burnie or Port Latta via the following roads (Figure 16):

1. Wuthering Heights Road (responsible authority: Forestry Tasmania)
2. Rebecca Road (responsible authority: DIER)
3. Blackwater Road (responsible authority: Forestry Tasmania)
4. Sumac Road (responsible authority: Forestry Tasmania)
5. Roger River Road (responsible authorities: Forestry Tasmania/Circular Head Council)
6. Trowutta Road (responsible authority: Circular Head Council)
7. Grooms Cross Road (responsible authority: Circular Head Council)
8. Irishtown Road (responsible authority: Circular Head Council)
9. Bass Highway (responsible authority: DIER) to either Port Latta or the Port of Burnie.

All processing infrastructure will be on-site and the only off-site infrastructure used will be the State road network for product transport to Burnie port (or Port Latta), although it is possible that unprocessed ore could alternatively be sold to an existing licensed processor for processing, subject to commercial agreements.

Product transport will be up to 7 days a week but for conservative impact assessment purposes in this DPEMP, a 5 day week has been assumed (with consequential higher daily truck movements).

Product transport from the 150,000 tonnes pa operating mine will require approximately 40 truck movements a day (i.e. 20 loads per day). This is based on a nominal five day week but, subject to the transport contract, trucking may occur 7 days a week. During year 1, while the DSO pit is operating, the transport task will be approximately 350,000 tonnes pa (assuming a ROM recovery rate of 90%).

Product transport estimates are shown in Table 21 (based on ore quantities shown in Table 1).





Figure 16: Product transport route

Table 21: Product transport estimates

Component	Year 1	Years 2 - 10
Cartage period	7 days a week but assumed 5 days per week for assessment purposes; average 12 hour day	
Product production (tonnes per annum)	350,000	150,000
Truck capacity (tonnes)	33	33
Approximate average number of loads per day	41	17
Trips on route (vehicle movements per day)	82	34

There will also be traffic associated with worker movement to and from the mine. However, as a mitigation measure against potential wildlife roadkill, Shree will provide a bus to transport workers to and from Smithton (some may need to use their own cars if they live away from that transport route).

A Traffic Impact Assessment has been prepared in accordance with the Department of Infrastructure, Energy and Resources (DIER) publication *Traffic Impact Assessments (TIA) Guidelines* September 2007. This assessment, summarised below, is included as Appendix M.

The objective of the TIA was to assess the proposed cartage routes and to determine the traffic impact of the cartage of product to the Port of Burnie and/or Port Latta.

The results of the TIA, which included an examination of parking, sight distances from junctions, traffic operations and road safety, were as follows:

- The Safe Intersection Sight Distances from the mine access must be in accordance with the requirements of the *Circular Head S.46 Planning Scheme No.1, 1995*.
- There were no crashes in the vicinity of the mine in the last 5 years.
- The increased traffic generated by the proposed development will have minimal impact, for both 24 hour and daylight only carting operations. The traffic operations of the surrounding road network will, therefore, continue to operate at an acceptable level of service.
- The Circular Head Planning Scheme requires that five parking spaces be provided for employees at the extractive pit sites. Dimensions for car spaces and associated turning areas must comply with the Australian Standard for off-street parking AS2890.1.

## 2.18 Construction

A Construction Environmental Management Plan (CEMP) will be prepared prior to mine development and construction work commencing.

### *Site preparation works*

Initial site preparation works will involve the following:

- Preparation of the CEMP
- Construction of access roads to the site
- Clearance and disposal of vegetation in areas required
- Removal of DSO overburden
- Levelling and grading of sites in preparation for establishment of crusher and generators, and the erection of buildings and other infrastructure
- Establishment of drainage lines, settlement ponds, etc.

### *Erosion mitigation measures*

In accordance with Section 35.1 of the *State Policy on Water Quality Management 1997*, all construction works must employ measures consistent with best practice environmental management to prevent erosion and the pollution of streams and waterways by runoff from sites of road construction.

All construction works will be undertaken in accordance with the DPIW Wetlands and Waterways Works Manual. A variety of erosion and sedimentation controls, particular to specific construction areas, will be utilised throughout the project and will include the following measures:

- The areas disturbed will be kept to the minimum practicable level required for construction.
- Disturbed areas will be rehabilitated and revegetated as soon as practicable after disturbance in order to minimise erosion and sedimentation.
- Temporary rehabilitation of sites will be undertaken in areas where final rehabilitation will be delayed for various reasons. This may include measures such as the installation of temporary erosion matting covers, etc.

- Overland drainage flow will be diverted away from disturbed areas and bare soil to outfalls with sediment traps to reduce the potential for erosion.
- Sedimentation controls will be used, where required, to reduce particulates in surface water run-off from entering local waterways:
  - Silt stop fencing will be used to prevent any disturbed sediment from reaching local creeks and waterways
  - All drainage from site drains will be directed to outfalls with sediment traps
  - The materials or sediments collected in these sediment traps will be disposed of within the site, if practicable, or will be disposed of in accordance with Council requirements.
- The access road's crossing of East Creek will be constructed with an open-bottomed culvert, designed and sited in accordance with the Manual.
- Where any river/drainage line crossings require construction activities to be undertaken within the waterway:
  - Silt stop netting will be established at an appropriate distance downstream from the construction site to collect any disturbed sediment
  - If feasible, temporary measures will be undertaken immediately upstream of the site to control the rate of water flow (eg measures to divert the water around part of the site to enable construction)
  - All river/drainage line crossing construction work that requires any in-stream activities will be undertaken at times of low flow to minimise the potential for sediment generation.
- All erosion and sedimentation controls will be established prior to the commencement of the works and will only be removed following completion of the earthworks and other construction activities, once disturbed soil has stabilised.
- Erosion and sedimentation controls will be inspected at least weekly and also following heavy rainfall events throughout the construction period. If inspections reveal any damage, they will be repaired as soon as practicable.
- All stockpiled materials will be controlled to ensure that dust is minimised and potential runoff from these stockpiles does not enter watercourses.
- All mitigation measures will be outlined in detail in the Construction Environmental Management Plan.

Following construction, there is potential for impact to local waterways and drainage lines as a result of runoff from the road surfaces and mining activities. Environmentally sensitive drainage design that allows sufficient treatment of this runoff prior to release into the environment will be utilised.

### *Plant hygiene measures*

The botanical survey observed no symptomatic evidence of *Phytophthora* anywhere within the study area but the vegetation type would be susceptible to infection.

Hygiene measures for *Phytophthora* management have been implemented at entry points to the site during the exploration phase.

Appropriate hygiene protocols, including washdown procedures, will be maintained on the site during the development and operation of the mine. These protocols, which will be consistent with the recommendations of the DPIW

Biodiversity Conservation Branch report titled: “Interim *Phytophthora cinnamomi* Management Guidelines”, will include maintenance of current hygiene treatment stations at entry points to the area and ensuring that personnel observe strict protocols in treating boots, equipment, vehicles and machinery before entering any potentially infected area.

### *Construction materials*

The major requirements for construction materials will relate to construction of new roads and upgrading of existing roads, construction of the tailings storage facility and aggregate for concrete construction.

It is anticipated that all construction materials required will be sourced from on site, apart from some road materials and concrete aggregate. At this stage, the local materials appear to be suitable for road base and/or concrete aggregate after crushing.

NAF waste rock will be used to construct the tailings storage facility dam wall and locally derived clay will be used to provide an impermeable lining. Local clay will be used to construct the PAF waste rock cell in the DSO pit.

### *Commissioning*

Commissioning is expected to consist of two main phases:

- Development of an initial, short-term operation based on mining and shipping of the near-surface oxidised ore (hematite) - the Direct Shipping Ore (DSO)
- Development of the main operation - the mining and processing of the lower grade hematite ore and then the underlying magnetite ore.

The initial short-term DSO operation is expected to last 1 year. It will require the installation of plant to crush and screen the DSO, the development of a shallow mining operation based on this ore and the establishment of infrastructure to load the crushed and screened ore. Port infrastructure to stockpile and load the ore will also be readied in this initial phase.

During this initial mining operation phase the main pit will be developed, together with the waste rock dump, the process plant and the tailings storage facility.

Commissioning of the main pit and process facilities is expected to occur in the second year after the commencement of DSO production.

## 2.19 Off-site infrastructure

All processing infrastructure will be on-site. The only off-site infrastructure used will be the State road network for product transport to the port of Burnie (or Port Latta).

Product transport from the 150,000 tonnes pa operating mine will require approximately 34 truck movements a day (i.e. 17 loads per day). This is based on a nominal five day week but, subject to the transport contract, trucking may occur 7 days a week.

During the first year, when the DSO pit is operating, the transport task would be up to 350,000 tpa and would involve approximately 82 truck movements a day (i.e. 41 loads a day).

Product will be stored in existing port storage facilities at either Burnie or Port Latta. The final decision on which port will be used has yet to be made and will depend on commercial negotiations that will be concluded following project approval.

## 2.20 Technical and management alternatives

There are no identified technical or management alternatives.



### 3. The Existing Environment

#### 3.1 Planning aspects

The area of the proposed resource extraction is located in the Circular Head Municipality. The relevant provisions of the *Circular Head S.46 Planning Scheme No. 1, 1995* (the Scheme) are discussed in the following sections.

#### 3.2 Use and Zone

The proposed development is best described as Industry Extractive, which is defined as:

*means any land used for the excavation of any resource(s) such as sand, earth, soil, clay, turf, gravel, rock, stone, minerals or the like.*

The development footprint and surrounding area are predominantly within the Forest Resource Zone of the Scheme. There are some small areas (that correspond to the extent of the Arthur Pieman Conservation Area) that fall within the Conservation Zone of the Scheme.

##### 3.2.1 Forest Resource Zone

The intent (4.9.1) of the Forest Resource Zone is:

- 1) *To identify the areas of forest on Crown Land which are under the control of the Forestry Commission;*
- 2) *To identify private land where a Private Timber Reserve or Timber Harvesting Plan has been sought and approved by the Forestry Commission;*
- 3) *To identify other land which is suitable for Commercial Forestry operations.*

Clause 4.9.2 Use of Land (in the Forest Resource Zone) lists “*Extractive Industry*” rather than Industry Extractive, as defined in Part 13 of the Scheme. It has been assumed these definitions refer to the same activity and the difference is the result of an error in drafting the Scheme.

“Extractive Industry” is a Discretionary use or development in the Forest Resource Zone.

##### *Development Standards of the Forest Resource Zone*

Height - Appendix C contains the conceptual processing plant design. The permitted height limit of 12 metres will be exceeded by the primary crusher. This exceedance will not detrimentally affect any dwellings or open recreation space of neighbours; the nearest dwellings are several kilometres away on the coast. The development is predominantly located within State Forest; as such it is surrounded by significant areas of Eucalyptus forest, providing effective screening of all infrastructure.



Setbacks - All infrastructure and development activities are located 30 metres or greater from the nearest rivers and creeks. The significant development works that are directly adjacent to watercourses (such as the Waste Dump and Tailings Dam) have a bund wall / drain diversion that runs to the sedimentation dam. Please refer to the section on surface water, later in this document, for further information on the compliance of the development with the *State Policy on Water Quality Management 1997*.

There is no subdivision proposed as part of this application.

### 3.2.2 Conservation Zone

The intent (4.16.1) of the Conservation Zone is:

*...to identify those areas having significance for their contribution to maintaining natural habitats, protecting areas of cultural heritage, retaining landscape values and where human activities are managed in recognition of those resource values and development of land.*

Clause 4.16.2 of the Scheme requires use and development within the Conservation Zone to be in accordance with a Management Plan prepared by the Agency responsible for the management of the area and approved by Council.

The Conservation Zone boundaries correspond with the boundaries of the Arthur-Pieman Conservation Area. The Arthur-Pieman Conservation Area Management Plan 2002 was approved by his Excellency the Governor-in-Council on 17<sup>th</sup> December 2001 and took effect on 16 January 2002. The proposed development will be undertaken in accordance with this management plan - see section 3.3 for a full discussion.

### 3.2.3 Planning Scheme Standards

Compliance of the proposal with the relevant Planning Scheme standards is summarised in Table 22.

More detailed information on individual issues is outlined throughout this report.

Table 22: Compliance with relevant Scheme standards

Issue	Compliance
<b>Part 6 Hazard Controls and Land Protection</b>	
<i>6.2 Unstable Land</i>	There will be no subdivision of land or construction of buildings on “unstable land” as defined in the Scheme.  Some of the resource extraction activities will be located on a slope of greater than 1:4, however, the extraction control measures outlined elsewhere in this document will ensure that any risk of landslip, soil erosion or danger to the public is appropriately mitigated. Please refer to the Hazard Analysis and Risk Assessment contained later in this document for further information.
<i>6.3 Fire Hazard Area</i>	The project site clearance, construction, commissioning and operations will be conducted in accordance with the Fire Management Plan. Please refer to the Fire Risk section contained later in this document for further information.

Issue	Compliance
6.4 Flood Prone Areas	The resource extraction areas and ancillary buildings are not located in areas known to be flood prone.
6.5 Coastal Protection	Not applicable
6.6 Watercourse Protection Areas	There are no buildings proposed within 30 metres of a watercourse. See discussion on surface waters later in this document for further information.
6.7 Tree Preservation	Not applicable.
6.8 Distances Between Dwelling Units or Residential Zones and Scheduled Premises or Sources of Pollution	There are no nearby residential uses likely to be affected by the proposed resource extraction. The nearest dwellings are several kilometres away on the coast.
Part 9 Roads and Access Provisions	
All provisions are dealt with in the accompanying traffic impact assessment	See the Traffic Impact Assessment contained in Appendix M.

### 3.3 Arthur Pieman Conservation Area

The Arthur-Pieman Conservation Area, a reserve of approximately 103,000 hectares, provides protection to significant areas of Aboriginal cultural heritage, coastal landscapes and wilderness, and significant ecosystems. It is also important for a range of commercial activities that have significant economic implications, particularly for the local community, including mineral exploration and extraction.

The objectives of conservation areas include providing for exploration activities and utilisation of mineral resources. Section 5.3 of the Arthur Pieman Conservation Management Plan details the aims and prescriptions for Mineral Resources.

The aims are *"To ensure that exploration or any subsequent extraction and rehabilitation are undertaken in accordance with best practice to provide maximum environmental protection."*

The prescriptions are:

- *Exploration shall be conducted in accordance with conditions laid out in the Mineral Exploration Code of Practice.*
- *Extraction will be subject to the Quarry Code of Practice and environmental assessment as required by State legislation including the Environmental Management and Pollution Control Act 1994, the Mineral Resources Development Act 1995 and the Mining Act 1993.*
- *Rehabilitation shall be carried out on all activities associated with mineral exploration and mining activity in the Arthur-Pieman Conservation Area.*

The Conservation Area has been zoned to ensure appropriate management and use in different parts of the reserve. Zoning is applicable to use and development associated with tourism, recreation, reserve management and the controlled use of natural resources, with the exception of mining. Zoning does not apply to mining but is intended to provide a sensitivity guide for mining activities.

The proposed development is located within the Natural Zone. The General aims of this zone are:

- *To conserve natural integrity and protect, maintain and monitor the diversity of plant and animal species and communities.*
- *To conserve cultural heritage values.*
- *To maintain the wilderness character of naturalness, tranquillity and isolation.*

Table 23 details the development features, and their respective area of impact on the Arthur-Pieman Conservation Area (APCA). Appendix N contains a map showing the location of the impact areas on the APCA.

Table 23: Impacts of the development features on the Arthur-Pieman Conservation Area

Feature	Area of impact (ha)
Tailings dam	7.08
Recycle dam	0.894
Processing plant	5.91
DSO pit	0.802
Rock dump collection drain	0.0578
Total area of impact of development	14.7
Total area of APCA	103,287.21
Area of impact of development as percentage of total APCA	0.014%

The area of the Arthur-Pieman Conservation Area impacted by the proposed development is 0.014% of its total area. The prescriptions for mining activities contained in the Arthur-Pieman Conservation Area Management Plan will be achieved through the commitments and subsequent approval of the activity in accordance with this DPEMP. Likewise, the Natural Zone general aims are furthered by the implementation of this DPEMP.

Because of the very small proportion of land lost (0.014%) and the fact that the loss occurs on the edge of the APCA, it is anticipated that a compensatory offset will not be required.

## 3.4 Environmental aspects

### 3.4.1 Topography

The topography over much of the area is relatively subdued as the site is located on an old peneplain.

Over the wider mine site area the surface is gently undulating, largely varying between about 80 and 100 m above sea level. Locally the Nelson Bay River has become incised into this old surface to a depth of 30 - 40 m.

### 3.4.2 Geology

#### *Regional geology*

Regional geology has been outlined in the reports cited in the mine site geology section below. The regional geology consists of mixed Proterozoic siltstones, sandstones and carbonaceous mudstones of the Cowrie Siltstone, part of the Rocky Cape Stratotectonic Element.

The Rocky Cape Stratotectonic Element, which consists of Early NeoProterozoic autochthonous marine shelf clastic sequences, is relatively unmetamorphosed to lower greenschist facies and is overlain by several suites of younger neoProterozoic rocks.

These rocks, which have been extensively folded and faulted, may have been thrust over the younger Cambrian sequence of the area.

#### *Mine site geology*

Resource geology has been described in three reports prepared for earlier tenement holders:

- SMG Consultants (November 2005) *Nelson Bay River licence EL41/2004: Literature study report*. Prepared for Zinco Resources NL.
- Simon Tear (January 2007) *Report on the resource estimation of the Nelson Bay River magnetite deposit, NW Tasmania*. Report by Hellman and Schofield Pty Ltd.
- Minserve (July 2007) *Nelson Bay River magnetite deposit conceptual mining study*. Prepared for Gujarat NRE Resources NL.

This historical work has been supplemented by drilling programs undertaken by Shree Minerals in 2009, 2010 and 2011, described in:

- Simon Tear (November 2010) *Report on the resource estimation of the Nelson Bay River magnetite and hematite deposit, NW Tasmania*. Report by Hellman and Schofield Pty Ltd.

The following description is based on the above reports and the findings of Shree's own drilling.

Rocks in the local area are finely laminated, psammo-pelitic, Proterozoic-aged siltstones with medium grained sandstones/quartzites. The quartzites are clean well-sorted, and massive to thinly bedded and up to 200 m thick.

Within the exploration area, there are four known mineral occurrences. The occurrence of principal interest is the Nelson Bay River Iron Occurrence; the other three are sand and gravel occurrences.

The Nelson River Iron Occurrence is approximately 4 km long and is split into a northern magnetic anomaly and a southern magnetic anomaly. The body of mining interest is the northern anomaly; the southern anomaly does not appear to be a commercial resource.

The northern anomaly at surface is an 800 m long lode of granular aggregates of hematite and magnetite in an iron clay and/or siliceous matrix. At depth it becomes an ultramafic dyke-like structure up to 40 m wide, containing a quartz-carbonate-magnetite-pyrite-garnet-chlorite-amphibole assemblage. Associated with the dyke are a white mineral and olive coloured silicate, fibrous amphibole and green silicates. There are also dense garnet clusters at the ultramafics contact with the sediments.

There is a magnetite footwall zone to the dyke, which is a sulphide poor magnetite-actinolite/chlorite skarn.

The resource shape is approximately 600 m long with an average downdip extension of 220 m. True thickness ranges from 2.2 m in the southern end to 27 m in the middle and 18 m at its northern end. Surface weathering extends vertically from the plateau to a depth of typically 30 m (similar to the depth to which the Nelson Bay River has incised the plateau).

The global iron resource estimate is 12.7 Mt at 36.1% Fe, including magnetite resources and goethite-hematite resources.

The upper oxidised layer of the ore body is close to the surface (upper 30 m) on the eastern side of the proposed pit and is high grade hematite, suitable for direct shipping with little beneficiation (probably crushing and screening only). This Direct Shipping Ore (DSO) layer extends southeast from the pit for approximately a further 1 km.

It is proposed to mine this DSO first, while the main pit is being prepared and the processing plant and other infrastructure is being established. The main pit and processing plant will be brought on line in parallel with the DSO mining. It is expected that the DSO will provide 1 to 2 years of resource.

Assuming a typical DSO pit depth of 30 m and a 20 m wide pit floor, the surface expression of the DSO excavation is likely to be approximately 60 m wide.

The location of the main pit and the DSO pit are shown in Appendix A, together with the processing plant, waste rock dump and the tailings dam.

### 3.4.3 Geoconservation

There are no features of geoconservation significance in the proposed mine site area. There are, however, a large number of such features throughout the wider area. These sites include sites of local, regional, Tasmanian, Australian and world significance. The sensitivity of these sites also varies considerably, ranging from extremely fragile areas to large scale features and values that would only be destroyed by catastrophic events.

### 3.4.4 Geomorphology

The landscape reflects the underlying geology, and has been shaped by fluvial processes and the development of peat bogs. The area is part of an extensive peneplain that has been formed on the Proterozoic siltstones, sandstones and carbonaceous mudstones of the Cowrie Siltstone.

The wider region is marked by an extensive drainage network that flows northwest and west to the Southern Ocean. This drainage network consists of a number of major rivers, such as the Arthur, Frankland and Nelson Bay Rivers, and numerous smaller tributaries of varying length.

To the west, the peneplain contains fossil sand dunes while to the east it becomes more undulating and incised by drainage lines, particularly by major drainage lines, such as the Frankland and Nelson Bay Rivers.

Extensive blanket bogs (peat deposits) occur throughout the wider area. The development of these blanket bogs has resulted in the surface topography being locally more subdued than would otherwise be the case.

### 3.5 Climate

The Bureau of Meteorology (BOM) has a rainfall station at Temma, which has operated since 1943. This site is 7 km from the mine site at an altitude of 105 m. The nearest temperature station is at Redpa, approximately 34 km away, which has operated since 1952.

The rainfall and temperature data are summarised as follows:

- Mean annual rainfall 1300 mm/year
- Maximum mean monthly temperature 16.2 °C
- Minimum mean monthly temperature 8.2 °C.

The prevailing winds at the site are north westerly to south westerly.

Rainfall and evaporation has been summarised previously in Table 2.

### 3.6 Catchments

The wider region has a number of major rivers, including the Arthur, Frankland and Nelson Bay Rivers, together with an intensive network of tributary streams.

The site is located on the southern side of the Nelson Bay River, which flows northwest and west to the Southern Ocean at Nelson Bay, and is located wholly within the Nelson Bay River catchment. This catchment is considered to be part of the Arthur River catchment for the purposes of establishment of protected environmental values PEVs (see below).

The site is located on the southwestern side of the Nelson Bay River, a class 1 stream under the Forest Practices Code. The proposed mine site and associated facilities are located between two northwesterly trending tributaries (class 2 drainage lines) of the Nelson Bay River, referred to as West Creek and East Creek. These tributaries both have an extensive network of sub-tributaries. West Creek will receive overflow water from settling dams. East Creek will receive excess water from the pits and recycle dam (via the acid neutralisation plant).

#### *Protected Environmental Values (PEVs)*

Environmental management goals for surface waters in this area are contained in the Department of Primary Industries, Water and Environment document:

*Environmental Management Goals for Tasmanian Surface Waters, Catchments within the Circular Head & Waratah/Wynyard Municipal Areas, January 2000.*

Examination of this document indicates that the proposed mine site is located within State Forest in the Arthur catchment.



Sections of the established PEVs for surface waters in State Forest in the Arthur River catchment that are relevant to this proposal are:

*A: Protection of Aquatic Ecosystems*

- (ii) *Protection of modified (not pristine) ecosystems*
  - a. *from which edible fish are harvested;*

*having regard for Forestry Tasmania's 'Management Decision Classification System'.*

*B: Recreational Water Quality & Aesthetics*

- (i) *Primary contact water quality*
- (ii) *Secondary contact water quality*
- (iii) *Aesthetic water quality*

These PEVs reflect historical impacts on the Arthur River from upstream mining.

The Nelson Bay River, however, has not been subject to such impacts and for the purposes of this project the PEV of Nelson Bay River catchment will be assumed to be:

*A: Protection of Aquatic Ecosystems*

- (i) *Protection of pristine or nearly pristine ecosystems.*

The project's Water Quality Objectives (WQOs) will be developed to ensure that this PEV is not compromised (see below).

## 3.7 Project water monitoring

Water monitoring programs have been established to provide baseline water quality data for the site.

### 3.7.1 Catchment monitoring

Streamflow and water quality are currently measured by the Government at the Nelson Bay River at Temma Road (Nelson Bay) - Station No. 1307. This information is contained on the Water Information System of Tasmania website: <http://water.dpiw.tas.gov.au/wist/ui>

A summary of that monitoring follows (stream flow data accessed 12 October, 2010; water quality data accessed 2 July 2010).

*Streamflow:*

Average monthly streamflow between 1997 and 2008 ranged from a low of 1.1 cumecs in 2007 to a high of 1.6 cumecs in 1999. Minimum recorded flows ranged from 0.002 cumecs (18 March, 2008) to 0.023 cumecs (19 January, 1996). Maximum recorded flows ranged from 9.473 cumecs (1 September, 2008) to 24.598 cumecs (23 September, 1998).

*Analytical data:*

Turbidity ranged from 1.27 to 22.2 NTU's, with a mean value of 4.4 NTU's (based on 98 samples).

Field conductivity ranged from 91 to 368  $\mu\text{S}/\text{cm}$ , with a mean value of 180  $\mu\text{S}/\text{cm}$  (based on 107 samples).

Field pH ranged from 3.49 to 6.65, with a mean value of 4.57 (based on 71 samples).

Dissolved oxygen levels ranged from 4 to 13.2 mg/L, with a mean value of 9.4 mg/L (based on 92 samples).

### 3.7.2 Surface water

Surface water monitoring in Nelson Bay River commenced in February 2010, following confirmation of proposed mine location.

Samples were collected over a 15 month period from February 2010 to May 2011, during high and low flow conditions consistent with winter and summer flow conditions in the catchment.

#### *Monitoring sites*

Eight surface water monitoring locations (NBRSW01, NBRSW02, NBRSW03, NBRSW04, NBRSW05, NBRSW06, NBRSW07 and NBRSW08) have been monitored to obtain representative samples of surface water quality in Nelson Bay River, immediately upstream and downstream of the proposed mine, and in the lower reaches of Nelson Bay River along Temma Road.

The locations of the surface water sampling sites are shown in Figure 17. Location descriptions are as follows:

- NBRSW01: 317638E 5437603N: downstream (south) side of the Rebecca Road bridge crossing of Nelson Bay River, about 2 km west of the junction of Rebecca Road and Wuthering Heights Road.
- NBRSW02: 312676E 5441802N: on upstream side of the road bridge crossing of Nelson Bay River.
- NBRSW03: 310681E 5442017N: Nelson Bay River at southeastern end of the proposed pit site.
- NBRSW04: 309934E 5442745N: Nelson Bay River at northwestern end of the proposed pit site.
- NBRSW05: 305946E 5444267N: downstream side of the Nelson Bay River bridge crossing of Temma Road, at the gauging station.
- NBRSW06: 305961E 5441990N: downstream side of the Sardine Creek twin-pipe culvert crossing of Temma Road.
- NBRSW07: 310932E 5440983N: on West Creek, downstream from the tailings dam location.
- NBRSW08: 309823E 5442467N: on West Creek, downstream from the NAF rock dump sedimentation basin.

Prior to construction work commencing, additional permanent water monitoring sites will be established in East Creek, upstream and downstream from the recycling dam overflow discharge point, and in West Creek upstream from the seepage dam overflow discharge point and upstream from the NAF dump sediment pond. An additional sampling site will also be established in Nelson Bay River, immediately downstream from its confluence with West Creek.

Both West and East Creeks are ephemeral and are characterised by boggy, silty reaches and debris filled reaches, so much so that there are no riffle zones at which macroinvertebrate sampling stations could be established for Ausrivas monitoring<sup>6</sup>.

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<sup>6</sup> Todd Walsh pers. comm.

The presence of the operating mine will change the flow regime of the lower section of East Creek. Discharges from the mine operations to East Creek may act to clear the debris from the creek that is currently precluding the establishment of Ausrivas sites. If this occurs, an Ausrivas station will be established there.

### *Analytical results*

Samples were analysed in the field and under laboratory conditions for the following parameters:

- Dissolved oxygen (field)
- pH (field)
- Electrical conductivity (field)
- Turbidity (field)
- Temperature (field)
- Alkalinity
- Acidity
- Total heavy metals
- Sulphate
- Nutrients
- Total anions/cations.

The surface water quality monitoring database is included as Appendix O.

Indicator averages are provided in Table 24, together with proposed Water Quality Objectives (WQOs) which, using the ANZECC guideline methodology, are the 80<sup>th</sup>ile values of the individual observations at NBRSW01 (located upstream of the mine site at the Rebecca Road crossing of the Nelson Bay River). The EPA will determine the final WQOs.

The water quality across the general site area is good with no elevated concentrations causing concern.

The monitoring results indicate good water quality when assessed using *Australian and New Zealand Environment and Conservation Councils (ANZECC) Guidelines for Fresh and Marine Water Quality, 2000*. The physical water quality properties are mostly within the range of the guidelines. Concentrations of nutrients are considered to be low.

No noticeable scums, sheens or gross odours were identified during any of the sampling events at the monitoring locations.

This background data will provide a reference against which future surface water quality in Nelson Bay River can be assessed, when the proposed mine becomes fully operational.

The East Creek discharge point will begin to receive a discharge when dewatering of the DSO pit commences. The upstream and downstream sampling points will allow any changes in the water quality of East Creek as a result of the pit water discharge to be determined.

West Creek will begin to receive a discharge from the NAF dump sediment pond once runoff from the NAF dump accumulates; this will be during the DSO mining phase. The upstream and downstream sampling points will allow any changes in the water quality of West Creek as a result of the NAF dump runoff discharge to be determined.

Neither East Creek nor West Creek will receive any discharge of water used in the processing plant or from tailings until the main pit has been opened up and magnetite is being processed. This will be at least two years after mining operations commence and there will therefore be two years of monitoring data with only pit water discharges available before they receive any process water discharges.

The upstream and downstream monitoring points on both creeks will allow the impact of these discharges on creek water quality to be determined.

Table 24: Water monitoring sites - key indicator averages and proposed Water Quality Objectives

	pH	EC (µS/cm)	DO (%)	Turb (NTU)	SS (mg/L)	SO <sub>4</sub> (mg/L)	Cl (mg/L)	Hard (mg/L)	Al <sup>1</sup> (mg/L)	As (mg/L)
NBRW01	5.11	109.7	75.4	3.3	8.0	6.8	39.4	10.4	0.362	0.001
NBRW02	5.42	118.4	80.1	4.0	6.8	4.8	35.7	10.7	0.274	<0.001
NBRW03	5.44	112.7	86.1	4.2	5.2	5.2	37.9	9.6	0.232	0.001
NBRW04	5.74	115.5	85.5	3.4	4.0	6.7	31.7	19.4	0.208	0.002
NBRW05	4.96	127.1	87.3	4.1	7.2	18.8	60.2	30.0	0.187	0.001
NBRW06	5.17	278.8	75.3	3.5	4.0	14.6	51.0	26.0	-	<0.001
NBRW07 <sup>1</sup>	6.06	207.4	80.9	12.3	<5	<1	56.0	21.0	-	<0.001
NBRW08 <sup>1</sup>	6.4	264	75.2	9.0	<5	<1	71.0	26.0	-	<0.001
ANZECC*	6.5-7.5	350	90-110	2-25			700			0.013
WQO**	6.2	156	78	4.3	16	11	42	14	0.4	0.002

\*80%ile of observed data at NBRW01

	Cd mg/L	Cr mg/L	Co mg/L	Cu mg/L	Pb mg/L	Mn mg/L	Ni mg/L	Zn mg/L	Fe <sup>1</sup> mg/L
NBRW01	0.003	<0.001	0.001	0.002	0.027	0.020	0.001	0.014	0.302
NBRW02	0.004	0.002	0.001	0.002	0.002	0.021	0.001	0.008	0.661
NBRW03	0.003	0.002	0.001	0.002	0.003	0.015	0.001	0.008	0.969
NBRW04	0.0001	0.001	0.001	0.001	0.003	0.022	0.001	0.006	0.807
NBRW05	0.0001	0.002	0.003	0.003	0.003	0.041	0.003	0.011	0.895
NBRW06	0.001	0.002	<0.001	0.001	0.002	0.024	0.001	0.005	-
NBRW07 <sup>1</sup>	<0.0001	<0.001	<0.001	<0.001	0.004	0.054	0.001	0.005	-
NBRW08 <sup>1</sup>	<0.0001	<0.001	<0.001	<0.001	0.001	0.018	<0.001	<0.005	-
ANZECC*	0.0002	0.001		0.0014	0.0034	1.900	0.0110	0.008	0.0006
WQO**	0.001	0.001	0.001	0.01	0.12	0.01	0.002	0.01	

\*ANZECC guidelines for surface waters

\*\*80%ile of observed data at NBRW01

EC = electrical conductivity; DO = Dissolved oxygen; Turb = lab turbidity; Hard = hardness; SS = suspended solids; SO<sub>4</sub> = sulphate; Cl = chloride; Al = aluminium; As = arsenic; Cd = cadmium; Cr = chromium; Co = cobalt; Cu = copper; Pb = lead; Mn = manganese; Ni = nickel; Zn = zinc; Fe = iron.

<sup>1</sup> One sampling period only

### 3.7.3 Groundwater

#### *Monitoring sites*

Groundwater bores have been installed at six locations around the proposed mining and processing areas (Figure 17). Details of these locations are shown in Table 25.

Access to proposed groundwater bore site NBRGW02 was not feasible at the time of installation of the other groundwater bores because of a significant boggy area on the route, as well as other difficult sites on the access route. The drillers would not take the drill rig into the area without a significant track upgrade as the existing access was considered to be unsafe, with high potential for rig damage and bogging on route. This groundwater bore will be installed during a later drilling program.

The groundwater monitoring program commenced in mid May 2011. This program will continue at approximately six monthly intervals.

Table 25: Groundwater monitoring bore locations

Bore	Location	Easting	Northing
		(GDA 94)	
NBRGW01	South east (upstream) of the tailings dam	311690	5440320
NBRGW02	North west (downstream) of the tailings dam		
NBRGW03	South west of the waste rock dump	309893	5441461
NBRGW04	North west (downstream) of the waste rock dump	309720	5442195
NBRGW05	North west of the magnetite (main) pit	309797	5442651
NBRGW06	South east of the magnetite (main) pit	310487	5441962
NBRGW07	Processing plant area	311249	5441240



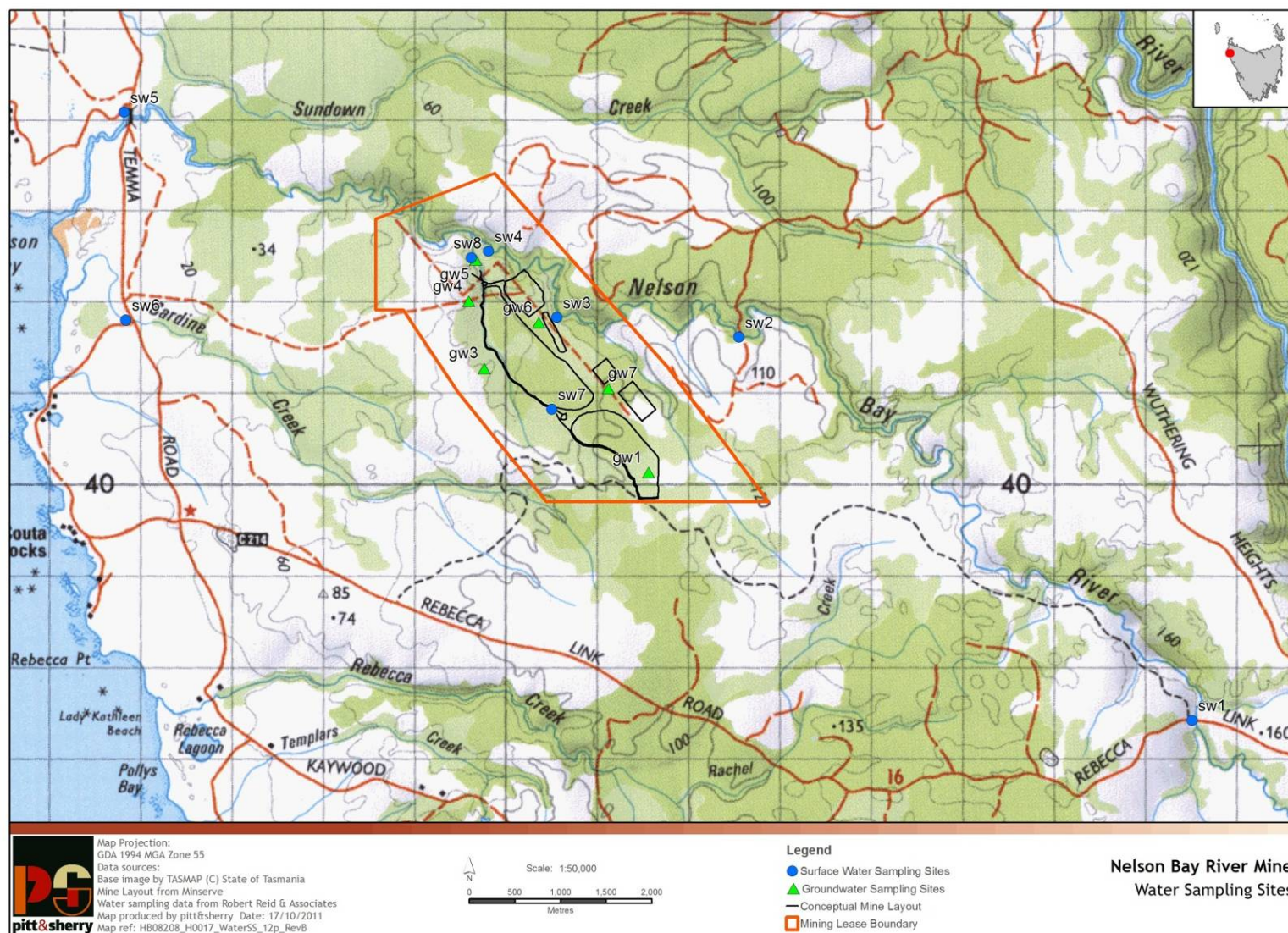


Figure 17: Established surface water and groundwater monitoring locations



### Groundwater levels

Groundwater levels recorded in the initial monitoring run are summarised in Table 26.

Table 26: Groundwater levels

Bore	Date	Depth to groundwater (m)
NBRGW01	18 May 2011	9.01
NBRGW02	Not yet installed	-
NBRGW03	19 May 2011	8.7
NBRGW04	20 May 2011	6.5
NBRGW05	20 May 2011	0.97
NBRGW06	19 May 2011	9.83
NBRGW07	18 May 2011	0.8

### Analytical results

One monitoring run has been completed at this stage. The analytical results from this run are summarised in Table 27.

Table 27: Groundwater monitoring results

	pH	EC (µS/cm)	DO (%)	Turb (NTU)	SS (mg/L)	SO <sub>4</sub> (mg/L)	Cl (mg/L)	Hard (mg/L)	Al <sup>1</sup> (mg/L)	As (mg/L)
NBRGW01	-	-	-	26400	9360	14	72	38		0.036
NBRGW02	Not yet installed									
NBRGW03	5.26	332	28.5	58	26	9	93	24		0.003
NBRGW04	5.82	287	34.9	3220	1010	11	69	37		0.04
NBRGW05	5.74	310	19.6	320	154	12	69	23		0.099
NBRGW06	5.67	447	19.8	1060	283	10	123	38		0.013
NBRGW07	7.72	383	8.6	272	214	14	86	19		0.24
ANZECC*	6.5-7.5	350	90-110	2-25			700			0.013

\*ANZECC guidelines for surface waters

	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Cu (mg/L)	Pb (mg/L)	Mn (mg/L)	Ni (mg/L)	Zn (mg/L)	Hg (mg/L)
NBRGW01	0.0004	0.037	0.039	0.266	0.199	0.238	0.054	0.048	<0.0001
NBRGW02	Not yet installed								
NBRGW03	<0.0001	0.002	0.002	0.004	0.005	0.156	0.002	<0.005	<0.0001
NBRGW04	0.0042	0.014	0.011	0.073	0.088	0.12	0.017	0.334	<0.0001
NBRGW05	0.0013	0.012	0.01	0.939	0.356	0.423	0.01	0.255	<0.0001
NBRGW06	<0.0001	0.004	0.002	0.01	0.009	0.064	0.004	0.038	<0.0001
NBRGW07	0.0002	0.003	0.014	0.003	0.022	0.271	0.016	0.015	<0.0001
ANZECC	0.0002	0.001		0.0014	0.0034	1.900	0.0110	0.008	0.0006

EC = electrical conductivity; DO = Dissolved oxygen; Turb = lab turbidity; Hard = hardness; SS = suspended solids; SO<sub>4</sub> = sulphate; Cl = chloride; Al = aluminium; As = arsenic; Cd = cadmium; Cr = chromium; Co = cobalt; Cu = copper; Pb = lead; Mn = manganese; Ni = nickel; Zn = zinc; Fe = iron.

<sup>1</sup> One sampling period only

As with the surface water sampling, this background data will provide a reference against which future groundwater quality and depth can be assessed, when the mine becomes fully operational.

The groundwater shows localised elevations of copper, lead and zinc at NBRGW05 (and zinc at NBRGW04). This is likely to be a reflection of the underlying geology.

The magnetite skarn at Nelson Bay River is accompanied by a separate phase of green pyroxene-amphibole skarn which has elevated copper and, to a lesser extent, lead and zinc. Indeed, the prospect has been targeted for copper in the past.

In the NBRGW04 and NBRGW05 catchment, aeromagnetism indicates no further likelihood of significant magnetite mineralisation. However, a previous (Geopeko) soil survey found ill-defined iron and copper anomalies to the south west (and north east), at the margins of the soil survey, which likely strike parallel to the magnetite. The elevated copper, lead and zinc levels in NBRGW05 are probably related to skarn mineralisation. The elevated zinc in NBRGW04 may reflect a more distal mineralised zone (hydrothermal geological systems often zone from proximal hotter copper-rich to more distal cooler lead and zinc-rich). Previous exploration has also noted regionally significant anomalous copper (20 ppm) in a Nelson Bay River sediment survey downstream of the magnetite and 5 ppm copper returned from sediment in the NBRGW05 catchment. These findings are not surprising, given that the mine site is a mineralised area.

NBRGW01 also has weakly elevated copper and zinc, which is not unexpected given that the bore is located near the inferred southeast strike extension of the magnetite and skarn.

The comparison in Table 27 with the ANZECC guidelines for surface waters shows differences typical of those between surface and ground waters, notably higher pH, conductivity, suspended solids and some metals and lower dissolved oxygen in groundwater relative to surface waters.

As noted above, because of the area's mineralisation, elevated metals are likely to occur naturally in Nelson Bay River sediments and in the groundwater within and downstream of the mineralisations. Surface waters, on the other hand, would have lower concentrations of metals due to their comparatively short contact time with the mineralised zone soils.

Pit water from within the ore body is likely to have similar metal elevations to that observed at the downstream groundwater bore NBRGW05 but new groundwater moving into the open pit is likely to have lower concentrations, due to not yet having had extended contact with the ore body. Newly arrived groundwater will be the dominant component of pit water and metal concentrations in water discharged from the pits is therefore expected to reflect those of the other bores and not be significantly elevated relative to natural surface water.

The discharge of mine water to surface waters will be managed through a variable discharge regime, as described in section 4.2.2.

### 3.8 Land systems

The proposed mine site and surrounding areas are located within the Thornton River Land System, as mapped by Richley<sup>7</sup>.

#### *613111 Thornton River*

This land system has developed on gently undulating plains on Precambrian sandstone-mudstone sequences in areas with an average annual rainfall of 1250 - 1500 mm.

Black sandy organic soils, becoming gravelly, have developed on the plains (average sideslope of 1°). These soils have a peat surface texture, high permeability, an average depth of 0.6 m and a low susceptibility to sheet erosion. The native vegetation in these areas is open heath.

On the slight rises (average sideslope 2°) stony, strong brown duplex soils have developed. These soils have a loam surface texture, moderate permeability, an average depth of 1.6 m and a low susceptibility to sheet erosion. The native vegetation in these areas is open forest.

In the drainage lines (average sideslope 24°) the soils are black sandy organic soils with a sandy peat surface texture. These soils have high permeability, an average depth of 0.3 m and a high susceptibility to rill and gully erosion. The native vegetation is closed scrub.

### 3.9 Land capability

Although a specific land capability survey has not been undertaken for the area, an estimation of the likely land capability classes can be made, based on the known geology, land systems and land usage. As the area is currently protected in either State Forest or Conservation Areas, it would be excluded from agricultural use (classified as Exclusion Areas in land capability mapping).

If any of this land was capable of being converted to an agricultural land classification, it would be likely to be classified as land capability Class 7 (land with very severe to extreme limitations which make it unsuitable for agricultural use) or Class 6 (land marginally suitable for grazing because of severe limitations).

### 3.10 Land tenure and land values

As shown in Figure 18, approximately 55% of the exploration licence mining tenement is covered by a State forest designation and 45% is classified as a Conservation Area (the mining lease is a smaller area within the exploration licence area).

There is a significant Protection Informal Reserve in the area which:

- Has been created to preserve some of the transitional forest as the vegetation changes from wet heathland through to tall forest.
- Forms a buffer between the Arthur Pieman conservation area and the timber area accessed by the Wuthering Heights network.

<sup>7</sup> Richley, LR. 1978. *Land Systems of Tasmania Region 3*. Tasmanian Department of Agriculture.

## 3.11 Wilderness values

### 3.11.1 Approach

As part of the Regional Forest Agreement (RFA) process (mid-1990's), the Australian Heritage Commission prepared a national inventory of wilderness quality.

The nationally agreed Reserve Criteria for a Comprehensive, Adequate and Representative Reserve (CAR) System in Australia defined high quality wilderness as areas larger than 8,000 ha having National Wilderness Inventory ratings of 12 or greater, on a scale of 0 to 20. This definition was used in the delineation of high quality wilderness areas under the Tasmanian Regional Forest Agreement process in 1997.

The National Wilderness Inventory (NWI) is maintained by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities<sup>8</sup> and is supported by a systematic methodology for rating wilderness values.

The NWI ratings are determined by four wilderness quality indicators that describe remoteness and naturalness, which are the fundamental attributes of wilderness:

- Remoteness from settlement: *Remoteness from places of permanent occupation*
- Remoteness from access: Remoteness from established access routes
- Apparent naturalness: The degree to which the landscape is free from the presence of permanent structures associated with modern technological society
- Biophysical naturalness: The degree to which the natural environment is free from biophysical disturbance caused by the influence of modern technological society.

The NWI methodology is applicable to Commonwealth assessments of wilderness value and in its complete form requires comprehensive GIS modelling. The State has no comparable methodology but, for the purposes of this DPEMP, the general approach of the NWI can be followed, albeit in a less quantitative and prescriptive manner than would be applicable to a full regional wilderness assessment.

For the purposes of this DPEMP, the NWI rating score of 12 will be adopted as defining high quality wilderness, irrespective of the total contiguous area (ie. disregarding the CAR requirement for the area to be larger than 8,000 ha). The assessment of the potential impact of the mine on wilderness values will therefore examine whether the mine would lead to a reduction of the rating score of any high quality wilderness area to below 12.

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<sup>8</sup> <http://www.environment.gov.au/heritage/publications/anlr/wilderness-inventory/index.html>



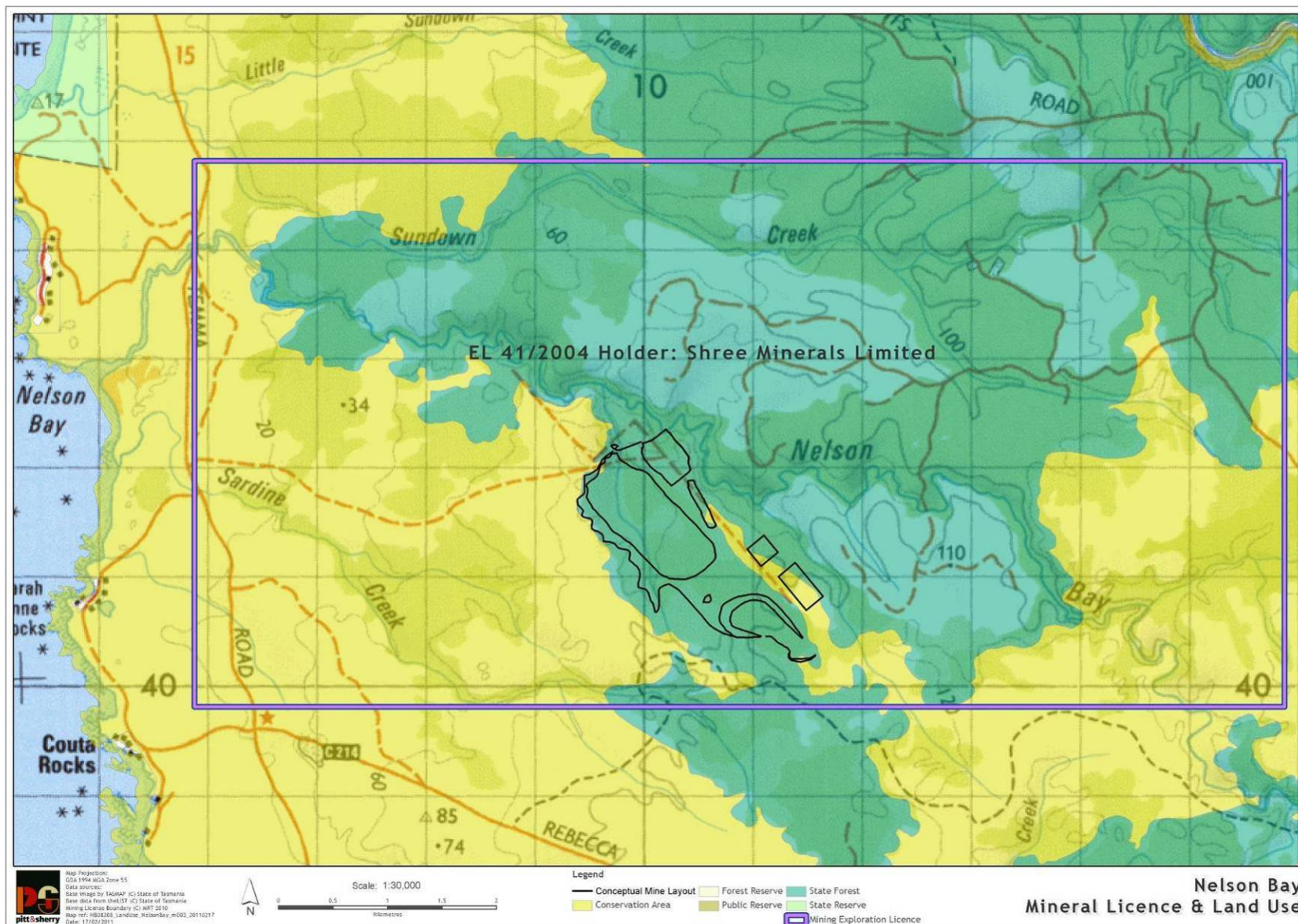


Figure 18: Land use across the mining tenement and surrounding areas

The NWI uses weighted distance factors to produce standardised curves<sup>9</sup> for the first three indicator classes (remoteness from settlement, remoteness from access and apparent naturalness), as shown in Table 28. In these standardised curves, all distances are represented in units equivalent to distance to the nearest high grade wilderness feature.

Under the methodology, the maximum contribution that each of these classes can make to the overall wilderness score is 5, shown on Figure 19.

The slopes of the curves show that distance from settlement is more sensitive to distance (decreases more slowly) than remoteness from access, which in turn is more sensitive than apparent naturalness.

To achieve a maximum score of 5, remoteness from settlement must be at least 15 km. A maximum score of 5 for remoteness from access requires a distance of at least 10 km. A maximum score of 5 for apparent naturalness requires a distance of at least 6 km.

The fourth indicator, biophysical naturalness, is unrelated to distance and is a characteristic of the wilderness area itself. It also is scored up to a maximum of 5.

Taken together, the four wilderness indicators can add to a maximum total score of 20. Scores of 12 or above are taken to be high quality wilderness.

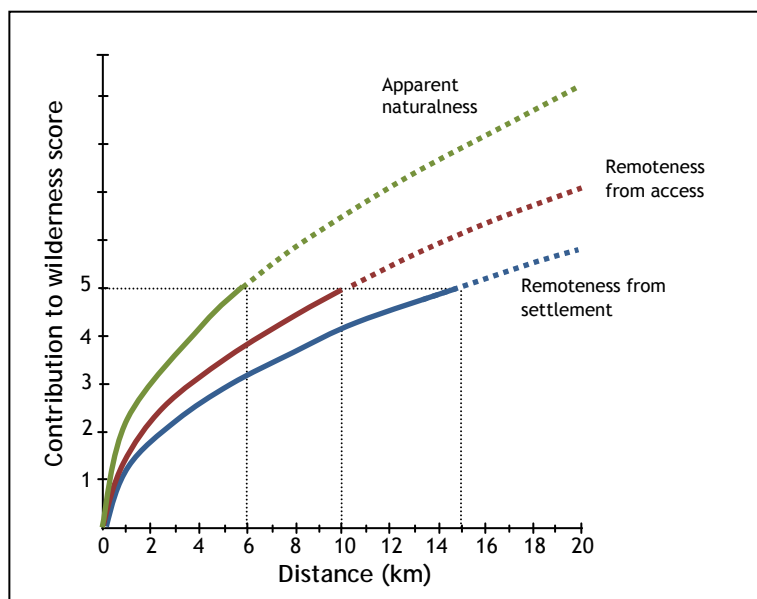


Figure 19: National Wilderness Inventory score contributions with increasing distance

Figure 20 shows the wilderness quality mapping of Tasmania prepared during the Regional Forest Agreement process in 1997. There are no electronic versions of the original mapping in existence and the image has therefore been copied from the 2003 Tasmanian State of the Environment Report<sup>10</sup>.

<sup>9</sup> <http://www.environment.gov.au/heritage/publications/anlr/wilderness-inventory/chapter-4-1.html> (note: the figure in this publication appears to have a labelling error on the y-axis, which has been corrected here)

<sup>10</sup> <http://soer.justice.tas.gov.au/2003/indicator/176/index.php>



Figure 21 shows a zoomed in view of the proposed mine site relative to the mapped wilderness values (the limited resolution of the mapping is a consequence of the image capture process, there being no electronic versions of the original map in existence). The map shows 6, 10 and 15 km distance radii from the centroid of the proposed lease area. These are the respective distances at which each of the distance-related wilderness indicators achieve their maximum score of 5.

As is evident from Figure 21, the proposed mine lease area is mapped with a wilderness quality class of 10 or less. The closest high quality (score of 12 or more) wilderness area lies more than 10 km to the east of the proposed mine lease.

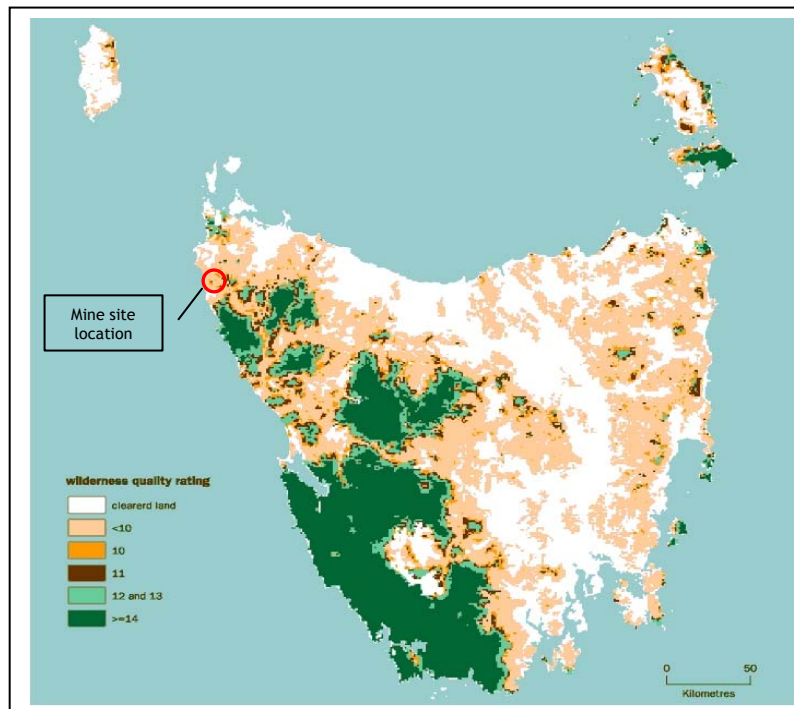


Figure 20: Statewide National Heritage Inventory wilderness mapping (map source Tasmanian 2003 State of the Environment report)

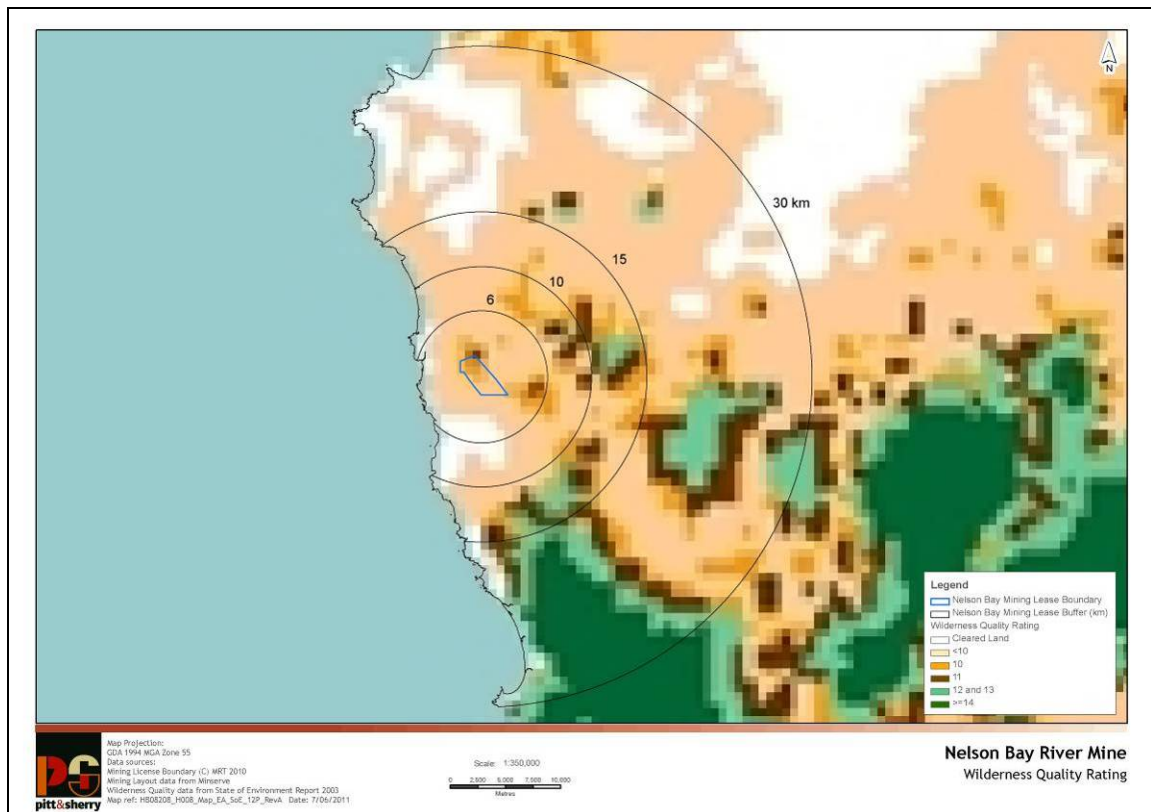


Figure 21: Statewide National Heritage Inventory wilderness mapping (map source Tasmanian 2003 State of the Environment report)

### 3.11.2 Potential impact of the mine on wilderness values

For each of the distance-based indicators, the NWI methodology grades features according to their associated amount of impact on high quality wilderness values. Remoteness from access and remoteness from settlement use four grades of impact. Three grades are used in determining apparent naturalness. Descriptions of these grades are presented in Table 28.

Table 28: Grades of impact for wilderness indicators

Indicator	Grade	Description
Remoteness from Access	Major	Major two-wheel drive roads: generally sealed or at least surfaced to ensure regular and continuous public use.
	Medium	Minor roads: generally unsurfaced, or, if surfaced, then irregularly used and maintained. Also included are constructed and maintained airstrips and operating railways.
	Low	Low Vehicle tracks (usually four-wheel drive).
	Very Low	Established but unconstructed vehicle access routes (e.g. beach access) and cleared lines; established walking tracks; cleared land.
Remoteness from Settlement	Major	Built-up areas and commercial and/or service location with 100 permanent residents or more.
	Intermediate	Commercial and/or service location with more than ten but fewer than 100 permanent residents.
	Minor	Commercial and/or service location with ten permanent residents or fewer.
	Residential	Residential location only.
Apparent Naturalness	Major	Intrusive infrastructure (including medium and high grade access routes) and cleared land boundaries
	Medium	Small-scale infrastructure (including four-wheel drive)
	Minor	Minor Structures.

The establishment and operation of the proposed mine will require no new roads to be established, other than on the mine site itself. The remoteness from access indicator achieves its maximum score of 5 at a 10 km separation distance and the mine will be more than 10 km from the nearest high quality wilderness (Figure 21). The mine will have therefore no impact on the remoteness from access score for that high quality wilderness.

The establishment and operation of the proposed mine will lead to no new built-up areas, commercial or service centres or residential areas. The mine will therefore have no impact on the remoteness from settlement score for the nearest high quality wilderness.

The mine would constitute a Major potential impact for the apparent naturalness wilderness indicator (Table 28). However, the apparent naturalness indicator achieves its maximum score of 5 at a 6 km separation distance and the mine will be more than 10 km from the nearest high quality wilderness (Figure 21). The mine will therefore have no impact on the apparent naturalness score for the nearest high quality wilderness.

The remaining indicator, biophysical naturalness, is not based on distance but describes the biophysical quality of a wilderness area itself. The proposed mine is more than 10 km from the nearest high quality wilderness and the mine could have no impact on the biophysical naturalness of that high quality wilderness area.

The presence of the mine will therefore have no impact on the nearest high quality wilderness using any of the four NWI wilderness indicators.

Accordingly, the mine will have no significant impact on wilderness values.

## 3.12 Flora

A flora (and fauna) habitat assessment<sup>11</sup> has been undertaken and the survey report is provided in Appendix P.

The mapped vegetation communities and threatened species flora (and fauna) observations from the survey are shown in Figure 22.<sup>12</sup>

### 3.12.1 Vegetation communities

The vegetation communities identified by the North Barker survey are shown in Table 29 and in Figure 22.

Table 29: Vegetation communities in the study area

TASVEG Community	State-wide Conservation Status	Bioregional Conservation Priority
<b>Wet <i>Eucalyptus obliqua</i> forest over broad-leaf shrubs</b>		
Wet <i>Eucalyptus obliqua</i> forest over broad-leaf shrubs WOB	Not threatened and well reserved	Not threatened but not adequately reserved
<b>Wet <i>Eucalyptus obliqua</i> forest over tea tree</b>		
Wet <i>Eucalyptus obliqua</i> forest over <i>Leptospermum</i> WOL	Not threatened and well reserved	Not threatened but not adequately reserved
<b>Wet <i>Eucalyptus obliqua</i> forest over rainforest</b>		
Wet <i>Eucalyptus obliqua</i> forest over rainforest WOR	Not threatened and well reserved	Not threatened but not adequately reserved
<b>Dry <i>Eucalyptus nitida</i> forest and woodland</b>		
Dry <i>Eucalyptus nitida</i> forest and woodland DNI	Not threatened and well reserved	Not threatened and well reserved
<b>Dry <i>Eucalyptus obliqua</i> woodland and forest</b>		
Dry <i>Eucalyptus obliqua</i> woodland and forest DOB	Not threatened and well reserved	Not threatened but not adequately reserved
<b>Western wet scrub</b>		
Western wet scrub SWW	Not assessed for conservation and reservation status	Not assessed for conservation and reservation status
<b>Wet heathland</b>		
Wet heathland SHW	Not assessed for conservation and reservation status	Not assessed for conservation and reservation status

<sup>11</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>12</sup> This map includes a small extension outside the surveyed area, an extension that resulted from design changes to the tailings dam in response to matters raised in the EIS guidelines. For that extension, Tasveg mapping is used. The vegetation communities of this extension are not habitats suited to likely threatened flora (such as orchids).



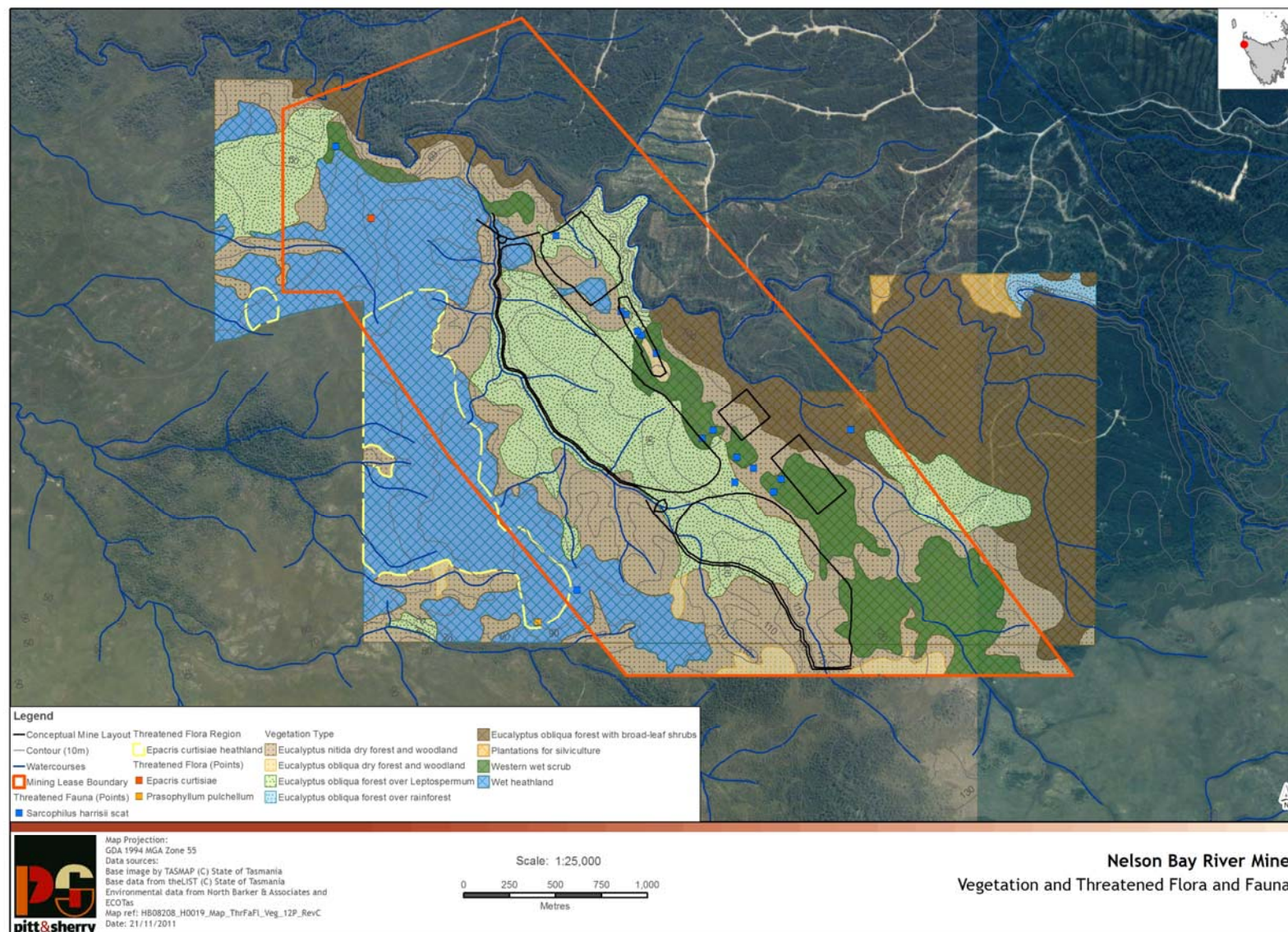


Figure 22: Vegetation communities and flora and fauna species

No vegetation community listed under Schedule 3A of the Tasmanian *Nature Conservation Act 2002* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) occurs within or adjacent to the study area.

There is no non-native vegetation on the site.

### *Wet Eucalyptus obliqua forest over broad-leaf shrubs WOB*

*Eucalyptus obliqua* forest over broad-leaf shrubs is widespread along most of the Nelson Bay River, including the steeply incised banks. It occurs more extensively in the north eastern section of the mining lease that has been logged. In the unlogged forest along the river there is a fire damaged *Eucalyptus obliqua* layer with a tall understorey comprised of a mix of rainforest species and broad-leaf shrubs and more sclerophyllous species. Ferns and graminoids are a relatively minor proportion of the species composition.

The regeneration of this mapping community following logging and artificial regeneration is much more simplistic, both structurally and in species diversity.

This community is outside the proposed impact zone.

### *Wet Eucalyptus obliqua forest over Leptospermum WOL*

This *Eucalyptus obliqua* community occurs on the local soils of this area in northwest Tasmania where the vegetation would generally be expected to be forest dominated by *Eucalyptus nitida*. The trees are in general relatively short with a dense tall understorey consisting of a mix of *Leptospermum* species and other shrubs. Due to the dense nature of the understorey, there are only occasional low shrubs, herbs and ferns, although these are relatively diverse.

In the tailings dam area many of the tall *Eucalyptus obliqua* have seriously fire damaged crowns.

### *Wet Eucalyptus obliqua forest over rainforest WOR*

This community occurs in the most north-eastern extremity of the study area surrounding the Nelson Bay River, outside the proposed impact zone. This is a small area of mixed forest that was burned, probably about 15 years ago. It consists of scattered mature *Eucalyptus obliqua* with an open understorey of rainforest species regenerating amongst broad-leaf shrubs. The ground ferns are dense in patches but of low diversity, as are the shrubs.

### *Dry Eucalyptus nitida forest and woodland DNI*

This community is a transitional community between the denser forest and the neighbouring scrub and heathland communities. In this location it consists of regrowth *Eucalyptus nitida* trees that merge with a dense understorey particularly rich in myrtaceous species. The height of the understorey is quite variable, ranging from approximately 2 to 8 m. Graminoids are frequent and intertwine with the shrubs to make an impressive thicket of under shrubs.

### *Dry Eucalyptus obliqua woodland and forest DOB*

There is a small patch of *Eucalyptus obliqua* woodland on the western edge of the proposed tailings dam area. It has a relatively open understorey with a graminoid and heath rich ground cover. The occurrence of *Lepidosperma concavum* suggests that this area has better localised drainage and possibly better nutrient levels.



### Western wet scrub SWW

This community has many species common to the Dry *Eucalyptus nitida* woodland (DNI), except that the eucalypts are only occasional or absent and the graminoids are more diverse and abundant. The most likely reason that eucalypts are absent and herbs are so frequent is that drainage is impeded in this small area. The community is an uneven scrub with *Leptospermum* sp., *Sprengelia incarnata*, *Philotheca virgata* and *Melaleuca* sp. dominating, and with *Acacia mucronata* frequent.

### Wet heathland SHW

This community, which occupies an extensive area on the western side of the mining lease area, also occurs as three separate slivers within the waste rock dump area. In this area there is an extensive population of the rare (TSPA) heath *Epacris curtisiae* and a discrete population of the critically endangered (EPBCA) orchid *Prasophyllum pulchellum*. There are occasional emergent *Eucalyptus nitida* and *E. obliqua* and a rich diversity of shrub and graminoid species, with ferns and fern allies typical of slow drainage and poor soils.

There is a mosaic of fire ages in the wet heathland which is the result of planned management fires (as demonstrated by the presence of slashed tracks that have been used as burning boundaries).

### Vegetation distribution

The distribution of the various vegetation communities in the mine site and associated areas is shown in Table 30 and Figure 22.

Table 30: Distribution of vegetation communities

TASVEG Community	DSO Pit	Main Pit	Process Plant	Tailings Dam	Waste Rock Dump	Mining Lease outside impact zone
Wet <i>Eucalyptus obliqua</i> forest over broad-leaf shrubs WOB						*
Wet <i>Eucalyptus obliqua</i> forest over <i>Leptospermum</i> WOL	*	*		*	*	
Wet <i>Eucalyptus obliqua</i> forest over rainforest WOR						*
Dry <i>Eucalyptus nitida</i> forest and woodland DNI	*	*		*	*	
Dry <i>Eucalyptus obliqua</i> woodland and forest DOB				*		
Western wet scrub SWW	*	*	*	*		
Wet heathland SHW					*	*

### 3.12.2 Threatened flora species

Threatened flora species, listed on one or both of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA) and the Tasmanian *Threatened Species Protection Act 1995* (TSPA), previously identified within 5 km of the study area are shown in Table 31.

Table 31: Threatened flora species known within 5 km of the study area

Species	EPBC Act listing	TSP Act listing	Potential to occur <sup>13</sup>	Closest distance of known populations to the mine lease boundary (km) <sup>14</sup>
<i>Caladenia dienema</i> windswept spider orchid	Critically Endangered	Endangered	low	0.1
<i>Caladenia pusilla</i> tiny fingers	-	Rare	low	-
<i>Corunastylis brachystachya</i> short-spiked midge orchid	Endangered	Endangered	low	3.0
<i>Cullen microcephalum</i> dusky scurfpea	-	Rare	none	-
<i>Diuris lanceolata</i> large golden moths	Endangered	Endangered	none	3.4
<i>Epacris curtisiae</i> northwest heath	-	Rare	present	-
<i>Lotus australis</i> Australian trefoil	-	Rare	none	-
<i>Phyllangium divergens</i> wiry mitrewort	-	Vulnerable	none	-
<i>Prasophyllum favonium</i> western leek orchid	Critically Endangered	Endangered	moderate	3.3
<i>Prasophyllum pulchellum</i> pretty leek orchid	Critically Endangered	Endangered	present	0.2
<i>Prasophyllum secutum</i> northern leek orchid	Endangered	Endangered	none	4.8
<i>Pterostylis rubenachii</i> Arthur River greenhood	Endangered	Endangered	none	4.8
<i>Spyridium vexilliferum</i> var. <i>vexilliferum</i> helicopter bush	-	Rare	low	-
<i>Xerochrysum bicolor</i> eastcoast everlasting	-	Rare	low	-

<sup>13</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River – Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>14</sup> Natural Values Atlas data (Download on 3/05/2011) and field survey data from Northbarker Ecosystem Services

Two threatened vascular plant species *Epacris curtisiae* - northwest heath - and *Prasophyllum pulchellum* - pretty leek-orchid - listed under the schedules of the *Threatened Species Protection Act 1995* were recorded from the study area. *Prasophyllum pulchellum* - pretty leek-orchid is also listed under the *Environment Protection and Biodiversity Conservation Act 1999*. However, neither of these species was recorded from any of the potential disturbance areas associated with the mine. Neither species will, therefore, be impacted by the proposal.

### *Epacris curtisiae* – northwest heath

This Tasmanian endemic species is listed as rare under the TSPA but is not listed on the EPBCA. It occurs in heathland and moorland in a localised area, mainly confined to the Dempster Plains, Frankland River catchment and western slopes of the Norfolk Range between the Arthur and Pieman Rivers.

There is a very extensive population in the wet heathland on the western edge of the mineral exploration lease. The estimated population in this section of the lease is between 1 and 2 million plants. The density varies considerably, but there is generally at least one plant per 10 m<sup>2</sup>, but can be up to 8 for mature plants and is even higher where plants are regenerating from seed after fire. There are both seedlings and coppice growth of plants after fire from about four years ago.

This species is thought to be sensitive to *Phytophthora cinnamomi*, based on symptomatic evidence obtained during the survey of the Tarkine Road in 2009. There was, however, no symptomatic evidence of the pathogen at all within the study area.

### *Prasophyllum pulchellum* - pretty leek-orchid

This orchid species, listed as endangered under the TSPA and critically endangered under the EPBCA, was recorded in the current survey in the southern end of the wet heathland, on the western side of the study area.

The small discrete population, which consisted of 20 plants that were in various stages of flowering, was located beside a track in an area that had been used for turning machinery around.

This species, endemic to Tasmania, occurs in widely scattered localities in the west, northwest and south of the state, generally in coastal areas. Given the small compact nature of the subpopulations of this species, it is considered highly likely that other patches occur, possibly even within the study area.

## 3.12.3 Introduced plants

The EPBC Protected Matters Search Tool identifies the following Weeds of National Significance (WONS) as occurring or potentially occurring in the vicinity of the lease:

- Bridal creeper (*Asparagus asparagoides*)
- Boneseed (*Chrysanthemoides monilifera*)
- Serrated tussock (*Nasella trichotoma*)
- Willows (*Salix* sp excepting *S. babylonica*, *S.x calodendron* and *S.x reichardtiji*)
- Blackberry (*Rubus fruticosus*)
- Gorse (*Ulex europaeus*)

The North Barker survey, however, found no weeds within the site that would be subject to the provisions of the Tasmanian *Weed Management Act 2001* and no Weeds of National Significance (WONS).

### 3.12.4 Plant pathogens

The proposed mine lies within the zone that favours the establishment and spread of *Phytophthora cinnamomi*, being areas that receive above 600 mm of rainfall per annum and are below about 800 m altitude.

No symptomatic evidence of *Phytophthora cinnamomi* was observed in the study area during the North Barker survey. However, as the western wet scrub, wet heathland and dry eucalypt forest with a heathy understorey are susceptible to the soil borne pathogen, it will be important to ensure soil hygiene measures mitigate against the inadvertent introduction of *Phytophthora cinnamomi*.

### 3.13 Fauna

The study area contains a diverse range of habitats including low heathlands, dense wet scrub, dry sclerophyll forest and wet sclerophyll forest with fire damaged old growth, and considerable riparian habitat within an altitudinal range of approximately 20 to 120 m AHD.

A fauna habitat assessment of the site has been undertaken by North Barker Ecosystem Services<sup>15</sup> and an *Astacopsis* Survey by Todd Walsh<sup>16</sup>; the reports are provided in Appendix P and Appendix Q respectively. Macroinvertebrate surveys of appropriate strategic locations will be undertaken in September 2011.

The results of a roadkill and headlight observation survey<sup>17</sup> of regional roads commissioned by the Department of Infrastructure, Energy and Resources for a separate project are provided in Appendix R.

Threatened fauna species, listed on one or both of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA) and the *Threatened Species Protection Act 1995* (TSPA), that have previously been recorded from, or which are considered to potentially occur in suitable habitat within 5 km of the proposed development, based on habitat mapping<sup>18</sup> or identified in the EPBC Protected Matters Report<sup>19</sup>, are listed in Table 32.

<sup>15</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>16</sup> Walsh, T and Walsh, B. (2011). Survey of the Giant Freshwater Lobster (*Astacopsis gouldi*) at Nelson Bay River. Report by Bronwyn Walsh and Todd Walsh of Kanunnah Pty Ltd for Pitt and Sherry June 2011.

<sup>17</sup> Data (by Wildspot Consulting) and mapping (by Northbarker Ecosystem Services) provided courtesy of the Department of Infrastructure, Energy & Resources.

<sup>18</sup> Natural Values Report 10/11/2010, no. 40737

<sup>19</sup> EPBC Act Protected Matters Report 15/11/2010

Table 32: Threatened fauna species previously recorded, or which may potentially occur in suitable habitat, within 5 km of the study area - species shown in bold have significant suitable habitat within the study area.

Species	EPBCA listing	TSPA listing
<b>Birds</b>		
<i>Ceyx azurea</i> subsp. <i>diemenensis</i> azure kingfisher [previously named <i>Alcedo azurea</i> subsp. <i>diemenensis</i> ]	Endangered	Endangered
<i>Accipiter novaehollandiae</i> grey goshawk	-	Endangered
<i>Lathamus discolor</i> swift parrot	Endangered	Endangered
<i>Neophema chrysogaster</i> orange-bellied parrot	Critically Endangered	Endangered
<i>Myiagra cyanoleuca</i> satin flycatcher	Migratory	-
<i>Aquila audax</i> subsp. <i>fleayi</i> wedge-tailed eagle	Endangered	Endangered
<i>Haliaeetus leucogaster</i> white-bellied sea eagle	-	Vulnerable
<i>Tyto novaehollandiae</i> subsp. <i>castanops</i> Tasmanian masked owl	Vulnerable	Endangered
<b>Mammals</b>		
<i>Dasyurus maculatus</i> subsp. <i>maculatus</i> spotted-tailed quoll	Vulnerable	Rare
<i>Sarcophilus harrisii</i> Tasmanian devil	Endangered	Endangered
<b>Fish</b>		
<i>Prototroctes maraena</i> Australian grayling	Vulnerable	Vulnerable
<i>Galaxiella pusilla</i> eastern dwarf galaxias	Vulnerable	Vulnerable
<b>Amphibians</b>		
<i>Limnodynastes peroni</i> striped marsh frog	-	Endangered
<i>Litoria raniformis</i> green and gold frog	Vulnerable	Vulnerable
<b>Invertebrates</b>		
<i>Astacopsis gouldi</i> giant freshwater crayfish	Vulnerable	Vulnerable
<i>Oreisplanus munionga</i> tax. <i>larana</i> Marrawah skipper	-	Endangered

### *Ceyx azurea* subsp. *diemenensis* - azure kingfisher

[Previously named *Alcedo azurea* subsp. *diemenensis*]

This species inhabits tree-lined waterways, lakes, ponds and other wetlands with dense streamside vegetation, in particular in western and north-western Tasmania. Suitable habitat in the mine area is considered to be marginal. Visual and auditory searches during the current survey did not locate any azure kingfishers.

### *Myiagra cyanoleuca* - satin flycatcher

This species, which mainly inhabits eucalypt forests, often near wetlands or watercourses, is migratory, moving north in autumn to spend winter in northern Australia and Papua New Guinea. They return south in spring to spend summer in south-eastern Australia.

Satin flycatchers were seen foraging at several locations in the riparian areas along the Nelson Bay River.

*Aquila audax subsp. fleayi - wedge-tailed eagle*

This species requires large eucalypt trees in sheltered locations for nesting and is highly sensitive to disturbance during the breeding season. There is limited potential for suitable nesting habitat within the waste rock dump area and the northern section of the tailings dam within mature but fire damaged mature eucalypts. Elsewhere on the mining lease, but outside the proposed impact zone, there is also potential for nesting habitat in the narrow gully along the Nelson Bay River.

Although no nests were located during the aerial nest survey of the site the area is very likely to be utilised for foraging.

*Dasyurus maculatus subsp. maculatus - spotted-tailed quoll*

This naturally rare forest-dweller most commonly inhabits rainforest, wet forest and blackwood swamp forest. Priority habitat for the species is generally described as lowland, high-rainfall forest across the north of Tasmania. It forages and hunts on farmland, pasture and heathland, travelling up to 20 km at night, and shelters in logs, rocks or thick vegetation. Home ranges extend to more than 1,500 ha of continuous suitable habitat for a male and a little less for a female.

There are several records of the species within 5 km of the study area. It is present on the site, as evidenced by the scat observed during the current survey.

*Tyto novaehollandiae subsp. castanops - Tasmanian masked owl*

The bird inhabits a diverse range of forests and woodlands, including agricultural and forest mosaics. Particularly favoured are forests with relatively open under stories, especially when this habitat adjoins areas of open or cleared land. Nesting of the sub species occurs in large tree hollows of living or dead trees but sometimes in vertical spouts or limbs.<sup>20</sup>

There is a potential for masked owls to use hollow trees for nesting and preclearing surveys for nests are therefore warranted.

*Sarcophilus harrisii - Tasmanian devil*

This species inhabits a range of forest types, often within extensive tracts of remnant native vegetation. Numerous records of this species occur within 5 km of the study area. The area supports devils, as evidenced by scats found throughout the study area, and particularly in latrines on the tracks associated with mineral exploration.

The mature eucalypt forest has the greatest potential to support dens in the hollows at the bases of large eucalypts or in shelters created under fallen logs. No dens or potential shelters were seen in these areas or in the rocky outcrops on the steep banks in the riparian zone along the Nelson Bay River.

*Prototroctes maraena - Australian grayling*

The species inhabits the middle and lower reaches of rivers and streams that open to the sea. It needs to move between rivers and coastal seas to complete its life cycle - barriers block upstream migration, and can interfere with downstream migration, and can cause local extinction in the section of river upstream from the barrier<sup>21</sup>.

<sup>20</sup> <http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf>

<sup>21</sup> Backhouse, G., Jackson, J. and O'Connor, J. 2008a. National Recovery Plan for the Australian Grayling *Prototroctes maraena*. Department of Sustainability and Environment, Melbourne.



The mine site is 7 km upstream from a significant waterfall (Figure 23) of more than 2 metres height, which presents a natural barrier to upstream movement of the species into Nelson Bay River. This barrier is near the mouth of Nelson Bay River, close to where it is crossed by Temma Road.

Because of barrier, there is no significant likelihood of the species being any further upstream than Temma Road, which is 7 km downstream from the mine site.



Figure 23: Waterfall which presents a natural barrier to the Australian grayling (note Temma Road bridge in background) (Source: Northbarker Ecosystem Services (March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.)

Accordingly, no specific mitigation measures for this species are warranted.

Nevertheless, the project has adopted a “protection of pristine or nearly pristine ecosystems” Protected Environmental Value (PEV) for Nelson Bay River (see section 3.6). This PEV will ensure the protection of the Australian grayling in the very unlikely event that it could migrate up the river as far as the mine (the hydraulic barrier near the mouth of the river would prevent this).

Mine water management will ensure that no contaminated surface water or groundwater is discharged to Nelson Bay River.

### *Astacopsis gouldi - giant freshwater crayfish*

No specimens were located in the current survey.

The only record of this species in the Nelson Bay River area is of a juvenile that was found near Rebecca Road crossing some years ago. Although the Nelson Bay River has suitable habitat it is outside the range of the species and cannot, therefore, be considered a significant locality for the species. On the mine site, habitat in the western creek is very poor and in the eastern creek is only marginally better.

Accordingly, no specific mitigation measures for this species are warranted.

Nevertheless, the project has adopted a “protection of pristine or nearly pristine ecosystems” Protected Environmental Value (PEV) for Nelson Bay River (see section 3.6). This PEV will ensure the protection of the giant freshwater crayfish in the very unlikely event that it could migrate up the river as far as the mine (the hydraulic barrier near the mouth of the river would prevent this).

Mine water management will ensure that no contaminated surface water or groundwater is discharged to Nelson Bay River.

### 3.14 Aboriginal cultural heritage

An Aboriginal cultural heritage survey of the proposed route has been undertaken by CHMA<sup>22</sup>. This report has been provided separately to Aboriginal Heritage Tasmania. Relevant details are summarised below.

The aims of this survey were to:

- Locate and document Aboriginal heritage sites that may be present within the identified bounds of the proposed mine site, including the waste rock dump, the tailings dams, the processing facilities and all access roads
- Assess the archaeological and Aboriginal cultural sensitivity values of these areas
- Assess the scientific and Aboriginal cultural values of identified Aboriginal heritage sites and the heritage values of historic sites
- Develop a detailed set of management strategies which are aimed at minimising the impacts of the proposed mine development on the Aboriginal heritage resources in the study area.

#### *Methodology*

The survey assessment consisted of three stages:

- A pre-fieldwork background study
- Field investigations
- Consultation with the Aboriginal community, and report preparation.

The pre-fieldwork component comprised consultation with Aboriginal Heritage Tasmania (AHT), the Aboriginal Heritage Officer designated for the investigations, and collation of all appropriate topographic maps, aerial photos, archaeological reports and previously recorded Aboriginal site details.

The field component consisted of:

- A series of survey transects, 10 m and 5 m width depending on access, aligned so as to provide survey coverage of a representative sample of the study area, with specific focus on the proposed infrastructure areas
- Inspection of areas of improved surface visibility such as graded tracks or erosion scalds
- A total 24.8 km of transects within the bounds of the study area

Detailed notes of the environmental setting traversed by the route easement and the varying conditions of surface visibility were also taken.

<sup>22</sup> CHMA (December 2010) *An Aboriginal Cultural Heritage Assessment of the Proposed Nelson Bay River Magnetite Mine Development, North-West Tasmania*.

### *Previously recorded sites*

There are ten Aboriginal heritage sites located within a 5 km radius of the study area that have been previously recorded and registered on the Tasmanian Aboriginal Site Index (TASI) data base. None of these sites, however, are within the bounds of the study area.

### *Field investigation*

No Aboriginal heritage sites or specific areas of potential archaeological sensitivity were identified during the field investigations.

Surface visibility varied considerably across the site, ranging from 5% on the off track transects to 60% on transects along graded vehicle tracks.

### *Cultural heritage management*

Heritage management options and recommendations have been developed for the site, based on the following:

- Consultation with Aboriginal communities
- The legal and procedural requirements as specified in the *Aboriginal Relics Act 1975*
- The results of the current investigations
- Background research into the extant archaeological and historical record for the study area and its surrounding regions

### *Cultural heritage recommendations*

Based on the findings of this investigation, there are no site specific heritage constraints or requirements for development.

In the event that any artefacts or sites are discovered during operations on the site, the processes outlined in the Unanticipated Discovery Plan of the CHMA report are to be followed.

## 3.15 Historic heritage

There are no known or anticipated features of historic heritage significance within the proposed mine site area.

There are several tracks and a number of abandoned mining operations in the wider area that are considered to have some historic heritage significance. These features, however, are well removed from the proposed Nelson Bay River mine site.

## 3.16 Socio-economic aspects

The project will provide significant economic and social benefits at the local and regional scale.

Contractors will be responsible for in-pit operations. The contractors will provide all the equipment and personnel for the in-pit mining and transport activities. The processing operations will be staffed by Shree personnel.

It is anticipated that this proposal will provide jobs for the next 10 years, with a potential future increase in the workforce if throughput rates are increased or alternative onsite mining areas are developed.

The construction of the processing plant and infrastructure will cost approximately \$15 M and \$5 M respectively. It is expected that construction will be undertaken by a local contractor(s), thereby benefiting the local community.

Recently updated economic modelling estimates that at full operating capacity the project would:

- Employ 125 full time employees (by the company & /or through contractors) with many more employed indirectly because of flow-on effects.
- Result in a business turnover of approximately \$70 to \$88 million per annum for a total of approximately \$1.5 billion over the project life.

Establishment of the mine and associated facilities is likely to be undertaken, in part, by a local construction contractor, providing further social and economic benefits for the local community.

The proposal should have no effect on land value in the area or recreational use in the surrounding region. The presence of the mine is unlikely to impact on existing uses of the area, for example by 4WD, quad bike or trail bike users. Although an existing track runs through the western margins of the lease, this track is to the west of West Creek and therefore outside the mine's disturbance footprint.

North western Tasmania has a diverse range of wealth generating industries, including agricultural production and processing, forestry and forest processing, mining, specialized manufacturing and nature and culture based tourism. Despite this, the prosperity of the region is lower than the national average. The recent closure of several important manufacturing facilities has further reduced the resilience of the economy of this area.

Economic analyses have concluded that north western Tasmania:

- Has latent economic productive capacity which is currently undeveloped
- Is characterized by a level of productivity well below the national average
- Has the potential to further diversify and deepen Tasmania's economic capability and performance
- Could build on its existing contribution to foster Tasmania's competitive advantage.

This development will assist the region to progress towards a more resilient future as a key component of regional Australia, with improved social equity and quality of life within its community.

### 3.17 Alternative sites

The proposed location of the new magnetite/hematite mine and associated processing facilities has been identified as the most suitable location and no viable alternative sites have been identified.

#### *Mine site*

The proposed mine site has been selected because it will result in the most efficient exploitation of the known mineral resource in this particular area. Mining of the resource as shown in the proposed mine plan (Appendix A) will result in the minimisation of mineral resource loss during mining operations and also any long term sterilisation of resource.

#### *Overburden dump*

The proposed waste rock dump location (section 2.4.3) has been chosen because it provides for the most compact mine footprint and the shortest haul distances. In addition, a waste rock dump in this proposed location would not be visible from the Rebecca and Temma Road

#### *Ore processing facilities*

As indicated in section 2.3.3, the proposed location of the ore processing facilities is approximately 1.2 km southeast of the pit.

#### *Tailings storage facilities*

Several potential sites have been identified for the proposed location of the tailings storage facilities.

The proposed site is considered to be the most suitable location for the following reasons:

- The site is close to the proposed site for the process plant
- The site has suitable topography; it is relatively flat lying, thus maximising the capacity for a given footprint
- The class 3 drainage line at the TSF site will not be scheduled as an aqueous discharge point as the TSF will be operated to recycle all the decant water, including incident rainfall captured on the facility, into the existing clean decant water recycle system
- The site is secure and easily monitored
- The recycled decant clean water can be easily fed to the plant for reuse
- Use of the site for the TSF is appropriate, given the existing land use and ownership and ultimate mine closure strategy
- The expected satisfactory geology in the area
- The expected clay resource in the area that will facilitate the construction.

### 3.17.1 Community consultation

Shree Minerals Limited is committed to an open and constructive dialogue with key stakeholders and interested parties.

Consultations with the following organisations / groups / persons have occurred:

- Circular Head Council (September 2010; February 2011)
- Forestry Tasmania (March 2011)
- Minister for Mines (September 2010)
- Mineral Resources Tasmania (September 2010, March 2011)
- Relevant local politicians (September 2010; February 2011)
- Tarkine Coalition (February 2011)
- Tasports, Tasrail (August 2010)
- Potential transport operators (August 2010)
- Potential mining and construction contractors (August, September 2010)

These discussions will continue throughout the preparation of the DPEMP and during the wider approvals process. Input from other stakeholders will be sought as required.

Shree's preferred approach is to meet with stakeholders "face to face" to discuss what is proposed and to seek direct feedback that can then help shape the nature and culture of the proposed operations.



## 4. Potential emissions and their management

### 4.1 Air emissions

The primary air pollutant sources will be:

- Dust and smoke from the construction activities and vegetation removal
- Dust from mining activities, haul roads and dry (in the beaching area) tailings during operations
- Emissions from the process plant
- Emissions from mobile plant, equipment and vehicles.

The location of the mine on elevated land inland from the West Coast will result in the site being particularly exposed to the westerly and northwesterly winds. The exposure of the site to these dominant winds means that operations will be subject to significant dust generation potential during the drier periods of the year.

#### 4.1.1 Existing conditions

There are currently no known primary air pollutant sources in the area.

The forestry operations to the northeast of the site are likely to be the closest source of air pollutants, generating smoke and particulate matter during the occasional forest burn-offs. However, as the prevailing wind direction at the site is from the westerly sectors (Figure 24), any pollutants from forest burn-offs are likely to be directed away from the site, not towards it.

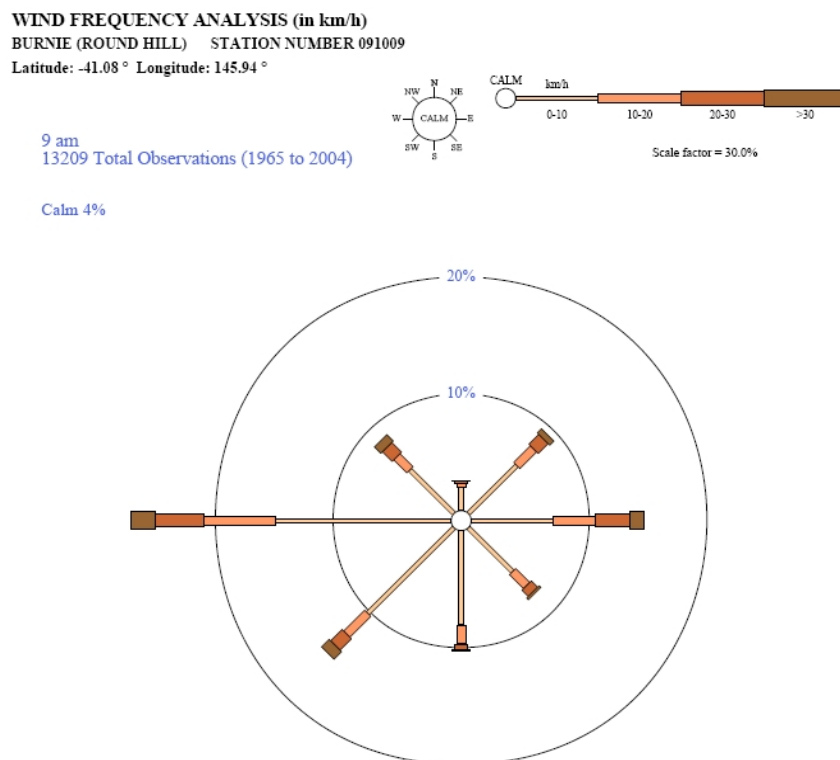


Figure 24: Wind rose for Burnie (source Bureau of Meteorology)

### 4.1.2 Performance requirements

Air emissions from the mining and processing operations must comply with the following:

- Tasmanian OHS requirements (Workplace Health and Safety Regulations 1998)
- National Environment Protection Measure (Air) - PM10 and PM2.5 limits at sensitive receptor locations
- Tasmanian *Environment Protection (Air Quality) Policy 2004*
- Tasmanian *Forest Industry Standard for Prescribed Silvicultural Burning Practice 2009*
- Tasmanian *Quarry Code of Practice 1999*
- Tasmanian *Environmental Management and Pollution Control Act 1994*, environmental nuisance provisions.

### 4.1.3 Potential sources

Environmental factors play a large role in the nature of diffuse air pollution and dust emissions.

Dust has the potential to cause an environmental nuisance if it is blown beyond the boundary of the proposed construction and operating activities. It can cause respiratory annoyance or problems, reduce visual amenity and fall out onto land or surfaces in other ownership.

The prevailing wind direction is from westerly sectors (Figure 24) but regardless of the wind direction there are no sensitive receptors within any reasonable site proximity for concern.

The Standard Recommended Attenuation Distance (SRAD)<sup>23</sup> for a quarry extractive activity with crushing on site is 750 m to the nearest sensitive land use. This distance is readily met by the proposed activities. The Tasmanian Planning Commission is currently reviewing SRADs and it is likely that the attenuation distance for open cut mines will be in the order of 3000 m, and for crushing in the order of 2000 m<sup>24</sup>. These distances are also readily met.

In addition to nuisance to people, dust can also fall onto vegetation and in extreme cases retard plant growth by blocking photosynthesis.

Diesel exhaust fumes can cause an environmental nuisance and, like all fossil fuel exhausts, contribute to greenhouse gases.

#### *Construction air emissions*

Construction of the mine, processing plant and associated infrastructure may result in the generation of the following air emissions:

- Dust generation during clearing of the site and stockpiling of soil for rehabilitation
- Dust generation during opening up of the pits, associated with movement of vehicles and machinery and excavation, transportation and emplacement of rock and soil
- Emissions from the operation of construction plant and equipment
- Smoke and associated particulates during the burning off of the cleared vegetation

<sup>23</sup> Department of Environment and Land Management (1996) *Environment Assessment Manual*.

<sup>24</sup> EPA advice pers. comm.

- More severe smoke and associated particulate impacts if vegetation burnoffs were to escape control.

### *Operation air emissions*

Operation of the mine, processing plant and associated infrastructure may result in the generation of the following air emissions:

- Dust generation arising from mining operations (including excavation, loading, transport and handling of materials)
- Emissions arising from the operation of plant and equipment
- Emissions from the processing plant
- Emissions from the diesel-powered generators

## 4.1.4 Potential environmental effects

Potential environmental effects include the dispersion of dust, smoke from burnoff of timber, and emissions from the processing plant and operating equipment to surrounding areas.

Dust, smoke and emissions could cause health impacts if appropriate management measures are not undertaken; however, they are unlikely to have any health effects beyond the site boundaries. The nearest sensitive receptors downwind of the prevailing wind directions are 15 km away at Balfour and 20 km away at Roger River (see section 2.1 and Figure 1).

## 4.1.5 Avoidance and mitigation measures

The following mitigation measures will be utilised to minimise the generation of air emissions during construction and operations:

- Vegetation clearance will not be undertaken during hot, dry and windy periods.
- Extra care will be taken at times of high wind speed, or during other adverse weather conditions, to minimise dust emissions
- Construction roads will be watered as necessary during extremely hot, dry and windy conditions; if necessary works will be suspended during extreme weather conditions
- Burnoffs of cleared vegetation will only be undertaken under the most appropriate meteorological conditions, using Forestry Tasmania personnel, and in accordance with the *Forest Industry Standard for Prescribed Silvicultural Burning Practice 2009*. This will minimise the potential health effects from smoke on the general community and construction and mine site workers
- Burnoffs will not be undertaken whilst other activities are being undertaken in the construction areas
- Exhaust emissions will be minimised by ensuring that all plant and equipment is properly maintained; only reputable contractors with well maintained equipment will be used
- The construction works will be planned and supervised by a qualified engineer so that the construction of each facility is undertaken in the most efficient and effective manner
- Existing native vegetation will be maintained for windbreaks where possible
- Haul roads, waste rock dumps and ore dumps (ROM) pad will be watered as necessary during extremely hot, dry and windy conditions.

## 4.1.6 Assessment of residual effects

### *Construction phase*

Potential significant air emissions are expected to occur mainly during the construction phases, in the form of dust.

Dust emission points will vary across the site over the construction period as dust generation will be related to the movement of vehicles and machinery and the excavation, transportation and emplacement of materials.

Smoke emission points will be determined by the organisation and orientation of the windrows of cleared vegetation. The 4 km buffer zone to the nearest residence (and 15 km in the prevailing wind direction) will significantly reduce the risk of air emissions causing environmental nuisance or harm.

The adoption of the above mitigation measures during the construction phases as summarised in the following commitments will ensure the risks to the environment are minimised.

The intent of the measures will be to protect workers from dust nuisance, to avoid dust being blown beyond the lease boundaries and to minimise dust plumes that might be seen from Rebecca or Temma Roads, 2 and 3 km to the south and west respectively.

### *Operational phase*

A Dust Management Plan will be prepared to minimise dust creation during construction and operations.

Dust emission points will vary across the site over the operational phase as dust generation will be associated with the various mining and processing operations.

As for the construction phase, the intent of dust management measures will be to protect workers from dust nuisance, to avoid dust being blown beyond the lease boundaries and to minimise dust plumes that might be seen from Rebecca or Temma Roads, 2 and 3 km to the south and west respectively.

Dust generation associated with the mining operations, including the haulage of ore and waste rock, is expected to be minimal as the area has a relatively high rainfall and roads and dumps will be watered during dry periods.

Air emissions associated with the operation of the generators, mining and transport equipment are expected to be kept to acceptable levels by use of appropriate and properly maintained equipment.

Air emissions from the processing plant will be restricted to dust associated with truck movements involved in the delivery of ore to the ROM pad and removal of the product offsite. There may also be some fugitive dust emissions from the crusher areas.

Air emissions from the tailings dam are expected to be negligible during the operational phases following construction, as the tailings will be in a slurry form when delivered and placed in the dam. The tailings generally remain well saturated, even when the water level is 0.5 m to 1.0 m below the tailings surface.

The water bodies formed during the operational phases and under the existing closure strategy will result in the mitigation of long term dust emissions from the facility and encourage aquatic fauna and water fowl inhabitancy.

### *Commitments*

Commitment 1: A Dust Management Plan for construction and operational phases will be prepared prior to construction work commencing.

Commitment 2: Construction phase dust impacts will be minimised by road tanker watering as required.

Commitment 3: Construction phase vegetation burnoff smoke impacts will be minimised by utilising qualified people to undertake the burnoffs at appropriate times and in consultation with Forestry Tasmania.

Commitment 4: Haul roads, the waste rock dump and the ROM pad will be kept watered in dry windy periods to reduce the potential for dust generation.

Commitment 5: All mining plant and equipment, including trucks, will be operated appropriately and will be regularly maintained.

Commitment 6: All processing plant and equipment will be operated in accordance with design specifications and regularly maintained.

## 4.2 Liquid discharges

### 4.2.1 Sewage waste

#### *Construction phase*

During the construction phase a portable crib room and toilet will be required. Sewage and other liquid waste will be stored and removed from the site for disposal at an approved wastewater treatment plant.

#### *Operational phase*

Once the mine is operational sewage and liquid waste will be treated in an appropriately designed onsite wastewater treatment plant.

Sewage will be treated to meet the EPA's Emission Limit Guidelines<sup>25</sup> emission limits for new accepted modern technology plants, shown in Table 33. Disinfection will be by chlorination. The plant will have an emergency storage tank capable of storing 2 days of effluent in case of plant malfunction.

Table 33: Emission limits for the sewage treatment plant

Parameter	50%ile	90%ile	Maximum
BOD (mg/L)	5	10	15
Non-filtrable residue (mg/L)	10	15	20
Thermotolerant coliforms (colony forming units/100 mL)			200
Oil and grease (mg/L)	2	5	10
Total nitrogen (mg/L)	7	10	15
Ammonia-nitrogen (mg/L)	1	2	5
Total phosphorus (mg/L)	0.5	1	3
pH			6.5-8.5

<sup>25</sup> Emission Limit Guidelines for Sewage Treatment Plants that Discharge Pollutants into Fresh & Marine Waters

Treated effluent will be discharged to the recycle dam to be reused in the process water stream, as described in section 2.3.3 and Figure 8. As shown in Figure 8, sewage effluent comprises less than 0.1% of the recycle dam's water budget, and its contribution to parameter concentrations in discharged water will be inconsequential. Accordingly, there is no warrant for nutrient removal.

## 4.2.2 Discharge of mine water to the environment

### Construction phase

The key surface water risks during construction will be from sediment runoff and potential fuel spills.

A mobile fuel tanker will be used to refuel equipment. Temporary bunded refuelling areas will be constructed at convenient location(s) and refuelling will take place inside those areas.

### Operation phase

Mine water will be managed through an integrated system, shown schematically in Figure 8 and repeated here in Figure 25 for convenience.

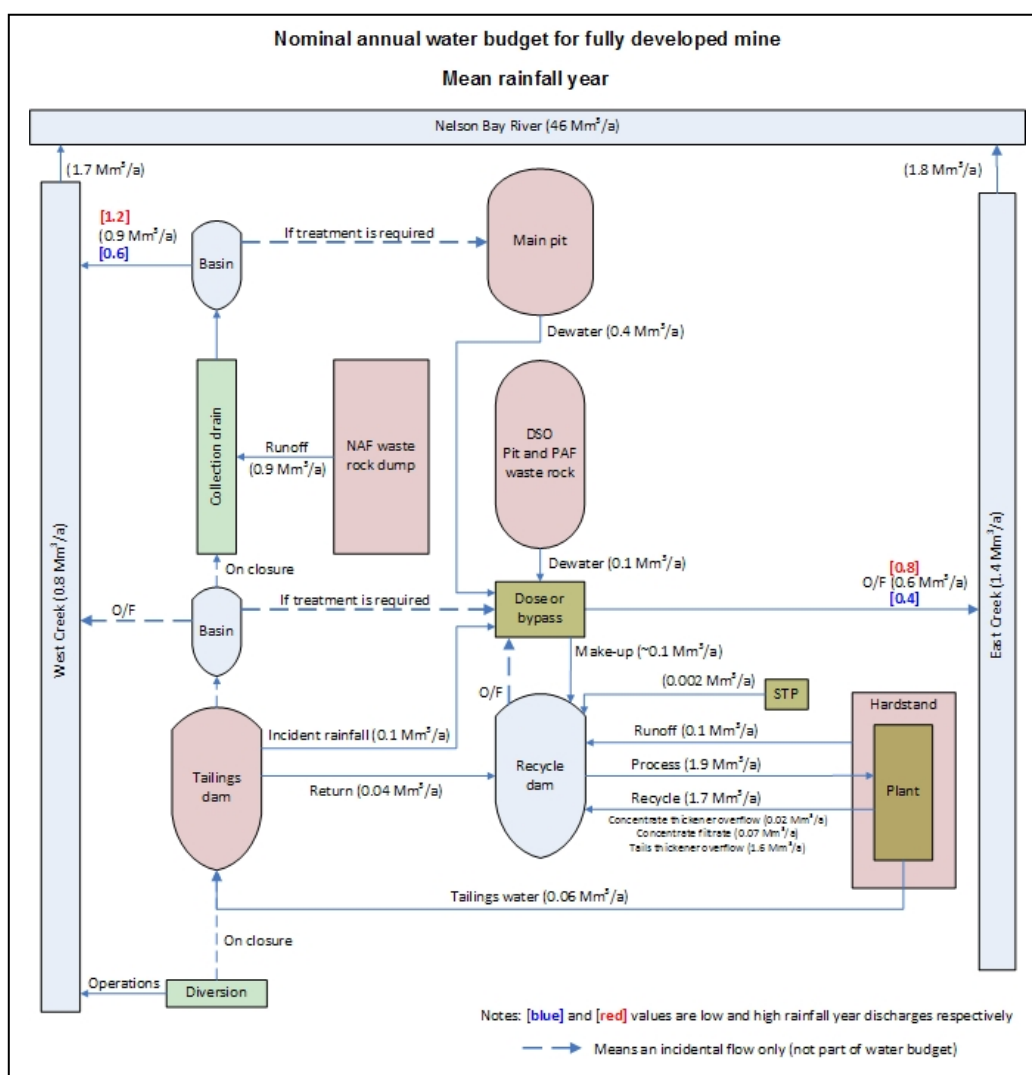


Figure 25: Nominal annual water budget for fully developed mine (mean rainfall year)



Two key features of this system are the recycling of process and tailings water and the provision of a centralised acid neutralisation treatment plant.

All significant streams of mine site water that are excess to process requirements will be directed to discharge via the dose-or-bypass neutralisation plant (DBNP), as shown in Figure 25. Water that is not affected by acidity (i.e. that has a pH of 7 or more) will be allowed to bypass the plant and will be discharged to East Creek. However, if any incoming stream has a pH less than 7 it will be neutralised in the plant prior to discharge.

Excess pit water will be discharged (via the neutralisation plant) to East Creek and hence to Nelson Bay River.

Pit water will largely comprise groundwater, which has different water quality characteristics to Nelson Bay River. A comparison of groundwater sampling results with the upstream Nelson Bay River site NBRW03 is provided in Table 34. Full data are in Appendix D and Appendix O. The ratios shown in Table 34 allow some broad groupings to be made, as indicated by the shading.

Table 34: Comparison of groundwater and Nelson Bay River water quality

Parameter	Units	Groundwater (NBRGW1-7)	Nelson Bay River (NBRW03)	Approximate ratio groundwater to surface water
pH		5.3 - 7.7	3.8 - 6.7	1 - 2
Ec	µS/cm	287 - 447	78 - 150	2 - 5
DO	%sat	8.6 - 28.5	75 - 98	0.1 - 0.3
TSS	mg/L	26 - 9360	4 - 7	4 - 2340*
Turbidity	NTU	58 - 26400	2.4 - 6.6	8 - 11000*
Total alkalinity	mgCaCO <sub>3</sub> /L	6 - 33	<1 - 4	1 - 30
Acidity	mgCaCO <sub>3</sub> /L	12 - 60	9 - 23	0.5 - 7
Sulphate	mg/L	9 - 14	4 - 9	1 - 3
Chloride	mg/L	69 - 123	22 - 50	1 - 6
Ca dissolved	mg/L	1 - 5	0.8 - 1	1 - 5
Mg dissolved	mg/L	4 - 8	1 - 3	1 - 8
Na dissolved	mg/L	25 - 60	14 - 28	1 - 5
K dissolved	mg/L	2 - 4	1	2 - 4
As total	mg/L	0.003 - 0.24	<0.001	3 - 200
Ba total	mg/L	0.011 - 0.035	0.003 - 0.007	1 - 10
Be total	mg/L	<0.001 - 0.001	<0.001	1
Cd total	mg/L	<0.0001 - 0.0042	<0.0001 - 0.0002	0.5 - 40
Co total	mg/L	0.002 - 0.039	<0.001	2 - 40
Cr total	mg/L	0.002 - 0.037	<0.001 - 0.006	0.3 - 40
Cu total	mg/L	0.003 - 0.939	<0.001 - 0.003	1 - 940
Hg total	mg/L	<0.0001	<0.0001	1
Mn total	mg/L	0.064 - 0.423	0.006 - 0.02	3 - 70
Ni total	mg/L	0.002 - 0.054	<0.001 - 0.001	2 - 50
Pb total	mg/L	0.005 - 0.356	<0.0005 - 0.01	0.5 - 70

Parameter	Units	Groundwater (NBRGW1-7)	Nelson Bay River (NBRSW03)	Approximate ratio groundwater to surface water
V total	mg/L	<0.01 - 0.05	<0.001 - 0.01	1 - 50
Zn total	mg/L	<0.005 - 0.334	<0.005 - 0.01	0.5 - 70
Fluoride	mg/L	<0.1	<0.1	1
NOx	mg/L-N	<0.01 - 0.02	<0.002 - 0.01	1 - 10
TKN	mg/L-N	0.3 - 7.7	0.3 - 1.5	0.2 - 25
Total N	mg/L-N	0.3 - 7.7	0.3 - 1.5	0.2 - 25
Total P	mg/L-P	0.08 - 2.69	<0.01 - 0.05	1 - 270
Total anions	meq/L	2.53 - 3.79	0.8	3 - 5
Total cations	meq/L	1.68 - 3.29	1.1	1 - 3

\*The values for groundwater are likely to be affected by the newness of the bores, which probably still contained residues of the drilling and installation process, so these ratios are unlikely to be reflective of the true nature of the groundwater

The elevated parameters for groundwater relative to river water are consistent with ground waters and surface waters in general. Groundwater acquires soluble matter, including mineralisation, from the aquifer as it moves through it. The longer groundwater remains in contact with its host rocks, the more soluble constituents it acquires. In the case of the proposed mine, the durations are likely to be relatively short because the recharge areas for flow towards the river are close by, being the heathlands in the western part of the lease. Nevertheless, the passage times are clearly sufficient for solutes to accumulate.

When the mine is operating, the dewatering of the pits will cause a groundwater depression centred on the pits and groundwater gradients will steepen (see section 2.3). The passage time of groundwater will therefore reduce and the concentrations of solutes would therefore be expected to decrease. It is likely that they will always be elevated relative to surface waters, however, probably by approximately an order of magnitude. This is the same order as the ratio of the mean year discharge flow (at full pit development) to mean year Nelson Bay River flow (Figure 8). The concentrations of these parameters would therefore return to the river's background levels on entry from East Creek, without any requirement for a mixing zone.

The potential impacts on East Creek are more significant because East Creek is ephemeral and there will be times of the year when the creek is dry. A discharge of mine water to the creek at these times would comprise the entire creek flow. There would be no mixing zone in the creek; mixing would only occur in Nelson Bay River.

If there was a constant discharge to East Creek throughout the year, an additional impact would be to change the nature of the creek's biota downstream of the discharge. The biota of ephemeral streams is adapted to survive extended periods of no flow. If the creek was changed to a permanent stream by the ongoing discharge of mine water during otherwise dry periods, it is likely that this biota would become at least partially displaced by biota characteristic of permanent streams.

To avoid these impacts, it would be desirable for the discharges to East Creek to mimic the natural flow patterns of the creek to the extent practicable. When the creek is dry, discharges should ideally be avoided. When the creek is flowing, discharges could increase proportionally to the creek flow. While these objectives may not always be achievable in practice, provided that the creek can be left dry for extended periods the creek biota would retain the characteristics of an ephemeral stream.

A key objective for the discharge to East Creek will therefore be to maintain it as an ephemeral creek, with extended periods of no discharge when East Creek is dry. Shree will work to this objective by using the recycle dam to buffer discharges.

As described in section 2.3.3, the recycle dam has been sized to store a nominal 4 week supply (28 days) of water for the process plant.

During the early years of the mine, the recycle dam will need to be maintained in a full state because the reliability of pit water will be low due to the shallowness of the pit. With a shallow pit, groundwater inputs to the pit will be driven by local aquifers and therefore largely reflect surface water flows. The capacity to use the recycle dam as a buffer storage for this purpose will therefore be low during the early years. The dam will need to be maintained in near full state and any excess pit water would need to be discharged to East Creek and could not be retained.

However, the same low reliability of pit water will mean that the likelihood of needing to discharge excess will be small, and the requirement for the dam to be used as a buffer for discharges to East Creek will be low. When conditions are dry in East Creek, pit water volumes are likely to be low and a discharge is less likely to be necessary. Conversely, if pit water inflows are high, requiring a discharge, it is likely that East Creek will already have a flow.

Towards the end of the mine's life, the depth of the pit will mean that the influx of groundwater will be more constant, being driven by deeper regional rather than shallow local aquifers. Pit water volumes will then be largely independent of surface water flows. Even if East Creek is dry, the influx of water to the pit will continue and the need for a discharge will be greater and more constant than in the early years. However, this constant supply of pit water will also mean that there is a much greater security of supply for the process water needs and the recycle dam will no longer need to be maintained in a full state. Most of the volume of the recycle dam will therefore be available for buffer storage.

In a dry year, when the use of the recycle dam as a buffer storage would be most needed, the expected volume of pit water to be discharged is  $0.4 \text{ Mm}^3$  (Figure 25). The total volume of the recycle dam is  $0.14 \text{ Mm}^3$ , so the recycle dam could hold up to 127 days of pit discharge. There is therefore ample capacity for pit water to be held for extended periods if East Creek is dry.

Over the full life of the mine, the use of the recycle dam will therefore transition from low buffer availability but low holding need to high holding need and high buffer availability. The details of this discharge strategy will progressively be developed as the pits are opened up and local knowledge of the behaviour of groundwater and surface waters improves. The discharge principles will be governed by a Discharge Management Plan, which will be developed prior to the commencement of processing and which will be updated annually to reflect improving knowledge of ground and surface water behaviour.

Dissolved oxygen is well below saturation levels in the groundwater, which again is typical of groundwater. This oxygen deficit will be quickly replaced, however, as groundwater becomes reoxygenated as emerges into the pits, is stored in the collection sump and ultimately is then pumped to the recycle dam or discharge.

West Creek will receive no pit water discharges and, other than if the tailings dam collection basin is overflowing, no mine water discharge in general. The water quality of discharges to West Creek will therefore be similar to that of the creek. Even if the collection dam is overflowing, this would be in a high rainfall situation and would be predominantly rainfall water and West Creek itself would be in a state of high flow.

Concentrate thickener overflow, concentrate filtrate and tails thickener overflow will be discharged directly to the recycle dam. The tailings stream will be dosed with crushed lime and/or dolomite to achieve a surplus alkalinity and will then be sent to the tailings dam. The decant from the tailings dam will be returned to the recycle dam and hence into the process water stream.

Incident rainfall onto the tailings dam that is excess to process water requirements will be sent to the DBNP.

An overflow/seepage basin will be positioned below the base of the tailings dam to allow any seepage through the dam liner (and uncaptured overflow) to be collected for testing. If necessary, this overflow could also be sent to the DBNP.

PAF waste rock and sludge from the DBNP will be stored in encapsulated cells the DSO pit (and temporarily above it if and when the DSO void is filled). Runoff from the PAF cells will accumulate in the pit, from where it will be pumped to the DBNP, with pit water.

Pit water from the main pit will also be pumped to the DBNP. While no PAF waste rock will be stored in the main pit during operations, there may be exposed PAF rock in the pit walls, so pumping of the pit water to the DBNP will allow it to be treated if necessary.

A bund wall/drain diversion will be constructed from the tailings dam, along the western side of the NAF waste rock dump to the sediment basin. Runoff from the NAF waste rock dump will therefore be directed to the sediment basin prior to discharge to West Creek. By design, this runoff should not become acidic. However, a provision will be made to allow this water to be pumped back to the main pit, and hence to the DBNP, if necessary.

A similar bund wall/drain diversion will also be constructed from the northwestern corner of the main pit to this sediment dam.

The above measures will effectively manage mine water during operations.

### *Closure phase*

On mine closure, excess PAF material stored above the DSO pit will be relocated into the bottom of the main pit and the tailings dam and DSO pit will be allowed to flood. The voids of both will only be 1 to 2 m deep by this stage, and the area's excess of rainfall over evaporation will mean that their flooding will only take 1 to 2 years and the flooding will be permanent. PAF material in these voids will therefore be permanently submerged under a cover of water at least 2 m deep.

On mine closure, the main pit, with its newly added PAF material will also be allowed to flood. Because of the depth of the pit, complete flooding is likely to take in the order of a decade. However, the added PAF material in the bottom of the pit is expected to also flood within 1 to 2 years.

Following closure, PAF material will therefore become quickly covered with a permanent cover of water, resulting in a passive close-out for acid management.

On mine closure, the progressive rehabilitation of the NAF waste rock dump will be completed. The final unrehabilitated benches and the top of the dump will be covered with a layer of crushed rock, clay and topsoil and seeded with vegetation commensurate with the surrounding areas. Runoff and seepage from the dump will continue to flow to the dump's collection drain and hence sediment dam, which will be maintained throughout the vegetation maintenance period. At the end of the vegetation maintenance period, when the dump's soil cover will be vegetated and therefore protected from erosion, the sediment dam will be removed and the collection drain will be diverted to connect directly with West Creek.

With the exclusion of PAF (and UC) material from the NAF dump being a fundamental mine management principle, acid generation from the NAF dump is not expected to occur. This will be confirmed post-closure by monitoring during the vegetation maintenance period. If signs of acidity nevertheless appear during this period, Shree will take expert advice on the significance of this and on potential mitigation measures. Shree will then implement a remedial program of works or treatment to the satisfaction of the Director of the EPA.

### 4.2.3 Existing conditions

There are currently no activities conducted on the designated site and no chemicals or fuels stored on site.

There are three main surface water drainage lines in the project area:

- The Nelson Bay River runs in a northwesterly direction on the eastern side of the site; it is approximately 600 m east of the process plant site at its closest point and is immediately east of the proposed pit area
- A tributary of the Nelson Bay River ("East Creek") runs in a northwesterly direction for approximately 1.5 km along the eastern side of the process plant, before joining the Nelson Bay River upstream of the proposed pit area
- A tributary of the Nelson Bay River runs in a northwesterly direction for approximately 1.5 km along the western side of the tailings dam and waste rock dump sites, before joining the Nelson Bay River downstream stream of the proposed pit area.

There is also a small creek at the location of the main pit (see Figure 3 of the NorthBarker report in Appendix P). While the last few tens of metres of this creek will remain untouched, the pit will remove the majority of the creek line and its local catchment and the flow in this creek will reduce to only incident rainfall. Surface water from disturbed areas of the pit will flow back into the pit and not into this creek line.

The clean decant water is expected to be of an acceptable quality for recycle and reuse in the mill. The quality is not expected to interfere with the mill processes or the discharge water quality. The tailings dam area will result in the catchment of rainwater which will improve the quality of the decant water and discharge water.

All process area (i.e. potentially contaminated) stormwater and surface drainage will be directed to the recycle dam. Overflow from the recycle dam will be discharged to East Creek, on the eastern side of mine.

As all potentially acid forming material will be stored in the DSO pit, there will be no discharge of acid drainage to surface waters.

Any potential impacts on the Nelson Bay River and its tributaries will be detected under the existing surface water monitoring regime.

It is anticipated that approximately 200,000 m<sup>3</sup>pa of wet tailings containing approximately 60,000 kL/year of water will be pumped to the tailings dam (see section 2.13). Assuming that approximately 40% of the water remains in the tailings and approximately 60% can be recycled, approximately 36,000 kL/year will be available for recycling.

In addition to the tailings decant water that will be returned to the clean decant water pond, there will be an annual incident rainfall addition to the existing 42 ha tailings dam. This will equate to the collection on average of approximately 110,000 kL/year of rainwater (after accounting for evaporation). The tailings dam decant system will be designed to take these flows to the recycle dam.

Temporary site huts/crib rooms and portable toilets will be used during the construction phase. The waste water from these temporary facilities will be disposed of by the construction contractor to an approved waste facility, using an approved waste transporter.

#### 4.2.4 Performance requirements

Designated and scheduled aqueous discharge points will be required for the project.

Aqueous emissions, including diffuse surface waters and groundwater, during construction must meet the requirements of the *State Policy on Water Quality Management 1997*.

The State Water Policy requirements are outlined in the *Environmental Management Goals for Tasmanian Surface Waters, Catchments within the Circular Head & Waratah/Wynyard Municipal Areas, January 2000*.

The standard measures to control and manage surface water quality and sediment loads during mine site extraction activities are outlined in the *Quarry Code of Practice 1999*.

The PEVs for the permanent surface waters and groundwater and the water quality objectives have been discussed in section 3.6.

#### 4.2.5 Potential effects

During construction the primary potential water contaminant may be sediment loss from the construction area and burnoff areas. This will result from the collection of incident rainfall and potentially some groundwater ingress into the tailings dam and process plant footprints.

Sediment loss to Nelson Bay River has the potential to:

- Increase turbidity and reduce visibility for natural predation and sunlight for photosynthesis
- Displace aquatic animals from river bed habitat by filling up the spaces between the rocks and gravels on the river bed
- Affect fish gills and respiration under extreme sediment loads
- Degrade habitat, such as spawning beds
- In cases of substantial deposition, alter the fluvial processes in the recipient stream.

There appear to be negligible impacts from other potential contaminants that may be present, based on the existing water and groundwater quality in the area (refer to Table 24 in section 3.7.2 and Table 27 in section 3.7.3), and the lack of impact from previous construction activity in the area.



The other potential effect during construction is from the loss of diesel fuel or hydraulic oil during construction equipment operations and refuelling. Loss can occur from spillage, breakage or vandalism.

Although any potential loss of fuels or oils is likely to be absorbed by the soils and vegetation in the buffer zones to the nearest surface waters, it has the potential to contaminate groundwater in the area. This will be assessed in section 0.

The potential effects from the operating phases are:

- Seepage from the tailings storages
- Tailings dam failure
- Change in decant water quality that affects the existing aqueous discharge quality and therefore jeopardises the ability to recycle the clean decant water to the mill
- The volume of the incident rainfall caught by the tailings dam, especially during winter, is more than the mill can reuse
- Failure in water utilisation and discharge in the process plant
- Significant unanticipated inflow of groundwater to the pit area
- Potential contamination from sewage effluent and hydrocarbon runoff.

While the mine is operating, excess water from pit dewatering will be discharged (after treatment if required) into the lower reaches of East Creek. Excess water from the tailings dam decant will similarly discharge at this location.

The discharge point will be approximately 20% up the length of the creek from its junction with Nelson Bay River and this small section of the creek is likely to flow more frequently and for longer periods while the mine is operating. Greater and more extended flows might allow species that otherwise could not survive an ephemeral regime to move up into the creek from Nelson Bay River, and the species assemblage could alter. However, the proposed discharge regime would ensure that East Creek is allowed to regularly dry up, just as it would naturally, and ephemeral-flow biota are unlikely to be completely excluded. It is not possible to predict the actual change in flow regime or biota because it will be a complex combination of surface, pit and process water input and outputs, day to day rainfall conditions and catchment and aquifer behaviour, which will only become evident as the mine develops.

The increased flow in this part of East Creek may act to clear the debris from the creek that is currently precluding the establishment of an Ausrivas site downstream from the future discharge. If this occurs, an Ausrivas station will be established there, which will allow any subsequent changes in species mix to be described.

In West Creek, other than the upper section, which will be subsumed by the tailings dam, the changes to the flow regime are likely to be marginal. The dam will intercept the creek's upper catchment water and divert it into the recycle dam, which is in the East Creek catchment, but this is not a major component of the West Creek catchment as a whole. The creek is primarily fed by a number of tributary streams that drain the wet heathlands in the western parts of the lease, and these inflows will remain unaffected.

The selected Ausrivas sampling sites are shown in Figure 26.

In addition to changes to flow regimes, the presence of a mine has the potential to discharge acid waters if this risk is not properly managed. The impacts of acid discharges to west coast waters are well known and have been described, for example, by Freshwater Systems<sup>26</sup>.

Toxicological testing showed that low pH discharges from mines can cause mortality across a wide range of macroinvertebrate species. Similarly, macroinvertebrate community composition, abundance and diversity all show significant reductions with low pH discharges. Aluminium and sulphates were implicated as the primary cause of these impacts. However, if the discharges are diluted to pH 6 to 7 or above, these impacts largely disappear. Fish species avoid low pH water, apparently mainly due to iron and copper concentrations, but again these effects are lost when the discharge is diluted to a pH of 6 to 7.

Freshwater Systems noted that pH has a major controlling influence on metal toxicity due to the formation of metal hydroxides at pHs between 3 and 7.

Maintaining the pH of any discharges from the mine at above 7 is therefore a primary management objective and this pH has therefore been set to be the trigger threshold for diversion of water through the neutralisation plant for treatment prior to discharge (see section 2.12).

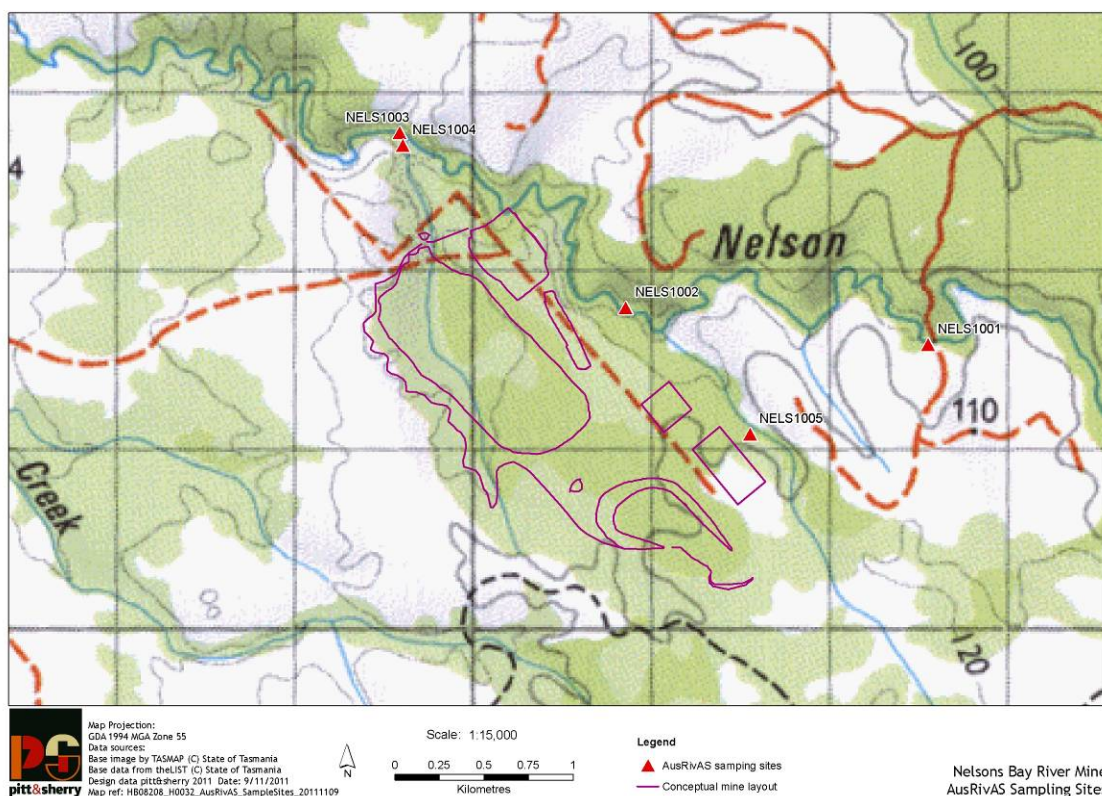


Figure 26: Ausrivas sampling sites

No significant changes to the aquatic life of West Creek are anticipated. If a suitable Ausrivas site can be found, a macroinvertebrate sampling station will be established during the mine's operations to examine this expectation.

<sup>26</sup> Freshwater Systems (2000) *Toxicological evaluation of acid mine drainage waste water treatment options at Mt Lyell, Tasmania*. MLADRP Project 4.

## 4.2.6 Avoidance and mitigation measures

### *Construction phase*

During the construction phase, the following avoidance measures are proposed:

- The general erosion control measures described in section 2.18 will be implemented.
- The area of disturbance and the surface water drainage from the mine site, tailings dam and process plant footprints will be controlled and managed.
- Temporary settlement basins and silt fencing will be used and final runoff will be directed to naturally vegetated gently sloping ground. Runoff from settlement basins will be field-monitored weekly for turbidity, pH and dissolved oxygen. If turbidity exceeds 130 NTU, a water sample will be taken for laboratory analysis of suspended solids. Settlement basins will be sampled monthly for laboratory analysis of suspended solids, BOD, total petroleum hydrocarbons and oil and grease. This monitoring and the monitoring locations will be described in a Construction Environmental Monitoring Plan, which will be prepared prior to construction work commencing.
- Burnoff areas will be at least 20 m from the class 1, 2 and 3 surface water drainage lines and from natural bush, and will be separated with silt fences.
- Reputable civil works contractors will be employed with properly trained operators and properly maintained equipment.
- Fuel will not be stored on site in any fixed location but will be transported, stored and dispensed in a mobile, purpose-built tanker with an expected capacity of approximately 1,000 L. The fuel tanker will be parked in a relatively secure area and will carry fuel cleanup equipment in case spills occur during refuelling.
- Any hydrocarbon contaminated soil will be removed immediately and taken to an appropriate authorised disposal or treatment facility.
- Oil absorbent mats will be located at the construction site for use on any emergency spill.
- Any suitable topsoil will be appropriately stockpiled for subsequent use in rehabilitation on the site
- Sewage effluent will be collected and tankered off site to a treatment facility.

### *Operational phase*

During the operational phase, the following avoidance measures are proposed:

#### General site

- A Drainage Management Plan will be prepared for the management of site water during operations and on closure.

#### Mine area:

- If alkalinity dosing is not necessary, the pit water will then be directed to satisfy process water make-up requirements in the first instance or discharged to East Creek if make-up requirements are satisfied.
- Runoff from in-pit haul roads will collect in the base of the pit as pit water, from where it will be pumped to the recycle dam.

- Runoff from the out-of-pit haul road will be directed to local sediment basins for settling prior to discharge to local drainage lines on the eastern edge of the waste rock dump. The location of these basins will be determined as part of detailed design. Any of this water that finds its way through the dump would ultimately report to the dump's collection drain and hence to the dump's sediment basin prior to discharge to West Creek.
- A cut-off drain at the northern end of the main pit will divert water into the waste rock dump's sediment basin prior to discharge to West Creek.
- A cut-off drain at the head of the tailings dam will divert water into the tailing dam's collection dam, from where it will be pumped to the recycle dam (or overflow to West Creek if inflow exceeds pumping capacity).

#### Waste rock dumps:

- During emplacement of waste rock, care will be taken to ensure that dumps remain within their defined boundaries and that there is no movement of material, particularly down the drainage lines in the area.
- Revegetation of dump surfaces will be undertaken as soon as is practicable.
- Any potential acid-forming (PAF and also UC) material will be encapsulated within the DSO pit.
- Run-off from this dump will be collected in the pit and then pumped to the acid neutralisation plant for alkalinity dosing if and as necessary.
- Non-acid forming (NAF) material will be disposed of into the NAF dump.
- Run-off from the NAF dump will collect in a sedimentation dam for settlement prior to discharge to West Creek.
- NAF dump run-off should not become acidic. However, as a conservative measure, a pumping capacity will be installed to allow water to be pumped from the sedimentation dam to the main pit and hence to the acid neutralisation plant if necessary.

#### Tailings dam:

- The tailings dam has been sited and conceptually designed to ensure a permanent water cover of at least 1 m, both during operations and following mine closure. Tailings will also be dosed with crushed lime and/or dolomite to achieve a surplus alkalinity (see section 2.13). These measures will ensure that the risk of any pyritic material in the tailings oxidising to produce acid conditions is negligible.
- The deposited tailings will be analysed every six months to identify if any changes to the geochemistry of the tailings is occurring that may jeopardise the way the tailings are being managed. Six monthly monitoring is deemed appropriate to detect any significant geochemical changes because of the expected consistent nature and reliable geological knowledge of the ore to be mined.
- Tailings decant water will be recycled into the process stream via the recycle dam.
- The tailings decant water will be analysed every six months to identify if any changes to the geochemistry of the tailings is occurring that may jeopardise the recycling of tailings water. Six monthly analysis is deemed appropriate given the buffer volumes of the tailings storage capacity and of the recycle dam.
- The tailings dam will be designed and the construction supervised by an appropriately qualified engineer to satisfy the Australian Committee on Large Dams (ANCOLD) engineering standards.

- The storage facility design will be assessed by the ACDC during the project assessment by the EPA Board. The tailings will consolidate following deposition and improve the impervious nature and integrity of the facility, thus reducing the likelihood of any seeps to surface water.
- Approximately 60% of the water content of the wet tailings will be recycled to the process plant (the remaining 40% will remain 'bound' to the tailings). Incident rainfall onto the tailings dam will be pumped to the acid neutralisation plant where it could be neutralised if necessary before being sent to the recycle dam as make-up water or discharged to East Creek (see Figure 8). Neutralisation is highly unlikely to be required because of the alkalinity dosing of the tailings (see section 2.13), which will provide a residual alkalinity in the tailings dam. Pumping this water to the recycle dam via the treatment plant is a conservative design measure only. Because of the alkalinity dosing, there is no significant risk of this water having low pH or high metal concentrations, and discharge to East Creek would therefore not compromise Protected Environmental Values for Nelson Bay River. This water may also assist with the neutralisation plant's treatment of any acid waters from the pits.
- In high rainfall conditions, there may be additional excess water (beyond the pumping capacity) which will discharge over a spillway into a sedimentation dam before flowing into West Creek. Similarly, because of the alkalinity dosing, there is no significant risk of this discharge water having low pH or high metal concentrations and Nelson Bay River Protected Environmental Values would again be protected.

#### Process plant area:

- The area of disturbance associated with the mine process area will be kept to the minimum practicable level, consistent with process plant operating requirements.
- Storm water runoff from the process plant buildings and surface areas will be directed to the recycle dam.
- Hardstand run-off will be diverted to an interceptor to remove oil and grease prior to pumping to the recycle dam.
- Sewage effluent will be treated to accepted modern technology standards prior to discharge to the recycle dam.

### 4.2.7 Assessment of residual effects

The measures outlined above should ensure that potential aqueous emissions during the construction and operation phases are properly controlled, monitored and managed and present a negligible risk to the environment.

#### *Proposed treatment processes*

Water in the tailings storages will not be subject to any treatment processes. On settlement of the tailings, water will be decanted and reused in the processing plant, with any excess discharged to the existing drainage lines at approved locations.

#### *Nature of the discharge*

Analysis of the tailings decant will be undertaken on a regular basis. The decant water is expected to be benign and to present a negligible risk of causing environmental nuisance or impacts to the existing environment.

#### *Discharge points to the receiving environment*

All decant discharge to the environment will be via discharge points, in accordance with the requirements associated with the project approval.



*Nature of receiving water*

The results of the mine site surface water monitoring program are discussed in section 3.7.2. The database indicates that the quality of the receiving waters is variable but primarily of good quality given the activities in the catchment.

The data analysis indicates very little difference between the upstream, discharge and downstream water qualities using pH and sulphate as key water quality indicators.

*Contingency measures*

Appropriate contingency measures will be established in accordance with the requirements of the project approval.

*Commitments*

The following commitments will ensure that any risks to the environment are minimised:

**Commitment 7:** The areas of disturbance will be controlled and surface water drainage diverted around the site footprints during the construction phases. Where possible, temporary sedimentation basins and silt fencing will be used and final runoff will be directed to the existing naturally vegetated gently sloping drainage lines.

**Commitment 8:** A Drainage Management Plan will be prepared for the management of site water during operations and on closure. The plan will be prepared prior to the commencement of operations.

**Commitment 9:** Runoff from settlement basins will be field-monitored weekly for turbidity, pH and dissolved oxygen. If turbidity exceeds 130 NTU, a water sample will be taken for laboratory analysis of suspended solids. Settlement basins will be sampled monthly for laboratory analysis of suspended solids, BOD, total petroleum hydrocarbons and oil and grease.

**Commitment 10:** The tailings dam will be designed and the construction supervised by an appropriately qualified engineer to an appropriate engineering standard. A reputable civil works contractor will be commissioned with properly trained operators and properly maintained equipment.

**Commitment 11:** Fuel or hydrocarbons will not be stored on site in any fixed storage facility during the early construction phase. Refuelling of equipment will be undertaken using a mobile purpose built tanker. The tanker will carry fuel cleanup equipment in case spills occur on site.

**Commitment 12:** A bunded area will be constructed in an appropriate site to store fuel and hydrocarbons for use during the mine operation phase.

**Commitment 13:** In the event of a spill, any hydrocarbon contaminated soil will be removed immediately and taken to an appropriate authorised disposal or treatment facility. The Director, Environment Protection Authority, will be notified immediately.

**Commitment 14:** Run-off from the process area hardstand will be diverted to an interceptor to remove oil and grease prior to pumping to the recycle dam.

**Commitment 15:** Sewage effluent will be treated to accepted modern technology standards prior to discharge to the recycle dam.

**Commitment 16:** Pit water from both the main and DSO pits (which will include influx surface water and infiltrated groundwater) will be pumped to a centralised acid neutralisation plant, where it will be alkalinity dosed if its pH falls below 7. If alkalinity dosing is not necessary, pit water will then be directed to the recycle dam to satisfy process water make-up requirements in the first instance or discharged to East Creek if make-up requirements are satisfied.



Commitment 17: The discharge from the neutralisation plant will be via a sludge settling pond or thickener tank(s), designed to suit the chosen treatment plant's configuration. Periodically, the pond/tank(s) will be desludged and the sludge will be deposited within the PAF rock dump inside the DSO pit immediately prior to the addition of a dump cover layer. The PAF cell will therefore retain the sludges *in situ* and they, together with the rock within the PAF dump, will be permanently flooded on mine closure.

Commitment 18: Tailings will be pH adjusted prior to deposition in the tailings dam so as to achieve a residual alkalinity.

Commitment 19: Decant from the tailings dam will be returned to the recycle dam for reuse as process water.

Commitment 20: Runoff from the NAF waste rock dump will be collected in a sediment settling basin prior to discharge to West Creek. If testing shows that the pH of the basin water is below 7, it will be pumped to the main pit and hence to the neutralisation plant for treatment.

Commitment 21: Excess water from the recycle dam will be discharged to East Creek via the neutralisation plant, where it will be treated prior to discharge if its pH is below 7.

Commitment 22: The discharge of water to East Creek will be managed to protect the ephemeral nature of the creek. The recycle dam will be used to buffer discharges in accordance with a Discharge Management Plan that will be prepared prior to the commencement of operations. The Discharge Management Plan will be updated annually to reflect the accumulation of knowledge about groundwater and surface water flow patterns.

## 4.3 Groundwater

The pit development is likely to have a significant impact on groundwater levels over a considerable area and may alter the down gradient groundwater behaviour across the wider area, particularly as the pit reaches the deeper proposed levels.

The excavation and construction for the TSF may also alter the groundwater levels in the local area but it is not expected to alter the down gradient groundwater behaviour to any great extent. The TSF construction should not interfere with any deeper contained aquifers.

Construction of the process plant may have some impact on the shallow aquifer but is unlikely to have any significant impact on down gradient groundwater behaviour. It is unlikely to have any impact on the deeper aquifers.

### 4.3.1 Existing conditions

The groundwater in the project area appears to be basically at the ground surface during the winter period across most of the project area.

Monitoring of groundwater levels and quality has commenced, and will continue on a regular basis.

### 4.3.2 Performance requirements

Groundwater emissions from mining and mineral processing sites must comply with the following:

- *State Policy on Water Quality Management 1997.*
- *Environmental Management and Pollution Control Act 1994.*
- *Water Management Act 1999.*
- *Groundwater Act 1985.*

### 4.3.3 Potential effects

#### *Groundwater quality*

The potential impacts on groundwater resulting from mining activities are similar to the potential impacts on surface water. If the quality of the decant water in the tailings dam was to alter adversely over time then seepage from the tailings dam to groundwater may impact on groundwater quality.

Seepage from the base of the DSO pit where PAF rock is being stored will be minimal because the PAF cells will be clay lined and will also have progressively added cover layers, each of which will further inhibit water infiltration. Any water that accumulates in the pit sump while the DSO is being mined will be pumped out to the recycle dam or discharge, via the neutralisation plant, and there would be little time for any significant infiltration through the pit floor.

Any NAF dump runoff that percolates to the dump base is then likely to run along the natural ground surface into the dump's collection drain and would be unlikely to infiltrate into groundwater. Even if it did, its quality would be similar to that of runoff from the natural ground (because there would be no PAF material in this dump).

#### *Groundwater levels*

Dewatering of the pits during mining will result in a drawdown of the water table in the surrounding areas, with the extent of this drawdown diminishing with increasing distance from the pits. If the pumping is continued for a sufficiently long period of time, a near steady state condition will emerge where lowering of the water table will cease. Cessation of pumping will result in a rise in the water table.

Cromer (refer Appendix D and section 2.3 above) has estimated that the area of influence affected by dewatering towards the end of mine life would be limited to about 800 - 1200 m +/- 20% from the Main Pit and (if pumped alone) about 350 - 600 m +/- 20% from the DSO Pit.

As described in section 2.3, the wet heathlands in the western part of the lease are a groundwater recharge area and are not dependent on groundwater - groundwater is fed from precipitation onto the heathlands and not the other way around. West Creek, which flows through the heathlands, will similarly be fed by precipitation onto the heathlands and creek flows are therefore unlikely to be significantly affected by any drawdown of the underlying watertable as a result of mine dewatering.

#### 4.3.4 Avoidance and mitigation measures

The management measures used to protect surface waters from contamination will also protect groundwater.

The following mitigation measures will be utilised to minimise the potential impacts on groundwater in the area:

- Groundwater intercepted during construction of the process plant and the tailings dam will be controlled and managed by the contractor. Temporary sedimentation ponds, silt fencing and dissipation drains into natural sloping vegetation will be used to minimise potential impact to downstream surface waters.
- Permanent sedimentation ponds and dissipation drains that discharge into local drainage lines at approved locations will be used to minimise the potential impact to downstream surface waters of groundwater discharged from the pit.
- To minimise seepage, the tailings dam will be lined with compacted clay, which is expected to have a permeability in the order of  $10^{-9}$  m/s, and dam walls will have a clay core. This, together with the impermeable nature of the tailings will ensure minimal impact on the groundwater quality in the area, in accordance with the State Policy on Water Quality Management 1997.
- The tailings storage facility will consolidate following deposition and improve the impervious nature and integrity of the facility, thus further reducing the likelihood of any seepage to groundwater.
- A series of groundwater monitoring boreholes have been installed to monitor groundwater levels and quality. Monitoring will be undertaken every 6 months and include pH, EC, REDOX, sulphate and the routine heavy metal suite of analytes.

#### 4.3.5 Assessment of residual effects

Potential impacts on groundwater levels will occur during the construction phases and during the development and operation of the pits.

All groundwater encountered during construction activities will be pumped to the recycle dam, together with groundwater from the pits, prior to discharge.

The discharge of groundwater during operations is discussed in section 4.2.2. There is not expected to be any impact on groundwater quality as a result of the proposed mining operation.

The following commitments will ensure that the risks to the groundwater environment are minimised:

Commitment 23: Groundwater encountered during construction will be disposed of in a similar manner to the surface water, using temporary sedimentation ponds, silt fencing and dissipation drains to minimise potential impact to downstream surface waters.

## 4.4 Noise emissions

### *Construction*

Noise emissions will be associated with the construction phases. The noise will relate to the operation of earthmoving and construction equipment.

### *Operation*

Noise emissions during the operation phase will be associated with the operation of earth moving equipment, transport of materials and the operation of the process plant equipment, particularly crushing and grinding.

Blasting may be required in the main pit, below 20 m from the surface, but is not expected to be necessary in the DSO pit or in the upper, oxidised layers of the main pit.

It is expected that the full DSO pit and the upper 20 m (oxidised layers) of the main pit will be free-dig mining, requiring no blasting. Blasting is only anticipated in the main pit, below the free-dig horizon.

Blasting will generally occur at fixed times, usually at the end of shift and during the mid shift crib break. Blasting times therefore are likely to be:

- 1200 to 1230 or 1300 hours and
- 1600 to 1700 hours.

Blasting times will be determined and confirmed with the mining contractor when one has been appointed. They will be dependent on the shift and working hours arrangements agreed with the contractor.

### 4.4.1 Existing conditions

Ambient noise levels at the site are low as there are currently no mining or other activities in the area. The area is likely to be subject to some noise emissions from forestry activities and forestry transport activities in the State Forest to the northeast of the site at times.

### 4.4.2 Performance requirements

Noise emissions from sites must comply with the following:

- *Environmental Management and Pollution Control Act 1994* - environmental nuisance.
- *Environment Protection (Miscellaneous Noise) Regulation 2004*.
- *The Quarry Code of Practice*.

### 4.4.3 Potential effects

Ambient noise levels will be altered both by the construction activities associated with mine establishment and the operation of the mine.

There will be significant noise emissions from heavy earthmoving equipment and construction machinery and vehicles during the construction phase. Once the mine is commissioned there will be significant noise emissions from heavy earthmoving equipment and vehicles in the mine and mine dump areas and from the operation of machinery in the process plant. There will also be blasting when the deeper (below 20 m from the surface) layers of the main pit are being mined.

These elevated ambient noise levels are considered unlikely to have any adverse impacts on terrestrial or freshwater wildlife. They will have no impact on domestic livestock or neighbouring residences as there are none within the vicinity.

Exposure of construction and operation personnel to high noise emissions can, however, affect human health if appropriate mitigation measures are not taken.

### *Earthmoving equipment and vehicles*

Using a typical engine power of up to 162 kW for the largest earthmoving equipment, a sound power level emission of approximately 105 dB(A) can be expected. A large front end loader or bulldozer of similar power will have a similar sound power level.

Other mobile equipment or a truck can be expected to have a sound pressure level at 1 m distance of 93 dB(A), which equates to a sound power level of 101 dB(A).

The combined sound power of both emissions operating simultaneously will be the logarithmic addition of 105 and 101 dB(A), which is 106.5 dB(A).

Assuming half-spherical sound propagation from this source over flat ground, the drop in sound pressure levels with distance from the source can be calculated. The resultant the drop off in sound pressure levels at various distances from the construction equipment source (assuming no screening effects from intervening topography or vegetation) are shown in Table 35.

Table 35: Sound pressure levels versus distance from source

Distance from noise source (m)	Sound pressure level (dB(A))
7.5	81.0
100	58.5
200	52.5
300	49.0
335	48.0
400	46.5
475	45.0
500	44.5
600	43.5
700	41.6
800	40.5
900	39.4
1000	38.5

Under schedule 2 of the *Environmental Management and Pollution Control (Miscellaneous Noise) Regulations 2004*, noise from equipment such as front end loaders must not exceed between 83 and 92 dB(A) (depending on engine power) 7.5 m away. As shown in Table 35, this requirement will be met even with the combined noise from the two nominal sources.

Under regulation 14 of the same Regulations, unless otherwise approved by the Director, Environment Protection Authority, noise from the equipment must not exceed 45 dB(A) at domestic premises outside the 0700-1800 hours Monday-Friday, 0800-1800 hours Saturday and 1000-1800 hours on public holidays. This will not be applicable as there are no domestic premises within the wider area. Consequently there should be no need for restrictions on construction or operation (including blasting) hours.

#### 4.4.4 Avoidance and mitigation measures

In order to mitigate noise levels:

- Equipment and vehicles appropriate to the required tasks will be utilised
- All equipment and vehicles will be fitted with the manufacturer's silencing equipment and will be appropriately maintained
- Processing plant will be appropriately designed, operated and maintained
- Mandatory use of appropriate hearing protection will be required in all areas to protect the health of workers.

As there are no nearby residences or sensitive land users, no other specific measures are required to mitigate these temporary increases in ambient noise levels.

#### 4.4.5 Assessment of residual effects

Adherence to the identified avoidance and mitigation measures, as outlined above, will ensure that any noise effects from construction and operation of the mine will be kept to acceptable levels. As a result:

- Noise from equipment will meet the requirements of the *Environmental Management and Pollution Control (Miscellaneous Noise) Regulations 2004*
- Ambient noise will meet the requirements of the *Quarry Code of Practice* and will not cause an environmental nuisance under the *Environmental Management and Pollution Control Act 1994*
- The occupational health and safety requirements of the *Workplace Health and Safety Act 1995* and the *Workplace Health and Safety Regulations 1998* will be met

#### *Commitments*

The following commitments will ensure that any impacts to the ambient noise levels of the area will be minimised:

Commitment 24: All equipment and vehicles will be fitted with manufacturer's silencing equipment, operated appropriately and regularly maintained.

Commitment 25: Use of appropriate hearing protection equipment will be mandatory in all relevant areas.



## 4.5 Solid and controlled waste

### 4.5.1 Geochemical assessment of waste rock

The geochemical assessment of the waste rock was discussed in detail in the following sections:

- 2.6 Acid generation potential
- 2.7 Geochemical sampling program
- 2.8 Analytical program
- 2.10 Estimated amounts of pyritic waste material
- 2.11 Management of pyritic material.

#### *Geochemical sampling program and sampling constraints*

The sampling program undertaken is considered to be representative of the various lithologies and mineralisation styles, as well as their spatial distributions.

The choice of cores was made on the basis of any particular drill hole being able to provide a suitable number of samples of the material required for analysis (e.g. lithology, mineralisation style).

The sampling program was further modified by consideration of the time when the particular hole was drilled. Some potential drill cores were avoided on this basis because it was considered that, given the length of time since extraction of these cores, oxidation of the pyrite content of the core may have occurred. Any such oxidation of pyritic core post drilling could result in an underestimation of the potential for acid generation from this material.

### 4.5.2 Waste rock types

Waste rock material will consist of:

- The country rock: predominantly quartz sandstone with lesser amounts of grey laminar bedded siltstone, of the Proterozoic Rocky Cape Group (Cowrie Siltstone)
- Some oxidised ore that is not of sufficiently high iron concentration for direct shipment
- Ultramafic dyke material
- Thermally metamorphosed sediments: dyke-country rock contact material.

This waste rock material will contain some pyritic material and will, therefore, be potentially acid forming.

### 4.5.3 Waste rock acid potential

The resource contains pyrite in varying proportions, as shown in Figure 9 (section 2.6.1).

The core samples indicate that the occurrence of pyrite is not strata bound but occurs along fractures, joints and faults, with encrustations and veins having pinch and swell of varying size. Occurrence and concentration will, therefore, be hard to predict.

The waste rock is quartz sandstone with lesser amounts of grey laminar bedded siltstone. The occurrence of pyrite in the bulk of the waste rock is most commonly <0.5%, occurring in disseminated and to a lesser extent veinlet form.

As shown in the cored distributions in Figure 9, pyrite content varies considerably and reaches a maximum of 40% in spots by visual assessment. However, strong pyrite zones (10 to 40% by visual assessment) typically extend only over short distances down hole (e.g. 30 cm @ 40% from 189.7 m in NBR017 and 2.4 m @ 30% from 176.6 m in NBR001) and are not reflected in sample analysis. These zones can be readily visually identified and set aside for encapsulation.

Pyrite in waste rock, which is mostly quartz sandstone with lesser amounts of grey laminar bedded siltstone, is more commonly <0.5% as disseminated and, to a lesser extent, veinlet form. Strong (to ~15% in spots by visual assessment, although only ~3% by sample analysis) disseminated pyrite is evident in association with pervasive silica alteration locally, being most prevalent west of the magnetite ore on sections 10000 & 10100N. Disseminated and veined sulphide is also evident within skarn in both the footwall and hanging wall. This illustrates the variability in the distribution of pyrite, which is more likely to be found in discrete localised occurrences.

Skarn also often bears significant chalcopyrite, which can also be visually delineated and stockpiled.

A lot of the pervasive pyrite is encapsulated in silica. How much of this pyrite will be released during the mining process will depend on crush sizes.

#### 4.5.4 Acid generating potential

Forty five samples, including four samples of tailings material, were analysed as part of the acid accounting program, as discussed in section 2.8.

These samples consisted of the following geochemical classes (ARD rock type categories):

- UC (Unclear): 5 samples
- NAF (Non acid forming): 15 samples (including four tailings samples)
- PAF Low Capacity (Potential acid forming - low capacity): 10 samples
- PAF (Potential acid forming): 15 samples.

No potentially acid consuming materials were identified. Although the siderite and calcite in the ore are potentially acid consuming in test samples, they are not well defined and secondary reactions mean that siderite provides no net neutralising capacity in the field. This material, which cannot be quantified, will end up in the tailings.

Samples subjected to K-NAG testing indicated significant potential to generate acid drainage, with rapid onset of acid production predicted. The predicted lag time to the onset of acid conditions ranged between 4 and 16 weeks.

##### *Estimated amounts of acid forming material*

The estimated amounts of acid forming material and the anticipated timing and exposure of these materials are discussed in section 2.10.3.

The estimated volume of acid forming material is 1.7 Mm<sup>3</sup>, which is greater than the capacity of the DSO pit (0.8 Mm<sup>3</sup>).

All potentially acid forming material cannot, therefore, be disposed of within the DSO pit void (based on the ten year life of the proposed mining operation). The excess PAF material will be stored above the DSO pit during operations and relocated into the main pit on mine closure.

#### 4.5.5 Disposal requirements

##### *Waste rock material*

The proposal will result in the generation of approximately 1.7 Mm<sup>3</sup> of potentially acid forming waste rock and 9.8 Mm<sup>3</sup> of non acid forming waste rock.

The disposal and management of waste rock material is discussed in detail in section 2.4. Dump stability and drainage are discussed in detail in section 2.5.

The disposal and management of the potentially acid forming material is discussed in detail in section 2.11.

##### *Tailings*

Concentration of the magnetite ore will result in the production of approximately 250,000 tpa or 170,000 m<sup>3</sup>pa of dry tailings. These tailings will be deposited in a specially constructed tailings storage dam, as discussed in section 2.13. The tailings dam will have a clay core and the dam base will be lined with clay compacted to achieve a permeability of less than  $1 \times 10^{-9}$  m/s. The tailings themselves will provide additional sealing as they consolidate over time.

##### *Other solid waste*

The proposed development will not produce any other solid and/or controlled wastes and no process waste will be produced.

The proposal involves the mining and processing (concentration) of magnetite, the transport offsite of the concentrated product and the storage onsite of a solid waste (tailings).

During construction of the process plant and TSF, contractors may produce some general solid wastes such as papers, plastics, food materials and empty bottles, and fuel and oil contaminated wastes from routine minor machinery maintenance.

The tailings are not classified as a controlled waste as interpreted under Schedule A of the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure as varied December 2004*.

#### 4.5.6 Existing conditions

The footprint currently has a variety of vegetation types with some areas of thick wet forest.

No solid or controlled wastes are currently stored on site. All wastes associated with exploration activities have been removed from the site by the contractors involved.

#### 4.5.7 Anticipated conditions

##### *Acid rock drainage*

Based on a visual examination of the core and the geochemical analytical program, there will be a significant quantity of potentially acid forming waste rock to be disposed of (approximately 1.7 Mm<sup>3</sup>).

As a result, special measures to encapsulate potentially acid forming materials will be necessary, given present understanding of the likely nature of overburden material. This will involve the construction of special encapsulation cells, as described in section 2.11 and illustrated in Figure 14.

The amount of material that will need to be encapsulated in these cells is approximately 1.7 Mm<sup>3</sup>, as detailed in section 2.10. As this amount is considerably more than the capacity of the DSO pit, only about 50% of the potentially acid forming waste rock material will be able to be disposed of inside this pit. The excess PAF material will be temporarily stored in a raised dump above the pit while mining is occurring in the main pit. On mine closure the raised PAF dump will be removed and dumped into the main pit, where it will be flooded, and the PAF material remaining in the DSO pit will also be flooded.

Because these temporary cells will be above ground, they would not be accessible to the rising phreatic zone within the DSO pit and could therefore not become enveloped within a saturated zone like the deeper cells. The risk of oxidation of PAF material within the above ground cells is therefore greater and because of this these cells will be covered with clay rather than NAF rock (which may be used for the cells inside the pit). The risk of oxidation of PAF material in these cells having commenced before the material is relocated into the main pit for flooding will therefore be minimised.

#### *Other waste*

It is not anticipated that the proposed mining operations will produce significant quantities of any other waste materials.

### 4.5.8 Performance requirements

Solid and controlled waste from mine sites must comply with the following:

- National *Environment Protection (Movement of Controlled Waste between States and Territories) Measure* as varied December 2004.
- Tasmanian *Environmental Management and Pollution Control Act 1994* - Environmental nuisance or harm provisions.
- Tasmanian *Environmental Management and Pollution Control (Waste Management) Regulations 2000*.
- Tasmanian *Quarry Code of Practice 1999*.

### 4.5.9 Potential effects

Waste material can cause environmental nuisance or harm if it is not contained and disposed of appropriately. Acidic runoff from PAF rock dumps could occur if those dumps are not properly managed.

### 4.5.10 Avoidance and mitigation measures

The following mitigation measures will be utilised to minimise the risk from solid and controlled waste handling:

Construction phase:

- Solid refuse will be stored on the project area by contractors in a lidded skip bin or similar container and regularly taken to a waste transfer station for disposal
- Portaloos will be managed and routinely emptied by the selected civil contractor.
- Any soil contaminated by hydrocarbons will be managed by the contractor and removed and taken to an appropriate disposal or treatment facility by an authorised transporter.

**Operation phase:**

- Acid runoff prevention and management is described in sections 2.4 through 2.16.
- All fuels will be stored within a bunded area, in accordance with the requirements of the *Dangerous Substances (Safe Handling) Act 2005*.
- Solid refuse will be stored in a lidded skip bin or similar container and regularly taken to a waste transfer station for disposal.
- An appropriately designed sewage treatment plant will be constructed and maintained, treating effluent to Accepted Modern technology standards (see section 4.2.1). Treated effluent will be reused in the process water stream, via the recycle dam.
- Stormwater runoff from the processing plant hardstand area will be directed to an oil and grease separator prior to it being pumped to the recycle dam.
- Any soil contaminated by hydrocarbons will be removed and taken to an appropriate disposal or treatment facility by an authorised transporter.
- The tailings storage dam will be used only for the storage of process tailings.
- Depending on market demand, some NAF waste rock may be taken the ROM pad for crushing and stockpiling for commercial on-sale, which would be subject to the approval of the EPA.

**Closure phase**

On closure, all PAF material will be submerged under a permanent water cover, which will prevent the formation of acid generating conditions.

With the exclusion of PAF (and UC) material from the NAF dump being a fundamental mine management principle, acid generation from the NAF dump is not expected to occur. This will be confirmed post-closure by monitoring during the vegetation maintenance period. If signs of acidity nevertheless appear during this period, Shree will take expert advice on the significance of this and on potential mitigation measures. Shree will then implement a remedial program of works or treatment to the satisfaction of the Director of the EPA.

**4.5.11 Assessment of residual effects**

Only minimal amounts of waste will be produced during construction. As all these materials will be taken offsite for appropriate disposal there will be no residual effects.

The operation phase will produce significant amounts of waste rock material, some of which will be potentially acid forming. Some of the non acid forming material will be used to construct the tailings storage dam but the bulk of it will be stored in an appropriately designed and constructed waste rock dump.

The potentially acid forming material will be encapsulated in specially designed and constructed cells within the DSO pit and flooded on mine closure. Excess material will be stored in encapsulation cells above the DSO pit and pushed into the main pit on mine closure. The material will also be flooded on mine closure. Pit water, tailings dam decant water and PAF rock dump runoff will be directed to a central acid neutralisation plant where it can be treated by acid neutralisation if and as necessary (see sections 2.4 through 2.16, Figure 8 and Appendix H).

As all other waste materials will be disposed of offsite, in accordance with EPA and/or Circular Head Council requirements, there will be no long term effects on the site from these materials.

#### 4.5.12 Commitments

The following commitments will ensure that any risks to the environment are minimised:

Commitment 26: Refuse will be stored on site in a covered bin and periodically taken to a waste transfer station for disposal.

Commitment 27: Rubbish bins will be provided at appropriate locations around the site and all staff will be required to avoid littering and to collect and bin any rubbish and litter that they observe on the site.

Commitment 28: Any hydrocarbon contaminated soil will be removed to an appropriate disposal site or treatment facility.

Commitment 29: Potential acid forming waste rock will be encapsulated in appropriately designed and constructed cells within the DSO pit. Excess PAF material will be encapsulated in appropriately designed and constructed cells above the DSO pit; this material will be pushed into the main pit on mine closure.

Commitment 30: Potential acid forming waste rock will be regularly covered with layers of low permeability material at a frequency dictated by the results of acid potential testing to ensure that the PAF rock is covered before the onset of acid producing conditions. For cells inside the pits, the cover material will be clay or crushed NAF. For temporary cells above the pit, the cover material will be clay.

Commitment 31: All non-potentially acid forming waste rock not required for tailings dam or waste rock storage cell or other infrastructure construction will be disposed of in an appropriately designed and constructed waste rock dump unless sold or provided to other parties for off-site use. Any NAF rock to be sold or provided for off-site use will be taken to the ROM pad for crushing and stockpiling. The sale or provision of this rock for off-site use would be subject to the approval of the Director of the EPA.

Commitment 32: The tailings storage dam will be used only for the storage of process tailings.

Commitment 33: The tailings storage dam will be constructed with a clay core.

Commitment 34: The base of the tailings dam and of PAF rock cells will be lined with clay compacted to achieve a permeability of less than  $1 \times 10^{-9}$  m/s.

Commitment 35: If signs of acidity occur in runoff from the NAF rock dump during the post-closure vegetation maintenance period, Shree will take expert advice on the significance of this and on potential mitigation measures. Shree will then implement a remedial program of works or treatment to the satisfaction of the Director of the EPA.

## 4.6 Dangerous goods

### *Construction phase*

Neither fuels nor oils, nor any other dangerous good, will be stored in bulk on site in any permanent facility during the construction phase. Fuel and oil will be brought onto the site as required in a mobile tanker for the construction activities.

The tanker is expected to have a capacity of approximately 1,000 L and will be parked away from the class 1 and 2 drainage lines in a secure area for refuelling activity.

Refuelling and minor maintenance (e.g. lubrication) of equipment will be undertaken on site in a secure area but major repairs will only occur off-site.



### *Operation phase*

Fuels and oils will be stored on site in a permanent facility once the mine moves to the operation phase. These, together with any other dangerous goods required, will be stored in an appropriately designed and operated bunded area.

Refuelling and major repairs of plant and equipment will be undertaken on site within a bunded area. These operations will be performed in appropriately designed and operated facilities equipped with measures to contain and clean up any spills that might occur.

Explosives will be stored in a secure facility located at an appropriate distance from all other facilities.

#### **4.6.1 Existing conditions**

Fuels and oils for drilling exploration are the only known previous use of dangerous goods on the project area.

#### **4.6.2 Performance requirements**

Dangerous goods management must comply with the following statutes, regulations and code:

- *National Code for the Storage and Handling of Workplace Dangerous Goods* (NOHSC 2001)
- *Environmental Management and Pollution Control Act 1994* - Environmental nuisance or harm provisions
- *Environmental Management and Pollution Control (Waste Management) Regulations 2000*
- *Dangerous Substances (Safe Handling) Act 2005* - storage of fuels
- *Quarry Code of Practice 1999*.

#### **4.6.3 Potential effects**

- Fuel storage can be an explosion risk
- Fuels and oils can cause environmental nuisance or harm if they are spilled and contaminate either land or water
- Explosives can be an explosion risk.

#### **4.6.4 Avoidance and mitigation measures**

The fuel storage and transport requirements of the *Dangerous Substances (Safe Handling) Act 2005* will be met.

### *Construction phase*

- The fuel tanker will satisfy appropriate construction standards. The fuel tanker will have a bund with 110% capacity of the fuel tank
- The tanker will carry fuel cleanup equipment in case fuel spills occur during refuelling
- Refuelling and lubrication will be undertaken away from any freestanding water
- Oil spill absorption materials will be used immediately for cleanup if there is a spill

- If there is any residual contaminated soil evident after a spill and clean up, it will be excavated immediately and taken for disposal or treatment at an appropriately licensed facility.

### *Operation phase*

- The fuel tanks will satisfy appropriate construction standards and will have a bund with 110% capacity of the fuel tanks
- Maintenance and repair facilities will be appropriately designed and operated; they will be designed to contain any fuel and oil spills and will be equipped with measures to contain and clean up any spills that might occur
- Fuel cleanup equipment will be stored in readily accessible sites
- Oil spill absorption materials will be used immediately for cleanup if there are any spills
- If there is any residual contaminated soil evident outside the bunded area after a spill and clean up, it will be excavated immediately and taken for disposal or treatment at an appropriately licensed facility.
- Explosives will be stored in a secure facility located at an appropriate distance from all other mine site activities

## 4.6.5 Assessment of residual effects

The potential for a spill of fuel or oil is considered to be limited, provided that the avoidance measures outlined are followed. Any spills will be cleaned up immediately using dedicated equipment.

As any remaining contaminated soil will be excavated and taken offsite for disposal at an appropriately authorised site, any residual effects are considered to be negligible.

Secure storage of explosives and strict adherence to safe handling practices will reduce any potential risks.

The following commitment, extra to those already outlined, will ensure that the risks to the environment are minimised.

Commitment 36: Equipment maintenance and refuelling will occur within an appropriately bunded area(s).

Commitment 37: Fuel storage and transport and explosives storage and handling will comply with the requirements of the *National Code for the Storage and Handling of Workplace Dangerous Goods* (NOHSC 2001).

## 5. Potential ecological impacts and their management

The new mine, waste rock dump, process plant and the tailings storage facility will generally be constructed in stages on a 152 ha area as shown in Appendix A. The vegetation in the area is diverse.

### 5.1 Existing conditions

A botanical survey and faunal habitat assessment of the site was undertaken by North Barker Ecosystem Services in December 2010 and a helicopter based eagle nest survey in March 2011<sup>27</sup>. This assessment, included as Appendix P, found the following:

- There are no threatened vegetation communities within the mine lease area.
- Two threatened flora species were recorded from the area:
  - *Epacris curtisiae* (northwest heath): listed as rare TSPA
  - *Prasophyllum pulchellum* (pretty leek orchid): listed as endangered TSPA and critically endangered EPBCA.
- Seven threatened and one migratory fauna species are considered to have suitable habitat within the area:
  - Tasmanian devil (*Sarcophilus harrisii*): listed as endangered TSPA and EPBCA
  - Spotted-tailed quoll (*Dasyurus maculatus maculatus*): listed as rare TSPA, vulnerable EPBCA
  - Wedge-tailed eagle (*Aquila audax* subsp. *fleayi*): listed as endangered TSPA and EPBCA
  - Tasmanian masked owl (*Tyto novaehollandiae* subsp. *castanops*): listed as endangered TSPA and Vulnerable EPBCA
  - White-bellied sea-eagle (*Haliaeetus leucogaster*): listed as vulnerable TSPA
  - Azure kingfisher (*Ceyx azurea* subsp. *diemenensis*): listed as endangered TSPA and EPBCA [previously named *Alcedo azurea* subsp. *diemenensis*]
  - Tasmanian giant freshwater crayfish (*Astacopsis gouldi*): listed as vulnerable TSPA and Vulnerable EPBCA
  - Satin fly catcher (*Myiagra cyanoleuca*): listed as migratory EPBCA.
- No eagle wedge-tailed or white-bellied sea eagle nests were located within the proposed mining area.
- No symptomatic evidence of *Phytophthora cinnamomi* was observed anywhere within the mineral lease area.
- No declared weed species were recorded from the area.

<sup>27</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

## 5.2 Performance requirements

Flora and fauna management must comply with the following statutes:

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Threatened Species Protection Act 1995*
- *Nature Conservation Act 2002*
- *Forest Practices Act 1985*
- *Forest Practices Code 2000*
- *Crown Lands Act 1976*
- *Weed Management Act 1999*.

## 5.3 Vegetation communities

Vegetation communities will be cleared as shown in Table 36 and Table 37. None of the vegetation communities impacted has conservation significance.

Table 36: Proposed overall disturbance to vegetation communities from the proposed mine site layout (aggregated by project element)

Component	Disturbance area (ha)	Vegetation type
DSO pit*	0.4614	<i>Eucalyptus nitida</i> dry forest and woodland (DNI)
	1.1734	<i>Eucalyptus obliqua</i> dry forest and woodland (DOB)
	0.7099	Western wet scrub (SWW)
	1.1763	<i>Eucalyptus obliqua</i> forest over <i>Leptospermum</i> (WOL)
Main pit	4.9763	<i>Eucalyptus nitida</i> dry forest and woodland (DNI)
	1.5337	Wet heathland (SHW)
	6.9351	<i>Eucalyptus obliqua</i> forest over <i>Leptospermum</i> (WOL)
Rock dump	2.223	<i>Eucalyptus nitida</i> dry forest and woodland (DNI)
	1.9281	Wet heathland (SHW)
	1.303	Western wet scrub (SWW)
	64.6855	<i>Eucalyptus obliqua</i> forest over <i>Leptospermum</i> (WOL)
Processing plant	1.7425	<i>Eucalyptus nitida</i> dry forest and woodland (DNI)
	5.6491	Western wet scrub (SWW)
	0.6084	<i>Eucalyptus obliqua</i> forest with broad-leaf shrubs (WOB)
Collection dam	0.0737	<i>Eucalyptus nitida</i> dry forest and woodland (DNI)
	0.2409	<i>Eucalyptus obliqua</i> forest over <i>Leptospermum</i> (WOL)
Tailings dam	14.3741	<i>Eucalyptus nitida</i> dry forest and woodland (DNI)
	0.0046	Buttongrass Moorland (undifferentiated) (MBU)
	3.5554	Western wet scrub (SWW)
	23.8946	<i>Eucalyptus obliqua</i> forest over <i>Leptospermum</i> (WOL)
Sedimentation dam	0.0167	<i>Eucalyptus nitida</i> dry forest and woodland (DNI)
	0.1231	Wet heathland (SHW)
Recycle dam	2.6045	<i>Eucalyptus nitida</i> dry forest and woodland (DNI)
	0.1599	Western wet scrub (SWW)
	1.2356	<i>Eucalyptus obliqua</i> forest with broad-leaf shrubs (WOB)
Cut-off drains and bunds	3.4051	<i>Eucalyptus nitida</i> dry forest and woodland (DNI)
	0.6331	Wet heathland (SHW)
	0.1669	Western wet scrub (SWW)
	3.823	<i>Eucalyptus obliqua</i> forest over <i>Leptospermum</i> (WOL)

Component	Disturbance area (ha)	Vegetation type
Access and haul roads	0.4373	<i>Eucalyptus nitida</i> dry forest and woodland (DNI)
	0.117	<i>Eucalyptus obliqua</i> dry forest and woodland (DOB)
	0.0251	Wet heathland (SHW)
	0.9245	Western wet scrub (SWW)
	0.2993	<i>Eucalyptus obliqua</i> forest with broad-leaf shrubs (WOB)
	0.4756	<i>Eucalyptus obliqua</i> forest over <i>Leptospermum</i> (WOL)
Total	151.6955	

\*If the DSO pit goes deeper than the currently contemplated c. 40 m (see section 2.11), the pit will also be wider. For example, if the DSO pit is 60 m deep, the pit will be approximately 10-15 m wider either side, a total area increase of 1.5 ha.

Table 37: Proposed overall disturbance to vegetation communities from the proposed mine site layout (aggregated by community type)

Vegetation type	Component	Disturbance area within component (ha)	Total disturbance by vegetation type (ha)
Buttongrass moorland (undifferentiated) (MBU)	Tailings dam	0.0046	0.0046
<i>Eucalyptus nitida</i> dry forest and woodland (DNI)	DSO pit	0.4614	30.3146
	Main pit	4.9763	
	Rock dump	2.223	
	Processing plant	1.7425	
	Collection dam	0.0737	
	Tailings dam	14.3741	
	Sedimentation dam	0.0167	
	Recycle dam	2.6045	
	Cut-off drains & bunds	3.4051	
	Access & haul roads	0.4373	
<i>Eucalyptus obliqua</i> dry forest and woodland (DOB)	DSO pit	1.1734	1.2904
	Access & haul roads	0.117	
<i>Eucalyptus obliqua</i> forest over <i>Leptospermum</i> (WOL)	DSO pit	1.1763	101.231
	Main pit	6.9351	
	Rock dump	64.6855	
	Collection dam	0.2409	
	Tailing dam	23.8946	
	Cut-off drains & bunds	3.823	
	Access & haul roads	0.4756	
<i>Eucalyptus obliqua</i> forest with broad-leaf shrubs (WOB)	Processing plant	0.6084	2.1433
	Recycle dam	1.2356	
	Access and haul roads	0.2993	
Western wet scrub (SWW)	DSO pit	0.7099	12.4687
	Rock dump	1.303	
	Processing plant	5.6491	
	Tailings dam	3.5554	
	Recycle dam	0.1599	
	Cut-off drains & bunds	0.1669	
	Access & haul roads	0.9245	
Wet heathland (SHW)	Main pit	1.5337	4.2431
	Rock pump	1.9281	
	Sedimentation dam	0.1231	
	Cut-off drains & bunds	0.6331	
	Access and haul roads	0.0251	
TOTALS		151.6955	151.6955

## 5.4 Threatened flora

There will be no impact to threatened flora species (TSPA or EPBCA) by the proposed operations as the two listed species that occur in the area will not be impacted:

- *Epacris curtisiae* (northwest heath): listed as rare TSPA
- *Prasophyllum pulchellum* (pretty leek orchid): listed as endangered TSPA and critically endangered EPBCA.

Although the observed orchid population will not be impacted, there is a potential that other orchid populations are present in the vicinity of the mine site (orchids do not flower every year and can be missed in surveys). The potential for there to be impacts on other, unknown, populations is discussed below.

Impacts on orchids could arise from two pathways: direct impacts or indirect impacts.

Direct impacts on orchids would occur if there was direct physical disturbance or removal of individuals, populations or habitat.

Indirect impacts could arise from habitat fragmentation, altered fire regimes, spread of weeds, genetic effects of small population size, loss of mycorrhizal fungus and loss of pollinators<sup>28</sup>.

### 5.4.1 Potential impacts on threatened orchids

#### *Direct physical disturbance or loss of individuals*

Targeted surveys (undertaken in the spring of 2010) found no threatened orchid plants within the mine lease area. Orchids do not always flower in every year and it is conceivable that individual plants could emerge in other flowering years. However, whether and where individual plants might occur some unknown time in the future can only be speculative and cannot be the basis for development planning or decision making.

#### *Direct physical disturbance or loss of populations*

As noted above, targeted surveys (undertaken in the spring of 2010) found no threatened orchid plants within the mine lease area but it is conceivable that orchid populations could emerge in other flowering years.

As for individual plants, whether and where populations might occur can only be speculative. However, at the population scale it is possible to make a reasoned judgement as to the likelihood of this occurring based on the preferred habitat of the orchid species.

Habitat preferences of threatened orchid species that occur in northwestern Tasmania are summarised in Table 38<sup>29</sup> and <sup>30</sup> and <sup>31</sup>.

<sup>28</sup> Nigel Swarts pers. comm.

<sup>29</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>30</sup> ECOTas (February 2009) Extension surveys for threatened flora: *Caladenia dienema* and *Prasophyllum favonium* in the Arthur-Pieman Conservation Area, *Chiloglottis trapeziformis* in the Wynyard area, *Thelymitra jonesii* and *Thelymitra malvina* in the Rocky Cape National park area, miscellaneous findings of other threatened species and species of biogeographic interest. Report prepared for Threatened Species Section (DPIPWE).

<sup>31</sup> DPIPWE listing statements



Table 38: Summary of preferred habitats of threatened orchid species

Species	Preferred habitat	Comments
<i>Caladenia dienema</i>	Coastal heathland within 1 km of the coastline. The species is known from coastal scrub and windswept coastal grassland and heaths amongst stunted shrubs and sedges on moist to well-drained sand and clay loams	The mine site is several kilometres inland but there is a record within 100 m of the lease boundary, although this is not within its preferred habitat.
<i>Caladenia patersonii</i>	Favours coastal and near coastal areas in the north from south of Marrawah to Bridport, occupying about 5 ha in total. It occurs in low shrubby heathland in moist to well-drained sandy and clay loam.	There are no Natural Values Atlas records within 5 km of the mine site.
<i>Corunastylis brachystachya</i> [Previously named <i>Genoplesium brachystachyum</i> ]	Heathland and heathy eucalypt woodland on well-drained rocky sites	There is heathland in the western part of the mine lease but the nearest record of the species is more than 3 km away.
<i>Diuris lanceolata</i>	Windswept coastal grassland and coastal scrub and heathland among dwarfed shrubs and sedges on moist to well drained sandy and clay loam, sometimes on rocky outcrops	The mine site is several kilometres inland from the coast, well away from the preferred habitat of this species, and the nearest record is more than 3 km away.
<i>Microtidium atratum</i>	Occurs in habitats subject to periodic inundation such as swamps, depressions and soaks.	Uncommon and localised in coastal and near-coastal lowland areas, almost exclusively in the northeast and the Furneaux islands with outliers in the Arthur-Pieman area and Bruny Island in the south. There are no Natural Values Atlas records within 5 km of the mine site.
<i>Orthoceras strictum</i>	Occurs in a wide range of habitat types including buttongrass moorland, sedgy and scrubby heathland, sedgy eucalypt shrubland and open forest, usually on poorly to moderately drained peaty, sandy and clay soils that are at least seasonally moist.	There are no Natural Values Atlas records within 5 km of the mine site.
<i>Prasophyllum favonium</i>	Among shrubs in windswept dense low heathland on moderately drained grey to black sandy peaty loam	There is heathland in the western part of the mine lease but the nearest record of the species is more than 3 km away.
<i>Prasophyllum pulchellum</i>	Dense low sedgy heath with pockets of paperbark or tea-tree on poorly to moderately drained sandy or peaty loam	There is heathland in the western part of the mine lease and a population of this species was found within it (but outside the lease boundary).
<i>Prasophyllum secutum</i>	Coastal scrub in the swales of stabilised sand dunes on white to grey sands and sandy loam	The mine site is several kilometres inland from the coast, well away from the preferred habitat of this species, and the nearest record is almost 5 km away.
<i>Pterostylis rubenachii</i>	Dry, sandy slopes of sparsely vegetated stabilised sand dunes, and also in permanently wet to moist scrubby and sedgy coastal heath converted to semi-improved pasture by annual slashing	The mine site is several kilometres inland from the coast, well away from the preferred habitat of this species, and the nearest record is almost 5 km away.
<i>Pterostylis ziegelieri</i>	Slopes of low stabilised sand dunes and in the grassy dune swales	The mine site is several kilometres inland from the coast, well away from the preferred habitat of this species, and the nearest record is more than 10 km away.
<i>Thelymitra mucida</i>	Occurs in moist to wet depressions, swamp margins and other low-lying sites in coastal and near-coastal heathland, heathy forest and shrubland in dark sandy or peaty soils, usually below about 50 m elevation.	There are no Natural Values Atlas records within 5 km of the mine site.

Protection of the species will best be achieved by protecting optimal habitat because it is that habitat that is most likely to contain sustainable populations. Table 38 shows that the orchid habitat within and in the vicinity of the mine site that is most conducive to orchid populations is the wet heathland.

The protection of wet heathland is therefore the design objective of the mine. Protecting this habitat provides the best assurance against minimising the loss of populations of threatened orchid species.

### *Direct physical disturbance or loss of habitat*

Within the vicinity of the mine, the wet heathland is the habitat most likely to be preferred by any threatened orchid species that exist in the area. Table 36 and Table 37 show that there will be 4.2 ha of wet heathland lost within the mine footprint. These heathland patches occur above the main pit and at the northern end of the rock dump (see Figure 22).

The mine has been redesigned since the original Notice of Intent to keep its disturbance footprint away from the large area of wet heathland found in the western part of the lease. In particular, the rock dump has been pushed east so that its footprint lies entirely to the east of West Creek, well away from that heathland.

Relative to the wider region, the 4.2 ha lost represents 1.2% of the total wet heathland occurring within a 5 km radius of the lease (see Figure 27 and Table 39), which is insignificant. In fact, the site survey undertaken by NorthBarker indicates that the vegetation mapped by Tasveg as buttongrass moorland to the west of the mine site is actually wet heathland, meaning that the 1.2% figure is probably a significant overestimate of the proportion of wet heathland in the region that would be lost due to the mine.

### *Altered fire regime*

The life cycle of orchids is related to fire and populations often emerge 1 to 3 years after a fire passes through a habitat area.

It is known that the fire regime has changed since European settlement, with Aboriginal firestick farming practices having ceased, wild fires being deliberately lit and suppressed and regular low intensity burns being conducted in some areas<sup>32</sup>.

It is conceivable that the presence of the mine could alter the fire regime in the region.

Without appropriate fire minimisation measures, the mine could introduce a new potential source for a fire starting. This could increase the likelihood of orchid habitat being burnt. Increased fire frequency might increase the likelihood of orchids flowering but if too intense it might also kill orchid plants and seeds or kill other plants within the orchids' preferred habitat. Increased fire might also increase the likelihood of weed invasion, and weeds could out-compete orchids for space or resources, although there is no evidence of this happening in the Arthur-Pieman region<sup>33</sup>. In general, however, increased fire frequency is beneficial to orchids<sup>34</sup>.

<sup>32</sup> Threatened Species Section (2006) Threatened Tasmanian Orchids Flora Recover Plan 2006-2010. Department of Primary Industries & Water.

<sup>33</sup> Mark Wapstra pers. comm.

<sup>34</sup> Mark Wapstra pers. comm.

The presence of the mine might reduce the potential severity of wildfires in the region. The mine site will provide a fire break against the spread of any fires that did occur and mine workers would also be available to assist with fire fighting. The presence of the mine might therefore reduce the exposure of orchid habitat to wildfire. Decreased fire frequency and/or intensity might decrease the likelihood of orchids flowering.

Because of the benefits to orchids species of burning Shree Minerals will cooperate with any Government requests to conduct prescribed burning within the lease area to enhance orchid habitat, should such requests be made. However, in the absence of such requests the mine operations will be managed so as to minimise changes to the natural fire regime in the area.

The mine will actively manage its operations to minimise the risk of fire starting on the mine site and it will also actively suppress any fires that do nevertheless start or that encroach upon it from outside. However, unless infrastructure or human life is threatened (or there is a request from fire fighters), fire fighting measures will not be conducted outside the mine lease area. This restriction will minimise alterations to the prevailing fire regime to which orchids in surrounding habitat are naturally exposed.

The net effect of these management measures is that there is unlikely to be a significant change to the historical fire regime.

### *Spread of weeds*

The spread of weeds and also plant diseases (such as *Phytophthora*) is highly undesirable irrespective of their potential impact on threatened orchid species and active weed and disease management measures will therefore be implemented at the mine. Indeed, they have already been implemented during the exploration phase.

Equipment, machinery and vehicle inspection, washdown and disinfection procedures will be implemented and enforced for anything coming to the mine from a site where it has been exposed to disturbed soil.

These measures will continue throughout the life of the mine.

The risk of introducing weeds and/or plant diseases to the mine site is greatest during the initial mine construction phase, when earthmoving equipment is first brought to the site. Once the mine is operating, earthmoving will be undertaken by the mine's own machines, which will remain on-site, and there will be very little requirement to bring external earthmoving equipment onto the site.

Product and worker transport will use existing formed roads and will not go off-road, so day to day operations do not present a significant risk.

With appropriate management measures, there is unlikely to be a significant risk to orchids from weed or plants disease introduction.

### *Genetic effects of small population size*

Genetic effects, if any, arising from small population sizes would be a factor intrinsic to the existing gene pools and distributions of the various orchid species.

If these effects do exist, the most appropriate way to mitigate against adverse consequences would be to protect the core habitat of each species. As described above, this means protecting the wet heathland, which is achieved by the mine design.

There is no significant potential for the mine to influence the genetic characteristics of the orchids or to exacerbate any inherent genetic risks if indeed such risks exist in the first instance.

### *Loss of mycorrhizal fungus*

Mycorrhizal fungus associations with orchids are known to be easily compromised by weed invasion, edge effects due to altered land use, changes to soil chemistry, changes to organic content and changes to hydrology<sup>35</sup>.

The task for the mine therefore becomes one of ensuring that its activities do not cause any of these changes.

Weeds management has been discussed above. Those same measures will minimise the risk of weed invasion to the mine site itself and therefore consequential weed invasion of the wet heathlands in the western part of the lease.

The mine design by intent creates a clear separation buffer between the mine footprint and the wet heathland in the western part of the lease. That buffer will exclude any edge effects because the mine footprint and the heathlands will not share a contiguous boundary.

There is no identifiable causal relationship between the presence of the mine in the eastern part of the mine lease and the soil chemistry or organic content of the wet heathland in the western part. Any mooted of some possible unknown relationship could only be speculative at best, and without scientific basis. Even something as already tenuous as atmospheric fallout of dust from the haul roads or exhaust from the mine's diesel power generators is not credible given the very strong prevailing winds of the area, which blow away from the heathland, not towards it.

The remaining potential impact of the mine on mycorrhizal fungus associations with orchids is a change to the hydrology of the soil where those associations take place. The wet heathland (the preferred habitat of the orchids) in the western part of the lease is well away from the mine pits and will be at the extreme margins of the water table depression that will occur from pit dewatering. More importantly, the wet heathland is a groundwater recharge area - the heathland soil does not derive its water from the underlying groundwater but rather from precipitation from above (see section 2.3 and also Appendix D).

Even if it did occur, any lowering of the watertable below the heathland (which at most would be marginal anyway) could therefore not change the soil water regime and therefore could not affect mycorrhizal fungus associations.

In summary, no potential causal pathway can be identified by which the mine could significantly affect the mycorrhizal fungus associations of any orchids in the wet heathland in the western part of the lease.

The mine will therefore not have any significant impact on the mycorrhizal fungus associations of threatened orchid species.

### *Loss of pollinators*

Many orchids (but not all - some are self-pollinating) rely on insects for pollination. Loss of pollinator habitat could therefore impact on orchids by reducing their pollination rates. This loss of pollinator habitat could be direct, such as removal of the habitat of pollinating wasps, or indirect, such as the removal of the habitat of beetles that are parasitized by orchid pollinating wasps.

Protecting orchid habitat may not equally protect the habitat of their pollinators because the pollinators may use, and possibly prefer, other habitats and might only use orchid habitat opportunistically and facultatively.

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<sup>35</sup> Nigel Swarts pers. comm.

The ecological relationships between orchids and pollinators in the region surrounding the mine are likely to be complex and are not well understood. Nevertheless, it is possible to make an informed judgement about the likely level of risk to orchids that might arise from a loss of pollinator habitat.

Figure 27 shows the distribution of vegetation communities in the wider region around the mine site.

Table 39 shows loss of vegetation communities due to the mine, expressed as a percentage of the area of those communities found within a 5 km radius of the mine lease (including within the lease).

Table 39: Vegetation community loss as a proportion of surrounding areas

Vegetation type	Area cleared within mine site (ha)	Area within 5 km radius of mine site (ha)	Proportion lost from within 5 km radius (%)
Buttongrass moorland (undifferentiated) (MBU)	0.0046	2814.0548	0.01
<i>Eucalyptus nitida</i> dry forest and woodland (DNI)	30.3146	1711.7779	1.8
<i>Eucalyptus obliqua</i> forest*	104.6647	3695.6324	2.8
Western wet scrub (SWW)	12.4687	1133.8719	1.1
Wet heathland (SHW)	4.2431	340.9899**	1.2

\*Differentiation between DOB, WOL and WOB is not possible because of lack of differentiation in Tasveg data outside the mine's survey area

\*\*The site survey undertaken by NorthBarker indicates that the vegetation mapped by Tasveg as buttongrass moorland to the west of the mine site is in fact wet heathland, meaning that this figure is probably a significant underestimate (and therefore the % lost due to the mine is probably a significant overestimate)

Table 39 shows that, regardless of which particular vegetation community might be preferred by particular orchid pollinators, the maximum percentage loss of any given preference within a 5 km radius of the mine is less than 3%. Notwithstanding the uncertainties about orchid pollinator habitat preferences, a less than 3% potential impact cannot reasonably be considered to be significant.

The mine will therefore not have any significant impact on orchid pollinators.



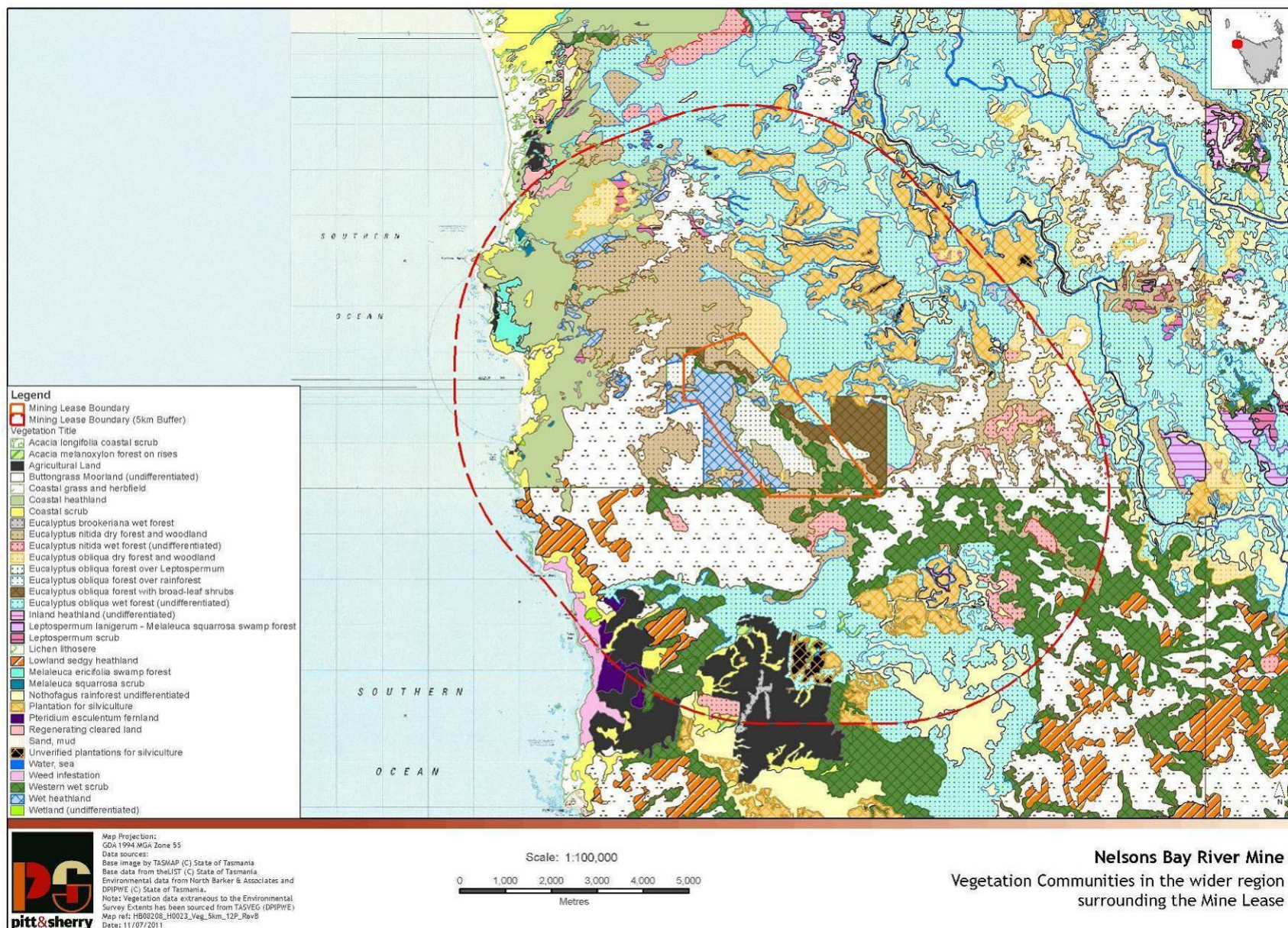


Figure 27: Distribution of vegetation communities in the wider region surrounding the mine site



## 5.5 Weeds

Potential introduction of declared and/or environmental weeds to an essentially weed free area. During and after the proposed works, disturbed areas will be susceptible to weed regeneration and potential future weed invasion.

## 5.6 Plant pathogens

Potential introduction and spread of *Phytophthora* to susceptible species, particularly *Epacris curtisiae*.

## 5.7 Fauna

### 5.7.1 Tasmanian devil *Sarcophilus harrisii*

Numerous records of *Sarcophilus harrisii* occur within 5 km of the study area and scats were located at a latrine site on the exploration tracks.<sup>36</sup>

Approximately 152 hectares of vegetation will be cleared for the proposed mine. This vegetation is potential devil habitat.

For *Sarcophilus harrisii*, good quality habitat encompasses a combination of year round food supply, enough den sites for breeding and daily movements, and structural features for refuge and foraging.

Habitat requirements include the following<sup>37</sup>:

- Places to hide and shelter during the day (such as dense vegetation, hollow logs, burrows or caves);
- Areas with an open understorey mixed with dense patches of vegetation which allow hunting; and
- Soil suitable for burrowing for the purpose of maternal dens.

The combination of these features within a habitat is more important than a particular vegetation community or habitat type.<sup>38</sup>

The proposed mine area is potential foraging habitat and, like all forested environments, the mine site vegetation also offers denning opportunities.<sup>39</sup>

Devils occupy several different dens, changing them every 1 to 3 days (other than maternal dens) and they travel an average nightly distance of approximately 9 km (and up to 50 km); a typical home range size is 13 km<sup>2</sup> (ranging from 4 to 27 km<sup>2</sup>)<sup>40</sup>.

The species is therefore likely to range much wider than the area of the vegetation clearance.

<sup>36</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>37</sup> Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*).

<sup>38</sup> Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*).

<sup>39</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>40</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=299](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=299)

The northwest population of devils impacted by the proposed mine consist of between 3000 and 12,500 individuals over an area of approximately 13,400 km<sup>2</sup>.<sup>41</sup> Based on this it could be assumed that the proposed clearing of 152 hectares of habitat may displace between 0.4 and 1.5 individuals. The upper end of this range is conservatively high and would only apply if the mine site had the same devil population density as Woolnorth, which is very unlikely.

Dens are typically underground burrows (such as old wombat burrows), caves or log heaps. Although devils apparently change non-maternal dens often, female adults are thought to remain faithful to their maternal dens for life, so maternal den disturbance can be destabilising to populations.<sup>42</sup> The significance of any destabilisation that might be caused by vegetation clearance would be related to the number of maternal dens disturbed or lost through vegetation clearance and the availability of replacement dens in surrounding areas.

Dens will be in logs, caves, burrows amongst the vegetation, the vegetation being of use to screen dens and add roof stability; each animal will have the choice of multiple dens simply because accidents such as roof collapse or flooding happen naturally and they move to another or make a new one if this happens<sup>43</sup>. A conservative assumption is that all denning opportunities within the vegetation to be cleared are in use by the species. With this assumption, removal of a den would displace the occupying devil, which would attempt to find another den, thereby possibly displacing that den's occupant. Displacement attempts would propagate serially through the surrounding habitat, with displaced devils attempting to displace others in turn<sup>44</sup>.

Because of the potential for the species to be occupying dens within the landscape to be cleared for the mine, preclearing surveys for dens are warranted. The appropriate time for these surveys is immediately before each stage of clearing so as to ensure the temporal relevance of the surveys to the clearing activity. Also, any den opportunities lost through the vegetation clearing should be replaced by the creation of compensatory new opportunities.

The location of the proposed mine site in the northwest is one of the only remaining regions supporting high densities of *Sarcophilus harrisii* where devil facial tumour disease (DFTD) has not yet been detected.<sup>45</sup>

DFTD has not been recorded in the vicinity of the proposed mine despite regular local checks of road kills, direct observation at a food station near Arthur River<sup>46</sup> and, most importantly, extensive trapping by the Save the Tasmanian Devil Program. The most recent trapping (from 26/10/10 to 19/11/10) was a search for the disease front and found no disease west of the Murchison Highway (DPIPWE unpublished data) which is some 50 km from the proposed mine site<sup>47</sup>.

<sup>41</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=299](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=299)

<sup>42</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=299](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=299)

<sup>43</sup> Nick Mooney pers. comm.

<sup>44</sup> Nick Mooney pers. comm.

<sup>45</sup> Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*).

<sup>46</sup> Nick Mooney pers. comm. of observation by Geoff King

<sup>47</sup> Nick Mooney pers. comm.

The current most western location of the disease front is located to the east of the Murchison Highway close to Oonah.<sup>48</sup> The spread of DFTD is continuing, with the disease front moving 15 km west since 2008. It is possible that DFTD will reach the northwest in 3-10 years. However, it is not known whether mortality will be as high in the western populations or whether these populations will react to the disease in the same way that eastern ones have.<sup>49</sup>

Based on the understanding of DFTD, the mine will not introduce any changes to the environment that would increase the risk of DFTD entering the area or facilitate the intermixing of devil populations.

All rivers and creeks separating eastern and western devil populations already have many natural crossing points (such as sandbars and logs) and/or road bridges, which provide possible east-west movement and intermixing routes. The mine will create no new stream crossings. Although a culvert crossing of East Creek will be constructed to for the mine access road, this creek is ephemeral and does not present an existing barrier to devil movement.

The study area has long been an area of forestry and mineral prospecting and tracks have existed for at least the last two decades. Because the area has already been opened up and subjected to levels of human activity, the mine proposal is unlikely to accelerate the spread of DFTD into the area.<sup>50</sup>

The mine lies within the western devil population and the eastern limits of that population are considered to be well to the east of the proposed mine. The mine, supporting infrastructure and associated activities would not facilitate intermixing of populations<sup>51</sup>.

It is therefore very unlikely that the proposed mine could increase the risk of introduction of DFTD. The only conceivable way in which this could occur was if diseased or dead individuals (for example, retrieved road kill picked up east of the site) or equipment that has come in contact with diseased individuals was brought into the site<sup>52</sup>. The likelihood of this occurrence is negligible, and as an added safeguard this issue will be addressed during staff and contractor induction.

Although any roadkill found on Wuthering Heights Road will be handled to remove it from the road as an impact mitigation measure (see section 6.6), that road also lies within the western population and this measure could not introduce DFTD.

An increase in traffic volume may result in a direct impact due to higher incidence of road kill or injury to the species. The scavenging diet of the species, their occasional reluctance to leave food and their dark colour make them particularly vulnerable to being killed on the road. As a source of carcasses, and as a means of dispersion, roads attract the species and put them at risk of being killed themselves.<sup>53</sup> In 2008 it was suggested that over 3000 individuals are killed on Tasmanian roads each year.<sup>54</sup>

<sup>48</sup> Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*).

<sup>49</sup> Department of Primary Industries, Parks, Water and Environment (2010) Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*).

<sup>50</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>51</sup> Nick Mooney pers. comm.

<sup>52</sup> Nick Mooney pers. comm.

<sup>53</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=299](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=299)

<sup>54</sup> Lawrence, C. & Donnelly, C. (2010) *Save the Tasmanian Devil Program Roadkill Project*. Report prepared for the Save the Tasmanian Devil Program.

Roadkill rates of Tasmanian devils peak in summer, impacting relatively heavily on young animals just out of the den and migrating males which may have been driven out by dominant adults. Roadkill can have a substantial impact on even non-DFTD local populations in areas of high traffic (e.g. Cradle Valley, Freycinet before DFTD), being responsible for many premature deaths of both sexes and all ages, and could have an even more serious impact on depleted populations such as those affected by DFTD.<sup>55</sup>

While the study area continues to have a DFTD-free population of the species, roadkill impacts on devil populations will be less significant than they would if DFTD ever becomes established in the area, when the effects of roadkill and DFTD would be combined.<sup>56</sup>

The Save the Tasmanian Devil Program Roadkill Project has identified several key findings in relation to the impact of road kill on the species<sup>57</sup>:

- Figure 28 shows the location of reported roadkill of *Sarcophilus harrisii* between 2001 and 2010. A visual analysis of this figure indicates high roadkill density along the Murchison Highway in the northwest and on the Forestier Peninsula in the south east. In its current form, fine scale analysis is not possible, given the poor location accuracy (up to a 10 km radius in some cases) of many road kill reports (to a considerable degree the spread represents a clustering of study and interest in the issue<sup>58</sup>).
- The number of roadkill incidences reported to the project showed a clear temporal trend, with numbers peaking in summer and being relatively low in winter.
- Of the 100 roadkill reports in which speed limit was provided, 91 involved stretches of road with speed limits greater than 80 kph. This suggests that higher speeds are a factor in the species roadkill rates, as seen in other Tasmanian roadkill studies (this does not take into account the relative prevalence or frequency of travel on roads with different speed limits).
- The mean night-time detection distances for the species from a car with headlights on high beam is 60.8 m; this corresponds to a maximum speed of 54 kph at which a driver could stop safely to prevent collision with the species. This is an important speed relationship for any roadkill mitigation measures.

<sup>55</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>56</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>57</sup> Lawrence, C. & Donnelly, C. (2010) *Save the Tasmanian Devil Program Roadkill Project*. Report prepared for the Save the Tasmanian Devil Program.

<sup>58</sup> Nick Mooney pers. comm.

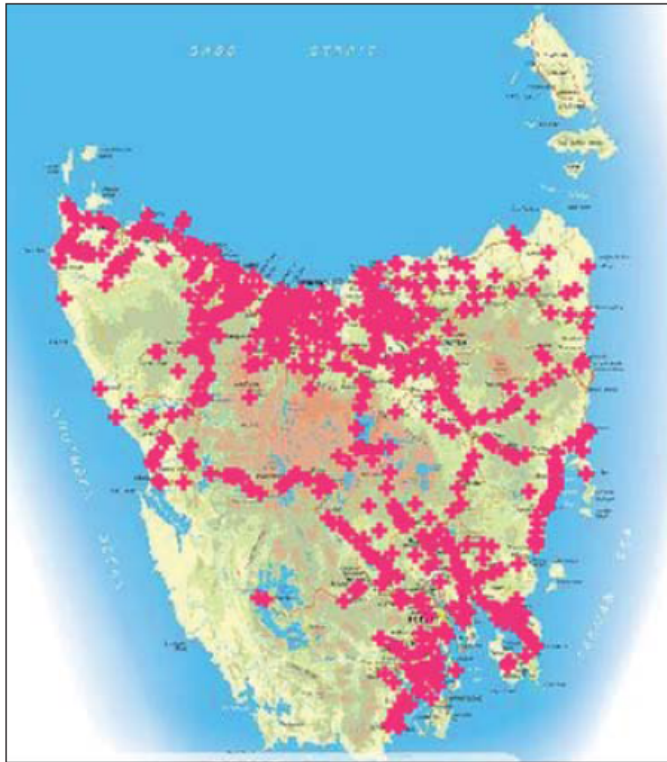


Figure 28: Location of reported roadkill *Sarcophilus harrisii* between 2001 and 2010 (Source: Lawrence, C. & Donnelly, C. (2010) *Save the Tasmanian Devil Program Roadkill Project*. Report prepared for the Save the Tasmanian Devil Program.)

Roadkill and headlight surveys undertaken by Wildspot Consulting for the Department of Infrastructure, Energy and Resources noted 258 Tasmanian devil observations and 5 roadkills between 5 October 2009 and 18 April 2010 on the road between Arthur River township and Roger River (Appendix R)<sup>59</sup>.

The nearest devil observation was at the junction of Wuthering Heights Road with Rebecca Road. The nearest devil roadkill was approximately 25 km to the northeast of that junction, north of Arthur River. That section of road has a significantly higher wildlife roadkill risk than the southern Rebecca Road sections of the transport route (Appendix R).

The average traffic along the high risk section of the transport route is 100 vehicles per day (see Figure 16 and Appendix M). Product transport for the mine (after the first year) is likely to add approximately 34 movements per day for years 2 to 10, a 34% increase, and 82 per day for year 1, an 82% increase for that one year. Shree Minerals will be providing a bus service for workers to and from Smithton, so additional worker traffic is unlikely to be significant.

The existing devil roadkill risk is equivalent to 10 per year<sup>60</sup>. A 34% increase in traffic movements due to the mine might proportionally add 3 additional kills to that risk (8 during the first year).

<sup>59</sup> Data (by Wildspot Consulting) and mapping (by Northbarker Ecosystem Services) provided courtesy of the Department of Infrastructure, Energy & Resources.

<sup>60</sup> The risk along this route appears to be substantially less than the alternative route of travelling west from the mine site through the Arthur River township - observations by Geoff King note approximately 30 roadkill per year between Arthur River and Marrawah (Nick Mooney pers. comm.)

Roadkill risk is primarily a night time occurrence - the risk during daylight hours is approximately 25% of the night time risk<sup>61</sup>.

A prudent risk minimisation measure would therefore be to avoid product transport at night.

Confining product transport to daylight hours would proportionally reduce the roadkill risk increase to one fifth<sup>62</sup> of the total daily risk increase.

The increase in traffic movements due to the mine's product might then proportionally add  $3 \div 5 = 0.6$  additional kills every year to that risk ( $8 \div 5 = 1.6$  during the first year).

### 5.7.2 Spotted-tailed quoll *Dasyurus maculatus* subsp. *maculatus*

There are several records of this species within 5 km of the study area. It is present in the proposed mine site area, as evidenced by the observed probable scat.<sup>63</sup>

The species inhabits a large range of habitats, including rainforests, wet and dry sclerophyll forest, coastal heathland, scrub and dunes, woodland, heathy woodland, swamp forest, beaches and sometimes in grassland or pastoral areas adjacent to forests.<sup>64</sup>

The proposed mine will contribute to potential habitat loss. However, the mine will not significantly impact on the wider availability of habitat for the species nor on the movement of quolls within that wider habitat. The potential impact on the species due to habitat reduction is therefore not considered to be significant, other than perhaps for denning habitat.

The species is known to use multiple dens and changes these every 1-4 days. Den sites have been recorded in a variety of structure types, including rock crevices, hollow logs, hollow tree buttresses, tree hollows, windrows, clumps of vegetation, caves, boulder tumbles, under buildings, and in the dens of rabbits and wombats. They are also known to dig burrows when a suitable substrate is available. A study of the mainland populations indicates that prey density and den availability are the two main factors in the use of habitat. These results are likely to apply to Tasmanian populations. Habitat critical to the species is that which contains adequate denning resources in large forest areas.<sup>65</sup>

Approximately 152 hectares of vegetation will be cleared for the proposed mine. The quality of the foraging habitat is likely to be similar throughout the proposed impact areas although denning opportunities are likely to be greater in the mature forest in the large dry hollows of eucalypts or under fallen logs or, in well drained sites, burrows might be dug or existing wombat burrows used.<sup>66</sup>

The species is solitary and occupies large home ranges. The male territory overlaps multiple female home ranges and has been recorded as ranging between 359 ha and 5512 ha in size. Females generally have a non-overlapping home range between 88 ha and 1515 ha in size.<sup>67</sup>

<sup>61</sup> Nick Mooney pers. comm.

<sup>62</sup> A day rate 25% of the night rate means proportionally 4 night kills for every 1 day kill, so 1 in 5 occur during the day

<sup>63</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>64</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=75183](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183)

<sup>65</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=75183](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183)

<sup>66</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>67</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=75183](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183)



Less is known about population quoll densities in this area of the State than for devils but headlight observations (Appendix R) show that quoll densities are very much lower than devil densities. While the 152 ha of the mine site footprint might contain a maximum of 1.5 devils (see section 5.7.1), that same area would very likely contain much less than 1 quoll.

Clearance of the vegetation for the mine is therefore likely to displace 1 quoll at most.

Vegetation removal may remove denning opportunities but the species, in particular males, is therefore likely to range much wider than the area of the vegetation clearance.

Nevertheless, because of the potential for the species to be occupying dens within vegetation to be cleared for the mine, preclearing surveys for occupied dens are warranted. The appropriate time for these surveys would be immediately before each stage of clearing so as to ensure the temporal relevance of the surveys to the clearing activity.

Any den opportunities lost through the vegetation clearing should be replaced by the creation of compensatory new opportunities.

A facilitated impact by the proposed mine could occur as a result of the increase of traffic volume to and from the proposed mine site. An increase in traffic volume may result in a higher incidence of road kill or injury to individual animals.

Given the low density of individuals (one individual per 4 km<sup>2</sup>) any quoll roadkill might be considered significant.<sup>68</sup>

It is estimated that 1-2 individuals are killed daily on the main road between Hobart and the north west of the state<sup>69</sup>, which is a very low kill rate per kilometre. Juvenile males are most at risk due to extensive range. The full impacts of road mortality on the species are not well known but other carnivorous marsupials have been significantly impacted.<sup>70</sup>

Increased traffic to the site may increase the incidences of road mortality. Although the risk of roadkill is low, it would be prudent to implement mitigation measures to minimise this risk.

Roadkill and headlight surveys undertaken by Wildspot Consulting for the Department of Infrastructure, Energy and Resources noted 11 spotted-tailed quoll observations and 1 spotted-tailed quoll roadkill between 5 October 2009 and 18 April 2010 on the road between Arthur River township and Roger River (Appendix R)<sup>71</sup>.

<sup>68</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>69</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=75183](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183)

<sup>70</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=75183](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75183)

<sup>71</sup> Data (by Wildspot Consulting) and mapping (by Northbarker Ecosystem Services) provided courtesy of the Department of Infrastructure, Energy & Resources.

The nearest quoll observation was approximately 2 km east of the junction of Wuthering Heights Road with Rebecca Road. The (only) quoll roadkill was near Roger River West, approximately 30 km to the northeast of that junction. This section of road, north of Arthur River, has a significantly higher wildlife roadkill risk than the southern Rebecca Road sections of the transport route (Appendix R).

The average traffic along the high risk section of the transport route is 100 vehicles per day (see Appendix R). Product transport for the mine (after the first year) is likely to add approximately 34 movements per day for years 2 to 10, a 34% increase, and 82 per day for year 1, an 82% increase for that one year.

The existing quoll roadkill risk is low, equivalent to 2 per year. Disregarding time of day, a 34% increase in traffic movements due to the mine might proportionally add 0.6 additional kill every year to that risk (1.6 during the first year).

Roadkill risk is primarily a night time occurrence - the risk during daylight hours is approximately 25% of the night time risk<sup>72</sup>.

A prudent risk minimisation measure would therefore be to avoid product transport at night.

Confining product transport to daylight hours would proportionally reduce the roadkill risk increase to one fifth<sup>73</sup> of the total daily risk increase. The increase in traffic movements due to the mine's product transport might then proportionally add  $0.6 \div 5 = 0.1$  additional kills every year to that risk ( $1.6 \div 5 = 0.3$  during the first year).

### 5.7.3 Wedge-tailed eagle *Aquila audax subsp. fleayi*

This species forages in open areas and has been recorded hunting over most types of terrestrial habitat in the state.<sup>74</sup> The survey area is considered to be very likely utilised for foraging.<sup>75</sup> Approximately 152 hectares of vegetation will be cleared for the proposed mine. A direct impact on potential foraging habitat will therefore occur.

No specific figures are available on the size of home ranges occupied by the species but they are generally considered to be in the order of tens of square kilometres or more. Where suitable habitat is available, territories tend to be evenly dispersed. As a result of this, the species is only recorded nesting in low densities. The estimated densities of territories range from a maximum of one pair per 20-30 km<sup>2</sup> in a mosaic of dry sclerophyll forest and fertile open habitat in the lowlands of eastern and northern Tasmania, to a minimum of one pair per 1200 km<sup>2</sup> in the highlands of western and south - western Tasmania.<sup>76</sup>

Because of the small size of the mine site relative to the eagle's range, the vegetation clearing is not considered likely to have a significant impact on food supply.

The species nests in a range of old-growth forest, with the majority of nests occurring in forests dominated by eucalypts. Nests are almost always built in an emergent tree that is among the tallest and broadest of those available and are usually in trees on sloping ground, at an aspect that offers protection from prevailing winds. The species is highly sensitive to disturbance during the breeding season.<sup>77</sup>

<sup>72</sup> Nick Mooney pers. comm.

<sup>73</sup> A day rate 25% of the night rate means proportionally 4 night kills for every 1 day kill, so 1 in 5 occur during the day

<sup>74</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=64435](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435)

<sup>75</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>76</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=64435](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435)

<sup>77</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=64435](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435)

Loss of nesting habitat and disturbance of breeding birds has been identified as key threats to this species.<sup>78</sup>

Generally, the survey area was considered to have a low probability to contain nests as most of the mature eucalypts within the study area have been badly fire damaged.<sup>79</sup>

A direct impact is anticipated to mature eucalypts that have the potential to be used as nest trees within the proposed waste dump area and along the northerly edge of the tailings dam. However, as the bulk of the trees in this area have been severely fire damaged and the crowns are generally dead the value of the nesting habitat has probably been degraded.<sup>80</sup>

Within the mining lease but outside the proposed impact zone another potential nesting area is in the riparian forest along the banks of the Nelson Bay River. The quality of the nesting habitat in this area has also been reduced by severe fire damage to the crowns of the mature eucalypts trees.<sup>81</sup>

There is no potential nesting habitat within the main pit, DSO pit, the processing plant and ROM pad or the southern side of the tailings dam, as these sites are exposed to wind and have either no eucalypt trees or no mature eucalypts taller than 27 m.<sup>82</sup>

Potential for nesting habitat within 500 m or 1 km line of sight of the mine areas is low as the forest to the northeast has been logged and regenerated or planted to eucalypt plantation. Database records indicate that there are no known locations of existing nests within a 1 km line of sight from the proposed works. The nearest known eagle nest is approximately 1.8 km to the north east of the study area (nest id 971500).<sup>83</sup>

A helicopter-based search for potential nest trees in all these areas described above failed to locate any nests.<sup>84</sup>

There is therefore no significant likelihood of the mine impacting on eagle nesting.

A facilitated impact by the proposed mine could potentially occur as a result of the increase of traffic volume to and from the proposed mine site. An increase in traffic volume could potentially result in a higher incidence of road kill or injury to individual birds as they feed on carcasses of wildlife killed by traffic.

Without mitigation, increased traffic to the site could potentially increase the incidences of unnatural mortality.

The average traffic along the high risk section of the transport route is 100 vehicles per day (see Figure 16 and Appendix M). Product transport for the mine (after the first year) is likely to add approximately 34 movements per day for years 2 to 10, a 34% increase, and 82 per day for year 1, an 82% increase for that one year. Shree Minerals will be providing a bus service for workers to and from Smithton, so additional worker traffic is unlikely to be significant.

<sup>78</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=64435](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64435)

<sup>79</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>80</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>81</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>82</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>83</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>84</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

Increased traffic to the site may increase the incidence of road mortality. Although the risk increase will be low, it would be prudent to implement mitigation measures to minimise this risk because roadkill introduces a consequential risk to eagles that might feed on carcasses and become potential roadkill victims themselves.

#### 5.7.4 White-bellied sea-eagle *Haliaeetus leucogaster*

White-bellied sea eagles are found primarily close to the coast near large areas of open water, such as large rivers, swamps and the sea although they are known to also forage over terrestrial habitats such as grasslands<sup>85</sup>. The comments made above (section 5.7.3) in relation to the potential for road kill are therefore relevant to the white-bellied sea eagle also.

Home ranges can be up to 100 km<sup>2</sup> although the breeding territories within these are typically close to water<sup>86</sup>.

Their nest construction is similar to those of the wedge-tailed eagle and if resources are limited nests can be interchanged between the two species<sup>87</sup>. The comments made above (section 5.7.3) in relation to nests are therefore relevant to the white-bellied sea eagle also.

#### 5.7.5 Tasmanian masked owl *Tyto novaehollandiae* subsp. *castanops*

This species inhabits a diverse range of forests and woodlands, including agricultural and forest mosaics. Particularly favoured are forests with relatively open under stories, especially when this habitat adjoins areas of open or cleared land.<sup>88</sup> Its preferred habitat is lowland dry forest and woodlands.<sup>89</sup>

Nesting of the species occurs in large tree hollows of living or dead trees but sometimes in vertical spouts or limbs.<sup>90</sup> The wet forest that has been burnt has some evidence of large hollows, which may provide potential nesting habitat. Likelihood of occurrence is low, however<sup>91</sup>.

The densities of species vary across the state with the highest densities occurring in the east and north and the lowest densities at elevations more than 600 m in the western half of the state (this could be due to the lack of survey effort).<sup>92</sup>

There is a potential for masked owls to use hollow trees for nesting and preclearing surveys for nests are therefore warranted.

#### 5.7.6 Azure kingfisher *Ceyx azurea* subsp. *diemenensis*

[Previously named *Alcedo azurea* subsp. *diemenensis*]

No known nest sites or records occur within 5 km of the study area and suitable habitat is considered to be marginal. As visual and auditory searches did not locate any *Ceyx*

<sup>85</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=943#habitat](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=943#habitat)

<sup>86</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=943#habitat](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=943#habitat)

<sup>87</sup> Bryant, S. and Jackson, J. (1999) *Tasmania's threatened fauna handbook*. Threatened Species Unit.

<sup>88</sup> <http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf>

<sup>89</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>90</sup> <http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf>

<sup>91</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>92</sup> <http://www.environment.gov.au/biodiversity/threatened/species/pubs/67051-conservation-advice.pdf>

*azureus diemenensis*, the potential of occurrence is considered to be low.<sup>93</sup> As the species was not found during the field survey, there is no evidence to suggest that direct impacts on it will occur from the proposed mine.

Potential habitat for the species is the Nelson Bay River. The river has relatively fast moving water with still deep sections but the banks are generally unsuitable for nesting as they are predominantly sheer rock rather than sediments.<sup>94</sup>

The species inhabits tree-lined waterways, lakes, ponds and other wetlands with dense streamside vegetation, in particular in western and north-western Tasmania.<sup>95</sup> A potential direct impact on habitat could be any clearing along the Nelson Bay River. However, no such clearing of streamside habitat will occur; therefore, no direct significant impact on habitat for this species is anticipated.

Acidic runoff into rivers from mines can adversely affect local populations of this species. The worst affected river systems due to historical acid drainage within the range of the kingfisher are not inhabited by it, suggesting that acid mine drainage may make some sections of river systems unsuitable for the species.<sup>96</sup> However, this mine will manage acidic rock to ensure that there will be no acid runoff and no direct impact on the river system is anticipated (see section 2.11).

A potential indirect impact on the species could occur if there were any alterations to the levels of the Nelson Bay River that resulted in the flooding of any nesting tunnels that might be present. However, this indirect impact is considered very unlikely as the area is generally unsuitable for nesting and the mine will not extract water from or discharge water to the river. While there will be diversions of surface waters and groundwaters within the mine site due to the presence of the mine, there will be no significant effect on the natural flow patterns of Nelson Bay River (see section 2.16).

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

### 5.7.7 Satin flycatcher *Myiagra cyanoleuca*

This species was seen foraging at several locations in the riparian areas along the Nelson Bay River. Within the current study area they were only recorded outside the proposed mine layout.<sup>97</sup>

There is no evidence to suggest that direct impacts on the species will occur from the proposed mine.

The species mainly inhabits eucalypt forests, often near wetlands or watercourse. On migration they occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.<sup>98</sup>

<sup>93</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>94</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>95</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>96</sup> <http://www.environment.gov.au/biodiversity/threatened/species/pubs/25977-listing-advice.pdf>

<sup>97</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>98</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=612#australian\\_distribution](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=612#australian_distribution)

A potential direct impact on habitat could be any clearing along the Nelson Bay River and other suitable riparian habitat. However, no clearing of this habitat will occur. Although the closest clearing to the Nelson Bay River is approximately 30 metres (associated with the main pit), this is outside the river gorge and is not riparian vegetation (the gorge is very steep and deep in this location); therefore, no significant direct impact on habitat along the river is anticipated.

Riparian habitat occurs along West and East Creeks but this is not where the birds were observed.<sup>99</sup> East Creek will not be impacted, apart from a road crossing. The rock dump has been designed to avoid impact on West Creek. There will be a 30 metre buffer along West Creek to the dump's collection drain; therefore no significant direct impact on habitat along this creek is anticipated.

Clearing and logging of mature forests in south east Australia<sup>100</sup> is the key threat in context with the development and the known threats to the species.

Known threats are addressed above as direct impacts which are not anticipated to occur as a result of the proposed mine. The mine therefore will make no significant contribution to the known threatening processes affecting this species.

No direct, indirect, facilitated or cumulative impacts on this species are anticipated.

### 5.7.8 Tasmanian giant freshwater crayfish *Astacopsis gouldi*

Although Nelson Bay River itself has suitable habitat, it is at the margins of the species' range and surveys found no presence of the species in the river.

Accordingly, no specific mitigation measures for this species are warranted.

Nevertheless, the project has adopted a "protection of pristine or nearly pristine ecosystems" Protected Environmental Value (PEV) for Nelson Bay River (see section 3.6). This PEV will ensure the protection of the species in the unlikely event there it is present downstream from the mine.

Mine water management will ensure that no contaminated surface water or groundwater is discharged to Nelson Bay River.

### 5.7.9 Conclusions for threatened fauna species

The above analyses conclude that the potential impacts on threatened fauna warranting mitigation measures are:

- *Wedge-tailed eagle and white-bellied sea eagle*: There is a potential impact from increased roadkill risk when feeding on roadkill due to the increase in road traffic because of the mine.
- *Masked owl*: There is a potential impact on nesting owls from vegetation clearing if it occurs during the nesting season.

<sup>99</sup> Northbarker Ecosystem Services (22 March 2011) *Nelson River - Shree Minerals Mine & Infrastructure Proposal, Flora and Fauna Assessment*. Report prepared for Shree Minerals.

<sup>100</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=612#australian\\_distribution](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=612#australian_distribution)



- *Spotted-tailed quoll*: There is a potential impact on shelter dens from vegetation clearing at any time and potential impact on breeding dens if clearing occurs during the breeding season. There is a potential impact from increased roadkill risk when crossing roads or when feeding on roadkill due to the increase in road traffic because of the mine. Based on conservative (high) assumptions about quoll densities on the site, clearing of vegetation for the mine could displace up to 1 quoll. Without mitigation, product transport could increase the quoll roadkill on the region's roads by 0.6 every year but 1.6 in year 1. Confining product transport to daylight hours would reduce these risks to 0.1 and 0.3 kills per year respectively.
- *Tasmanian devil*: There is a potential impact on shelter dens from vegetation clearing at any time and potential impact on breeding dens if clearing occurs during the breeding season. There is a potential impact from increased roadkill risk when crossing roads or when feeding on roadkill due to the increase in road traffic because of the mine. Based on conservative (high) assumptions about devil densities on the site, clearing of vegetation for the mine could displace up to 1 to 2 devils. Without mitigation, product transport could increase the devil roadkill on the region's roads by 3 per year (and 8 in year 1). Confining product transport to daylight hours would reduce these risks to 0.6 and 1.6 kills per year respectively.

## 6. Avoidance and mitigation measures

### 6.1 Vegetation clearing

Site vegetation is described in section 5.3.

- Vegetation to be cleared almost entirely comprises *Eucalyptus nitida* and *obliqua* forest and wet scrub, which do not have significant conservation values.
- There is a small, isolated fragment of wet heathland over the main pit and the northern end of the rock dump, which will be lost when the pit overburden is removed.
- The mine pits lie between the two creeks that cross the mine site (West Creek and East Creek) and the mine infrastructure has been designed to also lie between them, so avoiding any significant lost of riparian habitat.
- Topsoil will be recovered during the construction of the open pit, the waste dump areas and the access roads and will be stockpiled for future rehabilitation works. Topsoil will be used throughout the life of the mine for progressive rehabilitation and final close-out. The stockpiles will be as low as practicable, with a large surface area and will be revegetated for erosion protection.
- The NAF rock dump will be the largest vegetation clearance footprint. Its footprint comprises *Eucalyptus nitida* and *obliqua* forest and wet scrub, which do not have significant conservation values. This vegetation will be progressively cleared as the rock dump grows.
- Best practice erosion and sedimentation controls, particular to specific construction areas, will be utilised throughout the project (see section 2.18).

### 6.2 Plant hygiene measures

- Hygiene measures for Phytophthora management have been implemented at entry points to the site during the exploration phase.
- Appropriate hygiene protocols, including washdown procedures, will be maintained on the site during the development and operation of the mine. These protocols, which will be consistent with the recommendations of the DPIW Biodiversity Conservation Branch report titled: “Interim Phytophthora cinnamomi Management Guidelines”, will include maintenance of current hygiene treatment stations at entry points to the area and ensure that personnel observe strict protocols in treating boots, equipment, vehicles and machinery before entering any potentially infected area.

### 6.3 Threatened flora protection

Threatened flora is described in section 5.4.

- Vegetation to be cleared almost entirely comprises *Eucalyptus obliqua* and *nitida* forest and western wet scrub, which do not have significant conservation values.
- There is a small, isolated fragment of wet heathland over the main pit and the northern end of the rock dump, which will be lost when the pit overburden is removed. However, the site survey found no threatened plant species in this area and these patches represent no more than 1.2% of the wet heathland in a surrounding 5 km radius.
- There will be no disturbance of the sensitive wet heathlands to the west of West Creek, which provide known and potential habitat for threatened orchid species.

- The limits of the allowable disturbance will be marked on mine plans and also marked in the field by permanent signage. The reason for disturbance restrictions and the importance of staying within the limits of the disturbance footprint will form part of employee and site visitor induction information.
- There is no significant likelihood for direct, facilitated or cumulative impacts on any plant species listed under the Tasmanian *Threatened Species Protection Act 1999* or the *Environment Protection and Biodiversity Conservation Act 1999*.

## 6.4 Masked owl nests

There is a potential for masked owls to use hollow trees for nesting and preclearing surveys for nests are therefore warranted.

To mitigate against the potential impact on this species, to all practical extents vegetation clearance will be scheduled for outside the nesting season. However, if vegetation clearance must be undertaken during the nesting season, preclearance surveys will take place in the week prior to each stage of clearing commencing to identify any nesting habitat trees currently in use by masked owls. These surveys will be conducted by a suitably qualified person.

A temporary 50 metre buffer will be established around any such nests during the forest clearing operations. The buffer will encompass all structural elements of the surrounding forest and will remain unless and until the nest has been confirmed to have been vacated (which may take up to 3 to 4 months, depending on timing relative to the breeding season).

Only after the nest has been confirmed to be vacated will the vegetation clearing be completed.

### *Residual impact significance*

These mitigation measures will reduce the potential impacts on masked owls to a level of insignificance.

## 6.5 Quoll and devil dens and habitat

Observed den sites are described in section 5.7.1 and 5.7.2.

### *Pre-clearance surveys for dens*

To mitigate against the potential impact on spotted-tailed quoll and Tasmanian devils, to all practical extents vegetation clearance will be scheduled for outside the denning season. However, if vegetation clearance must be undertaken during the denning season, preclearance surveys will take place in the week prior to each stage of clearing commencing to identify any occupied quoll or devil dens.

These surveys will be conducted by a suitably qualified person. Because of the mobility of devils and quolls between dens, timing the surveys to closely precede clearing is important. If surveys were undertaken too early, the survey findings could not be relied upon - dens found to be occupied during the survey might no longer be so and potential dens found to be unoccupied during the survey might have since become occupied.

In addition to identifying the dens actually in use, the preclearance surveys will determine the amount, quality and type of quoll and devil denning opportunities within the area to be cleared.

### *Habitat protection during vegetation clearing operations*

During vegetation clearing operations, a temporary 50 m buffer will be established around any occupied maternal dens found in the pre-clearance surveys. The buffer will encompass all structural elements of the surrounding forest and will remain unless and until the den has been confirmed to have been vacated. Only after the den has been confirmed to be vacated (which may take up to 3 to 4 months, depending on timing relative to the breeding season) will the vegetation clearing be completed.

### *Establishment of suitable habitat within the Fauna Habitat Protection Zone*

A Fauna Habitat Protection Zone (FHPZ) will be established in the western part of the lease, west of West Creek (Figure 29).

The FHPZ encompasses 154 ha of the following habitats:

- Thick scrub along West creek encompassing *Eucalyptus obliqua* forest with broad-leaf scrub and *Eucalyptus nitida* dry forest and woodland
- Wet heathland.

The FHPZ boundaries have been delineated so as to be readily identifiable on the ground and readily manageable, being West Creek on the east, the lease boundary on the west and existing tracks at the north and south. The linear extent of the FHPZ parallels the extent of the rock dump and tailings dam.

The purpose of the FHPZ is to provide local refugia for any devils and quolls displaced by the clearance of 152 hectares of vegetation to the east of West Creek. Importantly, the clearance of that 152 ha will not occur in one campaign but rather progressively over the first few years of the mining operation, a period which is longer than the natural lifespan of any individual animal. Displacement of any quolls and devils will therefore be gradual and progressive.

Within the FHPZ, the following will take place in relation to devils and quolls:

- Establishment and enhancement of denning and refugia opportunities
- Monitoring of devil and quolls frequenting the FHPZ using camera traps.

The creation of new denning opportunities for devils and quolls will achieve at least the quantum and quality of the pre-existing natural opportunities identified during the pre-clearance surveys.

Denning and shelter opportunities for quolls and devils will be created by the establishment of windrows (piles of soil, green timber and other vegetation) within the 30 m buffer separating West Creek and the waste rock dump collection drain (see Appendix A and Figure 29). The windrows will be created as close as possible to the waste rock dump collection drain to avoid damage to existing vegetation.



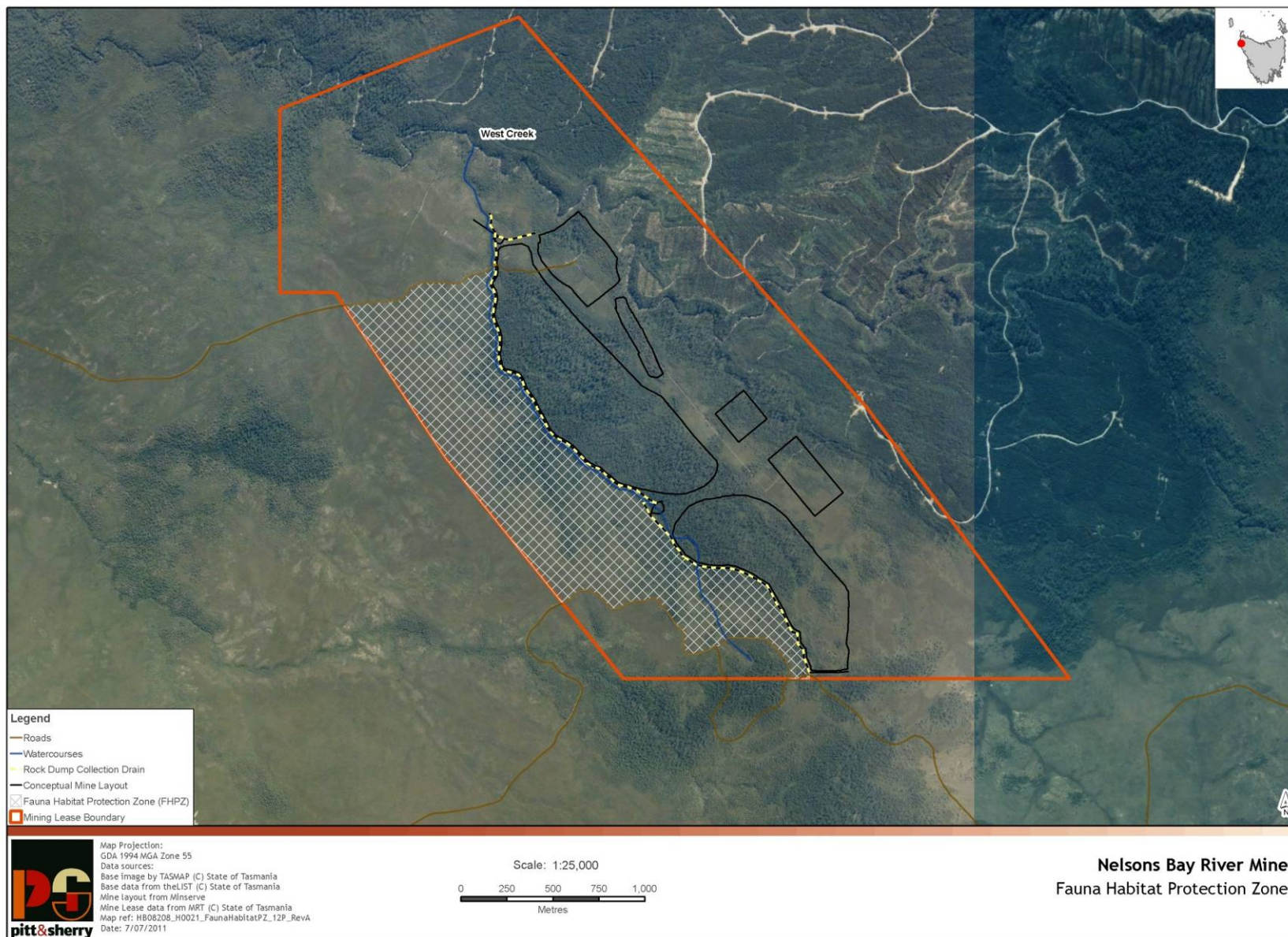


Figure 29: Fauna habitat protection zone (FHPZ)

The design and establishment of windrows will be coordinated by a suitably qualified person.

As a general guide<sup>101</sup>, at a well-drained site 3 to 5 m long lengths of tree trunks larger than 50 cm in diameter will be pushed into a settled pile at least 25 m long, 10 m wide and 4 m high, preferably including pushed topsoil also. A 1 m (at least) thick layer of branches, bark and off-cuts will then be placed on top and around all sides of the pile. As many of these windrow piles as possible will be created.

Materials for the creation of windrows will be sourced from the forest materials cleared for the waste rock dump and tailings dam and will include large trees placed specifically to create suitable denning hollows and to create good fauna shelter.

The location of windrows within the FHPZ is shown schematically in Figure 30.

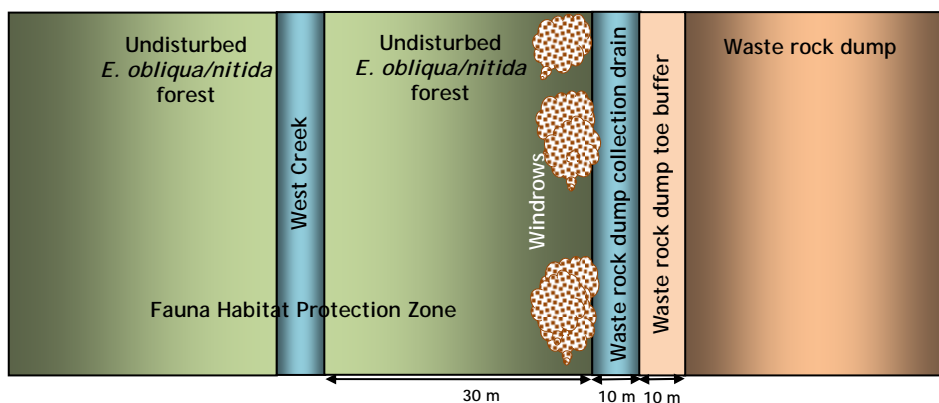


Figure 30: Schematic arrangement of the location of windrows within the Fauna Habitat Protection Zone

### Monitoring

Monitoring of the effectiveness of this proposed mitigation measure will be implemented by using camera traps.

These stations will comprise an infrared camera designed specifically for the detection of wildlife. They will be placed within the FHPZ at the windrows and along existing wildlife pads within the FHPZ (pads being the tracks which are deemed suitable for passage of the species).

Information from the sentinel monitoring stations will be used to measure occurrences of devils and quolls at the windrows and within the FHPZ generally. Of particular importance will be the occurrence of devils within the FHPZ which could have DFTD.

The monitoring stations will regularly be checked for functionality and damage. At these checks the data will be downloaded and interpreted by a suitably qualified person.

Devil photos will also be examined for any signs of DFTD. Any evidence of potential symptoms will be forwarded immediately to the Save the Tasmanian Devil Program (STDP).

Monitoring information will be provided to the STDP at regular intervals.

<sup>101</sup> Nick Mooney pers. comm.



*Ban on dogs and pets*

Shree Minerals will prohibit dogs or other pets being brought onto the mine site.

*Residual impact significance*

These mitigation measures will reduce the potential impacts on quolls and devils from vegetation clearing to a level of insignificance.

## 6.6 Roadkill

Road kill observations on the local road network are described in section 5.7.1.

A facilitated impact by the proposed mine on wedge-tailed eagles, spotted-tailed quolls and Tasmanian devils could potentially occur as a result of the increase of traffic volumes on the region's roads due to workers and product transport vehicles travelling to and from the mine site. Increases in traffic volume could potentially lead to a higher incidence of road kill or injury to eagles, quolls and devils.

The following mitigation measures will reduce the potential roadkill risk to eagles, quolls and devils to a level of insignificance.

*Speed limit reduction on roads*

The mean night-time detection distances for the species from a car with headlights on high beam is 60.8 m; this corresponds to a maximum speed of 54 kph at which a driver could stop safely to prevent collision with the species.<sup>102</sup>

The speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour. This is the critical stopping distance for avoiding roadkill at night but will be applied throughout the day also as a conservative measure.

*Removal of roadkill from roads*

Mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily). The roadkill will be moved at least 40 m from the edge of the road verge. The employee responsible for roadkill removal will hold an appropriate permit under the *Nature Conservation Act 2002*.

If a roadkill eagle or quoll is found, this will be reported to the Threatened Species Unit, Biodiversity Conservation Branch (DPIPWE) as soon as possible to obtain advice on appropriate further action.

If a roadkill devil is found, it will be reported directly to the Save the Tasmanian Devil Program to obtain advice on appropriate further action.

Roadkill data will be recorded by time, date, location and species. Road kill risk maps will be updated on an annual basis as part of the annual report on the Fauna Management Plan (see section Commitment 53 in section 6.9).

<sup>102</sup> Lawrence, C. & Donnelly, C. (2010) *Save the Tasmanian Devil Program Roadkill Project*. Report prepared for the Save the Tasmanian Devil Program.

### *High risk mapping*

Shree Minerals will provide mine workers and product transporters with maps identifying high roadkill risk areas along the route between the mine site and Smithton.

Mine workers and product transporters will be required to pay particular attention to roadkill risk when driving through these high risk spots and will encourage them to reduce speed to below 50 kph during the dawn to dusk period (subject to road safety considerations and the convenience of other road users).

### *Education of employees*

All employees will be informed through inductions and toolbox meetings of the importance of reducing roadkill and of responding appropriately if it does occur.

### *Transport hour restrictions*

Night time is the period of greatest quoll and devil activity and hence the time of greatest risk of roadkill for these species. The risk during daylight hours is only approximately 25% of the night time risk<sup>103</sup>.

Product transport will therefore be restricted to daylight hours.

Daylight hours will be defined as the period between the end of the morning civil twilight period and the beginning of the evening civil twilight period. Civil twilight is the period when vehicle headlights should be switched on. Product transport will therefore be outside the headlight period.

Over a year, the average daily transport period will be approximately 12 to 13 hours, about 2 hours above that in summer and about 2 hours below that in winter.

Restricting product transport to daylight hours will reduce the incremental roadkill risk to quolls to 0.1 kills each year (0.3 in the first year) and to devils to 0.6 kills each year (1.6 during the first year).

### *Worker transport*

The mine will provide employees with a daily bus service to and from the mine site. This will avoid up to approximately 30 additional vehicles from travelling on the region's roads.

### *Residual impact significance*

These mitigation measures will reduce the potential roadkill impacts on eagles, quolls and devils to a level of insignificance.

## **6.7 Devil facial tumour disease**

The significance of devil facial tumour disease (DFTD) is described in section 5.7.1.

The mine will not introduce any risk of increasing the spread of DFTD.

However, the presence of the mine in the area will provide an opportunity to facilitate further research into the disease.

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<sup>103</sup> Nick Mooney pers.comm.

Devil numbers around the mine site will be monitored as part of the mine's operational monitoring of the effectiveness of its devil (and quoll) impact mitigation measures, and these observations will be valuable data for the Save the Tasmanian Devil Program (STDP).

Shree Minerals would also be happy to cooperative and support any wider area monitoring and research being undertaken by the STDP, for example through the provision of site office facilities and other logistical support.

The potential support and contributions that Shree Minerals might provide to the STDP will be determined through consultation with the program during the operating phase of the mine.

## 6.8 Assessment of effects

Adherence to the avoidance and mitigation measures outlined above will ensure that there are no residual significant risks to the matters of State and/or National Environmental Significance identified in the area of the proposal.

## 6.9 Commitments

Commitment 38: A *Phytophthora* quarantine protocol will be developed, focusing on washdown of all machinery and equipment coming onto the site from other earthwork areas.

Commitment 39: All machinery and vehicles undertaking earthwork activities will be cleaned prior to leaving the mining lease for work at other premises.

Commitment 40: Any areas that become infected with *Phytophthora cinnamomi* will be managed in accordance with DPIW 'Interim *Phytophthora cinnamomi* Management Guidelines'.

Commitment 41: The extent of clearance required for the project will be clearly defined; appropriate measures (including marking tape, signs, site plans, site inductions, tool box talks and work inspections) will be undertaken to ensure that no additional clearance occurs.

Commitment 42: Unless prescribed burns to foster orchid populations are requested by the EPA Director on behalf of DPIW, there will be no disturbance of the sensitive wet heathlands to the west of West Creek, which provide known and potential habitat for threatened orchid species.

Commitment 43: All works, vehicles and materials will be confined to the designated works areas.

Commitment 44: To the extent practicable, vegetation clearing will be undertaken outside the masked owl nesting season and outside the Tasmanian devil and spotted-tailed quoll denning seasons.

Commitment 45: If vegetation clearing must be undertaken during the masked owl nesting season or the Tasmanian devil or spotted-tailed quoll denning seasons, preclearance surveys will be conducted in the week prior to vegetation clearing for each stage commencing, to identify any occupied masked owl nests or maternal quoll dens or devil dens.

Commitment 46: A temporary 50 metre buffer will be established around any masked owl nest, or maternal quoll or devil den during the vegetation clearing operations. Only after the nest or den has been confirmed to be vacated will the vegetation clearing be completed.

Commitment 47: A Fauna Habitat Protection Zone (FHPZ) will be established in the western part of the lease, west of West Creek, within which quoll and devil denning and refugia opportunities will be established and enhanced.

Commitment 48: Dogs and other pets will be banned from the mine site.

Commitment 49: The speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour.

Commitment 50: Mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily).

Commitment 51: Offsite transport of mine product will be confined to daylight hours.

Commitment 52: The mine will provide employees with a daily bus service to and from the mine site.

Commitment 53: The project's fauna impact avoidance and mitigation measures will be consolidated into a Fauna Management Plan that will be prepared before construction activities commence. The Fauna Management Plan will describe all actions and commitments, particularly those relating to road kill, the establishment and maintenance of the Fauna Habitat Protection Zone and road kill and den activity monitoring and reporting. An annual report on the implementation of the Fauna Management Plan will be prepared and provided to the EPA for information.

## 6.10 Marine and coastal

The Nelson Bay River mine and processing facilities will be located approximately 5 km due east of the coastal area.

The proposed development will not have any impact on any marine or coastal areas and will not be affected by any marine or coastal hazards, including:

- Potential tidal inundation
- Storm surge inundation or wave impacts
- Climate change induced sea level rise impacts
- Potential coastal erosion processes.

### 6.10.1 Legislative and policy requirements

As indicated, the project will not have any direct impact on any marine or coastal areas and discharge control measures, as outlined in Section 4.2.2 (Discharge of wastewater to the environment), will ensure that there are no indirect impacts.

The project is, therefore, consistent with all relevant marine and coastal policies and legislation, including the *Living Marine Resources Management Act 1995*, *State Policy on Water Quality Management 1997* and the *Tasmanian State Coastal Policy 1996*.

## 6.11 Greenhouse gases and ozone depleting substances

### *Greenhouse gases*

Greenhouse gases (predominantly carbon dioxide) will be generated during the construction phase as a result of:

- Vehicle and construction machinery emissions
- Production of carbon dioxide associated with the burning off of cleared vegetation.

During the operational phase greenhouse gas emissions will be generated by:

- Mining machinery (excavators, drill rigs, etc) and within mine transport vehicles
- Diesel powered generators (no mains power to the site)

- Processing plant operations
- Concentrate transport offsite
- Light vehicle transport activities, both onsite and offsite.

### *Existing site conditions*

Currently generation of greenhouse gases on the site only occurs during periods of exploration activity as a result of emissions from vehicles and drilling equipment. No ozone depleting substances are used during exploration activities on the site.

### *Vegetation clearance*

The development of the new mine, waste rock dump, process plant and tailings storage facility will result in the progressive clearance of timber from the site. Timber that is not of commercial quality will be windrowed and either burned or used on site for a variety of rehabilitation activities over the mine life.

Carbon dioxide will be released in both cases but in the latter case (storage for future use) decay and release of carbon dioxide will be slow. In the event that all non-commercial cleared timber is stored for later use in mine site rehabilitation, no major change in the onsite carbon inventory is expected over time, beyond that which would have naturally occurred.

### *Mining*

The onsite power generator, haulage vehicles and equipment, and other onsite transport vehicles will emit carbon dioxide.

### *Offsite transport*

Offsite transport of the resource will be to either Port Latta or Burnie<sup>104</sup> and will involve 20 round trips per day, five days per week in years 2 -10. In year one the number of round trips per day will be approximately 41, five days per week.

In year one, transport to Port Latta would involve approximately 54,050 km of travel per week, based on a round trip distance of approximately 235 km. In years 2 - 10 this would reduce to approximately 23,500 km of travel per week.

In year one, transport to Burnie would involve approximately 69,000 km of travel per week, based on a round trip distance of approximately 300 km. In years 2 - 10 this would reduce to approximately 30,000 km of travel per week.

Shree Minerals will provide a bus for transporting workers to and from Smithton, so worker vehicles numbers are not expected to be significant.

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<sup>104</sup> Although an alternative possibility is the transport of ore to an existing licensed processing plant under a commercial arrangement with the owner of that plant

### 6.11.1 Estimate of greenhouse gas emissions

#### *Estimated emissions*

The estimated annual carbon dioxide emissions and energy consumption of the proposed mining operation is summarised in Table 40 and Table 41. These estimated figures are based on the following:

- Information in the National Greenhouse and Energy Reporting System Calculator
- Electricity generation: generation of 2MW 12 hours per day, 5 days per week, 52 weeks per year
- Excavation: 1,280,000 m<sup>3</sup> per year, assuming that the cumulative total of 12,761,977 m<sup>3</sup> is equally moved over each of the ten years of mine life
- On site ore transport: 1,280,000 m<sup>3</sup>, assuming that the cumulative total of 12,761,977 m<sup>3</sup> is equally moved over each of the ten years of mine life
- Offsite product transport: 150,000 tonnes per year to the Port of Burnie or Port Latta.

Table 40: Estimated carbon dioxide emissions

Operation	Amount	Carbon factor	Calculation	Carbon dioxide emissions tonnes CO <sub>2</sub> -e/yr
Electricity generation	2 MW (0.5 MW during year 1)	0.32 kgCO <sub>2</sub> -e/kWh (NGER)	2 MW x 12 hr/day x 5 days/week x 52 weeks = 6240 kWh	1997
Excavation	1,280,000 m <sup>3</sup>	0.219 kgCO <sub>2</sub> -e/m <sup>3</sup> (Stripple, 2001)	1.28 Mm <sup>3</sup> x 0.219	280
On site transport	1,280,000 m <sup>3</sup>	2.78 kg CO <sub>2</sub> -e/m <sup>3</sup> (EU LCA dataset)		2558
Offsite transport of 150,000 t of product to Burnie	150,000 tonnes	0.000044 kg CO <sub>2</sub> -e/kg /km (EU LCA dataset)	150,000 x 300 km = 45,000,000 tonne km	1980
Offsite transport of 150,000 t of product to Port Latta	150,000 tonnes	0.000044 kg CO <sub>2</sub> -e/kg /km (EU LCA dataset)	150,000 x 235 km = 35,250,000 tonne km	1551
Total, shipping to Port Latta				6386
Total, shipping to Burnie				6815

NGER: National Greenhouse Accounts Factors. Department of Climate Change and Energy Efficiency, July 2010.

Stripple, 2001: Life Cycle Assessment of Roads. A Pilot Study for Inventory Analysis. Second Revised Edition. IVL Swedish Environmental Research Institute Ltd, Stockholm.

EU LCA dataset: from SimaPro Australian and other databases: The database is used *a priori* and references to the database are not expanded upon.



Table 41: Estimated carbon dioxide emissions and energy consumption

	Carbon dioxide emissions kt CO <sub>2</sub> -e per year	Energy consumption TJ per year	Carbon dioxide emissions kt CO <sub>2</sub> -e per year	Energy consumption TJ per year
Transport of product to Port Latta				
	150,000 t/year		350,000 t/year (Year 1)	
Mining and associated activities	4.835	69.04	3.337	47.65
Offsite transport to Port Latta	1.551	22.15	3.412	48.72
Total: mining and transport to Port Latta	6.386	91.19	6.749	96.38
Transport of product to Burnie				
Mining and associated activities	4.835	69.04	3.337	47.65
Offsite transport to Burnie	1.980	28.27	4.620	65.97
Total: mining and transport to Burnie	6.815	97.31	7.957	113.62

The estimated carbon dioxide emissions are based on the following conservative assumptions (values rounded for convenience):

- DSO ore production 350,000 tpa (year 1)
- Main pit 400,000 tpa
- Main pit ore 150,000 tpa
- Waste rock dump 250,000 tpa
- DSO transport to crusher 1km
- Main ore transport to processing plant 1km
- Waste rock transport 1 km
- Product transport to Burnie 300 km; Port Latta 235 km
- Product loads 33 t
- Product loads per day 20
- At 150,000 tpa product = ~200 days transport, 40 weeks at 5 days/week
- At 150,000 tpa and 300km to port = 45,000,000 tonne km
- Offsite transport 0.000044 kg CO<sub>2</sub>-e/kg /km; ie 0.044 kg CO<sub>2</sub>-e/tonne /km
- 1 kt CO<sub>2</sub>-e per year ~ 14.28 TJ of energy consumption per year.

*Estimate of greenhouse gas emissions and energy consumption*

Estimated levels for the project are:

Year 1:

- Carbon dioxide emissions: 8.3 kt CO<sub>2</sub>-e per year (delivery to Port Latta); 9.5 kt CO<sub>2</sub>-e per year (delivery to Burnie)
- Energy consumption: 117.8 TJ per year (delivery to Port Latta); 135.0 TJ per year (delivery to Burnie)

Years 2 - 10:

- Carbon dioxide emissions: 6.4 CO<sub>2</sub>-e per year (delivery to Port Latta); 6.8 kt CO<sub>2</sub>-e per year (delivery to Burnie)
- Energy consumption: 91.2 TJ per year (delivery to Port Latta); 97.3 TJ per year (delivery to Burnie).

### 6.11.2 Implementing greenhouse best practice

*Avoidance and mitigation measures*

The location of the waste rock dump close to the mine site will keep emissions to the minimum practicable level.

The location of the tailings storage facility will provide a greenhouse benefit as it will allow for gravity feed of decanted water back to the plant. No pumping will be required to reuse this water in the mill.

Excavation areas around the waste dump area and the tailings storage facility will be actively regenerated, thereby quickly establishing a carbon sink. The mine site rehabilitation plan will involve the revegetation of mine site areas, offsetting the project carbon emissions.

All mining equipment, machinery and vehicles will be well maintained in order to minimise the generation of greenhouse gases.

In order to reduce onsite greenhouse gas emissions, a gravity clean tailings decant return to the mill will be used where possible.

It is planned to construct the tailings storage facility solely from onsite clay and rock resources, thereby minimising the need for extraction and transport of offsite material to the project area.

Cleared areas around the mining development will be actively regenerated wherever possible, thereby quickly establishing a nominal carbon sink.

*Assessment of effects*

The carbon sink effects of the mine will be maximised by ongoing site rehabilitation and greenhouse gas generation minimisation.

The energy requirements will be minimised by locating the tailings storage facility close to, and upslope from, the mill.

Utilising onsite resources to the maximum extent will minimize the transport of materials from offsite and thereby greenhouse gas emissions.

No further reduction of greenhouse emissions for the project is deemed possible.

### 6.11.3 Ozone depleting substances

Construction and operation of the new mine and processing plant will not involve the generation or use of any ozone depleting substances.

### 6.11.4 Reporting requirements

Organisations are required to report details of their greenhouse gas emissions under the *National Greenhouse and Energy Reporting Act 2007*. Reporting guidance is provided in the associated *National Greenhouse and Energy Reporting Guidelines*.

Reporting annual thresholds for carbon dioxide and energy are as follows:

- Carbon dioxide emissions: 25 kt CO<sub>2</sub>-e
- Energy consumption: 100 TJ of energy consumed or produced

#### *Year 1*

Estimated carbon dioxide emissions in Year 1 are:

- Carbon dioxide emissions: 8.3 kt CO<sub>2</sub>-e per year (delivery to Port Latta); 9.5 kt CO<sub>2</sub>-e per year (delivery to Burnie)
- Energy consumption: 117.8 TJ per year (delivery to Port Latta); 135.0 TJ per year (delivery to Burnie)

As energy consumption levels associated with transport to both Port Latta and Burnie are above the annual threshold of 100 TJ, an application for registration to report under the *National Greenhouse and Energy Reporting (NGER) Act 2007* will be required in year 1.

#### *Years 2 – 10*

Estimated carbon dioxide emissions in Years 2 - 10 are:

- Carbon dioxide emissions: 6.4 CO<sub>2</sub>-e per year (delivery to Port Latta); 6.8 kt CO<sub>2</sub>-e per year (delivery to Burnie)
- Energy consumption: 91.2 TJ per year (delivery to Port Latta); 97.3 TJ per year (delivery to Burnie)

As these levels are below the annual threshold level of carbon dioxide emissions of 25 kt CO<sub>2</sub>-e and energy consumption of 100 TJ, an application for registration to report under the *National Greenhouse and Energy Reporting (NGER) Act 2007* will not be required in years 2 - 10.

In the event that production levels materially change in years 2 - 10, registration for reporting may become a requirement.

### 6.11.5 Commitments

Commitment 54: All construction, mining equipment, machinery and vehicles will be appropriately maintained in order to minimise the generation of greenhouse gases.

Commitment 55: Disturbed areas will be actively revegetated, offsetting the project carbon emissions.

Commitment 56: Onsite materials will be used for construction of the tailings storage dam to minimise the need for extraction and transport of offsite material to the mine.

Commitment 57: No ozone depleting substances will be used or generated during construction and operation of the mine and processing plant.

## 6.12 Heritage

### 6.12.1 General

The potential effects of the project on Aboriginal cultural heritage and historic heritage sites and areas are assessed below.

### 6.12.2 Aboriginal heritage

Aboriginal people are known to have lived in the region. It is recognised that all registered and unregistered Tasmanian Aboriginal sites are protected by the State *Aboriginal Relics Act 1975* and the Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*.

#### *Existing conditions*

The 180 ha project area is well vegetated with diverse vegetation. A few old tracks surround and traverse parts of the area. No environmentally relevant activities have been undertaken in the project area.

#### *Performance requirements*

The project must comply with:

- Tasmanian *Aboriginal Relics Act 1975*
- Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*

#### *Potential effects*

Approximately 152 ha will be cleared over the life of the mine, consisting of approximately:

- Pits: 20 ha
- Process plant area: 8 ha
- Waste rock dump area: 70 ha
- Tailings storage facility: 42 ha
- Sediment dams, drains, etc: 13 ha.

Not all areas will be cleared initially. In particular, the waste rock dump and the tailings storage facility will be cleared systematically over a considerable period of time as the mine develops.

This project clearance has the potential to inadvertently destroy or damage any Aboriginal cultural heritage that may exist in the project area.

#### *Aboriginal heritage survey*

An Aboriginal cultural heritage survey of the area, encompassing approximately 500 ha, was undertaken in November 2010 by Cultural Heritage Management Australia<sup>105</sup>. Consultation with the Aboriginal community was also undertaken at the same time.

<sup>105</sup> CHMA, 2010. *An Aboriginal Cultural Heritage Assessment of the Proposed Nelson Bay River Magnetite Mine Development, North-West Tasmania*.

The findings of the cultural heritage survey were as follows:

- There are no identified Aboriginal heritage sites or areas of potential archaeological sensitivity present within the designated bounds of the study area (approximately 500 ha)
- The general assessment is that the study area encompasses a landscape that is assessed as being of low archaeological sensitivity.

The report concluded that:

*"Based on these negative findings it is advised that there are no site specific heritage constraints or requirements to development activity proceeding within the bounds of these areas."*

### **Cultural heritage management**

As part of the Aboriginal cultural heritage assessment, heritage management options and recommendations have been developed for the site, based on the following:

- Consultation with Aboriginal communities
- The legal and procedural requirements as specified in the *Aboriginal Relics Act 1975*
- The results of the current investigations
- Background research into the extant archaeological and historical record for the study area and its surrounding regions.

### **Cultural heritage management recommendations**

Based on the findings of this investigation, there are no site specific heritage constraints or requirements for development.

In the event that any artefacts or sites are discovered during operations on the site, the processes outlined in the Unanticipated Discovery Plan of the CHMA report are to be followed.

### **Avoidance and mitigation measures**

The *Aboriginal Relics Act 1975* will be adhered to, in particular Section 14 (1), which states in part:

*'Except as otherwise provided in this Act, no person shall, otherwise than in accordance with the terms of a permit granted by the Minister on the recommendation of the Director -*

*Destroy, damage, deface, conceal, or otherwise interfere with a relic'.*

In the event that any Aboriginal artefacts are discovered during the land clearance, all work will stop immediately in that area and the Manager, Aboriginal Heritage Tasmania at the Department of Primary Industries, Parks, Water and Environment will be contacted to assess the situation.

### **Assessment of effects**

There are no site specific archaeological requirements or impediments to the construction of the proposed mine, waste rock dump, tailings storage facility and process plant.

As the study area has been assessed as being of low archaeological sensitivity, there are no further requirements for implementing a sub-surface test program within the study area and no specific management measures are required.

All Aboriginal sites are non-renewable and have high cultural significance for today's Aboriginal community as they reinforce Aboriginal connections with the land. The following commitment will ensure that any risks of damaging or destroying Aboriginal cultural heritage are minimised.

### 6.12.3 Historic heritage

The project must comply with the *Historic Cultural Heritage Act 1995*.

Construction and operation of the proposed mine and associated processing facilities will not have any impact on any listed heritage properties and/or values as no places or sites exist in the project area that are listed on the National Heritage List, Register of the National Estate, Tasmanian Heritage Register or the Tasmanian Historic Places Inventory.

### 6.12.4 Consultation

Consultation with the relevant Aboriginal bodies and communities has been undertaken as part of the Aboriginal heritage investigations for the project. Details of these consultations are outlined in section 3.14 (Aboriginal Cultural Heritage). The full details are provided in the Aboriginal cultural heritage survey report, which has been provided separately to Aboriginal Heritage Tasmania.

### 6.12.5 Commitments

Commitment 58: In the event that any Aboriginal artefacts are discovered during the project area clearance and construction, all work will stop immediately in that area and the Manager, Aboriginal Heritage Tasmania at the Department of Primary Industries, Parks, Water and Environment will be contacted to assess the situation.

## 6.13 Land use and development

Land use in the retention licence mining tenement is currently conservation and forestry activities.

The proposal will have no detrimental effects on potential land use in the area.

### 6.13.1 Existing conditions

Some elements of the mine footprint will be located partially on State Forest managed by Forestry Tasmania and partially on a Conservation Area (see Appendix N). The mine site and the waste rock dump will be located on State Forest areas.

The land has very low potential for viable agricultural production. Forestry Tasmania may require the reinstatement of forestry vegetation in specific areas of the Mining Lease at mine closure.

In the longer term, flooding of the mine pits and tailings dam following closure of the mine will enhance the aquatic amenity of the site and achieve a beneficial outcome for mining heritage.



### 6.13.2 Performance requirements

The project must comply with the requirements of the *Circular Head S.46 Planning Scheme No. 1 1995*.

Because part of the mine will intersect with the Arthur-Pieman Conservation Area, the relevant prescriptions of the Arthur-Pieman Conservation Area Management Plan must be complied with. These prescriptions require mining to be approved under the *Mineral Resources Development Act 1995* (MRDA) and the *Environmental Management and Pollution Control Act 1994* (EMPCA), and that disturbed areas are rehabilitated. A mining lease has been applied for under MRDA and this DPEMP addresses the approval requirements under EMPCA, including those relating to rehabilitation.

### 6.13.3 Potential effects

The project could conflict with other land use and developments if they occurred in the area. However, no significant other activities occur within the mine footprint.

### 6.13.4 Avoidance and mitigation measures

No specific mitigation measures are necessary as, apart from forestry, no other significant activities occur in the lease area and forestry is currently confined to the opposite side of Nelson Bay River. The small areas of the footprint that intersect with the Arthur-Pieman Conservation Area will not be a significant impact on that reserve (see section 3.3).

### 6.13.5 Assessment of effects

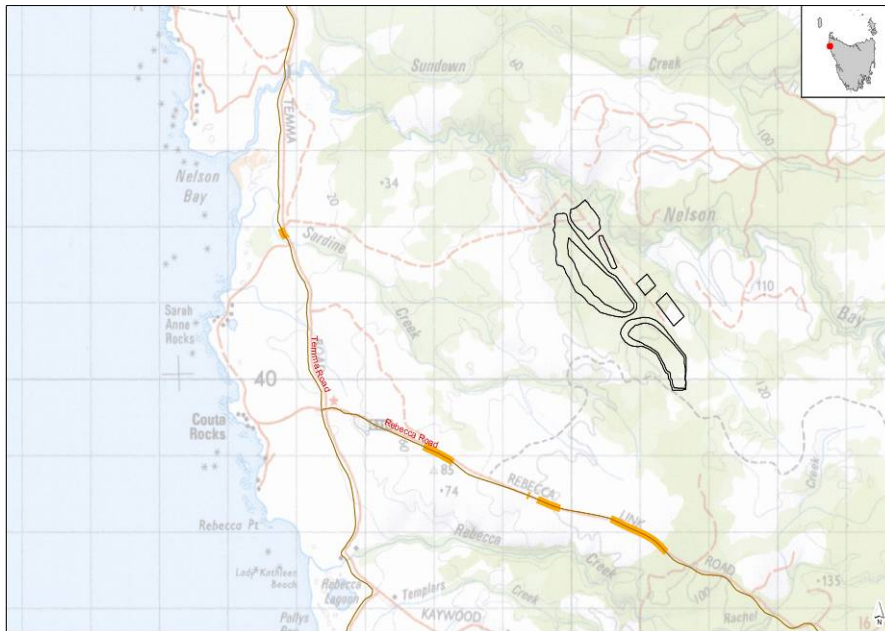
Forestry activities already exist in the lease area but not within the mine footprint.

Although significant changes will result from the proposed mining and processing activities, on mine closure land use will become available for forestry activities again in those areas of the lease classified as State Forest. The parts of the footprint that intersect with the Arthur-Pieman Conservation Area will be unencumbered after rehabilitation on mine closure.

## 6.14 Visual effects

### *Potential effects*

Viewshed analyses of the mine are provided in Figure 31 for mid and late mine life.



(a) Estimated mid-mine life visibility of rock dump from roads (ignoring the planned revegetation of dump batters)



(b) Estimated late-mine life visibility of rock dump from roads (ignoring the planned revegetation of dump batters)

Figure 31: Viewshed analyses for mid and late mine life

The analyses examined the visibility of the mine infrastructure from Rebecca and Temma Roads within an approximately 5 km radius of the mine. As shown in Figure 31, the mine will be only marginally visible from short sections of Rebecca and Temma Roads up to mid-mine life but from longer and more numerous sections in later mine life.

In both cases, the visibility is driven by the waste rock dump. Other elements (plant and pits) have no significant visibility. The increased visibility of the rock dump toward the later stages of mining is due to it being higher than would otherwise be necessary because of the decision to confine its footprint to the eastern side of West Creek, so as to provide for the Fauna Habitat Protection Zone. Confining the footprint necessarily raises the height of the dump. The increased rock dump height is therefore a consequence of balancing the competing objectives of protecting habitat and minimising visibility, as described in section 2.4.4.

### *Avoidance and mitigation measures*

The potential visual impact of the rock dump from public roads in the later years of the mine life will be reduced by early and progressive rehabilitation of the dump batters, particularly on the southern and western sides. As vegetation takes hold, the rock faces will become covered and as trees become established the lines of the dump benches will be visually broken up. The appearance the dump from the roads, which are approximately 3 to 4 kilometres away, is therefore not expected to become obtrusive or significantly diminish the landscape quality.

### *Commitment*

Commitment 59: The NAF waste rock dump will be progressively rehabilitated and revegetated to reduce visual impact from roads.

## 6.15 Socio-economic issues

The project is expected to provide significant economic and social benefits at the local, regional and State levels.

Recently updated economic modelling estimates that at full operating capacity the project would:

- Employ 125 full time employees (by the company & /or through contractors) with many more employed indirectly because of flow-on effects.
- Result in a business turnover of approximately \$70 to \$88 million per annum for a total of approximately \$1.5 billion over the Project life.

Establishment of the mine and associated facilities is likely to be undertaken, in part, by a local construction contractor, providing further social and economic benefits for the local community.

The proposal should have no effect on land value in the area or recreational use in the surrounding region. The presence of the mine is unlikely to impact on existing uses of the area, for example by 4WD, quad bike or trail bike users. Although an existing track runs through the western margins of the lease, this track is to the west of West Creek and therefore outside the mine's disturbance footprint.

## 6.16 Health and safety issues

Safety management systems consistent with the requirements of Workplace Standards Tasmania, and any requirements attached to approval of the project, will be applied during the construction and operation of the new mine and associated facilities.

All operations, maintenance and inspection health and safety issues on the mine site will be compliant with the *Workplace Health and Safety Act 1995* and the *Workplace Health and Safety Regulations 1998*.

Appropriate security arrangements to prevent unauthorised access to the site of the mining and processing operations will be established.

As indicated in Section 4.2, no scheduled emissions of liquid waste are proposed from the tailings storage facility.

However should an emergency discharge of clean tailings decant occur to natural drainage lines that report to the Nelson Bay River, the discharge of this excess decant water is not expected to have any detrimental impact on downstream water quality, users or present any risk to human health.

The nearest known residential properties, which are approximately 5 km to the north west of the proposed site, are considered extremely unlikely to be affected by any construction activity or operation of the mine.

### 6.16.1 Commitments

Commitment 60: All operations, maintenance and inspection health and safety issues on the mine site will be compliant with the *Workplace Health and Safety Act 1995* and the *Workplace Health and Safety Regulations 1998*.

## 6.17 Hazard analysis and risk assessment

### 6.17.1 Hazard analysis

The major possible hazard events identified relate to failure of the following mine features:

- Pit walls (both the DSO pit and the main pit)
- Tailings facility wall
- Waste rock dump slopes
- Explosives storage
- Fuel storage
- Power generators
- Processing plant.

### 6.17.2 Risk assessment

A detailed risk (hazard) assessment will be undertaken as part of the final design of the project components.

#### *Main pit and DSO pit*

- Pit development will be consistent with ongoing geotechnical assessments of the site.

#### *Waste rock dump*

- A geotechnical assessment of the waste rock dump site will be undertaken to determine site foundation conditions
- The waste rock dump slopes will be based on a geotechnical assessment of slope stability, given the size range and nature of the material involved
- Slopes will be revegetated as soon as is practicable to assist with any potential stability issues (as well as visual issues).

#### *Tailings storage facility*

The likelihood of a major failure of the tailings storage facility wall is considered to be extremely low because:

- Construction of the proposed tailings storage facility will be compliant with ANCOLD design and management guidelines
- The constructed tailings storage facility will be inspected regularly, consistent with ANCOLD requirements
- The site will be removed from all high risk site locations and facilities, including the mining operations
- The storage facility design will be assessed by the ACDC and is expected to be assessed as low risk rating
- There are no historic or current underground workings in the area.

#### *Explosives and fuel storage*

Explosives and fuel will be stored and managed in accordance with the *Dangerous Substances (Safe Handling) Act 2005* and the associated Workplace Standards Tasmania *Dangerous Substances Locations Guide for Occupiers*.

Shree Minerals will implement a Safety Management System that will describe:

- The system's safety objectives
- The performance criteria to be met
- Procedures to achieve the objectives; and
- Procedures to ensure that the system will be maintained.

#### *Processing plant and generators*

A HAZID analysis of the process plant and generators will be undertaken as part of the detailed design/selection process and resulting risk avoidance, reduction and mitigation measures will be developed and implemented.

### 6.17.3 Commitments

Commitment 61: A detailed risk (hazard) assessment will be undertaken as part of the final design of pits, waste rock dump and tailings storage area.

Commitment 62: A geotechnical site assessment of the waste rock dump site, tailings dam and processing site facilities will be undertaken to determine site foundation conditions.

Commitment 63: Determination of the waste rock dump slopes will be based on a geotechnical assessment of slope stability, given the size range and nature of the waste rock material.

Commitment 64: Construction of the proposed tailings storage facility will be compliant with ANCOLD design and management guidelines.

Commitment 65: A Safety Management System will be developed and implemented to manage risks associated with the storage of explosives and fuel.

Commitment 66: A HAZID analysis will be undertaken as part of the detailed design/selection process for the processing plant and power generators and resulting risk avoidance, reduction and mitigation measures will be developed and implemented.

## 6.18 Fire risk

The project site clearance, construction, commissioning and operations will be conducted in accordance with the Fire Management Plan. The Fire Management Plan will be reviewed and updated in the DPEMP reviews. Facilities in the processing area will be designed in accordance with all relevant standards to ensure fire protection systems and equipment are installed and operational at all times.

The potential fire risks, potential onsite sources and potential onsite avoidance measures are identified below.

### *Potential fire risks*

- Fire originating within the operations
- Fire escaping from the operations
- Fire originating from outside the operations.

### *Potential onsite sources*

- Electrical fire
- Explosion from fuel vapours (storage or equipment)
- Detonation of explosives
- Oil/fuel fire
- Dry vegetation
- Equipment exhaust on flammable material and vegetation
- Discarded cigarettes and dry vegetation
- Lightning strike
- Building fire
- Arson.



## 6.18.1 Avoidance and mitigation measures

### *Potential onsite avoidance*

- All buildings will have properly installed electrical equipment and safety earth and/or leakage detection devices
- Properly designed and ventilated oil/fuel storage tanks
- Safe storage for explosives
- Appropriate security, fencing and site vigilance/monitoring
- Improve area vigilance and security in consultation with key stakeholders
- Regular housekeeping and site safety audits
- Mobile equipment to have elevated and protected exhaust systems
- Smoking to be restricted to low fire risk areas
- Smoke detectors in process and office buildings
- Fire alarm and extinguishing systems installed
- Appropriate management provisions during controlled burns
- Mobile fire fighting water pump(s) to extract water from storages (eg. recycle dam, sedimentation dams) as needed.

### *Mitigation measures for fire originating within the operations*

- Buildings will have fire detection, alarm and sprinkler systems
- Fire control and management measures will be in place for the processing plant and the mining area
- Fire/emergency action plan will be in place in consultation with local authorities, Forestry Tasmania, Tasmania Police, SES, Parks and Wildlife Service and the Tasmanian Fire Service.

### *Mitigation measures for fire escaping from the operations*

- Contain within reason any fires onsite using generally accepted fire fighting equipment
- Have fire fighting extinguishers on mobile equipment and have a water tanker on site
- Maintain existing site access roads, tracks and containment lines to acceptable standard
- Maintain clear areas around the mining and processing plant areas
- Fire/emergency action plan will be in place in consultation with local authorities, Forestry Tasmania, Tasmania Police, SES, Parks and Wildlife Service and the Tasmanian Fire Service.

### *Mitigation measures fire originating outside the operations*

- Maintain fire breaks around the operations
- Maintain site access roads, tracks and containment lines to acceptable standard for fire fighting authorities to use
- Fire/emergency action plan will be in place in consultation with local authorities, Forestry Tasmania, Tasmania Police, SES, Parks and Wildlife Service and the Tasmanian Fire Service.

### 6.18.2 Assessment of effects

The potential fire risk associated with this proposal is considered to be low for the following reasons:

- All combustible material will be cleared from the mine, waste rock dump, process plant and the tailings storage facility sites.
- Wildfire originating outside the site:
  - Is unlikely to have any impact on the tailings storage facility site because of the earthen nature of the walls and the slurry nature of the materials being stored.
  - Is unlikely to have any impact on the pit or waste rock dump areas.
  - Could have some impact on the process area.
- As the site is surrounded by forest (Forestry Tasmania) and conservation areas (Parks and Wildlife Service) it is subject to the scrutiny of their fire watch service during fire danger periods
- The availability of water and earthmoving equipment on site will enable a rapid and effective response in the event of fire.

### 6.18.3 Fire Management Plan

This fire management plan has been developed in accordance with the requirements of the appropriate authorities. The legislative and regulatory framework for the plan is outlined below:

- The *Fire Services Act 1979*
- The *Workplace Health and Safety Act 1995*
- Relevant Australian Standards
- Forestry Tasmania requirements
- Parks and Wildlife Service requirements
- Circular Head Planning Scheme requirements.

The objective of the Fire Management Plan is to be consistent with existing local fire authority requirements and public property management expectations. The main objectives of the plan are to protect life and property, and the natural values of the mine lease areas and surrounds in the event of fire.

#### *Action plan*

- Total fire ban days will be enforced on the Mining Lease.
- Fire weather information will be collected on a daily basis during designated fire alert days from the Fire Weather Forecaster, Bureau of Meteorology, Hobart. When required, back-up forecasts will be collected from the District Forester for the region, the nearest Forestry Tasmania office, or the Duty Technical Officer at Launceston airport.
- Ground patrols will be used for fire surveillance by the appointed Fire Officer on normal working days during designated fire alert days, with patrols of normal work areas being included in routine duties of all personnel and contractors.

- Appropriate fire fighting equipment will be located or stored on the Mining Lease during all phases from construction through to rehabilitation. This is expected to take the form of the following:
  - Extinguishers in all buildings, all light vehicles and all mining and transport vehicles and equipment
  - Site mobile fire tanker to be used for road watering and dust suppression also
  - Emergency fire water tank 20,000 L and emergency powered pump will be located at the processing plant area.
- The Tasmanian Fire Service will be notified immediately in the case of fire in any of the project facilities.
- Fire risk associated with the generation of flammable gases and with the storage of hazardous materials onsite will be minimised through the application of appropriate mitigation measures and as assessed for the individual project hazards and associated risks.
- Site personnel and contractors will be required to carry a UHF radio capable of linking into the site UHF radio network.
- All employees and contractors will be briefed during induction on fire detection, reporting requirements, fire prevention and the site fire management plan.
- Any fire occurring on the Ming Lease will be reported immediately to the nominated Fire Officer or the administration office who will be responsible for follow-up action and reporting.
- Firebreaks will be maintained around areas and machinery from which there is a risk of fire escaping (while taking into account the need to minimise vegetation clearance in some areas).
- Hazard reduction burns will not be undertaken unless under the instruction of the State authority and Forestry Tasmania.
- Cleared vegetation at the site will not be burnt but used for windbreaks, runoff berms supports and potential fauna habitat.
- All vehicles and machinery will be kept in good working order and where necessary have spark arresters installed to minimise the potential for fires on site.
- All site staff will be trained in emergency procedures and the use of the designated fire fighting equipment.
- Vegetation clearance at the site will be consistent with the Forest Industry Fire Management Committee - Procedure: Fire Prevention at Forest Operations - Revised October 2009.

### *Commitments*

Commitment 67: A Fire Management Plan will be developed for the mine site.

Commitment 68: The project site clearance, construction, commissioning and operations will be conducted in accordance with the Fire Management Plan.

Commitment 69: The Fire Management Plan will be reviewed and updated as part of the EMP review.

Commitment 70: Facilities in the processing area will be designed in accordance with all relevant standards to ensure fire protection systems and equipment are installed and operational at all times.

## 6.19 Infrastructure and off-site ancillary facilities

The proposed mine will utilise existing road and port infrastructure. The port requirements are a stockpile storage area and vessel loading equipment. The existing facilities at the candidate ports (Port Latta and Burnie) are adequate and no structural changes are required for either of these ports.

## 6.20 Environmental management systems

Operation of the mining and processing facilities will be undertaken in accordance with the mine environmental management systems that will be developed as part of the operational requirements for the proposed mine, together with the requirements of any EPN that may be placed on the mine site by the EPA.

### *Commitments*

Commitment 71: A Mine Environmental Management System will be developed in accordance with EPA requirements.

Commitment 72: Operation of the mine and processing facilities will be undertaken in accordance with the Mine Environmental Management System.

## 6.21 Cumulative and interactive effects

The proposed mine will be located in an area having little development other than plantation forestry, which is located immediately across Nelson Bay River from the mine site. No significant cumulative or interactive effects with the forestry activities are foreseen other than through the additional traffic on local and regional roads.

The additional traffic is discussed in section 2.17 and roadkill potential and mitigation measures are discussed in sections 5.7 and 6.6.

The proposal will leave the following structures on closure:

- A large waste rock dump on the western side of the site
- A flooded tailings dam on the southern end of the site
- Two deep pits (approximately 40+ m and 225 m deep) that will become completely flooded over time.

These structures will place constraints on any future uses of the site.

The flooded dam and pits will also create permanent lakes that will become attractive to wildlife. The dam and DSO pit will be shallow lakes (in the order of 1 to 2 m deep) while the main pit will be a deep lake, in the order of 200 m deep. There are few natural standing freshwater bodies in the region and the colonisation of the lakes may be of scientific interest.

The high points of the rock dump are likely to be briefly visible from sections of Rebecca Road (see section 6.14) but the visual impact of this will diminish as rehabilitation vegetation grows.

The proposal does not have any other significant cumulative or interactive environmental effects.

The mine, with a planned life of 10 years, will provide a significant flow-on effect for the regional economy and it is possible that existing service industries in the wider economic region will grow or that new industries will commence as a result of the presence of the mine. These industries may themselves have consequential effects. While it is not possible to speculate where or what those might be, the nature of such industries means that any environmental effects are unlikely to be significant.

## 6.22 Traffic impacts

There will be a temporary increase in traffic on the following roads associated with mine construction traffic:

- Wuthering Heights Road (Forestry Tasmania)
- Rebecca Road (DIER)
- Blackwater Road (Forestry Tasmania)
- Sumac Road (Forestry Tasmania)
- Roger River Road (Forestry Tasmania / Circular Head Council)
- Trowutta Road (Circular Head Council)
- Grooms Cross Road (Circular Head Council)
- Irishtown Road (Circular Head Council)
- Bass Highway (DIER) to either Port Latta or Burnie.

There will be a permanent increase in traffic on these roads during the operation phase associated with product movement and other vehicular traffic.

A traffic impact assessment report is provided in Appendix M.

The current number of vehicles per day on Rebecca Road, based on January 2010m traffic counts 800 m west of the Western Explorer-Blackwater Road junction, is 56. In year 1 of the mine, the mine's transport movements will approximately double this traffic; in subsequent years, the mine will increase daily traffic by approximately 50% over current levels. Although these are significant increases, the capacity of the roads is underutilised.

The traffic impact analysis concludes that the additional traffic associated with the presence of the mine will create no operational or safety issues.

## 7. Monitoring and Review

### *Surface water and groundwater*

The current programs of surface water and groundwater monitoring will be continued.

The existing eight surface water sampling stations (NBRW01, NBRW02, NBRW03, NBRW04, NBRW05, NBRW06, NBRW07 and NBRW08) and six groundwater monitoring stations (NBRGW01, NBRGW03, NBRGW04, NBRGW05, NBRGW06 and NBRGW07) described in section 3.7 will be continued and the additional (seventh) groundwater site NBRGW02, which is currently not accessible, will also be established.

The surface water sites will be sampled every 3 months and the groundwater sites every six months during operations. Samples will be analysed for physicochemical parameters and metals (as listed in Table 24 and Table 27 in section 3.7). Depth to groundwater will also be recorded in the groundwater bores.

The surface water sites will be supplemented with additional sites in East Creek upstream and downstream from the recycling dam overflow discharge point, in West Creek, upstream from the tailings dam basin overflow discharge point, and downstream from the NAF dump sediment pond. Sampling at these sites will commence before mining commences.

V-notch sampling weirs will be constructed at these discharge points and the discharge flow rate, pH and turbidity will be measured weekly when discharges are occurring. Supplementary event based sampling will be undertaken of the East Creek discharge if the neutralisation plant has to be bypassed because the volumes exceed the design capacity of the plant.

If pH levels drop below 7, representative samples will be collected for laboratory analysis to measure the dissolved metal concentrations. A reduction in pH below 7 would trigger an operational response (which would likely have been triggered further up in the discharge stream anyway) to neutralise the acidity of discharge water in the neutralisation plant. Samples will continue to be taken for laboratory analysis on a weekly basis until the pH has returned to above 7.

### *PAF material*

PAF material will be tested as described in section 2.4.5. The range of tests, the test procedures and the QA/QC procedures for static and K-NAG tests will be similar to those already undertaken and identified in the laboratory reports provided in Appendices I and J. The laboratory to be used is likely to continue to be SGS; any alternative laboratory will first be approved by the EPA Director as having appropriate expertise.

### *Main pit water*

Main pit water will be tested for acidity on a weekly basis. A reduction in pH below 7 will trigger an operational response to neutralise the acidity of pit water in the neutralisation plant prior to it going to the recycle dam.

### *DSO pit water*

DSO pit water will be tested for acidity on a weekly basis. A reduction in pH below 7 will trigger an operational response to neutralise the acidity of pit water in the neutralisation plant prior to it going to the recycle dam.



### *Recycle dam water*

The recycle dam will be tested for acidity on a weekly basis. A reduction in pH below 7 will not necessarily trigger an operational response to neutralise this water in the treatment plant because it will be recycled through the processing plant, where alkalinity will be added to the tailings stream (see section 2.13). However, a reduction in pH will flag a concern that would need to continue to be watched.

### *Tailings dam water and settled tailings*

The tailings stream will be monitored daily to determine the amount of alkalinity required to be added to achieve a residual surplus alkalinity in the tailings dam. Confirmation testing of the tailings pH will also be undertaken daily.

The pH of the tailings dam decant will be tested weekly as it returns to the recycle dam.

The pH and turbidity of the tailings dam overflow/seepage collection basin will be tested weekly. If pH levels drop below 7, the water will be pumped to the acid neutralisation plant.

Samples of the settled tailings will be taken every 6 months and tested for Net Acid Generating Potential and Acid Neutralising Capacity, to confirm that the tailings have a residual alkalinity from the alkalinity dosing.

### *NAF dump runoff water*

A V-notch sampling weir will be constructed at the NAF dump sediment basin discharge point and the discharge flow rate, pH and turbidity will be measured weekly.

If pH levels drop below 7, the water will be pumped to the main pit from where in turn it will be pumped to the acid neutralisation plant.

### *PAF storage phreatic zone*

The phreatic zone will rise inside the DSO pit as successive layers of PAF material are laid down. The height of this zone above the base of the lowest PAF cell will be monitored with a piezometer.

### *Water balance*

In addition to the flow monitoring of the discharges to East and West Creeks, pumped volumes from the various pumps within the water management system will be determined on a weekly basis.

### *Macroinvertebrate monitoring*

Pre-disturbance macroinvertebrate monitoring surveys of the Nelson Bay River will be undertaken at appropriate strategic locations in accordance with the Ausrivas protocol, a widely accepted methodology for monitoring changes to river ecosystems.

Surveys are planned to be undertaken at five sites: one on Nelson Bay River upstream of the mine where the river is crossed by the Wuthering Heights Road bridge; one each in Nelson Bay River downstream of the entry points of West and East Creeks respectively; and one each in West and East Creeks.

The results of the pre-disturbance surveys will provide a baseline against which to compare surveys undertaken when the mine is operating. A survey will be undertaken downstream of the mine prior to construction commencing and annually during the first 3 years of operations. Similar surveys will be repeated in years 6 and 10.

### *Fish monitoring*

The DPEMP's Project Specific Guidelines required a survey for the Australian grayling (*Prototroctes maraena*) in Nelson Bay River and also required that this survey opportunistically include fish in general. However, as shown in Figure 23 in section 3.13, a hydraulic barrier near the mouth of the river would prevent the grayling from swimming upstream and the grayling survey was therefore unwarranted.

Instead, a general fish survey will be undertaken downstream of the mine at an appropriate time of year prior to construction commencing and after the first year of operations. Similar surveys will be repeated in 3 year intervals, in years 4, 7 and 10.

### *Nests and den observations*

Sentinel Monitoring Stations will be established to monitor the use of the Fauna Habitat Protection Zone and its denning opportunities by quolls and devils.

### *Roadkill*

Records will be maintained of roadkill removed from Wuthering Heights Road and from within the mine site.

### *Summary of operational monitoring*

The above operational monitoring commitments are summarised in Table 42.

Table 42: Summary of operational monitoring

Element	Location(s)	Description	Reporting	Frequency
Surface water	NBRSW01, NBRSW02, NBRSW03, NBRSW04, NBRSW05, NBRSW06, NBRSW07 and NBRSW08 and at an additional sampling site in Nelson Bay River, immediately downstream from its confluence with West Creek	Physicochemical and metal suite	Annual report to the Director EPA	Every 3 months, commencing pre-construction
Ground water	NBRGW01, NBRGW02, NBRGW03, NBRGW04, NBRGW05, NBRGW06, NBRGW07 and NBRGW08	Physicochemical and metal suite and depth to water	Annual report to the Director EPA	Every 3 months, commencing pre-construction
Waste rock - initial further exploration	Exploratory drill cores and mining faces	NAPP, MCA, ANC, column leaching, mineralogy, TCLP	Laboratory reports maintained for inspection by EPA on request; summary of findings included in Annual Report to Director	At DSO break-ground (within the first 6 months into the project), further exploratory drilling of the DSO and oxidised ore in the main pit will be undertaken and samples will be subjected to kinetic testing, including free draining column leach or humidity cell tests.  In year two, further exploration drilling of the main pit magnetite resource will be undertaken (while the overlying oxidised ore is being mined) and these samples will also be subjected to static and kinetic testing.
Waste rock - routine	Exploratory drill cores and mining faces	NAPP, MCA, ANC, K-NAG, mineralogy and TCLP as part of routine grade control testing	Laboratory reports maintained for inspection by EPA on request; summary of findings included in Annual Report to Director	Throughout the mine's life, regular static and kinetic testing will be undertaken of pit wall material and in advance of mining if exploration drilling of new areas is conducted.
PAF storage phreatic zone	DSO pit	The height of this zone above the base of the lowest PAF cell will be monitored with a piezometer.	Records maintained for inspection by EPA on request	Weekly

Element	Location(s)	Description	Reporting	Frequency
PAF storage phreatic zone	DSO pit	The height of this zone above the base of the lowest PAF cell will be monitored with a piezometer.	Records maintained for inspection by EPA on request	Weekly
Main pit water	In-pit water, prior to pumping to recycle dam	Field pH	Records maintained for inspection by EPA on request	Weekly
DSO pit water	In-pit water, prior to pumping to recycle dam	Field pH	Records maintained for inspection by EPA on request	Weekly
Recycle dam water	In dam	Field pH	Records maintained for inspection by EPA on request	Weekly
Tailings out of plant	Tailings stream as they emerge from the process	Field pH	Records maintained for inspection by EPA on request	Daily
Tailings dam water	Tailings dam decant	Field pH	Records maintained for inspection by EPA on request	Weekly
Tailings in dam	Settled tailings	NAG and ANC	Annual report to the Director EPA	6 monthly
Discharge to East Creek	Upstream and downstream of recycle dam overflow discharge point	Field flow rate, pH and turbidity	Records maintained for inspection by EPA on request	Weekly when discharges are occurring, with supplementary event based sampling if the neutralisation plant has to be bypassed
Discharges to West Creek	Upstream from the tailings dam basin overflow discharge point and downstream from the NAF dump sediment pond	Field flow rate, pH and turbidity	Records maintained for inspection by EPA on request	Weekly during overflow events
Water balance	Discharges to East and West Creeks (see above) and pump stations	Flow rate at creek discharges, pump volumes at pump stations	Records maintained for inspection by EPA on request	Weekly
Stream macroinvertebrates	Five sites to be selected to be suitable under the Ausrivas protocol: One in Nelson Bay River upstream of the mine where the river is crossed by the Wuthering Heights Road bridge; one each in Nelson Bay River	Ausrivas protocol	Annual report to the Director EPA	A survey will be undertaken prior to construction commencing and annually during the first 3 years of operations. Similar surveys will be repeated in years 6 and 10.

Element	Location(s)	Description	Reporting	Frequency
	downstream of the entry points of West and East Creeks respectively; and one each in West and East Creeks.			
Stream fish	In Nelson Bay River, immediately downstream of its confluence with West Creek	General fish survey	Annual report to the Director EPA	A survey will be undertaken downstream of the mine prior to construction commencing and after the first year of operations. Similar surveys will be repeated in 3 year intervals, in years 4, 7 and 10.
Fauna Habitat Protection Zone denning opportunities	Representative locations to be determined by expert advice once denning opportunities have been created	Sentinel monitoring stations, including remote cameras	Annual report to the Director EPA	Ongoing throughout each year's devil and quoll breeding season, commencing after initial vegetation clearance
Roadkill	Wuthering Heights Road and within mine site	Records will be maintained of roadkill removed from Wuthering Heights Road and from within the mine site	Annual report to the Director EPA	Mine staff will remove any roadkill observed on Wuthering Heights Road weekly and within the mine site daily, commencing when construction commences.

### *Commitments*

Commitment 73: Surface water samples will be taken at stations NBRSW01, NBRSW02, NBRSW03, NBRSW04, NBRSW05, NBRSW06, NBRSW07 and NBRSW08 and at an additional sampling site that will be established in Nelson Bay River, immediately downstream from its confluence with West Creek, every 3 months and analysed for physicochemical parameters and metals.

Commitment 74: Groundwater samples (and depth to groundwater) will be taken at stations NBRGW01, NBRGW02, NBRGW03, NBRGW04, NBRGW05, NBRGW06, NBRGW07 and NBRGW08 every 6 months and analysed for physicochemical parameters and metals.

Commitment 75: Additional surface water sampling sites will be established in East Creek upstream and downstream from the recycling dam overflow discharge point, in West Creek upstream from the tailings dam basin overflow discharge point, and upstream from the NAF dump sediment pond. Discharges from these locations will be sampled weekly for flow, pH and turbidity during operations but background sampling at these sites will commence before mining commences.

Commitment 76: The pH of water from the main pit and DSO pit, the tailings dam decant, and in the tailings dam basin and the recycle dam will be tested weekly.

Commitment 77: The tailings stream will be tested daily to determine alkalinity dosing requirements to achieve a residual alkalinity in the tailings dam.

Commitment 78: Samples of the settled tailings will be taken every 6 months and tested for net acid generating potential and acid neutralising capacity.

Commitment 79: Pre-disturbance macroinvertebrate monitoring surveys of the Nelson Bay River will be undertaken annually in accordance with the Ausrivas protocol at five sites: one on Nelson Bay River upstream of the mine where the river is crossed by the Wuthering Heights Road bridge; one each in Nelson Bay River downstream of the entry points of West and East Creeks respectively; and one each in West and East Creeks.

Commitment 80: A general fish survey will be undertaken in Nelson Bay River downstream of the mine in years 1, 4, 7 and 10.

Commitment 81: The new denning opportunities created by vegetation windrowing will be monitored for use by quolls and devils.

Commitment 82: Records will be maintained of roadkill removed from Wuthering Heights Road and from within the mine site.



## 8. Decommissioning and Rehabilitation

A Mine Closure Plan is included as Appendix S. Key aspects of this plan are as follows:

### *Infrastructure*

- All infrastructure, including plant, buildings and concrete foundations, will be removed
- Plant and equipment will be sold, for scrap or reuse where possible
- All concrete will be disposed of within the main pit
- All other waste materials will be disposed of in accordance with Circular Head Council and EPA requirements
- These areas will be recontoured, provided with an appropriate soil covering and revegetated

### *Tailings dam*

- The tailings dam will be established with a permanent water cover
- The creek upstream of the tailings dam will be partially diverted to ensure a constant water cover on the tailings dam
- Overflow from the tailings dam will be to the settling pond downstream, prior to discharge to the creek and then to Nelson Bay River

### *Main and DSO pits*

- These pits will be allowed to fill with water
- Drainage will be established to ensure that overflow from the DSO pit is directed to the main pit
- Drainage (overflow) from the main pit will be to the settling pond downstream of the waste rock dump, prior to discharge to the creek and then to Nelson Bay River

### *Potential acid forming material*

- Potential acid forming material will be encapsulated in specifically designed cells, initially within the DSO pit
- Encapsulation in these cells within the DSO pit will preclude the generation of acid drainage from the site
- On closure, flooding of the DSO pit, including these cells, will provide additional protection against acid drainage
- Encapsulation outside the DSO pit will be in similarly designed cells within the waste rock dump

### *Waste rock dump*

- Rehabilitation of the waste rock dump, including final recontouring and final revegetation, will be undertaken

### *Commitment*

Commitment 83: A site decommissioning and rehabilitation plan (Mine Closure Plan) will be prepared in accordance with EPA requirements.

## 9. Commitments

Table 43: Summary of commitments

Commitment	When	Responsible	Page
<b>Air Emissions</b>			
Commitment 1: A Dust Management Plan for construction and operational phases will be prepared prior to construction work commencing.	Prior to construction commencing	Mine Manager / Relevant Contractor	112
Commitment 2: Construction phase dust impacts will be minimised by road tanker watering as required.	During construction	Relevant contractor	112
Commitment 3: Construction phase vegetation burnoff smoke impacts will be minimised by utilising qualified people to undertake the burnoffs at appropriate times and in consultation with Forestry Tasmania.	During construction	Relevant contractor	112
Commitment 4: Haul roads, the waste rock dump and the ROM pad will be kept watered in dry windy periods to reduce the potential for dust generation.	Ongoing	Mine Manager / Relevant Contractor	112
Commitment 5: All mining plant and equipment, including trucks, will be operated appropriately and will be regularly maintained.	Ongoing	Mine Manager / Relevant Contractor	112
Commitment 6: All processing plant and equipment will be operated in accordance with design specifications and regularly maintained.	Ongoing	Mine Manager	112
<b>Liquid waste/surface water</b>			
Commitment 7: The areas of disturbance will be controlled and surface water drainage diverted around the site footprints during the construction phases. Where possible, temporary sedimentation basins and silt fencing will be used and final runoff will be directed to the existing naturally vegetated gently sloping drainage lines.	During construction	Relevant contractor	125
Commitment 8: A Drainage Management Plan will be prepared for the management of site water during operations and on closure. The plan will be prepared prior to the commencement of operations.	Ongoing	Mine Manager	125
Commitment 9: Runoff from settlement basins will be field-monitored weekly for turbidity, pH and dissolved oxygen. If turbidity exceeds 130 NTU, a water sample will be taken for laboratory analysis of suspended solids. Settlement basins will be sampled monthly for laboratory analysis of suspended solids, BOD, total petroleum hydrocarbons and oil and grease.	During construction	Construction manager	125
Commitment 10: The tailings dam will be designed and the construction supervised by an appropriately qualified engineer to an appropriate engineering standard. A reputable civil works contractor will be commissioned with properly trained operators and properly maintained equipment.	During construction	Mine manager / Construction Manager	125

Commitment	When	Responsible	Page
Commitment 11: Fuel or hydrocarbons will not be stored on site in any fixed storage facility during the early construction phase. Refuelling of equipment will be undertaken using a mobile purpose built tanker. The tanker will carry fuel cleanup equipment in case spills occur on site.	During construction	Relevant contractor	125
Commitment 12: A bunded area will be constructed in an appropriate site to store fuel and hydrocarbons for use during the mine operation phase.	Ongoing	Mine manager	125
Commitment 13: In the event of a spill, any hydrocarbon contaminated soil will be removed immediately and taken to an appropriate authorised disposal or treatment facility. The Director, Environment Protection Authority, will be notified immediately.	Ongoing	Mine manager	125
Commitment 14: Run-off from the process area hardstand will be diverted to an interceptor to remove oil and grease prior to pumping to the recycle dam.	Ongoing	Mine manager	125
Commitment 15: Sewage effluent will be treated to accepted modern technology standards prior to discharge to the recycle dam.	Ongoing	Mine manager	125
Commitment 16: Pit water from both the main and DSO pits (which will include influx surface water and infiltrated groundwater) will be pumped to a centralised acid neutralisation plant, where it will be alkalinity dosed if its pH falls below 7. If alkalinity dosing is not necessary, pit water will then be directed to the recycle dam to satisfy process water make-up requirements in the first instance or discharged to East Creek if make-up requirements are satisfied.	Ongoing	Mine manager	125
Commitment 17: The discharge from the neutralisation plant will be via a sludge settling pond or thickener tank(s), designed to suit the chosen treatment plant's configuration. Periodically, the pond/tank(s) will be desludged and the sludge will deposited within the PAF rock dump inside the DSO pit immediately prior to the addition of a dump cover layer. The PAF cell will therefore retain the sludges <i>in situ</i> and they, together with the rock within the PAF dump, will be permanently flooded on mine closure.	Ongoing	Mine manager	126
Commitment 18: Tailings will be pH adjusted prior to deposition in the tailings dam so as to achieve a residual alkalinity.	Ongoing	Mine manager	126
Commitment 19: Decant from the tailings dam will be returned to the recycle dam for reuse as process water.	Ongoing	Mine manager	126
Commitment 20: Runoff from the NAF waste rock dump will be collected in a sediment settling basin prior to discharge to West Creek. If testing shows that the pH of the basin water is below 7, it will be pumped to the main pit and hence to the neutralisation plant for treatment.	Ongoing	Mine manager	126

Commitment	When	Responsible	Page
Commitment 21: Excess water from the recycle dam will be discharged to East Creek via the neutralisation plant, where it will be treated prior to discharge if its pH is below 7.	Ongoing	Mine manager	126
Commitment 22: The discharge of water to East Creek will be managed to protect the ephemeral nature of the creek. The recycle dam will be used to buffer discharges in accordance with a Discharge Management Plan that will be prepared prior to the commencement of operations. The Discharge Management Plan will be updated annually to reflect the accumulation of knowledge about groundwater and surface water flow patterns.	Ongoing	Mine manager	126
Groundwater			
Commitment 23: Groundwater encountered during construction will be disposed of in a similar manner to the surface water, using temporary sedimentation ponds, silt fencing and dissipation drains to minimise potential impact to downstream surface waters.	During construction	Relevant contractor	128
Noise emissions			
Commitment 24: All equipment and vehicles will be fitted with manufacturer's silencing equipment, operated appropriately and regularly maintained.	During construction / Ongoing	Relevant contractor / Mine Manager	131
Commitment 25: Use of appropriate hearing protection equipment will be mandatory in all relevant areas.	Ongoing	Mine manager	131
Solid and controlled waste management			
Commitment 26: Refuse will be stored on site in a covered bin and periodically taken to a waste transfer station for disposal.	Construction / Ongoing	Relevant contractor / Mine manager	137
Commitment 27: Rubbish bins will be provided at appropriate locations around the site and all staff will be required to avoid littering and to collect and bin any rubbish and litter that they observe on the site.	Ongoing	All mine staff	137
Commitment 28: Any hydrocarbon contaminated soil will be removed to an appropriate disposal site or treatment facility.	Construction / Ongoing	Relevant contractor / Mine manager	137
Commitment 29: Potential acid forming waste rock will be encapsulated in appropriately designed and constructed cells within the DSO pit. Excess PAF material will be encapsulated in appropriately designed and constructed cells above the DSO pit; this material will be pushed into the main pit on mine closure.	Ongoing	Mine manager	137
Commitment 30: Potential acid forming waste rock will be regularly covered with layers of low permeability material at a frequency dictated by the results of acid potential testing to ensure that the PAF rock is covered before the onset of acid producing conditions. For cells inside the pits, the cover material will be clay or crushed NAF. For temporary cells above the pit, the cover material will be clay.	Ongoing	Mine manager	137

Commitment	When	Responsible	Page
Commitment 31: All non-potentially acid forming waste rock not required for tailings dam or waste rock storage cell or other infrastructure construction will be disposed of in an appropriately designed and constructed waste rock dump unless sold or provided to other parties for off-site use.	Ongoing	Mine manager	137
Commitment 32: The tailings storage dam will be used only for the storage of process tailings.	Ongoing	Mine manager	137
Commitment 33: The tailings storage dam will be constructed with a clay core.	Construction	Relevant contractor/ Mine manager	137
Commitment 34: The base of the tailings dam and of PAF rock cells will be lined with clay compacted to achieve a permeability of less than $1 \times 10^{-9}$ m/s.	Construction	Relevant contractor/ Mine manager	137
Commitment 35: If signs of acidity occur in runoff from the NAF rock dump during the post-closure vegetation maintenance period, Shree will take expert advice on the significance of this and on potential mitigation measures. Shree will then implement a remedial program of works or treatment to the satisfaction of the Director of the EPA.	Post-closure	Mine manager	137
<b>Dangerous Goods</b>			
Commitment 36: Equipment maintenance and refuelling will occur within an appropriately bunded area(s).	Construction /Ongoing	Relevant contractor/ Mine manager	139
Commitment 37: Fuel storage and transport and explosives storage and handling will comply with the requirements of the National Code for the Storage and <i>Handling of Workplace Dangerous Goods</i> (NOHSC 2001).	Construction /Ongoing	Relevant contractor/ Mine manager	139
<b>Biodiversity and nature conservation values</b>			
Commitment 38: A Phytophthora quarantine protocol will be developed, focusing on washdown of all machinery and equipment coming onto the site from other earthwork areas.	During construction	Relevant contractor	170
Commitment 39: All machinery and vehicles undertaking earthwork activities will be cleaned prior to leaving the mining lease for work at other premises.	During construction	Relevant contractor	170
Commitment 40: Any areas that become infected with <i>Phytophthora cinnamomi</i> will be managed in accordance with DPIW 'Interim <i>Phytophthora cinnamomi</i> Management Guidelines'.	During construction / Ongoing	Relevant contractor/ Mine manager	170
Commitment 41: The extent of clearance required for the project will be clearly defined; appropriate measures (including marking tape, signs, site plans, site inductions, tool box talks and work inspections) will be undertaken to ensure that no additional clearance occurs.	During construction / Ongoing	Relevant contractor/ Mine manager	170

Commitment	When	Responsible	Page
Commitment 42: Unless prescribed burns to foster orchid populations are requested by the EPA Director on behalf of DPIPWE, there will be no disturbance of the sensitive wet heathlands to the west of West Creek, which provide known and potential habitat for threatened orchid species.	During construction / Ongoing	Relevant contractor / Mine manager	170
Commitment 43: All works, vehicles and materials will be confined to the designated works areas.	During construction / Ongoing	Relevant contractor / Mine manager	170
Commitment 45: If vegetation clearing must be undertaken during the masked owl nesting season or the Tasmanian devil or spotted-tailed quoll denning seasons, preclearance surveys will be conducted in the week prior to vegetation clearing for each stage commencing, to identify any occupied masked owl nests or maternal quoll dens or devil dens.	Ongoing	Mine manager	170
Commitment 46: A temporary 50 metre buffer will be established around any masked owl nest, or maternal quoll or devil den during the vegetation clearing operations. Only after the nest or den has been confirmed to be vacated will the vegetation clearing be completed.	Ongoing	Mine manager	170
Commitment 47: A Fauna Habitat Protection Zone (FHPZ) will be established in the western part of the lease, west of West Creek, within which quoll and devil denning and refugia opportunities will be established and enhanced.	Ongoing	Mine manager	170
Commitment 48: Dogs and other pets will be banned from the mine site.	Ongoing	Mine manager	171
Commitment 49: The speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour.	Ongoing	Mine manager	171
Commitment 50: Mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily).	Ongoing	Mine manager	171
Commitment 51: Offsite transport of mine product will be confined to daylight hours.	Ongoing	Mine manager	171
Commitment 52: The mine will provide employees with a daily bus service to and from the mine site.	Ongoing	Mine manager	171
Commitment 53: The project's fauna impact avoidance and mitigation measures will be consolidated into a Fauna Management Plan that will be prepared before construction activities commence. The Fauna Management Plan will describe all actions and commitments, particularly those relating to road kill, the establishment and maintenance of the Fauna Habitat Protection Zone and road kill and den activity monitoring and reporting. An annual report on the implementation of the Fauna Management Plan will be prepared and provided to the EPA for information.	Ongoing	Mine manager	171



Commitment	When	Responsible	Page
Greenhouse gases and ozone depleting substances			
Commitment 54: All construction, mining equipment, machinery and vehicles will be appropriately maintained in order to minimise the generation of greenhouse gases.	During construction / Ongoing	Relevant contractor / Mine manager	176
Commitment 55: Disturbed areas will be actively revegetated, offsetting the project carbon emissions.	Ongoing	Mine manager	176
Commitment 56: Onsite materials will be used for construction of the tailings storage dam to minimise the need for extraction and transport of offsite material to the mine.	Ongoing	Mine manager	176
Commitment 57: No ozone depleting substances will be used or generated during construction and operation of the mine and processing plant.	During construction / Ongoing	Relevant contractor / Mine manager	176
Heritage			
Commitment 58: In the event that any Aboriginal artefacts are discovered during the project area clearance and construction, all work will stop immediately in that area and the Manager, Aboriginal Heritage Tasmania at the Department of Primary Industries, Parks, Water and Environment will be contacted to assess the situation.	During construction / Ongoing	Relevant contractor / Mine manager	179
Visual impact			
Commitment 59: The NAF waste rock dump will be progressively rehabilitated and revegetated to reduce visual impact from roads.	Ongoing	Mine manager	182
Health and Safety Issues			
Commitment 60: All operations, maintenance and inspection health and safety issues on the mine site will be compliant with the Workplace Health and Safety Act 1995 and the Workplace Health and Safety Regulations 1998.	During construction / Ongoing	Relevant contractor / Mine manager	183
Hazard Analysis and Risk Assessment			
Commitment 61: A detailed risk (hazard) assessment will be undertaken as part of the final design of pits, waste rock dump and tailings storage area.	Prior to construction	Design engineers	185
Commitment 62: A geotechnical site assessment of the waste rock dump site, tailings dam and processing site facilities will be undertaken to determine site foundation conditions.	Prior to construction	Proponent	185
Commitment 63: Determination of the waste rock dump slopes will be based on a geotechnical assessment of slope stability, given the size range and nature of the waste rock material.	Prior and during construction	Mine Manager	185
Commitment 64: Construction of the proposed tailings storage facility will be compliant with ANCOLD design and management guidelines.	During construction	Relevant contractor / Mine manager	185

Commitment	When	Responsible	Page
Commitment 65: A Safety Management System will be developed and implemented to manage risks associated with the storage of explosives and fuel.	During detailed design	Mine manager	185
Commitment 66: A HAZID analysis will be undertaken as part of the detailed design/selection process for the processing plant and power generators and resulting risk avoidance, reduction and mitigation measures will be developed and implemented.	During detailed design	Mine manager	185
<b>Fire Risk</b>			
Commitment 67: A Fire Management Plan will be developed for the mine site.	Prior to construction	Proponent	188
Commitment 68: The project site clearance, construction, commissioning and operations will be conducted in accordance with the Fire Management Plan.	During construction / Ongoing	Relevant contractor / Mine manager	188
Commitment 69: The Fire Management Plan will be reviewed and updated as part of the EMP review.	Ongoing	Mine Manager	188
Commitment 70: Facilities in the processing area will be designed in accordance with all relevant standards to ensure fire protection systems and equipment are installed and operational at all times.	Ongoing	Mine Manager	188
<b>Environmental Management Systems</b>			
Commitment 71: A Mine Environmental Management System will be developed in accordance with EPA requirements.	Prior to construction	Proponent	189
Commitment 72: Operation of the mine and processing facilities will be undertaken in accordance with the Mine Environmental Management System	Ongoing	Mine Manager	189
<b>Monitoring and Review</b>			
Commitment 73: Surface water samples will be taken at stations NBRSW01, NBRSW02, NBRSW03, NBRSW04, NBRSW05, NBRSW06, NBRSW07 and NBRSW08 and at an additional sampling site that will be established in Nelson Bay River, immediately downstream from its confluence with West Creek, every 3 months and analysed for physicochemical parameters and metals.	Ongoing	Mine Manager	197
Commitment 74: Groundwater samples (and depth to groundwater) will be taken at stations NBRGW01, NBRGW02, NBRGW03, NBRGW04, NBRGW05, NBRGW06, NBRGW07 and NBRGW08 every 6 months and analysed for physicochemical parameters and metals.	Ongoing	Mine Manager	197
Commitment 75: Additional surface water sampling sites will be established in East Creek upstream and downstream from the recycling dam overflow discharge point, in West Creek upstream from the tailings dam basin overflow discharge point, and upstream from the NAF dump sediment pond. Discharges from these locations will be sampled weekly for flow, pH and turbidity during operations but background sampling at these sites will commence before mining commences.	Ongoing	Mine Manager	197

Commitment	When	Responsible	Page
Commitment 76: The pH of water from the main pit and DSO pit, the tailings dam decant, and in the tailings dam basin and the recycle dam will be tested weekly.	Ongoing	Mine Manager	197
Commitment 77: The tailings stream will be tested daily to determine alkalinity dosing requirements to achieve a residual alkalinity in the tailings dam.	Ongoing	Mine Manager	197
Commitment 78: Samples of the settled tailings will be taken every 6 months and tested for net acid generating potential and acid neutralising capacity.	Ongoing	Mine Manager	197
Commitment 79: Pre-disturbance macroinvertebrate monitoring surveys of the Nelson Bay River will be undertaken annually in accordance with the Ausrivas protocol at five sites: one on Nelson Bay River upstream of the mine where the river is crossed by the Wuthering Heights Road bridge; one each in Nelson Bay River downstream of the entry points of West and East Creeks respectively; and one each in West and East Creeks.	Prior to construction	Consultant	197
Commitment 80: A general fish survey will be undertaken in Nelson Bay River downstream of the mine in years 1, 4, 7 and 10.	Ongoing	Mine Manager	197
Commitment 81: The new denning opportunities created by vegetation windrowing will be monitored for use by quolls and devils.	Ongoing	Consultant	197
Commitment 82: Records will be maintained of roadkill removed from Wuthering Heights Road and from within the mine site.	Ongoing	Mine Manager	197
Commitment 83: A site decommissioning and rehabilitation plan (Mine Closure Plan) will be prepared in accordance with EPA requirements.	As part of this DPEMP	Proponent	198

## 10. Summary of key assessed risks

Table 44: Summary of key risks assessed

Matter	Risk assessed	Residual significance
<b>Surface and groundwater</b>		
Impact on quality	<p>Construction and operation of the mine could impact on the quality of surface water through mine site discharge of surface and groundwater.</p> <p>During construction, temporary settlement basins and silt fencing will be used and final runoff will be directed to naturally vegetated gently sloping land to natural drainage lines.</p> <p>All surface water will be recycled. Any excess water that will need to be discharged will be passed through permanent sedimentation ponds and dissipation drains prior to discharge to local drainage lines at approved locations.</p> <p>Tailings will be stored in a facility with a compacted clay lining to reduce the possibility of seepage to groundwater.</p>	Not significant
<b>Biological values of Nelson Bay River</b>		
Direct impact on river habitat	<p>Sediment loss to Nelson Bay River could result in loss of habitat, displacement of aquatic animals and impact on fish gills and respiration.</p> <p>The use of temporary settlement basins and silt fencing during construction and permanent settlement basins and water recycling will ensure that there is no sediment loss to Nelson Bay River.</p>	Not significant
Change to the ephemeral nature of East Creek	A constant discharge of mine water to East Creek could change it from an ephemeral stream to a permanent stream and the creek biota could change accordingly. To avoid these impacts, the discharge of water will to the extent practicable mimic an ephemeral stream, with water held back from discharge for extended periods when the creek is dry.	Not significant
Acid drainage to natural streams	Acid discharges from mines can cause mortality across a wide range of macroinvertebrate species. Similarly, macroinvertebrate community composition, abundance and diversity all show significant reductions with low pH discharges. Fish can also be excluded from affected reaches. Acid generation prevention and treatment measures are a fundamental basis of the mine plan and operations.	Not significant
<b>Acid drainage</b>		
Highly reactive PAF and/or high rainfall events	All PAF material will be stored in or above the DSO pit. The PAF will be regularly covered with layers of clay or crushed NAF rock to create a barrier to water and oxygen infiltration. The rate of cover layering will be determined by regular K-NAG testing and will be prior to the predicted onset of acid generation. Any runoff from the PAF cells will collect in the DSO pit, to be pumped out to the recycle dam via the neutralisation plant. These measures will minimise the likelihood of acid water discharging to surface waters.	Not significant

Matter	Risk assessed	Residual significance
DSO pit capacity	The DSO pit may not have a sufficiently large volume to accommodate all pyritic waste material - temporary storage may be required pending closure of the main pit	Not significant
DSO pit storage	Pyritic material stored in the DSO pit will be covered with water on mine closure	Not significant
Temporary storage of PAF waste rock	Temporary storage of pyritic material in separate encapsulation cells with appropriate drainage controls above the DSO pit. There may be some acid drainage from this dump but this will be collected within the pit to be managed as part of the pit water.	Not significant
Main pit storage	On mine closure, all pyritic material in the temporary storage cells above the DSO pit will be pushed into the main pit and eventually covered with water	Not significant
Discharge to Nelson Bay River	The minimisation of the risk of acid drainage to surface waters is the fundamental intent of the mining and water management strategy. The mine plan, the separation of NAF and PAF material, the provision of a centralised neutralisation plant, the regular and routine acid accounting testing regime, the alkalinity dosing of tailings, the flooding of the tailings dam on closure, the storage of PAF material in or above the DSO pit with covering at a frequency determined by its reactivity, and the flooding of all PAF waste rock on mine closure are all designed to avoid the formation in the first instance and ultimately the discharge of acid water. The risk of an acid discharge to Nelson Bay River is therefore not significant.	Not significant
<b>Waste rock dump</b>		
Long term stability	The dump could become unstable, resulting in partial failure. Geotechnical assessment of the foundation materials, construction of the dump within the established safe slope parameters and timely rehabilitation will ensure safe long term stability	Not significant
<b>Tailings storage facility</b>		
Failure of dam walls	Long term failure of the tailings storage facility walls. Construction of the dam to ANCOLD standards will ensure that the facility will withstand a 1 in 10,000 year storm event.	Not significant
Water cover drying out	On mine closure, the creek upstream of the tailings dam will be partially redirected to ensure that the tailings dam retains a long term cover of water to prevent oxidation of any pyritic material in the tailings.	Not significant
<b>Threatened orchids</b>		
Direct disturbance or loss of individual plants	Targeted surveys (undertaken in the spring of 2010) found no threatened orchid plants within the mine lease area. Orchids do not always flower in every year and it is conceivable that individual plants could emerge in other flowering years. However, whether and where individual plants might occur some unknown time in the future can only be speculative and cannot be the basis for development planning or decision making.	Not significant

Matter	Risk assessed	Residual significance
Direct disturbance or loss of populations	<p>Targeted surveys (undertaken in the spring of 2010) found no threatened orchid plants within the mine lease area but it is conceivable that orchid populations could emerge in other flowering years.</p> <p>Although it is conceivable that populations of threatened orchid species might appear within non-preferred habitat, these occurrences would be incidental and by definition would be within areas that are not optimal.</p> <p>Protection of the species will best be achieved by protecting optimal habitat because it is that habitat that is most likely to contain sustainable populations.</p> <p>The protection of wet heathland is therefore the design objective of the mine. Protecting this habitat provides the best assurance against minimising the loss of populations of threatened orchid species, irrespective of whether particular populations may or may be found within the habitat in any particular seasonal survey.</p>	Not significant
Direct physical disturbance or loss of habitat	<p>Within the vicinity of the mine, the wet heathland is the habitat most likely to be preferred by any threatened orchid species that exist in the area. The mine footprint will require the clearance of 4.2 ha of wet heathland patches (to the east of West Creek) but will entirely protect a very much larger area of wet heathland that lies in the western part of the lease (west of West Creek).</p> <p>Relative to the wider region, the 4.2 ha lost represents only 1.2% of the total wet heathland mapped by Tasveg as occurring within a 5 km radius of the lease. In fact, the site survey indicates that the vegetation mapped by Tasveg as buttongrass moorland to the west of the mine site is actually wet heathland, meaning that the 1.2% figure is probably a significant overestimate of the actual proportion of wet heathland in the region that would be lost due to the mine.</p>	Not significant
Altered fire regimes	<p>Fire can have positive and negative effects on orchids. Orchids often flower 1 to 3 years after a fire. On the other hand fires could kill orchids if they are too intense.</p> <p>The mine will actively manage its operations to minimise the risk of fire starting on the mine site and it will also actively suppress any fires that do nevertheless start or that encroach upon it from outside.</p> <p>The net effect of these management measures is that there is unlikely to be a significant change to the historical fire regime. This is a conservative, small change approach. Local orchid populations may, in fact, actually benefit from an increased fire frequency. However, unless Shree Minerals is specifically requested by the EPA Director on behalf of DPIPWE to undertake prescribed burning within its lease, the small change approach will be implemented.</p>	Not significant
Spread of weeds	<p>The spread of weeds and also plant diseases (such as Phytophthora) is highly undesirable irrespective of their potential impact on threatened orchid species and active weed and disease management measures will therefore be implemented at the mine. Indeed, they have already been implemented during the exploration phase.</p> <p>Equipment, machinery and vehicle inspection, washdown and disinfection procedures will be implemented and enforced for anything coming to the mine from a site where it has been exposed to disturbed soil.</p>	Not significant



Matter	Risk assessed	Residual significance
	These measures will continue throughout the life of the mine.	
Genetic effects of small population size	<p>Genetic effects, if any, arising from small population sizes would be a factor intrinsic to the existing gene pools and distributions of the various orchid species.</p> <p>If these effects do exist, the most appropriate way to mitigate against adverse consequences would be to protect the core habitat of each species. As described above, this means protecting the wet heathland, which is achieved by the mine design.</p> <p>There is no significant potential for the mine to influence the genetic characteristics of the orchids or to exacerbate any inherent genetic risks if indeed such risks exist in the first instance.</p>	Not significant
Loss of mycorrhizal fungus	<p>Mycorrhizal fungus associations with orchids are known to be easily compromised by weed invasion, edge effects due to altered land use, changes to soil chemistry, changes to organic content and changes to hydrology. The task for the mine therefore becomes one of ensuring that its activities do not cause any of these changes.</p> <p>Weed management measures will minimise the risk of weed invasion to the mine site itself and therefore consequential weed invasion of the wet heathlands in the western part of the lease.</p> <p>The mine design by intent creates a clear separation buffer between the mine footprint and the wet heathland in the western part of the lease. That buffer will exclude any edge effects because the mine footprint and the heathlands will not share a contiguous boundary.</p> <p>There is no identifiable causal relationship between the presence of the mine in the eastern part of the mine lease and the soil chemistry or organic of the wet heathland in the western part. Any mooted of some possible unknown relationship could only be speculative at best, and without scientific basis.</p> <p>The remaining potential impact of the mine on mycorrhizal fungus associations with orchids is a change to the hydrology of the soil where those associations take place. The wet heathland (the preferred habitat of the orchids) in the western part of the lease is well away from the mine pits and will be at the extreme margins of the water table depression that will occur from pit dewatering. More importantly, the wet heathland is a groundwater recharge area. The heathland soil does not derive its water from the underlying groundwater but rather from precipitation from above. Even if it did occur, any lowering of the watertable below the heathland (which at most would be marginal anyway) could therefore not change the soil water regime and therefore could not affect mycorrhizal fungus associations.</p>	Not significant
Loss of pollinators	<p>Many orchids (but not all - some are self-pollinating) rely on insects for pollination. Loss of pollinator habitat could therefore impact on orchids by reducing their pollination rates.</p> <p>However, regardless of which particular vegetation community might be preferred by particular orchid pollinators, the maximum percentage loss of any given vegetation community within a 5 km radius of the mine is less than 3%.</p>	Not significant

Matter	Risk assessed	Residual significance
<b>Wedge-tailed eagle</b>		
Nest disturbance	The survey area has a low probability of containing eagle nests as most of the mature eucalypts within the study area have been badly fire damaged. The nearest known eagle nest is approximately 1.8 km to the north east of the study area (nest id 971500). A helicopter-based search failed to locate any other nests.	Not significant
Roadkill	An increase of traffic volume to and from the proposed mine site could potentially result in a higher incidence of road kill or injury to individual birds as they feed on any carcasses of wildlife killed by traffic. However, roadkill minimisation measures and the removal of any roadkill from mine roads and Wuthering Heights Road will mitigate this risk.	Not significant
<b>Masked owl</b>		
Nest loss due to vegetation clearing	There is a potential impact on nesting owls from vegetation clearing if owls use any of the old trees on the site for nesting and clearing occurs during the nesting season.  However, preclearance surveys will take place immediately before each stage of clearing to identify any nesting habitat trees currently in use by masked owls. A temporary 50 metre buffer will be established around any such nests during the clearing operations. Only after the nest has been confirmed to be vacated will the vegetation clearing be completed.	Not significant
<b>Spotted-tailed quoll</b>		
Displacement by vegetation clearing	Based on conservative (high) assumptions about quoll densities on the site, clearing of vegetation for the mine could displace up to 1 quoll. However, the area cleared will not be significant relative to the movement range of quolls or the large area of surrounding vegetation.	Not significant
Den loss due to vegetation clearing	There is a potential impact on quolls from vegetation clearing if any maternal dens are present and occupied and clearing occurs during the denning season.  However, preclearance surveys will take place immediately before each stage of clearing to identify any maternal dens currently in use by quoll. A temporary 50 metre buffer will be established around any such dens during the clearing operations. Only after the den has been confirmed to be vacated will the vegetation clearing be completed.  New denning opportunities will be created within a Fauna Habitat Protection Zone to the west of the mine footprint by constructing numerous windrows of cleared vegetation piles. Materials for the creation of the windrows will be sourced from the forest materials cleared for the waste rock dump and tailings dam and will include large trees placed specifically to create suitable denning hollows and to create good fauna shelter.	Not significant
Roadkill	An increase of traffic volume to and from the proposed mine site could potentially result in a higher incidence of quoll road kill. However, this risk will be mitigated through a number of measures.	Not significant

Matter	Risk assessed	Residual significance
	<p>The speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour. This is the critical stopping distance for avoiding roadkill at night but will be applied throughout the day also as a conservative measure.</p> <p>Mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily). The roadkill will be moved at least 40 m from the edge of the road verge.</p> <p>Product transport will be restricted to daylight hours. Without this restriction, product transport could increase the quoll roadkill on the region's roads by 0.6 every year (and 1.6 in year 1). Confining product transport to daylight hours will reduce these risks to 0.1 and 0.3 kills per year respectively.</p>	
<b>Tasmanian devils</b>		
Displacement by vegetation clearing	Based on conservative (high) assumptions about devil densities on the site, clearing of vegetation for the mine could displace up to 2 devils. However, the area cleared will not be significant relative to the movement range of devils or the large area of surrounding vegetation.	Not significant
Den loss due to vegetation clearing	<p>There is a potential impact on devils from vegetation clearing if any maternal dens are present and occupied and clearing occurs during the denning season.</p> <p>However, preclearance surveys will take place immediately before each stage of clearing to identify any maternal dens currently in use by devils. A temporary 50 metre buffer will be established around any such dens during the clearing operations. Only after the den has been confirmed to be vacated will the vegetation clearing be completed.</p> <p>New denning opportunities will be created within a Fauna Habitat Protection Zone to the west of the mine footprint by constructing numerous windrows of cleared vegetation piles. Materials for the creation of the windrows will be sourced from the forest materials cleared for the waste rock dump and tailings dam and will include large trees placed specifically to create suitable denning hollows and to create good fauna shelter.</p>	Not significant
Roadkill	<p>An increase of traffic volume to and from the proposed mine site could potentially result in a higher incidence of devil road kill. However, this risk will be mitigated through a number of measures.</p> <p>The speed limit for mine workers and product transporters on Wuthering Heights Road from the Rebecca Road turnoff will be limited to 50 km per hour. This is the critical stopping distance for avoiding roadkill at night but will be applied throughout the day also as a conservative measure.</p> <p>Mine staff will remove any roadkill observed on Wuthering Heights Road (weekly) and within the mine site (daily). The roadkill will be moved at least 40 m from the edge of the road verge.</p> <p>Product transport will be restricted to daylight hours. Without this restriction, product transport could increase the devil roadkill on the region's roads by 3 every year (and 8 in year 1). Confining product transport to daylight hours will reduce these risks to 0.6 and 1.6 kills per year respectively.</p>	Not significant

## 11. Summary of management plans to be prepared

Following project approval, construction and operational management plans, summarised in Table 45, will be prepared before development of the mine and construction work commences.

Table 45: Operational management plans to be prepared prior to mine development and construction work commencing

Plan	Purpose	Section reference
Construction Environmental Management Plan	To manage environmental impacts during construction	4.2.6
Drainage Management Plan	To manage general site drainage during operations and on closure	4.2.6
Mine Closure Plan	To manage closure and site rehabilitation	Appendix S
Dust Management Plan	To manage dust emissions during construction and operations	4.1.5
Fire Management Plan	To protect the assets from fire and to maintain the existing natural fire regime, consistent with existing local fire authority requirements and public property management expectations	6.18.3
Fauna Management Plan	To manage the establishment and maintenance of the Fauna Habitat Protection Zone, road kill mitigation measures and den activity monitoring and reporting	Commitment 53
Environmental Monitoring Plan	To manage environmental monitoring during operations and post-rehabilitation	Section 7
Discharge Management Plan	To manage discharges of mine water to surface waters, particularly East Creek	4.2.2

## 12. Conclusions

- This Development Proposal and Environmental Management Plan (DPEMP) has been developed in accordance with the EPA Division's generic DPEMP guidelines and the site specific guidelines from the Board of the Tasmanian Environment Protection Authority issued on 18 May 2011, entitled: *Development Proposal and Environmental Management Plan Project Specific Guidelines for Shree Minerals Nelson Bay River Magnetite Mine Nelson Bay River*.
- The Development Proposal and Environmental Management Plan has identified and assessed the potential impacts associated with the proposed project.
- The specific commitments contained in the Development Proposal and Environmental Management Plan demonstrate that appropriate operational and management measures will be in place to minimise any potential impacts and to minimise any risks to the environment and human health. With these measures in place, there are no significant risks of significant residual environmental impacts.
- The Development Proposal and Environmental Management Plan demonstrates that the proposal will be compliant with Tasmanian policies, legislation and regulations.
- The community will benefit from the socioeconomic advantages generated by the project.

## Appendix A

### Conceptual mine layouts showing staging

DSO mining (year 1)  
Mid-mine life (year 5)  
End of mine (year 10)  
10 years after closure





## Appendix B

### Conceptual mine pit cross-sections



## Appendix C

### Conceptual processing plant design



## Appendix D

### Hydrogeological report



## Appendix E

### Preliminary processing flowsheet for high grade hematite



## Appendix F

### Preliminary processing flowsheet for low grade hematite



## Appendix G

### Preliminary magnetite processing flowsheet





## Appendix H

### Water monitoring staging



## Appendix I

### Waste rock accounting analytical results



## Appendix J

### K-NAG test interpretive report



## Appendix K

### Pit section potential acid forming (PAF) zones



## Appendix L

### PAF waste rock estimation



## Appendix M

### Traffic impact assessment





## Appendix N

### Conceptual mine elements and conservation area



## Appendix O

### Water quality monitoring database



## Appendix P

### Flora and fauna assessment



## Appendix Q

### Giant freshwater crayfish report



## Appendix R

### Roadkill and headlight survey data



## Appendix S

### Mine closure plan





transport infrastructure | community infrastructure | industrial infrastructure | climate change



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