Invitation

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. Both electronic and hard copy submissions are most welcome. The environmental impact assessment process is designed to be transparent and accountable, and includes specific points for public involvement, including opportunities for public review of environmental review documents. In releasing this document for public comment, the EPA advises that no decisions have been made to allow this proposal to be implemented.

International Minerals Pty Ltd, a wholly owned subsidiary of Australasian Resources Limited (ASX – “ARH”), proposes to develop the Balmoral South Iron Ore Project (the “Project”) located approximately 80 kilometres south west of Karratha in Western Australia.

The Project will consist of open-cut mining of iron-ore, on-site processing to produce magnetite concentrate and pellets, and product transport via a conveyor to a stockpile area at the proposed port at Cape Preston, for product export to international markets. It will include the construction of an accommodation village approximately 10 kilometres south of the mine site and concentrating and pelletising facilities, a power station, a 30 kilometre infrastructure corridor connecting the mine and process areas to the port, along which will be installed either product conveyors or slurry pipelines, high voltage power lines, and water pipelines. Facilities at the port area include product stockpiles, and a desalination plant from which process water will be piped along the corridor back to the process area.

Access to the minesite will be provided by upgrading an existing farm access road between the North West Coastal Highway and the Project facilities.

This application does not seek approval for the port, which will be installed and operated by others.

It is proposed that process tailings will be filtered to remove excess water and stored with mine waste in a combined waste disposal facility; as such this application does not seek approval for a wet tailings storage facility.

In accordance with the Environmental Protection Act 1986, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 8 weeks from 9 March, 2009, closing on 4 May, 2009.

Comments from government agencies and from the public will assist the EPA to prepare an assessment report in which it will make recommendations to government.

Where to get copies of this document

Printed and CD copies of this document may be obtained from Australasian Resources Pty Ltd at Level 4, 5 Mill Street, PERTH WA 6000 (Ph: 08 9322 2288) at a cost of $10. The document/s may also be accessed through the proponent’s website at www.austresources.com.au/balmoral.

Why Write a Submission

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Electronic submissions will be acknowledged electronically. The proponent will be required to provide adequate responses to points raised in submissions. In preparing its assessment report for the Minister for the Environment, the EPA will consider the information in submissions, the proponent’s responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the Freedom of Information Act 1992, and may be quoted in full or in part in each report.
Invitation to Make a Submission

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific elements of the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER;
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering; and
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- Your name
- Address
- Date
- Whether you want your submission to be confidential and the reason why you want your submission to be confidential

The closing date for submissions is: 1 May, 2009

The EPA prefers submissions to be made electronically using one of the following:

- The submission form on the EPA’s website: [www.epa.wa.gov.au/submissions.asp](http://www.epa.wa.gov.au/submissions.asp);
- By email to [submissions.eia@dec.wa.gov.au](mailto:submissions.eia@dec.wa.gov.au);

Alternative 1: Submissions can be posted to:

Chairman
Environmental Protection Authority
Locked Bag 33
CLOISTERS SQUARE WA 6850
Attention: Danielle Griffiths
Invitation to Make a Submission

Alternative 2: Submissions can be delivered to:

Environmental Protection Authority
Level 4, The Atrium
168 St Georges Terrace
PERTH WA 6000
Attention: Danielle Griffiths

Alternative 3: Faxed to:

Environmental Protection Authority
Fax number: (08) 6467 5562
Attention: Danielle Griffiths

If you have any questions on how to make a submission, please ring the EPA assessment officer, Danielle Griffiths on (08) 6467 5440.
Invitation to Make a Submission
Summary and Conclusions

Introduction and Project Overview

International Minerals Pty Ltd (IM) proposes to develop the Balmoral South Iron Ore Project in the Cape Preston region of Western Australia, 80 km south west of Karratha. The Project will comprise:

- an open-cut iron ore mine producing 80 Mtpa of magnetite ore;
- overburden and waste disposal facilities;
- processing facilities including crusher, concentrator and pellet plant;
- the production of 24 Mtpa of concentrate, of which approximately 14 Mtpa will be pelletised, and all will be exported;
- materials handling facilities including a 30 km conveyor linking the plant site to port stockyard facilities at Cape Preston;
- utilities including a 40 GLpa desalination plant and 600 MW combined cycle power station;
- accommodation village for 4,000 construction and 1,500 operations personnel; and
- offices, workshops and other supporting infrastructure including explosives magazine, landfill, fuel storage and distribution, and warehousing.

The proposed Project is adjacent to the approved Mineralogy Central Block Project.

The Project does not cover any marine based export activities. From the stockyard, product will be conveyed to the port being established by the Central Block Project. From here product handling and loading will be managed by Mineralogy as a component of the Central Block approvals.

Project construction is expected to commence in 2009 with development occurring in 2 stages, initial development over a three year period for the production of 12 Mtpa of export product followed by a doubling of production to 24 Mtpa over a further three year period.

The Project is expected to operate for at least 28 years after the first 3 years of construction and commissioning, with extensions beyond this being dependant on continued contracts for ore supply and economic analysis.

The Project key characteristics are provided in the table below.

Table 0-1: Project Key Characteristics

<table>
<thead>
<tr>
<th>Element</th>
<th>Characteristics (All quantities are NOMINAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
</tr>
<tr>
<td>Development Period</td>
<td>Project Development Stage 1: 3 years</td>
</tr>
<tr>
<td></td>
<td>Project Development Stage 2: 3 years (immediately after Stage 1)</td>
</tr>
<tr>
<td>Operation Period</td>
<td>Minimum 28 years after Project Development Stage 1</td>
</tr>
<tr>
<td><strong>Mining</strong></td>
<td></td>
</tr>
<tr>
<td>Ore reserves</td>
<td>2 billion tonnes</td>
</tr>
<tr>
<td>Ore mining rate</td>
<td>80 Mtpa</td>
</tr>
<tr>
<td>Pit depth (ultimate)</td>
<td>300 m</td>
</tr>
<tr>
<td>Overburden and waste</td>
<td>80 Mtpa</td>
</tr>
<tr>
<td>Stripping ratio</td>
<td>1.0 / 1.0 waste ore</td>
</tr>
<tr>
<td>Materials handling</td>
<td>Conventional drill, blast, load and haul.</td>
</tr>
<tr>
<td>Dewatering rate</td>
<td>Up to 4 GLpa, including groundwater inflows and weather events</td>
</tr>
</tbody>
</table>
### Summary and Conclusions

<table>
<thead>
<tr>
<th>Element</th>
<th>Characteristics (All quantities are NOMINAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dewatering disposal</td>
<td>To process water stream and dust suppression</td>
</tr>
<tr>
<td><strong>Concentrator</strong></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>Concentrate: 24 Mtpa</td>
</tr>
<tr>
<td>Waste</td>
<td>56 Mtpa</td>
</tr>
<tr>
<td><strong>Pelletising</strong></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>Pellets: 14 Mtpa</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>Up to 600 MW installed capacity gas fired combined cycle power station</td>
</tr>
<tr>
<td>Conveyor / Slurry Pipeline</td>
<td>~ 30km in length between the Process Plant site and Cape Preston Stockyard</td>
</tr>
<tr>
<td>Gas supply</td>
<td>Up to 34,000 Tjpa</td>
</tr>
<tr>
<td>Water Supply</td>
<td>40 GLpa desalination plant and up to 4 GLpa pit dewatering</td>
</tr>
<tr>
<td>Port Stockyard</td>
<td>2 Mt storage capacity</td>
</tr>
<tr>
<td>Roads</td>
<td>General traffic, haulage, mine, accommodation and access, infrastructure maintenance access</td>
</tr>
<tr>
<td>Buildings</td>
<td>Administration, maintenance workshops, storage, accommodation village and power station</td>
</tr>
<tr>
<td>Sewage</td>
<td>Package treatment plants</td>
</tr>
<tr>
<td><strong>Disturbance Areas</strong></td>
<td></td>
</tr>
<tr>
<td>Areas of disturbance and rehabilitation</td>
<td>Total Disturbance During Project 5,282 ha</td>
</tr>
<tr>
<td></td>
<td>Final Pit Outline Surface Area 355 ha</td>
</tr>
<tr>
<td></td>
<td>Total Rehabilitation 4,927 ha</td>
</tr>
<tr>
<td><strong>Workforce</strong></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Up to 4,000</td>
</tr>
<tr>
<td>Permanent</td>
<td>Up to 1,500</td>
</tr>
<tr>
<td>Accommodation</td>
<td>Onsite for the entire workforce</td>
</tr>
</tbody>
</table>

### Assessment

The Project is being assessed under Part IV of the *Environmental Protection Act 1986* and the *Environment Protection and Biodiversity Conservation Act 1999*. A bilateral agreement between the Commonwealth and WA governments accredits the State environmental impact assessment process. This means that a single assessment process will be carried out that satisfies both State and Commonwealth requirements. This Public Environmental Review (PER) is the document prepared for environmental assessment.

### Project Benefits

The Project will contribute to the regional economy through export earnings, taxes, salaries and purchase of goods and services during construction and operation. It will generate approximately $3 billion in sales revenue per annum over its project life, and will contribute to the local economy, both directly and indirectly, as a result of contractual opportunities to local communities, including indigenous groups and full-time employment for approximately 1500 people on an ongoing basis. Further contribution will be created by the flow-on effects on service industries and other sectors of the economy.

### Key Values of the Project Area

Cape Preston is a remote site, relatively far from existing emission sources. As a result, existing levels of atmospheric pollutants are low.
Summary and Conclusions

The Project is located adjacent to the lower reaches of the Fortescue River and approximately 15 km from the river mouth. The Fortescue River has a well defined main flow channel, typically 4–6 m deep and 100 m wide adjacent to the Project Area. The ephemeral Edward and Du Boulay Creeks flow through the Project Area in a north-westerly direction and discharge to the Fortescue River.

The major aquifer in the area is the gravels of the Fortescue River alluvium. Depth to the water table is generally 4-12 m below ground level. Groundwater within the Fortescue River alluvium generally conforms to drinking water guidelines. Groundwater users in the Project Area are pastoral wells, phreatophytic vegetation and subterranean fauna.

Within the Project Area a total of 500 vascular flora species have been recorded. No Declared Rare or Threatened Flora have been recorded, although two Priority Flora species have been found. The Declared Plants *Prosopis pallida* (Mesquite) and *Datura leichhardtii* (Native Thornapple) occur in the area and drainage lines tend to be heavily infested with *Cenchrus ciliaris* (Buffel Grass).

The Project Area is predominantly degraded cattle grazing country, broadly consisting of various *Acacia* shrublands over *Triodia* hummock grasslands on the more rugged, shallow soil habitats, and *Eragrostis xerophila* tussock grasslands dominating the heavy clay soils. Drainage lines are dominated by *Eucalyptus* spp. over *Melaleuca* and *Acacia* shrublands.

Eighty vegetation communities have been mapped. Of particular importance are the cracking clays of the Horseflats Land System and the phreatophytic vegetation of the River and Paraburdoo Land Systems. In 2004, the Minister for Planning and Infrastructure approved an area of approximately 2,555 ha to be excluded from Mardie Station as part of the "2015 Exclusion Process". The area was identified as particularly valuable for its conservation value because of the Horseflats Land System and related vegetation. No Threatened Ecological Communities have been recorded.

Three phreatophytic flora species (*Eucalyptus camaldulensis*, *Eucalyptus victrix* and *Melaleuca argentea*) occur within eight vegetation communities.

A well-developed and structurally complex mangrove system is associated with the major tidal creek and connective tidal flats that join Cape Preston with the mainland (Mangrove Creek). Other areas of mangrove occur in the wider locality, including a generally narrow zone of *Avicennia marina* which borders the western shoreline and embayments between the creek and the mouth of the Fortescue River.

The vertebrate fauna of the Project Area is generally dominated by birds and reptiles. Several species of mammal are also common, predominantly consisting of smaller species such as native mice. Database searches have indicated that several fauna species of conservation significance potentially occur in the area. In general, it has been determined over the course of the 2000 and 2006 field surveys that fauna habitats within the Project Area are well represented in the Region and none are considered as regionally significant or unique. Of the habitats sampled, rivers and creek lines yielded the highest number of species.

Studies to date suggest that the Project Area contains a subset of the subterranean fauna that occurs within the larger Cape Preston area. It appears likely, based on the distribution of the more frequently occurring species and the lack of major geological discontinuities between the mining areas that the same communities extend through all orebodies at Cape Preston.

At Cape Preston, nearshore water movements and mixing patterns are driven primarily by large tidal ranges (HAT of 4.75 m), local currents and winds. The water column is relatively well mixed. Turbidity in the region is generally high due to the episodic high volume river flows, dominant marine sediment types, strong local winds, large tides and common occurrences of cyanobacterial blooms. Water quality in the area is relatively undisturbed by anthropogenic sources.

Macroalgae dominate submerged limestone reefs within the Cape Preston area, and also grow on stable rubble and boulder surfaces. Seagrasses form interspersed macroalgae beds. Fauna of the shallow water limestone reefs and platforms include hard and soft corals, sponges, ascidians, fan worms, molluscs, crustaceans, urchins and sea stars. Dense areas of high coral cover are sparsely distributed in the region, whilst areas of low coral cover tend to occur as a thin border along steep slopes that descend from shallow algal dominated pavements around islands to a deep sandy seafloor. The nearest major reefs to Cape Preston which support high live coral cover are over three kilometres away.
Limited turtle breeding occurs on the beaches of Cape Preston. Small numbers of dugong have been sighted in the region. Migratory shorebirds utilise Pilbara coastal habitats such as beaches, tidal flats and other intertidal wetlands during the non-breeding season. The highest concentration of shorebirds occurs along the western shore of Cape Preston.

Land use in the area comprises pastoral grazing, mining activities at the Central Block and limited tourism and recreation. The port site is within the Great Sandy Island Nature Reserve and lies west of the proposed Regnard Marine Management Area.

Studies have identified the Aboriginal heritage values of the area and the presence of a number of sites of heritage significance. No sites of European heritage significance occur in the area.

In summary, the key environmental values of the Balmoral South Project Area include:

- surface water flow and quality in the Fortescue River and Du Boulay Creek;
- groundwater quality in the Fortescue River alluvials;
- cracking clays of the Horseflats Land System;
- phreatophytic vegetation of the River and Paraburdoo Land Systems;
- mangrove communities occurring between Cape Preston and the mainland;
- subterranean fauna;
- marine water quality; and
- shorebirds and turtles.

The assessment for the Balmoral South Project has been prepared to quantify impacts associated with the development of this project in isolation and to address cumulative impacts based on the assumption that the impacts predicted for the Central Block Project have already occurred. In particular the PER has addressed individual and cumulative impacts associated with the following environmental factors:

- terrestrial flora and vegetation
- mangroves
- terrestrial fauna
- subterranean fauna
- marine ecology
- surface water
- groundwater
- process emission
- marine water quality and
- noise

Table 0-2: Summary of Impacts and Management Measures Applicable to the Relevant EPA Environmental Factors summarises the potential environmental and social impacts associated with the Project, identifies the key management measures that will be implemented to avoid or mitigate impacts, and describes the predicted outcomes once management measures have been implemented.
Environmental Management Framework

IM is committed to developing and implementing an Environmental Management System (EMS) consistent with ISO14001:2004 to promote excellence in environmental management. The EMS will be supported by a Project Environmental Management Plan (PEMP) which has been submitted as part of this PER for approval.

The PEMP contains plans, guidelines and procedures to manage environmental issues associated with construction, operation and decommissioning of the Project. The PEMP is comprised of an overall environmental management framework and specific management sections to address relevant environmental factors and mitigate potential impacts of the proposed activities.

This PEMP is a live, interactive document that will be updated in accordance with best practice environmental management practices, standard operating procedures, any Works Approvals and Licence conditions, and in consultation with key project stakeholders.

Conclusion

The PER identifies the key environmental and social values of the Cape Preston area and quantifies the likely impacts on these values as a result of the Project. In designing the project, IM has incorporated features and improvements to minimise the environmental impact of the proposed operations. These include:

- maximising the sharing of infrastructure between the Balmoral South and Central Block Projects;
- maximising the recovery and reuse of water from pit dewatering, materials processing and tailings disposal;
- locating the seawater intake and brine disposal pipelines in an area of low environmental sensitivity;
- location of the eastern services corridor on high tidal flats to minimise loss of Benthic Primary Producer Habitat;
- construction of the western services corridor on a trestle to maintain tidal exchange and to limit the mangrove loss to areas where piling operations and trestle construction activities will occur;
- adopting combined cycle gas turbines with low NOx burners to reduce greenhouse gas emissions to as low as reasonably practical and a heat recovery system to improve efficiency;
- construction of mine site infrastructure to minimise encroachment into the 100 yr ARI floodplain of the Fortescue River and Du Boulay Creek; and
- developing common practices and procedures to effectively manage environmental and social impacts associated with both the Balmoral South and Central Block Projects.

Recognising the improvements made to the Project, and the management measures proposed, it is concluded that the Project will not have a significant impact on the environmental and social values of the Cape Preston area.
## Summary and Conclusions

### Table 0-2: Summary of Impacts and Management Measures Applicable to the Relevant EPA Environmental Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BIOPHYSICAL</strong></td>
<td></td>
<td>Land systems</td>
<td>Clearing control procedures will be implemented during construction.</td>
<td>Based on the regional extent of these Land Systems it is considered that this disturbance will not be regionally significant.</td>
</tr>
<tr>
<td>Terrestrial Vegetation and Flora</td>
<td>Maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. Protect species listed under the Environment Protection and Biodiversity Conservation Act 1999 and Rare and Priority Flora consistent with the provisions of the Wildlife Conservation Act 1950. Scope of Work Field survey of the Project area to document and map vegetation types and flora present. Survey to be undertaken consistent with EPA Position Statements No. 2 and No. 3, and Guidance Statement No. 51. Overlay Project components onto habitat mapping to quantify impacts. Mapping of phreatophytic communities at risk from dewatering, modelling of groundwater drawdown and quantification of potential community loss. Identification of any Threatened or Priority Flora, unusual or poorly known taxa, or restricted vegetation types (including Threatened Ecological Communities). Evaluation of the local and regional conservation significance of the species and vegetation types present, including species at their geographical limits. Analysis of clearing areas to quantify loss of vegetation and identify impacts on Threatened or Priority Flora, or TECs. Field survey to document the extent and occurrence of introduced flora in the Project area.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Summary and Conclusions

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
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<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation clearing</td>
<td>45 vegetation communities will be impacted. Around 5282 ha of vegetation will be cleared. Cracking clay grasslands of the Horseflats Land System are recognised as regionally significant vegetation communities. Around 690 ha will be disturbed (0.23% of the Roebourne Subregion).</td>
<td>Clearing control procedures will be implemented during construction. Existing drainage patterns are maintained where possible. Progressive rehabilitation of disturbed areas where possible. Detailed design will consider the presence of Cracking Clay Grasslands with disturbance minimised where possible. Pastoral lease boundary rationalisation in 2015 will ensure that substantial areas of these grasslands are preserved within the conservation estate.</td>
<td>The Balmoral South Project will not result in the loss of any vegetation type below the EPAWA &quot;threshold level&quot; of 30%. Impact on cracking clay grassland is unavoidable but has been minimised where possible. Pastoral lease boundary rationalisation and destocking will ensure local conservation of this Land System and an improvement in its condition.</td>
<td></td>
</tr>
<tr>
<td>Threatened flora</td>
<td>Two priority flora have been identified from the Cape Preston region. No DRF or EPBC listed threatened species will be disturbed as a result of the proposed Balmoral South Project.</td>
<td>Detailed design will consider the locations of Priority Flora, and disturbance will be avoided where possible. The Project will avoid or minimise impacts from clearing on flora</td>
<td>No significant impact is likely on any threatened flora species.</td>
<td></td>
</tr>
</tbody>
</table>

International Minerals Pty Ltd
February 2009
## Summary and Conclusions

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phreatophytic vegetation</strong></td>
<td>Approximately 460 ha of phreatophytic vegetation will be potentially impacted by pit dewatering, approximately 8.5% of the phreatophytic vegetation of the Cape Preston survey area.</td>
<td>There will be some unavoidable loss of phreatophytic vegetation but it will be minimised by reducing water level drawdown rates where possible, monitoring vegetation and vegetation stress and implementing management measures at identified trigger levels.</td>
<td>The overall potential loss of phreatophytic vegetation in the lease area is relatively small. The groundwater model is conservative in its predictions as it doesn’t account for seasonal creek flows or the presence of perched water tables.</td>
<td></td>
</tr>
<tr>
<td><strong>Weeds</strong></td>
<td>Two Declared species have been identified from the Project area. Potential to spread weeds to uninfected areas.</td>
<td>Development of weed management and hygiene protocols. Monitoring for the presence of weeds as a component of the vegetation monitoring program. Ongoing weed control programme will be implemented during operations.</td>
<td>Implementation of standard control practices will ensure that environmental weeds are not spread as a result of the project.</td>
<td></td>
</tr>
<tr>
<td><strong>Mangroves</strong></td>
<td>Maintain the abundance, diversity, geographic distribution and productivity of mangroves and mangrove associations through the minimisation of direct and indirect impacts. Scope of Work Document the condition and local and regional representation of mangrove species / assemblages. Evaluate the local and regional significance of affected mangrove areas. Quantify the extent of mangrove clearing and identify aspects of the Project with the potential to restrict or alter tidal flushing. Assess impacts against EPA Guidance Statement No. 1 and No. 29.</td>
<td>Mangrove communities Cumulatively, around 5.7 ha of mangroves and 23.3 ha of algal mat will be cleared for construction of infrastructure corridors across Mangrove Creek. Potential indirect impacts through changes in hydrodynamics. Potential disturbance to acid sulphate soils.</td>
<td>Adoption of construction techniques to minimise mangrove clearing and changes to hydrodynamics. Management of adverse impacts and improve management through implementation of a Mangrove Monitoring Program. Development and implementation of an ASS Management Plan.</td>
<td>The percentage loss of mangroves and algal mat is low, around 1.1% and 5.8% of their respective occurrence in the area and well under the 10% cumulative impact criteria stated in EPA Guidance Statement No. 29.</td>
</tr>
</tbody>
</table>
### Terrestrial Fauna

**Objectives and Scope of Work**

- Maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

**Scope of Work**

- Field survey of Project area to document fauna communities, threatened taxa and potential short-range endemics. Survey to be undertaken consistent with EPA Position Statement No. 3 and Guidance Statement No. 56.
- Evaluation of the local and regional significance of the fauna and communities present.
- Quantify reduction in extent of habitat units attributable to the Project, with evaluation of impacts on fauna occurring on the affected habitat types and on patterns of fauna movement (corridors).

**Project Component / Potential Impacts**

- Fauna habitat
  - Around 5282 ha of vegetation will be cleared

**Proposed Mitigation and Management Measures**

- Detailed design will be undertaken to minimise as much as practical the extent of clearing for construction and operational activities.
- Impacts on fauna will be managed through a process of minimising the area to be disturbed, workforce education, avoidance, monitoring impacts, implementation of remedial strategies where practical and progressive rehabilitation of disturbed areas where possible.

**Predicted Outcome**

- Potential to impact on threatened fauna is low. The Lakeland Downs Mouse occurs on cracking clay habitat which is wide spread in the region. The Bustard is associated with the Fortescue River system on which the project will have limited impact. Habitat for the Pilbara Leaf-Nosed Bat does not occur in the area. Mulgara and Olive Python have not been recorded from the site. Rainbow Bee Eater habitat (river and creek lines) will not be significantly impacted. The White Bellied Sea Eagle makes opportunistic use of the area.
# Summary and Conclusions

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threatened fauna</td>
<td>Two Priority 4 Species (Lakeland Downs Mouse and Bustard) are potentially impacted by the project.</td>
<td>Threatened fauna Two Priority 4 Species (Lakeland Downs Mouse and Bustard) are potentially impacted by the project. Three nationally threatened species (Mulgara, Pilbara Leaf-Nosed Bat and Olive Python) listed under the EPBC Act potentially occur. Two nationally significant migratory birds (Rainbow Bee Eater and White Bellied Sea Eagle) occur in the Project Area.</td>
<td>Proposed Mitigation and Management Measures</td>
<td>Predicted Outcome</td>
</tr>
</tbody>
</table>

International Minerals Pty Ltd
February 2009
## Summary and Conclusions

| Environmental Factor                                      | Objectives and Scope of Work                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Project Component / Potential Impacts                                                                                                                                                                                                                                                                                                                                                   | Proposed Mitigation and Management Measures                                                                                                                                                                                                                                                                                                                                                         | Predicted Outcome                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **Subterranean Fauna and Other Short Range Endemics (SRE's)** | Maintain the abundance, diversity, geographic distribution and productivity of subterranean fauna and other SREs at the species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.  
**Scope of Work**  
Review all information on subterranean fauna in the locality and its conservation value.  
Undertake surveys in accordance with EPA Guidance Statements No. 54 and No. 54a.  
Document the potential impacts of the Central Block and Balmoral South projects on groundwater drawdown and the amount of orebody likely to remain after development of the Project.  
Undertake a risk assessment and if appropriate, surveys for short-range endemic fauna over the disturbance and wider impact footprint in order to assess impacts and recommend appropriate management / mitigation strategies. | Groundwater extraction has the potential to affect stygofauna. 15 species have been identified, all of which are known to be more widely distributed.  
Nine species of troglofauna have been recorded from Balmoral South. All but two have been recorded elsewhere.  
Stygofauna and troglofauna will be impacted through habitat loss.  
Three likely SRE species have been identified within the Cape Preston region. Clearing of habitat could reduce species numbers, distribution and diversity | Monitor the impacts of groundwater extraction.  
Continue field survey work to further define the distribution of subterranean fauna in the Cape Preston area.  
Complete identification of land snails collected to date. | No stygofauna species will be threatened by the project. Two troglofauna species have only been recorded from Balmoral South which is likely an artefact of a single animal being collected. Given the inferred distribution of troglofauna and minimal detrimental effects of dewatering, it is unlikely that development will affect the conservation of troglofauna species.  
No SRE species will be threatened by the Project. |
| **Marine Biota**                                           | Maintain the ecological function, abundance, species diversity and geographical distribution of marine biota and habitat.  
**Scope of Work**  
Field surveys to document the presence of BPPH and the presence of any species of conservation significance.  
Evaluation of the local and regional conservation significance of species present.  
Assessment of impacts consistent with EPA Guidance Statement No. 29. | Benthic primary producers  
Construction of the seawater intake, brine outfall and diffuser could impact on Benthic Primary Producers (BPP) and Benthic Primary Producer Habitat (BPPH). | The pipelines and diffuser will be located in areas of low environmental sensitivity. Impacted habitats have wide distribution in the Project Area. Filling of the pipeline trench’s with rock to construct artificial reef. | There will be no impact on sensitive BPPH. |
## Summary and Conclusions

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine fauna</td>
<td>Potential entrainment of fauna in the intake current of the desalination plant. Habitat disturbance to areas where marine turtles and dugong, both listed under the EPBC Act, are known to occur. Whales and dolphins are also known from the area. Potential for an increase in turbidity levels during construction.</td>
<td>The intake flow velocity to the desalination plant will be maintained below 0.33 m/s which will allow most species to swim against the current. Three sets of mesh screens will also reduce the possibility of intake of fauna. No habitat to be impacted is an “important habitat” for a migratory species as defined under the EPBC Act.</td>
<td>The project will not significantly impact any marine species. The area of impact is small and the effects of turbidity during construction will be localised and short lived. There is no indication that an ecologically significant proportion of a turtle or dugong population relies on habitats in the area of Cape Preston.</td>
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<tr>
<td>Migratory shorebirds</td>
<td>Potential disturbance to shorebird roosting and feeding areas. The most important areas occur along the western shoreline of Cape Preston. The number of migratory shorebirds present at Cape Preston is well below the 20,000 figure used for identifying areas of international importance.</td>
<td>The proposed infrastructure will be located away from the main roosting and feeding areas on the western shoreline of Cape Preston. Potential for minor disturbance to intertidal areas at the tip of Cape Preston. Evidence suggests that migratory shorebirds are generally tolerant of limited disturbance from light and noise.</td>
<td>The project will not significantly impact migratory shorebirds.</td>
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</table>
## Summary and Conclusions

<table>
<thead>
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<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
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<td>Surface Water</td>
<td>Maintain the quantity of water so that existing and potential environmental values, including ecosystem function, are protected. Maintain the integrity, ecological functions and environmental values of wetlands. Scope of Work Undertake hydraulic modelling of surface water flows in the Fortescue River and Du Boulay Creek to quantify potential changes as a result of the Project. Demonstrate that infrastructure and facilities that encroach on the floodplains will withstand flood events with minimal likelihood of catastrophic failure.</td>
<td>Flood levels Waste Disposal Facility No. 1 (WDF1) will encroach into the flood plain of the Fortescue River. Modelling demonstrates that the Project will increase the 100 year ARI flood level by up to 0.30 m at the southern end of WDF1. WDF1 pit bunds, and plant and processing platforms will be located above the Fortescue River and Du Boulay Creek floodplains.</td>
<td>Detailed design will minimise impacts through bunding to redirect surface water around mine structures, riprap / armouring to slow and redistribute runoff, culverts to maintain major flow paths intercepted by infrastructure, location of mine site infrastructure to minimise encroachment into the 100 yr ARI floodplain, drainage works around WDF1 to separate river water from water internal to the WDF and bunding to contain sediment laden runoff.</td>
<td>There will be an increase in flood level adjacent to WDF1. At this location water depth would be shallow and water velocities are not expected to significantly increase. With significant infrastructure located above the 100 year ARI flood level for the Fortescue River and Du Boulay Creek, the project is not expected to have a significant impact on these watercourses.</td>
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<tr>
<td>Sedimentation</td>
<td>Modification of sediment transport, erosion and deposition patterns.</td>
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Summary and Conclusions

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
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<td>Groundwater</td>
<td>Maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem function, are protected. Scope of Work Modelling of the cumulative cone of depression from the Central Block and Balmoral South Projects to determine impact on groundwater levels.</td>
<td>Dewatering Groundwater levels in the pit will be reduced by around 290 m through dewatering. Dewatering of the Central and Southern Block orebodies will result in a cone of depression extending up to 14 km north, 5 km south, 7 km east and 2 km west of the Southern Block pit. Potential to impact on phreatophytic vegetation, stygofauna and groundwater users. Following mining the pit will remain dry.</td>
<td>Dewatering is unavoidable as it is essential for the economic development of the mine. Trigger levels will be established for the provision of alternative water supply to phreatophytic vegetation and groundwater users. Groundwater drawdown will be monitored to confirm that impacts are confined to the areas predicted.</td>
<td>The groundwater model is conservative in its predictions as it doesn’t account for seasonal creek flows or the presence of perched water tables. The overall potential loss of phreatophytic vegetation in the lease area is relatively small.</td>
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POLLUTION MANAGEMENT

| Air Quality | Ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses. Scope of Work Identify potential sources of dust and quantify likely impacts on the receiving environment. Impact assessment and management will recognise the requirements of the Draft DEC Dust Guidance Statement. Modelling of emissions to determine compliance with appropriate standards and guidelines. Undertake a photochemical smog study which accounts for other emissions in the region. | Dust emissions Earthworks, mining, ore processing and ore handling will produce dust. The accommodation camps and the public camping ground at the mouth of the Fortescue River will not be impacted by dust. | Project design will ensure that dust is captured at source wherever practical. Dust will be managed using standard dust suppression techniques such as water sprays, chemical suppressants, revegetation and mulching. Dust monitoring will comply with the current ambient air quality NEPM and monitor PM\textsubscript{10} and TSP. | Dust will be managed at source and no significant impacts are predicted to occur. |
## Summary and Conclusions

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
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|                      | Demonstrate that best practicable technology has been adopted for the design and construction of the power station, particularly with regards to NO\textsubscript{X} emissions, in line with the EPA Guidance Statement No.15. The assessment to consider cumulative emissions from the approved Central Block Project. Undertake modelling in accordance with the DoE’s Air Quality Modelling Guidance Notes. | Process emissions  
The pellet plant and power station will emit particulates, CO, NO\textsubscript{X} and SO\textsubscript{2} which have the potential to impact on human and animal health, and vegetation. | Project design will ensure that levels of atmospheric pollutants are minimised at source wherever practical. The combined cycle power station will be equipped with low NO\textsubscript{X} burners, to reduce NO\textsubscript{X} emissions to less than 25 ppm, and a heat recovery system. Monitoring of the exhaust stacks will measure O\textsubscript{3}, NO\textsubscript{X} and CO\textsubscript{2} to ensure compliance with guidance levels. | Assessment demonstrates that cumulative emissions of NO\textsubscript{X}, NO\textsubscript{2} and PM\textsubscript{10} are well below accepted criteria for human health. The 24-hour NO\textsubscript{X} vegetation criterion is exceeded up to 1 km from the pellet plant. |
|                      |                            | Photochemical smog  
Power station and pellet plant will emit NO\textsubscript{X} which could lead to an increase in photochemical smog. |                            | The regional impacts on photochemical smog formation due to emissions from the project are very low. |
| Greenhouse Gases      | Minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.  
**Scope of Work**  
Quantification of greenhouse gas emissions and demonstration that emissions are as low as reasonably practical. | The Project will generate 2.2 Mtpa of greenhouse gas equivalent emissions. The highest emissions will occur from the power station (70%). | Efficient gas turbines have been incorporated in the combined cycle power station, reducing emissions by 33% over conventional open cycle turbine plants. The project will continue to reduce its emissions by improving fuel consumption efficiency per tonne of ore hauled, focussing on the quality of fuel / lubricants used with an objective to reduce hydrocarbon waste and increase productivity per truck, and assessing alternative waste and ore disposal technologies, such as in-pit crushing and conveyor to reduce fuel burn. | Greenhouse gas emission reduction measures have been incorporated into project design and there is a commitment to further reduce emissions on an on-going basis. |
### Summary and Conclusions

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
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<td><strong>Surface and Groundwater Quality</strong></td>
<td>Maintain or improve the quality of surface water and groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected.</td>
<td><strong>Surface water</strong> Potential for downstream water quality to deteriorate from the discharge of chemicals and hydrocarbons from the workshop and plant areas, seepage from the WDF’s and discharge from the sewage treatment plant.</td>
<td>Project design recognises the need to correctly store hazardous materials such as hydrocarbons, minimises waste generation and incorporates environmentally appropriate technologies for waste management. A waste management plan will be developed to ensure appropriate handling, treatment and disposal of wastes and identification of opportunities to avoid, reduce, ameliorate and manage development wastes. Construction of diversion works around infrastructure areas to separate natural runoff waters from internal site runoff.</td>
<td>Appropriate handling and disposal of wastes will ensure that the potential for the project to contaminate surface waters is minimal.</td>
</tr>
<tr>
<td><strong>Surface and Groundwater Quality</strong></td>
<td><strong>Scope of Work</strong> Characterise waste materials and the potential for seepage to contaminate groundwater. Assess the environmental threats posed by the wastes identified. Determine appropriate disposal procedures. Assessment of changes to water quality in the pit over time and prediction of the likely environmental impact of these changes.</td>
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<tr>
<td><strong>Groundwater</strong></td>
<td>Potential contamination of the Fortescue River Alluvial aquifer.</td>
<td><strong>WDF1</strong> has been designed to minimise seepage. Monitoring will be undertaken to detect any seepage and contingency measures developed to correct unacceptable contaminate loss.</td>
<td>WDF1 will largely contain waste rock and dewatered tailings. Both of these materials are inert. There is limited opportunity for contaminants to be released from WDF1.</td>
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<tr>
<td><strong>Pit void</strong></td>
<td>Potential for long term build up of salinity in the pit lake which could locally impact groundwater quality.</td>
<td>Modelling has indicated that the pit will remain dry at the cessation of mining.</td>
<td>Low potential for salinity build up.</td>
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### Summary and Conclusions

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<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
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</tr>
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<td><strong>Marine Water Quality</strong></td>
<td>Maintain water and sediment quality consistent with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Protect environmental values for recreation, aesthetics, aquatic life and maintenance of ecosystems in specified areas. <strong>Scope of Work</strong> Field survey to describe the existing environment including mapping and benthic habitat characterisation and classification. Modelling of the Central Block and Balmoral South Projects outfalls to determine the cumulative impact of brine discharge on the marine environment. Modelling will predict the frequency, duration and intensity of discharge events to the marine environment and associated zones of impact. Assess impacts against EPA Guidance Statement No. 29. Impact predictions will be prescribed and spatially defined in the context of the environmental quality management framework presented in the Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives (DoE 2006). Investigations will spatially define and justify the environmental quality objectives around the outfall and the environmental values that will be protected. Justify the location of the discharge point and confirm that the discharge will not impact water quality and biodiversity values of the Regnard Marine Management Area.</td>
<td>The brine outfall will discharge 252 ML/d for short durations and 157 ML/d for most of the time under normal operating conditions. There is the potential to: • reduce local marine water and sediment quality; • adversely affect individual marine biota within the vicinity of the outfall; and • reduce the abundance of sensitive benthic primary producer habitat, including coral communities.</td>
<td>Modelling has defined a brine discharge location which is adequate from a flushing perspective and defined a 4 ha mixing zone where salinity resulting from the plant is no greater than 5% above ambient for more than 1% of the time. None of the chemicals in the waste stream will have a detrimental effect on the marine environment. A Water Quality Management Framework will be developed to ensure that water quality is maintained as a result of the brine discharge. The strategy will establish Environmental Quality Objectives, Environmental Quality Criteria and provide a high level of protection to waters except for the mixing zone surrounding the outfall. A program will also be established to monitor relevant parameters in the desalination plant outfall to confirm modelling predictions and ensure that salinity and toxicants do not exceed stipulated limits.</td>
<td>Given the low environmental sensitivity of the outfall site, the excellent flushing provided by tidal movements and the low toxicity of the effluent components, the likelihood of any adverse effects arising from the brine discharge on the marine environment outside the mixing zone is extremely low. The risk to receiving waters within the mixing zone is also extremely low.</td>
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</table>
## Summary and Conclusions

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
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</tr>
</thead>
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<td><strong>Noise</strong></td>
<td>Protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal. <strong>Scope of Work</strong> Noise and vibration modelling using SoundPLAN to demonstrate compliance with the <em>Environmental Protection (Noise) Regulations 1997</em>. Mining, ore processing and ore handling will produce noise emissions with the potential to impact the public and the workforce. Blasting will be employed during mining. Noise management strategies will be implemented to minimise the potential for impact from noise emissions including use of the quietest readily available equipment, equipment maintenance, limiting blast size and modifying practices if noise complaints occur. Assessment demonstrates that noise levels comply with relevant criteria at noise sensitive receivers.</td>
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<tr>
<td><strong>Solid and Liquid Wastes</strong></td>
<td>Minimise any solid and liquid wastes produced as a result of the Project. Integrate a waste hierarchy (i.e. avoid, reuse, reduce, recycle, treat, dispose) for waste minimisation and establish a ‘closed loop’ within as many waste streams as possible. Ensure no release of hydrocarbons to the environment, either as a result of storage or handling incidents. Ensure liquid and solid wastes are treated onsite or disposed of offsite at an appropriate landfill facility. <strong>Scope of Work</strong> Describe the types of wastes including: - domestic, industrial and hazardous wastes (e.g. waste water and workshop wastes); - mining wastes (e.g. waste rock); and - process wastes (e.g. tailings and waste water). Identify management options for the various waste streams. The Project will generate a variety of waste materials including scrap metal, tyres, wood, paper, hydrocarbons, domestic solid and liquid wastes and processing wastes. If these wastes are not managed in an appropriate manner, a range of potential impacts are possible. These include the contamination of land, change in water quality of surface water and groundwater, and/or contamination of ecological habitats. Solid and liquid wastes will be minimised, recycled, recovered and reused where possible. Where not possible, they will be disposed of in an appropriate manner within the landfill or at an approved offsite facility. Pyritic Black Shales, which can give rise to acid mine drainage, and fibrous forming materials if present will be identified during drilling. These materials will be managed through the application of appropriate procedures including characterisation of the material, implementation of handling techniques, and encapsulation and neutralisation of material within waste stockpiles. Waste materials will be handled and appropriately disposed to ensure there is minimal risk to the environment.</td>
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</table>
## Summary and Conclusions

<table>
<thead>
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<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOCIAL SURROUNDS</strong></td>
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<tr>
<td>Recreation</td>
<td>Minimise the impact of mine employees and contractors on the &quot;visitor locations&quot; within the vicinity of the Project site. Ensure that access to popular &quot;visitor sites&quot; is maintained for the use of the general public. Ensure that recreational activities do not significantly increase pressure on the natural resources of the area. <strong>Scope of Work</strong> Quantify impacts on existing recreational uses and resources in the area.</td>
<td>Potential to impact on the camping ground at the mouth of the Fortescue River. An influx of construction and operations personnel has the potential to place additional pressure on the environment.</td>
<td>All Project personnel will undergo a site specific environmental induction before commencing work at the operation. The induction will include information regarding the responsibilities and expected behaviour of all personnel toward the environment, and will provide necessary awareness of recreational impacts and how those impacts will be managed.</td>
<td>The Project is not expected to have any significant impact on the environment due to increased recreational pressures.</td>
</tr>
<tr>
<td>Aboriginal Heritage</td>
<td>Avoid or minimise impacts to Aboriginal cultural heritage sites. To ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972. <strong>Scope of Work</strong> Finalise Heritage Agreements, management plans or other agreements following further consultation with the Claimant Groups and the Department of Indigenous Affairs. Conduct further surveys across the Balmoral South Project area in consultation with local Aboriginal groups.</td>
<td>Work done to date has identified the heritage values of the area. There is the potential impact on sites of Aboriginal significance.</td>
<td>Heritage Agreements will be finalised with Claimant Groups. Procedures will be implemented for the identification and management of any additional sites located during the construction and operational phases of the Project. This may include the use of monitors during ground disturbing activities and the development of specific procedures for the preservation of heritage sites.</td>
<td>The work proposed and the procedures to be put in place will ensure that heritage values of the area are protected and that changes to the environment do not adversely affect the cultural associations of the area.</td>
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<tr>
<td>European Heritage</td>
<td>Ensure that changes to the biological and physical environment resulting from the Project do not adversely affect historical and cultural associations with the area and comply with relevant heritage legislation. <strong>Scope of Work</strong> Identify whether sites of European heritage value occur in the Project Area and, if so, whether they will be affected by the Project.</td>
<td>There are no European heritage sites known to occur within the Project Area.</td>
<td>No specific management is required.</td>
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</table>
## Summary and Conclusions

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
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<td>Public Health And Safety</td>
<td><strong>Scope of Work</strong>&lt;br&gt;Ensure that the risk to the public is as low as reasonably practicable and complies with appropriate standards.&lt;br&gt;Ensure that traffic activities resulting from the Project do not adversely impact on the social surroundings.&lt;br&gt;Ensure that the risk is managed to comply with DoIR requirements and EPA criteria in respect of public health and safety.&lt;br&gt;Demonstrate an understanding of the potential impacts of the Project on public health and safety and document the measures proposed to minimise or mitigate the impact.</td>
<td>The potential health and safety issues for the Project are include increased traffic on the Fortescue River access road, public access to the Project area, spillage of hazardous materials on public roads, process emissions from the pellet plant and power station and dust from exposed areas and materials handling.</td>
<td>The general public will be excluded from the Project area. Access to the Project Area will be via a dedicated access road. Dust will be management through the use of water carts (or similar), vehicle speed restrictions will be enforced, safety procedures will be adopted and spill kits installed on transport vehicles.</td>
<td>The project is not expected to pose a risk to the general public.</td>
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</table>

## OTHER

<table>
<thead>
<tr>
<th>Matters of National Environmental Significance</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
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<td></td>
<td><strong>Scope of Work</strong>&lt;br&gt;Ensure that Matters of National Significance are identified and potential impacts quantified and, where necessary, mitigated.</td>
<td>The project has the potential to impact on ten listed Threatened species and 23 listed Migratory species listed under the EPBC Act.</td>
<td>Surveys demonstrate that there is a low likelihood that species listed under the EPBC Act will be significantly impacted. Marine activities are limited and fauna habitats within the Project Area are well represented in the region.</td>
<td>The project is unlikely to impact on Matters of National Environmental Significance.</td>
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</table>
## Summary and Conclusions

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
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<tr>
<td>Cumulative Impacts for Assessment of Balmoral South Project</td>
<td>Ensure that impacts from the Project are understood and assessed in the context of impacts arising from other approved projects in the area. <strong>Scope of Work</strong> Quantify impacts associated with the Balmoral South Project and assess these impacts in relation to those predicted for the approved Central Block Project.</td>
<td>Development of the Balmoral South Project will result in additional impacts to those already assessed for the approved Central Block Project. These include surface water and groundwater impacts, cumulative impacts of vegetation clearing and cumulative process emissions.</td>
<td>The PER assesses the cumulative impacts of the two projects.</td>
<td>The PER identifies a range of management measures that will ensure that cumulative impacts of the two projects can be managed.</td>
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<tr>
<td>Decommissioning</td>
<td>To ensure that rehabilitation occurs in a planned sequential manner consistent with best practice. <strong>Scope of Work</strong> Assessment of potential impacts on existing landforms. Detail measures proposed to rehabilitate the impacted area to an acceptable standard which will integrate the post mining landform with the surrounding environment.</td>
<td>Mining will result in the excavation of overburden and ore, mineral processing and the establishment of new landforms to accommodate mine waste.</td>
<td>International Minerals will prepare a Mine Closure Plan. Progressive rehabilitation of disturbed areas will occur where possible and ongoing monitoring will determine the success of this rehabilitation.</td>
<td>The Mine Closure Plan will establish the objectives for rehabilitation of disturbed areas and put in place a process that will allow operations to recognise the long term objectives associated with decommissioning.</td>
</tr>
</tbody>
</table>
# Table of Contents

<table>
<thead>
<tr>
<th>Rev Code</th>
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<th>Revision Description &amp; Issued For</th>
<th>Signatures</th>
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<td>December 08</td>
<td>EPA Final Submission</td>
<td>Ian M'Ccardle</td>
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<td>Issued for Public Comment</td>
<td>Ian M'Ccardle</td>
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</tr>
</tbody>
</table>

International Minerals Pty Ltd
February 2009
# Table of Contents

**Main Report**  
(Volume 1)

**Invitation to Make a Submission** ................................................................. i

**Summary and Conclusions** ........................................................................... v

## 1 Introduction ............................................................................................. 1-1

1.1 The Proposal ............................................................................................ 1-1
1.2 Background .............................................................................................. 1-2
1.3 The Proponent .......................................................................................... 1-2
1.4 Objectives of the PER ............................................................................. 1-3
1.5 Decision Making Authorities (DMAs) ..................................................... 1-3
1.6 Environmental Assessment Process ....................................................... 1-4
1.7 Relevant Legislation, Policies and Guidelines ......................................... 1-9

## 2 Project Description .................................................................................. 2-1

2.1 Overview ................................................................................................. 2-1
2.2 Relationship with the Mineralogy Projects ............................................ 2-11
2.3 Infrastructure Being Provided by / to Other Projects .............................. 2-17
2.4 Construction and Commissioning Activities ......................................... 2-17
2.5 Operations ............................................................................................... 2-22
2.6 Waste Disposal Facilities ....................................................................... 2-25
2.7 Ore Processing ......................................................................................... 2-27
2.8 Tailings Disposal ..................................................................................... 2-31
2.9 Corridor ................................................................................................... 2-32
2.10 Port Storage and Export ......................................................................... 2-37
2.11 Operations Water Supply ....................................................................... 2-37
2.12 Power and Gas Supply ........................................................................... 2-43
2.13 Workforce and Accommodation ............................................................. 2-43
2.14 Domestic Waste Disposal ....................................................................... 2-44
2.15 Fuel Storage ............................................................................................. 2-44
2.16 Explosives Magazines / Depot ................................................................. 2-44
2.17 Raw Materials Import ........................................................................... 2-44
2.18 Rehabilitation and Closure .................................................................... 2-46
# Table of Contents

3 Project Justification and Evaluation of Alternatives .................................................. 3-1
   3.1 Project Benefits ........................................................................................................... 3-1
   3.2 Evaluation of Alternatives ......................................................................................... 3-2

4 Existing Environment .................................................................................................... 4-1
   4.1 Overview and Key Values ......................................................................................... 4-1
   4.2 Climate ....................................................................................................................... 4-3
   4.3 Air Quality .................................................................................................................. 4-3
   4.4 Soils and Geology ...................................................................................................... 4-5
   4.5 Surface Water ............................................................................................................ 4-8
   4.6 Hydrogeology ............................................................................................................ 4-8
   4.7 Terrestrial Flora and Vegetation ................................................................................. 4-14
   4.8 Mangroves .................................................................................................................. 4-33
   4.9 Terrestrial Fauna ........................................................................................................ 4-37
   4.10 Subterranean Fauna ................................................................................................. 4-40
   4.11 Short Range Endemics (SREs) ................................................................................. 4-44
   4.12 Marine Environment ............................................................................................... 4-51
   4.13 Social Environment .................................................................................................. 4-64
   4.14 Land Uses .................................................................................................................. 4-67
   4.15 Aboriginal Heritage ................................................................................................. 4-72
   4.16 European Heritage ................................................................................................. 4-72

5 Stakeholder Consultation ............................................................................................... 5-1

6 Relevant EPA Factors ................................................................................................... 6-1

7 Biophysical Issues and Their Management ................................................................. 7-1
   7.1 Introduction .................................................................................................................. 7-1
   7.2 Terrestrial Flora and Vegetation ................................................................................. 7-1
   7.3 Mangroves ................................................................................................................. 7-14
   7.4 Terrestrial Fauna ........................................................................................................ 7-23
   7.5 Subterranean Fauna ................................................................................................... 7-29
   7.6 Marine Ecology ......................................................................................................... 7-33
   7.7 Surface Water ............................................................................................................ 7-39
   7.8 Groundwater .............................................................................................................. 7-45

8 Pollution Issues and their Management ....................................................................... 8-1
   8.1 Introduction .................................................................................................................. 8-1
# Table of Contents

8.2 Process Emissions ................................................................. 8-1
8.3 Dust Emissions ................................................................. 8-18
8.4 Greenhouse Gas Emissions .................................................. 8-20
8.5 Marine Water Quality .......................................................... 8-25
8.6 Noise .............................................................................. 8-36
8.7 Solid and Liquid Wastes ...................................................... 8-42

9 Social Issues and their Management ......................................... 9-1

9.1 Introduction ....................................................................... 9-1
9.2 Adjacent Land Users .......................................................... 9-1
9.3 Recreation ........................................................................ 9-2
9.4 Indigenous Heritage .......................................................... 9-4
9.5 European Heritage ............................................................ 9-6
9.6 Public Health and Safety ....................................................... 9-6

10 Sustainability .................................................................... 10-1

10.1 Sustainability Assessment .................................................... 10-1
10.2 Assessment against EPAWA Principles of Environmental Protection ........................................................................ 10-4

11 Matters of National Environmental Significance ......................... 11-1

11.1 Overview ........................................................................ 11-1
11.2 Marine Species ................................................................. 11-7
11.3 Terrestrial and Avian Species ............................................... 11-7
11.4 Conclusion ....................................................................... 11-10

12 References .......................................................................... 12-1

13 Abbreviations ....................................................................... 13-1
Tables

Table 0-1: Project Key Characteristics ...................................................................................................... v
Table 0-2: Summary of Impacts and Management Measures Applicable to the Relevant EPA
Environmental Factors ......................................................................................................................... xi
Table 1-1: State Legislation ................................................................................................................... 1-9
Table 1-2: Policies, Guidelines and Standards ......................................................................................... 1-10
Table 1-3: EPA Position and Guidance Statements ............................................................................... 1-10
Table 1-4: Works Approvals and Licensing ........................................................................................... 1-11
Table 1-5: Commonwealth Legislation ................................................................................................... 1-12
Table 1-6: Other Guidelines .................................................................................................................. 1-12
Table 2-1: Project Facilities Locations .................................................................................................... 2-1
Table 2-2: Project Development Stages for Balmoral South Project (Nominal) ......................................... 2-2
Table 2-3: Key Project Characteristics .................................................................................................. 2-3
Table 2-4: Water Loss for the Process ..................................................................................................... 2-34
Table 2-5: Chemicals Used in the RO Process and Dilutions in the Marine Environment ..................... 2-38
Table 2-6: Expected Vehicle Movements ............................................................................................... 2-41
Table 4-1: Summary of Hydrogeological Properties .............................................................................. 4-9
Table 4-2: Summary of Floristic Survey results within the Balmoral South Project Area ...................... 4-20
Table 4-3: Stygofauna Collected at Both Balmoral South and the Cape Preston Area Since 2007 ........ 4-36
Table 4-4: Troglofauna Collected from Central Block and Balmoral South ......................................... 4-37
Table 4-5: Tidal Planes at Cape Preston .................................................................................................. 4-49
Table 4-6: Dissolved Metal Concentrations in the Vicinity of the Brine Outfall Site ............................. 4-53
Table 4-7: Pilbara Region Demographics .............................................................................................. 4-59
Table 4-8: Economic Statistics for the Pilbara Region 2005/06 .............................................................. 4-60
Table 5-1: Summary of Key Issues Identified ........................................................................................ 5-2
Table 6-1: Summary of Impacts and Management Measures Applicable to the Relevant EPA
Environmental Factors .......................................................................................................................... 6-2
Table 7-1: Categories of Significant Flora Under the EPBC Act .......................................................... 7-2
Table 7-2: Definitions of Rare and Priority Flora ................................................................................... 7-2
Table 7-3: Categories of Declared Plants ............................................................................................... 7-4
Table 7-4: Total Area of Each Land System to be Cleared by the Balmoral South Project .................... 7-5
Table 7-5: Areas of Direct Vegetation Clearing by Community Type .................................................... 7-6
Table 7-6: Areas of Phreatophytic Vegetation Impacted by Groundwater Drawdown ........................... 7-10
Table 7-7: Cumulative Loss Thresholds for BPPH within Defined Management Units ........................ 7-15
Table 7-8: Assessment of BPPH Loss from Balmoral South Project .................................................... 7-19
Table 7-9: Categories of Threatened Fauna ............................................................................................ 7-23
Table 7-10: Classifications of Schedule Fauna ....................................................................................... 7-24
Table 7-11: Classifications of Priority Fauna ......................................................................................... 7-24
Table of Contents

Table 7-12: Summary of Pastoral Wells and Effects of Dewatering ............................................. 7-55
Table 8-1: Ambient Air Quality NEPM Goals.................................................................................. 8-2
Table 8-2: World Health Organisation Air Quality Guidelines for Europe........................................ 8-2
Table 8-3: Emissions from the Balmoral South Project................................................................. 8-3
Table 8-4: Meteorological monitoring Station Locations ............................................................... 8-4
Table 8-5: Predicted Concentrations from the Balmoral South Project........................................... 8-6
Table 8-6: Cumulative Concentrations from Balmoral South and Central Block Projects ................. 8-8
Table 8-7: Predicted Ozone Concentrations (Existing and Approved Sources) ............................... 8-11
Table 8-8: Predicted Ozone Concentrations (Existing, Approved and Proposed Sources)................ 8-14
Table 8-9: Dust Emissions Estimation............................................................................................ 8-19
Table 8-10: Project Energy and Emissions ....................................................................................... 8-23
Table 8-11: Levels of Ecological Protection for Maintenance of Ecosystem Integrity ..................... 8-26
Table 8-12: Chemicals Used in the RO Process and Dilutions in the Marine Environment .............. 8-29
Table 8-13: Possible Operational Impacts of RO Plants and Applicability to the Project................ 8-32
Table 8-14: Coastal Sub-ecosystems and Characteristics Ranked by Sensitivity ............................... 8-34
Table 8-15: Assigned Noise Levels................................................................................................ 8-37
Table 8-16: EPA Guidance Statement ............................................................................................. 8-39
Table 8-17: Predicted Environmental Noise Levels ......................................................................... 8-40
Table 10-1: Sustainability Checklist ............................................................................................... 10-1
Table 10-2: Principles of Environmental Protection .......................................................................... 10-5
Table 11-1: Fauna Species Listed by the EPBC Act......................................................................... 11-2
# Table of Contents

## Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1-1</td>
<td>Location Plan – Balmoral South Iron Ore Project</td>
<td>1-1</td>
</tr>
<tr>
<td>Figure 1-2</td>
<td>Relationship between the State and Commonwealth Environmental Approval Systems</td>
<td>1-7</td>
</tr>
<tr>
<td>Figure 2-1</td>
<td>Balmoral South Iron Ore Project Areas of Disturbance Sheet 1 of 2</td>
<td>2-5</td>
</tr>
<tr>
<td>Figure 2-2</td>
<td>Balmoral South Iron Ore Project Areas of Disturbance Sheet 2 of 2</td>
<td>2-6</td>
</tr>
<tr>
<td>Figure 2-3</td>
<td>Balmoral South Project Process Flow Diagram</td>
<td>2-7</td>
</tr>
<tr>
<td>Figure 2-4</td>
<td>Balmoral South Iron Ore Project and Mineralogy Central Block Project Approved Areas of Disturbance Sheet 1 of 2</td>
<td>2-11</td>
</tr>
<tr>
<td>Figure 2-5</td>
<td>Balmoral South Iron Ore Project and Mineralogy Central Block Project Approved Areas of Disturbance Sheet 2 of 2</td>
<td>2-12</td>
</tr>
<tr>
<td>Figure 2-6</td>
<td>Major Access Roads</td>
<td>2-16</td>
</tr>
<tr>
<td>Figure 2-7</td>
<td>Schematic Layout for the Four Mining Stages</td>
<td>2-20</td>
</tr>
<tr>
<td>Figure 2-8</td>
<td>General Layout of ROM Pad, Process and Pellet Plants</td>
<td>2-25</td>
</tr>
<tr>
<td>Figure 2-9</td>
<td>Typical Cross Section Eastern Corridor</td>
<td>2-31</td>
</tr>
<tr>
<td>Figure 2-10</td>
<td>Location for Desalination Plant and Intakes and Outfalls</td>
<td>2-35</td>
</tr>
<tr>
<td>Figure 2-11</td>
<td>Typical Seawater Intake System</td>
<td>2-36</td>
</tr>
<tr>
<td>Figure 2-12</td>
<td>Design Principles for the Hanging Wall</td>
<td>2-43</td>
</tr>
<tr>
<td>Figure 4-1</td>
<td>Wind Roses for Mardie - 1956 to 2007</td>
<td>4-4</td>
</tr>
<tr>
<td>Figure 4-2</td>
<td>Regional Geology</td>
<td>4-6</td>
</tr>
<tr>
<td>Figure 4-3</td>
<td>Schematic Geological Cross Section</td>
<td>4-7</td>
</tr>
<tr>
<td>Figure 4-4</td>
<td>Groundwater Salinity Contours &amp; Existing Pastoral Well Locations</td>
<td>4-11</td>
</tr>
<tr>
<td>Figure 4-5</td>
<td>Groundwater Investigations</td>
<td>4-13</td>
</tr>
<tr>
<td>Figure 4-6</td>
<td>Land Systems in the Balmoral South Project Area</td>
<td>4-16</td>
</tr>
<tr>
<td>Figure 4-7</td>
<td>Cape Preston Flora and Fauna Survey History</td>
<td>4-19</td>
</tr>
<tr>
<td>Figure 4-8</td>
<td>Cape Preston Potential Locations of Declared (Weed) Plants - Northern Area</td>
<td>4-21</td>
</tr>
<tr>
<td>Figure 4-9</td>
<td>Cape Preston Potential Locations of Declared (Weed) Plants - Southern Area</td>
<td>4-22</td>
</tr>
<tr>
<td>Figure 4-10</td>
<td>Vegetation Communities and Disturbance Areas – Northern Area</td>
<td>4-25</td>
</tr>
<tr>
<td>Figure 4-11</td>
<td>Vegetation Communities and Disturbance Areas – Southern Area</td>
<td>4-26</td>
</tr>
<tr>
<td>Figure 4-12</td>
<td>Mangrove Assemblages for Cape Preston</td>
<td>4-29</td>
</tr>
<tr>
<td>Figure 4-13</td>
<td>Locations of Bores Where Stygofauna were Collected in the Vicinity of Cape Preston</td>
<td>4-35</td>
</tr>
<tr>
<td>Figure 4-14</td>
<td>Bores in the Cape Preston Area Where Troglofauna Occurring at Balmoral South Were Recorded</td>
<td>4-38</td>
</tr>
<tr>
<td>Figure 4-15</td>
<td>SRE Survey Sites Locations within the Cape Preston Iron Ore Mining Precinct</td>
<td>4-40</td>
</tr>
<tr>
<td>Figure 4-16</td>
<td>Mygalomorphae and Araneomorphae Species Locations Recorded During the Survey of the Cape Preston Iron Ore Mining Precinct</td>
<td>4-41</td>
</tr>
<tr>
<td>Figure 4-17</td>
<td>Pseudoscorpions Locations Recorded During the Survey of the Cape Preston Iron Ore Mining Precinct</td>
<td>4-42</td>
</tr>
<tr>
<td>Figure 4-18</td>
<td>Buthidae Scorpion Species Locations Recorded During the Survey of the Cape Preston Iron Ore Mining Precinct</td>
<td>4-43</td>
</tr>
</tbody>
</table>
# Table of Contents

Figure 4-19: Buddelundia Isopod Species Locations Recorded During the Survey of the Cape Preston Iron Ore Mining Precinct ................................................................. 4-44
Figure 4-20: Cape Preston Bathymetry .................................................................................. 4-47
Figure 4-21: Cape Preston Geomorphic Components ............................................................... 4-51
Figure 4-22: Cape Preston Benthic Habitats ........................................................................... 4-55
Figure 4-23: Designated Marine Social Values in the Cape Preston Area ................................ 4-63
Figure 4-24: Proposed Regnard Marine Management Area .................................................... 4-65
Figure 7-1: Phreatophtic Vegetation Impacted by the Cumulative 3 m Drawdown Contour ....... 7-11
Figure 7-2: Cape Preston Mangrove Management Area ......................................................... 7-14
Figure 7-3: Management Unit for the Assessment of Mangrove and Algal Mat Habitats ........ 7-17
Figure 7-4: Comparison of Tidal Heights During a Spring Tide Event Before (Blue) and After (Red) the Eastern Service Corridor Culverts are Installed (GEMS 2008) .......................... 7-21
Figure 7-5: Subterranean Fauna Habitat in the Cape Preston Region ...................................... 7-32
Figure 7-6: Typical Seawater Intake System .......................................................................... 7-34
Figure 7-7: Seafloor Near Diffuser Sites .................................................................................. 7-35
Figure 7-8: 100 Year ARI Flood Levels in the Fortescue River .............................................. 7-42
Figure 7-9: 100 Year ARI Flood Levels in Du Boulay Creek ................................................... 7-43
Figure 7-10: 20 Year Drawdown Contours – Central Block Project Only ............................... 7-50
Figure 7-11: 28 Year Drawdown Contours – Central Block and Balmoral South Projects ....... 7-51
Figure 8-1: Predicted Maximum 24-Hour NOx Concentration (µg/m^3) ............................... 8-6
Figure 8-2: Predicted 2nd Highest 1-Hour NO2 Concentration (µg/m^3) ............................... 8-7
Figure 8-3: Predicted 6th Highest PM10 Concentration (µg/m^3) .......................................... 8-7
Figure 8-4: Predicted Maximum 24-Hour NOx Concentration (µg/m^3) ............................... 8-9
Figure 8-5: Predicted 2nd Highest 1-hour NO2 Concentration (µg/m^3) ............................... 8-9
Figure 8-6: Predicted 6th Highest PM10 Concentration (µg/m^3) .......................................... 8-10
Figure 8-7: Predicted Annual Average NO2 Concentrations (ppb) ........................................ 8-11
Figure 8-8: Predicted 2nd Highest 1-hour NO2 Concentrations (ppb) ..................................... 8-12
Figure 8-9: Predicted 2nd Highest 4-hour O3 Concentrations (ppb) ...................................... 8-12
Figure 8-10: Predicted 2nd Highest 1-hour O3 Concentrations (ppb) .................................... 8-13
Figure 8-11: Predicted Annual Average NO2 Concentrations (ppb) ....................................... 8-14
Figure 8-12: Predicted 2nd Highest 1-hour NO2 Concentrations (ppb) ............................... 8-15
Figure 8-13: Predicted 2nd Highest 4-hour O3 Concentrations (ppb) .................................... 8-15
Figure 8-14: Predicted 2nd Highest 1-hour O3 Concentrations (ppb) .................................... 8-16
Figure 8-15: Project Lifecycle Emission .................................................................................. 8-23
Figure 8-16: Emissions Breakdown ....................................................................................... 8-24
Figure 8-17: Zones of Ecological Protection .......................................................................... 8-27
Figure 8-18: Percentage Compliance of the Two Proposed Brine Discharges ....................... 8-31
Figure 8-19: Noise Contour Plot for the Worst Case Operational Scenario ......................... 8-41

International Minerals Pty Ltd
February 2009
Appendices

Appendix A  Project Environmental Management Plan (Included in Volume 1)

VOLUME 2

Appendix B  Balmoral South Iron Ore Project Environmental Scoping Document
Appendix C  Balmoral South Environmental Impact Assessment – Flora And Fauna Survey
Appendix D  Subterranean Fauna Sampling at Balmoral South Iron Ore Project and Adjacent Area
Appendix E  Tidal Flow Monitoring GEMS 2008
Appendix F  Marine Impact Assessment Water Production Desalination Plant at Cape Preston

VOLUME 3

Appendix G  Balmoral South Iron Ore Project – Surface Water Management Plan
Appendix H  Balmoral South Iron Ore Project – Groundwater Assessment
Appendix I  Balmoral South Project Air Quality Assessment
Appendix J  Photochemical Smog Assessment for the Proposed International Minerals Iron Ore Mine and Associated Infrastructure at Cape Preston
Appendix K  International Minerals (Balmoral South) Iron Ore Mine Environmental Noise Assessment
Appendix L  Short Range Endemic Invertebrate Fauna Survey
Appendix M  Development of Air Dispersion Modelling Meteorological Data Sets for Cape Preston
Appendix N  Greenhouse Gas Assessment
Appendix O  Conceptual Design of Waste Storage Facility
Appendix P  Acid Mine Drainage (AMD) Review
Table of Contents

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Section 1

Introduction

1.1 The Proposal

International Minerals Pty Ltd (IM) proposes to develop the Balmoral South Iron Ore Project, which consists of a magnetite iron ore mine, processing facility and associated infrastructure (the "Balmoral South Project") in the Cape Preston region of Western Australia, 80 km south-west of Karratha (Figure 1-1: Location Plan). The Balmoral South Project will comprise:

- an open-cut iron ore mine producing 80 Mtpa of magnetite ore;
- 80 Mtpa overburden and waste disposal facilities;
- processing facilities including crusher, concentrator and pellet plant;
- the production of 24 Mtpa of concentrate, of which approximately 14 Mtpa will be pelletised, and all will be exported;
- materials handling facilities including 30 km of conveyors linking the plant site to port stockyard facilities located at Cape Preston;
- utilities including a 40 GLpa desalination plant and 600 MW combined cycle power station;
- accommodation village for 4,000 construction and 1,500 operations personnel; and
- offices, workshops and other supporting infrastructure including explosives magazine, landfill, fuel storage and distribution, and warehousing.

Project construction is expected to commence in 2009.

Figure 1-1: Location Plan – Balmoral South Iron Ore Project
Section 1

Introduction

The Balmoral South Project is expected to operate for at least 28 years after the first 3 years of construction and commissioning, with extensions beyond this being dependant on continued contracts for ore supply, and the Project continuing to be economically viable.

1.2 Background

IM has entered into a series of agreements with Mineralogy Pty. Ltd. (Mineralogy) which provide access to all of the Mineralogy tenements necessary to carry out the Balmoral South Project. These agreements have been approved by the Minister for Resources Development and are set out in the First Schedule of the Iron Ore Processing (Mineralogy Pty Ltd) Agreement Act 2002.

The Balmoral South Project lies adjacent and to the south of the Mineralogy Central Block Project (Central Block Project), which received environmental approval for the development of a mine, processing plant, stockyards, villages, port, dredging and associated infrastructure (Ministerial Statement 000635) in October 2003. The Central Block Project is currently being developed by CITIC Pacific Mining Management (CPMM) under a commercial agreement with Mineralogy. In 2008 the potential of the Cape Preston area as a major iron ore mining and downstream processing precinct has been realised through the commencement of construction for the Central Block Project.

The Central Block Project and its immediate surrounds were extensively assessed to support the project’s approvals. IM has built on this previous work through the completion of a number of specialist studies to fill in the gaps in knowledge and to complete an assessment of the cumulative impacts of the Balmoral South and Central Block Projects.

The Central Block Project has completed a suite of Environmental Management Plans (EMPs) to satisfy the Ministerial Conditions Statement 000635. The EMPs set out the statutory requirements and industry accepted practices and management strategies for an iron ore mining and processing project in the Cape Preston region. IM will implement a Project Environmental Management Plan (PEMP) that adopts and, where necessary, updates the management strategies for the Central Block Project to ensure that there is consistency in environmental management for the region. The PEMP (Appendix A) includes industry standard environmental management practices throughout the construction, operation and decommissioning of the Balmoral South Project. IM is seeking the approval of the PEMP as part of the Environmental Impact Assessment (EIA) process.

The Balmoral South Project does not cover any marine based export facilities. From the port stockyard facilities, product will be conveyed to the wharf at the Port which will be established by the Mineralogy Central Block Project. From here, product handling and loading will be managed by Mineralogy as a component of the Mineralogy Central Block approvals.

1.3 The Proponent

The Proponent for the Balmoral South Project is:

International Minerals Pty Ltd
Level 4, 5 Mill Street
PERTH WA 6000.

The company contact is:

Nick Jukes
Study Director.
Telephone: (08) 9322 2288
Facsimile: (08) 9324 2164

Email: njukes@austresources.com.au

IM is a wholly owned subsidiary of the Australian Stock Exchange listed company Australasian Resources Limited (ASX Code: ARH).
Section 1

Introduction

1.4 Objectives of the PER

The objectives of this PER are to:

- place the proposed Balmoral South Project in the context of the local and regional environment;
- adequately describe all components of the proposal;
- identify key environmental issues that may occur as a result of the Balmoral South Project;
- provide the basis of the Proponent’s environmental management measures, which demonstrate that the environmental impacts resulting from the Balmoral South Project, including cumulative impacts, are minimised and can be managed in an environmentally acceptable manner;
- communicate clearly with stakeholders (including the public and government agencies), so that informed public comment can be obtained by the Environmental Protection Authority (EPA) to assist in providing advice to the WA Minister for the Environment; and
- provide a document which clearly demonstrates why the Balmoral South Project should be determined by the EPA and the Minister for the Environment to be environmentally acceptable.

1.5 Decision Making Authorities (DMAs)

The primary agencies involved in the assessment and monitoring of the Balmoral South Project are:

Commonwealth

- Department of the Environment, Water, Heritage and the Arts (DEWHA) which administers the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and associated regulations;

State

- EPAWA which provides overarching environmental advice to the Minister for the Environment through the preparation of environmental protection policies and the assessment of development proposals and management plans;
- Department of Environment and Conservation (DEC) which is responsible for administering the Environmental Protection Act 1986, the Conservation and Land Management Act 1984 and Wildlife Conservation Act 1950 on behalf of the Minister for the Environment, for considering and initiating measures for the conservation, protection and management of the environment, and for the prevention, control and abatement of pollution;
- Department of Water (DoW) which is responsible for the administration of the Rights in Water and Irrigation Act 1914, Water and Rivers Commission Act 1955 and Waterways Conservation Act 1976 to ensure that the State’s water resources are managed to support sustainable development and conservation of the environment for the long term benefit of the community;
- Department of Industry and Resources (DoIR) which administers the Mining Act 1978;
- Department of Consumer and Employment Protection (DoCEP) which administers the Explosives and Dangerous Goods Act 1961 and the Mines Safety and Inspections Act 1994 and associated Regulations;
- Department of Indigenous Affairs (DIA) which administers the Aboriginal Heritage Act 1972 and supports the Aboriginal Land Trust; and
- Shire of Roebourne which manage local legislation, policies, and strategic plans.
Section 1

Introduction

1.6 Environmental Assessment Process

1.6.1 Assessment under the WA Environmental Protection Act 1986

The purpose of the WA environmental assessment process is to provide information to the relevant DMAs, as well as to the public, about proposed developments that may impact on the natural and social environment.

In May 2007, IM submitted an application to the EPAWA to trigger the environmental assessment process for the Balmoral South Project. Following review by the EPAWA, IM was advised on the 14th May 2007 that the Balmoral South Project would be formally assessed via a Public Environmental Review (PER) with a public review period of eight weeks.

IM, in consultation with the EPAWA and other relevant DMAs, prepared a draft Environmental Scoping Document (ESD) pursuant to Section 6.1 of the Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002, which outlines the requirements for the ESD where the level of assessment has been set at PER, and submitted the final ESD to the EPA in September 2008. This document identifies the potential environmental impacts on relevant environmental factors that the DMAs believe should be addressed in the PER, summarises any previously carried out works and gives their suitability for this proposal. It also sets out the proposed environmental surveys / investigations to be undertaken by the proponent for the preparation of PER. The ESD (Appendix B) was approved by the EPA in September 2008.

The PER will be available for public comment for an eight week period. During this time, government agencies, private organisations, community groups and the public are invited to make submissions to the EPAWA in relation to the Balmoral South Project. At the close of the public review period, IM will summarise and respond to issues raised in submissions. The EPAWA will then assess the proposal and release its report and recommendations to the Minister for the Environment, which is then subject to a statutory 14 day appeal period.

The Minister for the Environment will then determine any appeals and consult with the DMAs to seek agreement on whether or not, and in what manner, the proposal may be implemented.

Consultation will also occur between the State and Commonwealth Ministers.

The Minister for the Environment will issue a Statement (provided approval for the Balmoral South Project is given) which legally binds IM to implement the proposal as documented and described, subject to the Minister’s conditions and procedures and Proponent commitments.

An overview of the assessment process is provided in Figure 1-2: Relationship between the State and Commonwealth Environmental Approval Systems.

1.6.2 Assessment under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), an action requires approval from the Commonwealth Minister for the DEWHA if the action has, will have, or is likely to have a significant impact on a Matter of National Environmental Significance (MNES). The MNES are:

- World Heritage Properties;
- National Heritage places;
- Ramsar wetlands of international significance;
- Nationally listed threatened species and ecological communities;
- Listed migratory species;
- Commonwealth marine areas; and
- Nuclear actions.
Section 1

Introduction

In May 2008, IM referred the Balmoral South Project (EPBC Ref 2008/4236). On 2nd July 2008 the Balmoral South Project was determined to be a “controlled action”, and would therefore require approval under the EPBC Act. The controlling provisions were that the project was likely to have a significant impact on listed threatened species and communities (Section 18 and 18A) and listed migratory species (Section 20 and 20A).

The environmental assessment of the Balmoral South Project will be conducted in accordance with the “Agreement between the Commonwealth of Australia and WA under Section 45 of the EPBC Act Relating to the Environmental Impact Assessment (the Bilateral Agreement) and in conformance with the Cooperative Arrangements to the Bilateral Agreement”. This means that the environmental impact assessment undertaken by the State for the Balmoral South Project is accredited by the Commonwealth.

Following its review of the PER and other relevant documentation, DEWHA will prepare an assessment report for the Commonwealth Minister.

If the Minister decides to approve the Balmoral South Project, IM will be notified and the decision published. This approval is a separate approval to the one issued by the WA Minister for the Environment.
**Section 1**

**Introduction**

### State Process

**EPA Process**
- Referral of Proposal to EPA*
  - EPA Sets level of Assessment
  - Submit Scoping Document
  - EPA approves Scoping Doc
  - PER/ERMP prepared
  - EPA authorises PER/ERMP for release
  - Receipt of Public Submissions
  - Response to submissions
  - EPA report and recommendations to Minister
  - Minister publishes EPA report and recommendations

**Minister’s Process**
- Minister refers back to EPA to re-assess
- Minister upholds appeal
- Appeals to Minister to raise assessment level?

### Commonwealth Process

**Referral of Proposal to DEH**
- Minister determines if approval required
- Designate proponent. Notify proponent and State
- Does a bilateral agreement apply?
- Assessment under a bilateral agreement
- State Assessment process accredited under a bilateral agreement

---

*EPA guidance recommends that for projects expecting a level of assessment at PER or ERMP, a draft Scoping Document should be submitted with the project referral.

**Figure 1-2: Relationship between the State and Commonwealth Environmental Approval Systems**
1.7 Relevant Legislation, Policies and Guidelines

The EPAWA requires that proponents identify the Commonwealth and State legal framework and any standards, policies and guidelines that underpin the environmental assessment process relevant to the Proposal and with which the Proponent will need to comply. The relevant legislation includes the Acts and Regulations listed below.

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Relevance / Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron Ore Processing (Mineralogy Pty Ltd) Agreement Act 2002</td>
<td>Act under which the project is developed and to which IM is a co-signatory</td>
</tr>
<tr>
<td>Aboriginal Heritage Act 1972</td>
<td>Protection of Aboriginal heritage sites</td>
</tr>
<tr>
<td>Agriculture and Related Resources Protection Act 1976</td>
<td>Addresses the obligations for management, control, destruction, and notification of gazetted noxious plants and animals</td>
</tr>
<tr>
<td>Conservation and Land Management Act 1984</td>
<td>Protection and management of land vested for conservation purposes</td>
</tr>
<tr>
<td>Environmental Protection Act 1986</td>
<td>Mechanism that provides for formal assessment of the proposal and assigns impact management responsibilities to the proponent</td>
</tr>
<tr>
<td>Mining Act 1978</td>
<td>Act to consolidate and amend the law relating to mining and for incidental and other purposes.</td>
</tr>
<tr>
<td>Explosives and Dangerous Goods Act 1961</td>
<td>Correct procedures for transporting handling and storing explosive and dangerous goods such as explosives, hydrocarbons and chemicals</td>
</tr>
<tr>
<td>Health Act 1911 – Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste Regulations) 1974</td>
<td>Procedures for the treatment and disposal of effluent waste</td>
</tr>
<tr>
<td>Occupational Health, Safety and Welfare Act 1984</td>
<td>Sets workplace limits for air quality</td>
</tr>
<tr>
<td>Rights in Water and Irrigation Act 1914</td>
<td>Governs water resource management and allocation ensuring water resources are comprehensively and appropriately managed. Regulation of draw on groundwater</td>
</tr>
<tr>
<td>Wildlife Conservation Act 1950</td>
<td>Provides for the conservation and protection of wildlife (flora and fauna). Special provisions and schedules cover protection and management of gazetted rare flora and fauna</td>
</tr>
</tbody>
</table>
Section 1

Introduction

Table 1-2: Policies, Guidelines and Standards

<table>
<thead>
<tr>
<th>Best Environmental Practice in Mining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Consultation and Involvement</td>
</tr>
<tr>
<td>Tailings Containment</td>
</tr>
<tr>
<td>Rehabilitation and Revegetation</td>
</tr>
<tr>
<td>Planning a Workforce Environmental Awareness Training Programme</td>
</tr>
<tr>
<td>Managing Sulphidic Mine Wastes and Acid Drainage</td>
</tr>
<tr>
<td>Environmental management Systems</td>
</tr>
<tr>
<td>Water Management</td>
</tr>
<tr>
<td>Decommissioning and Planning for Mine Closure</td>
</tr>
<tr>
<td>Noise, Vibration, and Airblast Control</td>
</tr>
<tr>
<td>Dust Control</td>
</tr>
<tr>
<td>Environmental Monitoring and Performance</td>
</tr>
</tbody>
</table>

National Environmental Protection Council Guidelines

| National Environmental Protection (Ambient Air Quality) Measure for Particles as PM$_{2.5}$ |
| National Environmental Protection (Ambient Air Quality) Measure. Technical Paper on Monitoring for Particles as PM$_{2.5}$ |

Table 1-3: EPA Position and Guidance Statements

<table>
<thead>
<tr>
<th>Environmental Protection Authority Position Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Environmental Protection of native Vegetation in Western Australia</td>
</tr>
<tr>
<td>3 Terrestrial biological Surveys as an Element of Biodiversity Protection</td>
</tr>
<tr>
<td>5 Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia</td>
</tr>
<tr>
<td>6 Towards Sustainability</td>
</tr>
<tr>
<td>7 Principles of Environmental Protection</td>
</tr>
<tr>
<td>9 Environmental Offsets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental Protection Authority Guidance Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Protection of Tropical Arid Zone Mangroves Along the Pilbara Coastline</td>
</tr>
<tr>
<td>12 Minimising Greenhouse Gas Emissions</td>
</tr>
<tr>
<td>15 Emissions of Oxides of Nitrogen from Gas Turbines</td>
</tr>
<tr>
<td>18 Prevention of Air Quality Impacts from Land Development Sites</td>
</tr>
<tr>
<td>29 Benthic Primary Producer Habitat Protection for Western Australia’s Marine Environment</td>
</tr>
<tr>
<td>51 Terrestrial Flora and Vegetation Survey for Environmental Impact Assessment in Western Australia</td>
</tr>
<tr>
<td>54 Sampling of subterranean fauna in groundwater and caves</td>
</tr>
<tr>
<td>54a Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia</td>
</tr>
<tr>
<td>55 Implementing best practice in proposals submitted to the environment impact assessment process</td>
</tr>
<tr>
<td>56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia</td>
</tr>
</tbody>
</table>
# Section 1

## Introduction

### Table 1-4: Works Approvals and Licensing

<table>
<thead>
<tr>
<th>Category Number</th>
<th>Description of Category</th>
<th>Production or Design Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td><strong>Processing or beneficiation of metallic or non-metallic ore:</strong> premises on which</td>
<td>50 000 tonnes or more per year</td>
</tr>
<tr>
<td></td>
<td>a) metallic or non-metallic ore is crushed, ground, milled or otherwise processed;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) tailings from metallic or non-metallic ore are reprocessed; or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) tailings or residue from metallic or non-metallic ore are discharged into a containment cell or dam.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td><strong>Mine dewatering:</strong> premises on which water is extracted and discharged into the environment to allow mining of ore.</td>
<td>50 000 tonnes or more per year</td>
</tr>
<tr>
<td>44</td>
<td><strong>Metal smelting or refining:</strong> premises on which metal ore, metal ore concentrate or metal waste is smelted, fused, roasted, refined or processed.</td>
<td>1000 tonnes or more per year</td>
</tr>
<tr>
<td>52</td>
<td><strong>Electric power generation:</strong> premises (other than premises within category 53 or an emergency or standby power generating plant) on which electrical power is generated using a fuel.</td>
<td>20 megawatts or more in aggregate (using natural gas)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 megawatts or more in aggregate (using a fuel other than natural gas)</td>
</tr>
<tr>
<td>54</td>
<td><strong>Sewage facility:</strong> premises - a) on which sewage is treated (excluding septic tanks); or</td>
<td>100 cubic metres or more per day</td>
</tr>
<tr>
<td></td>
<td>b) from which treated sewage is discharged onto land or into waters.</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td><strong>Used tyre storage (general):</strong> premises (other than premises within category 56) on which used tyres are stored.</td>
<td>100 tyres or more</td>
</tr>
<tr>
<td>58</td>
<td><strong>Bulk material loading or unloading:</strong> premises on which clinker, coal, ore, ore concentrate or any other bulk granular material is loaded onto or unloaded from vessels by an open materials loading system.</td>
<td>100 tonnes or more per day</td>
</tr>
<tr>
<td>62</td>
<td><strong>Solid waste depot:</strong> premises on which waste is stored, or sorted, pending final disposal or re-use.</td>
<td>500 tonnes or more per year</td>
</tr>
<tr>
<td>64</td>
<td><strong>Class II or III putrescible landfill site:</strong> premises on which waste (as determined by reference to the waste type set out in the document entitled &quot;Landfill Waste Classification and Waste Definitions 1996&quot;, published by the Chief Executive Officer and as amended from time to time) is accepted for burial.</td>
<td>20 tonnes or more per year</td>
</tr>
</tbody>
</table>
Section 1

Introduction

Table 1-5: Commonwealth Legislation

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Relevance / Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment Protection and Biodiversity Conservation Act 1999</td>
<td>Protection for matters of national environmental significance from development impacts</td>
</tr>
<tr>
<td>Native Title Act 1993</td>
<td>Affords certain rights to Indigenous land owners</td>
</tr>
</tbody>
</table>

Table 1-6: Other Guidelines

<table>
<thead>
<tr>
<th>Other</th>
<th>Relevance / Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recreational Fishing Guidelines – Pilbara and South Coast Regions 2003/04</td>
<td>Provides guidance to recreational fishers in coastal waters of WA</td>
</tr>
<tr>
<td>Recreational Net Fishing Guidelines for WA 2004</td>
<td>Controls use of fish nets in coastal waters of WA</td>
</tr>
<tr>
<td>Environmental Protection (Noise) Regulations 1997</td>
<td>Control of construction and operational noise</td>
</tr>
<tr>
<td>Environmental Protection (Controlled Waste) Regulations 2001</td>
<td>Management of Contaminated Soil Bioremediation landfarm.</td>
</tr>
<tr>
<td>Draft Code of Practice for Rural Landfills</td>
<td>Correct protocol for design and management of putrescible waste landfill.</td>
</tr>
<tr>
<td>Landfill Waste Classification and Waste Definitions</td>
<td>Classification of site waste.</td>
</tr>
<tr>
<td>Guidelines for Direct Land Application of Biosolids and Biosolids Products</td>
<td>Method for disposal of sludge</td>
</tr>
<tr>
<td>Bioremediation of hydrocarbon-contaminated soils in Western Australia</td>
<td>Methods for Contaminated Soil Bioremediation</td>
</tr>
<tr>
<td>Management of Asbestos in Mining Operations</td>
<td>Provides guidance for the appropriate handling and disposal of asbestiform minerals</td>
</tr>
<tr>
<td>Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000</td>
<td>Provides criteria for marine water quality</td>
</tr>
</tbody>
</table>
Section 2

Project Description

2.1 Overview

This section describes the development of the Balmoral South Iron Ore Project (the Balmoral South Project) from commencement of construction through to the completion of mining.

International Minerals (IM) is seeking approval to construct and operate mining, process, materials handling, utilities, services and general infrastructure facilities, in the areas shown in Figure 2-1: Balmoral South Iron Ore Project Areas of Disturbance Sheet 1 of 2 and Figure 2-2: Balmoral South Iron Ore Project Areas of Disturbance Sheet 2 of 2.

The Balmoral South Project consists of the mine, processing facilities and key infrastructure, generally located as shown in Table 2-1: Project Facilities Locations.

<table>
<thead>
<tr>
<th>Lease</th>
<th>Project Intended Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>M08/122</td>
<td>corridor</td>
</tr>
<tr>
<td>M08/123</td>
<td>corridor</td>
</tr>
<tr>
<td>M08/124</td>
<td>corridor</td>
</tr>
<tr>
<td>M08/125</td>
<td>corridor</td>
</tr>
<tr>
<td>M08/126</td>
<td>mine, waste disposal facilities, processing plants and corridor</td>
</tr>
<tr>
<td>M08/127</td>
<td>mine, waste disposal facilities, processing plants and corridor</td>
</tr>
<tr>
<td>M08/128</td>
<td>corridor</td>
</tr>
<tr>
<td>M08/129</td>
<td>corridor</td>
</tr>
<tr>
<td>M08/130</td>
<td>corridor and Accommodation Village</td>
</tr>
<tr>
<td>M08/264</td>
<td>corridor</td>
</tr>
<tr>
<td>M08/266</td>
<td>corridor</td>
</tr>
<tr>
<td>G08/52</td>
<td>corridor and stockyards</td>
</tr>
<tr>
<td>G08/53</td>
<td>corridor</td>
</tr>
<tr>
<td>G08/54</td>
<td>corridor</td>
</tr>
<tr>
<td>G08/55</td>
<td>corridor</td>
</tr>
<tr>
<td>G08/63</td>
<td>waste disposal facilities</td>
</tr>
<tr>
<td>L08/20</td>
<td>corridor</td>
</tr>
</tbody>
</table>

The Balmoral South Project is seeking approval for the establishment of:

- an Open Pit Mine;
- Waste Disposal Facilities (WDF1 and WDF2);
- Run of Mine (ROM) pad;
- Processing Plants and Pelletising Plants;
- Utilities, including Power Station and Desalination Plant with saltwater intake and brine outfall;
- Distribution Networks for power, communication, data, water and gas;
- Accommodation Village (Camp);
Section 2

Project Description

- mine to Port Corridor with service roads, conveyors (or slurry pipelines), services pipelines, overhead power transmission lines and buried gas transmission pipeline;
- administration and support services buildings, access roads and associated infrastructure; and
- other services and infrastructure as required to support the project.

It is proposed to develop the Balmoral South Project in two project development stages, and to mine, process and export at the rates described in Table 2-2: Project Development Stages for Balmoral South Project. The Balmoral South Project is expected to occupy at least 31 years in total, consisting of an initial 3 year construction period and a subsequent 28 year expansion and processing period. Extensions beyond this will depend on continued contracts for ore supply and economic analysis.

At the end of Year 3 from commencement, Project Development Stage 1 will produce magnetite concentrate at the process plant at a rate of 12 Mtpa, of which 6.8 Mtpa will be pelletised. With the addition of binders, a total of 7 Mtpa of pellets will be produced. Approximately 5.2 Mtpa of concentrate remains available for export, along with the 7 Mtpa of pellets. All products will be exported, commencing at end of Year 3.

Project Development Stage 2 will commence in Year 4 and complete in Year 7, which will then double the Balmoral South Project production rates to 24 Mtpa of concentrate of which 13.6Mtpa will be pelletised.

<table>
<thead>
<tr>
<th>Table 2-2: Project Development Stages for Balmoral South Project (Nominal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Development - Years from Start</td>
</tr>
<tr>
<td>Design and Construct Project Stage 1 (12Mtpa)</td>
</tr>
<tr>
<td>Design and Construct Project Stage 2 (12Mtpa)</td>
</tr>
<tr>
<td>Mining to supply Stage 1 (80Mtpa - nominal)</td>
</tr>
<tr>
<td>Mining to supply Stage 2 (80Mtpa - nominal)</td>
</tr>
<tr>
<td>Production Rates (Nominal Mtpa)</td>
</tr>
<tr>
<td>Concentrate Production and Export</td>
</tr>
<tr>
<td>Concentrate Pelletised for Export</td>
</tr>
<tr>
<td>Subtotal - Exported</td>
</tr>
<tr>
<td>Mining (Ore)</td>
</tr>
<tr>
<td>Mining (Pit Waste)</td>
</tr>
<tr>
<td>Subtotal - Mining</td>
</tr>
<tr>
<td>Process Waste (Filtered Tailings)</td>
</tr>
<tr>
<td>Subtotal - Waste to Disposal Facilities (WDFs) (Pit Waste + Process Waste)</td>
</tr>
<tr>
<td>Operations Y4 to Y31</td>
</tr>
</tbody>
</table>

Table 2-3: Key Project Characteristics lists the key characteristics for the Balmoral South Project. Whilst best endeavours will be taken to develop plant designs that conform to these specifications, final quantities will not be known until detailed design is finalised.

Figure 2-3: Balmoral South Project Process Flow Diagram presents a schematic of the mine to export process flow, also indicating the location of each of the Project’s major components.
### Project Description

#### Table 2-3: Key Project Characteristics

<table>
<thead>
<tr>
<th>Element</th>
<th>Characteristics (All quantities are NOMINAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
</tr>
<tr>
<td>Development Period</td>
<td>Project Development Stage 1: 3 years</td>
</tr>
<tr>
<td></td>
<td>Project Development Stage 2: 3 years (immediately after Stage 1)</td>
</tr>
<tr>
<td>Operation Period</td>
<td>Minimum 28 years after Project Development Stage 1</td>
</tr>
<tr>
<td><strong>Mining</strong></td>
<td></td>
</tr>
<tr>
<td>Ore resources</td>
<td>2 billion tonnes</td>
</tr>
<tr>
<td>Ore mining rate</td>
<td>80 Mtpa</td>
</tr>
<tr>
<td>Pit depth (ultimate)</td>
<td>300 m</td>
</tr>
<tr>
<td>Overburden and waste</td>
<td>80 Mtpa</td>
</tr>
<tr>
<td>Stripping ratio</td>
<td>1.0 / 1.0 waste to ore</td>
</tr>
<tr>
<td>Materials handling</td>
<td>Conventional drill, blast, load and haul.</td>
</tr>
<tr>
<td>Dewatering rate</td>
<td>Up to 4 GLpa, including groundwater inflows and weather events</td>
</tr>
<tr>
<td>Dewatering disposal</td>
<td>To process water stream and dust suppression</td>
</tr>
<tr>
<td><strong>Concentrators</strong></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>Concentrate: 24 Mtpa</td>
</tr>
<tr>
<td>Waste</td>
<td>56 Mtpa</td>
</tr>
<tr>
<td><strong>Pelletising</strong></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>Pellets: 14 Mtpa</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>Up to 600 MW installed capacity gas fired combined cycle Power Station</td>
</tr>
<tr>
<td>Conveyor / Slurry Pipeline</td>
<td>~ 30km in length between the Process Plant site and Cape Preston Stockyard</td>
</tr>
<tr>
<td>Gas supply</td>
<td>Up to 34,000 Tjpa</td>
</tr>
<tr>
<td>Water Supply</td>
<td>40 GLpa Desalination Plant and up to 4 GLpa pit dewatering</td>
</tr>
<tr>
<td>Port Stockyard</td>
<td>2 Mt storage capacity</td>
</tr>
<tr>
<td>Roads</td>
<td>General traffic, haulage, mine, accommodation and access, infrastructure maintenance access</td>
</tr>
<tr>
<td>Buildings</td>
<td>Administration, maintenance workshops, storage, Accommodation Village and Power Station</td>
</tr>
<tr>
<td>Sewage</td>
<td>Package treatment plants</td>
</tr>
<tr>
<td><strong>Disturbance Areas</strong></td>
<td></td>
</tr>
<tr>
<td>Areas of disturbance and</td>
<td>Total Disturbance During Project 5,282 ha</td>
</tr>
<tr>
<td>rehabilitation</td>
<td>Final Pit Outline Surface Area 355 ha</td>
</tr>
<tr>
<td></td>
<td>Total Rehabilitation 4,927 ha</td>
</tr>
<tr>
<td><strong>Workforce</strong></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Up to 4,000</td>
</tr>
<tr>
<td>Permanent</td>
<td>Up to 1,500</td>
</tr>
<tr>
<td>Accommodation</td>
<td>Onsite for the entire workforce</td>
</tr>
</tbody>
</table>
Section 2

Project Description

Figure 2-1: Balmoral South Iron Ore Project Areas of Disturbance Sheet 1 of 2
Section 2

Project Description

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Figure 2-2: Balmoral South Iron Ore Project Areas of Disturbance Sheet 2 of 2
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Figure 2-3: Balmoral South Project Process Flow Diagram
2.2 Relationship with the Mineralogy Projects

The Balmoral South Project is adjacent to the Mineralogy Central Block Project (the Central Block Project) which has received environmental approval for the development of a mine, processing plant, stockyards, villages, port, dredging and associated infrastructure (Ministerial Statement 000635). The Central Block Project is currently being developed by CITIC Pacific Mining Management Pty. Ltd. (CPMM) under commercial agreements with Mineralogy.

The Central Block Project and its immediate surrounds were extensively assessed to support that project’s approvals. The Balmoral South Project has built on this previous work through the completion of a number of specialist studies to fill in the knowledge gaps and to complete an assessment of the cumulative impacts of the Balmoral South and Central Block Projects (Figure 2-4: Balmoral South Iron Ore Project and Mineralogy Central Block Project Approved Areas of Disturbance Sheet 1 of 2 and Figure 2-5: Balmoral South Iron Ore Project and Mineralogy Central Block Project Approved Areas of Disturbance Sheet 2 of 2).

Two further projects are currently proposed by Mineralogy for the Cape Preston area. These projects are:

- Austeel Steel Project; and
- Mineralogy Iron Ore Project.

Given that the projects are all located in the general area of Cape Preston, a number of cumulative environmental impacts are likely. At the request of the EPA, Mineralogy has agreed to prepare a discussion of the key environmental values that may be impacted through development of the four projects. This document will not attempt to quantify impacts, rather it will examine at a high level the likely impacts on key environmental values based on the current level of knowledge of these values and of the specific engineering details available on the projects.

Copies of this Cumulative Impacts document are available from Mineralogy via their website (www.mineralogy.com.au) or hard copies can be obtained from Level 7, 218 St Georges Terrace, PERTH, WA, 6000..

A suite of Environmental Management Plans (EMPs) have been prepared to satisfy the Ministerial Conditions for the Central Block Project. The Balmoral South Project recognises the important role that many Government Departments have played in working with the Central Block proponent to develop these EMPs. The EMPs set out the statutory requirements and industry practice management strategies for an iron ore mining and processing project in the Cape Preston region.

The Balmoral South Project has reviewed the Central Block Project management strategies as the basis for the Project Environmental Management Plan (PEMP), which is included in Appendix A, to ensure consistency in environmental management for the region.
Section 2  Project Description

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Figure 2-4: Balmoral South Iron Ore Project and Mineralogy Central Block Project Approved Areas of Disturbance Sheet 1 of 2
Section 2

Project Description

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Section 2

Project Description

Figure 2-5: Balmoral South Iron Ore Project and Mineralogy Central Block Project Approved Areas of Disturbance Sheet 2 of 2
Section 2

Project Description

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Section 2

Project Description

2.3 Infrastructure Being Provided by / to Other Projects

Mineralogy and the Balmoral South Project have agreed to govern the development, operation and use of shared infrastructure facilities for the transport and export of iron ore products. The transport facilities, including corridors from the Balmoral South Project’s Accommodation Village north to Cape Preston, for power lines, conveyors / slurry pipelines, water and gas pipelines, roads, bridges and other facilities, are intended to facilitate the export of iron ore products for the Balmoral South Project and future third party access.

Product will be conveyed from the Port stockyard facilities to the Port established by the Central Block Project, where product handling and loading will be managed by Mineralogy as a component of the Central Block approvals. Projects in the Cape Preston region will share infrastructure as much as possible in order to minimise environmental impact and lower development costs.

2.4 Construction and Commissioning Activities

The main construction activities will include:

- construction of monitoring equipment and commencement of monitoring activities;
- clearing of the mine and infrastructure sites including collection and reuse of topsoil where available;
- extraction of a bulk sample from the mine pit;
- pre-strip of the open pit to expose ore in advance of Processing Plant operation;
- construction of temporary facilities (such as lay down areas, construction camps and offices, workshops, concrete batching plant);
- construction of permanent accommodation, stream diversions, building pads, waste disposal facility, waste management facilities;
- construction of plant, roads, pipelines, materials handling facilities, Power Station, communications and other services;
- construction of crushing, concentrating and pelletising facilities;
- construction of mining infrastructure; and
- construction of water desalination facilities including water intake and wastewater outfall pipes.

2.4.1 Project Development Stages

Project Development Stage 1: Construction of Facilities for 12 Mtpa of Product

The initial site works will commence immediately on approval of the project and take around 12 months to complete. This will involve:

- upgrading the existing station access track to form the Southern Access Road;
- establishing a 200 person Accommodation Village;
- constructing a road from the camp to the processing and mine area;
- constructing temporary facilities at the processing plant; and
- commencing site earthworks.
Section 2

Project Description

The bulk of the construction work for Development Stage 1 will take place from 12 months to 36 months after approval and involve:

- pre-strip at the mine;
- completing site earthworks;
- constructing the initial Concentrator (12 Mtpa concentrate);
- constructing the initial Power Station (300 MW);
- constructing the initial Pellet Plant (7 Mtpa);
- constructing the initial overland conveyor / slurry pipeline (30 km in length);
- constructing the initial Port stockyard (1 Mt storage);
- constructing the initial Desalination Plant (20 GLpa);
- constructing the administration and support buildings; and
- constructing a 2,800 person Village.

Project Development Stage 2: Construction of Additional Facilities for 24 Mtpa of Product

This work will start on the completion of the 12 Mtpa facilities, and continue for another 3 years. The work will include construction of the following facilities:

- second stage Concentrator (12 Mtpa to 24 Mtpa concentrate);
- second stage Power Station (300 MW to 600 MW);
- second stage Pellet Plant (7 Mtpa to 14 Mtpa);
- second overland conveyor / slurry pipeline (30 km in length, parallel to Stage 1 installation);
- expand Port stockyard (1 Mt to 2 Mt);
- second stage Desalination Plant (20 GLpa to 40 GLpa); and
- Village expansion (to 4,000 persons).

2.4.2 Construction Water Supply

Water required during construction, and possibly during initial operations, will be sourced via arrangements with the Central Block proponents and / or Mineralogy which has applied for an extraction licence for a borefield in the Fortescue River alluviums. Other potential sources may be investigated as required, including mobile desalination plants or the controlled use of seawater. The Balmoral South Project also intends to apply for 5C licenses to extract water from within the Balmoral South Project area. The volumes of water required for construction activities will vary according to the activity undertaken.

2.4.3 Site Roads

The primary access to the Balmoral South Project will be from the North West Coastal Highway, heading west north west for approximately 6 km on the Southern Access Road (following the existing alignment of the Balmoral Station access road), and joining the corridor near the Accommodation Village (Figure 2-6: Major Access Roads).
Section 2  Project Description

This primary access road will be extended approximately 8 km northward from the Accommodation Village along the corridor to link to the process plant. The primary access road will continue approximately another 3 km north to link to the roads installed by the Central Block proponent. The Balmoral South Project will use the Port access road, located within the access corridor between the processing / mining facilities and the Port, by commercial arrangement with the Central Block Project.

The primary access roads will be built to Main Roads WA standards, with a 110 km/hr design speed and heavy duty traffic loading (there will be around one B-double/hr delivering operational supplies to the site). Roads will be sealed and typically have a 7.4 m pavement and a 3 m shoulder on each side.

These roads will be designed with culverts for a 1 in 10 year rainfall event, with flows in excess of that carried by integrated floodways. Floods are generally associated with cyclones, and traffic movements at such times are usually low.

Road pavement materials will be sourced from a commercial quarry operating in the Karratha region.

Unsealed haul roads will be constructed around the project site to support mining activities, plus additional unsealed access roads will be installed to gain access to lightly serviced utilities.

The Central Block Project will establish its own primary access road (called “Mine Access Road”) from the North West Coastal Highway heading west to join the access corridor.

Public access to the two main access roads will be discouraged. Public access to the Fortescue River Mouth camping site will continue to be available by the existing unsealed Fortescue River Mouth Road from the North West Coastal Highway, which will require the Central Block Project to divert portions of the Fortescue River Mouth Road away from the Mine Access Road, as shown in Figure 2-6. The intersection of the Fortescue River Mouth Road and the access corridor will also be designed by the Central Block Project.
Section 2

Project Description

Figure 2-6: Major Access Roads
Section 2

Project Description

2.4.4 Site Drainage and Flood Protection

The Balmoral South Project footprint has been engineered within the constraints of legal tenure boundaries, with consideration given to legally-binding Agreements with the tenement holder. Key project infrastructure will be located above the 100 year ARI flood level.

The WDF1 area to the west of the pit encroaches slightly into the floodplain of the Fortescue River. The WDF2 area to the east of the pit does not encroach into the floodplain of Du Boulay Creek.

The toe of the disposal facilities will be protected by armour rock to resist erosion by the river. The slope will be surfaced by rock selected from the waste, and thus erosion of fine material by rain will be minimal. Drainage structures will be constructed within the WDFs to handle runoff from a 100 year ARI storm.

Du Boulay Creek passes between the proposed pit and the processing plants. The pit will be protected by an armoured bund to prevent surface water from the creek entering the pit.

Rainfall within the WDF areas will run off to retention ponds. Water which falls on the open mine will collect in the pit. This water will be pumped out of the mine to retention ponds by a system of fixed pipes and movable pumps. Water in the retention ponds will normally be pumped to the process water system but, as a last resort, will be discharged to Du Boulay Creek or the Fortescue River. Water will be sampled and analysed as per PEMP Section 12 to ensure appropriate quality prior to controlled discharge.

Retention ponds will slow down the runoff and allow larger particles to settle out, and the settled material will be periodically cleaned out. The retention ponds will be designed to hold the 1 in 5 year rainfall of 151 mm in 72 hours. Once rainfall exceeds the 5 year storm event the neighbouring countryside is flooded and any contribution from erosion from the WDFs will be swamped by the general runoff.

The site level for the processing plants has been set above the 100 year ARI flood level in Du Boulay Creek, using selected fill obtained from mining pre-stripping activities. The fill face exposed to floods will be armoured. Run-off from the plant site will report to a retention pond which has the capacity to contain a 1 in 5 year rainfall event. Any water collected will be added to the process water circuit.

The Port stockyard area will also contain a retention pond designed for a 1 in 5 year rainfall event. Water collected in this retention pond will be used for dust control in the stockyard area. Sedimentation collected in the retention pond will be excavated and recycled either within the process circuit or placed in the WDFs.

The retention ponds will be constructed of compacted mine waste and graded in-situ to provide a relatively impermeable containment. Larger rocks will be sorted to the inside and outside faces to provide armouring.

2.4.5 Mining Pre-strip

The Balmoral South Project mining pre-strip will excavate around 100 Mt of waste material, with most of this material consisting of oxidised banded iron formation (BIF). The pre-strip will also expose some ore, which will be stockpiled then used for commissioning and initial plant start-up.

The pre-strip will be completed in two stages. The first stage involves the excavation of a pit to source appropriate construction material for the plant infrastructure pad, flood protection bunds, initial construction of the ROM pad and other infrastructure pads as required. All mining operations will involve drill and blast to break the in-situ rock, with the material loaded and transported using a conventional hydraulic excavator and truck fleet. As the material from the pre-strip is being used for construction, some of the material will undergo sorting or crushing prior to placement as engineered fill.

The second pre-strip phase will commence 12 to 18 months prior to the commissioning of the processing plant. This phase of the pre-strip will be completed by the primary mining fleet. Mining operations will be conventional truck and face shovel, with rock breakage achieved by drill and blast activities. Waste mined during pre-strip will be used to complete the ROM pad infrastructure with the remainder being placed in the waste disposal areas. Any ore encountered during the pre-strip phase will be stockpiled on the ROM pad for use in commissioning the processing plants.
Section 2

Project Description

2.4.6 Commissioning

Commissioning of the facilities constructed during Project Development Stage 1 will commence approximately 30 months from commencement of site works. Commissioning of the plant involves:

- static checking of the works, energisation and pressure testing, protection and control testing, introduction of water to the plant then introduction of ore; and
- production ramp-up to name plate capacity and exporting of product.

Commissioning is expected to be completed over a six month period.

Commissioning of facilities constructed in Project Development Stage 2 will proceed as outlined above between months 66 and 72 from initial commencement on site, thus bringing the full 24 Mtpa facilities into production in approximately six years.

2.5 Operations

2.5.1 Operational Activities

The main operational activities include:

- extraction of ore and waste for the mining operations;
- movement and placement of waste ore/rock into WDFs;
- operation of processing facilities (such as primary crushers, Concentrators and Pellet Plants);
- disposal of waste processing material (dewatered tailings) to WDFs;
- operation of project utilities including Power Station and Desalination Plant, and distributed services such as power, data and communications, and water;
- operation of support facilities such as accommodation, transport, and OHSE services;
- transportation of finished products from process plant site to Port stockyard facilities at Cape Preston;
- operation of desalination intake and wastewater outfall; and
- progressive rehabilitation of waste dump facilities.
Section 2

Project Description

2.5.2 Mining Methodology

The mining methodology proposed for the Project is based on current industry practice for a hard rock open pit mining operation, utilising conventional hydraulic face shovel and truck equipment for the primary load and haul fleet. The primary rock breakage is achieved by conventional drill and blast techniques, with secondary breakage completed by either mobile rock breaker or secondary drill and blast.

The mining method is based on large scale mining equipment. The hydraulic shovel and truck option was selected as the basis for the initial development of the pit as it provided the lowest technical risk relative to the other mining options assessed, including in-pit crushing and conveying. Other mining options may be assessed later in the project life to reduce the cost of mining at depth.

The primary mining fleet proposed comprises blast-hole drills, hydraulic face shovels and off-highway trucks. The ancillary fleet comprises front-end loaders, tracked and wheeled dozers, graders, water carts and a small excavator.

The selection of the primary loading unit was dependent on maintaining the required movement of ore and waste, without the need for excessive mining fleet numbers, and maintaining acceptable levels of ore loss and dilution during safe mining operations.

It is planned that a contractor will undertake the mining for the first seven years; thus the final selection of equipment will be determined by contractor preference, provided that the equipment operating parameters satisfy the mining requirements for the Project.

2.5.3 Mine Design

Ore will be sourced from a single open pit and mined in stages designed to meet the scheduled mining production rates and ore feed specifications. The mine design is based on the interpreted resource with applicable economic, contractual and geotechnical parameters applied to determine the ultimate pit limits. The current mine design limit of approximately 300 m below ground level is due to the limits of exploration drilling rather than a technical or economic limitation.

The mine slope design is based on geotechnical data collected from a diamond drilling program completed in October 2007. The final slope design may be modified as required to account for local ground conditions or where greater data density may indicate a change in design.

The practical mining sequence for the Balmoral South Project pit can be split into four separate stages (Figure 2-7: Schematic Layout for the Four Mining Stages):

- Mining Stage 1 operations are expected to last 10 years, with the majority of the mining taking place in Mining Years 1 to 4;
- Mining Stage 2 commences after Mining Year 2 and continues over an 11 year timeframe;
- Initial stripping for Mining Stage 3 begins in Mining Year 10 and continues until the cessation of mining operations in Mining Year 28 (Project Year 31, Table 2-2); and
- Mining Stage 4 is to be mined concurrently with Stage 3.
Access to the working areas of the pit is achieved by a network of mine roads and haulage ramps located in the hanging and footwall slopes, with separate haulage routes for ore and waste haulage. The haul ramps have been designed to be 3.5 times the width of the haul trucks in the mining fleet allowing for dual way ramps, drains and appropriate bunding.

**Figure 2-7: Schematic Layout for the Four Mining Stages**

2.5.4 **Pit Dewatering**

Aquaterra (2008) predict that peak groundwater inflow into the open pit will reach approximately 19 L/s at the commencement of Stage 3 mining operations. It is also expected that up to an additional 22 L/s of inflow will be received from the Du Boulay Creek alluvium. To this needs to be added the water volume generated by direct rainfall from the significant weather events that occur in the region.

The bulk of dewatering will be undertaken by in pit sump pumping, whereby diffuse inflows from pit walls are directed to in-pit sumps for removal to the retention ponds, from where it will be pumped and used primarily for dust suppression, with excess water diverted into the process water circuit.

Portions of the pit will be advanced at least one bench level below current operations with drainage sumps excavated from this lower level to lower groundwater levels as much as possible in advance of the working surfaces on the pit floor.

The piezometric pressure in the pit walls will be measured as part of the mining operation and the drainage design developed to ensure pit wall stability. It may also be possible to opportunistically install dewatering bores in zones of higher hydraulic conductivity to aid in advance dewatering.

The water available to be pumped from the pit due to the above is estimated to be up to 4 GLpa.
Section 2

Project Description

2.6 Waste Disposal Facilities

Mine waste rock and dewatered process tailings will be co-disposed in the designated disposal areas (WDF1 to the west of the pit and WDF2 to the east of the pit).

The tails stream produced from processing magnetite ore consists of inert materials comprising a fine and coarse fraction. The tails will be dewatered by pressure filtering, and conveyed to the WDFs by conveyors and stackers, or truck haulage, to either co-dispose with waste rock or dispose in specific areas allocated to dry tails within the WDF disturbance area. Traditional tailings dams may be required if this process is not viable. However, the traditional tailings option is not a part of this approval assessment, and would be subject to separate assessment and approval.

The concept of an Integrated Waste Disposal Facility, receiving both tailings and overburden, has been investigated by geotechnical specialists, who have concluded that “from a tailings management perspective the Integrated Waste Landform can be simply defined as a tailings storage facility that is located within the waste rock storage. This conceptual design broadly follows the Guidelines of the Department of Industry and Resources, Western Australia for design of tailings storage facilities” (Appendix O)

The bulk density of the filtered tails is approximately 2.00 t/m$^3$, with an estimated moisture content of 15%. The moisture content achievable in the tails is currently being tested.

An AMD (Acid Mine Drainage) test work program was commissioned by IM to investigate the potential for acid formation from the waste material encountered within the Balmoral South pit. This initial testwork was followed by further review on likely AMD related properties for strata that will be mined at Balmoral South (Appendix P). A geochemical assessment undertaken by Golder for the Central Block Project was used to provide background information for this review. The stratigraphy for the two projects is effectively continuous and the strata of the Hamersley Group are relatively uniform, hence results can be extrapolated between projects.

Initial AMD sampling did not include all lithologies that might be exposed during mining, but was instead biased towards high sulphur lithologies, predominantly the Mt McCrae Shale and Whaleback Shale, neither forming a significant tonnage with respect to the entire tonnage mined. The Whaleback Shale tonnage in the ultimate pit stands at approximately 0.5% of total material. The McCrae Shale is not likely to be mined in significant amounts except for local occurrences due to faulting and uplift. The occurrence of high sulphur BIF material (>1.5% S) is extremely rare.

The samples were initially categorised based on stratigraphy and sulphur content. Analysis of these formations indicates that on a 0.5% total sulphur cut-off, approximately 1% of the BIF, 21% of the Shale and 6% of the remaining material has acid generating potential. Taking the total volumes of each of these units into account, this equates to approximately 5% of total material moved having some acid generating potential. The AMD test work also confirmed the limited acid neutralising capacity (ANC) of the samples selected; this is not to say that there is no material demonstrating some neutralising capacity within the ultimate pit limits, but that suitable mineralogy is not present in the samples tested.

The higher sulphur material with assays greater than 3.0% exist predominantly in the black shale bands of the Whaleback and McCrae Shale units, and it is not anticipated that significant quantities of high sulphur material will be mined. Investigations undertaken for the Central Block Project found that ore materials are likely to be non-acid forming (NAF).

However if any potential AMD waste is encountered it will be separately encapsulated in the waste disposal area, surrounded by low permeability material or blended with neutralising waste. In the long term the possibility of sourcing a suitable bulk waste material with ANC from material within the pit will be investigated. Monitoring bores will be installed around the WDFs to ensure performance of the AMD management actions.

In addition to the generally low occurrence of high sulphur samples, all of the samples identified as having likely potential for AMD were collected from a depth greater than 200 m below ground level. With the planned mining schedule, the mining landforms, infrastructure and mining procedures will be developed prior to any mining disturbance reaching the depths at which the AMD material is likely to be located.
Section 2

Project Description

The Pilbara region has the potential for asbestiform mineral occurrence. The Balmoral South Project is working closely with the Central Block Project to identify potential issues, and has developed management plans for safe work procedures.

The creation of a stable landform is an important design consideration for the proposed WDFs. The final land form will be used to encapsulate a number of materials including any potential acid generating waste, potential fibrous material and the fine tails fraction.

The ultimate height for the WDF is 90 m above ground level. The WDF final landform will reflect surrounding landforms, which may incorporate concave slopes. Various slope design options will be tested prior to choosing the most viable.

The WDFs' outer layers will be constructed with inert coarse mine waste, and only material suitable to form a long term stable slope will be used. In areas that may be exposed to frequent water action, rip-rap over size material (boulders > 1.0t) will be used to rock armour the WDF.

The interim and final profiles will be built to ensure that a stable (non-eroding) land form is created, and to shed as much surface water as possible, achieving two goals:

- help reduce the potential for acid mine drainage to develop; the more water that percolates through the waste layers, the greater the chance of oxidation of any potential acid forming waste and subsequent mobilisation of this contaminated water; and
- establishment of a stable land form to better withstand high intensity rainfall events in severe weather events, without serious degradation.

The top surface of the WDFS will be covered in scree, raked out of the waste, so that the surface is dust free. It will be contoured to provide drainage paths above relatively impermeable layers below the scree. In addition any available topsoil together with its inherent seed bank will be spread over the waste dump.

Rock drains will be included on the WDF slope to absorb the energy of the runoff water. Given the availability of large rocks on the site, the runoff from the top of the dump will be directed to engineered watercourses comprised of large rocks, which can handle such flow, and short drops and pools for energy dissipation. This will be designed and built progressively during the life of the mine, and interim versions of the watercourse will be tested by storms, with adjustments made to the design if necessary. The runoff from the slopes on the waste dump will be similarly guided to ground level.
Section 2

Project Description

The key to stable WDFs is correct engineering and construction of the water control works. The visual impact of the rock covered WDFs will be similar to many rock covered slopes in the Pilbara, except that WDFs have a regular shape compared to generally irregular shapes of the natural slopes.

2.7 Ore Processing

Unlike direct shipping iron ores, Balmoral South Project magnetite ore requires beneficiation prior to export to steel mills. The processing facilities for the Balmoral South Project will include:

- material stockpiles;
- primary and secondary crushing;
- high pressure grinding rolls;
- milling / grinding;
- concentration via magnetic separation;
- waste disposal; and
- pelletising.

A general layout of the Processing Plant is provided in Figure 2-8: General Layout of ROM Pad, Process and Pellet Plants.

Testwork and assay have demonstrated that the magnetite ore, comprising primarily magnetite and silica rich chert, produces a saleable concentrate product when ground to 80% passing ($P_{80}$) 28 microns.

The plant comprises a number of stages of crushing, grinding and magnetic separation to separate the magnetite product from the gangue. The basic physical principle involved is that magnetite is attracted to a magnet, and the gangue (primarily silica) is not. The ore has to be ground to fineness such that individual grains of magnetite are separated from the gangue. No reagents are used in the crushing, grinding and magnetic separation process, except for small amounts of flocculant in the tailings thickener. The plant has multiple stages of magnetic separation in order to minimise the grinding of waste (and hence minimising energy consumption). The plant also has filtration of tailings to minimise water loss to tailings, and to avoid the need for a tailings dam.

2.7.1 Ore Crushing

Primary gyratory crushers will reduce the ROM ore to less than 165 mm. The crushers will be fed either from ore trucks delivering directly from the pit, or reclaimed by front end loader and truck from a ROM stockpile.

Storage of the primary crushed ore in 100,000 t stockpiles will provide a buffer between the mine and Concentrators. Secondary crushing will reduce the ore to less than 32 mm.

2.7.2 Concentrators

The Concentrator plants will use the following process:

- High Pressure Grinding Rolls to reduce the ore to 3 mm;
- Wet Rougher Magnetic Separators, with the tailings screened to provide a low moisture coarse tailings and a fine tailings slurry;
- primary grinding to reduce the first stage concentrate to a $P_{80}$ of 55 microns;
- intermediate magnetic separation;
- fine grinding to reduce the second stage concentrate to a $P_{80}$ of 28 microns;
Section 2

Project Description

- final magnetic separation;
- possible reverse flotation to further reject silica;
- filtering of the concentrate to produce a filter cake of 9% moisture;
- filtering of the fine tailings to produce a tailings cake with a moisture content of 15%; this step was chosen to minimise water use (evaporation and other losses in a slurry tailings dam); and
- stockpiling of magnetite concentrate.

The water that needs to be replaced in the plant is the water contained within the concentrate and tailings leaving the Concentrators, and water that evaporates from various parts of the process where it is exposed to atmosphere. All other water is totally recycled.
Section 2

Project Description

Figure 2-8: General Layout of ROM Pad, Process and Pellet Plants
2.7.3 Pellet Plants

The Pellet Plants will consist of two lines of 7 Mtpa capacity each. A 7 Mtpa capacity pellet line is the largest (and most efficient) plant available from the two competing technology suppliers Outotec (travelling grate) and Metso (grate kiln).

The plant will comprise a:

- balling section, where the damp concentrate from the filter plant is mixed with approximately 7.5 kg/t of bentonite and 10 kg/t of ground limestone and formed into green balls 12-16 mm in diameter;
- drying section, where the green balls are dried;
- induration section, where the green balls are heated to 1200°C; at this temperature the limestone calcines, the magnetite oxidises to hematite, and the limestone, bentonite and silica in the concentrate combine to form complex calc silicates which give the pellets high strength; and
- cooling section, where heat is recovered from the fired balls.

To minimise heat losses the plant is set up so that hot gases from the cooling zone are used to provide preheated air to the burners in the firing zone, and then the off-gases are transferred from the firing zone to the drying zone. The two discharge stacks per line, one on the cooler and one from the drying zone, discharge air at about 100 to 150°C.

Pellets will be stored in stockpiles prior to reclaiming to the overland conveyor for transport to the Port Stockyard.

2.8 Tailings Disposal

Tailings from the Concentrators originate from two streams: sand (<3 mm) produced by screening the rougher magnetic separator tailings at 0.7 mm, and filter cake produced by pressure filtering of the fine tailings stream.

The tailings are rejected at as coarse a size as possible, and the size grading will be approximately:

- 2,600 t/hr with a P80 of 1.8 mm from the rougher magnetic separators;
- 3,900 t/hr with a P80 of 55 microns from the intermediate magnetic separators; and
- 500 t/hr with a P80 of 28 microns from the cleaner magnetic separators.

The fine tailings are filtered in plate and frame pressure filters to recover water. The sands and filter cake are recombined and will have a moisture content of around 15%.

The tailings will be handled as a damp soil and will be co-disposed with the mine waste in the WDFs as described in Section 2.6.

In general, the benefits of dry stacking tailings can be summarised as follows (Coffey 2008):

- Water conservation in arid environments where either water supply is scarce and / or expensive to procure;
- Tailings are more easily handled;
- Recovery of metals from solutions through the filtration process prior to stacking;
- Recovery of process chemicals from solution through the filtration process prior to stacking;
- Dry stacks are essentially “immune” to catastrophic failure and can be designed to withstand static and seismic forces;
Section 2

Project Description

- The unsaturated nature of the tailings means that they are resistant to saturation because the tailings stack becomes dense creating a hydrophobic high matric suction tailings surface;
- The footprint is smaller, when compared to other forms of tailings storage, because of the low moisture content and higher density of the stacked tailings;
- There is limited leachate production because the volume of moisture incorporated within the tailings is very small during initial deposition.
- Consolidation of the dry stacked tailings further reduces moisture during the operation of the stack;
- Allows for progressive covering and rehabilitation for closure;
- Use of dry stacked tailings is seen as good environmental stewardship.

2.9 Corridor

The Balmoral South Project will construct a corridor between the Accommodation Village and the approved corridor for the Mineralogy Central Block Project, with the two sections then providing a traffic and services link from the Accommodation Village to the Central Block Port at Cape Preston (Figure 2-4 and Figure 2-5).

This corridor will be 300 m wide and will be located within the eastern edge of the mining leases M08/123 to M08/130 and the western edge of G08/63, and a slight encroachment into the south eastern corner of M08/122. There will also be a 100 m wide extension within the southern edge of M08/130.

This application seeks to widen the eastern corridor to 300 m (90 m currently approved for the Mineralogy Central Block Project) and to also establish an additional 250 m wide western corridor (Figure 2-4 and Figure 2-5).

These corridors will provide access for conveyors / slurry pipelines, roads, utilities / services and other infrastructure, and also cater for future third party use as required by Clause 6(5) of the Iron Ore Processing (Mineralogy Pty. Ltd.) Agreement Act 2002.

A typical cross section of the 300m wide service corridor is shown in Figure 2-9: Typical Cross Section Eastern Corridor. Balmoral South Project infrastructure within this corridor will typically include:

- two covered conveyors to carry the Stage 1 and Stage 2 products to the Port stockyard (alternatively, two slurry pipelines);
- a 220 kV powerline;
- buried water and gas pipelines; and
- single lane unsealed access track for conveyor maintenance.

The main access within the corridor will be a sealed road some 40 kilometres long, extending from the Accommodation Village to the Port, and generally within Central Block corridor. This road will be suitable for heavy haul traffic and be accessible in all weather conditions with the exception of a cyclone event when some sections of the road will be over-topped for a short period of time (less than 24 hrs).

The service road will be single lane, unsealed and capable of accommodating cranes and heavy service vehicles. Within the service road, normal traffic flow should be in a single direction. In the event of an emergency, two-way traffic will be possible via vehicle crossing points installed along the length of the service road.
Section 2  

Project Description

The corridor traverses flood affected areas, creeks, and a mangrove estuary, and interfaces with a public road. Where possible the Balmoral South corridor extension has been maintained at or near grade and follows the contours of the approved Central Block corridor, with the exception of the conveyor, which having an electrical supply and being susceptible to damage by water inundation, will be constructed above the 100 year ARI level. This has been achieved using local earth embankments, raised steel structures (piled in places) and culverts installed to permit adequate drainage during cyclone events.

This application also seeks approval for a 250 m wide western corridor and a central portion connecting the eastern and western corridor (Figure 2-5).

The western corridor allows for the construction of additional infrastructure that may be required for the Balmoral South Project based on detailed future engineering review, and following issues found by the Central Block Project during current construction activities. Current Central Block Project construction activities have highlighted many difficulties in maintaining alignments proposed in initial environmental approvals due to physical, heritage and environmental constraints. This has resulted in the need to submit further proposals to amend existing approvals. The western corridor allows the Balmoral South Project to plan and construct infrastructure with due consideration of environmental and heritage issues, as well as cost and schedule.

It is proposed that facilities within the western corridor will be constructed on trestle structures (in the case of conveyors), or pylon structures (in the case of HV powerlines), such that the physical impact on Mangrove Creek and associated vegetation is minimised.

The central portion provides the access for connecting the services and facilities in the eastern corridor (conveyors, power lines, etc) to the stockpile area on the western side of the western corridor.
Section 2

Project Description

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Figure 2-9: Typical Cross Section Eastern Corridor
Section 2

Project Description

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Section 2

Project Description

2.10 Port Storage and Export

The Cape Preston stockyard will be a conventional open stockyard, as used extensively in the iron ore industry. Reclaimed concentrate and pellets will be transported to the Mineralogy Central Block Port by conveyor. Concentrate will be damp (9% moisture) on arrival at the stockyard, and is not dusty at this moisture level. The stockyard will be set up with spray monitors for controlled water application to allow a crust to form on the concentrate stockpiles. Stacking and reclaiming machines will have water sprays to suppress dust when operating. The pellets give off little dust, as they are screened to remove fine material as they leave the Pellet Plants.

The Port stockyard will be constructed in an area created by cut and fill to form a pad as high as practical, with surrounding rock armour for protection from storm surges. The stockyard pad will drain to retention ponds from which trapped sediment will be periodically removed, and from which the drained water will be pumped for use in stockpile dust suppression.

2.11 Operations Water Supply

2.11.1 Water Requirements

Water will be required for ore processing, and potable water will be required for the mine, plant and camp areas (Table 2-4: Water Loss for the Process). As no suitable alternative sources are available in the Cape Preston area, a 40 GLpa Desalination Plant is proposed, and forms part of this assessment. The Marine Impact Assessment Report (Appendix F) has been modelled on brine outfall for 64 GLpa desalinated water production to provide an environmental management contingency for the proposed 40 GLpa Desalination Plant. This Desalination Plant is proposed to be the sole, sustainable source of water for the Project (other than incidental water recovered from the mine pit during mining).

Package treatment plants will treat sewage effluent from on-site amenities. Treated water from this process will be used for irrigation where appropriate or re-used as process water.

The water balance has been calculated on the assumption that the tailings can be dewatered at the process plant to a moisture content of 15% or less by screening coarse tails and filtering fine tails. If the filtering of fine tailings does not prove viable, then the tailings will need to be discharged as slurry to a conventional tailings dam, and an extra 15.7 GLpa above the filtered tails case will be required. Approval of a tailing dam is not part of this submission.

A 40 GLpa Desalination Plant provides enough water for discharge of the fine tails as slurry, and approval is sought for the 40 GLpa Desalination Plant.

Further testwork is expected to confirm that the tailings can be dewatered to 15% and hence the overall desalination water production requirement is expected to be less. There is also the possibility of recovering up to 4 GLpa of water from pit dewatering operations which will further reduce the requirement for desalinated water. No approvals are sought to source water from the surrounding Fortescue and Robe River alluvials.
Section 2

Project Description

Table 2-4: Water Loss for the Process

<table>
<thead>
<tr>
<th>Area of use</th>
<th>Annual activity</th>
<th>Water usage rate</th>
<th>Water consumption (GLpa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining dust suppression</td>
<td>160 Mtpa total movement in the mine</td>
<td>3% of material moved</td>
<td>4.8</td>
</tr>
<tr>
<td>Water in concentrate exiting the filter plant</td>
<td>24 Mtpa produced</td>
<td>9%</td>
<td>2.2</td>
</tr>
<tr>
<td>Water in screened and filtered coarse tailings leaving the plant</td>
<td>56 Mtpa</td>
<td>15%</td>
<td>8.4</td>
</tr>
<tr>
<td>Additional water for discharge of fine tailing</td>
<td>56 Mtpa</td>
<td>28%</td>
<td>15.7</td>
</tr>
<tr>
<td>Evaporation in the plant</td>
<td></td>
<td>10% of water used in plant</td>
<td>2.0</td>
</tr>
<tr>
<td>Pellet Plant</td>
<td>14 Mtpa</td>
<td>8% of pellets produced</td>
<td>1.1</td>
</tr>
<tr>
<td>Port stockyard</td>
<td>24 Mtpa</td>
<td>3% of material handled</td>
<td>0.7</td>
</tr>
<tr>
<td>Power station</td>
<td>450 MW for 7800 hrs</td>
<td>1.28 m³/MWh, mostly evaporated in cooling tower</td>
<td>4.5</td>
</tr>
<tr>
<td>Camp</td>
<td>4000 people</td>
<td>0.4 m³/day</td>
<td>0.6</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>40.0</td>
</tr>
</tbody>
</table>

2.11.2 Desalination Process

A modular Desalination Plant based on reverse osmosis (RO) technology is proposed. The plant’s process equipment, such as filters, clarifiers and RO membranes, will be designed to operate at a product water rate of 40 GLpa.

The plant will contain three stages: pre-treatment, reverse osmosis, and post treatment chemical addition, and will be serviced by a raw seawater feed system, a brine discharge system, and a product water storage and distribution system pumping desalinated water to the process users described in Table 2-4 above.

The location of the Desalination Plant and the seawater intake and discharge system are shown in Figure 2-10: Location for Desalination Plant and Intakes and Outfalls)
Figure 2-10: Location for Desalination Plant and Intakes and Outfalls

Seawater Intake and Brine Discharge System

The plant seawater intake will be located in 8 m of water at Lowest Astronomical Tide, approximately 1,900 m NNE of Cape Preston.

The majority of the seawater intake and brine discharge pipelines will be trenched, commencing at the Desalination Plant allocated area, under the beach and into the seafloor to the intake and outfall diffusers.

The trench will be some 4 m wide by 3 m deep, with a volume of approximately 30,000 m$^3$ of marine sediment to be removed. Excavation will be by barge mounted excavator, with spoil transported back to shore for sorting and potential use as selected backfill in the trench.

The pipelines will be constructed on-shore, floated out to position, and sunk into the trench using concrete ballast blocks to keep the pipelines in place until buried.
Section 2

Project Description

The backfill used for the trench bottom and pipeline surrounds will be de-slimed engineered coarse material, to ensure no damage to the pipeline or diffuser. The trench will then be topped with lump rock for protection against sea movement damage.

The total task is anticipated to take between two and three months depending on the weather.

The seawater is transported on-shore via a buried HDPE pipeline under natural head pressure. Subject to final design, the seawater intake system and components will resemble Figure 2-11: Typical Seawater Intake System.

The brine discharge system will be similar, except with outflow. An outfall pipeline is proposed to carry concentrated brine and filter backflush water to a discharge diffuser located approximately 1,600 m northeast of Cape Preston, in 7 m of water at Lowest Astronomical Tide. (Figure 2-10)

<table>
<thead>
<tr>
<th>Item</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>InvisiHead</td>
<td>Both the seawater intake and brine discharge points will use an &quot;InvisiHead™&quot; (IH) type system</td>
</tr>
<tr>
<td></td>
<td>The intake point will be made up of a number of IH units and be the super spread type to accommodate the limited narrow low turbidity depth margin located just below the trough of the 4.2 metre wave, and 2 metres above the sea floor. Each IH will be anchored to a concrete block buried under the sea bed.</td>
</tr>
<tr>
<td></td>
<td>The paraboloidal shape of the IH intake system will be tailored for site conditions. The flow streamlines will be controlled so that the take off velocities of the extreme bottom and the extreme top streamlines would have no suction effect on the floor and top sediments. At maximum plant capacity, the maximum entrance velocity is 0.091 m/s rising from a maximum approach velocity of 0.0025 m/s.</td>
</tr>
<tr>
<td></td>
<td>The IH technology surpasses the principles of Integrated Pollution Prevention and Control (detailed in European Union Reference Document on the application of Best Available Techniques (BAT) to Industrial Cooling Systems: Dec 2001) for the selection, design and operation of cooling water systems and effluent discharge.</td>
</tr>
</tbody>
</table>

Figure 2-11: Typical Seawater Intake System

The seawater intake and brine outfall components are briefly described below.
### Section 2

#### Project Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake Pipeline</td>
<td>The seawater intake will be made of HDPE pipe, with a relatively thick wall. The discharge lines will be made of HDPE or Glass Reinforced Plastic (GRP). Both pipelines will be constructed on-shore, floated out to the required location and sunk into a pre-prepared trench. The flow inside the intake pipe will move fast enough to inhibit sediment and debris settlement and marine life growth inside the pipe. The pipes will be self cleaning and self flushing. The pipes will be concrete weighted and positioned in a 3 metre deep trench, which will be backfilled flush with the sea floor.</td>
</tr>
<tr>
<td>NatSep Basin</td>
<td>The NatSep™ acts as a gravity flow controller and provides passive removal of coarse sediment and debris from the flow. A travelling screen will be installed at the upstream end of the sedimentation zone of the basin. The depth of the basin will include the calculated head loss in the intake pipeline, the standard tide variation of 4 metres, the 6.5 metre storm surge, plus 2 metres as a margin of safety. The NatSep basin will be installed onshore within the area allocated for the Desalination Plant. The NatSep basin will remove any sediment 160 microns (0.16 mm) or larger from the flow, including fine sand, seaweed, and debris, which will settle in the sediment storage zone at the bottom of the basin. The basin is made of two bays; each 100% of the capacity, so that the intake system remains in full operation during clean up of the sediment storage area. The basin is divided into 5 distinctive zones: The inlet zone or the stabilisation and energy dissipation zone located upstream of the basin, three zones located at the middle of the basin including the flow through zone, the sedimentation zone, the sediment storage zone, and the outlet zone.</td>
</tr>
</tbody>
</table>

#### Pre-treatment

The plant must be reliable and produce water 365 days per year, 24 hour per day. Intake seawater first passes through significant raw water pre-treatment facilities to remove suspended solids which would otherwise clog the RO membranes. The pre-treatment process includes: flocculation, lamella sedimentation, direct air flotation, and gravity dual media filtration. Flocculation and backwash discharges are disposed to the brine outfall, as is common industry practice throughout global installations.

The pre-treatment process will involve the following steps:

- injection of coagulant (ferric sulphate, Fe₂(SO₄)₃) to the seawater feed to ensure that optimal conditions for the coagulation process are reached; if required, sulphuric acid (H₂SO₄) may be added to adjust the pH to the range required for ferric sulphate;
- injection of pre-treated seawater with polymer as it enters two large flocculation chambers equipped with variable-speed mixers; the seawater is slowly mixed to achieve optimum flocculation and the formation of large flocs that can easily be removed;
Section 2

Project Description

- removal of larger suspended solid masses from the flocculated seawater via Lamella clarifier packs;
- introduction of microscopic bubbles of air to the Dissolved Air Flotation system to gently remove suspended matter with low specific gravity such as algae, plankton and other organic matter;
- filtration of the remaining suspended matter using gravity dual media filters; and
- final filtering to the reverse osmosis system using cartridge filters.

RO Membranes

The reverse osmosis system removes dissolved solids from the seawater, producing clean permeate and a brine with a salinity approximately twice that of seawater.

A series of pumps and energy recovery devices deliver filtered high pressure seawater from the pre-treatment filter plant to racks of RO membranes. Here the seawater undergoes reverse osmotic separation to produce permeate (desalinated water) and brine (concentrated seawater). Fresh water permeates through the membranes at high pressure, passing through the energy recover devices, and is then discharged to the post treatment system and the product tank. The concentrated brine leaves the RO plant and is collected in a brine outfall tank, where it is mixed with the solids removed in the pre-treatment plant and discharged through the ocean outfall pipelines.

Post treatment

The (desalinated) permeate water leaving the RO plant is very low in alkaline mineral content and is therefore corrosive. The post treatment system adds lime (CaO) and carbon dioxide ($CO_2$) to the water so that the water is neither aggressive nor calcium deficient and can be pumped to the processing equipment for use. Silicate impurities in the lime are removed and disposed of with the brine.

Chemicals used in the Desalination Plant

A number of chemicals are required for efficient operation of the Desalination Plant. These are included in Table 2-5: Chemicals Used in the RO Process and Dilutions in the Marine Environment, along with their predicted dilutions at the end of pipe and in the marine environment.

Table 2-5: Chemicals Used in the RO Process and Dilutions in the Marine Environment

<table>
<thead>
<tr>
<th>Dosing chemical</th>
<th>Purpose</th>
<th>Dosing concentration ppm</th>
<th>Discharge concentration ppm</th>
<th>Modelled Mixing-zone boundary concentration ppm (refer Appendix F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Hypochlorite NaOCl</td>
<td>Intake. Intermittent oxidiser</td>
<td>5</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Sulphuric Acid $H_2SO_4$</td>
<td>Pre-treatment. Continuous</td>
<td>29</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Ferric Sulphate $Fe_2(SO_4)_3$</td>
<td>Pre-treatment. Continuous</td>
<td>12</td>
<td>8.0 – discharged as Ferrous Hydroxide</td>
<td>0.3</td>
</tr>
<tr>
<td>Polymer (anionic polyacrilic such as Nalco 8103 Plus or equivalent)</td>
<td>Flocculant. Continuous</td>
<td>0.3</td>
<td>0.5</td>
<td>Nil</td>
</tr>
<tr>
<td>SBS (Sodium Bisulphite)</td>
<td>Pre-treat intermittent oxidiser</td>
<td>10</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Anti-scalant (Permatreat PC 191 or equivalent)</td>
<td>RO. Continuous</td>
<td>1.5</td>
<td>2.2</td>
<td>0.05</td>
</tr>
<tr>
<td>Lime</td>
<td>Pre-treatment. Continuous</td>
<td>46</td>
<td>2 – discharged as silicate impurities</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Section 2

Project Description

2.12 Power and Gas Supply

A combined cycle gas-fired Power Station will be constructed adjacent to the Concentrator / Pellet Plant complex to supply up to 450 MW of power for the project. With standby capacity, the installed capacity of the Power Station will be up to 600 MW. The Power Station will operate in isolation from the Northwest Electrical grid. Gas for the Power Station will be transported via a pipeline connecting to the Mineralogy Central Block gas supply pipeline.

The Power Station will consist of a series of combined cycle gas turbine power generators with heat recovery steam generators and steam turbines. The gas turbines will be equipped with low NOₓ burners, and the heat recovery system will convert heat energy from the gas turbine exhaust to steam and feed this to the steam turbines. The Power Station will be designed to produce a NOₓ concentration of less than 25 ppm. Other emissions (CO, CO₂, and hydrocarbons) will also be controlled. Periodic monitoring on the turbine exhaust stacks will measure moisture, O₂, NOₓ, and CO₂.

The details of the Power Station layout and operations will be subject to approval under Part V of the Environmental Protection Act 1986 through the Works Approval and Licensing process.

Power station ancillaries will include:

- two 2 MW black start diesel generators, with bunded diesel tanks, that will operate only when the Power Station is shut down, to provide power for starting and emergency stopping of the turbine system;
- a water treatment plant to demineralise and polish the water required by the steam generators, with waste water neutralised and sent to the Concentrators for re-use;
- a gas conditioning system that cleans and pressurises the incoming natural gas to the quality required for firing in the turbines; and
- fan driven wet cooling towers to allow condensing of the low pressure steam exiting the steam turbines.

The cooling tower is the primary water user in the Power Station. In total, the Power Station will use 1.28 m³ of water per MWhr of electricity produced. Blowdown water from the Power Station will be sent to the process plant for re-use. Wet cooling towers provide the most thermally efficient power generation configuration as they utilise the least auxiliary energy to meet the steam turbine condenser cooling requirements.

Power will be distributed at 50 Hz, 220 kV to the main site transformers and then reticulated to the Concentrator / Pellet Plants, Desalination Plants, Port, Accommodation Camp and Mine areas. The reticulation network will be a combination of underground and overhead lines suitably designed for cyclonic conditions. The network will be designed and constructed in accordance with Australian Standards.

Individual sections of the main process plant will also have dedicated emergency power systems to cope with line failure, maintain essential services and ensure safe, orderly shutdowns following loss of main power.

The Accommodation Camp will initially have a dedicated 6 MW diesel power station to provide power, and will then be connected to the reticulation from the main Power Station.

2.13 Workforce and Accommodation

The construction and operations Accommodation Village will be located on M08/130 about 8 km south of the mine. It will comprise in total 4,000 prefabricated single rooms with ensuite bathrooms, kitchens and dining halls, wet messes, shop, and recreational facilities. The Accommodation Village will be designed to the appropriate wind loading codes. A section of the Accommodation Village (likely to be the dining building) will be designed and constructed as a refuge for the workforce during cyclone events.
Section 2

Project Description

After construction, the Accommodation Village will be downsized to accommodate an operations and maintenance workforce of up to 1,500 permanent employees.

The workforce will be fly-in / fly-out from both Western Australia and the other Australian states. The flights will be to Karratha airport, with the workforce bussed from there to the camp and from the camp to the work sites. The use of private vehicles will be discouraged as much as possible. Access onto the worksite will be controlled 24 hours/day.

2.14 Domestic Waste Disposal

Sewage from the Accommodation Village and other on-site amenities will be treated in packaged treatment plants to Department of Health requirements, and reticulated for landscaping irrigation.

Landfill for Project inert and putrescible waste will be incorporated in a dedicated section of the WDFs, which will move as the WDFs develop, and operated in accordance with Works Approval and Site Licence conditions.

2.15 Fuel Storage

Diesel fuel storage will be in conventional 100,000 L horizontal self bunded transportable tanks. There will be 6 tanks at the Accommodation Village, and 20 tanks at the mine, installed in accordance with regulations and fuel industry codes of practice.

2.16 Explosives Magazines / Depot

Ammonium nitrate, emulsion and packaged explosives will be stored in explosives magazines located in the south west corner of WDF1, in a location which is well away from areas that are regularly trafficked, and built and operated as per the Dangerous Goods Regulations. Applications for a Magazine Licence or a licence to store dangerous goods will be submitted to the relevant government agencies before commencing construction of the explosives storage facilities.

2.17 Raw Materials Import

Table 2-6: Expected Vehicle Movements summarises the expected vehicle movements associated with importation of raw materials and supplies during Development Stages 1 and 2, and the subsequent operations phase.
### Table 2-6: Expected Vehicle Movements

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Transport</th>
<th>Movements (per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Freight – Dampier / Port Hedland to site</td>
<td>Estimated 50,000 freight tonnes for yr 1 &amp; 2</td>
<td>Heavy duty vehicle</td>
<td>1,600</td>
</tr>
<tr>
<td>Sea freight barge – Dampier / Port Hedland to Cape Preston (oversize / heavy cargo)</td>
<td>Estimated 37,000 freight tonnes for yr 1 &amp; 2</td>
<td>Barge and heavy duty trailer</td>
<td>500</td>
</tr>
<tr>
<td>Construction equipment (yr 1 mob. and yr 2 demob.)</td>
<td>15,000 freight tonnes per year</td>
<td>Heavy duty vehicle</td>
<td>500</td>
</tr>
<tr>
<td>Construction infrastructure (yr 1 mob. and yr 2 demob.)</td>
<td>20,000 freight tonnes per year</td>
<td>Heavy duty vehicle</td>
<td>660</td>
</tr>
<tr>
<td>Permanent Camp Accommodation (mob.)</td>
<td>2000 loads for yr 1</td>
<td>Heavy duty vehicle</td>
<td>2,000</td>
</tr>
<tr>
<td>Cement</td>
<td>15,000 t for yr 1 &amp; 2</td>
<td>Double trailer heavy duty vehicle</td>
<td>250</td>
</tr>
<tr>
<td>Aggregate</td>
<td>40,000 m³ for yr 1 &amp; 2</td>
<td>Heavy duty vehicle</td>
<td>1,000</td>
</tr>
<tr>
<td>Sand</td>
<td>20,000 m³ for yr 1 &amp; 2</td>
<td>Heavy duty vehicle</td>
<td>500</td>
</tr>
<tr>
<td>Gas Bottles (Construction use)</td>
<td>100 loads for yr 1 &amp; 2</td>
<td>Heavy duty vehicle</td>
<td>100</td>
</tr>
<tr>
<td>Gas Bottles (Operation use)</td>
<td>50 loads per year</td>
<td>Heavy duty vehicle</td>
<td>50</td>
</tr>
<tr>
<td>LPG (Camp operations)</td>
<td>50 loads per year</td>
<td>Heavy duty vehicle</td>
<td>50</td>
</tr>
<tr>
<td>Diesel Port Hedland or Dampier to site</td>
<td>70 KL/day for yr 1 &amp; 2</td>
<td>Triple road train tanker</td>
<td>365</td>
</tr>
<tr>
<td>Diesel Port Hedland or Dampier to site</td>
<td>320 KL/day for yr 3 onward</td>
<td>Triple road train tanker</td>
<td>1,460</td>
</tr>
<tr>
<td>Chlorine bottles (drinking water chlorination)</td>
<td>1 per month</td>
<td>Heavy duty vehicle</td>
<td>12</td>
</tr>
<tr>
<td>Garbage (Cleanaway)</td>
<td>1 per day</td>
<td>Heavy duty vehicle</td>
<td>365</td>
</tr>
<tr>
<td>Project waste (Cleanaway)</td>
<td>1 per day</td>
<td>Heavy duty vehicle</td>
<td>365</td>
</tr>
<tr>
<td>Lube oil</td>
<td>2 per month</td>
<td>Heavy duty vehicle</td>
<td>24</td>
</tr>
<tr>
<td>Lube oil and transformer oil (first fills)</td>
<td>500 m³ yr 2</td>
<td>Heavy duty vehicle</td>
<td>25</td>
</tr>
<tr>
<td>Explosives (for pre-strip)</td>
<td>10,000 t yr 1 &amp; 2</td>
<td>Heavy duty vehicle</td>
<td>500</td>
</tr>
<tr>
<td>Explosives (for mine operations)</td>
<td>60,000 t per year</td>
<td>Heavy duty vehicle</td>
<td>800</td>
</tr>
<tr>
<td>Food</td>
<td>4 per week</td>
<td>Heavy duty vehicle</td>
<td>208</td>
</tr>
<tr>
<td>Personnel site to Karratha Airport</td>
<td>4 per day</td>
<td>Bus</td>
<td>1,460</td>
</tr>
<tr>
<td>Personnel site to Karratha Airport</td>
<td>10 per day</td>
<td>Light vehicle</td>
<td>3,650</td>
</tr>
<tr>
<td>Craneage (mob. / demob.)</td>
<td>50</td>
<td>Heavy duty vehicle</td>
<td>50</td>
</tr>
<tr>
<td>Caustic soda (40% sol)</td>
<td>12 yr for 3 onward</td>
<td>Heavy duty vehicle</td>
<td>12</td>
</tr>
<tr>
<td>Sulphamic acid</td>
<td>12 yr for 3 onward</td>
<td>Heavy duty vehicle</td>
<td>12</td>
</tr>
<tr>
<td>Poly Maleic acid</td>
<td>12 yr for 3 onward</td>
<td>Heavy duty vehicle</td>
<td>12</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>120 yr for 3 onward</td>
<td>Heavy duty vehicle</td>
<td>120</td>
</tr>
<tr>
<td>Limestone, dolomite, grinding media, bentonite, lime</td>
<td>2500 yr for 3 onward</td>
<td>Heavy duty triple vehicle</td>
<td>2,500</td>
</tr>
<tr>
<td>Spares, parts etc</td>
<td>700 yr for 3 onward</td>
<td>Heavy duty vehicle</td>
<td>700</td>
</tr>
<tr>
<td>Ferric Sulphite</td>
<td>50 yr for 3 onward</td>
<td>Heavy duty vehicle</td>
<td>50</td>
</tr>
<tr>
<td>Sodium Bisulphite</td>
<td>20 yr for 3 onward</td>
<td>Heavy duty vehicle</td>
<td>20</td>
</tr>
</tbody>
</table>
Section 2
Project Description

2.18 Rehabilitation and Closure

As shown in the PEMP (Appendix A), the Balmoral South Project will plan for closure commencing from the early stages of project development so that the project area is left in an environmentally acceptable condition after completion of the mining operations. The PEMP action plans will ensure that progressive rehabilitation activities achieve landform stability, maintain public safety, provide compatible land use and aim towards the establishment of sustainable ecosystems as a long-term goal.

Mine closure planning is an ongoing process. Mine closure and rehabilitation will be further defined through stakeholder consultation, detailed engineering design and various studies, and the PEMP updated as requirements evolve.

The Balmoral South Project will be designed, constructed and operated to achieve the following objectives of:

- identifying issues that are necessary to meet legal requirements and other obligations for rehabilitation and decommissioning;
- minimising the potential for unacceptable environmental impacts to occur following the completion of project activities;
- ensuring that adequate resources are set aside to implement environmental plans during operations and closure;
- ensuring that mine development is consistent with closure objectives and strategies; and
- creating stable landforms.

Rehabilitation

The Balmoral South Project's rehabilitation objectives are to ensure that reconstructed landforms are safe and stable, and a self-sustaining vegetation community is established, where practicable, to replicate current vegetation and support the post-Project land-use of pastoralism.

The Balmoral South Project will be designed, constructed and operated to meet rehabilitation objectives, using the following principles:

- minimising soil erosion, particularly from the WDFs;
- collecting and correctly stockpiling growth medium for later use at selected rehabilitation sites;
- progressively rehabilitating completed areas as soon as practicable;
- only using local native plant species for rehabilitation; and
- deep ripping all hardstand areas to relieve compaction and provide niches for seeds.

Rehabilitation of the WDFs will occur progressively, delivering a number of benefits including a reduction in dust generated from the WDFs and the ability to schedule topsoil stripping and re-spreading as a single operation thus making use of the seed stock while seed is still viable. Section 2.6 Waste Disposal Facilities provides a more detailed discussion on the intended interim and final landform for the WDFs. Appendix A PEMP (Section 14) describes the action plans relating to rehabilitation of the WDF landforms.

Areas of installed infrastructure that will require rehabilitation include:

- administration buildings, mining workshops and other services buildings;
- haul roads and site access roads;
- site drainage systems and water storage areas;
- explosive magazines;
Section 2  

Project Description

- ROM pad; and
- service corridors and Port stockyards.

Generally, progressive rehabilitation will be done for specific facilities and areas when these are no longer required for mining, processing and export operations.

Pit void

The Balmoral South Project plans to leave the mine in a stable state at the end of mining.

Progressive backfill of the pit void may be considered in the future. Backfilling the pit void during mining operations may prove to be an effective way to reduce mining costs over the life of the mine, provided it can be achieved without sterilisation of potential ore resources.

*Figure 2-12: Design Principles for the Hanging Wall* outlines the indicative design of the hanging wall slope and the projected position of the mine abandonment bunds, as required after the cessation of mining operations.

Completion Criteria

Completion criteria are an agreed set of indicators that will demonstrate successful rehabilitation once met. They are based on legislative requirements, recognition of final land use objectives, and are arrived at through consultation with stakeholders. Suitable completion criteria will be quantitative and measurable through objective verification and are specific to the mine sites environmental, social and economic circumstances (ANZEMC 2000).
Section 2  

Project Description

The Balmoral South Project will define detailed completion criteria during the life of the mine in consultation with and to the satisfaction of stakeholders, including the Department of Environment and Conservation and Department of Industry and Resources.

The following broad principles will apply to facilitate effective decommissioning and closure, which are further described in detail in the PEMP. These will be adjusted as final land use objectives are defined in more detail following stakeholder consultation during the project life:

- developing and implementing rehabilitation trials throughout the operational life of the mine to develop appropriate site specific methodology;
- dealing with residual infrastructure in accordance with the Iron Ore Processing (Mineralogy Pty Ltd) Agreement Act 2002 at the time of closure;
- ensuring that all project components comply with relevant requirements pursuant to the Mines Safety and Inspections Act 1994;
- removing all sources of contamination such as waste disposal and hydrocarbon storage facilities;
- ensuring that the natural drainage is restored as far as is practicable to minimise erosion at the time of closure;
- ensuring progressive rehabilitation is undertaken as practicable to restore the natural vegetative cover over any disturbed areas to minimise the potential for wind erosion and dust generation;
- using locally sourced (provenance) seed for rehabilitation purposes;
- restoring, as far as practicable, access to any sites which had been restricted by the operation to a level consistent with the pre-project condition at the time of closure;
- ensuring that the site is returned to a state which minimises the risk to public health and safety;
- monitoring and managing site rehabilitation in accordance with The Balmoral South Project’s obligations under the Iron Ore Processing (Mineralogy Pty Ltd) Agreement Act 2002 and the Environmental Protection Act 1986;
- lodging any documents and records deemed relevant with the responsible authority;
- undertaking stakeholder consultation while developing the rehabilitation and decommissioning sections included in the PEMP (Appendix A);
- actioning as per the rehabilitation and decommissioning sections included in the PEMP; and
- undertaking five-yearly reviews of the rehabilitation and decommissioning PEMP sections to ensure they reflect developing standards and expectations of both the public and regulatory authorities.
3.1 Project Benefits

Australia has a large natural resource base. In most cases Australian natural resources have been sold to overseas companies with little or no downstream processing, forgoing the opportunity to process raw materials into higher value products. As a result, Australia has lost the opportunity to create additional wealth and employment. There is a pressing need for Australia to take as many opportunities as possible to add value to its own natural resources and capitalise on the added benefit to the community and nation, which the Balmoral South Project (the “Project”) proposes to address.

The Balmoral South Project will use an ore resource which is undervalued by current operators in the Pilbara, and could eventually lead to significantly more development in terms of support industries, other port users and offshore gas fields.

In 2005, the world production of steel was 1.1 billion tonnes, an increase of 5.8% from the previous year. In 2006 the international steel market continued with strong growth driven by strong demand. The international steel price rose throughout 2006 and continues to rise in 2008. This rise in price has been spurred by global economic growth and high demand growth in many countries and communities, such as the USA, EU, Japan and China.

Australia’s balance of payments will improve through the production of value-added minerals that would otherwise be exported in a partially processed form.

The benefits to Western Australia include:

- expenditure of up to $4 billion dollars for Project Development Stage 1;
- increased royalties from the sale of additional iron ore products;
- increased employment and training opportunities;
- encouragement in the growth of ancillary industries in WA;
- increased use of natural gas derived from local gas fields and indirect value-adding to that natural resource tapped locally; and
- additional infrastructure development.

Benefits to the local region will include:

- provision of direct business, employment and training opportunities for the communities in the Pilbara Region during the construction and operation phases; and
- economic multiplier effects to other local businesses.

The Balmoral South Project will contribute to the regional economy of Australia through export earnings, taxes, salaries and purchase of goods and services during construction and operation of the project. It will generate approximately $3 billion in sales revenue per annum over a project life of at least 31 years, and will contribute to the local economy, both directly and indirectly, as a result of contractual and full-time employment opportunities to local communities, including indigenous groups. Further contribution will be created by the flow-on effects on service industries and other sectors of the economy.

The ‘no project’ option would result in the compounding of a number of undesirable issues which have been recognised in Australia’s minerals extraction industry, namely:

- loss of employment and training opportunities to overseas pellet suppliers and downstream processors;
- the inability to improve export earnings from the natural resources extracted; and
- loss of a new industry together with the associated developments and ancillary industries that would flourish in support.
Section 3

Project Justification and Evaluation of Alternatives

3.2 Evaluation of Alternatives

3.2.1 Project Components

As part of the approvals process for the Central Block Project a number of options were considered for the location of project components, including a port. These can be divided into three alternatives:

- construction of the concentrator at the mine site (a feature common to all three alternatives due to the need to dispose of a large quantity of tailings), slurry or rail transport of the concentrate to a site near the Burrup Peninsula (e.g. West Intercourse Island, South West Burrup, Hearson Cove, Maitland Estate) for pelletising, and export via a port constructed on the Burrup Peninsula (e.g. West Intercourse Island, King Bay, South-West Burrup);

- construction of the processing plant at the mine site with the rail of finished product to the Burrup Peninsula for stockpiling and export via a port constructed at one of the above locations; and

- construction of the processing plant at the mine site and construction of a port at Cape Preston. (Initial investigations also evaluated the option of locating the processing plant site at Cape Preston. However, the mine site was selected since it provides a significant area of flat ground).

The above alternatives were considered against a number of criteria including:

- environmental – shorter transport distance will result in less land clearing and less greenhouse gas emissions;

- plant economics – costs of building the facility at a location remote from a population centre (Karratha) compared with operational savings associated with having an integrated project with all of the downstream processing components located in close proximity to each other. There would also be additional costs associated with building a power station at one location and having to transmit power to a second location 100km away, and the power loss such transmission would involve;

- economics of materials handling –30 km of product transport to Cape Preston versus 100 km to the Burrup Peninsula; and

- capacity for expansion – sufficient area exists adjacent to the mine site for further downstream processing and at the port site for further materials stockpiles and construction of berths to allow the export of different products.

With the recognition by the State of Western Australia of Cape Preston as a major future industrial area and the commencement of construction for the Central Block Project, options for the location of infrastructure components have significantly reduced. The Balmoral South Project will use shared infrastructure (including service corridors and port facilities) as much as possible in order to minimise environmental impacts and lower development costs.

3.2.2 Water Supply

40 GLpa of water will be required for ore processing and the supply of potable water for the mine, plant and camp areas. The alternatives considered for the supply of water to the project were:

- raw seawater;

- surface water sources;

- groundwater; and

- desalinated water.
Section 3  Project Justification and Evaluation of Alternatives

Raw Seawater

With seawater having a salt content of 35,000 ppm (35 kg/t) and the final concentrate having 9% moisture, then, discounting any other concentration of salts in the process, the final concentrate would contain 3.2 kg of salts (primarily chlorides) per tonne. This is unacceptable for subsequent pelletising, sintering or iron making. Thus seawater as a water source is not suitable.

Metallurgical investigation showed that using seawater, then washing the concentrate in fresh water would use as much fresh water as an all fresh water circuit. The use of seawater in the plant would also considerably increase maintenance costs.

Surface Water

Surface water from the Harding Dam in conjunction with groundwater is used to supply the Karratha area. This water is used when available after heavy rains, and before evaporation removes it. There is insufficient rain and too much evaporation for surface water to provide a reliable source of water in the area.

Construction of a new dam on the Fortescue River was also considered but the approvals process necessary to secure construction would be arduous, even if a suitable site were available.

Groundwater

Groundwater is the primary source of water in the Pilbara. Stream flow after heavy rains replenish aquifers, where it is stored without being subject to evaporation. Some water in the aquifers is transpired by vegetation and the remainder flows to the sea.

Potential groundwater resources lie in the alluvial of the Fortescue River adjacent to the project site, and the Robe River which is about 68km south west of the site.

Whilst there has been no testing, the Robe River is likely to yield about the same as the Fortescue River (10 - 12 GLpa).

The Fortescue and Robe Rivers combined would not be able to supply sufficient water for the project. In addition, if there was a run of dry years, both groundwater sources would be restricted, placing a risk on project operations. These aquifers could be used to provide part of the water needed.

All groundwater to the east of the project is allocated to Karratha.

Desalination

Desalination has been chosen to provide the 40 GLpa needed for the project. Two desalination technologies were considered for the project.

Reverse osmosis (RO), which uses about 4 kWhr/m$^3$ of water produced, and mechanical vapour compression which uses about 10 kWhr/m$^3$. Both technologies yield about 45% of the feed water as product, with the remainder returned to the sea as a brine at about twice the concentration of seawater (7% salts).

The mechanical vapour compression technology is robust and forgiving of suspended solids and organic matter in the feed water. This is important given the proximity of the desalination plant to the mouth of the Fortescue River. By contrast, RO needs extremely clean feed water and there is a risk of major maintenance expense should the membranes become fouled.

On the basis of energy efficiency, RO has been chosen as the initial preferred technology. However, further baseline studies may determine that other technologies may need to be used because of issues such as feed water quality.

3.2.3 Energy Supply

The processing of magnetite ores requires about 120 kWhr/t of concentrate.

The primary energy requirement for this project is mechanical energy for drives for mills, crushers, pumps, conveyors and other equipment.
Individual diesel or gas engine drives for each piece of plant would be uneconomic and electric drives are the only feasible alternative.

The fuels considered for supply of electrical power were oil, coal or gas.

Oil is uneconomic. At $US100/barrel the cost of oil is $0.625/kg. The calorific value of oil is about 50 GJ/t, so the price equates to $US12.50/GJ. A combined cycle power station with a thermal efficiency of 45% uses 8 GJ/MWh and thus would have a fuel cost of $AU110/MWh. Transport and storage costs of the fuel also need to be added to this and there is the risk of instability in oil prices.

Traded thermal coal normally has an energy content of 30 GJ/t and a coal fired sub-critical station with a thermal efficiency of 36% therefore requires around 10 GJ/MWh. Coal prices are volatile at present and have increased from $US30/t to $US100/t in recent times. At $US100/t ($AU3.70/GJ) coal fuel for a power station would be $37/MWh. However a coal fired power station would have a higher capital cost than a combined cycle gas plant and require facilities for the import of coal, most likely from Collie or Indonesia.

Gas, which is usually available in the Pilbara, is the obvious fuel of choice but has recently become very expensive with a price of the order of $8/GJ. The fuel required for a combined cycle power station costs $64/MWh. A gas fired station is considerably simpler than an oil or coal fired station and does not need fuel import and storage facilities.

A gas fired combined cycle plant was chosen due to its simplicity, no solid wastes and simple pipeline supply of the fuel, as well as high efficiency, lowest greenhouse gas emissions of any conventional technology and lowest emissions of NO\textsubscript{X} and SO\textsubscript{X}.

3.2.4 Product Transport – Mine to Port

The alternatives considered for product transport over the 30 km distance from the mine to the port at Cape Preston were:

- trucks;
- trains;
- slurry pipeline; and
- conveyor.

Trucks are uneconomic, there are issues surrounding safety, and ongoing truck and road maintenance costs.

Trains are uneconomic for bulk materials over short distances, primarily because of the cost and time involved in loading and unloading.

Concentrate can be transported very economically by slurry pipeline, and a slurry pipeline (with filtering near the port) would be the transport method of choice if concentrate were the only product. Two 400 mm slurry lines would be needed to transport 24 Mtpa. Each line would need a pump of 1500-2000 kW capacity.

Conveyors are economic over a distance of 30 km, and are suitable for both pellets and concentrate. A conveyor requires far lower Manning than a rail system, and the loading and unloading facilities are minor compared to truck or train. It also needs far less earthworks as grades can be much steeper than a railway. The technology for curved conveyors is well established, and radii can be tighter than a railway.

From an environmental perspective a conveyor or slurry pipeline is preferred due to the smaller area that will need to be disturbed to allow construction and operation. They will also result in fewer greenhouse gas emissions per tonne of material moved compared to road and rail transport.

As the project is planning to produce both concentrate and pellets, a conveyor is the only realistic choice.
4.1 Overview and Key Values

The Balmoral South Project is located in the Pilbara region of Western Australia, on the north-west coast near the mouth of the Fortescue River. The Pilbara region is characterised by a hot arid climate. Occasional heavy rainfall events and flooding occur as a result of cyclone activity, normally during the summer months.

Cape Preston is a remote site, relatively far from existing emission sources. As a result, existing levels of atmospheric pollutants are low.

The eastern part of the Balmoral South Project Area is characterised by two series of north-north-easterly trending ridges of outcropping Lower Proterozoic aged rocks of the Mount Bruce Supergroup, which are part of the Hamersley Basin. The western series of ridges are made up of banded iron formation, cherts, shales and breccias of the Brockman Iron Formation.

The Balmoral South Project is located adjacent to the lower reaches of the Fortescue River and approximately 15 km from the river mouth. The Fortescue River has a well defined main flow channel, typically 4 – 6 m deep and 100 m wide adjacent to the Balmoral South Project Area. Above the Balmoral South Project Area, the Fortescue River has an effective catchment area of approximately 20,000 km². The ephemeral Edward and Du Boulay Creeks flow through the Balmoral South Project Area in a north-westerly direction and discharge to the Fortescue River. Du Boulay Creek has a catchment area of approximately 200 km².

The major aquifers in the area are the gravels of the Fortescue River alluvium and to a lesser extent the Yarraloola Conglomerate. Depth to the water table is generally 4 to 12 m below ground level. Groundwater within the Fortescue River alluvium generally conforms to drinking water guidelines. Groundwater users in the Balmoral South Project Area are pastoral wells, phreatophytic vegetation and subterranean fauna.

Within the Balmoral South Project Area a total of 500 vascular flora species, from 64 families and 196 genera have been recorded. Two Priority Flora species have been found, although no Declared Rare or Threatened Flora have been recorded. The Declared Plants Prosopis pallida (Mesquite) and Datura leichhardtii (Native Thornapple) occur in the area and drainage lines tend to be heavily infested with Cenchrus ciliaris (Buffel Grass).

The Balmoral South Project Area is predominantly degraded cattle grazing country within the Fortescue Botanical District, broadly consisting of various Acacia shrublands over Triodia hummock grasslands on the more rugged, shallow soil habitats, and Eragrostis xerophila tussock grasslands dominating the heavy clay soils. Drainage lines are dominated by Eucalyptus spp. over Melaleuca and Acacia shrublands.

Eighty vegetation communities have been mapped. Of particular importance are the cracking clays of the Horseflats Land System and the phreatophytic vegetation of the River and Paraburdo Land Systems. In 2004, the Minister for Planning and Infrastructure approved an area of approximately 2,555 ha to be excluded from Mardie Station as part of the "2015 Exclusion Process". The area was identified as particularly valuable for its conservation value because of the Horseflats Land System and related vegetation associations that are poorly represented within the conservation estate. No Threatened Ecological Communities have been recorded.

Three phreatophytic flora species (Eucalyptus camaldulensis, Eucalyptus victrix and Melaleuca argentea) occur within eight vegetation communities.

A well-developed and structurally complex mangrove system is associated with the major tidal creek and connective tidal flats that join Cape Preston with the mainland (Mangrove Creek). Other areas of mangrove occur in the wider locality, including a generally narrow zone of Avicennia marina which borders the western shoreline and embayments between the creek and the mouth of the Fortescue River.
Section 4

Existing Environment

The vertebrate fauna of the Balmoral South Project Area is generally dominated by birds and reptiles. Several species of mammal are also common, predominantly consisting of smaller species such as native mice. Database searches have indicated that several fauna species of conservation significance potentially occur in the area. In general, it has been determined over the course of the 2000 and 2006 field surveys that fauna habitats within the Project Area are well represented in the Region and none are considered as regionally significant or unique. Of the habitats sampled, rivers and creek lines yielded the highest number of species.

Studies to date suggest that the Balmoral South Project Area contains a subset of the subterranean fauna that occurs within the larger Cape Preston area. It appears likely, based on the distribution of the more frequently occurring species and the lack of major geological discontinuities between the mining areas that the same communities extend through all orebodies at Cape Preston.

At Cape Preston, nearshore water movements and mixing patterns are driven primarily by large tidal ranges (HAT of 4.75 m), local currents and winds, but are also influenced by seabed topography and the steering effect of islands and reefs. The water column is relatively well mixed with stratification not apparent to any marked degree. Turbidity in the region is generally high, due to the episodic high volume river flows, dominant marine sediment types, strong local winds, large tides and common occurrences of cyanobacterial blooms. Water quality in the area is relatively undisturbed by anthropogenic sources.

Macroalgae dominate submerged limestone reefs within the Cape Preston area, and also grow on stable rubble and boulder surfaces. Seagrasses form interspersed macroalgae beds. Fauna of the shallow water limestone reefs and platforms include hard and soft corals, sponges, ascidians, fan worms, molluscs, crustaceans,urchins and sea stars. Dense areas of high coral cover are sparsely distributed in the region, whilst areas of low coral cover tend to occur as a thin border along steep slopes that descend from shallow algae dominated pavements around islands to a deep sandy seafloor. The nearest major reefs to Cape Preston which support high live coral cover are over three kilometres away.

The beaches of Cape Preston are utilised for a very limited amount of turtle breeding activity. Small numbers of dugong have been sighted in the Dampier Archipelago / Cape Preston region. Migratory shorebirds utilise Pilbara coastal habitats such as beaches, tidal flats and other intertidal wetlands during the non-breeding season. The highest concentration of shorebirds occurs along the western shore of Cape Preston.

Land use in the area comprises pastoral grazing, mining activities at the Central Block and limited tourism and recreation. The port site is within the Great Sandy Island Nature Reserve and lies west of the proposed Regnard Marine Management Area.

Archaeological and ethnographic studies have identified the Aboriginal Heritage values of the area and the presence of a number of sites of heritage significance. No sites of European heritage significance occur in the area.

In summary, the key environmental values of the Balmoral South Project Area include:

- surface water flow and quality in the Fortescue River and Du Boulay Creek;
- groundwater quality in the Fortescue River alluvials;
- cracking clays of the Horseflats Land System;
- phreatophytic vegetation of the River and Paraburdoo Land Systems;
- mangrove communities occurring between Cape Preston and the mainland;
- subterranean fauna;
- marine water quality; and
- shorebirds and turtles.
Section 4

Existing Environment

4.2 Climate

Cape Preston is situated on the Pilbara coast. Rainfall is low throughout the region and quite variable. Annual totals vary from 200 – 450 mm, and many years without significant rainfall occur. Most of the summer rain comes from scattered thunderstorms and the occasional tropical cyclone. A secondary peak in the monthly rainfall occurs in May/June as a result of rainfall caused by tropical cloud bands which intermittently affect the area. The number of thunderstorms average 20 - 30 per annum over most of the area.

This region contains some of Australia's consistently hottest places. The coast is 2 - 3° C cooler but usually more humid due to the sea breezes. Summer maximum temperatures exceed 32° C almost every day. Winter maximum temperatures are mild / warm in the 23 - 27° C range in the south. Minimum temperatures range from 25° C in midsummer to 12° C in July near the coast.

Wind roses for Mardie are shown in Figure 4-1: Wind Roses for Mardie - 1956 to 2007. Morning (9am) winds are predominantly from the east to south (57% of the time), while afternoon winds (3pm) are predominantly from the west to north (73%). The afternoon winds most likely represent sea breeze conditions, especially during the summer months.

On average, five tropical cyclones pass through the west Australian region each year, although this may be highly variable on a year-to-year basis. Cyclones are typically generated offshore from the Kimberley, although they may be generated across a broader range of longitudes under suitable conditions.

Although the Cape Preston region is to the south of the zone with the highest frequency of cyclone events, it is well known that the Cape Preston–Mardie Station region is subject to intense cyclonic activity, with the most severe storm on record, Severe Tropical Cyclone Vance (1999) causing extensive coastal inundation between Onslow and North West Cape. In 1989 another severe cyclone (Orson) crossed the coast close to Cape Preston. More recently, during the 2005-06 season two cyclones (Clare and Glenda) also crossed the coast in the Cape Preston region. Cape Preston does experience significant onshore winds and therefore enhanced wave energy.

4.3 Air Quality

Cape Preston is a remote site, relatively far from existing emission sources. As a result, existing levels of SO$_2$ and NO$_2$ are low. Evidence for this is provided in the very low monthly averages recorded at Mardie station as part of the Burrup rock art monitoring by CSIRO (2006). Ozone levels are moderate as indicated in the DEP monitoring at Dampier where, over two years of monitoring, two events with 1-hour concentrations exceeding 0.06 ppm or 60% of the NEPM standard were recorded (DoE 2004a). These were due to bushfire smoke and as such, similar levels could be expected at Cape Preston.

NO$_X$ levels also are low with data indicating that the background annual average is around 3 μg/m$^3$ with a 70th percentile 1-hour concentration of 5 μg/m$^3$ (Sinclair Knight Merz 2003).

Particulate concentrations (as TSP or PM$_{10}$) can be high in the region due to natural sources such as bushfires and dust storms. Based on data collected by BHP Billiton at its background monitors at Boodarie and Port Hedland airport (BHP Billiton 2002, 2006), the number of exceedances of the NEPM Standard for 24-hour average PM$_{10}$ varies between zero per year to forty six per year on an annualised basis.

Average annual background (concentrations at areas with no local sources) PM$_{10}$ values in the Port Hedland region have been determined at between 19.5 μg/m$^3$ and 20 μg/m$^3$.
Figure 4-1: Wind Roses for Mardie - 1956 to 2007
4.4 Soils and Geology

The Balmoral South Project Area includes the weakly gilgaied cracking clay plains of the Horseflat Land System, rugged basalt or jaspilite plateaus and ridges shifting to stony plains and active floodplains of deltaic deposits flanking major rivers and creeks.

The sediments of Mangrove Creek have been identified as ‘high to moderate’ risk for the occurrence of Acid Sulphate Soils (ASS) by the Western Australian Planning Commission in Planning Bulletin No. 64 (WAPC 2003). ASS have been encountered during geotechnical work in Mangrove Creek.

The surface geology of the general project area is illustrated in Figure 4-2: Regional Geology. The eastern part of the area is characterised by two series of north-north-easterly trending ridges of outcropping Lower Proterozoic aged rocks of the Mount Bruce Supergroup, which are part of the Hamersley Basin. These rocks dip steeply to the west-north-west and become generally younger from east to west, although there are numerous minor faults in the area that have resulted in some repeats of stratigraphic horizons.

A schematic geological section through the project area is presented in Figure 4-3: Schematic Geological Cross Section.

The eastern and highest series of ridges are formed by the Kylena and Maddina Volcanics which comprise basalts and tuffs. The western series of ridges are made up of banded iron formation (BIF), cherts, shales and breccias of the Brockman Iron Formation (and to a lesser extent the underlying Mount McRae Shale - Mount Sylvia Formation). Three main orebodies have been identified as Northern Block, Central Block and Southern Block. The Southern Block orebody is located within the southernmost occurrence of Brockman Iron Formation. The orebodies are high-grade magnetites that have developed within the Joffre Member of the Brockman Iron Formation. A thin veneer of Quaternary aged alluvial, colluvial and residual soils overlies the basement rocks in low lying areas, with some creek bed alluvium along drainage courses.

Basement stratigraphy within the project area, from youngest to oldest, is summarised as follows:

- Breccia - which appears to be the local equivalent of the Yandicoogina Shale;
- Joffre Member - in which the magnetite orebodies have developed;
- Whaleback Shale;
- Dales Gorge Member - BIF, chert and shales;
- Shales - shales, breccia and BIF which appear to be a local equivalent to lower units of the Dales Gorge Member; and
- Mount McRae Shale - Mount Sylvia Formation - shales and BIF.

Numerous faults exist (both strike-slip and dip-slip) and significant strike slip displacement has resulted in the several repeats of the Joffre Member across the mine site area. Many of the fault planes have been intruded with dolerites.
Section 4

Existing Environment

Figure 4-2: Regional Geology
Section 4

Existing Environment

Figure 4-3: Schematic Geological Cross Section
4.5 Surface Water

Cape Preston and the Pilbara lie in the dry tropical northern part of WA, receiving summer rainfall in a wet season lasting from December to March. Cyclones occur during this period, bringing heavy rain to coastal towns.

The Balmoral South Project area is located between the North West Coastal Highway and the sea, and adjacent to the Fortescue River. The total Fortescue River Basin has a catchment area of around 50,000 km², however, the upper portion of this basin drains only as far as the Fortescue Marsh Area, approximately 350 km from the coast. The effective catchment area at the project, below the Fortescue Marsh Area, is approximately 20,000 km² (Appendix G).

Upstream from the North West Coastal Highway, the Fortescue River is generally contained between ridges. Downstream of the Highway, the topography becomes less pronounced and the river flow path less constrained. During large flood events, river flows break away from the main flow channel and extend over the adjacent floodplains. Through the floodplains, numerous smaller flow channels have developed, discharging in the same general direction as the main channel.

The Fortescue River adjacent to the project area has a well defined main flow channel, typically 4 - 6 m deep and around 100 m wide. The main channel has a gravelly bed, and typically gum trees along both banks, except near the tidal river mouth where mangroves occur along the banks. Vegetation over the floodplains varies. Some sections contain wide open grass areas with scattered trees, while other sections comprise dense scrub.

The Edward and Du Boulay Creeks flow in a north-westerly direction through the general project development area and discharge into the Fortescue River. These creeks, which drain ridges located to the east and south-east of the project area, have catchment areas of approximately 29 km² and 200 km² respectively. Near the project areas, both creeks typically have main flow channels with 5 - 10 m width gravel beds and trees along the banks. Floodplains adjacent to the creeks typically comprise open grassed areas with scattered trees. These creeks are generally dry and are not considered functional aquatic ecosystems (Strategen 2008). For this reason, the objectives, targets, monitoring measures and management actions described in the Balmoral South PEMP are aimed at protecting the environmental values of the aquatic systems of the Fortescue River.

Rainfall runoff from the steep ridges located within the general project area tends to be rapid and short lived. These steep and incised drainage lines typically link into lower energy flow channels located around the perimeter of the ridges, and then drain to the main Fortescue, Du Boulay or Edward Creek systems, or directly to the coast.

4.6 Hydrogeology

4.6.1 Regional Hydrogeology

The hydrogeology of the region has been dealt with in detail in previous reports, including Aquaterra 2001, Aquaterra 2007, and Commander 1993, and is summarised in Appendix H – Aquaterra 2008. A summary of the hydrogeological properties of the various geological units outlined above is presented in Table 4-1: Summary of Hydrogeological Properties.
### Section 4

**Existing Environment**

#### Table 4-1: Summary of Hydrogeological Properties

<table>
<thead>
<tr>
<th>Age</th>
<th>Unit</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Fortescue River Alluvium</td>
<td>Gravels form major aquifer with high permeability.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aquifer covers extensive area beneath floodplain.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Groundwater is fresh in most of floodplain area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Groundwater is marginal to brackish on edge of floodplain.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Groundwater is brackish to saline at depth near coast.</td>
</tr>
<tr>
<td></td>
<td>Eluvium - Residual Soils</td>
<td>Mostly above the water table.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forms local aquifer where saturated, connected to alluvium.</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Trealla Limestone</td>
<td>Aquitard.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forms confining layer to Yarraloola Conglomerate.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forms base of overlying alluvial aquifer.</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>Yarraloola Conglomerate</td>
<td>Confined aquifer with moderate to low permeability.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forms narrow channel aquifer in old river course.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intersected in three GSWA bores.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Groundwater is fresh in these bores.</td>
</tr>
<tr>
<td>Proterozoic</td>
<td>Weeli Wolli Formation</td>
<td>Indurated rocks with no primary porosity or permeability.</td>
</tr>
<tr>
<td></td>
<td>Brockman Iron Formation</td>
<td>Some minor fracture induced secondary aquifer properties.</td>
</tr>
<tr>
<td></td>
<td>Mt McRae - Mt Sylvia Formation</td>
<td>Not aquifers in project area.</td>
</tr>
<tr>
<td></td>
<td>Maddina Volcanics</td>
<td>Groundwater is marginal to brackish in mine area.</td>
</tr>
</tbody>
</table>

The major aquifers in the project area are the gravels of the Fortescue River alluvium and to a lesser extent the Yarraloola Conglomerate. Previous investigations (Commander 1993, Bradberry Associates 1965) indicate that the alluvium is potentially a major source of fresh water and could support substantial pumping. Hydraulic conductivity values in excess of 50 m/d and individual bore yields up to 900 kL/d have been demonstrated. Sustainable abstraction of around 10,000 ML per year has been estimated and the Department of Water (DoW) has ear-marked the aquifer system as a potential area for future development. Numerous station wells and bores in the area also tap this aquifer.

The Yarraloola Conglomerate is much less extensive than the shallower alluvium in the project area. Hydraulic conductivity values of less than 2 m/d have been indicated, although the water quality, where tested, appears to be as good, if not better than in the alluvium.

There are only minor secondary aquifer properties in the Proterozoic basement rocks, generally associated with fracturing. There are some station wells and bores in areas of sub-cropping basement, although much of the water yielded is likely derived from the overlying eluvium (residual soils).

#### 4.6.2 Groundwater Flow

Groundwater flow in the region is generally to the northwest towards the ocean, with local groundwater flows being influenced by topography, recharge and discharge zones.

The Proterozoic Basement Rock aquifers are recharged by the infiltration of rainfall and local runoff in areas of outcrop and via leakage from overlying residual soils and sediments in areas of subcrop. These aquifers discharge by base flow to local drainages and by throughflow to the Fortescue River alluvium and coastal sediments.
As such, groundwater flow in the basement rock aquifers is generally from topographic highs towards the Fortescue River and the coast, with some local convergence about creeks during non-flood periods.

The Fortescue River Alluvium aquifer and deeper sediments on the main floodplain are mostly recharged by the infiltration of river flow, although there is some minor direct infiltration of rainfall and some throughflow from flanking basement rock aquifers. These aquifers discharge by base flow to the Fortescue River during periods when the water table is above the riverbed and above river water levels, and by evapotranspiration. The latter occurs via vegetation on the floodplain and also as direct evaporation from the near shore tidal flats where the fresh groundwater flows up to the surface above a saline water interface.

The permeable saturated alluvium of the Fortescue River does not come into contact with the underlying basement lithologies, rather it is separated by clays associated with the Quaternary alluvial deposits and underlain by clays of the Trelial Limestone. There is no indication of direct hydraulic connection between either the orebody and saturated alluvium or the basement lithologies and saturated alluvium (Commander 1993). As such, groundwater level contours tend to be parallel to the coast with flow in a north-westerly direction, although there will be divergence of groundwater flow away from the main river channels at times of river flow and local convergence of groundwater flow about the river channels in periods of little to no flow. The groundwater throughflow in the main aquifer (gravels) in the alluvium has been estimated to be between 2.3 GL/annum and 9.2 GL/annum (Commander 1993).

**4.6.3 Groundwater Quality**

The distribution of groundwater quality is best illustrated by salinity. Groundwater salinity contours based on April 2000 field survey results and earlier (pre-1993) results for the Fortescue River alluvium bores are illustrated in *Figure 4-4: Groundwater Salinity Contours*. There are basically three groundwater quality types in the region:

- fresh groundwater (<1,000 mg/L Total Dissolved Solids, TDS) in the central part of the Fortescue River alluvium. This fresh water forms a “lobe” elongated along the main channels of the River as a result of recharge;

- marginal to brackish groundwater (1,000 mg/L to around 2,000 mg/L TDS) in the basement rock aquifers and on the flanks of the Fortescue River alluvium where throughflow from the basement rocks mixes with the fresh water in the alluvium. This is supported by recent field Electrical Conductivity (EC) testing during the airlift testing program in the Southern Block, which indicates groundwater in the Southern Block ore body to have a salinity of around 1,500 mg/L TDS; and

- brackish to saline groundwater (greater than 5,000 mg/L TDS) adjacent to the coast, where there is a saline water interface between the fresh groundwater flowing northwards and seawater. This interface dips to the south (i.e. inland) forming a “salt water wedge” and groundwater salinity would increase with depth in the near coastal and tidal flats areas.

Groundwater quality data from the Basement Rock aquifers (from 1993 and 2000) indicate the groundwater to be a predominantly sodium chloride type water typical of mature groundwater with long residence times and little influence from recharging groundwater. Analysis of the data shows no obvious correlation between reported salinity and depth of drill-hole.

Groundwater within the Fortescue River Alluvium, with the exception of the flanks of the floodplain and in the near coastal zone, generally conforms to the drinking water guidelines (as defined in the Australian Water Quality Guidelines for Fresh and Marine Waters). Groundwater within the Basement Rocks generally does not meet drinking water guidelines, mostly in relation to salinity (TDS) and chloride, but in some cases also with regards to sulphate, manganese, barium, nickel, boron and cadmium. However, groundwater with the Basement Rock is generally within the guidelines for stock water usage, except in coastal areas or adjacent to the tidal flats.
Section 4

Existing Environment

Figure 4-4: Groundwater Salinity Contours & Existing Pastoral Well Locations
Section 4

Existing Environment

4.6.4 Groundwater Users

The only existing groundwater user in the area are pastoral wells. However, a number of both approved and proposed future mine operations are likely to draw on groundwater supplies for construction and mine dewatering. The published 1:50,000 scale topographic map series for the area indicate thirteen pastoral wells in the project area (Figure 4-4). The majority of these wells are assumed to be equipped with wind-mill driven pumps with at least one (Du Boulay Well) indicated as being equipped with a solar powered electric pump. It is recognised that additional groundwater users may occur in the future and that mining operations will continue to impact on local groundwater long after mining has ceased.

4.6.5 Orebody Hydrogeology

A review of the exploration drilling database indicated that a number of holes particularly in the northern part of the Southern Block ore body reported drilling difficulties due to groundwater inflow. One hole, (SB022) located to the north of the ore body, has also been utilised as a temporary drilling water supply bore. SB022 has been pumped at 2.9 L/s for 60 minutes, with a resulting 2.7 m drawdown. A program of hydrogeological investigations was subsequently undertaken to assess the bulk permeability across the Southern Block ore body for input into the groundwater model and assessment of potential inflows to mining operations.

Results of groundwater level survey are presented in Figure 4-5: Groundwater Investigations. Groundwater levels range from 9 to 13 m AHD (typically 7 to 20 m below ground level) across the northern area of the Southern Block ore body. The groundwater potentiometric contours indicate that groundwater flow is generally to the northwest across the ore body (groundwater flow direction being down gradient perpendicular to the groundwater contours). The relatively steep gradient across the ore body with elevated groundwater levels on the Du Boulay Creek side indicate that the ore body is acting as a hydraulic barrier impeding the groundwater flow from the Du Boulay system to the Fortescue system to the west. Elevated groundwater levels in the north of the ore body in the vicinity of Du Boulay Creek indicate that the Du Boulay Creek may act as a source of groundwater recharge.

The results of permeability testing provide quantitative estimates of bulk permeability and transmissivity. Test results indicate an average permeability for the ore body (based on the holes tested) in the order of 0.6 m/d. Given the depths of the holes tested (in the order of 290 m), these data indicate a transmissivity in the order of 170 m$^2$/d. However, it is assumed that the bulk of groundwater inflows to the bores tested is sourced from transition zone aquifers near the base of oxidation.

Early airlift testing at the Central Block ore body (Aquaterra 2000) indicated permeability values in the order of 0.01 m/d. However, test pumping of a trial dewatering bore recently at the Central Block indicated a permeability of 0.5 m/d which is more in line with the recent Balmoral South testing results.
Section 4

Existing Environment

Figure 4-5: Groundwater Investigations
4.6.6 Groundwater Dependant Ecosystems

A Groundwater Dependent Ecosystem (GDE) is a natural ecosystem that requires access to groundwater to meet some, or all, of its water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (Resource & Environmental Management Pty Ltd 2007). Two ecosystems in the Pilbara region are recognised nationally as GDEs (Sinclair Knight Merz, 2001). These are:

- Pilbara spring systems, which are entirely dependent on groundwater and have a high conservation value. None of these will be impacted by the project; and
- Pilbara river pool ecosystems, which are highly dependent on groundwater and have a moderate conservation value.

GDE’s are represented locally by the occurrence of phreatophytic vegetation and subterranean fauna. Descriptions of phreatophytic vegetation and potential impacts are provided in Sections 4.7.5 and 7.2.2 respectively and for subterranean fauna in Sections 4.10 and 7.5 respectively.

4.7 Terrestrial Flora and Vegetation

4.7.1 IBRA Region

There are 85 recognised IBRA Biogeographic regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (Environment Australia 2000). The Balmoral South project area lies within the Pilbara Biogeographic Region of Interim Biogeographic Regionalisation for Australia (IBRA) and is divided into four subregions; the Chichester, Fortescue Plains, Hamersley and Roebourne. On a finer scale, the Balmoral South Project area lies within the Roebourne Subregion.

Kendrick and Stanely (2001) have broadly described the Roebourne subregion as Quaternary alluvial and older colluvial coastal and sub-coastal plains with a grass savannah of mixed bunch and hummock grasses and a dwarf shrub steppe of *Acacia stellaticeps* or *Acacia pyrifolia* and *Acacia inaequilatera*.

4.7.2 Land System

The Department of Agriculture WA has mapped the Land Systems of the region from aerial photography, providing the largest scale interpretation of vegetation units for the project area (Van Vreeswyk et al. 2004). Ten Land Systems (Figure 4-6: Land Systems in the Balmoral South Project Area) occur within the project leases (two additional Land Systems – Peedamulla and Ruth occur nearby but not within the lease areas):

- **Boolgeeda** - stony lower slopes and plains found below hill systems, supporting hard and soft spinifex grasslands and mulga shrublands. Predominantly deposition surfaces of very gently inclined stony slopes and plains becoming almost level further downslope.
- **Cheerawarra** - sandy coastal plains and saline clay plains supporting soft and hard spinifex grasslands and minor tussock grasslands. Depositional surfaces of gently undulating sandy surfaced coastal plains.
- **Horseflats** - extensive, gilgaied clay plains supporting tussock grasslands and minor grassy snakewood shrublands. Depositional surfaces consisting of gilgaied and non – gilgaied clay plains, stony plains, narrow linear drainage depressions and dissected slopes marginal to the River Land Systems.
- **Littoral** - coastal fringe consisting of areas of mangal on the seaward fringe, samphire shrublands on mudflats, *Acacia coriacea* shrublands over spinifex or tussock grasses on coastal dunes and *Triodia angusta* hummock grasslands on broad sandy plains.
Section 4

Existing Environment

- **Macroy** - stony plains and occasional tor fields based on granite supporting hard and soft spinifex grasslands.

- **Newman** - rugged jaspilite plateaux and ridges with hard Spinifex grassland; prominent in the Northern, central and western sections of the study area.

- **Paraburdoo** - stony gilgai plains derived from basalt, supporting snakewood shrublands and mulga shrublands with spinifex and tussock grasses. Consists of depositional surfaces such as isolated low basalt hills and stony upper interfluves and plains with small groves.

- **River** - active floodplains and terraces flanking major rivers and creeks, supporting riverine woodlands and tussock and hummock grasslands; associated with the Fortescue River system. Flood plains and river terraces are subject to fairly regular overbank flooding from major channels and watercourses, sandbanks and poorly defined levees and cobble plains.

- **Rocklea** - rugged Basalt hills and plateau remnants with hard Spinifex grasslands; prominent in the northern portion of the survey area.

- **Yamerina** - floodplains and deltaic deposits supporting tussock grasslands with chenopod low shrubs and soft Spinifex grasslands; occurred in the western portions of the study area.
Section 4

Existing Environment

Figure 4-6: Land Systems in the Balmoral South Project Area
4.7.3 Flora

A detailed flora and vegetation assessment is presented in Appendix C.

Five detailed flora and vegetation surveys have been conducted in the region to date, in accordance with EPAWA Guidance Statement No. 51. An initial vegetation and flora survey was undertaken between the 15th and 28th of April 2000 for the Austeel Public Environmental Review for the Central Block Project (Halpern Glick Maunsell, 2001). Additional surveys were undertaken within the project area between 2003 and 2007 (Maunsell Australia 2003, Maunsell Australia 2006, Mattiske Consulting 2007, Astron Environmental Services 2007). The total survey area is 40,717 ha. Figure 4-7: Cape Preston Flora and Fauna Survey History highlights where flora and vegetation surveys have been conducted over the project area. Table 4-2: Summary of Floristic Survey results within the Balmoral South Project Area has been generated listing the Surveyor, Year of Report, Scope, Results and Survey Limitations.

The spatial distribution of vegetation communities mapped by various surveys throughout the project area, with the footprints of the approved Central Block Project and proposed Balmoral South Project overlaid, is displayed in Figures 5.1 – 5.14 of Appendix E to Maunsell-Aecom “Cape Preston Mining Estate Consolidated Vegetation, Flora and Fauna Assessment” (Refer Appendix C of this PER), which also contains a description of each of the vegetation communities recorded.

General

Within the entire Cape Preston project area a total of 500 vascular flora species, from 64 families and 196 genera were recorded. This total includes 482 (96.4%) native species and 18 (3.6%) introduced (weed) or non-endemic species. Families with the highest representation were Poaceae (Grass family – 73 native taxa; 4 introduced taxa); Papilionaceae (Pea family – 44 native taxa); and the Malvaceae (Mallow Family – 49 native taxa, 2 introduced taxa).

One of the species recorded during the flora surveys conducted between 2000 and 2007 was found to exhibit a range extension (Acacia victoriae). Acacia victoriae will not be impacted by the Project, as it occurs in vegetation types Mr3, Mr6 and Roc3 (Maunsell Australia 2008) which will not be directly cleared.

Declared Rare and Priority Flora

A search of the DEC database revealed that ten species of Threatened Flora have the potential to occur within the project area.

No species listed as Declared Rare Flora by the Department of Environment and Conservation (DEC), under the Wildlife Conservation Act 1950, or as Threatened under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) were recorded within the project area during site surveys.

Two Priority Flora species have been identified in the Balmoral South Project Area:

- Goodenia sp. East Pilbara (AA Mitchell PRP 727); and
- Phyllanthus aridus.

None of these species are listed under the EPBC Act.

All Goodenia species recorded from the 2000 survey were submitted to a specialist taxonomist at DEC for confirmation. These confirmed identifications were used as reference for identification of specimens in subsequent surveys.

Introduced Weed Species

The Balmoral South Project area supports populations of the Declared Plants Prosopis pallida (Mesquite) and Datura leichhardtii (Native Thornapple) (Department of Agriculture 2006). The spatial distribution of
Section 4

Existing Environment

These communities within the project area is presented in Figure 4-8: Cape Preston Potential Locations of Declared (Weed) Plants - Northern Area and Figure 4-9: Cape Preston Potential Locations of Declared (Weed) Plants - Southern Area. Pursuant to Part V of the Agriculture and Related Resources Protection Act 1976, landholders are obliged to carry out control measures, each specific to the species.

In addition to the two declared weed species, ten environmental weeds have been recorded in the project area. These species are largely common and widespread within the Pilbara region. They are:

- **Aerva javanica** – Kapok;
- **Argemone ochroleuc** - Mexican poppy;
- **Bidens bipinnata** - Beggar’s Ticks;
- **Cenchrus ciliaris** - Buffel grass;
- **Cenchrus setigerus** - Birdwood grass;
- **Citrullus lanatus** - Pie Melon;
- **Malvastrum americanum** - Spiked Malvastrum;
- **Melochia pyramidata**;
- **Setaria verticillata** - Whorled Pigeon Grass; and
- **Vachellia farnesiana** - Mimosa bush.
Existing Environment

Figure 4-7: Cape Preston Flora and Fauna Survey History
Section 4

Existing Environment

Table 4-2: Summary of Floristic Survey results within the Balmoral South Project Area

<table>
<thead>
<tr>
<th>Survey</th>
<th>Year</th>
<th>Scope</th>
<th>Results</th>
<th>Survey Limitations</th>
</tr>
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</table>
| Halpern Glick Maunsell  | February 2001 | Austeel Pty Ltd (Austeel) intended to develop a project in the Cape Preston Region approximately 80km south west of Karratha capable of producing up to 4.7 million tonnes per annum of Direct Reduced Iron/Hot Briquetted Iron (DRI/HBI). The project includes development of an open-cut pit, waste dumps, tailings dams, product stockpiles and additional infrastructure including access roads, haul roads, construction camps, village, power station, power distribution network and desalinated water plant. Halpern Glick Maunsell was commissioned to conduct flora and fauna assessment of the Austeel Project area. | The results of the Flora assessment conducted during 2000 are summarised below:  
- 64 Terrestrial communities identified from nine Land System Units;  
- total of 426 flora species from 190 genera and 64 Families. This included 6 mangrove species;  
- no species of DRF were recorded;  
- six Priority Flora were recorded, however since the time of the report preparation only two species remain Priority Flora, namely Goodenia sp East Pilbara (AA Mitchell PRP 727) (P1) and Phyllanthus aridus (P3);  
- *Prosopis pallida a declared plant is common throughout the survey area. | • limited amount of sampling conducted;  
• survey restricted to a two week period;  
• sampling concentrated within areas proposed to be disturbed at time of survey;  
• heavy rain prior to survey caused delay and made access difficult;  
• survey only conducted during one season and unlikely to be representative of the entire floristic community; |
| Halpern Glick Maunsell  | November 2003 | This report details the findings of an additional seasonal flora study undertaken in June and July 2003 to specifically survey the mine footprint area for species of threatened flora. This study was commissioned by Austeel in response to the EPA requirement for an additional seasonal survey to be conducted. | • No populations of Threatened or Priority Flora were located;  
• 162 vascular flora species from 94 genera and 36 Families were recorded;  
• no species of Declared Rare Flora were recorded to occur;  
• one Priority flora species was recorded to occur namely Goodenia pascua (formerly P3) which has since, been removed from the Priority Flora List;  
• two Declared weeds, namely *Prosopis pallida (Mesquite) and Datura leichhardtii (Native Thornapple), were recorded within project area; | • survey restricted to a 100m corridor within the infrastructure corridor;  
• vegetation communities in which Priority Flora were known to occur in were targeted; |
| Maunsell Australia Pty Ltd | November 2006 | This report presents the findings of the Maunsell biological survey for the proposed mine and associated infrastructure locations. It includes new survey results and conclusions from 2006 as well as a review of information gathered as part of the previous study conducted in 2000. | • 162 vascular flora species from 94 genera and 36 Families were recorded;  
- no species of Declared Rare Flora were recorded to occur;  
- one Priority flora species was recorded to occur namely Goodenia pascua (formerly P3) which has since, been removed from the Priority Flora List;  
- two Declared weeds, namely *Prosopis pallida (Mesquite) and Datura leichhardtii (Native Thornapple), were recorded within project area; | • poor accessibility to some areas;  
• time limitations to traverse such a large project area with few vehicular access tracks;  
• relatively short days in terms of the hours of sunlight, limiting the effective duration of survey days;  
• difficulty in placement of pegs for quadrats in compacted clays or rocky soils;  
• a lack of good quality aerial photography, which was not made available until after field investigations, due to a period of high demand and delays at the Department of Land Information (DLI). |
| Astron Environmental Services | June 2007 | Area surveyed extends from the east coast of Cape Preston in the north to directly west of Mount Potter in the south, within General purpose lease G08/52 and G08/53. This assessment was an extension of flora work previously conducted by HGM. | • majority of survey area belong to Littoral Land System Unit;  
- nine additional vegetation communities identified | Not noted |
| Maunsell AECOM Pty Ltd  | 2008    | Extrapolation of existing vegetation community mapping based on interpretation of aerial photography for the purposes of exploration drilling program. | N/A | • not ground truthed |
Section 4

Existing Environment

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Figure 4-8: Cape Preston Potential Locations of Declared (Weed) Plants - Northern Area
Figure 4-9: Cape Preston Potential Locations of Declared (Weed) Plants - Southern Area
Section 4

Existing Environment

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Section 4

Existing Environment

4.7.4 Vegetation

The Balmoral South Project area is situated within the Fortescue Botanical District of the Pilbara Biogeographic region and broadly consists of various Acacia Shrublands over Triodia Hummock Grasslands on the more rugged, shallow soiled habitats and Eragrostis xerophila Tussock Grasslands dominating the heavy clay soils. Drainage lines are dominated by Eucalyptus species over Melaleuca and Acacia Shrublands. These areas also tend to be heavily infested with Cenchrus ciliaris (Buffel Grass), a highly invasive weed introduced by pastoralists for its high grazing value.

Beard’s (1975) 1:1,000,000 scale mapping of the Pilbara region identified the following broad terrestrial vegetation types occurring in the study area:

- **T1Hi**  
  *Triodia pungens* steppe (hummock grassland).

- **A2Sr,t1Hi**  
  Shrub-steppe of *Acacia pyrifolia* over *Triodia pungens*.

- **xGc/t1Hi**  
  Mosaics of grass savannah with Spinifex *Triodia pungens*.

- **e40Lr.xGc**  
  *Eucalyptus* sp. aff. *aspersa* sparse tree savannah over short grassland.

- **a11Sb.xGc/a2Sr.t1Hi**  
  Shrub savannah of *Acacia xiphophylla* over short grassland and shrub-steppe of *Acacia pyrifolia*.

No Threatened Ecological Communities (TEC’s) were recorded to occur within the project area (as determined by DEC database searches and field surveys).

A total of 80 vegetation communities have been described and mapped in the Cape Preston area (Appendix C). These communities include hummock and tussock grasslands, annual herblands on cracking clays, *Acacia* shrublands over hummock grasslands, tall *Acacia* shrublands and low Corymbia woodlands over *Acacia* shrublands. The spatial distribution of these communities within the project area is presented in Figure 4-10: Vegetation Communities and Disturbance Areas – Northern Area and Figure 4-11: Vegetation Communities and Disturbance Areas – Southern Area.
Section 4

Existing Environment

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Figure 4-10: Vegetation Communities and Disturbance Areas – Northern Area
Figure 4-11: Vegetation Communities and Disturbance Areas – Southern Area
Section 4

4.7.5 Phreatophytic Vegetation

Three phreatophytic (a deep-rooted plant that obtains water from a permanent ground supply or from the water table) species occur within the project area. These are:

- *Eucalyptus camaldulensis*;
- *Eucalyptus victrix*; and
- *Melaleuca argentea*.

These species occur in the following eight communities in the project area:

- Pc – *Eucalyptus victrix*, *E. camaldulensis* woodland over *Acacia coriacea*, Mesquite high shrubland over open herbland;
- Pc2 – *Eucalyptus victrix* open woodland over *Acacia coriacea* high shrubland over *Cenchrus* sp. tussock grassland;
- Pc3 – *Eucalyptus victrix* open woodland over *Acacia coriacea* high shrubland over *Triodia epactia* open curly spinifex grassland and *Cenchrus ciliaris* open tussock grassland;
- Pc4 – *Eucalyptus victrix* scattered trees over *Acacia anistrocarpa* high open shrubland over *Sorghum* spp. open annual tussock grassland and *Triodia wiseana* very open hummock grassland;
- Rc2 – *Melaleuca argentea*, *Eucalyptus camaldulensis* open forest over patches of *Acacia coriacea* high shrubland over *Cenchrus* sp. tussock grassland;
- Rc3 – *Eucalyptus camaldulensis* woodland over patches of *Melaleuca glomerata* high shrubland over patches of *Cyperus vaginatus* sedgeland;
- Rc4 – *Eucalyptus victrix* and *E. camaldulensis* woodland over patches of *Melaleuca glomerata* high shrubland over *Cenchrus* sp. tussock grassland; and
- Rf1 – *Eucalyptus victrix* open woodland over *Cenchrus* spp. tussock grassland.

4.8 Mangroves

The distribution of mangrove habitat along the Pilbara coast is restricted to sheltered areas such as estuaries, tidal creek and sheltered embayments. Mangrove areas are recognised as being important for feeding grounds and fish nurseries as well as protecting coastal areas from erosion by stabilising sediments. Due to high groundwater and soil salinities the mangroves along the Pilbara coastline are characterised by smaller tree size, relatively lower productivity and less species diversity than mangroves found in the wet tropical areas of northern Australia.

A well-developed and structurally complex mangrove system is associated with the major tidal creek and connective tidal flats that join Cape Preston with the mainland. Other areas of mangroves occur in the wider locality, including a generally narrow zone of *Avicennia marina* which borders the western shoreline and embayments between the creek and the mouth of the Fortescue River. During preparation of the Austeel PER (Halpern Glick Maunsell 2000), the mangroves in the Balmoral South Project area were mapped from aerial photography in combination with a field survey to ground truth assemblages.
The local occurrence of mangrove species and assemblages within the creek system exhibited similar patterns to those observed elsewhere in the region in relation to species distribution, local geomorphology and substrate. The most abundant and widespread species were *Avicennia marina* (dominant or codominant in most assemblages in the study area) and *Rhizophora stylosa* (which formed dense monospecific assemblages). The occurrence of *Aegialitis annulata* and *Aegiceras corniculatum* was strongly related to newly formed islands, accretionary creek banks or other zones of recent deposition. In the most seaward sections of the creek system, the substrates were sandy and rocky and the mangroves occurred here as a relatively narrow fringe. Further into the creek system, mangal development becomes more structurally complex and species richness increased particularly on the connective tidal land that bridges Cape Preston and the mainland (Halpern Glick Maunsell 2000).

Landward of the mangrove zone, expansive areas of high tidal mudflats extend to the hinterland terrestrial vegetation. While the majority of the high tidal flats are devoid of vegetation, areas of cyanobacterial (algal) mats occur on the mudflat surface.

*Figure 4-12: Mangrove Assemblages for Cape Preston* shows the mangrove assemblages that were determined on the basis of species composition, vegetation structure and physiognomy, substrate and geomorphology. Alignments of both the eastern and western service corridors are also shown in Figure 4-12.
Section 4

Existing Environment

Figure 4-12: Mangrove Assemblages for Cape Preston
Section 4
Existing Environment

4.9 Terrestrial Fauna

A detailed fauna assessment, conducted in accordance with EPAWA Guidance Statement No. 56, is presented in Appendix C.

In 2003, the Hamersley – Pilbara region was identified as one of 15 biodiversity hotspots of Australia. The Hamersley – Pilbara hotspot provides habitat for a number of threatened, endemic and fire sensitive species and communities (DEWHA 2007) and provides protected habitats for Threatened and Priority fauna species such as the Ghost Bat (Macroderma gigas), Mulgara (Dasycercus cristicauda) and Spectacled Hare – wallaby (Lagorchestes conspicillatus leichardti).

On a finer scale the Roebourne Sub Region of the Pilbara IBRA Region is known to support nine fauna species that are afforded protection under the EPBC Act. In addition, three specially protected fauna are also reported to occur within the sub region and the offshore islands have known values in relation to landscape, ecosystems, species and genetic values (Kendrick and Stanley 2001).

The large coastal plain and inland ranges of the Pilbara Region support an extensive sheep and cattle grazing industry. The effects of past over-grazing are exacerbated by the total grazing pressure of current stock and introduced species, contributing to land degradation (DEWHA 2007).

Fauna values of the project area have been developed from field surveys and desktop studies. A previous fauna survey of the general project area was conducted for the Central Block Project including the mine, plant, tailings and waste dump sites, as well as the conveyor corridor and port facilities (Halpern Glick Maunsell 2001). A second fauna survey of the general project area was conducted in September 2008. The species recorded in these surveys are considered to be indicative of the fauna diversity of the Balmoral South Project area. All major fauna habitat types occurring in the Project area were surveyed.

Locations of Fauna survey sites can be found in Figures 5.01-5.14 - Vegetation Community Maps within Appendix E of Maunsell document Cape Preston Mining Estate Consolidated Vegetation, Flora and Fauna Assessment (Appendix C to this report).

Fauna values of the project area have been developed from field surveys and desktop studies. An initial fauna survey of the general project area was conducted for the Central Block Project including the mine, plant, tailings and waste dump sites, as well as the conveyor corridor and port facilities (Halpern Glick Maunsell 2001). A second fauna survey of the general project area was conducted in September 2008 (Phoenix 2008). The species recorded in these surveys are considered to be indicative of the fauna diversity of the Balmoral South Project area. All major fauna habitat types occurring in the project area were surveyed.

The vertebrate fauna of the project area is dominated by avifauna (birds) and reptiles. Several species of mammal are also common, predominantly consisting of small species such as native mice. Migratory shorebirds and other marine avifauna are discussed in Section 4.12.3.

4.9.1 Priority and Schedule listed Fauna Species

Ten species of conservation significance are reported by DEC database searches to occur in the area. Only the Bustard (Ardeotis australis) was recorded within the project area during the 2000, 2006 and 2008 field surveys.

Schedule 1

- Dasycercus cristicauda (Mulgara). This species was not recorded during the 2000, 2006 or 2008 field surveys. It has been recorded approximately 300 km east of the Project area.

- Pezoporus occidentalis (Night Parrot). This species was not recorded during the 2000, 2006 or 2006 field survey. A search of the DEC Rare Fauna database noted “A record occurs approximately 12km south of the search areas south west corner” (Maunsell Australia 2006).
Later verification of this against the records held by the Western Australian Museum has shown this to be in error. The nearest sighting of a Night Parrot is 120km south of the Project area.

Schedule 4

- *Falco peregrines* (Peregrine Falcon). This species was not recorded in any of the fauna surveys. This species may hunt, but is not likely to nest, in the general Project area.

Priority 1

- *Mormopterus loriae cobourgiana* (Little North-Western Mastiff Bat). This species occurs along the north-west coast and is known to roost in mangroves. This species was not recorded during the opportunistic 2006 field survey. It was recorded in 2000 and 2008 in the mangrove vegetation community at Cape Preston, outside of the Balmoral South project area. The species is restricted to mangrove forests and adjacent areas (Churchill 1998).

Priority 3

- *Lagorchestes conspicillatus leichardti* (Spectacled Hair Wallaby). This species was not recorded during the 2000, 2006 or 2008 field surveys. It is known to have declined from many parts of its previous distribution and is susceptible to predation by introduced carnivores.

Priority 4

- *Leggadina lakedownensis* (Lakeland Downs Mouse, Kerakenga). This species was recorded in the general Project area in the 2000 field survey from cracking clay habitat and low hills. It was not recorded during the 2006 or 2008 field surveys. Halpern Glick Maunsell (2001), suggest that the preferred habitat of this species may be cracking clays, which are wide-spread throughout the Project area. It is expected that this species will occur in the project area.

- *Pseudomys chapmani* (Western Pebble Mound Mouse). This species was not recorded during the 2006 field survey. It is known to inhabit low slopes and rocky hills. A single active mound was observed at Mardie during the 2000 survey; however, despite searching the small area of potentially suitable habitat (stony slopes and rises) no evidence of this species was encountered in the project area.

- *Ardeotis australis* (Bustard). This species was recorded in 2006 at four locations in the Project area, including sites along the Fortescue River. It was also observed outside of the survey area in the general location of the Balmoral shearing shed.

- *Burhinus grallarius* (Bush Stone Curlew). This species was not recorded during the 2006 survey. It was recorded along the North West Coastal Highway in 2000.

- *Numenius madagascariensis* (Eastern Curlew). This species was not recorded during the 2006 and 2008 field surveys in the general Project area along the mud flats west and north of the Balmoral South Project Area.

### 4.9.2 Nationally Significant Threatened Species

A search of the EPBC database revealed that the following nationally significant threatened species may occur within or near the project area. These species have not been recorded to date from field surveys of the project area:

- *Macronectes giganteus* (Southern Giant-Petrel) – Endangered. This species would rarely occur as far north as Cape Preston.
Section 4

Existing Environment

- *Dasycercus cristicauda* (Mulgara) – Schedule 1, Vulnerable. Occurs within drainage lines near sandy plains and dunes;

- *Rhinonicteris aurantius* (Pilbara form) (Pilbara Leaf-Nosed Bat) – Vulnerable. Occurs within caves and abandoned mines. The closest record of the species to the study area is a single roadkill, made near the Fortescue River Roadhouse in 1990. A targeted survey undertaken in 2001 throughout the Pilbara Region did not yield any results at Fortescue Roadhouse (Armstrong, 2001);

- *Morelia olivacea barroni* (Olive Python) – Vulnerable. Occurs within drainage lines of the Fortescue River System. Targeted searches were conducted for this species in the 2008 field survey. Little evidence was found to suggest that Pilbara Olive Python occurs within the Project area during the 2008 fauna survey (Phoenix Environmental Services 2008a); there are virtually no permanent water bodies adjacent to suitable habitat within the Project area. One permanent artificial pool was observed, however this water body is not considered to have been present long enough to have supported local colonisation by the species; and,

- *Petrogale lateralis lateralis* (Black-flanked Rock-wallaby) – Vulnerable. Existing populations of this subspecies are scattered in small distributions throughout Western Australia, with one population occurring east of the Fortescue River Roadhouse (Pearson and Kinnear, 1997). The species is unlikely to be present in the Project area as there are no major rock face or cliff formations.

The EPBC database search revealed that four nationally significant migratory terrestrial bird species may also occur within the project area. These are the Rainbow Bee-eater (*Merops ornatus*), the White Bellied Sea Eagle (*Haliaeetus leucogaster*), the Barn Swallow (*Hirundo rustica*), and the Fork Tailed Swift (*Apus pacificus*):

- The Rainbow Bee-eater has been observed in the project area, mostly along river and creek lines. It prefers to excavate burrows for breeding and they are described as quite common in the region (Flegg 2002). As the project does not directly impact significantly on rivers and streams, the potential for impacts on this species is considered minimal;

- Simpson and Day (1999) describe the White-bellied Sea-Eagle habitat as being large rivers, lakes, coastal seas and islands. This species is considered widespread but erratic in distribution and rarely common (Flegg 2002). The individual sighted was making opportunistic use of standing water in the Fortescue River. As this is outside the project’s direct area of influence, it is considered unlikely that the project will have any impact on this species; and

- The Barn Swallow and Fork Tailed Swift have not been recorded in the project area.

In general, it has been determined over the course of the 2000 and 2006 field surveys that fauna habitats within the project area are well represented in the region and none are regarded as regionally significant or unique. Of the habitats sampled, rivers and creek lines yielded the highest number of species.

No mammal species of conservation significance were recorded within the Balmoral South Project area during the field surveys. A targeted search of low stony rises failed to identify any signs of the priority species *Pseudomys chapmani* (Western Pebble Mound Mouse) and targeted trapping on cracking clays failed to record *Leggadina lakedownensis* (Lakeland Downs Mouse).
Section 4

Existing Environment

4.10 Subterranean Fauna

Subterranean fauna is a term used to describe animals that spend all, or most of, their life cycle underground and possess morphological adaptations to an underground existence. Most commonly, these are loss of skin pigmentation and eyes (although some animals retain eyes) and a vermiform body shape. There are two kinds of subterranean animals: stygofauna and troglofauna. Stygofauna are aquatic and occur in groundwater. Troglofauna are air-breathing and occur in underground cavities and small fissures above the water table. Nearly all subterranean fauna are invertebrates.

Stygofauna occur throughout the Pilbara and the region is recognised as a global hotspot for stygofauna. About 350 species have been collected and 500-550 species are likely to occur (Eberhard et al. 2008). Many stygofauna have localised distributions but it appears that coastal plain alluvium supports a rich fauna comprised mostly of species that are relatively widespread: they occur across much of a river catchment or across several catchments (Halse et al. in prep.).

Troglofauna have only recently become a focus of environmental assessment and there is relatively little information about their distribution in the Pilbara, although they are known to occur along the coast and in the eastern Pilbara as well as at Cape Range and Barrow Island.

Subterranean fauna survey was undertaken at Balmoral South in the context of a substantial amount of work having already been done in relation to mining of the Central Block. The proposed pit at Balmoral South is less than 3 km from the Central Block and there is continuous Brockman Iron Formation habitat between the two areas surveyed.

The lateral continuity of lithostratigraphic detail within the Brockman Iron and Dales Gorge members within the Hamersley Basin is unparalleled in the sediments of any other recorded depositional basin of any age. Studies in the Hamersley Basin have found that the same stratigraphic lateral continuity extends from Mount Newman in the east to Point James in the west, and from Wittenoom in the north to Paraburdoo in the south, as well as being evident at many intervening points (Blockley, 2008). Therefore, given the close proximity of the Central Block and Balmoral South deposits, they are considered to be a single habitat from the viewpoint of subterranean fauna.

During the environmental approval process for the Central Block, 46 bores were sampled twice for stygofauna in March and October 2001 (i.e. 92 samples) (Halpern Glick Maunsell 2002). Stygofauna sampling continued around the Central Block with an additional 40 stygofauna samples being collected in May and June 2007.

Subterranean fauna sampling at the Balmoral South Project and further sampling at the Central Block Project began in mid 2007. The number of stygofauna samples collected from the Balmoral South impact zone (22) is less than suggested by the EPAWA (2007a) for a site rich in stygofauna, however, it has been demonstrated that the Balmoral South Project area is not rich in stygofauna. Sufficient stygofauna samples have been collected from Balmoral South Project for adequate characterisation of the stygofauna community and environmental assessment of the project (refer Figure 4-13: Locations of Bores Where Stygofauna were Collected in the Vicinity of Cape Preston).
Section 4

Existing Environment

Figure 4-13: Locations of Bores Where Stygofauna were Collected in the Vicinity of Cape Preston
Results of sampling at the Central Block and in the surrounding alluvium were used to examine the wider distribution of the subterranean fauna species found at Balmoral South and, more particularly, the communities to which they belong.

Only 15 stygofauna species were present at Balmoral South and all were recorded elsewhere in the Cape Preston area beyond the zone of impact (Table 4-3: Stygofauna Collected at Both Balmoral South and the Cape Preston Area Since 2007). At least 54 species of stygofauna have been identified from the broader Cape Preston region (Eberhard et al. 2008) and the community at Balmoral South appears to comprise a subset of this broader community. The Balmoral South community contained copepods (6 species), ostracods (3), amphipods (2), thermosbaenacids (1), worms (1), mites (1) and nematods (1). The community of the broader Cape Preston area was dominated by copepods (12 species), ostracods (11), worms (11), amphipods (7) and single species of seven other groups.

**Table 4-3: Stygofauna Collected at Both Balmoral South and the Cape Preston Area Since 2007**

<table>
<thead>
<tr>
<th>Species</th>
<th>No. of Records of Each Species at Balmoral South</th>
<th>No. of Records of Each Species at Cape Preston</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nematod</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Nematoda sp.</em></td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Worm</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Enchytraeidae</em></td>
<td>1</td>
<td>1 (also collected in 2001)</td>
</tr>
<tr>
<td>Mite</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Acarifomes</em></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Seed shrimp</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Humphreyscandona fovea</em></td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td><em>Humphreyscandona woutersi</em></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><em>Areacandona fortescueiensis</em></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Copepod</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Stygoridgewayia trispinosa</em></td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td><em>Halicyclops roachi</em></td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td><em>Diacyclops humpreysi humpreysi</em></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><em>Diacyclops humpreysi X unispinosa</em></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><em>Stygonitrocella unispinosa</em></td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><em>Parastenocaris jane</em></td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Thermosbaenacid</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Halosbaena tulki</em></td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Scud</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Nedsia sp</em></td>
<td>3</td>
<td>2 (20 occurrences of named Nedsia species)</td>
</tr>
<tr>
<td>Bogidiellidae sp.</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>
Section 4

Existing Environment

The number of troglofauna samples collected from the Balmoral South impact zone (60) meets the recommendations of the EPAWA (2007a). Sufficient troglofauna samples have been collected for adequate characterisation of the Balmoral South troglofauna community.

Nine species of troglofauna were collected at Balmoral South and six of them occurred at the Central Block where at least 19 species of troglofauna occur (Table 4-4: Troglofauna Collected from Central Block and Balmoral South). Current knowledge suggests the Cape Preston area, best represented at the Central Block, supports a rich troglofaunal community. Cryptos sp B2 (nr australis) appears to be the same species as recorded in surface leaf litter at Cape Preston (Appendix D). The only species found at Balmoral South but yet to be found elsewhere are the millipede Polyxenida sp. B1 and silverfish Trinemura sp. B1 (nr troglophila). Polyxenida millipedes occur across the Pilbara with little morphological differentiation, so the status of the Balmoral South animal is uncertain. Trinemura sp. B1 (nr troglophila) is closely related to Trinemura troglophila from Cape Range but the status of the single animal collected is uncertain.

Table 4-4: Troglofauna Collected from Central Block and Balmoral South

<table>
<thead>
<tr>
<th>Species</th>
<th>Balmoral South</th>
<th>Central Block</th>
<th>Species</th>
<th>Balmoral South</th>
<th>Central Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schizomoid</td>
<td></td>
<td></td>
<td>Centipede</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Draculoides sp B1</td>
<td>4</td>
<td>15</td>
<td>Chilopoda sp</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Slater</td>
<td></td>
<td></td>
<td>Cryptos sp B1 (nr spinifer)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Haloniscus sp B1</td>
<td>2</td>
<td>3</td>
<td>Cryptos sp B2 (nr australis)</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Philosciidae sp B1</td>
<td>0</td>
<td>3</td>
<td>Geophilomorpha sp</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Isopoda sp</td>
<td>0</td>
<td>2</td>
<td>Silverfish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bristle-tail</td>
<td></td>
<td></td>
<td>Atelurinae sp</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Parajapygidae sp B1</td>
<td>0</td>
<td>3</td>
<td>Atelurinae sp B1</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Japygidae sp</td>
<td>0</td>
<td>1</td>
<td>Atelurinae sp B2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Japygidae sp B1</td>
<td>0</td>
<td>2</td>
<td>Hemitrinemura sp B1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Japygidae sp B2</td>
<td>0</td>
<td>1</td>
<td>Trinemura sp B1 (nr troglophila)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Japygidae sp B3</td>
<td>0</td>
<td>1</td>
<td>Beetles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campodeidae sp B1</td>
<td>0</td>
<td>2</td>
<td>Curculionidae sp B3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Pseudoscorpion</td>
<td>2</td>
<td>2</td>
<td>Coleoptera sp B1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Pseudoscorpionida sp B2</td>
<td>2</td>
<td>2</td>
<td>Millipede</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Polyxenida sp B1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

The sampling to date suggests that Balmoral South contains a subset of the troglofauna community occurring in the Cape Preston area. Sufficient troglofauna species have been collected from Balmoral South Project to show the basic taxonomic structure of the troglofauna community. It appears likely, based on the distribution of the more frequently occurring troglofauna and the lack of major geological discontinuities between the mining areas, that the same troglofauna community extends through all orebodies at Cape Preston (see Nr Draculoides sp. B1 and Pseudoscorpionida sp. B2 in Figure 4-14: Bores in the Cape Preston Area Where Troglofauna Occurring at Balmoral South Were Recorded., Other species show same patterns.
4.11 Short Range Endemics (SREs)

Short Range Endemics (SRE) are fauna that display restricted geographic distributions that may be disjunct and highly localised (nominally defined as < 10km²). The most appropriate analogy is that of an island, where the movement of fauna is restricted by the surrounding marine waters, thus isolating the fauna from other terrestrial island populations.

Within the Pilbara the following taxonomic groups are known to contain SRE's:

- trap-door spiders (Mygalomorphae);
- non-marine snails (Mollusca);
- millipedes (Diplopoda);
- centipedes (Chilopoda);
- scorpions; and
- pseudoscorpions.
Section 4

Existing Environment

There are a number of processes that may threaten SRE fauna and their isolated habitats and thus may threaten their long term survival in a given area / habitat. The EPBC Act and the Australian Biological Resource Assessment (2002) list a number of processes that are relevant to SREs in general and in the context of the study area:

- land clearance;
- grazing: much of the site is already degraded. Buffel Grass (*Cenchrus ciliaris*) and Bidens (*Bidens pilosa*) are found along most drainage courses and the infestation of Mesquite is one of the worst in the Pilbara;
- changed fire regimes: an altered fire regime may act to promote the premature ‘drying’ of mesic refuge habitats for SREs; and
- changed hydrology such as altered flow regimes affecting riparian vegetation.

The Project Area contains few disjunct habitats which typically give rise to short range endemism and the floristic condition of the area is generally poor due to its long history of cattle grazing (which has led to infestation of Mesquite and the widespread presence of Buffel Grass and Bidens particularly along the minor and major drainage systems).

Specific SRE surveys have been conducted in August and September 2008 within and external to the proposed areas of impact. The reference sites identified were generally considered to have a greater potential to facilitate short range endemism than the sites within the study area. Final site selection was determined on commencement of the initial field survey, following site verification. A total of 50 sites were surveyed across the Cape Preston Precinct and adjacent reference sites (Figure 4-15 to Figure 4-19)

A total of six families known to include SRE taxa were identified during the survey. These families were represented by nine genera and 19 species. The results exclude data for the land snails, as taxonomic work is incomplete at the time of writing.

Of the 19 species identified, only three of these are considered likely to be SRE. Two of these three species were found outside of the area of impact of the Project. The third species *Synothele pseudoidiomata*, whilst identified within the impact area of the Project, has also been identified in separate survey to have a wider distribution, and so classification as an SRE is tentative (Phoenix,2009) (Appendix L)
Section 4

Existing Environment

Figure 4-15: SRE Survey Sites Locations within the Cape Preston Iron Ore Mining Precinct
Section 4

Existing Environment

Figure 4-16: Mygalomorphae and Araneomorphae Species Locations Recorded During the Survey of the Cape Preston Iron Ore Mining Precinct
Section 4

Existing Environment

Figure 4-17: Pseudoscorpions Locations Recorded During the Survey of the Cape Preston Iron Ore Mining Precinct
Figure 4-18: Buthidae Scorpion Species Locations Recorded During the Survey of the Cape Preston Iron Ore Mining Precinct
Figure 4-19: Buddelundia Isopod Species Locations Recorded During the Survey of the Cape Preston Iron Ore Mining Precinct
Section 4

Existing Environment

4.12 Marine Environment

A detailed description of the marine environment is presented in Appendix F (URS 2008).

4.12.1 Physical Processes

Bathymetry

The bathymetry of the region has extensive intertidal areas particularly to the south and southeast of Cape Preston and a shallow nearshore platform extends to the southwest of the Cape (Figure 4-20: Cape Preston Bathymetry). This platform to the east of Cape Preston is very shallow and drains Regnard Bay. It contains two small islands (SW and NE Regnard) and shoals.

To the west of Cape Preston lies a shallow embayment known as Fortescue Roads. The Fortescue River discharges at the base of this embayment, 23 km to the south-west of Cape Preston, and is the closest river to the Cape. Both the Maitland and the Fortescue Rivers drain large areas of hinterland, but only flow occasionally in response to cyclonic downpours over the hinterland. On such occasions they discharge large volumes of fresh and highly turbid silty waters to the nearshore environment. Fortescue Roads drains northward into a large basin where water depths extend to -16 m CD (16 metres below Chart Datum).

Preston Island is located approximately 1.2 km to the north-west of Cape Preston near the tip of a shallow nearshore platform. At low spring tide it is barely separated from the mainland by very shallow water (<1 m CD). The seabed is relatively shallow (< 8 m CD) south-west of Preston Island, however, immediately north to north west of the island (~300 m offshore) the seabed drops rapidly to over 13 m CD, and deep navigable waters (>20 m) occur some 11 km to the north (URS 2007).
Section 4

Existing Environment

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Figure 4-20: Cape Preston Bathymetry
Section 4

Existing Environment

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Section 4

Existing Environment

Tidal Water Levels

Water levels have been monitored at Cape Preston since October 2006 (GEMS 2008). Cape Preston experiences semi-diurnal tides, with a lowest to highest astronomical tidal range of 4.75 m (Table 4-5: Tidal Planes at Cape Preston).

Table 4-5: Tidal Planes at Cape Preston

<table>
<thead>
<tr>
<th>Reference Level</th>
<th>Cape Preston (to the nearest 0.05 m)</th>
<th>Dampier (to the nearest 0.1 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAT (Highest Astronomical Tide)</td>
<td>2.35</td>
<td>2.5</td>
</tr>
<tr>
<td>MHWS (Mean High Water Springs)</td>
<td>1.75</td>
<td>1.8</td>
</tr>
<tr>
<td>MHWN (Mean High Water Neaps)</td>
<td>0.50</td>
<td>0.5</td>
</tr>
<tr>
<td>MSL (Mean Sea Level)</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>MLWN (Mean Low Water Neaps)</td>
<td>-0.50</td>
<td>-0.5</td>
</tr>
<tr>
<td>MLWS (Mean Low Water Springs)</td>
<td>-1.65</td>
<td>-1.9</td>
</tr>
<tr>
<td>LAT (Lowest Astronomical Tide)</td>
<td>-2.40</td>
<td>-2.6</td>
</tr>
</tbody>
</table>

Currents

The dominant influence on the circulation in the waters off Cape Preston is the North West Shelf tides and the regional winds. Water movements in the region during spring tides are more influenced by tidal currents than local wind conditions. Surface current velocities during spring tides can reach 0.75 m/s (1.5 knots) whereas during neap tides the peak current velocities are typically 0.25 m/s (0.5 knots).

The combination of relatively strong tidal currents, episodically strong winds producing wave action and surface currents, and the relatively shallow bathymetry around Cape Preston limit the opportunity for stratified layers to develop (GEMS 2008).

The majority of the flood tide reaches Cape Preston from the open ocean by going around the Montebello Islands and then flowing southwards towards the coast. When the flood tide reaches Cape Preston it splits around the Cape with flow occurring to the south-west and to the south-east along the coast. The ebb tide generally reaches the open ocean by flowing north to north-west around the Montebello Islands.

The dominant mixing and dispersion mechanism off Cape Preston is the strong and varying tidal currents and the episodic influence of strong surface winds.

The dominant flushing mechanism is the ebb tide which generally flows north-north-west from the site. The analysis of the Acoustic Doppler Current Profiler (ADCP) data (GEMS 2008) also highlights a relatively strong residual current to the north-east driven by the south-westerly winds and the ebb tide.

Wave Climate and Coastal Processes

Cape Preston is exposed to a relatively mild ambient wave climate, typically less than 1 m significant wave height, which is predominantly from the west-northwest during the warm season and from the north to east during the cool season. The effect of tropical cyclones is episodic, with the capacity to produce waves from any offshore direction depending on the path of the system. The most severe Metocean (data) conditions are produced by cyclones located approximately 20 to 60 km west of Cape Preston, causing extreme wave and surge conditions. These conditions have derived from hindcast models which indicate a significant wave height of up to 6.3 m and a 4.5 m surge with a 1 in 100 year average recurrence interval (GEMS 2008).
Section 4

Existing Environment

Active sediment transport patterns have been inferred on the basis of the present coastal morphology, historic aerial imagery and interpretation of available metocean data. The regional structure suggests a net movement of sediment towards Cape Preston, notably with supply from the Fortescue River during cyclonic flooding. This material accumulates on the western side of the Cape, as a series of low profile dunes, Preston Spit (Figure 4-21: Cape Preston Geomorphic Components) and a complex structure of shoals across the extensive rock platform. Under ambient summer conditions, there is a general low volume northward sediment transport along the outer edge of the shoals, which is reversed under northerly conditions that occur occasionally throughout the year. Instability of the western beach has been observed over the historic period and is further evidenced by the loss of a mangrove stand on the northern part of the beach. However, it appears likely that this destabilisation is a combination of marine and fluvial sediment transport (GEMS 2008).

Cape Preston and Preston Island are largely bare of sediment, suggesting a limited supply. This reflects an erosive tendency for the Cape, due to its exposure to strong tidal currents and waves. Extensive storm deposits including cobbles and boulders were observed high on the beach face suggesting highly energetic conditions can be experienced during extreme events. The presence of a sandy ‘tail’ on Preston Island on aerial imagery since 1966 suggests that sediment occasionally bypasses the Cape.

The beach to the east of Cape Preston is controlled by rock features, including basalt ridges that act as groynes (northern beach Figure 4-21). These features are fully saturated with sediment on their western side, suggesting a net eastward sediment transport. The beach has remained largely stable within the 40 year history of available aerial photography. The beach on the eastern side (eastern Beach Figure 4-21) of the Cape has also been stable over the historic period, although it exhibits signs of seasonally alternating northward and southward alongshore transport, with net southwards movement. The southern limit of the beach (eastern spit Figure 4-21) is controlled by an eastward running rock platform, which apparently represents the limit of sheltering provided by Cape Preston.
Section 4

Existing Environment

Figure 4-21: Cape Preston Geomorphic Components
4.12.2 Water Quality

Temperature, Salinity, pH and Oxygen

The following paragraph is a summary of information provided by CALM (2005) in relation to the former (proposed) Cape Preston Marine Management Area.

The waters of the area are relatively undisturbed by anthropogenic sources. Near-shore water movements and mixing patterns in the Dampier Archipelago / Cape Preston region are driven primarily by large tidal ranges, local currents and winds, but are also influenced by seabed topography and the steering effect of islands and reefs. Sea-surface temperatures within the Dampier Archipelago range from about 18º C in winter to 31.5º C in summer, with near-shore waters having a greater seasonal temperature range than the offshore waters. The smallest range and lowest salinities (35.1 to 36.1 ppt) occur offshore at the 20 m contour, and the largest range and highest salinities (35.45 to 37.1 ppt) occur inshore within 2 km of the Burrup Peninsula. Salinity and temperature differences between the near-shore and mid-shelf regions are expected to drive gentle cross-shelf circulation in the region.

Monitoring data collected by URS in 2007 at two locations near-shore to Cape Preston identified that waters are generally supersaturated with Dissolved Oxygen (>100%) and pH values are high (>8.1).

Turbidity and Total Suspended Solids

Turbidity in the region is generally high, due to the episodic high volume river flows, dominant marine sediment types, strong local winds, large tides and common occurrences of cyanobacterial blooms (Trichodesmium sp.). Turbidity is typically higher in the shallow near-shore areas than in the deeper sites further offshore, and can vary considerably on a spatial scale due to localised re-suspension of sediments temporally over hours and days depending on wind and tide.

Turbidity data collected by URS ranged from 0 to 23 NTU (Nephelometric Turbidity Units). The high turbidity readings (>20 NTU) are believed to be associated with an algal bloom event and not caused by a change in tide, water depth, sediment structure, wind and current situations or river inflow. The latter are the observed physical causes responsible for significant changes in turbidity on a spatial and temporal scale.

TSS data obtained by URS during 2007 and 2008 indicate that ambient concentrations range between 2 mg/L and 10 mg/L.

TSS and turbidity can change significantly throughout cyclonic events. As no cyclone approached the area during the time of investigation no data is available for such an event.

Nutrients and Trace Elements

Nutrient concentrations obtained by Halpern Glick Maunsell (2002) were all found to be slightly above ANZECC & ARMCANZ (2000) guideline values. This finding supports the assumption that the project area is biologically productive.

Regional studies undertaken by the DEC identified that Pilbara waters generally had very low concentrations of metals. Localised elevations were identified adjacent to industrial centres and ports.

Samples collected by URS in 2008 (Table 4-6: Dissolved Metal Concentrations in the Vicinity of the Brine Outfall Site) showed results similar to those reported by DEC. With the exception of two elements (lead and boron) all samples were below recommended ANZECC & ARMCANZ (2000) guideline values for 99% species protection (very high level of protection) or below laboratory detection limits.
Table 4-6: Dissolved Metal Concentrations in the Vicinity of the Brine Outfall Site

<table>
<thead>
<tr>
<th></th>
<th>Mean (n=3) surface metal concentrations (mg/l)</th>
<th>Mean (n=3) bottom metal concentrations (mg/l)</th>
<th>ANZECC Guideline (mg/l) 99% species protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>0.005</td>
<td>&lt;0.005</td>
<td>0.0005*</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.0016</td>
<td>0.0016</td>
<td>N/A</td>
</tr>
<tr>
<td>Beryllium</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>N/A</td>
</tr>
<tr>
<td>Cadmium</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.0007</td>
</tr>
<tr>
<td>Chromium</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>N/A</td>
</tr>
<tr>
<td>Copper</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.0003</td>
</tr>
<tr>
<td>Lead</td>
<td>0.008</td>
<td>&lt;0.001</td>
<td>0.0022</td>
</tr>
<tr>
<td>Manganese</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.08*</td>
</tr>
<tr>
<td>Nickel</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.007</td>
</tr>
<tr>
<td>Zinc</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.007</td>
</tr>
<tr>
<td>Iron</td>
<td>&lt;0.005</td>
<td>&lt;0.005</td>
<td>N/A</td>
</tr>
<tr>
<td>Bromide</td>
<td>94.3</td>
<td>82</td>
<td>N/A</td>
</tr>
<tr>
<td>Barium</td>
<td>0.007</td>
<td>0.007</td>
<td>N/A</td>
</tr>
<tr>
<td>Strontium</td>
<td>6.53</td>
<td>7.56</td>
<td>N/A</td>
</tr>
<tr>
<td>Boron</td>
<td>5.63</td>
<td>5.6</td>
<td>5.1*</td>
</tr>
<tr>
<td>Mercury</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

*Low reliability trigger value

Guideline below laboratory detection limits

Exceedance of guideline

Sediment Quality

Surface marine sediments obtained in 2002 and in 2004 (Maunsell Australia 2006b) were analysed for metals, nutrients, organic and calcium carbonate percentage, tributyltin (TBT), hydrocarbons and particle size. Sediments were found to have inorganic contents ranging from approximately 4% to 40%. Calcium carbonate ranged from 15% to 40%. Arsenic levels were found to be above ANZECC trigger values (also found in tissues of carnivorous fish from the area). TBT and hydrocarbons were all below detection limits.

4.12.3 Marine Biota and Benthic Habitats

Macroscale Biogeography

Cape Preston is situated in the northern Australian tropical zone. The zone is continuous with the vast Indo-West Pacific biotic province that extends from about 30°N to 30°S of the equator and from the east coast of Africa across the entire tropical portions of the Indian and Pacific Oceans to Hawaii. A few species extend even to the west coasts of central and South America (Wilson & Allen 1987).

Most marine invertebrates and fish have planktonic larvae that live in the water column for periods ranging from a few days to a year or more. This is a distributional phase in the life cycle during which the larvae are moved about by currents and wave action. Even species that lack a planktonic distributional phase in their life cycle are able to move considerable distances by rafting on logs, Sargassum mats, etc.
Similarly, marine and intertidal plants such as seagrasses and mangroves are able to move over time over considerable distances by dispersal of seeds or propagules by tides and ocean currents. Hence the seagrass species that occur along the Pilbara coast have, in general, a widespread distribution around the northern coast of Australia and adjacent tropical waters. However, community structure and composition of seagrasses can vary considerably depending on regional and local scale conditions.

The net effect of the patterns of marine biogeography is that species of marine fauna and flora in the Cape Preston area are generally distributed for thousands of kilometres along the northern Australian coastline, and into countries to the north such as Indonesia, Papua New Guinea and the Philippines (Wells 1990). Some species occur widely across the entire Indo-West Pacific. Relatively few species have restricted ranges, and those that do are on the scale of tens or hundreds of kilometres.

**Mesoscale Regionalisation**

At the Mesoscale (IMCRA 1998), i.e. broad regional ecosystem scale (region areas extending between 3,000km² and 240,000km²) the project occurs within the Pilbara Offshore and Pilbara Nearshore regions. Pilbara Nearshore, with an area of 13,861 km², covers the waters between the shoreline and 10 m depth contour and extends from North West Cape to Cape Keraudren. The intertidal and shallow subtidal habitats is described as supporting a high diversity of infauna on mudflats and sandflats associated with fringing mangals in bays and lagoons. The water is highly turbid with a large tidal range. Fringing coral reefs occur around some of the islands. Pilbara Offshore, with an area of 41,491 km², comprises waters seaward of the 10 m depth contour between North West Cape and Cape Keraudren. The water is less turbid than in the nearshore region and there are significant differences in marine ecosystems. It includes coral reef ecosystems with Indonesian and Pacific affinities.

Cape Preston occurs roughly in the middle of these broad regional ecosystem types.

**Benthic Habitats**

*Figure 4-22: Cape Preston Benthic Habitats* presents the distribution of marine habitats in the vicinity of Cape Preston.

Dense areas of high coral cover are sparsely distributed in the region, whilst areas of low coral cover tend to occur as a thin border along steep slopes that descend from shallow algae dominated pavements around islands to a deep sandy seafloor. The nearest major reefs to Cape Preston which support high live coral cover are located as follows:

- approximately 3 - 5 km to the southwest of Cape Preston;
- 4 km to the east-northeast of Cape Preston on the southeast end of SW Regnard Island; and
- 5 km east of Cape Preston.

These reefs support >50% and in parts up to 100% live coral cover and are comprised primarily of large colonies of massive species such as *Porites*, *Favites*, *Lobophylia* and *Goniastera*. These reefs are obviously old and have survived many cyclones although evidence of cyclone damage is abundant.
Section 4

Existing Environment

Figure 4-22: Cape Preston Benthic Habitats
Marine Flora

The Indicative Management Plan for the Proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area (CALM 2005) describes the marine flora of the region as follows:

“Within the Cape Preston area, macroalgae (seaweeds) dominate submerged limestone reefs and also grow on stable rubble and boulder surfaces. These communities are most commonly found on shallow limestone pavement in depths less than 10 m. Brown algae are the most abundant group of algae in the region with Sargassum sp., Dictyopteris sp. and Padina sp. being the dominant species. The most common green algae are the articulate coralline Halimeda sp, while prominent red algal species include crustose corallines, non-coralines and algal turf. Seagrass occurs in the larger bays and sheltered flats of the region. Six species of seagrass are present on the subtidal soft sediment habitats, these being Cymodocea angustata, Halophila ovalis, Halophila spinulosa, Halodule uninervis, Thalassia hemprichii and Syringodium isoetifolium. Seagrasses do not form extensive meadows within the proposed reserves, but rather form interspersed seagrass/macroalgae beds. The most significant areas of seagrass are found between Keast and Legendre islands and between West Intercourse Island and Cape Preston. Macroalgae and seagrasses are important primary producers, trapping light energy from the sun and making it available to the ecosystem. They also provide important habitats for molluscs, sea urchins, sea stars, sea cucumbers, crabs and fishes. Marine turtles feed on algae and seagrass, and the ephemeral seagrass typically found in the area is likely to be the preferred food source for the resident dugong population.”

Benthic Marine Fauna

Fauna of the shallow water limestone reefs and platforms include hard and soft corals, sponges, ascidians, fan worms, molluscs (octopus, gastropods [snails], and bivalves), crustaceans (crabs, rock lobsters), urchins and seastars.

Fifty species of hard coral representing 11 families have been reported off Cape Preston (Campey & Gilmour 2000). This compares with 229 species reported from the Dampier Archipelago (Griffith 2004). All species reported by Campey and Gilmour (2000) have been reported from the Dampier Archipelago and other areas of Australia. The dominant families, in terms of species recorded, include Acroporidae, Poritidae and Faviidae. Taxa, such as Turbinaria, Caulastrea and Euphyllia, which are typically associated with turbid nearshore water (Veron & Marsh 1988), were also present at Cape Preston. As with many nearshore areas fringing the Pilbara coast, most of the coral assemblages at Cape Preston do not form true coral reefs because erosion exceeds accretion. Instead, corals form assemblages on rock pavement without contributing greatly to the substratum. However there are some true coral reefs at Cape Preston where living coral cover is very high and based on dead coral substratum.

Veron and Marsh (1988) identified 18 broad coral localities in Western Australia. The coral reefs off Cape Preston form part of the location referred to by Veron and Marsh (1988) as the Dampier Archipelago. All coral species recorded in the Dampier Archipelago and most in Western Australian waters are not endemic, rather they are found throughout tropical Australia and, in many cases, more widely throughout the Indo-Pacific region. The wide distribution of most Western Australian scleractinian corals suggest that dispersal mechanisms, availability of suitable colonising substrate, and exposure to wave energy have major influences on coral species composition and distribution along the Western Australian coastline.
Section 4

Existing Environment

Marine Turtles

Pendoley Environment (2006) conducted a review of turtle habitat usage reports for the Cape Preston locality on behalf of URS. Sea state and prevailing weather conditions combine to erase evidence of turtle breeding activities at Cape Preston consequently surveys had to rely mostly on live sightings rather than remaining signs as used in surveys elsewhere. Available survey information obtained during three separate seasons indicates that the beaches of Cape Preston are utilised for a very limited amount of turtle breeding activity. The results suggest the northern end of the western beach is a nesting area for hawksbill turtles (*Eretmochelys imbricata*), the eastern beaches are used by the green turtle (*Chelonia mydas*) and south western beaches by flatback turtles (*Natator depressus*).

Dugong

In the Dampier Archipelago / Cape Preston region, small numbers of dugongs (*Dugong dugon*) have been sighted in the shallow, warm waters in bays and between islands, including at East Lewis Island, Cape Preston, Regnard Bay, Nickol Bay and west of Keast Island. Current knowledge on the size of the population, distribution, migratory habits and regional and local importance of the Dampier Archipelago / Cape Preston area for dugongs is limited.

The presence of dugongs is dependent on the distribution of tropical and subtropical seagrasses on which they feed (Edmonds et al. 1997). Dugongs are generally associated with shallow seagrass meadows which occur throughout the shallow waters between the offshore islands and the mainland (ChevronTexaco Australia 2005). The dugong diet consists primarily of *Halodule* mixed with *Cymodocea* and *Halophila* seagrass, and feeding generally occurs over seagrass meadows at depths of five to ten metres (ChevronTexaco Australia 2005). They are wholly herbivorous and their seasonal movements and feeding grounds within the north western region are not well understood.

A review of recent literature indicates that moderate concentrations of dugongs were observed in the region between Exmouth Gulf and De Grey River during shoreline surveys in the 1980's, with most animals observed in areas such as Mangrove and Passage Islands, Regnard Bay, Nickol Bay and within the Dampier Archipelago (Prince et al. 1981, Prince 1986). In April 2000, a quantitative aerial survey of this area recorded 2,046 (± s.e. 376) dugongs at an average density of 0.10 dugongs per km$^2$. Most of the dugongs were in the locations identified from the earlier surveys and incidental reports of sightings or strandings (Prince et al 1995, Marsh et al. 2002).

Dugong feeding trails have been observed in dense seagrass meadows of *Halodule* and *Halophila*, between Middle and North Mangrove Islands (Pendoley & Fitzpatrick 1999). This region has extensive areas of shallow water, extending to the seaward side of Barrow Island and the Monte Bello Islands (Marsh et al. 2002). In surveys of Exmouth Gulf in October and November 2004, the majority (76%) of dugong herds sighted were in shallow (<6m) water (Oceanwise Environmental Scientists 2005). Regional quantitative surveys indicate a minimum population estimate of approximately 1,000 individuals in Exmouth Gulf during winter. Individual dugong have been occasionally sighted off the west coast of Cape Preston and SW Regnard Island during field surveys carried out by URS during December 2006, June 2007, and May 2008 for CPMM’s Sino Iron Project at Cape Preston (LeProvost pers comm.). Further information regarding the status of the dugong population in the region is provided in Appendix F.

Migratory Shorebirds

Migratory shorebirds (or wading birds) utilise Pilbara coastal habitats such as beaches, tidal flats and other intertidal wetlands during the non-breeding season. Breeding occurs following migration to Asian and Pacific countries from the breeding grounds in eastern Russia (i.e. to avoid the northern hemisphere winter). Migratory waders are protected under the *Environment Protection and Biodiversity Conservation Act 1999* in addition to international agreements such as the Japan-Australia Migratory Bird Agreement (JAMBA) and the China - Australia Migratory Bird Agreement (CAMBA).
Section 4

Existing Environment

Shorebird surveys undertaken in the Cape Preston area in February 2001 and October 2002 recorded 16 migratory shorebird species listed under the JAMBA and CAMBA international agreements (Hassell 2002). The highest single count of 680 shorebirds was from the high tide roosting site located along the sandy beach between Preston Spit and the tip of Cape Preston. An EPBC database search identified ten migratory bird species with habitat that may, or is likely to, occur at the project area.

While little is known about shorebird movements along the Pilbara coast, shorebird species are very mobile and the availability of similar habitat to that occurring at Cape Preston is extensive. It is therefore unlikely that the Cape Preston area represents a major wintering location but rather a stopover point for feeding and resting while shorebirds move up and down the coastline (Halpern Glick Maunsell 2000).

Other Fauna

The humpback whale migrates along the Western Australian Coast in winter and early spring. Along parts of the migratory route there are narrow corridors and bottlenecks resulting from physical and other barriers where the majority of the population passes close to shore (i.e. within 30 km of the coastline). These habitat areas are important during the time of migration and in Western Australia include areas around Geraldton/Abrolhos Islands, and Point Cloats to North West Cape. Calving takes place of the Southern Kimberley between Broome and the northern end of Camden Sound and there are resting areas located around Exmouth Gulf, Shark Bay and Geographe Bay (Department of Environment and Heritage 2005). The whales are not known to aggregate in the waters offshore Cape Preston, but it is possible that individuals, as well as small pods of dolphins pass through the area.

It further should be noted that sea snakes have been observed to occur in the proposed area and Wells and Walker (2003) reported the occurrence of six different species in the Dampier Archipelago.

4.13 Social Environment

The population of the Pilbara region was estimated by the Australian Bureau of Statistics at 40,132 people in 2005/2006, making up 2% of the population of Western Australia. The majority of this population resides in the western third of the region.

The Balmoral South Project Area is located within the Shire of Roebourne, which is one of the four local government areas within the Pilbara. The nearest major town centre to the Balmoral South Project Area is Karratha.

Table 4-7: Pilbara Region Demographics provides population and demographic statistics for the Pilbara region.

In 1997/98, the mean taxable income for the Pilbara Region was $43,926. This increased to $57,223 in 2003/04, representing a nominal increase of 30.3% (10.1% when CPI adjusted) over the period (Department of Local Government and Regional Development 2006a).

It was also reported that the labour force (total persons employed and unemployed aged 15 and over) in the Pilbara Region in the March quarter 2006 totalled 24,685 persons. This represented an increase of 1.4% from the previous quarter total of 24,356. The labour force in the Region remained steady and had increased by 2.4% since the September quarter 2003 (Department of Local Government and Regional Development 2006b).
Table 4-7: Pilbara Region Demographics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population 2005/2006</td>
<td>40,132 (2% of the State)</td>
</tr>
<tr>
<td>Total Number of Males</td>
<td>21,697</td>
</tr>
<tr>
<td>Total Number of Females</td>
<td>17,585</td>
</tr>
<tr>
<td>Population Distribution by Age &lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Age 0 - 14</td>
<td>Male: 5,296</td>
</tr>
<tr>
<td></td>
<td>Female: 4,858</td>
</tr>
<tr>
<td>Age 15 - 24</td>
<td>Male: 2,697</td>
</tr>
<tr>
<td></td>
<td>Female: 2,371</td>
</tr>
<tr>
<td>Age 25 - 44</td>
<td>Male: 8,306</td>
</tr>
<tr>
<td></td>
<td>Female: 6,703</td>
</tr>
<tr>
<td>Age 45 - 64</td>
<td>Male: 4,814</td>
</tr>
<tr>
<td></td>
<td>Female: 3,208</td>
</tr>
<tr>
<td>Age 65+</td>
<td>Male: 582</td>
</tr>
<tr>
<td></td>
<td>Female: 445</td>
</tr>
<tr>
<td>Avg Population Growth 05/06</td>
<td>-0.1%</td>
</tr>
<tr>
<td>Avg Population Growth 04/05</td>
<td>0.1%</td>
</tr>
<tr>
<td>Avg Population Growth 96/06</td>
<td>1.6%</td>
</tr>
<tr>
<td>Australian Citizens 2001</td>
<td>31,876</td>
</tr>
<tr>
<td>Indigenous Persons 2001</td>
<td>6,515</td>
</tr>
<tr>
<td>Median Age</td>
<td>29 years</td>
</tr>
</tbody>
</table>

Source: Department of Local Government and Regional Development (2007c)

Of the total labour force in the 2006 March quarter, there were 23,973 people employed and 712 people unemployed (Department of Local Government and Regional Development 2006a).

Statistics relating to the economy of the Pilbara region are presented in Table 4-8: Economic Statistics for the Pilbara Region 2005/06.
### Table 4-8: Economic Statistics for the Pilbara Region 2005/06

<table>
<thead>
<tr>
<th>Economic Aspect</th>
<th>Value</th>
<th>% of State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Regional Product (GRP) 05/06 ($M)</td>
<td>$6,756</td>
<td>5.7</td>
</tr>
<tr>
<td>GRP per capita</td>
<td>$168,350</td>
<td></td>
</tr>
<tr>
<td>Total Agriculture 04/05 ($M)</td>
<td>$51.90</td>
<td>1.0</td>
</tr>
<tr>
<td>Crops and pastures ($M)</td>
<td>$0.40</td>
<td>0</td>
</tr>
<tr>
<td>Livestock disposals ($M)</td>
<td>$50.50</td>
<td>4.4</td>
</tr>
<tr>
<td>Livestock products ($M)</td>
<td>$1.00</td>
<td>0.2</td>
</tr>
<tr>
<td>Agriculture Land (ha)</td>
<td>15,101,389</td>
<td>14.4</td>
</tr>
<tr>
<td>Number of Establishments</td>
<td>61</td>
<td>0.5</td>
</tr>
<tr>
<td>Mining 05/06 ($M)</td>
<td>$28,505</td>
<td></td>
</tr>
<tr>
<td>Fishing Catch 04/05 by Value ($M)</td>
<td>$15.30</td>
<td>3.8</td>
</tr>
<tr>
<td>Fishing Total Weight tonnes</td>
<td>3,947</td>
<td>9.7</td>
</tr>
<tr>
<td>Manufacturing 01/02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Locations</td>
<td>185</td>
<td>1.2</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>997</td>
<td>1.2</td>
</tr>
<tr>
<td>Turnover ($M)</td>
<td>$309.10</td>
<td>1.2</td>
</tr>
<tr>
<td>Building and Construction 05/06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Approvals</td>
<td>$236.30</td>
<td>3.2</td>
</tr>
<tr>
<td>Total non residential approvals</td>
<td>$144.20</td>
<td>7.4</td>
</tr>
<tr>
<td>Residential approvals</td>
<td>$92.10</td>
<td>1.7</td>
</tr>
<tr>
<td>Retail 05/06 turnover</td>
<td>$363.20</td>
<td>1.7</td>
</tr>
<tr>
<td>Tourism 04/05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of International Visitors</td>
<td>28,500</td>
<td>2.9</td>
</tr>
<tr>
<td>No. of Domestic Visitors</td>
<td>310,500</td>
<td>4.3</td>
</tr>
</tbody>
</table>

4.14 Land Uses

4.14.1 Regional Land Use

The predominant land uses in the Pilbara are mining and pastoral. The areas to the north and northeast of the Pilbara are too dry to support the grazing of livestock and include few settlements. Tourism plays an important part in the region’s economy, with an average of 339,000 overnight visitors to the Region across 2004 and 2005 (Department of Local Government and Regional Development 2006a). Three national parks have been proclaimed in the region, Karijini, Millstream - Chichester, and Rudall River. Karijini National Park includes the spectacular “gorge country” of the Hamersley Range (which contains disused asbestos mines). The Rudall River National Park is located in the eastern Pilbara, outside the pastoral areas.

Commercial activities in the Pilbara primarily service the mineral and energy sector, and include engineering, surveying, and personnel and equipment hiring services.

Manufacturing consists mainly of small businesses supplying the regional market. The Pilbara region also supports an aquaculture industry, with the catch made up primarily of finfish and prawns.

4.14.2 Local Land Uses

The immediate vicinity of Cape Preston has been declared a port site and port limits have been established. The mainland immediately adjacent to Cape Preston, Regnard Bay and the Fortescue River has been zoned for industrial use and is covered by mining and exploration leases held by Mineralogy.

Local Recreation

Although remote, Cape Preston and the Fortescue River mouth are used by Pilbara residents and tourists for recreational pursuits, particularly fishing. The waters and shallow marine habitats of Regnard Bay are fished recreationally by low numbers of visitors from Dampier and by itinerant “grey nomads” who occupy the 40 mile beach camp site during winter months. The waters on the west side of Cape Preston are similarly fished recreationally by visitors from Panawonica and by “grey nomads” who occupy the Fortescue River campsite during winter.

Long term campers regularly stay at the river mouth for periods of up to several months. During high tide, the Fortescue River is accessible by boat to a point some 2 km upstream of the river mouth. There are also a number of seasonally variable pools along the Fortescue River and its tributaries which are currently accessed via a network of minor tracks throughout the project area.

A boat ramp carved into the river bank is located at the river mouth and is presently maintained by the owners of Indian Ocean Pearls, who have established a permanent camp near the river mouth.

Rubbish bins provided by the Roebourne Shire are emptied weekly during peak season and fortnightly during the off season. The camping season traditionally runs between Easter and September / October, depending on the seasonal conditions.

In addition to the mainland visitor points mentioned above, there are several islands located off the Pilbara coast which form the Great Sandy Island Nature Reserve. Furthermore, the Dampier to Cape Preston Marine Management Area will incorporate a number of other islands. Special regulations will be applied to control the impact of visitors on these islands. These regulations will vary depending on the classification of the island to which they apply.
Section 4

Existing Environment

Commercial Fisheries

The deeper waters to the west of Cape Preston are used occasionally by Onslow based prawn trawlers. The Onslow Prawn Managed Fishery operates along the western part of the North West Shelf and targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*) using otter trawl. The governing legislation / fishing authority is the *Onslow Prawn Fishery Management Plan 1991* and the Onslow Prawn Managed Fishery Licence. Cape Preston falls in both Fishing Area 3 and the Fortescue Nursery Area of the Onslow Prawn Managed Fishery.

There are two aquaculture lease sites within the vicinity of Cape Preston (*Figure 4-23: Designated Marine Social Values in the Cape Preston Area*). One is presently operated by Indian Ocean Pearls and is involved in the culture of the winged oyster (*Pteria penguin*). The operator is believed to be seeking approval for expansion. Indian Ocean Pearls operates from a base at the mouth of the Fortescue River, with their pearling lease located about 3 km west of Cape Preston. The other lease is not currently operational.

Local Reserves

*Great Sandy Island Nature Reserve*

The project site is located on a remote stretch of coast, within the Great Sandy Island Nature Reserve (GSINR), which incorporates 26 islands as a ‘B’ Class Reserve for the ‘Conservation of Flora and Fauna’ (*Figure 4-23: Designated Marine Social Values in the Cape Preston Area*). The reserve does not affect the activities that can be undertaken in the marine environment around the islands.

Many of the islands in the reserve are inaccessible and well protected from human impacts. Day trippers, however, regularly visit a number of islands. The islands are known to be valuable nesting grounds for a variety of seabirds, providing important undisturbed nesting and refuge sites protected from introduced ground predators common on the mainland (CALM 2000). While none of the islands within the GSINR is listed as significant breeding grounds for turtles (CALM 2000), it is possible that many of the islands with sandy beaches may be used by the five species of turtle occurring along the Pilbara coast.
Figure 4-23: Designated Marine Social Values in the Cape Preston Area
Section 4

Existing Environment

Regnard Marine Management Area

The proposed Regnard Marine Management Area is mooted for the mainland coastal areas extending from Eaglehawk and West Intercourse Islands westwards to SW Regnard Island (Figure 4-24: Proposed Regnard Marine Management Area). This management area replaces the former proposed Cape Preston Marine Management Area (CALM 2005) that extended to the west of Cape Preston as far as the Fortescue River mouth. The westward extension of the proposed Cape Preston Marine Management Area has been deleted as it included port facilities and areas covered by State Agreements Acts.

The DEC is currently preparing for the formal gazettal of the proposed Regnard Marine Management Area under the provisions of the Conservation and Land Management Act 1984. A draft management plan is also being prepared and will be released following the creation of the reserve.

Figure 4-24: Proposed Regnard Marine Management Area

A Marine Management Area differs from a marine nature reserve or park in that they allow multiple uses (CALM 2003). The Conservation and Land Management Act 1984 states that a Marine Management Area is established for the purpose of managing and protecting the marine environment so that it may be used for conservation, recreation, scientific and commercial purposes. Commercial purposes include:

- aquaculture, commercial fishing and pearling activity;
- mining, within the meaning of the Mining Act 1978;
- seismic surveys and exploration drilling for petroleum; and
- production of petroleum and associated activities.

The formation of the Marine Management Area will have implications for future utilisation of the marine environment, in particular with the formation of no-take zones. No take zones are considered important tools for managing fisheries, with ample evidence suggesting that the establishment of no-take zones has direct effects on the levels of fish stocks within them and in adjacent waters (Colman & Simpson 1999).

The Regnard Marine Management Area incorporates the transitional zone between the marine and terrestrial environments. Much of this zone comprises extensive mangrove communities.
Section 4

Existing Environment

Mangrove communities are considered to be highly valuable ecosystems, and many of the mangals found in the Pilbara region have been assessed as having international biodiversity and ecological significance, including the communities east of Cape Preston and at the Fortescue River delta (CALM 2003).

Formal legislation protects Mangroves throughout the state. Two conservation zones within the Regnard Marine Management Area have been designed to protect mangrove communities, one of which is located immediately east of Cape Preston and is a conservation zone for the protection of flora and fauna.

Coastal Margin Cape Preston to Cape Keraudren National Estate

The Balmoral South Project lies adjacent to the Coastal Margin Cape Preston to Cape Keraudren National Estate (identification number 17917) to the east and the Coastal Margin Exmouth Gulf to Cape Preston natural area (identification number 17918), located to the south-west of the mouth of the Fortescue River. Both National Estates are Indicative Places that have yet to receive official status. There will be no project activities in these areas.

Mardie Station

In 2004 the Minister for Planning and Infrastructure approved an area of approximately 2,555 ha to be excluded from Mardie Station as part of the “2015 Exclusion Process”. The area was identified by the DEC as particularly valuable for its conservation value because of the Horseflats Land System (cracking clay soils) and related vegetation associations that are poorly represented within the conservation estate and, also, because of its contiguous nature with the sanctuary Zone within the Regnard Marine Management Area.

4.15 Aboriginal Heritage

Human occupation of the Australian continent is estimated at between 30,000 and 80,000 years. It is believed that Australia’s Indigenous people journeyed over the Pilbara craton from Indonesia when seas were low. The last ice-age occurred between 14,000 and 25,000 years ago, and archaeological evidence suggests that the Pilbara coastline acted as a refuge during this period. Post glacier Aboriginal people began to move inland. It is believed that between 2,000 and 4,000 years ago, most areas of the Pilbara region were either occupied or had been traversed (Webb, undated).

The Aboriginal people of the Pilbara depended on a semi-nomadic food gathering and hunting economy. In the dry months, life was centred near the coast on rivers such as the Fortescue, Sherlock, Yule, Shaw and De Grey. Exact figures are hard to obtain but prior to colonisation there were an estimated 20 - 30 social / language groups in the Pilbara region. Each of these groups had their own language, spiritual mythologies and social organisation. Most have members fitting into one of four kin groups, Karrimarra, Burunga, Banaka or Balyirri (Webb, undated).

The increase in European activity from the 1860s had a dramatic impact on Aboriginal society. Enforced labour, introduced diseases and conflict displaced Aboriginal people from their country and claimed many lives. Between 1946 and 1947 there was a widespread walk off by Aboriginal pastoral workers (still known as the pastoral strike) demanding better pay and conditions and access to their traditional lands. This movement led to the establishment of Aboriginal communities on a number of stations, notably Strelley and later Yandeyarra (Pilbara Development Commission, undated).

Archaeological and ethnographic studies (O’Connor 2001, Quartermaine Consultants 2001) have previously been conducted in the Cape Preston region, including the Balmoral South Project area. The studies identified the Aboriginal Heritage values of the area and the presence of a number of sites of heritage significance. Local Aboriginal groups include the Wong-Goo-Tt-oo group, the Yaburara and Coastal Mardudhunera group, and the Kuruma Marthudunera group.

4.16 European Heritage

No sites of European heritage significance occur in the Balmoral South Project Area.
Section 5

Stakeholder Consultation

A community and stakeholder consultation process has occurred over eight years (2000 – 2008) to document the issues associated with industrial development in the Cape Preston region. International Minerals (IM) has undertaken specific stakeholder consultation on the environmental impacts associated with the Balmoral South Project. A Project specific targeted consultation process has been developed to ensure that as many key stakeholders as possible were informed and had opportunity to comment, and to provide technical guidance on the development plans.

IM conducted stakeholder consultation for the Balmoral South Project during October 2006. Through DoIR, the Office of Development Approval Coordination provided the Proponent with a list of potential key stakeholders, to whom a release of a Project discussion paper was distributed. Written responses were requested and a meeting with all respondents was held in early November 2006. Additional meetings with key Decision Making Authorities (DMA’s), including DEC, EPA and DoW have been conducted to help refine the potential significant issues on site and ensure baseline studies address those issues.

In August 2007 IM undertook a supplementary program, posting consultation packages to 52 groups, including:

- key government Ministers, agencies and regional branches;
- the Shire of Roebourne (Local Government Authority);
- non-government organisations that represent indigenous interests, conservation and recreation groups and industry bodies;
- community groups; and
- local business groups.

In March 2008, IM sent a further consultation package to keep stakeholders informed on the Project development, and the amendment to increase the concentrate production from 12 Mtpa to 24 Mtpa.

To assist stakeholders input into the consultation process, the Proponent provided a “Project Overview for Key Stakeholders” document within the packages to introduce the project concept to stakeholders and later consult with them on issues and potential impacts. The document provided:

- a description of the proposal;
- an overview of the Project benefits;
- a summary of environmental impacts; and
- Proponent’s environmental commitments.

IM also attached a pro-forma table to help guide stakeholder feedback based on specific environmental impacts identified. Currently feedback has been received from more than 30 representatives via letter, email, phone calls and meetings.

Key issues identified through the consultation process are summarised in Table 5-1: Summary of Key Issues Identified, grouped under headings under which they are discussed in the PER.

Consultation with stakeholders will continue through the environmental approvals process and throughout the life of the Balmoral South Project.
### Table 5-1: Summary of Key Issues Identified

<table>
<thead>
<tr>
<th>Factor</th>
<th>Issues</th>
<th>Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Terrestrial Flora and Vegetation</strong></td>
<td>Declared Plants issues need to be considered in consultation with Department of Agriculture and Food (e.g. Mesquite)</td>
<td>DEC, DAF</td>
</tr>
<tr>
<td></td>
<td>Need to consider conservation status of regionally significant native vegetation</td>
<td>DEC</td>
</tr>
<tr>
<td></td>
<td>Need to consider local and regional significance of impacting groundwater dependent vegetation</td>
<td>DEC, DOW</td>
</tr>
<tr>
<td></td>
<td>Project should address Conservation, Recreation and Natural Landscapes Reserve over Mangrove Creek and coastal zone adjacent to Stockpiles.</td>
<td>Shire of Roebourne</td>
</tr>
<tr>
<td><strong>Subterranean Fauna</strong></td>
<td>Need to provide supporting documents and consult experts on stygofauna and troglofauna.</td>
<td>DEC, DOW</td>
</tr>
<tr>
<td><strong>Matters of National Significance</strong></td>
<td>identify the Project's potential impacts on turtle nesting from lighting, construction works, loss of foraging habitat, increased recreational movement including camping and potential boat strike from increased boating activity</td>
<td>DEWHA</td>
</tr>
<tr>
<td></td>
<td>identify the Project's potential impacts on the marine environment, particularly seagrasses, from the chemical and temperature characteristics of the discharge from outlets. (Scientific data suggests that increased salinity will adversely affect the health of seagrass beds). Potential impacts on the Dugong from potential loss of feeding habitat and from increased boating activity</td>
<td>DEWHA</td>
</tr>
<tr>
<td><strong>Surface Water</strong></td>
<td>Strategies to minimise impact, including increased erosion and sedimentation.</td>
<td>DOW, DOIR</td>
</tr>
<tr>
<td></td>
<td>Modelling to include the cumulative impacts of the Balmoral South Iron Ore Project and Central Block Project.</td>
<td>DOW</td>
</tr>
<tr>
<td></td>
<td>Provide the methodology for hydraulic modelling</td>
<td>DOW</td>
</tr>
<tr>
<td></td>
<td>Detail the impact of the changes to the groundwater and surface water interactions as a result of the Project.</td>
<td>DOW</td>
</tr>
<tr>
<td><strong>Groundwater</strong></td>
<td>Consider the cumulative impacts across the total area of the proposed development.</td>
<td>DOW</td>
</tr>
<tr>
<td></td>
<td>Details of monitoring programs, trigger levels, mitigation measures and contingency plans.</td>
<td>DOW, DEC</td>
</tr>
</tbody>
</table>
## Section 5

### Stakeholder Consultation

<table>
<thead>
<tr>
<th>Factor</th>
<th>Issues</th>
<th>Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monitoring should cover saline intrusion from the ocean as a gradient is created towards the mine pit.</td>
<td>DOW</td>
</tr>
<tr>
<td></td>
<td>Consider hydro-geological conditions such as connectivity between aquifers.</td>
<td>DEC</td>
</tr>
<tr>
<td><strong>Water Quality</strong></td>
<td>Describe management of surface water quality during construction and operation.</td>
<td>DOW</td>
</tr>
<tr>
<td></td>
<td>Potential impacts of predicted rising sea levels and the risk of storm surge during cyclonic events.</td>
<td>DOW, DEC</td>
</tr>
<tr>
<td><strong>Flooding</strong></td>
<td>Need to ensure diversion channels are designed to accommodate the peak flood event during the life of the Project.</td>
<td>DoIR</td>
</tr>
<tr>
<td></td>
<td>Describe the impact from the peak flood event with a map showing the increase in area.</td>
<td>DOW</td>
</tr>
<tr>
<td></td>
<td>Assess sedimentation in the Fortescue River as a result of the waste dump and tailings facility impeding flood flows.</td>
<td>DEC, DoIR</td>
</tr>
<tr>
<td></td>
<td>Demonstrate that the process plant, power station and other infrastructure are protected from flooding during major flows.</td>
<td>DOW, DOH</td>
</tr>
<tr>
<td><strong>Water Supply</strong></td>
<td>Demonstrate the site water balance, water supplies and water use efficiency measures including improvement targets. The Project needs to look at alternative water supplies and develop contingency planning.</td>
<td>DOW, DOH, Industry groups</td>
</tr>
<tr>
<td><strong>Wastewater</strong></td>
<td>Wastewater treatment and disposal systems.</td>
<td>DOH, DOW</td>
</tr>
<tr>
<td><strong>Emission</strong></td>
<td>Need to consider the cumulative impacts associated with air emissions</td>
<td>DEC, DOH, DPI</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>Address the impacts of noise and vibration on fauna.</td>
<td>DEC</td>
</tr>
<tr>
<td></td>
<td>Address prediction of blasting noise levels.</td>
<td>DEC</td>
</tr>
<tr>
<td><strong>Heritage</strong></td>
<td>Resolve Aboriginal heritage issues including additional surveys, ongoing consultation and staff heritage awareness</td>
<td>DEC, DIA, Local Aboriginal groups</td>
</tr>
</tbody>
</table>
# Section 5

## Stakeholder Consultation

<table>
<thead>
<tr>
<th>Factor</th>
<th>Issues</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Social Impact</td>
<td>Workforce planning such as transport and transit requirements for construction and operation of this Project.</td>
<td>MRWA, DOH, Shire of Roebourne</td>
</tr>
<tr>
<td></td>
<td>Impacts on grazing lands and Pastoral Lease including: devaluation of Lease, jeopardising sale of Lease, direct loss of grazing land, loss of tourism potential, contamination affecting grazing land, loss of water supplies, road kills, dust impacts and loss of access.</td>
<td>Pastoral Lease Holder</td>
</tr>
<tr>
<td>Recreation</td>
<td>Management of impact on public usage of publicly accessible land in the area.</td>
<td>Shire of Roebourne, DPI</td>
</tr>
<tr>
<td></td>
<td>Need to consider Conservation Estate (e.g. Great Sandy Island Nature Reserve, parts of Mardie and Karratha Stations to be relinquished, proposed Dampier Archipelago Marine Park and Cape Preston Marine Management Area).</td>
<td>DoE(CALM), Marine and Parks Reserves Selection Working Group</td>
</tr>
</tbody>
</table>
The potential environmental and social impacts and associated management measures of the Balmoral South Iron Ore Project (the “Project”) are summarised in Table 6-1: Summary of Impacts and Management Measures Applicable to the Relevant EPA Environmental Factors. The issues were identified during the preparation of the Environmental Scoping Document, which was approved by the EPA in September 2008. Issues were also identified during meetings with government agencies, including the DEW (now DEWHA), DEC, DoIR, and DoW. Indigenous stakeholders and NGOs were also consulted during the environmental assessment of the Project, and their concerns were identified.

Table 6-1 is structured as follows:

- Column 1 provides the environmental factors;
- Column 2 outlines the management objective and scope of work to address the factor;
- Column 3 identifies the Project component and potential impact as a result of the Project;
- Column 4 provides an outline of the proposed mitigation and management measures; and
- Column 5 describes the predicted outcome once the management measures have been implemented.

Further information on the environmental and social impacts and their management measures is provided in Sections 7 to 11.

Cumulative Impacts

The Central Block Project received environmental approval for the development of a mine, processing plant, stockyards, villages, port, dredging and associated infrastructure (Ministerial Statement 000635) in October 2003. Construction activities associated with this project have commenced.

The assessment for the Balmoral South Project has been prepared to quantify impacts associated with the development of this project in isolation and to address cumulative impacts based on the assumption that the impacts predicted for the Central Block Project have already occurred. In particular the PER has addressed individual and cumulative impacts associated with the following environmental factors:

- terrestrial flora and vegetation
- mangroves
- terrestrial fauna
- subterranean fauna
- marine ecology
- surface water
- groundwater
- process emission
- marine water quality and
- noise

Where necessary, the predictions of impacts associated with development of the Central Block Project have been updated to reflect a greater level of knowledge gained through the continued collection of data over the last six years. For example, a better understanding of the hydrogeology of the region has allowed an upgraded regional groundwater model to be developed which better represents impacts associated with the development of multiple pits.
### Section 6

#### Relevant EPA Factors

**Table 6-1: Summary of Impacts and Management Measures Applicable to the Relevant EPA Environmental Factors**

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BIOPHYSICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terrestrial Vegetation and Flora</td>
<td>Maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. Protect species listed under the <em>Environment Protection and Biodiversity Conservation Act 1999</em> and Rare and Priority Flora consistent with the provisions of the <em>Wildlife Conservation Act 1950</em>. Scope of Work: Field survey of the Project area to document and map vegetation types and flora present. Survey to be undertaken consistent with EPA Position Statements No. 2 and No. 3, and Guidance Statement No. 51. Overlay Project components onto habitat mapping to quantify impacts. Mapping of phreatophytic communities at risk from dewatering, modelling of groundwater drawdown and quantification of potential community loss. Identification of any Threatened or Priority Flora, unusual or poorly known taxa, or restricted vegetation types (including Threatened Ecological Communities). Evaluation of the local and regional conservation significance of the species and vegetation types present, including species at their geographical limits. Analysis of clearing areas to quantify loss of vegetation and identify impacts on Threatened or Priority Flora, or TECs. Field survey to document the extent and occurrence of introduced flora in the Project area.</td>
<td>Land systems: The project will impact on the Boolgeeda, Horseflats, Cheerawarra, Littoral, Newman, Paraburdo, Yamerina, Rocklea and River Land Systems. The land system most impacted by clearing will be Newman with 9.17% to be cleared within the Roebourne subregion.</td>
<td>Clearing control procedures will be implemented during construction. Existing drainage patterns are maintained where possible. Progressive rehabilitation of disturbed areas where possible.</td>
<td>Based on the regional extent of these Land Systems it is considered that this disturbance will not be regionally significant.</td>
</tr>
</tbody>
</table>
### Relevant EPA Factors

<table>
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<tr>
<th>Environmental Factor</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Vegetation clearing</td>
<td>45 vegetation communities will be impacted. Around 5282 ha of vegetation will be cleared. Cracking clay grasslands of the Horseflats Land System are recognised as regionally significant vegetation communities. Around 690 ha will be disturbed (0.23% of the Roebourne Subregion).</td>
<td>Clearing control procedures will be implemented during construction. Existing drainage patterns are maintained where possible. Progressive rehabilitation of disturbed areas where possible. Detailed design will consider the presence of Cracking Clay Grasslands with disturbance minimised where possible. Pastoral lease boundary rationalisation in 2015 will ensure that substantial areas of these grasslands are preserved within the conservation estate.</td>
<td>The Balmoral South Project will not result in the loss of any vegetation type below the EPAWA &quot;threshold level&quot; of 30%. Impact on cracking clay grassland is unavoidable but has been minimised where possible. Pastoral lease boundary rationalisation and destocking will ensure local conservation of this Land System and an improvement in its condition.</td>
<td></td>
</tr>
<tr>
<td>Threatened flora</td>
<td>Two priority flora have been identified from the Cape Preston region. No DRF or EPBC listed threatened species will be disturbed as a result of the proposed Balmoral South Project.</td>
<td>Detailed design will consider the locations of Priority Flora, and disturbance will be avoided where possible. The Project will avoid or minimise impacts from clearing on flora</td>
<td>No significant impact is likely on any threatened flora species.</td>
<td></td>
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</tbody>
</table>
## Section 6 Relevant EPA Factors

<table>
<thead>
<tr>
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<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Phreatophytic vegetation</td>
<td>Approximately 460 ha of phreatophytic vegetation will be potentially impacted by Balmoral South pit dewatering, approximately 8.5% of the phreatophytic vegetation of the Cape Preston survey area.</td>
<td>There will be some unavoidable loss of phreatophytic vegetation but it will be minimised by reducing water level drawdown rates where possible, monitoring vegetation and vegetation stress and implementing management measures at identified trigger levels.</td>
<td>The overall potential loss of phreatophytic vegetation in the lease area is relatively small. The groundwater model is conservative in its predictions as it doesn’t account for seasonal creek flows or the presence of perched water tables.</td>
<td></td>
</tr>
<tr>
<td>Weeds</td>
<td>Two Declared species have been identified from the Project area. Potential to spread weeds to uninfected areas.</td>
<td>Development of weed management and hygiene protocols. Monitoring for the presence of weeds as a component of the vegetation monitoring program. Ongoing weed control programme will be implemented during operations.</td>
<td>Implementation of standard control practices will ensure that environmental weeds are not spread as a result of the project.</td>
<td></td>
</tr>
<tr>
<td>Mangroves</td>
<td>Maintain the abundance, diversity, geographic distribution and productivity of mangroves and mangrove associations through the minimisation of direct and indirect impacts. <strong>Scope of Work</strong> Document the condition and local and regional representation of mangrove species / assemblages. Evaluate the local and regional significance of affected mangrove areas. Quantify the extent of mangrove clearing and identify aspects of the Project with the potential to restrict or alter tidal flushing. Assess impacts against EPA Guidance Statement No. 1 and No. 29.</td>
<td>Mangrove communities Cumulatively, around 5.7 ha of mangroves and 23.3 ha of algal mat will be cleared for construction of infrastructure corridors across Mangrove Creek. Potential indirect impacts through changes in hydrodynamics. Potential disturbance to acid sulphate soils.</td>
<td>Adoption of construction techniques to minimise mangrove clearing and changes to hydrodynamics. Management of adverse impacts and improve management through implementation of a Mangrove Monitoring Program.</td>
<td>The percentage loss of mangroves and algal mat is low, around 1.1% and 5.8% of their respective occurrence in the area and well under the 10% cumulative impact criteria stated in EPA Guidance Statement No. 29.</td>
</tr>
</tbody>
</table>
## Section 6
### Relevant EPA Factors

| Environmental Factor | Objectives and Scope of Work                                                                                                                                                                                                 | Project Component / Potential Impacts                                                                 | Proposed Mitigation and Management Measures                                                                                                                                   | Predicted Outcome                                                                                                                                                                                                 |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Terrestrial Fauna    | Maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. Protect species listed under the Environment Protection and Biodiversity Conservation Act 1999 and Schedule and Priority Fauna consistent with the provisions of the Wildlife Conservation Act 1950. Scope of Work Field survey of Project area to document fauna communities, threatened taxa and potential short-range endemics. Survey to be undertaken consistent with EPA Position Statement No. 3 and Guidance Statement No. 56. Evaluation of the local and regional significance of the fauna and communities present. Quantify reduction in extent of habitat units attributable to the Project, with evaluation of impacts on fauna occurring on the affected habitat types and on patterns of fauna movement (corridors). | Fauna habitat Around 5282 ha of vegetation will be cleared                                               | Detailed design will be undertaken to minimise as much as practical the extent of clearing for construction and operational activities. Impacts on fauna will be managed through a process of minimising the area to be disturbed, workforce education, avoidance, monitoring impacts, implementation of remedial strategies where practical and progressive rehabilitation of disturbed areas where possible. | Potential to impact on threatened fauna is low. The Lakeland Downs Mouse occurs on cracking clay habitat which is wide spread in the region. The Bustard is associated with the Fortescue River system on which the project will have limited impact. Habitat for the Pilbara Leaf-Nosed Bat does not occur in the area. Mulgara and Olive Python have not been recorded from the site. Rainbow Bee Eater habitat (river and creek lines) will not be significantly impacted. The White Bellied Sea Eagle makes opportunistic use of the area. |
## Section 6
### Relevant EPA Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
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<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threatened fauna</td>
<td>Two Priority 4 Species (Lakeland Downs Mouse and Bustard) are potentially impacted by the project. Three nationally threatened species (Mulgara, Pilbara Leaf-Nosed Bat and Olive Python) listed under the EPBC Act potentially occur. Two nationally significant migratory birds (Rainbow Bee Eater and White Bellied Sea Eagle) occur in the Project Area.</td>
<td></td>
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</tbody>
</table>

International Minerals Pty Ltd
February 2009
### Section 6

#### Relevant EPA Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
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<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subterranean Fauna and Other Short Range Endemics (SRE’s)</strong></td>
<td>Maintain the abundance, diversity, geographic distribution and productivity of subterranean fauna and other SREs at the species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. <strong>Scope of Work</strong> Review all information on subterranean fauna in the locality and its conservation value. Undertake surveys in accordance with EPA Guidance Statements No. 54 and No. 54a. Document the potential impacts of the Central Block and Balmoral South projects on groundwater drawdown and the amount of orebody likely to remain after development of the Project. Undertake a risk assessment and if appropriate, surveys for short-range endemic fauna over the disturbance and wider impact footprint in order to assess impacts and recommend appropriate management / mitigation strategies.</td>
<td>Groundwater extraction has the potential to affect stygofauna. 15 species have been identified, all of which are known to be more widely distributed. Nine species of troglofauna have been recorded from Balmoral South. All but two have been recorded elsewhere. Stygofauna and troglofauna will be impacted through habitat loss. Three likely SRE species have been identified within the Cape Preston region. Clearing of habitat could reduce species numbers, distribution and diversity.</td>
<td>Monitor the impacts of groundwater extraction. Continue field survey work to further define the distribution of subterranean fauna in the Cape Preston area. Complete identification of land snails collected to date.</td>
<td>No stygofauna species will be threatened by the project. Two troglofauna species have only been recorded from Balmoral South which is likely an artefact of a single animal being collected. Given the inferred distribution of troglofauna and minimal detrimental effects of dewatering, it is unlikely that development will affect the conservation of troglofauna species. No SRE species will be threatened by the Project.</td>
</tr>
<tr>
<td><strong>Marine Biota</strong></td>
<td>Maintain the ecological function, abundance, species diversity and geographical distribution of marine biota and habitat. <strong>Scope of Work</strong> Field surveys to document the presence of BPPH and the presence of any species of conservation significance. Evaluation of the local and regional conservation significance of species present. Assessment of impacts consistent with EPA Guidance Statement No. 29.</td>
<td><strong>Benthic primary producers</strong> Construction of the seawater intake, brine outfall and diffuser could impact on Benthic Primary Producer Habitat (BPPH).</td>
<td>The pipelines and diffuser will be located in areas of low environmental sensitivity. Impacted habitats have wide distribution in the Project Area. Filling of the pipeline trench’s with rock to construct artificial reef.</td>
<td>There will be no impact on sensitive BPPH.</td>
</tr>
</tbody>
</table>
### Relevant EPA Factors

<table>
<thead>
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<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Marine fauna</strong></td>
<td>The desalination plant intake flow lines will be controlled so that the take off velocities of the extreme bottom and the extreme top streamlines into the InvisiHead™ would have no suction effect on the floor and top sediments. At maximum plant capacity, the maximum entrance velocity is 0.091 m/s rising from a maximum approach velocity of 0.0025 m/s. The InvisiHead™ technology surpasses the principles of Integrated Pollution Prevention and Control (detailed in European Union Reference Document on the application of Best Available Techniques (BAT) to Industrial Cooling Systems: Dec 2001) for the selection, design and operation of cooling water systems and effluent discharge. No habitat to be impacted is an &quot;important habitat&quot; for a migratory species as defined under the EPBC Act.</td>
<td>The project will not significantly impact any marine species. The area of impact is small and the effects of turbidity during construction will be localised and short lived. There is no indication that an ecologically significant proportion of a turtle or dugong population relies on habitats in the area of Cape Preston.</td>
</tr>
</tbody>
</table>
### Relevant EPA Factors

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Surface Water</strong></td>
<td>Maintain the quantity of water so that existing and potential environmental values, including ecosystem function, are protected. Maintain the integrity, ecological functions and environmental values of wetlands. <strong>Scope of Work</strong> Undertake hydraulic modelling of surface water flows in the Fortescue River and Du Boulay Creek to quantify potential changes as a result of the Project. Demonstrate that infrastructure and facilities that encroach on the floodplains will withstand flood events with minimal likelihood of catastrophic failure.</td>
<td><strong>Migratory shorebirds</strong> Potential disturbance to shorebird roosting and feeding areas. The most important areas occur along the western shoreline of Cape Preston. The number of migratory shorebirds present at Cape Preston is well below the 20,000 figure used for identifying areas of international importance.</td>
<td>The proposed infrastructure will be located away from the main roosting and feeding areas on the western shoreline of Cape Preston. Potential for minor disturbance to intertidal areas at the tip of Cape Preston. Evidence suggests that migratory shorebirds are generally tolerant of limited disturbance from light and noise.</td>
<td>The project will not significantly impact migratory shorebirds.</td>
</tr>
<tr>
<td><strong>Flood levels</strong></td>
<td>Waste Disposal Facility No. 1 (WDF1) will encroach into the flood plain of the Fortescue River. Modelling demonstrates that the Project will increase the 100 year ARI flood level by up to 0.30 m at the southern end of WDF1. WDF1 pit bunds, and plant and processing platforms will be located above the Fortescue River and Du Boulay Creek floodplains.</td>
<td>Detailed design will minimise impacts through bunding to redirect surface water around mine structures, riprap / armouring to slow and redistribute runoff, culverts to maintain major flow paths intercepted by infrastructure, location of mine site infrastructure to minimise encroachment into the 100 yr ARI floodplain, drainage works around WDF1 to separate river water from water internal to the WDF and bunding to contain sediment laden runoff.</td>
<td>There will be an increase in flood level adjacent to WDF1. At this location water depth would be shallow and water velocities are not expected to significantly increase. With significant infrastructure located above the 100 year ARI flood level for the Fortescue River and Du Boulay Creek, the project is not expected to have a significant impact on these watercourses.</td>
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</tbody>
</table>
## Section 6
### Relevant EPA Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
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</tr>
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<tbody>
<tr>
<td>Groundwater</td>
<td>Maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem function, are protected. <strong>Scope of Work</strong> Modelling of the cumulative cone of depression from the Central Block and Balmoral South Projects to determine impact on groundwater levels.</td>
<td><strong>Sedimentation</strong> modification of sediment transport, erosion and deposition patterns.</td>
<td>Dewatering is unavoidable as it is essential for the economic development of the mine. Trigger levels will be established for the provision of alternative water supply to phreatophytic vegetation and groundwater users. Groundwater drawdown will be monitored to confirm that impacts are confined to the areas predicted.</td>
<td>The groundwater model is conservative in its predictions as it doesn’t account for seasonal creek flows or the presence of perched water tables. The overall potential loss of phreatophytic vegetation in the lease area is relatively small.</td>
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# Section 6

## Relevant EPA Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
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<tr>
<td><strong>POLLUTION MANAGEMENT</strong></td>
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<tr>
<td>Air Quality</td>
<td>Ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses.</td>
<td>Dust emissions Earthworks, mining, ore processing and ore handling will produce dust. The accommodation camps and the public camping ground at the mouth of the Fortescue River will not be impacted by dust.</td>
<td>Project design will ensure that dust is captured at source wherever practical. Dust will be managed using standard dust suppression techniques such as water sprays, chemical suppressants, revegetation and mulching. Dust monitoring will comply with the current ambient air quality NEPM and monitor PM&lt;sub&gt;10&lt;/sub&gt; and TSP.</td>
<td>Dust will be managed at source and no significant impacts are predicted to occur.</td>
</tr>
<tr>
<td>Scope of Work</td>
<td>Identify potential sources of dust and quantify likely impacts on the receiving environment. Impact assessment and management will recognise the requirements of the Draft DEC Dust Guidance Statement. Modelling of emissions to determine compliance with appropriate standards and guidelines. Undertake a photochemical smog study which accounts for other emissions in the region. Demonstrate that best practicable technology has been adopted for the design and construction of the power station, particularly with regards to NO&lt;sub&gt;x&lt;/sub&gt; emissions, in line with the EPA Guidance Statement No.15. The assessment to consider cumulative emissions from the approved Central Block Project. Undertake modelling in accordance with the DoE’s Air Quality Modelling Guidance Notes.</td>
<td>Process emissions The pellet plant and power station will emit particulates, CO, NO&lt;sub&gt;x&lt;/sub&gt; and SO&lt;sub&gt;2&lt;/sub&gt; which have the potential to impact on human and animal health, and vegetation.</td>
<td>Project design will ensure that levels of atmospheric pollutants are minimised at source wherever practical. The combined cycle power station will be equipped with low NO&lt;sub&gt;x&lt;/sub&gt; burners, to reduce NO&lt;sub&gt;x&lt;/sub&gt; emissions to less than 25 ppm, and a heat recovery system. Monitoring of the exhaust stacks will measure O&lt;sub&gt;2&lt;/sub&gt;, NO&lt;sub&gt;x&lt;/sub&gt; and CO&lt;sub&gt;2&lt;/sub&gt; to ensure compliance with guidance levels.</td>
<td>Assessment demonstrates that cumulative emissions of NO&lt;sub&gt;x&lt;/sub&gt;, NO&lt;sub&gt;2&lt;/sub&gt; and PM&lt;sub&gt;10&lt;/sub&gt; are well below accepted criteria for human health. The 24-hour NO&lt;sub&gt;x&lt;/sub&gt; vegetation criterion is exceeded up to 1 km from the pellet plant. The regional impacts on photochemical smog formation due to emissions from the project are very low.</td>
</tr>
<tr>
<td>Photochemical smog</td>
<td>Power station and pellet plant will emit NO&lt;sub&gt;x&lt;/sub&gt; which could lead to an increase in photochemical smog.</td>
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## Section 6

### Relevant EPA Factors

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<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
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</table>
| **Greenhouse Gases** | Minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.  
**Scope of Work**  
Quantification of greenhouse gas emissions and demonstration that emissions are as low as reasonably practical. | The Project will generate 2.6 Mtpa of greenhouse gas equivalent emissions. The highest emissions will occur from the power station (65%). | Efficient gas turbines have been incorporated in the combined cycle power station, reducing emissions by 33% over conventional open cycle turbine plants.  
The project will continue to reduce its emissions by improving fuel consumption efficiency per tonne of ore hauled, focussing on the quality of fuel / lubricants used with an objective to reduce hydrocarbon waste and increase productivity per truck, and assessing alternative waste and ore disposal technologies, such as in-pit crushing and conveyor to reduce fuel burn. | Greenhouse gas emission reduction measures have been incorporated into project design and there is a commitment to further reduce emissions on an on-going basis. |
## Section 6

### Relevant EPA Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
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</table>
| Surface and Groundwater Quality | Maintain or improve the quality of surface water and groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected.  
**Scope of Work**  
Characterise waste materials and the potential for seepage to contaminate groundwater.  
Assess the environmental threats posed by the wastes identified.  
Determine appropriate disposal procedures.  
Assessment of changes to water quality in the pit over time and prediction of the likely environmental impact of these changes. | **Surface water**  
Potential for downstream water quality to deteriorate from the discharge of chemicals and hydrocarbons from the workshop and plant areas, seepage from the WDF’s and discharge from the sewage treatment plant. | Project design recognises the need to correctly store hazardous materials such as hydrocarbons, minimises waste generation and incorporates environmentally appropriate technologies for waste management.  
A waste management plan will be developed to ensure appropriate handling, treatment and disposal of wastes and identification of opportunities to avoid, reduce, ameliorate and manage development wastes.  
Construction of diversion works around infrastructure areas to separate natural runoff waters from internal site runoff. | Appropriate handling and disposal of wastes will ensure that the potential for the project to contaminate surface waters is minimal. |
| Groundwater | Potential contamination of the Fortescue River Alluvial aquifer. | **Groundwater**  
WDF1 has been designed to minimise seepage.  
Monitoring will be undertaken to detect any seepage and contingency measures developed to correct unacceptable contaminate loss. | WDF1 will largely contain waste rock and dewatered tailings. Both of these materials are inert. There is limited opportunity for contaminants to be released from WDF1. | |
| Pit void | Potential for long term build up of salinity in the pit lake which could locally impact groundwater quality. | **Pit void**  
Modelling has indicated that the pit will remain dry at the cessation of mining. | Low potential for salinity build up. | |
## Section 6

### Relevant EPA Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
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<tbody>
<tr>
<td>Marine Water Quality</td>
<td>Maintain water and sediment quality consistent with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Protect environmental values for recreation, aesthetics, aquatic life and maintenance of ecosystems in specified areas. <strong>Scope of Work</strong> Field survey to describe the existing environment including mapping and benthic habitat characterisation and classification. Modelling of the Central Block and Balmoral South Projects outfalls to determine the cumulative impact of brine discharge on the marine environment. Modelling will predict the frequency, duration and intensity of discharge events to the marine environment and associated zones of impact. Assess impacts against EPA Guidance Statement No. 29. Impact predictions will be prescribed and spatially defined in the context of the environmental quality management framework presented in the Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives (DoE 2006). Investigations will spatially define and justify the environmental quality objectives around the outfall and the environmental values that will be protected. Justify the location of the discharge point and confirm that the discharge will not impact water quality and biodiversity values of the Regnard Marine Management Area.</td>
<td>The brine outfall will discharge 252 ML/d for short durations and 157 ML/d for most of the time under normal operating conditions. There is the potential to: • reduce local marine water and sediment quality; • adversely affect individual marine biota within the vicinity of the outfall; and • reduce the abundance of sensitive benthic primary producer habitat, including coral communities.</td>
<td>Modelling has defined a brine discharge location which is adequate from a flushing perspective and defined a 4 ha mixing zone where salinity resulting from the plant is no greater than 5% above ambient for more than 1% of the time. None of the chemicals in the waste stream will have a detrimental effect on the marine environment. A Water Quality Management Framework will be developed to ensure that water quality is maintained as a result of the brine discharge. The strategy will establish Environmental Quality Objectives, Environmental Quality Criteria and provide a high level of protection to waters except for the mixing zone surrounding the outfall. A program will also be established to monitor relevant parameters in the desalination plant outfall to confirm modelling predictions and ensure that salinity and toxicants do not exceed stipulated limits.</td>
<td>Given the low environmental sensitivity of the outfall site, the excellent flushing provided by tidal movements and the low toxicity of the effluent components, the likelihood of any adverse effects arising from the brine discharge on the marine environment outside the mixing zone is extremely low. The risk to receiving waters within the mixing zone is also extremely low.</td>
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### Section 6

#### Relevant EPA Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
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<tbody>
<tr>
<td>Noise</td>
<td>Protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal.</td>
<td>Mining, ore processing and ore handling will produce noise emissions with the potential to impact the public and the workforce. Blasting will be employed during mining.</td>
<td>Noise management strategies will be implemented to minimise the potential for impact from noise emissions including use of the quietest readily available equipment, equipment maintenance, limiting blast size and modifying practices if noise complaints occur.</td>
<td>Assessment demonstrates that noise levels comply with relevant criteria at noise sensitive receivers.</td>
</tr>
<tr>
<td>Solid and Liquid Wastes</td>
<td>Minimise any solid and liquid wastes produced as a result of the Project. Integrate a waste hierarchy (i.e. avoid, reuse, reduce, recycle, treat, dispose) for waste minimisation and establish a ‘closed loop’ within as many waste streams as possible. Ensure no release of hydrocarbons to the environment, either as a result of storage or handling incidents. Ensure liquid and solid wastes are treated onsite or disposed of offsite at an appropriate landfill facility.</td>
<td>The Project will generate a variety of waste materials including scrap metal, tyres, wood, paper, hydrocarbons, domestic solid and liquid wastes and processing wastes. If these wastes are not managed in an appropriate manner, a range of potential impacts are possible. These include the contamination of land, change in water quality of surface water and groundwater, and/or contamination of ecological habitats.</td>
<td>Solid and liquid wastes will be minimised, recycled, recovered and reused where possible. Where not possible, they will be disposed of in an appropriate manner within the landfill or at an approved offsite facility. Pyritic Black Shales, which can give rise to acid mine drainage, and fibrous forming materials if present will be identified during drilling. These materials will be managed through the application of appropriate procedures including characterisation of the material, implementation of handling techniques, and encapsulation and neutralisation of material within waste stockpiles.</td>
<td>Waste materials will be handled and appropriately disposed to ensure there is minimal risk to the environment.</td>
</tr>
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</table>

**Scope of Work**
- Noise and vibration modelling using SoundPLAN to demonstrate compliance with the *Environmental Protection (Noise) Regulations 1997*.
- Describe the types of wastes including:
  - domestic, industrial and hazardous wastes (e.g. waste water and workshop wastes);
  - mining wastes (e.g. waste rock); and
  - process wastes (e.g. tailings and waste water).
- Identify management options for the various waste streams.
# Section 6

## Relevant EPA Factors

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
<th>Proposed Mitigation and Management Measures</th>
<th>Predicted Outcome</th>
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<tr>
<td><strong>SOCIAL SURROUNDS</strong></td>
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<tr>
<td>Recreation</td>
<td>Minimise the impact of mine employees and contractors on the &quot;visitor locations&quot; within the vicinity of the Project site.</td>
<td>Potential to impact on the camping ground at the mouth of the Fortescue River. An influx of construction and operations personnel has the potential to place additional pressure on the environment.</td>
<td>All Project personnel will undergo a site specific environmental induction before commencing work at the operation. The induction will include information regarding the responsibilities and expected behaviour of all personnel toward the environment, and will provide necessary awareness of recreational impacts and how those impacts will be managed.</td>
<td>The Project is not expected to have any significant impact on the environment due to increased recreational pressures.</td>
</tr>
<tr>
<td><strong>Aboriginal Heritage</strong></td>
<td>Avoid or minimise impacts to Aboriginal cultural heritage sites. To ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972.</td>
<td>Work done to date has identified the heritage values of the area. There is the potential impact on sites of Aboriginal significance.</td>
<td>Heritage Agreements will be finalised with Claimant Groups. Procedures will be implemented for the identification and management of any additional sites located during the construction and operational phases of the Project. This may include the use of monitors during ground disturbing activities and the development of specific procedures for the preservation of heritage sites.</td>
<td>The work proposed and the procedures to be put in place will ensure that heritage values of the area are protected and that changes to the environment do not adversely affect the cultural associations of the area.</td>
</tr>
<tr>
<td><strong>Scope of Work</strong></td>
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<tr>
<td>Scope of Work</td>
<td>Finalise Heritage Agreements, management plans or other agreements following further consultation with the Claimant Groups and the Department of Indigenous Affairs. Conduct further surveys across the Balmoral South Project area in consultation with local Aboriginal groups.</td>
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## Section 6
### Relevant EPA Factors

<table>
<thead>
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<th>Environmental Factor</th>
<th>Objectives and Scope of Work</th>
<th>Project Component / Potential Impacts</th>
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<th>Predicted Outcome</th>
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</table>
| **European Heritage**| Ensure that changes to the biological and physical environment resulting from the Project do not adversely affect historical and cultural associations with the area and comply with relevant heritage legislation.  
**Scope of Work**  
Identify whether sites of European heritage value occur in the Project Area and, if so, whether they will be affected by the Project. | There are no European heritage sites known to occur within the Project Area. | No specific management is required. | - |
| **Public Health And Safety** | Ensure that the risk to the public is as low as reasonably practicable and complies with appropriate standards.  
Ensure that traffic activities resulting from the Project do not adversely impact on the social surroundings.  
Ensure that the risk is managed to comply with DoIR requirements and EPA criteria in respect of public health and safety.  
**Scope of Work**  
Demonstrate an understanding of the potential impacts of the Project on public health and safety and document the measures proposed to minimise or mitigate the impact. | The potential health and safety issues for the Project are include increased traffic on the Fortescue River access road, public access to the Project area, spillage of hazardous materials on public roads, process emissions from the pellet plant and power station and dust from exposed areas and materials handling. | The general public will be excluded from the Project area. Access to the Project Area will be via a dedicated access road. Dust will be management through the use of water carts (or similar), vehicle speed restrictions will be enforced, safety procedures will be adopted and spill kits installed on transport vehicles. | The project is not expected to pose a risk to the general public. |
| **OTHER** | **Matters of National Environmental Significance** | Ensure that Matters of National Significance are identified and potential impacts quantified and, where necessary, mitigated.  
**Scope of Work**  
Survey of the Project area to document the occurrence of species listed under the EPBC Act.  
Assess the likelihood that species will be significantly impacted by the Project using the Significant Impact Criteria listed under the EPBC Act. | The project has the potential to impact on ten listed Threatened species and 23 listed Migratory species listed by the EPBC Act. | Surveys demonstrate that there is a low likelihood that species listed under the EPBC Act will be significantly impacted. Marine activities are limited and fauna habitats within the Project Area are well represented in the region. | The project is unlikely to impact on Matters of National Environmental Significance. |
## Relevant EPA Factors

<table>
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<tr>
<td>Cumulative Impacts for Assessment of Balmoral South Project</td>
<td>Ensure that impacts from the Project are understood and assessed in the context of impacts arising from other approved projects in the area. &lt;br&gt;<strong>Scope of Work</strong>&lt;br&gt;Quantify impacts associated with the Balmoral South Project and assess these impacts in relation to those predicted for the approved Central Block Project.</td>
<td>Development of the Balmoral South Project will result in additional impacts to those already assessed for the approved Central Block Project. These include surface water and groundwater impacts, cumulative impacts of vegetation clearing and cumulative process emissions.</td>
<td>The PER assesses the cumulative impacts of the two projects.</td>
<td>The PER identifies a range of management measures that will ensure that cumulative impacts of the two projects can be managed.</td>
</tr>
<tr>
<td>Decommissioning</td>
<td>To ensure that rehabilitation occurs in a planned sequential manner consistent with best practice. &lt;br&gt;<strong>Scope of Work</strong>&lt;br&gt;Assessment of potential impacts on existing landforms. Detail measures proposed to rehabilitate the impacted area to an acceptable standard which will integrate the post mining landform with the surrounding environment.</td>
<td>Mining will result in the excavation of overburden and ore, mineral processing and the establishment of new landforms to accommodate mine waste.</td>
<td>International Minerals will prepare a Mine Closure Plan. Progressive rehabilitation of disturbed areas will occur where possible and ongoing monitoring will determine the success of this rehabilitation.</td>
<td>The Mine Closure Plan will establish the objectives for rehabilitation of disturbed areas and put in place a process that will allow operations to recognise the long term objectives associated with decommissioning.</td>
</tr>
</tbody>
</table>
7.1 Introduction
This section addresses the potential biophysical factors relating to the development and operation of the Balmoral South Project. The relevant objectives and standards relating to each factor are identified, the issues and impacts, both for the Balmoral South Project in isolation and cumulatively with the Central Block Project, are discussed, and the proposed management measures outlined. The PER outlines the significant management issues that will be addressed by International Minerals with detailed information on management and monitoring contained in the Project Environmental Management Plan (PEMP) (Appendix A). The PEMP also covers other issues that, although not significant for the project, are still required to be addressed.

7.2 Terrestrial Flora and Vegetation

7.2.1 Objectives and Standards
The Balmoral South Project objectives for the protection of flora and vegetation are to:

- minimise the direct impacts as a result of construction activities;
- prevent direct and indirect impacts during operations; and
- minimise impacts on Groundwater Dependent Ecosystems.

Relevant legislation and standards include:

- Environment Protection and Biodiversity Conservation Act 1999;
- Wildlife Conservation Act 1950;
- Environmental Protection Act, 1986;
- EPAWA (2000). Environmental Protection of Native Vegetation in Western Australia. Position Statement No. 2;
- EPAWA (2002). Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3;
- EPAWA (2004c). Guidance for the Assessment of Environmental Factors No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia; and
- Agriculture and Related Resources Act 1976.

Environment Protection and Biodiversity Conservation Act 1999
The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) protects flora considered to be of national environmental significance. Species and communities are classified as Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct or Extinct in the Wild (Table 7-1: Categories of Significant Flora Under the EPBC Act).
Section 7

Biophysical Issues and Their Management

Table 7-1: Categories of Significant Flora Under the EPBC Act

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Extinct (Ex)</td>
<td>Taxa for which, at a particular time, there is no reasonable doubt that the last member of the species has died.</td>
</tr>
<tr>
<td>Extinct in the Wild (ExW)</td>
<td>Taxa which are only known to survive in cultivation or as a naturalised population outside its past range, or it has not been recorded in its known and / or expected habitat, at appropriate seasons, anywhere in its past range despite exhaustive surveys over a time frame appropriate to its life cycle and form.</td>
</tr>
<tr>
<td>Critically Endangered (CE)</td>
<td>Taxa which are facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.</td>
</tr>
<tr>
<td>Endangered (E)</td>
<td>Taxa which are not critically endangered and are facing a very high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.</td>
</tr>
<tr>
<td>Vulnerable (V)</td>
<td>Taxa which are not endangered and are facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with prescribed criteria.</td>
</tr>
<tr>
<td>Conservation Dependent (CD)</td>
<td>Taxa which are the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of five (5) years.</td>
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Wildlife Conservation Act 1950

The Wildlife Conservation Act 1950 protects all native flora in Western Australia. Flora considered to be rare are gazetted as Declared Rare Flora (DRF) under Section 23F of the Act. Under the Act it is an offence to ‘take’ (defined as “to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or allow the same to be done by any means”) or damage rare flora without approval from the Minister for the Environment. Species that appear to be rare or threatened, but for which there is insufficient evidence to properly evaluate their conservation significance, are assigned one of four Priority categories (Table 7-2: Definitions of Rare and Priority Flora) by the Department of Environment and Conservation.

Table 7-2: Definitions of Rare and Priority Flora

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Declared Rare - extant taxa (R)</td>
<td>Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction or otherwise in need of special protection.</td>
</tr>
<tr>
<td>Declared Rare – presumed extinct (X)</td>
<td>Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been more recently destroyed.</td>
</tr>
<tr>
<td>Priority 1 (P1)</td>
<td>Poorly known taxa which are known from one or a few (generally&lt; 5) populations which are under threat.</td>
</tr>
<tr>
<td>Priority 2 (P2)</td>
<td>Poorly known taxa which are known from one or a few (generally&lt; 5) populations, at least some of which are not believed to be under threat.</td>
</tr>
<tr>
<td>Priority 3 (P3)</td>
<td>Taxa which are known from several populations, at least some of which are not believed to be under threat.</td>
</tr>
<tr>
<td>Priority 4 (P4)</td>
<td>Rare taxa which have been considered to have been adequately surveyed and which are not currently threatened by any identifiable factors.</td>
</tr>
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</table>

Environmental Protection Act 1986

Flora and ecological communities are protected under the Environmental Protection Act 1986 (EP Act). Threatened Ecological Communities (TECs) considered to be at risk are protected under the Clearing Regulations of the Act. Rare flora has the same meaning as it has in Section 23F of the Wildlife Conservation Act 1950.
Section 7

Biophysical Issues and Their Management

EPAWA (2000): Environmental Protection of Native Vegetation in Western Australia. Position Statement No. 2

The EPAWA regards biological diversity as being a key environmental factor in Western Australia. The EPAWA’s consideration of biological diversity when assessing a proposal will include:

1. “A comparison of development scenarios, or options, to evaluate protection of biodiversity at the species and ecosystem levels, and demonstration that all reasonable steps have been taken to avoid disturbing native vegetation.

2. No known species of plant or animal is caused to become extinct as a consequence of the development and the risks to threatened species are considered to be acceptable.

3. No association or community of indigenous plants or animals ceases to exist as a result of the Balmoral South Project.

4. There would be an expectation that a proposal would demonstrate that the vegetation removal would not compromise any vegetation type by taking it below the “threshold level” of 30% of the pre-clearing extent of the vegetation type.

5. Where a proposal would result in a reduction below the 30% level, the EPAWA would expect alternative mechanisms to be put forward to address the protection of biodiversity.

6. There is comprehensive, adequate and secure representation of scarce or endangered habitats within the Balmoral South Project area and/or in areas which are biologically comparable to the Balmoral South Project area, protected in secure reserves.

7. If the Balmoral South Project area is large (and what is meant by large will vary depending on where in the State) the Balmoral South Project area itself should include a comprehensive and adequate network of conservation areas and linking corridors whose integrity and biodiversity is secure and protected.

8. The on-site and off-site impacts of the Balmoral South Project are identified and the proponent demonstrates that these impacts can be managed.”

EPAWA (2002): Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3

The flora and fauna of Western Australia are recognised as being internationally significant. Essential to the EPAWA’s consideration of biodiversity is the quality of the data provided, especially in relation to terrestrial biological surveys.

The EPAWA states that “The key to a sound and transparent assessment of biodiversity is to have the community, proponents and consultants understand the overarching principles which form the basis of the EPAWA’s expectations when assessments are being undertaken.” The overarching principles are:

1. The EPAWA adopts the definition of Biological Diversity and the Principles as defined in the National Strategy for the Conservation of Australia’s Biological Diversity (Commonwealth of Australia 1996) and will have regard for these in undertaking its role.

2. The EPAWA expects proponents to demonstrate in their proposals that all reasonable measures have been undertaken to avoid impacts on biodiversity. Where some impact on biodiversity cannot be avoided, it is for the proponent to demonstrate that the impact will not result in unacceptable loss.

3. The EPAWA aims to ensure that the information gathered for environmental impact assessment in Western Australia meets State, National, and International Agreements, Legislation and Policy in regard to biodiversity conservation.

4. The EPAWA requires that the quality of information and scope of field surveys meets the standards, requirements and protocols as determined and published by the EPAWA.
Section 7

Biophysical Issues and Their Management

5. The EPAWA will use the Interim Biogeographic Regionalisation of Australia (IBRA) as the largest unit for EIA decision-making in relation to the conservation of biodiversity. The IBRA has identified 26 bioregions in the State, which are affected by a range of different threatening processes and have varying levels of sensitivity to impact.

6. The EPAWA expects proponents to ensure that terrestrial biological surveys provide sufficient information to address both biodiversity conservation and ecological function values within the context of the type of proposal being considered and the relevant EPAWA objectives for protection of the environment.

7. The EPAWA expects that terrestrial biological surveys will be made publicly available and will contribute to the bank of data available for the particular region, to aid the overall biodiversity understanding and assessment by facilitating transfer into State biological databases.

8. In the absence of information that could provide the EPAWA with assurance that biodiversity will be protected, the EPAWA will adopt the precautionary principle."

EPAWA (2004c): Guidance for the Assessment of Environmental Factors No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia

This Guidance Statement provides the general standards and a common framework for terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia, the quality and quantity of information that should be derived from these surveys, and the consequent analysis, interpretation and reporting. In addition, it is primarily directed at the subset of biodiversity contained in all terrestrial vascular plants.

This Guidance Statement should be used when preparing documentation for referral of proposals, planning schemes and their amendments to the EPAWA, as well as for formal assessment and audit. Terrestrial flora and vegetation surveys referenced in this PER used Guidance Statement No. 51 to ensure quality of surveys, data analysis and reporting was sufficient for EPAWA referral of the PER.

Agriculture and Related Resources Protection Act 1976

The Agriculture and Related Resources Protection Act 1976 protects agriculture and related resources through the management, control and prevention of certain plants and animals. Under the Act, a Declared plant means a declared plant of category P2, P3 or P4 and, in relation to public land and land under the control of a local government, includes a declared plant of category P5 (Table 7-3: Categories of Declared Plants). Pursuant to Part V of the Act, landholders are obliged to carry out recommended control measures, each specific to the species.

Table 7-3: Categories of Declared Plants

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>In respect of an area if the introduction into and movement within that area of those plants should, in the opinion of the Protection Board, be prohibited</td>
</tr>
<tr>
<td>P2</td>
<td>In respect of an area if those plants should, in the opinion of the Protection Board, be eradicated in that area</td>
</tr>
<tr>
<td>P3</td>
<td>In respect of an area if the numbers or distribution, or both, of those plants should, in the opinion of the Protection Board, be reduced in that area</td>
</tr>
<tr>
<td>P4</td>
<td>In respect of an area if those plants should, in the opinion of the Protection Board, be prevented from spreading beyond the places in which they occur in that area for the time being</td>
</tr>
<tr>
<td>P5</td>
<td>In respect of an area, if, in the opinion of the Protection Board, particular action should be taken in relation to those plants on land in that area that is public land or land under the control of a local government</td>
</tr>
</tbody>
</table>
Section 7

Biophysical Issues and Their Management

7.2.2 Definition of Issues and Impacts

Balmoral South Project Specific Impacts

Potential site specific impacts of the Balmoral South Project on flora and vegetation are described below.

Impacts at the Land System Level

Of the nine Land Systems impacted by the project, the Horseflats, Newman, Rocklea and Paraburdoo are widespread throughout the Pilbara, according to the Department of Agriculture Land System Mapping. The vegetation types occurring as part of these Land Systems in the project area are therefore also likely to be well represented and not regionally significant.

The River Land System is widely distributed in the region, but is not very abundant as it covers only a small proportion of the land surface, occurring in association with river systems. This vegetation type is significant due to this limited shape and particularly as it provides connectivity along a vast area of the landscape. In the event that such areas are severed for development clearing, this connectivity will be lost. The areas of this System in the project area (as for the land system as a whole) tend to be highly degraded by grazing and subsequent erosion and weed invasion. The degree of degradation is highly variable, with more stony areas resisting erosion and invasion by weeds and the more sandy and loamy areas being more degraded and often severely infested with *Cenchrus ciliaris* (Buffel grass). The areas of this Land System within the project area that are in good condition hold significant conservation value due to the degree of degradation of the System as a whole and the limited area of its occurrence of good quality representation.

Only 33.87 ha of the River Land System will be cleared by the Project, representing 0.03% of distribution within the Roebourne sub-region and 0.01% of distribution within the Pilbara Region.

The Boolgeeda Land System occurs as a single thin swathe in the study area and is associated with the stony lower slopes and plains found below hill systems. There are significant areas of this Land System to the north-east and south-west of the study area and while the portion within the project area is considered locally significant due to being a locally limited type, these values are considered well represented outside of the project area.

Within the Roebourne subregion, the Newman Land System will have the greatest proportion of clearing with 9.17% to be removed. Within the Pilbara region, the highest impact will be on the Paraburdoo Land System with a total of 1.52% of its extent removed (*Table 7-4: Total Area of Each Land System to be Cleared by the Balmoral South Project*).

### Table 7-4: Total Area of Each Land System to be Cleared by the Balmoral South Project

<table>
<thead>
<tr>
<th>Land System</th>
<th>Balmoral South Project (ha)</th>
<th>Total area of Land System within Roebourne Subregion (ha)</th>
<th>% cleared in Roebourne Subregion</th>
<th>Total area of Land System within Pilbara Region (ha)</th>
<th>% cleared within Pilbara Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boolgeeda</td>
<td>132.26</td>
<td>27,085.24</td>
<td>0.49</td>
<td>826,416.12</td>
<td>0.02</td>
</tr>
<tr>
<td>Cheerawarra</td>
<td>6.05</td>
<td>48,424.73</td>
<td>0.01</td>
<td>49,210.84</td>
<td>0.01</td>
</tr>
<tr>
<td>Horseflats</td>
<td>1284.33</td>
<td>297,358.74</td>
<td>0.43</td>
<td>328,911.14</td>
<td>0.39</td>
</tr>
<tr>
<td>Littoral</td>
<td>375.37</td>
<td>212,125.90</td>
<td>0.18</td>
<td>248,221.78</td>
<td>0.15</td>
</tr>
<tr>
<td>Newman</td>
<td>447.06</td>
<td>4,872.65</td>
<td>9.17</td>
<td>1,458,027.91</td>
<td>0.03</td>
</tr>
<tr>
<td>Paraburdoo</td>
<td>973.77</td>
<td>17,850.10</td>
<td>5.46</td>
<td>64,135.89</td>
<td>1.52</td>
</tr>
<tr>
<td>River</td>
<td>33.87</td>
<td>125,519.60</td>
<td>0.03</td>
<td>463,955.92</td>
<td>0.01</td>
</tr>
<tr>
<td>Rocklea</td>
<td>1452.11</td>
<td>43,182.63</td>
<td>3.36</td>
<td>2,428,593.74</td>
<td>0.06</td>
</tr>
<tr>
<td>Yamerina</td>
<td>592.13</td>
<td>119,391.09</td>
<td>0.50</td>
<td>120,270.82</td>
<td>0.49</td>
</tr>
<tr>
<td>Totals</td>
<td>5296.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Consideration of the extent of clearing combined with that required for the Central Block project indicates that 25.93% of the Newman Land System within the Roebourne sub region will be impacted by clearing, which comprises only 0.09% of the Land System’s extent within the Pilbara region. The next highest, Paraburdoo Land System, will have 8.31% of its extent within the Roebourne sub region and 2.31% of its extent within the Pilbara region cleared.

**Vegetation Clearing**

Approximately 5,282 ha of vegetation is expected to be cleared for the proposed mine and associated infrastructure (Table 7-5: *Areas of Direct Vegetation Clearing by Community Type*). This impact will be spread over 9 Land Systems, comprised of 22 separate vegetative communities and a total of 60 vegetative types.

*NB: Vegetation Communities not impacted by the project have been excluded*

<table>
<thead>
<tr>
<th>Vegetation Community</th>
<th>Balmoral South Project (ha)</th>
<th>Cumulative (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bx1</td>
<td>127.66</td>
<td>127.66</td>
</tr>
<tr>
<td>Hc1</td>
<td>0</td>
<td>19.02</td>
</tr>
<tr>
<td>Hpg1, Hpg2, Hpg3, Hps1</td>
<td>689.66</td>
<td>926.97</td>
</tr>
<tr>
<td>Lb</td>
<td>1.06</td>
<td>1.24</td>
</tr>
<tr>
<td>Ld1, Ld2, Ld3, Ld4</td>
<td>95.32</td>
<td>122.57</td>
</tr>
<tr>
<td>Lm</td>
<td>29.93</td>
<td>67.29</td>
</tr>
<tr>
<td>Lp1, Lp3, Lp4a, Lp4b, Lp5</td>
<td>87.13</td>
<td>90.04</td>
</tr>
<tr>
<td>Ls1, Ls2, Ls3a</td>
<td>142.77</td>
<td>298.73</td>
</tr>
<tr>
<td>Rc1, Rc3, Rc4</td>
<td>41.97</td>
<td>42.20</td>
</tr>
<tr>
<td>ROc1, ROc2, ROc4, ROc5, ROc6, ROc7, ROc8</td>
<td>50.58</td>
<td>84.03</td>
</tr>
<tr>
<td>ROp1</td>
<td>33.6</td>
<td>42.70</td>
</tr>
<tr>
<td>Mr4</td>
<td>226.58</td>
<td>226.58</td>
</tr>
<tr>
<td>Mp1</td>
<td>0</td>
<td>23.91</td>
</tr>
<tr>
<td>Pct, Pcs, Pf1</td>
<td>235.84</td>
<td>248.06</td>
</tr>
<tr>
<td>Pp1, Pp2</td>
<td>104.47</td>
<td>152.86</td>
</tr>
<tr>
<td>Px1, Px2, Px4, Px5</td>
<td>1495.16</td>
<td>2024.39</td>
</tr>
<tr>
<td>Nc</td>
<td>74.68</td>
<td>191.40</td>
</tr>
<tr>
<td>Nh, Nh1, Nh2, Nh3</td>
<td>413.85</td>
<td>1154.06</td>
</tr>
<tr>
<td>Nr, Nr3</td>
<td>0.16</td>
<td>2.35</td>
</tr>
<tr>
<td>Rf1, Rf2</td>
<td>432.29</td>
<td>518.64</td>
</tr>
<tr>
<td>Roh1, Roh1a, Roh1b, Roh2, Roh2b, Roh3a</td>
<td>998.10</td>
<td>1559.96</td>
</tr>
<tr>
<td>ROr, ROr2</td>
<td>1.61</td>
<td>5.29</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5282.42</strong></td>
<td><strong>7929.95</strong></td>
</tr>
</tbody>
</table>

There is a discrepancy between the area of land systems impacted by the project in Table 7-4 and the area of the vegetation communities in Table 7-5, a shortfall of about 15 ha. The reason for this is that at the land system scale, broad rivers containing water (including tidal areas) are included in the overall areal extent. However, when mapping the vegetation communities, this area is excluded. This occurs at the Mangrove creek crossing in particular.
Section 7

Biophysical Issues and Their Management

The EPAWA's position on the impacts of clearing on biodiversity states: "vegetation removal would not compromise any vegetation type by taking it below the "threshold level" of 30% of the pre-clearing extent of the vegetation type". Loss of vegetation below the threshold level results in an exponential loss of species and thus a significant loss of biodiversity (EPAWA 2000). Close to 100% of the pre-clearing extent of vegetation in the Pilbara Region currently remains. Special consideration was given to Balmoral South Project impacts on cracking clays of the Horseflats Land System and the phreatophytic vegetation of the River and Paraburadoo Land Systems. Combined, the Central Block and Balmoral South Projects are expected to directly impact on 7,929.95ha, or 0.08% of the Pilbara Region. The Balmoral South Project will not result in the loss of any vegetation type below the "threshold level" of 30%.

The condition of the vegetation within the project area ranges from Completely Degraded to Very Good with those areas of Very Good condition vegetation concentrated around the ore body. The pit area exhibits the best quality vegetation due to the rugged and inhospitable terrain limiting cattle grazing.

The majority of the vegetation is in Good condition and weed invasion is relatively high throughout both the project area and the region, due to intensive pastoral activity for a number of years. *Cenchrus ciliaris* (Buffel Grass) occurs extensively throughout the grassy plains, and is often dominant along waterways and drainage lines in the region. A high degree of erosion is also present throughout much of the project area, particularly along waterways due to a long history of cattle activity.

Impacts on biodiversity of the project area will be limited by clearing highly degraded vegetation, where possible, in preference to good condition vegetation. Removal of vegetation is unlikely to contribute to a reduction in species abundance within the Balmoral South Project area.

**Significant Flora**

No DRF or EPBC listed threatened species will be disturbed as a result of the proposed Balmoral South Project.

Portions of vegetation communities that are known to support two Priority species (listed below) will be cleared as a result of the Project; however, no Priority flora species or their habitats will be directly impacted by clearing.

- *Goodenia sp.* East Pilbara (AA Mitchell PRP 727) (P1) located within Pp2. Approximately 41 ha of Pp2 will be cleared; and
- *Phyllanthus aridus* (P3) located within vegetation community Pf1. Approximately 0.02 ha of Pf1 will be cleared.

**Dust**

Dust generated through mining activities and travel on unsealed roads has the potential to cause a decline in vegetation health. Dust can stress vegetation by blocking stomata that could reduce photosynthetic ability and limit plant growth (Martinick Bosch Sell 2006). The greatest impact will be to vegetation immediately adjacent to mining activities such as haul roads and mining pits. Samphire and spinifex vegetation is particularly susceptible to this type of physical damage and can take extended periods to recover (Halpern Glick Maunsell 2000).

**Introduction and / or Spread of Weeds**

Two species listed as declared plants under the Agriculture and Related Resources Protection Act 1976 were identified within the Balmoral South Project area. These are *Prosopis pallida* (Mesquite) and *Datura leichhardtii* (Native Thornapple). Earthworks and disturbance to vegetation has the potential to spread populations of these, and other, species of weeds.

Pursuant to Part V of the Agriculture and Related Resources Protection Act 1976, the landowner has an obligation to implement measures to control the spread of declared species.

**Cumulative Impacts as a Result of Pit Dewatering**
Indirect impacts will occur to vegetation within the Balmoral South Project area as a result of groundwater drawdown through mine dewatering. Riparian vegetation is extremely sensitive to changes in the hydrological regime and is therefore an effective indicator of stress to vegetation due to dewatering and drawdown. Phreatophytes rely on groundwater sources for water uptake (Busch et al. 1992, Halpern Glick Maunsell 1999) and often show low tolerance to extended water stress due to a lack of physiological and/or morphological adaptation to drought (Smith et al. 1998, Graham 2001). Phreatophytes respond to significant and/or rapid groundwater drawdown by a decline in health and eventual death (Halpern Glick Maunsell 1999, BHP 1997).

Groundwater drawdown is not expected to impact adversely on water pools as creeks such as the Du Boulay are generally dry and not considered functional aquatic ecosystems (Strategen 2008). Modelling has indicated that surface and groundwater flows in the creek alluviums will continue to occur seasonally, and that as a consequence the formation of pools will also continue.

Shallow-rooted species are not likely to be directly affected by dewatering and consequently some vegetation cover may be retained. However, as a result of the permanent loss of phreatophytic vegetation, understorey species may also be lost depending on the extent of drawdown, drawdown level and drawdown rate (Maunsell Australia 2006a).

The groundwater assessments are based on the predicted drawdown in the basement rock aquifers and the Fortescue River alluvium. Under mining conditions, the same seasonal recharge and throughflow cycle in the alluvium will occur. However, the water table in the basement will be much lower and not rise up to the alluvium and so leakage from the alluvium to the basement will continue whenever the alluvium is saturated. The likely impact of this is that groundwater flow through the alluvium may be reduced, but it will continue to occur seasonally. GDE's in the alluvium will still be supported by seasonal groundwater flows (Aquaterra 2008a).

The assessment of drawdown risk to vegetation does not take into account seasonal creek flows and perched water tables, which will be available to vegetation. In addition the cumulative drawdown impacts do not take into account the potential for perched and shallow alluvial aquifers to support phreatophytic vegetation and, accordingly, the impact of groundwater drawdown is likely to be significantly less severe than the modelling suggests (Aquaterra 2008).

Three phreatophytic species that occur within the Balmoral South Project area and are considered key indicators for GDEs are:

- Eucalyptus camaldulensis;
- Eucalyptus victrix; and
- Melaleuca argentea.

BHP (1997) suggests that Melaleuca argentea is an indicator of shallow water tables, and is unlikely to occur where depth to groundwater exceeds 2 m to 3 m. To determine fatality or potential fatality to phreatophytic vegetation the 3m drawdown contour was used. The 3m drawdown contour is deemed a suitable critical value to determine the impact on phreatophytic vegetation within the Balmoral South Project area.

Dewatering of the Balmoral South pit will induce drawdown in groundwater levels around the pit, which will potentially impact vegetation within the Balmoral South Project area, particularly GDEs. The lateral and vertical extent of the “cone of depression” in groundwater level will be dependent on the nature of local and regional aquifers, the depth of the pit and the “interference” effects of dewatering at the nearby Central Block (Aquaterra 2008).

A numerical groundwater model was developed during 2001 using Modflow, and was initially set up to predict groundwater level drawdown resulting from the Central Block Project. During 2008, an upgraded model was developed that allowed for simulation of multi – pit developments. The 2001 flow model was upgraded with newly available data and captures an increased hydrological understanding of the system. The upgraded model was used to assess the dewatering requirements and impacts for both the Balmoral South and Central Block Projects (Aquaterra 2008).
Section 7
Biophysical Issues and Their Management

Groundwater modelling indicates that the cumulative impacts of dewatering operations from the Central Block and the Balmoral South projects will result in one large elongated cone of depression. The majority of this drawdown cone is a direct result from dewatering that will occur within the Central Block Project, with a smaller area of drawdown as a direct result of dewatering from Balmoral South (Figure 7-1: Phreatophytic Vegetation Impacted by the Cumulative 3 m Drawdown Contour). However, comparison of the 3 m drawdown contour with the phreatophytic vegetation indicates that this smaller drawdown area encompasses a larger area of phreatophytic vegetation. This is explained by the dendritic nature of the drainage lines, which converge into more defined channels when passing through the ranges on which the ore bodies are located.

The upgraded model predicts that drawdown, under cumulative abstraction conditions, will not extend as far to the north or south as that originally predicted for the Central Block Project (Aquaterra 2008). That is, the cumulative impacts associated with groundwater drawdown are in fact less than that approved for the original Austeel (Central Block) project in 2003.

Table 7-6: Areas of Phreatophytic Vegetation Impacted by Groundwater Drawdown summarises the areas of phreatophytic vegetation that will be impacted by pit dewatering from the Balmoral South Project alone and by the Balmoral South and approved Central Block projects combined. The table also shows the total area of phreatophytic vegetation communities within the broader area, bounded by the general purpose and mining lease boundaries currently held by Mineralogy.

The most significant project impact relates to potential loss of phreatophytic vegetation (representing 8 vegetation types). The areas listed in the table below indicate the total area of each vegetation community that supports phreatophytic vegetation that will be impacted as a result of groundwater drawdown excluding the area that will be directly impacted by clearing activities. Since the vegetation in these areas will be cleared, it is not appropriate to include them as being impacted by the effects of drawdown.

As a worse case, Balmoral South is predicted to impact 460 ha as a result of groundwater drawdown, which, when combined with the Central Block drawdown impacts, amounts to 1,271 ha. This is significant at a local level, however, the impacts are much lower when considered at the subregional and regional level.
# Section 7

## Biophysical Issues and Their Management

### Table 7-6: Areas of Phreatophytic Vegetation Impacted by Groundwater Drawdown

<table>
<thead>
<tr>
<th>Phreatophytic vegetation community</th>
<th>Balmoral South Project (ha)</th>
<th>Cumulative Impact (ha)</th>
<th>Total area of phreatophytic vegetation within Cape Preston vegetation survey areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pc – Eucalyptus victrix, E. camaldulensis woodland over Acacia coriacea, Mesquite high shrubland over open herbland</td>
<td>139.52</td>
<td>258.56</td>
<td>369.66</td>
</tr>
<tr>
<td>Pc2 – Eucalyptus victrix open woodland over Acacia coriacea high shrubland over Cenchrus sp. tussock grassland</td>
<td>0.02</td>
<td>13.96</td>
<td>34.97</td>
</tr>
<tr>
<td>Pc3 – Eucalyptus victrix open woodland over Acacia coriacea high shrubland over Triodia capita open curly spinifex grassland and Cenchrus ciliaris open tussock grassland</td>
<td>0.00</td>
<td>0.00</td>
<td>14.05</td>
</tr>
<tr>
<td>Pc4 – Eucalyptus victrix scattered trees over Acacia ancistrocarpa high open shrubland over Sorghum spp. open annual tussock grassland and Triodia wiseana very open hummock grassland</td>
<td>2.54</td>
<td>3.09</td>
<td>3.09</td>
</tr>
<tr>
<td>Rc2 – Melaleuca argentea, Eucalyptus camaldulensis open forest over patches of Acacia coriacea high shrubland over Cenchrus sp. tussock grassland</td>
<td>0.00</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Rc3 – Eucalyptus camaldulensis woodland over patches of Melaleuca glomerata high shrubland over patches of Cyperus vaginatus sedgeland</td>
<td>41.89</td>
<td>96.03</td>
<td>187.12</td>
</tr>
<tr>
<td>Rc4 – Eucalyptus victrix and E. camaldulensis woodland over patches of Melaleuca glomerata high shrubland over Cenchrus sp. tussock grassland</td>
<td>7.33</td>
<td>109.44</td>
<td>493.78</td>
</tr>
<tr>
<td>Rf1 – Eucalyptus victrix open woodland over Cenchrus spp. tussock grassland</td>
<td>268.75</td>
<td>790.21</td>
<td>3064.26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>460.05</strong></td>
<td><strong>1,271.43</strong></td>
<td><strong>4,167.07</strong></td>
</tr>
</tbody>
</table>
Figure 7-1: Phreatophytic Vegetation Impacted by the Cumulative 3 m Drawdown Contour
7.2.3 Management

A Project Environmental Management Plan (PEMP) has been prepared to document the management measures and monitoring actions to manage impacts on vegetation and flora during construction and operation (Section 4 of PEMP in Appendix A). In general terms, impacts on flora and vegetation communities will be managed through a process of workforce education, avoidance, minimising disturbance, monitoring impacts, implementation of remedial strategies where practical, and rehabilitation. The Balmoral South Project will implement the following management practices for the protection of terrestrial flora and vegetation:

- minimising adverse impacts of activities on vegetation and flora;
- minimising the extent of clearing required for construction and operational activities;
- recognising the outcomes of flora and vegetation surveys in detailed design and, where possible, ensure that significant species are avoided;
- preventing disturbance of vegetation adjacent to areas of activity;
- controlling erosion and sedimentation within disturbed regions;
- restoring / rehabilitating areas which are not required to remain permanently cleared;
- monitoring the effectiveness of vegetation, overburden and topsoil management measures;
- undertaking weed control and reduction programs within its area of control;
- induction, training and active management of employees and contractors to ensure that areas outside those to be cleared will not be impacted; and
- responding adaptively to results of the vegetation monitoring programme.

The Balmoral South Project Construction Manager or Operations Manager will also implement a minimum clearing policy on site such that:

- clearing for temporary activities will be scheduled to minimise the time between initial clearing and rehabilitation, and will be staged to allow for the local migration of mobile fauna species;
- areas will be cleared only when required and where necessary;
- ground disturbance permits will be completed and authorised by the relevant manager prior to any ground disturbance; and
- clearing is done in a manner that maximises salvage and retention of topsoil and organic matter.

To assess the impacts on terrestrial flora and vegetation during construction and operation of the Balmoral South Project, some management objectives are specifically addressed in other sections of the PEMP, including:

- to implement management measures for weed control (in particular, Mesquite and Native Thornapple, as they are listed as Declared Plants under the Agriculture and Related Resources Protection Act 1976) is specifically addressed in PEMP Section 5 (Weed Control);
- to protect phreatophytic vegetation where possible, particularly along creek lines, for fauna habitat and refuge is specifically addressed in PEMP Section 13 (Groundwater Management);
- to consider erosion control and sedimentation within disturbed regions is addressed in PEMP Section 12 (Surface Water Management); and
- to implement dust suppression measures to minimise dust impacts on adjacent vegetation is specifically addressed in Section 16 (Dust Management).
Section 7  Biophysical Issues and Their Management

7.3 Mangroves

7.3.1 Objectives and Standards

The Balmoral South Project objectives are to minimise the direct impacts to existing mangrove communities from construction of the service corridors and to provide sufficient tidal exchange upstream of the causeway for the maintenance of mangrove habitat condition and mangrove survival.

Relevant legislation and standards include:

- EPAWA (2001). Guidance for the Assessment of Environmental Factors No. 1: Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline; and

Mangrove Protection

The EPAWA recognises the significant ecological value of mangroves and identifies the Pilbara coast mangroves (tropical arid zone mangroves) as being of high conservation value and in need of protection from the potential impacts associated with industrial or other development of the region. In the context of mangrove protection, the environmental management of the Cape Preston area is subject to various planning initiatives and policies of the State Government administered through the Conservation Division of the DEC. The current status of these initiatives and policies is outlined below.

EPAWA (2001): Guidance for the Assessment of Environmental Factors No. 1: Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline

The mangroves associated with Cape Preston fall within Area 9 of the EPAWA Guidance Statement No. 1 (EPAWA 2001) (Figure 7-2: Cape Preston Mangrove Management Area). Guideline 3 of the Guidance Statement applies to areas that contain regionally significant mangroves that occur inside areas that have been designated as industrial areas.

The EPAWA's operational objective for Guideline 3 areas is that no development should take place that would significantly reduce the mangrove habitat or ecological function of the mangroves in these areas.

![Figure 7-2: Cape Preston Mangrove Management Area](image)

<table>
<thead>
<tr>
<th>Legend:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial area</td>
<td></td>
</tr>
<tr>
<td>Mangrove Management Area 9 (EPAWA 2001)</td>
<td></td>
</tr>
</tbody>
</table>
Section 7

Biophysical Issues and Their Management

EPAWA (2004d): Guidance for the Assessment of Environmental Factors No. 29: Benthic Primary Producer Habitat Protection for Western Australia’s Marine Environment

The EPAWA Guidance Statement No. 29 (EPAWA 2004d) sets out a framework for the assessment of proposals that may impact on Benthic Primary Producers (BPP) and the habitats that can or do support such communities, termed Benthic Primary Producer Habitats (BPPH). The Guidance considers that BPP are “predominantly marine plants (e.g. seagrasses, mangroves, seaweeds and turf algae), but include invertebrates such as scleractinian corals…”.

In this Guidance Statement, the EPAWA has provided a set of principles to be applied by proponents and the EPAWA when considering development proposals that may result in removal or destruction of, or damage to, marine benthic primary producer communities or the habitats which support them. The EPAWA uses the term Benthic Primary Producer Habitat throughout this Guidance Statement to mean the ecological units that are BPPH including the dominant BPP communities they support.

The EPAWA has also defined six categories of marine ecosystem protection and provided guidance on the amount of BPPH that may be lost due to development as a percentage of BPPH within a defined management unit for each category. These percentages are termed ‘cumulative loss thresholds’ that, if exceeded, will be used by the EPAWA as indicative of potential non-acceptability. However, given the difficulty of reliable measurement of the area of some BPPH and considering the difficulty of quantifying the ecological significance of their loss, these thresholds will not be used as rigid limits. The acceptability of BPPH damage / loss will in all cases be a judgment of the EPAWA based primarily on its assessment of the overall risk to the ecosystem integrity within a defined management unit if a proposal were allowed to be implemented.

The six categories of marine ecosystem protection and their corresponding cumulative loss thresholds are summarised in Table 7-7: Cumulative Loss Thresholds for BPPH within Defined Management Units.

Table 7-7: Cumulative Loss Thresholds for BPPH within Defined Management Units

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Cumulative loss threshold* (percentage of original BPPH within a defined management unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Extremely special areas</td>
<td>0%</td>
</tr>
<tr>
<td>B</td>
<td>High protection areas other than above</td>
<td>1%</td>
</tr>
<tr>
<td>C</td>
<td>Other designated areas</td>
<td>2%</td>
</tr>
<tr>
<td>D</td>
<td>Non-designated area</td>
<td>5%</td>
</tr>
<tr>
<td>E</td>
<td>Development areas</td>
<td>10%</td>
</tr>
<tr>
<td>F</td>
<td>Areas where cumulative loss thresholds have been significantly exceeded</td>
<td>0% net damage / loss (+ offsets)</td>
</tr>
</tbody>
</table>

Thresholds will be applied only after proponents can demonstrate to the EPAWA that all options to avoid / minimise damage / loss of the BPPH have been considered.

The Guidance Statement’s risk-based approach to assessing any implication for BPPH ecosystem integrity sets out several steps. The first is the definition of a ‘Management Unit’ for the purposes of applying the EPAWA Guidance. The Guidance considers that “a Management Unit would normally be approximately 50 km² (e.g. a rectangular area defined by a 10 km stretch of coastline extending 5 km offshore)” (EPAWA 2004d). The purpose of the Guidance is to focus the mind of proponents on the need to ensure that a proposed Management Unit is reasonable and defendable when considering the impact of a proposal on the ecological value and function (integrity) of the habitat of a specified benthic primary producer. As set out by the EPAWA, the Management Unit needs to be a geographical area which provides the most effective boundaries for the management of cumulative environmental impacts on ecological values and functions.
Section 7
Biophysical Issues and Their Management

The Management Unit defined for this assessment remains within the area zoned for industrial development at Cape Preston. As Category E in Table 7-7 therefore applies, the EPAWA’s cumulative habitat loss threshold target for BPPH habitat loss in this area is up to 10% of the mangrove habitat occurring within the Management Unit.

7.3.2 Definition of Issues and Impacts

An assessment of the known and potential impacts of the two service corridors on mangroves has identified the following issues:

- direct mangrove and algal mat habitat loss (clearing for causeway and associated works);
- indirect mangrove habitat loss as a result of modification to tidal hydrology and surface flows (extended ponding of mangrove roots, restricted tidal exchange/salinity increases, sedimentation/erosion changes, etc.);
- disturbance of potentially acid generating sediments;
- indirect mangrove habitat loss through sediment smothering of mangrove roots;
- indirect mangrove mortality as a result of hydrocarbon spill or leakages; and
- potential dieback of mangroves arising from dust generated by vehicles crossing the causeway.

Dot points 1 to 3 are addressed below and dot points 4 to 6 are considered to be of a localised or minor nature that can be addressed satisfactorily through construction related management plans.

An Environmental Management Plan (URS 2008) has been prepared for the Sino Iron Project Service Corridor to Cape Preston (now the Central Block Project) which would occupy the central section (80 m wide) of the eastern service corridor. That document provides a detailed assessment of the potential impacts to mangroves and includes environmental management measures for construction of the haulage road (and culverts) to be located within the eastern service corridor across a mangrove-lined tidal creek between the mainland and Cape Preston. The assessment provided in Sino Iron Project Service Corridor to Cape Preston EMP has been updated below to include the wider eastern service corridor (300 m wide) and the 250m wide western corridor that is proposed to contain a trestle / bridge structure. As the Central Block Project service corridor will be contained within the wider Balmoral South Project eastern corridor, the assessment below represents the cumulative impacts from both projects.

Direct Loss of Benthic Primary Producer Habitat (Mangroves and Algal Mats)

The location of the proposed service corridors have been overlayed on to mapping of mangrove and algal mat habitats to assist with an assessment of potential habitat loss (Figure 7-3: Management Unit for the Assessment of Mangrove and Algal Mat Habitats).
Figure 7-3: Management Unit for the Assessment of Mangrove and Algal Mat Habitats
An alignment for the eastern service corridor has been selected with the aim of minimising direct loss of mangrove habitat. The alignment of the corridor traverses high tidal flat areas that are largely devoid of mangroves and the creek crossing is in the upper reaches of a tidal creek system at a location where only a narrow band of mangroves fringe the creek channel approximately 30 m wide. The alignment is located as far to the east as is possible and still remains within the lease boundary. Mangrove habitats are typically shrublands dominated by *Avicennia marina* with minor species being *Rhizophora stylosa*, *Ceriops australis* and *Aegiceras corniculatum*. At higher elevations across the tidal flats the habitat is either bare mud flat (salt flat) or mud flat with patches of samphires (i.e. salt tolerant plants that typically occur on salt flats and tidal flat areas with very high soil salinities) or high tidal mud flat supporting algal mat. On the assumption that construction activities will require disturbance within the total footprint of the eastern service corridor (i.e. 300 m wide disturbance across the entire length of tidal flat crossing), the estimates of mangrove and algal mat habitat loss are 4.4 ha and 6.3 ha respectively.

The alignment of the western corridor traverses a broad creek (approximately 300 m wide) at a downstream location near the creek mouth. Mangroves in this area consist of a narrow fringe of shrublands and low forests dominated by *Avicennia marina* with minor species being *Rhizophora stylosa*, *Ceriops australis* and *Aegialitis annulata*. Algal mat habitat occurs on high tidal flats north of the creek crossing in the area where tidal flats abut the Cape Preston terrestrial habitats. Within the western service corridor footprint shown in Figure 7-3 there are 6.4 ha of mangrove habitat and 7.8 ha of algal mat habitat. For the purposes of this assessment it is assumed that construction within the western corridor will consist of a solid fill structure in the high tidal flats areas (i.e. where algal mats occur) and a trestle structure within mangrove areas and the broad creek crossing. On this basis a maximum of 7.8 ha of algal mat habitat will be lost. Construction of a trestle structure within mangrove areas should limit mangrove habitat disturbance to localised areas where piling operations and trestle construction activities will be required. For this assessment it is assumed that 20% (or 1.3 ha) of the mangrove area within the western corridor will be disturbed.

In addition to the algal mat habitat loss described above for the western and eastern corridors, a further 9.2 ha of algal mat occurs within the proposed Balmoral South Project footprint in the tidal flat area that is immediately adjacent to the Cape Preston Island and is located between the eastern and western service corridors (see Figure 7-3). This area is referred to as the “Central Portion” in Table 7-8: Assessment of BPPH Loss from Balmoral South Project and it assumed that this total area (i.e. 9.2 ha of algal mat habitat) will be reclaimed for Balmoral South Project infrastructure. There is no mangrove habitat occurring within the central portion.

To calculate the area of direct habitat loss and undertake an assessment within the framework of the BPPH guidance statement (EPAWA 2004d) the distribution of mangrove and algal mat habitats was mapped within the BPPH management unit shown in Figure 7-3. The area of the management unit is 50 km² and extends east from the western shoreline of Cape Preston and abuts the boundary of the proposed Regnard Marine Management Area (i.e. the mangrove management unit does not include any portion of the Regnard Marine Management Area within it). The mapping was undertaken by a mangrove specialist who digitised the distribution of mangrove and algal mat habitats on to high resolution (0.8 m pixel) ortho-rectified aerial photography flown over the Cape Preston area in October 2001.
Section 7

Biophysical Issues and Their Management

The total area of direct mangrove habitat loss associated with construction activities within the corridors was estimated to be 5.7 ha. The total area of mangroves within the management unit was calculated to be 502 ha, consisting of 188 ha from the western creek (i.e. the creek system that the proposed service corridors traverses) and 314 ha from the eastern creek systems. When considering the percentage loss (1.1%) from this Balmoral South Project, it is concluded that the direct loss of mangroves is low when compared to existing mangrove areas within the management unit and well under the 10% cumulative impact criteria stated in the BPPH Policy (see Section 6). The maximum loss of algal mat habitat (assuming disturbance across the entire width of the corridors and the central portion) is 23.3 ha which represents 5.8% of algal mat area within the BPPH management unit. No historical loss (human-related) to mangrove or algal mat habitat has occurred within the management unit.

Table 7-8 below summarises the potential BPPH direct habitat loss from the Balmoral South Project.

<table>
<thead>
<tr>
<th>BPPH Habitat</th>
<th>Area in Management Unit</th>
<th>Habitat Loss Estimates</th>
<th>Total Habitat Loss</th>
<th>% loss of Management Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mangroves</td>
<td>502 ha</td>
<td>1.3 ha</td>
<td>0 ha</td>
<td>4.4 ha</td>
</tr>
<tr>
<td>Algal Mat</td>
<td>401 ha</td>
<td>7.8 ha</td>
<td>9.2 ha</td>
<td>6.3 ha</td>
</tr>
</tbody>
</table>

Modification to Tidal Hydrology and Surface Flows

The construction of port infrastructure across tidal creeks and within the intertidal areas generally has the potential to modify tidal flows. Due to the lack of regular freshwater input into Pilbara zone mangroves from hinterland areas, tidal inundation is the dominant recharge mechanism responsible for maintaining the suitable groundwater / soil water conditions required for mangrove growth and survival. Modifications to tidal wetting and drying regimes can potentially impact mangroves. Case studies (Gordon 1988) involving the placement of infrastructure such as causeways, levees and roads across tidal creeks indicates that the changes to tidal flows arising from such structures may result in the following:

- localised erosion of creek banks in the immediate vicinity of the culverts;
- reduction in tidal flushing and the extent of tidal flat inundation in areas upstream from the restriction point. The decrease in tidal inundation may cause increasing groundwater / soil water salinities and this could result in loss of mangroves in marginal fringing environments which have high salinities under natural conditions; and
- impoundment of water at higher than natural levels, which can result in mangrove decline and death due to sustained inundation of pneumatophores and a decline in water quality. This ponding effect has been observed during spring tides in areas immediately upstream from the restriction point when ebbing spring tidal waters cannot recede to normal levels prior to the next incoming (flood) tide.

The EPAWA Guidance Statement for the Protection of Tropical Arid Zone Mangroves along the Pilbara Coast (EPAWA 2001) recognises the type of impacts described above and accordingly recommends the use of trestle structures within intertidal areas where possible. The western corridor will only include a trestle / bridge structure and hence is not expected to modify tidal flows. The eastern corridor will include a solid fill structure with culverts and in order to assess the potential for the above impacts to occur the following work was undertaken to determine existing tidal flows and the tidal levels required to inundate mangroves upstream of the tidal creek crossing and to model the tidal regime prior to and after construction activities:

- surveying of ground levels in mangroves upstream of the proposed eastern service location to characterise the tidal flat profile and determine the distribution of mangroves in relation to tidal levels (heights). Typically mangroves in these upstream areas occur as a narrow band (5 - 20 m wide) fringing narrow creek channels (5 - 10 m wide) and other minor drainage lines. The main
mangrove community was a shrubland (1 - 2 m high) dominated by *Avicennia marina* with *Ceriops australis* occurring as a minor species. Further landward of the mangroves were patches of samphire shrubs (i.e. a salt tolerant plant) and bare salt flats. A series of transects were surveyed at selected locations with each transect extending from the landward occurring salt flat, through the mangrove zone to the creek edge. The data obtained confirmed the tight correlation between surface elevation (i.e. position along the intertidal gradient) and mangrove zonation. Mean ground levels showed that the mangrove zone extended from 0.73 m AHD (lower limit on creek edge) to 1.31 m AHD (landward margin or upper limit of mangrove zone). Mean ground level in salt flat / samphire flat areas was 1.39 m AHD.

- aerial inspection of the mangrove system on Monday, 29 October 2007 during a spring tide period to view water flows (predicted high tide at 1315 hrs was 3.4 m CD or 1.4 m AHD). This inspection confirmed that the flood tide enters the tidal creek from the west and that there is no significant hydraulic connection via creek channels from the east between the mangroves which occur upstream of the causeway alignment and the large mangrove community which occurs immediately adjacent to the northeast. However, given that MHWS is 3.75 m CD or 1.75 m AHD and the surveyed ground levels of many of the high tidal flats (e.g. salt flats, samphire flats) that occur between the two major creek systems is approximately 1.4 m AHD, then it would be expected that during some spring tides, water would flow from the eastern creek system out onto the high tidal flats that surround the upper reaches of the western creek.

- Global Environmental Modelling Systems (GEMS) was engaged to undertake modelling studies to determine the effect of the proposed eastern service corridor on water levels upstream under a range of different scenarios. In an effort to minimise disturbance to water levels upstream, GEMS was originally requested to determine the cross-sectional area of culverts required to enable tidal floods to continue unhindered to MHWS for up to 80% of available time, and to ebb without ponding upstream of the causeway. GEMS advised that a total culvert opening of 250 m$^2$ was required to achieve the above. However, the design engineers responded that such a large area of culverts was technically impracticable and that the largest culvert area that it was feasible to provide was 109 m$^2$. GEMS was subsequently requested to model changes to tidal flows that would result from a total culvert / pipe cross-sectional area of 109 m$^2$.

Report “Tidal Flow Monitoring” (Appendix E) was originally part of the Sino Iron Project Causeway to Cape Preston EMP. It describes the modelling work undertaken to determine the effect of the proposed eastern service corridor on water levels upstream. GEMS used its GEMSURGE model run over three nested domains ranging from a simulation of the larger scale tidal dynamics in the Cape Preston region (100 m grid) to very high resolution simulations of the flow along the creeks to be crossed by the causeway (3 m grid). The principal sources of bathymetry / topography used in the model included a digital marine chart from Geosciences Australia and cadastral survey data obtained by Whelans (WA) Pty Ltd (surveyors) for the vicinity of the causeway alignment. The model has been validated against tidal data collected by GEMS at Cape Preston since October 2006.

GEMS has simulated the effect of the proposed 109 m$^2$ opening on tidal levels upstream of the service corridor to produce Figure 7-4: Comparison of Tidal Heights During a Spring Tide Event Before (Blue) and After (Red) the Eastern Service Corridor Culverts are Installed (GEMS 2008) which compares tidal heights during a spring tide event before (blue) and after (red) the culverts are installed, and shows that tidal levels above RL1.5 m AHD will no longer occur upstream of the service corridor, and that no ponding of waters upstream will occur either.
Other findings from the modelling included:

- the reduced cross-sectional areas across the tidal flats will create a head on the western side during the spring high tides and generate faster flow speeds through the culverts and potentially restrict the total mass of water passing through;

- the currents through the culverts at high spring tidal flows can reach 2 m/s and could potentially cause some local scouring without appropriate mitigation measures; and

- the period of tidal wetting at RL1.31 m AHD (i.e. landward margin of mangroves) during spring tides will be reduced by approximately 50%.

Assessment of the effect of the service corridor on mangroves fringing the creek upstream indicates that normal tidal flushing will occur over the majority of their zone of distribution (i.e. 0.73 to 1.31 m AHD - refer to Figure 7-4).

The reduction of tidal inundation at the landward edge of the mangrove zone predicted by the modelling has the potential to increase soil salinities and reduce soil moisture levels, resulting in tree stress. However, given that the mangroves upstream of the eastern service corridor occur as a very narrow band fringing the creek, the trees potentially impacted may only be one tree width and are likely to be low stunted shrubs. It is estimated that 7.8 ha of mangroves occur upstream of the eastern service corridor.

It is anticipated that the majority of the mangrove zone that occurs at lower levels in the tidal profile than the landward margin will not experience a significant change in tidal inundation and, as such, should remain healthy.
Given the level of the upper tidal flats (i.e. samphire / salt flats) was \(\sim 1.4\) m AHD, it is considered likely that some of these flats will be flooded to above RL1.5 m AHD from the mangrove creek to the east. If this does occur, then the upper tidal flats may still receive tidal flushing during spring tides. While it is difficult to accurately predict how much, if any, additional loss of mangroves may occur indirectly as a result of reduced flushing at the landward margin because of a lack of scientific understanding of mangrove wetting requirements, an estimate has been made based on an analysis of the wetting period shown in Figure 7-4. This shows that the tidal wetting period will not be reduced below 1.1 m AHD and therefore those mangroves potentially at risk are those that occur between 1.11 to 1.31 m AHD. Given that 7.8 ha of mangroves occur between 0.73 m and 1.31 m AHD, the area potentially at risk is equal to 36 % of the mangrove distribution range. This equates to 2.8 ha of mangroves which when added to the direct loss (5.7 ha) represents a maximum potential loss of 8.5 ha or 1.7% of the mangrove management unit. However, note that this represents a potential maximum loss of mangrove habitat and it is considered likely that the actual indirect loss will be less due to the contribution of tidal wetting from the eastern creek system during spring tides.

Further detailed geotechnical and topographic surveys of the causeway alignment are being undertaken and, once completed, opportunities will be investigated to refine the design of the causeway so as to further reduce the impact to mangroves.

### Potential Acid Generating Sediments

It is generally acknowledged that mangrove environments contain potentially acid generating soils. In its natural environment, some disturbance of acid sulphate soils (ASS) in mangroves may be considered low risk due to the surrounding highly alkaline environment and the continual neutralising effect of tidal flushing. However, excavation activities, if not properly managed, may play its part in the generation of a highly acid environment and the mobilisation of iron, aluminium and other heavy metals such as chromium and nickel, which may then flush into surrounding waterways.

The alignment of the service corridors intersects area that have been identified as ‘high to moderate’ risk for ASS by the Western Australian Planning Commission (WAPC) in Planning Bulletin No. 64 (WAPC 2003). ASS have been encountered during geotechnical work in Mangrove Creek.

In response, an ASS Management Plan (ASSMP) was prepared to comply with DEC requirements for the management of the potentially acid generating material as part of the Sino Iron Project (now Central Block Project) Causeway to Cape Preston EMP. This ASS Management Plan has served as a model for the Balmoral South Project ASS management actions (Section 18 of PEMP in Appendix A).

### 7.3.3 Management

The PEMP has been prepared to document the management measures and monitoring actions to manage the potential impacts of the service corridor on mangrove and other sensitive habitats during construction and operation (Section 6 of PEMP in Appendix A). The Balmoral South Project will implement the following management practices for the protection of mangroves:

- ensuring minimal impact is caused to existing mangrove communities and algal mat habitat;
- designing, constructing and operating the service corridor to provide sufficient tidal exchange to mangroves upstream of the tidal creek crossing for the maintenance of mangrove habitat condition and mangrove survival;
- implementing a mangrove monitoring programme to detect impacts to mangroves and provide protection during construction and operation;
- ensuring that the extension of the causeway does not reduce the tidal flows through the proposed culverts; and
- implementing an ASS Management Plan during construction of the causeway (refer Section 18 of PEMP in Appendix A).
Section 7

Biophysical Issues and Their Management

7.4 Terrestrial Fauna

7.4.1 Objectives and Standards

Balmoral South Project objectives for fauna include:

- minimise impact on abundance, species diversity, geographical distribution and productivity;
- protect specially Protected (Threatened) Fauna, consistent with the provisions of the Wildlife Conservation Act 1950;
- protect rare and endangered species listed under the Wildlife Conservation Act 1950;
- protect fauna listed on the Schedules of the Environment Protection and Biodiversity Conservation Act 1999;
- monitor and protect, where possible, species listed under the CALM Priority Fauna List; and
- protect other fauna species of particular conservation significance (e.g. undescribed taxa, range extensions, outliers).

Relevant legislation and standards include:

- Environment Protection and Biodiversity Conservation Act 1999;
- Wildlife Conservation Act 1950;
- Environmental Protection Act 1986;
- EPAWA (2002). Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3;
- EPAWA (2004f). Environmental Protection of Wetlands. Position Statement No. 4; and

Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) protects fauna considered to be of national environmental significance. A description of classification categories is provided in Table 7-9: Categories of Threatened Fauna.

Table 7-9: Categories of Threatened Fauna

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex</td>
<td>Extinct. Taxa not definitely located in the wild during the past 50 years.</td>
</tr>
<tr>
<td>ExW</td>
<td>Extinct in the Wild. Taxa known to survive only in captivity.</td>
</tr>
<tr>
<td>CE</td>
<td>Critically Endangered. Taxa facing an extremely high risk of extinction in the wild in the immediate future.</td>
</tr>
<tr>
<td>E</td>
<td>Endangered. Taxa facing a very high risk of extinction in the wild in the near future.</td>
</tr>
<tr>
<td>V</td>
<td>Vulnerable. Taxa facing a high risk of extinction in the wild in the medium-term.</td>
</tr>
<tr>
<td>NT</td>
<td>Near Threatened. Taxa that risk becoming Vulnerable in the wild.</td>
</tr>
<tr>
<td>CD</td>
<td>Conservation Dependent. Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.</td>
</tr>
<tr>
<td>DD</td>
<td>Data Deficient (Insufficiently Know). Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.</td>
</tr>
</tbody>
</table>
**Wildlife Conservation Act 1950**

The *Wildlife Conservation Act 1950* protects native fauna in Western Australia. A description of classification categories of species of fauna listed under Schedule 1 to 4 is provided in *Table 7-10: Classifications of Schedule Fauna*.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule 1</td>
<td>Fauna that is rare or likely to become extinct are declared to be fauna that is in need of special protection.</td>
</tr>
<tr>
<td>Schedule 2</td>
<td>Fauna that is presumed to be extinct are declared to be fauna that is in need of special protection.</td>
</tr>
<tr>
<td>Schedule 3</td>
<td>Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction are declared to be fauna that is in need of special protection.</td>
</tr>
<tr>
<td>Schedule 4</td>
<td>Fauna that is in need of special protection, otherwise than for the reasons mentioned [in Schedule 1 – 3].</td>
</tr>
</tbody>
</table>

Priority fauna not listed as Threatened (Scheduled) under the *Wildlife Conservation Act 1950*, but poorly known or poorly represented in the conservation estate are regarded as Priority and attention is given to their conservation, primarily through improving available information, by DEC. The four classifications of priority fauna are listed in *Table 7-11: Classifications of Priority Fauna*.

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority 1</td>
<td>P1</td>
<td>Taxa with few, poorly known populations on threatened lands.</td>
</tr>
<tr>
<td>Priority 2</td>
<td>P2</td>
<td>Taxa with few, poorly known populations on conservation lands.</td>
</tr>
<tr>
<td>Priority 3</td>
<td>P3</td>
<td>Taxa with several, poorly known populations, some on conservation lands.</td>
</tr>
<tr>
<td>Priority 4</td>
<td>P4</td>
<td>Taxa in need of monitoring – considered to have been adequately surveyed.</td>
</tr>
<tr>
<td>Priority 5</td>
<td>P5</td>
<td>Taxa in need of monitoring – not considered threatened.</td>
</tr>
</tbody>
</table>

**Environmental Protection Act 1986**

Fauna and faunal habitat are protected under the *Environmental Protection Act 1986*.

**EPAWA (2002): Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3**

Essential to the EPAWA’s consideration of biodiversity is the quality of the data provided, especially in relation to terrestrial biological surveys. A description of the EPAWA’s overarching principles, which form the basis of the EPAWA’s expectations when assessments are being undertaken, is described under Relevant Legislation for the protection of native flora Section 7.2.1.

**EPAWA (2004f): Environmental Protection of Wetlands. Position Statement No. 4**

In relation to fauna, wetlands are recognised as important wildlife habitats. They are among the most biologically productive and diverse habitats on the planet. They directly and indirectly supply food to a broad range of animals including micro-organisms, invertebrates, fish, birds, mammals and reptiles. The Position Statement on wetland protection defines important environmental values and functions of wetlands and establishes principles for the environmental protection of wetlands in general.
Section 7  Biophysical Issues and Their Management

EPAWA (2004b): Guidance for the Assessment of Environmental Factors No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia

Guidance Statement No. 56 provides information to proponents, consultants and the general public on the EPAWA’s requirements for terrestrial fauna and faunal assemblage surveys and resulting survey reports.

Terrestrial fauna surveys referenced in this PER used Guidance Statement No. 56 to ensure quality of surveys, data analysis and reporting was sufficient for EPAWA referral of the PER.

7.4.2 Definition of Issues and Impacts

Species Specific Impacts

The DEC database enquiry of the Balmoral South Project area returned results on two threatened species and seven Priority species. However, based on the type of habitats that exist within the Balmoral South Project area, only two of these species are considered to be potentially impacted by the proposal:

- *Leggadina lakedownensis* (Lakeland Downs Mouse, Kerakenga). This species is listed as a Priority 4 species and occurs on the cracking clay habitat that is widespread in the region and well represented in the conservation estate; and
- *Ardeotis australis* (Bustard). This species is listed as a Priority 4 species and occurs in association with the Fortescue River system. It was sighted in the Balmoral South Project area during the 2006 field survey.

Priority species that are known to occur outside of the Balmoral South Project area include:

- Little North-Western Mastiff Bat;
- Western Pebble Mound Mouse;
- Beach Stone Curlew; and
- Far Eastern Curlew.

These species have never been sighted within the Balmoral South Project area however given that they have been recorded in adjacent areas appropriate management measures for the protection of these species should also be developed.

The Little North-Western Mastiff Bat (*Mormopterus loriae cobourgiana*) was recorded in 2000 in the mangrove vegetation community at Cape Preston, north of the project area. They are restricted to mangrove forests and adjacent areas (Churchill 1998).

No targeted bat survey was undertaken during the 2006 field investigations but recommendations were made to undertake such surveys.

The bat fauna of the Cape Preston region were surveyed (Phoenix Environmental Services 2008b) using the non-invasive Anabat echolocation call recordings with a total of eight species being identified with a medium to high level of confidence.

The species identified were; Gould’s wattled bat (*Chalinolobus gouldii*), Northern free-tailed bat (*Chaerephon jobensis*), Western little free-tailed bat (*Mormopterus loriae cobourgiana*), Unidentified long-eared bat (*Nyctophilus sp.*), Yellow-bellied sheath-tailed bat (*Saccolaimus flaviventris*), Little broad-nosed bat (*Scotorepens greyii*), Common sheath-tailed bat (*Taphozous georgianus*) and Finlayson’s forest bat (*Vespadelus finlaysoni*).

The Little North-Western Mastiff Bat was not recorded during these surveys.

Consultation with EPBC personnel revealed that the following nationally significant threatened species may occur within or near the Balmoral South Project area:

- *Dasycercus cristicauda* (Mulgara);
Biophysical Issues and Their Management

- *Rhinonicteris aurantius* (Pilbara form) (Pilbara Leaf-nosed Bat); and
- *Morelia olivacea barroni* (Olive Python).

The Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) is restricted to caves and abandoned mines. Colonies have been found in three distinct areas: in the mines of the eastern Pilbara; scattered throughout the Hamersley Range in smaller colonies; and in sandstone formations south of the Hamersley Range. The extent of the occurrence of the Pilbara Leaf-nosed Bat is 122,447 km², bounded by records from Red Hill Station and Barlee Range Nature Reserve in the west; Cattle George and surrounding areas in the north; Copper Hills mine near Nullagine in the east; and Mt Vernon Station and Paraburdoo in the South. The foraging range of the Pilbara Leaf-nosed Bat is considered to be typical of that exhibited by other species of bats, e.g. within 10 km from their roost.

Maunsell (2008) (Appendix C) concluded that it is unlikely that the Project area supports colonies of the Pilbara Leaf-nosed Bat due to:

- there being no caves or abandoned mines within the Project area, nor were there any sightings of the Pilbara Leaf-nosed Bat despite targeted searches;
- colonies are confined to three distinct areas within the Pilbara, specifically in the Hamersley Ranges, south of the Hamersley Ranges and in the Eastern Pilbara. These areas are located hundreds of kilometres east and south of the Project area and exhibit different landforms to those identified in the Project area;
- given the distance between known colony sites and the Project area, and the bat’s short range (10 km from their roosts), it is highly unlikely that the bat would utilise the Project area for foraging; and
- there have been no recordings of the Pilbara Leaf-nosed Bat within the Project area during the Anabat echolocation survey undertaken by Phoenix Environmental Services (2008b). Historical data indicate that the extent of their occurrence is limited to the 122,447 km² identified above, hundreds of kilometres from the Project area.

Based on the type of habitats that exist within the Balmoral South Project area, it is considered that the Olive Python and Mulgara could potentially be impacted by the Balmoral South Project.

The Olive Python is known to occur within rocky outcrops of the Fortescue River System. Both the Newman and Rocklea land systems may contain rocky outcrops, which, if in close association to waterholes and drainage lines, could form suitable habitat for the Olive Python. Approximately 489 ha and 353 ha of the Newman and Rocklea land systems, respectively, will be cleared within the Balmoral South Project area which could potentially impact upon the availability of suitable habitat for the Olive Python. It is important to note however that the Olive Python has never been sighted within the region in which the Balmoral South Project area is located. Targeted searches were conducted for this species in the 2008 field survey (Phoenix Environmental Sciences, 2008b). Little evidence was found to suggest that Pilbara Olive Python occurs within the Project area during the survey; there are virtually no permanent water bodies adjacent to suitable habitat within the Project area. One permanent artificial pool was observed, however this water body is not considered to have been present long enough to have supported local colonisation by the species. Furthermore, the Balmoral South Project does not significantly directly impact on rivers and streams. Accordingly, the potential for impacts on this species is considered to be minimal.

The Mulgara occurs within drainage lines near sandy plains and dunes. The littoral land system may contain Spinifex within sand dunes and sandy plains which may form suitable habitat for the Mulgara. Approximately 340 ha of the littoral environment will be cleared for the stockpile, retention pond and desalinisation plant which could reduce the availability of suitable habitat for the Mulgara.
**Section 7  
Biophysical Issues and Their Management**

A recent survey (Phoenix Environmental Sciences, 2008b – in prep) targeted these potential habitats and has determined that it is highly unlikely that Mulgara will be present within the Balmoral South Project area. No individuals, or secondary evidence of individuals, were recorded within the Balmoral South Project area. A closer inspection of the dune system on which it was thought possible that Mulgara may exist determined that it was, in fact, unsuitable as habitat.

The EPBC database search revealed that two nationally significant migratory terrestrial bird species may also occur within the Balmoral South Project area. These are the Rainbow Bee Eater (Merops ornatus) and the White Bellied Sea Eagle (Haliaeetus leucogaster).

The Rainbow Bee Eater has been observed in the Balmoral South Project area, particularly along the river and creek lines. The Bee Eaters prefer to excavate burrows for breeding and they are described as quite common in the region (Flegg 2002). As the Balmoral South Project does not directly impact significantly on rivers and streams, the potential for impacts on this species is considered minimal.

Simpson and Day (1999) describe the habitat of the White Bellied Sea Eagle as being large rivers, lakes, coastal seas and islands. This species is considered widespread but erratic in distribution and rarely common (Flegg 2002). The individual sighted was making opportunistic use of standing water within the Fortescue River. As this is outside the Balmoral South Project’s direct area of influence, it is considered unlikely that the Balmoral South Project will have any impact on this species.

Section 7.6 addresses issues relating to migratory shorebirds.

Work conducted on Short Range Endemics (SRE’s) in the Cape Preston area is provided by Phoenix Environmental Science (Appendix L).

There is currently no formal Environmental Protection Authority guidance on the preferred survey methods for terrestrial SRE invertebrates in the context of EIA. Survey methods employed were based on Phoenix’s previous experience in undertaking SRE surveys in the Southwest, Goldfields, Midwest, Pilbara and Kimberley regions of Western Australia.

The methods employed adhere to the principles and guidelines outlined in EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002) and EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004b).

Overall it is considered that the likelihood of recording SRE invertebrate taxa within the Cape Preston Iron Ore Precinct is generally low as there are few landscape and biogeographical features present that would drive short-range endemism. In particular, the area contains few disjunct habitats and is relatively low-lying. The maximum height above sea level is 59 metres, averaging approximately 30 metres across sections of the Newman Land System.

This rise of just 10 – 20 metres above the surrounding alluvial plains is considered insufficient to produce a vegetation change from east to west that would indicate the potential for SRE species. Further, the floristic condition of the area is generally poor, due to its long history of cattle grazing, which has led to infestation of Mesquite and the presence of Buffel Grass and Bidens along the major and minor drainage systems.

The north-south orientation of the range also limits the number of south-facing slopes, which favour micro-climate formation and hence act as a refuge for historically isolated fauna species. The majority of creek lines tend east-west as they drain off the north-south trending ridge line. The ironstone outcrops, which are divided by the minor creek systems (except for the relatively large DeBoulay Creek) are the only existing isolated habitats within the study area.

There is little shade, leaf litter accumulation or soil to harbour species, such as millipedes and mygalomorph spiders. As expected, specimens of these groups were only recorded during foraging activities in cracking clay and alluvial plain habitats. Despite collecting only a few formally described species, most of the species recorded during the survey do not appear to be short-range endemics either because they are habitat generalists or were collected from multiple locations across significant distances (including reference sites).
The development of the Balmoral South Project has the potential to impact on SRE species through the removal of habitat (primarily through the excavation of the open pit).

The Balmoral South and Central Block Projects will not result in significant loss of any single land system (Section 7.2.2), and sampling has demonstrated that all species collected within the footprint of the proposed Balmoral South Project exist in areas outside of the predicted Balmoral South or approved Central block projects.

It is concluded that the Balmoral South Project, considered either singularly or cumulatively with the approved Central Block Project has a low risk of causing significant impact on SRE numbers, distribution or diversity.

**Habitat Loss and Modification**

Impacts on fauna in the Balmoral South Project area will largely occur due to habitat loss or modification. Vegetation clearing will potentially remove nesting hollows for bird species or the protection of the spinifex plains for smaller ground dwelling mammals. Minimal impacts on fauna are likely to result from operational activities such as dust and noise. The primary areas where fauna will be affected include the orebody, plant sites, waste disposal facilities, and access roads. The majority of potential faunal impacts are likely to have no adverse long term impact on the environment and can be managed through the implementation of routine management procedures and safeguards.

**Indirect Fauna Impacts**

Short-term loss of fauna species is likely to occur in and adjacent to the Balmoral South Project area during the construction phase due to increased noise levels, creation of dust and generally high levels of disturbance during the construction phase. An increase in noise and disturbance levels may deter fauna from inhabiting the surrounding areas which may contain possible breeding sites.

High levels of vehicle traffic during the construction phase may result in increased numbers of fauna road casualties. Direct infrastructure relating to mine construction and operations such as fencing and drill holes also have the potential to cause fauna deaths and injury and limit migration and movement within their normal range.

With the implementation of appropriate management measures and safeguards, risk to fauna will be maintained at a level where the Balmoral South Project activities are unlikely to result in long term negative impacts on the local fauna, except to result in some migration away from the Balmoral South Project area due to habitat loss.

**Cumulative Impacts from Pit Dewatering**

Pit dewatering is also likely to have an impact on fauna that is dependent on phreatophytic vegetation. Impacts associated with groundwater drawdown and its management is discussed in Section 7.8.2.3.

**7.4.3 Management**

The PEMP has been prepared to document the management measures and monitoring actions to manage the potential impacts of construction and operational activities on terrestrial fauna (refer Section 7 of PEMP in Appendix A). The Balmoral South Project will implement the following management practices for the protection of terrestrial fauna:

- ensuring barriers to native fauna are kept to a minimum;
- excluding domestic pets, traps and firearms from the Balmoral South Project Area;
- undertaking clearing at the time of the year least likely to impact breeding or nesting species;
- minimising the loss of fauna linkage corridors such as Du Boulay Creek;
- preventing native fauna, including snakes, from being deliberately impaired or killed by mine site personnel, and only destroying them as a last resort by a designated and trained person;
Section 7

Biophysical Issues and Their Management

- checking any trenches or open excavations at nominal times at the start and end of each day (within 2 hours of sunrise and 2 hours prior to sunset) for fauna and removing fauna as soon as possible without damage to the animal;
- installing barricading where practical, such as capping drill holes, to prevent fauna entry; and
- providing suitable instruction on environmental issues as part of the mine site induction process to ensure that employees are aware of their environmental responsibilities and are competent to carry out their work in an environmentally responsible manner.

Trench length and excavation time will depend upon the physical nature of the area excavated and the logistics of the services being installed. IM does not envisage that any significant lateral services will be installed, and as such, the length of any single open trench will be capped at 1,000m. Egress ramps will be installed at 100m intervals.

IM will manage the construction of open trenches such that in the event of a cyclone impacting on the area, excavation activity will be reduced, and installation activity increased such that a maximum of 100m is left open at the time of operational shutdown.

A land snail survey was undertaken in October 2008, within two days of the first seasonal rains, and is not considered to have recorded any additional species to those recorded during the foraging effort in the main survey in September 2008. Further work on the samples collected is required to confirm the identification and status of the non-marine land snails (mollusc) species collected.

Although taxonomic determination of the land snails collected in the survey is still pending, it is expected that up to seven species will be resolved. Preliminary information suggests that all of these appear to be widespread across the range and local area. Final survey results will be available for the “Response to Public Submissions” phase of the assessment process.

7.5 Subterranean Fauna

7.5.1 Objectives and Standards

The Balmoral South Project objective is to maintain the biological diversity of subterranean fauna through the avoidance or management of adverse impacts.

Relevant legislation and standards include:

- *Environmental Protection Act 1986*;
- *Environment Protection and Biodiversity Conservation Act 1999*;
- EPAWA (2003). Guidance for the Assessment of Environmental Factors No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia; and

7.5.2 Definition of Issues and Impacts

Impacts of the Balmoral South Project

Stygofauna

It is unlikely that development of Balmoral South will have any effect on the conservation of stygofauna species. With 15 species recorded, Balmoral South is not rich in stygofauna and all species present are known to be more widely distributed (Table 4-3, Figure 4-13 and literature on Pilbara stygofauna).
Section 7  

Biophysical Issues and Their Management

Troglofauna

Overall, the troglofauna collected at Balmoral South appears to represent a subset of the Central Block troglofauna community, with six of the nine species recorded at Balmoral South also known at Central Block. It is not surprising that the same fauna extends through both areas, which are geologically similar, connected and only 3 km apart. Although there has been little sampling of Brockman Iron Formation outside the mine-site, it may reasonably be inferred that the troglofauna species present at Balmoral South will also occur in this habitat.

Of the three species recorded at Balmoral South but not the Central Block, the centipede Cryptos sp. B2 (nr australis) occurs in surface litter outside the area to be mined. The millipede Polyxenida sp. B1 was recorded as a single individual and has an unknown distribution. Polyxenida millipedes occur across the Pilbara with little morphological differentiation, so the status of the Balmoral South animal is uncertain. The silverfish Trinemura sp. B1 (nr troglophila), also collected as a single individual, is similar to T. troglophila from Cape Range and also has an unknown distribution. The apparent restriction of these species to Balmoral South is likely to be an artefact of a single animal being collected.

Depth to groundwater within the Balmoral South Project is about 20-35 m and water is mostly fresh (1500-7000 mg/L TDS), although more saline water has also been recorded. Depth to groundwater in the surrounding alluvium is 5-15 m and groundwater has similar salinity (600-7000 mg/L TDS). Some de-watering (up to 300 m, although much less over most of the area) will occur in most of the Brockman Iron Formation habitat at Cape Preston as a consequence of the development of both Balmoral South and the Central Block.

In consultation with DEC, a succinct risk-based assessment on the basis of currently available information in the scientific literature and relevant ecological theory has been carried out (Appendix D). The following issue has been discussed:

- groundwater drawdown and the persistence of troglofauna in the mapped area in Figure 7-5: Subterranean Fauna Habitat in the Cape Preston Region; and
- the level of uncertainty that exists on the relationship between groundwater drawdown and fauna habitat

Small perched pools of water should remain throughout the fractured rock after de-watering, especially if de-watering is achieved by drainage through pit walls and collection of the inflowing groundwater in sumps within the pit (Aquaterra 2008). Some indication of the quantity of water remaining in the system is given by the fact that long-term discharge into the Central Block pit void will be at least 50 % of the discharge when the pit is first opened (0.9 compared 1.7 ML/day, Aquaterra 2008).

It is unlikely that groundwater drawdown of the order of 25-50 m poses a threat to the Balmoral South troglofauna community where it occurs outside mine pits at Cape Preston. The principle threat from groundwater drawdown is thought to be decrease in humidity but such decrease appears unlikely at Cape Preston. There is both theoretical and modeling evidence suggesting there will be no change in humidity in the habitats currently occupied by the troglofauna community. It appears likely that drawdown will, in fact, increase the extent of available troglofauna habitat (Appendix D).

Based on the inferred distribution of troglofauna species through most of the ranges at Cape Preston and minimal detrimental effects of dewatering, it is unlikely that development of Balmoral South will affect conservation of troglofauna species found in the proposed pit. However, further survey to document the troglofauna community more fully is needed to complete the risk assessment.

Cumulative Impacts with the Central Block Project

In addition to the stygofauna species collected from Balmoral South, two amphipod species (identified from report photographs Melitidae sp. 1 and Nr Wesniphargus sp.) and two worm species of the families Phreodrilidae and Tubifidae have been collected from the Central Block. All these taxa have wider distributions (Halse et al. in prep.) and it is unlikely that development of Balmoral South and Central Block will cumulatively have a significant adverse effect impact on stygofauna conservation values.
Section 7
Biophysical Issues and Their Management

The Central Block supports a rich troglofauna community of at least 18 species. In broad terms it is a similar community to that occurring in the Robe Valley, with both areas supporting schizomids, pseudoscorpions, centipedes, bristle-tails and silverfish (Biota 2006). The Central Block also supports beetles and isopods, which are widespread troglofauna elements in Western Australia, but appears to lack spiders, cockroaches and millipedes.

McConchie studied the Joffre and Whaleback Shale Members of the Brockman Iron Formation and determined that particular banding within the stratigraphy could be correlated over tens, and tentatively hundreds, of kilometres. The Balmoral South project is located in the Cape Preston area of Western Australia and aims to extract Magnetite that is present as bands within the Joffre BIF Member of the Brockman Iron Formation. The geology of the Balmoral South Deposit is identical to that of the Central Block Deposit, which also contains the Joffre BIF Member of the Brockman Iron Formation that will be mined by Citic Pacific Mining. The Central Block Deposit is located along the same strike to the north of Balmoral South. The ore bodies at both Balmoral South and the Central Block exhibit the same Brockman Iron Formation stratigraphy. These two deposits are separated by a later stage intrusive, expressed on the surface as the Du Boulay Creek and visible in the aeromagnetic data (Blockley 2008).

Given the Balmoral South and Central Block deposits are less than 3 kilometres apart, it is valid to assume that the two deposits will exhibit the same geological (chemical and physical) characteristics (Blockley 2008).

As argued for Balmoral South, it is likely that the troglofauna community at the Central Block extends beyond the proposed mine site into the outcropping Brockman Iron Formation that will not be mined or dewatered and, therefore, the community will not be at risk from the cumulative impacts of both projects (Figure 7-5: Subterranean Fauna Habitat in the Cape Preston Region). Whether all, rather than most, species extend into surrounding habitats remains to be confirmed through sampling.

De-watering impacts within the surrounding areas should not affect the quality of troglofauna habitat because a significant amount of water will remain in the system for the duration of mining, as demonstrated by long-term daily flow of groundwater into the mine remaining above 50 % of maximum inflow as the pit is dug (Aquaterra 2008).
7.5.3 Management

Based on the inferred distribution of troglofauna species through most of the ranges at Cape Preston, and minimal detrimental effects of dewatering, it is unlikely that development of the Balmoral South Project will impact troglofauna species found in the proposed mine pit. However, a precautionary approach to the management and monitoring of subterranean fauna will be implemented for the Balmoral South project (refer PEMP, Appendix A).

In order to ensure progress toward the achievement of the management objectives outlined in Section 8 of the PEMP, IM will undertake the Balmoral South Troglofauna Distribution Study (the “Study”). This Study will be completed prior to pit dewatering or open pit development activities. These activities will not commence prior to 24 months post Ministerial Consent.

The purpose of the Study is to examine the distribution of the Cape Preston troglofauna community and its constituent species. To ensure the management objectives outlined in PEMP Section 8 are met, the specific outcome of the Study is to demonstrate that the troglofauna community on the Balmoral South Project area is part of the Cape Preston community across all the ore bodies and / or are part of a wider Pilbara community.

To achieve this outcome the following activities will form part of the Study:

- an investigation of the relationship between troglofauna presence and changes in groundwater levels in relation to habitat through monitoring changes in troglofauna species presence in areas affected by dewatering over a suitable period during and after the mining operations;
- additional sampling of bores and leaf litter on the Cape Preston northern orebody and further sampling to the extent of the southern orebody;
Section 7

Biophysical Issues and Their Management

- taxonomy analysis of species found at Cape Preston with species found in the wider Pilbara Region (subject to samples being made available); and

- assessment of the additional information to consider:
  - how far the community extends beyond areas proposed for mining;
  - the ranges and conservation status of component species;
  - how the species from Cape Preston relate to those at other Pilbara orebodies; and
  - whether the members of the troglofauna community sometimes come to the surface, thus aiding dispersal.

7.6 Marine Ecology

This section addresses the potential impacts associated with construction of the brine outfall pipeline and the seawater intake. Operational impacts associated with brine outfall (discharge) and the seawater return outfall, and cumulative impacts of a second outfall at Cape Preston are addressed in Section 8.5. A full report is provided in Appendix F – Marine Impact Assessment.

7.6.1 Objectives and Standards

The Balmoral South Project objectives for the construction of the seawater intake, brine outfall pipeline and diffuser are to ensure:

- there are no significant impacts to sensitive Benthic Primary Producers (BPPs) or the habitats which support them (BPPH), as a result of construction activities;
- that the seawater intake is not hazardous to marine fauna; and
- to avoid loss of coastal habitat, specifically at Cape Preston beach, and
- to avoid significant disturbance the migratory shorebirds, dugongs and marine turtles.

Relevant legislation and standards include:

- EPAWA (2004d). Guidance for the Assessment of Environmental Factors No. 29: Benthic Primary Producer Habitat Protection for Western Australia’s Marine Environment. Application of the Guidance is discussed in Section 7.3.1;
- Environmental Protection Act 1986;
- Environment Protection and Biodiversity Conservation Act 1999; and

The EPBC Act lists migratory species that are recognised under international treaties such as CAMBA, JAMBA and the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals). Those species listed in JAMBA are also protected under Schedule 3 of the WA Wildlife Conservation Act 1950. Fauna species included under conservation acts and / or agreements are formally recognised as of conservation significance under State and / or Federal legislation.

7.6.2 Definition of Issues and Impacts

7.6.2.1 Seawater Intake and Brine Discharge

The plant seawater intake will be located in 8 m of water at Lowest Astronomical Tide, approximately 1,900 m NNE of Cape Preston. (Figure 2-10)
Section 7

Biophysical Issues and Their Management

The seawater is transported on-shore via a buried HDPE pipeline under natural head pressure. Subject to final design, the seawater intake system and components will resemble Figure 7-6: Typical Seawater Intake System and is described more fully in Sub-section 2.11 of Section 2 - Project Description.

The flow streamlines will be controlled so that the take off velocities of the extreme bottom and the extreme top streamlines into the InvisiHead™ would have no suction effect on the floor and top sediments. At maximum plant capacity, the maximum entrance velocity is 0.091 m/s rising from a maximum approach velocity of 0.0025 m/s. The InvisiHead™ technology surpasses the principles of Integrated Pollution Prevention and Control (detailed in European Union Reference Document on the application of Best Available Techniques (BAT) to Industrial Cooling Systems: Dec 2001) for the selection, design and operation of cooling water systems and effluent discharge.

The brine discharge system will be similar, except with outflow. An outfall pipeline is proposed to carry concentrated brine and filter backflush water to a discharge diffuser located approximately 1,600 m northeast of Cape Preston, in 7 m of water at Lowest Astronomical Tide. (Figure 2-10)

Figure 7-6: Typical Seawater Intake System

7.6.2.2 Trench and Pipeline Construction

The majority of the seawater intake and brine discharge pipelines will be trenched, commencing at the Desalination Plant allocated area, under the beach and into the seafloor to the intake and outfall diffusers.

The trench will be some 4 m wide by 3 m deep, with a volume of approximately 30,000 m³ of marine sediment to be removed. Excavation will be by barge mounted excavator, with spoil transported back to shore for sorting and potential use as selected backfill in the trench.

The pipelines will be constructed on-shore, floated out to position, and sunk into the trench using concrete ballast blocks to keep the pipelines in place until buried.

The backfill used for the trench bottom and pipeline surrounds will be de-slimed engineered coarse material, to ensure no damage to the HDPE or GRP. The trench will then be topped with lump rock for protection against sea movement damage.

The total task is anticipated to take between two and three months depending on the weather.

7.6.2.3 Environmental Impacts

The construction of the outlet pipeline and diffuser has the potential to:

- directly impact sensitive BPPH as a result of trenching activities for the installation of the pipeline; and,
- cause a localised decline in water quality as a result of pipeline construction activities, mainly turbidity.
Section 7

Biophysical Issues and Their Management

Benthic habitat mapping conducted for the Balmoral South Project area has identified that the pipelines and diffusers would be located in an area of low environmental sensitivity, mainly consisting of algal dominated limestone pavement and deep sand / silt. These habitats are deemed to be of low sensitivity due to their widespread distribution in the greater region of the Balmoral South Project.

The area in the vicinity of the outfall site was inspected by URS in May 2008. This dive survey confirmed that the brine discharge outfall will traverse an area of shallow sand veneered or exposed limestone pavement. Where the limestone pavement is exposed, a sponge, feather star and sea-whip garden community of filter feeding invertebrates colonises the seafloor. The sand seafloor is primarily rippled medium-coarse grains over pavement in a thin 1-10 cm veneer.

Marine Turtles and Dugongs

Sea turtles are listed threatened and migratory species under the EPBC Act 1999 and dugong are listed migratory species. Both Threatened Species and Migratory Species are matters of National Environmental Significance (NES) under the EPBC Act. As indicated in Section 4.12.3 both turtles and dugong are known to occur in nearshore waters between Dampier and Exmouth, and small numbers of turtles are believed to nest on the beaches on the west side of Cape Preston. The size of the dugong population in this region is not reliably known, but sightings of single dugong have been made by field survey teams in the region on more than one occasion.

Studies by URS (Appendix F) indicate that the Cape Preston area has not been identified to support an ecologically significant proportion of the population of either dugongs or turtles within the Pilbara region. Furthermore, given the fact that disturbances from operation and construction will be localised, it is very unlikely they will have any significant impact on dugongs and turtles that do use the area.

Population studies of Dugongs in the Pilbara region undertaken in the 1980's identified that the greatest dugong concentrations occurred in areas between Middle and North Mangrove Islands, Regnard Bay, Nickol Bay and the Dampier Archipelago. Follow up surveys in April 2000 estimated population numbers to be 2046 (± s.e. 376) dugongs, at an average density of 0.10 dugongs per km². This study also confirmed that the greatest populations occurred in those areas reported in the 1980's study (Marsh, et.al 2002).

Benthic Habitat mapping undertaken by URS has confirmed that the Cape Preston area does not contain habitat considered significant for dugongs, which includes large expanses of shallow water with dense seagrass meadows.

A report by Pendoley Environmental to URS stated that snap shot surveys undertaken over three separate turtle nesting seasons (2000/01 02/03, 04/05) identified that during these seasons very limited nesting was taking place on Cape Preston. These results showed that nesting effort was clearly less intense than other areas surveyed, including Cowrie Beach and Mundabullangana Station.

Pendoley Environmental also reported that although green turtles have been observed to use the near-shore algal-rock benthic community as feeding habitat, no mating activity has been observed.
Marsh et.al. (2002) stated that although individual dugongs and turtles may be impacted by industrial construction and operational disturbances, population level effects are unlikely.

The environmental effects of brine discharge on dugongs, turtles or other large marine fauna have not been studied at other desalination plants. However, there is no information available that suggests brine discharge will have a negative effect on dugong or turtle health. Furthermore, there are many examples of dugongs and turtles living in marine areas with elevated salinities.

Dugongs and marine turtles are large, highly mobile animals. Because of their mobility, it is expected that exposure to environmental conditions within the mixing zone, even if they were to be adverse, will be minimal.

Significant impact guidelines are available which provide criteria for use in determining if a proposed action will have a significant impact on a matter of NES. The criteria for listed migratory species are reproduced in the box below from the EPBC Act policy Statement 1.1 (May 2006).

### Significant impact criteria for Listed Migratory Species

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

### What is important habitat for a migratory species?

An area of ‘important habitat’ for a migratory species is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- habitat that is of critical importance to the species at particular life-cycle stages; and/or
- habitat utilised by a migratory species which is at the limit of the species range; and/or
- habitat within an area where the species is declining.

### What is an ecologically significant proportion?

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an ‘ecologically significant proportion’ of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species’ population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates).

### What is the population of a migratory species?

‘Population’, in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.

No habitat that will be disturbed by construction and operation of the outfall is “important habitat for a migratory species”. The location is mobile sand veneered limestone pavement which supports little to no seagrass. Habitat mapping undertaken by URS in 2007 indicates that *Halophila sp.* seagrass patches have been recorded in the shallow sand habitat on the western side of SW Regnard Island as well as in the lee of Fortescue Island. Sparse seagrasses also occur on the shallows to the west of Cape Preston. Surprisingly, the areas which support the densest and largest patches of *Halophila* seagrass occur in the deep water basin (>15 m) which is located some 8-10 km to the north of Cape Preston.

Significant impact guidelines are also available which provide criteria for use in determining if a proposed action will have a significant impact on a threatened species. These criteria are reproduced below from the EPBC Act policy Statement 1.1 (May 2006).
On the basis of the above criteria and preceding discussion, it is considered highly unlikely that construction and operation of an additional brine outfall at Cape Preston will have a significant impact on the regional population of sea turtles, particularly given that much more important breeding and nesting areas occur in the Montebello Islands which occur some 70 km to the west of Cape Preston, and in the islands of the Dampier Archipelago, which occur about 50 km to the east of Cape Preston. In addition, operation of the outfall will not affect the beaches to the west of Cape Preston where small numbers of turtles are believed to occasionally nest.

Hence it is considered that construction and operation of an additional brine outfall at Cape Preston will not have a significant impact on dugongs, turtles or other large marine fauna populations in the region surrounding Cape Preston.

Significant impact criteria for Listed Threatened Species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population;
- reduce the area of occupancy of the species;
- fragment an existing population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of a population;
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species’ habitat;
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

What is a population of a species?

A ‘population of a species’ is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations; or
- a population, or collection of local populations, that occurs within a particular bioregion.

What is an invasive species?

An ‘invasive species’ is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

What is habitat critical to the survival of a species or ecological community?

‘Habitat critical to the survival of a species or ecological community’ refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.
Migratory Shorebirds

In considering the significance of the Cape Preston area for migratory bird species, survey results were benchmarked against the two criteria under the Ramsar Convention for identifying wetlands of international importance (Hassell 2002). These are defined as sites that regularly support:

- 20,000 or more waterfowl (including shorebirds); or
- 1% or more of the individuals in a population of one species or sub-species of waterfowl (including shorebirds).

The number of migratory shorebirds present at Cape Preston was well below the twenty thousand figure used for identifying areas of international importance. However, two species, Ruddy Turnstone and Sanderling, were present in numbers greater than the 1% criteria used to determine an area of international importance (Hassell 2002). These species and the majority of other shorebirds were recorded from roosting sites within coastal habitat (inter-tidal mudflats, sandy beaches and dunes) stretching from the southern side of Preston Creek to the tip of Cape Preston (i.e. the western shoreline of Cape Preston) and therefore, these coastal habitats are considered sensitive habitats and will be protected as far as practicable. The survey of the beach to the east of Cape Preston concluded that this beach does not appear to have favourable feeding or roosting habitat and is not considered to be a sensitive habitat for shorebirds.

The potential impacts on shorebirds from the Balmoral South Project’s activities include:

- loss or disturbance of habitat from construction of port facilities and service corridors within or close to coastal habitats;
- disruption of shorebird feeding and roosting behaviour from access to the beaches, mangroves and tidal creeks;
- disruption of shorebird behaviour from lightspill and noise emissions from the port’s land-based facilities; and
- introduction or spread of feral animals (e.g. foxes, dogs).

The proposed infrastructure at Cape Preston will be located away from the main roosting and feeding areas for migratory shorebirds on the western shoreline of Cape Preston. Localised disturbance within tidal flat habitats may occur during construction activities; however, this would be minor when consideration is given to the mobility of shorebirds and the extensive areas of tidal flats habitat available for shorebird in the Cape Preston area and the broader region (many kilometres of tidal flats occur along the Pilbara coast between Karratha and Onslow). Based on observations from the major migratory shorebird site at Roebuck Bay, Broome it would appear that shorebirds are generally tolerant of limited disturbance from light and noise (Hassell 2002).

Other Marine Fauna

The humpback whale, listed as vulnerable under the EPBC Act, migrates along the Western Australian Coast in winter and early spring. Along parts of the migratory route there are narrow corridors and bottlenecks resulting from physical and other barriers where the majority of the population passes close to shore (i.e. within 30 km of the coastline). These habitat areas are important during the time of migration and in Western Australia include areas around Geraldton/Abrolhos Islands, and Point Cloats to North West Cape. Calving takes place of the Southern Kimberley between Broome and the northern end of Camden Sound and there are resting areas located around Exmouth Gulf, Shark Bay and Geographe Bay (Department of Environment and Heritage 2005). The whales are not known to aggregate in the waters offshore Cape Preston, but it is possible that individuals, as well as small pods of dolphins pass through the area. The impacts on these species of construction and operation of an additional brine outfall at Cape Preston for the Balmoral South Project are considered little to no risk.
Section 7

Biophysical Issues and Their Management

It further should be noted that seasnakes have been observed to occur in the proposed area. Wells and Walker (2003) reported that occurrence of the following six species in the Dampier Archipelago: *Aipysurus laevis*, *Astrotia stokesii*, *Ephalophis greyi*, *Hydrelaps darwiniwnsis*, *Hydrophis sp.* and *Fordonia leucobalia*. The impacts on these organisms of construction and operation of an additional brine outfall at Cape Preston for the Balmoral South Project are considered little to no risk.

**7.6.3 Management**

**Brine Outfall and Diffuser**

The PEMP also documents the management measures and monitoring actions associated with construction of the brine outfall pipeline and diffuser, and discharging brine and filter backwash into the marine environment (Refer Section 17 of PEMP in Appendix A). The Balmoral South Project will implement the following management practices:

- protecting sensitive habitats from construction and layout of the pipeline;
- protecting sensitive habitats from the operation of the pipeline outfall;
- protecting all social values (swimming and fishing);
- developing a monitoring program of ecosystem health indicators in the receiving marine environment, and selecting appropriate control sites for inclusion in the monitoring programme;
- monitoring the effectiveness of wastewater outfall management measures; and
- adaptively responding to inadequacies in controls through preventative action.

**Marine Turtles and Migratory Shorebirds**

The management measures and monitoring actions proposed to manage the potential impacts on marine turtles and migratory shorebirds and their habitats are presented in the PEMP (Refer Sections 10 and 11 of the PEMP in Appendix A). The PEMP recognises the importance of specific areas for wading birds and turtles and the Balmoral South Project avoids these areas to ensure their protection from Balmoral South Project-related impacts. The Balmoral South Project will implement the following management practices for the protection of marine turtles and migratory shorebirds:

- control of access to nesting beaches;
- appropriate lighting design and use to avoid impact on turtles;
- management of drainage;
- implementation of feral animal control programmes;
- training / induction of employees /contractors; and
- control of small vessel movements.

**7.7 Surface Water**

This section summarises the results of the surface water assessment for the Balmoral South Project and the implications for cumulative impacts from the adjacent Central Block Project. The full assessment is provided in Appendix G (Balmoral South Iron Ore Project – Surface Water Management Plan).
Section 7

Biophysical Issues and Their Management

7.7.1 Objectives and Standards

The approved Central Block Project will impact upon the surface water regime of the region. These impacts have been quantified and management plans developed as part of the Central Block Project approvals (including the Fortescue Iron Ore Project: Surface Water Management, Waste Dump Encroachment Fortescue River Floodplain, and Erosion and Runoff, (Aquaterra 2007a)). The Balmoral South Project area lies south and upstream of Central Block Project.

The surface water investigations focus on the potential impacts of mining operations at the Balmoral South Project that are additional to those of the currently approved Central Block Project. This section presents an assessment of the cumulative impacts of both projects.

The objectives with regards to surface water are to:

- maintain the integrity, functions and environmental values of watercourses and sheet flow; and
- maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected.

Applicable Guidelines and Standards include:

- DoW Water Quality Protection Guidelines; and
- ANZECC and ARMCANZ Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

7.7.2 Definition of Issues and Impacts

7.7.2.1 Investigations

Encroachment into the Fortescue River Floodplain

All proposed mine infrastructure is to be located above the Fortescue River 100 year ARI floodplain. WDF1 will potentially impact river flood levels adjacent to the site. A flood frequency analysis for the river was performed on stream flow data provided by the Department of Water, and the design 100 year ARI flood flow was estimated at 9,570 m$^3$/s.

There is a significant “break-out” area downstream of the North West Coastal Highway and south of Coolangara Hill, which redirects high level flood water away from the main channel system, in a north-west direction towards the coast. Break-out flows eventually exit to the ocean, at anywhere up to 10 km west of the main Fortescue River channels. A significant volume of flow could be diverted away from the main channels, but as the main purpose of the investigations and modelling was to gauge relative water levels in the river, the full flow of 9,570 m$^3$/s through the main river channels was assumed.

To gauge the impact of the encroachment into the floodplain, investigations and modelling were undertaken and a hydraulic backwater analysis program (HEC-RAS) was used to simulate flow conditions in the Fortescue River. Background information comprised stream flow gauging data, aerial photography and 1:50,000 topographical mapping. Detailed survey cross sections of the river channel and floodplains were obtained. Waterway roughness values (Manning’s n) were estimated from site observations, photographs (including aerial) and maps.

Predicted rising sea levels and the possible increase of cyclonic events (due to climate change) may increase the risk of storm surge. However, the Balmoral South Project is 11 km from the coast and too far upstream to be directly impacted by sea levels and storm surge (or backwater from flood events affected by sea levels and storm surge). A starting downstream river water level of RL4.0 m at the river mouth was adopted for the modelling, based on observed debris levels. This is higher than the HAT (Highest Astronomical Tide) and therefore considered conservative.
A number of studies have been carried out previously on the predicted flood levels adjacent to the Central Block Project waste dump within the Fortescue River floodplain, immediately to the north. This encroachment raises base flood water levels at the north end of the Balmoral South Project, and was included in the flood modelling to ascertain cumulative impact of the two projects.

The HEC-RAS model showed that, with both the Central Block Project waste dump and WDF1 included in the model, the impact of the Balmoral South Project was to extend the raised Central Block Project river flood levels upstream and south through that project (Figure 7-8: 100 Year ARI Flood Levels in the Fortescue River). The Balmoral South Project had no further impact on increasing maximum flood levels, over and the ‘natural’ river flood levels. Specifically, the 100 year ARI flood levels were estimated to increase by up to 0.30 m at the south end of the landform, or by up to 0.37 m when compared with existing conditions (i.e. with no encroachment from either project into the floodplain included).
Figure 7-8: 100 Year ARI Flood Levels in the Fortescue River
The increased flood levels return to existing levels approximately 3 km upstream of the Balmoral South Project WDF. The North West Coastal Highway 15 km to the south of the Balmoral South Project remains unaffected.

**Encroachment into the Du Boulay Creek Floodplain**

Du Boulay Creek flows in a north-westerly direction through the general Balmoral South Project area, and joins the Fortescue River approximately 6 km from the coast. The creek has an estimated 100 year ARI flood flow in the order of 1,000-1,600 m³/s (calculated using “Australian Rainfall and Runoff”, revised 1998). The proposed mine infrastructure area encroaches into the Du Boulay Creek 100 year ARI floodplain. By bunding off a proportion of the floodplain adjacent to the proposed pit and plant site, flow is restricted in width during large flood events, and causes water levels to rise adjacent to the site. Downstream of the plant site, Du Boulay Creek is confined between the Central and Southern ore bodies, where the floodplain width is reduced by proposed bunding to about 350 m wide.

To gauge the impact of the encroachment into the floodplain, a HEC-RAS model was developed and used to simulate flow conditions in Du Boulay Creek. Background information comprised aerial photography, topographical mapping, surveyed cross sections and estimated roughness values. The 100 year ARI flood levels were predicted to increase by a maximum of 1.4 m, from about 1.0 m-1.6 m in the vicinity of the plant (Figure 7-9: 100 Year ARI Flood Levels in Du Boulay Creek).

![Figure 7-9: 100 Year ARI Flood Levels in Du Boulay Creek](image-url)
7.7.2.2 Potential Impacts

Encroachment of WDF1 and Other Infrastructure

Due to encroachment of WDF1 and the consequent removal of a portion of the floodplain, flow is restricted in width during large flood events, and flood levels and flood velocities in the area will rise. WDF1 pit bunds and plant and processing platforms will be located above flood waters with suitable freeboard. The bunds will remain as permanent feature within the floodplains, and as such are certain to be subject to extreme flood events. It is proposed to protect fringing works from local and general scour, in areas of higher velocities, and where deeper flow channels are impacted by the works.

The actual western edge of the 100 year ARI Fortescue River floodplain is difficult to define due to the lack of accurate topographical information available. As a consequence, the changes in flow redistribution brought about by the increase in flood levels near the Balmoral South Project and the potential flood level rises at the western edge, are difficult to define. It is anticipated that flood level rises adjacent to the Balmoral South Project will be less than those predicted.

Open Pit

The proposed open pit area is located between Du Boulay Creek and the Fortescue River. There are a number of small ephemeral creeks which drain the hill and which will be disturbed by the open pit. The pit perimeter is all located on down slopes, and therefore all creek drainage is away from the open pit. If the pit, at all stages of development, is centred on the top of the hill, there will be no requirement for external surface water management from the ridge area.

The pit is also proposed to extend into the Fortescue River and Du Boulay Creek floodplains and bunding within these two waterways will be required.

Village Site

The proposed village site is located 8km south of the plant site in the north-east corner of Lease Area M08/130. Hydraulic modelling shows that parts of the proposed village site lie within the flood fringe of the Fortescue River, and DuBoulay Creek located 2 km to the north east also has the potential to break out west towards the Fortescue River and impact the village site. Figure 7-8 shows approximately 50% of the village site is within the fringe of the 100 year ARI Fortescue River floodplain. All main infrastructure and accommodation facilities will be situated in the portion of the site that is above the 100 year ARI Fortescue River floodplain. The other portion of the site may be used for facilities such as sports fields or other uses that will not be significantly damaged by flooding. Parts of the site will also be raised and or banded, the impacts have been assessed and are deemed localized in nature.

Erosion and Sedimentation

The Pilbara landscape is subject to extreme climatic events such as high rainfall intensities and storms associated with cyclonic activity. The risk of erosion and sedimentation can therefore be high, particularly on disturbed or degraded lands. Surface water management requires an integrated approach, defining the discrete catchment / drainage areas, and allowing appropriate engineering solutions. Sediment basins need to be considered for each disturbed catchment /drainage area to prevent sediment (and other contaminants) from entering drainage ways.

Potential surface water impacts include:

- interruption to the existing surface water flow patterns;
- reduction of surface water runoff volume and quality in the downstream environment;
- impact on downstream vegetation communities that may be dependent on this drainage;
- discharge of various chemicals, including hydrocarbons;
- impacts from haul roads and other infrastructure; and
- pooling of water and growth of invasive vegetation in low-lying areas and sediment basins.
WDFs and stockpiles have the potential to discharge sediment laden water to the environment, and surface runoff in general will typically be sediment laden. Pollutant loads in water courses downstream of mine operations may also include oil and grease.

### 7.7.3 Management

The PEMP documents the management measures and monitoring actions proposed to manage potential impacts associated with surface water (Refer Section 12 of PEMP in Appendix A). Surface water management principles have been applied during the Balmoral South Project planning and design phases. The engineering design of the Balmoral South Project will incorporate site-specific surface water controls including diversion and dispersion mechanisms, and erosion and sedimentation controls. The Du Boulay and Edwards creeks are generally dry and are not considered functional aquatic ecosystems (Strategen, 2008). If the Du Boulay creek is considered to be an aquatic ecosystem, then it should be recognized that when the Du Boulay creek is flowing due to seasonal rainfall, the Balmoral South Project will not impact on the hydrological regime of the creek, and therefore is not expected to impact on any temporal aquatic values. For this reason, the objectives, targets, monitoring measures and management actions described in the Balmoral South PEMP are aimed at protecting the environmental values of the aquatic systems of the Fortescue River. The Balmoral South Project will implement the following management practices to minimise the impacts on surface water:

- maintaining the integrity, functions and environmental values of watercourses and sheet flow;
- maintaining the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance, is protected;
- building the Balmoral South Project infrastructure above the 1:100 year flood levels or armouring infrastructure to withstand flood velocities;
- diverting the upstream surface water flows around structures, where feasible, with appropriate grades into adjacent or downstream defined surface flow paths;
- divert local Project runoff into sediment traps prior to discharging downstream;
- keeping surface runoff from haul roads local to minimise downstream impact;
- limiting initial clearing to areas of workable size actively being used for construction;
- providing adequate buffer zones between the areas of disturbance and natural drainage lines where possible;
- monitoring the effectiveness of controls; and
- adaptively responding to results of the surface water monitoring programme.

### 7.8 Groundwater

This section summarises the results of the groundwater assessment for the Balmoral South and the implications for cumulative impacts from the adjacent Central Block. The full assessment is provided in Appendix H (Balmoral South Iron Ore Project – Groundwater Assessment).

#### 7.8.1 Objectives and Standards

The approved Central Block Project will impact the hydrogeological regime of the region. These impacts have been quantified and management plans developed as part of the Central Block Project approvals (including the Central Block Project Groundwater Management Plan, Aquaterra 2007).
The hydrogeological investigations focused on the potential impacts that the Balmoral South Project will have in addition to those of the currently approved Central Block Project. This section presents an assessment of the cumulative impacts of both projects and determines the potential impacts that the Balmoral South Project (predominantly pit dewatering) will have, in addition to those of the Central Block Project, on local / regional groundwater resources and any consequent additional impacts on other local users and groundwater dependent ecosystems (GDEs).

The Balmoral South Project objectives for the management of groundwater are to:

- maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem maintenance, are protected;
- ensure that discharges do not adversely affect water quality or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards; and
- ensure that alterations to groundwater flows and quality do not have an adverse impact on beneficial or environmental uses of the water and that the integrity, functions and environmental values of watercourses are maintained.

Applicable Guidelines and Standards include:

- ANZECC and ARMCANZ Australian and New Zealand Guidelines for Fresh and Marine Water Quality;
- Rights in Water and Irrigation Act 1914;
- Water and Rivers Commission Act 1997;
- Water and Rivers Commission (2000). Environmental Water Provisions Policy for Western Australia: Statewide Policy No. 5; and

7.8.2 Definition of Issues and Impacts

7.8.2.1 Mine Dewatering Assessment

Previous investigations completed in the area (primarily associated with the Central Block ore body) suggest that the basement rocks which make up the ore host sequence, the footwall and hanging wall are indurated and have little to no primary porosity and permeability. There may be some minor secondary aquifer properties associated with faults and fractures; however, mineral exploration drilling in the area has not intersected significant water. The limited hydraulic testing results available for the surrounding basement rocks indicate low aquifer permeability and transmissivity. Thus, while initial inflows may be quite high as the ore body itself is drained, the limited extent of permeable aquifer means that long-term inflows will be much smaller.

The majority of the Balmoral South pit walls will be developed within the basement rocks, however, the northern extents of the proposed pit extend onto the floodplains of the Fortescue River and Du Boulay Creek. There is limited drilling information in this area of the pit, however, it is considered likely that saturated sediments will be intersected, especially in the vicinity of Du Boulay Creek. Potential for groundwater inflows from the alluvial deposits are discussed further in Section 7.8.2.3.

For the current mine plan of 24 Mtpa, an open pit mine will be developed down to approximately 300 m depth below surface, which equates to around 290 m below the current water table. As such, even with low permeability basement rocks surrounding the ore body, there is the potential for significant inflows of groundwater to the open pit.
Groundwater modelling has been undertaken to assess groundwater inflows to the Balmoral South pit as it is developed and also to assess the impacts that mine dewatering will have on local groundwater levels, other groundwater users and GDEs. The modelling captures the cumulative effects of mining / dewatering operations from both the Balmoral South and the nearby Central Block Projects.

**Previous Groundwater Modelling – Central Block Project**

A numerical groundwater flow model was originally developed (Aquaterra 2001) using Modflow to predict groundwater level drawdown resulting from the development of the Central Block Project.

The model included features to simulate the hydrogeological features of the system (Fortescue River Alluvium, and shallower parts of the Brockman Iron Formation and basement rocks), regional groundwater throughflow and dewatering of the Central Block pit. The model was calibrated to steady state conditions as there were no time varying data available at the time to allow for transient model calibration to dynamic (seasonal and annual) aquifer responses and to aquifer storativity. Aquifer storage parameters were assigned consistent with similar hydrogeological environments.

Groundwater modelling was subsequently undertaken (Aquaterra 2007) to support the now approved Central Block Project which was based on a mine plan of 67.4 Mtpa, an open pit developed down to approximately 220 m below ground level and a 20 year mine life. The modelling undertaken predicted:

- groundwater inflows to the Central Block pit would be 600 to 1,000 kL/d over the life of the mine;
- drawdown impacts extended mainly to the north and south of the Central Block due to the nature of the hydrogeological setting. Drawdown of 0.5 m was predicted 3.5 km to the west, 5.5 km to the east and 14 km to the north and south of the Central Block pit; and
- no significant drawdown impact was predicted in the Fortescue Alluvium.

**Current Groundwater Modelling – Balmoral South Project**

An upgraded regional groundwater flow model was developed for the mining area and surrounding aquifer systems. The upgraded model was developed using Modflow Surfact to allow for the simulation of multi-pit developments and potential water supply abstraction from the Fortescue Alluvial Aquifer. The model was upgraded with newly available data and captured an increased hydrogeological understanding of the system. The upgraded model was used to assess dewatering requirements and impacts for the cumulative Balmoral South and Central Block Projects. Specifically the model upgrade included the following features:

- update ore body hydraulic conductivity (both Southern and Central Block) based on newly available test pumping and airlifting data;
- inclusion of the Fortescue Alluvium Aquifer, Trealla Limestone and Yarraloola conglomerate units which are located to the west of the Balmoral South Project area. Four model layers were included to represent these aquifer units and the Weeli Wolli and Brockman Iron Formations;
- revision of aquifer geometry both horizontally and vertically to reflect newly available geological data and to allow variable hydraulic conductivity throughout the depth of the ore bodies;
- adoption of the AMG grid coordinate system with a non-uniform grid size ranging between 200 m at the model boundaries and 25 m in the vicinity of the ore body. The grid was aligned along the main strike of the ore body and basement rocks. The model grid comprises 726 columns and 1167 rows and the active region of the model covers an area of almost 1200 km$^2$; and
- inclusion of minor inflow via rainfall recharge with the majority of recharge, to the alluvial aquifer only, from seasonal leakage (especially in January, February and March) from the Fortescue River.
The calibrated groundwater model was used to predict mine inflows and the cumulative drawdown impacts of the simultaneous development of the Balmoral South Mining Stages 1, 2, 3 and 4 (refer Section 2.5.4) and the approved Central Block (67.4 Mtpa) Projects. Development of the Central Block and Balmoral South Projects was based on 20 and 28 year periods, respectively. For the final eight years of the Balmoral South Project it was assumed that the Central Block remains dewatered to maximum depth (-150 m RL).

### 7.8.2.2 Results

#### Mine Dewatering Inflows

##### Basement Rock

The results of modelling indicate that inflows to the Balmoral South open pit from the basement rocks are likely to peak at around 1,700 kL/d (19 L/s) at the commencement of Stage 3 of mining. Average predicted inflows over the life of the mine are around 1,100 kL/day (12.5 L/s). This equates to a total volume of approximately 11 GL over the 28 year mining period.

##### Du Boulay Creek Alluvium

The Balmoral South pit will potentially intersect saturated alluvial sediments within the Du Boulay Creek system. The groundwater flow model does not take into account the Du Boulay alluvial deposits between the Central and Balmoral South ore bodies. Potential inflow to the Balmoral South pit from the saturated alluvium was assessed using a simple analytical flow model (Aquaterra 2008). Groundwater inflow to the pit from the Du Boulay alluvium is predicted to be in the order of 4 L/s during Stage 2 of mining, increasing to approximately 22 L/s during Stage 3. Long-term inflows will depend on the hydraulic connection between the alluvium and the underlying basement rocks. If the shallow water table is perched and throughflow in the alluvium is not intercepted by the dewatering cone of depression then inflows may continue throughout the mine life. However, if the water table is not perched then groundwater throughflow in the alluvium will be captured by the cone of depression and inflows from the alluvium will tail off.

In times of high flow or flooding in Du Boulay Creek the entire thickness of alluvium may become saturated up to the flood protection bund, thus increasing potential inflow to the pit. Under these conditions inflows from the Du Boulay alluvium may be as high as 25 L/s to the Stage 2 pit and as high as 200 L/s to the Stage 3 pit.

##### Total Inflows

Overall, the results suggest that inflows peaking at around 1.7 ML/d and reducing to around 0.9 ML/d in the long term could be expected from basement lithologies throughout the development of the mine. In addition, inflows of around 0.35 ML/d and 1.9 ML/d may be expected once the Stage 2 and Stage 3 pits, respectively, breach the saturated Du Boulay Creek alluvium.

In practice, inflows (and groundwater level drawdown) will commence once the pit progresses below the water table and gradually increase as the pit deepens. This will cause a convergence of groundwater flow lines about the pit and could result in the interception of most of the groundwater throughflow in the Basement Rocks aquifer in the pit area. Some of the groundwater throughflow in the Fortescue River alluvium will also be captured by the dewatering cone of depression and diverted towards the pit. However, even assuming (conservatively) that around 25% of the water pumped from both Balmoral South and the Central Block operations derives from the alluvium, this would represent less than 2% of current estimated groundwater throughflow (9 GLpa) in the alluvium.
Dewatering Options

Modelling assumed that pit dewatering would be achieved via sump pumping with the water levels maintained just below the level of mining as the pit progresses. This is likely to be the most appropriate method of mine dewatering, with inflows to be directed towards pit sumps that can then be pumped to the surface. However, during the permeability investigations, airlift yields as high as 10 L/s were recorded from mineral exploration holes. If purpose built dewatering bores were able to intercept similar structures as these high yielding mineral holes, then significant dewatering may be able to be achieved in advance of mining with residual groundwater inflows collected and removed via sump pumping. The viability of advance dewatering via dewatering bores would require additional drilling and testing investigations to be undertaken.

Should geotechnical (pit wall stability) conditions require more dewatering or depressurisation than will be achieved via seepage through the pit walls, this would be best achieved by lateral drain holes drilled from the pit floor as it deepens. These would then drain into the pit with the water collected and removed via the in-pit sump pumping system.

Groundwater Level Drawdown

The lateral and vertical extent of the “cone of depression” in groundwater levels will be dependent on the nature of local and regional aquifers, the depth of the pit and the “interference” effects of dewatering both the Balmoral South and Central Block ore bodies.

As previously outlined, the predicted water level drawdown for the Central Block Project was based on an initially developed (more simplified) model whilst the predicted drawdown for the Balmoral South Project was based on an upgraded model (Section 7.8.2.3) which captured an increased hydrogeological understanding of the system based on newly available data.

The predicted water level drawdown contours at the end of 20 years mining (based on the initially developed model), for the approved Central Block Project only, are illustrated in Figure 7-10: 20 Year Drawdown Contours – Central Block Project. The predicted water level drawdown contours at the end of 28 years mining (based on the upgraded model), for the cumulative abstraction from both the Balmoral South and Central Block Projects, are illustrated in Figure 7-11: 28 Year Drawdown Contours – Central Block and Balmoral South Projects.
Section 7

Biophysical Issues and Their Management

Figure 7-10: 20 Year Drawdown Contours – Central Block Project Only
Section 7

Biophysical Issues and Their Management

Figure 7-11: 28 Year Drawdown Contours – Central Block and Balmoral South Projects
Section 7

Biophysical Issues and Their Management

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The predicted drawdown, from both the Central Block Project only and the cumulative abstraction from both projects, propagates to the north, south and east of the ore bodies. The upgraded model predicts that drawdown, under cumulative abstraction conditions, will not extend as far to the north or south, as that predicted for the Central Block Project only using the initially developed model. The upgraded model predicts that drawdown will extend further to the east under cumulative abstraction conditions. Thus, the extent of the predicted drawdown under cumulative abstraction conditions (using the upgraded model) is within the initially predicted drawdown for the Central Block Project only (using the initially developed model), with the exception of the eastern area. However, under cumulative abstraction conditions, water level drawdown around the Balmoral South pit is predicted to be significantly increased, with drawdown in close proximity to the Balmoral South pit (at end of mining) estimated to be up to 300m below ground level.

Six pastoral wells are located within the predicted 0.5 m drawdown contour (using the initially developed model) for the Central Block Project only, with several others located just outside this contour (Figure 7-10). Seven pastoral wells are located within the predicted 0.5 m drawdown contour (using the upgraded model) for the cumulative abstraction scenario (Figure 7-11).

It should be noted that the model predicts drawdown within the basement rock aquifers around the mine sites and within the main Fortescue River alluvial aquifers. There are also minor (and largely seasonally intermittent) aquifers associated with shallow alluvium within several creeks that drain westwards through the mine areas towards the Fortescue River. While the drawdown in the basement rock aquifers will induce some leakage from these shallow alluvial aquifers (depending on local aquifer properties), these aquifers will be recharged seasonally and will maintain some perched groundwater levels.

Final Voids

For the purposes of this assessment, it has been assumed that the Balmoral South pit will be left largely as it is at the completion of mining. That is, the pit will neither be backfilled or in-filled with waste rock from any existing or future mining operation.

At present the mineralisation at Balmoral South has been defined by drilling to approximately 300 m below ground level, and mineralisation has been determined to be open at depth. Initial mining plans extend to only 300m depth, and at this level there is sufficient working area to extract ore from deeper areas of the pit should deeper drilling confirm the presence of economically extractable ore.

Although there is no intention at present to mine below 300 m, plans to back fill the pit would put at risk the ability to extract additional ore.

Staging of the pit development is such that any backfilling would have to occur post-mining, and such activity would be economically unfeasible. However, there may be some potential for selective backfilling of sections of the pit during operation where it can be confirmed that ore reserve sterilisation will not occur. These will be investigated should opportunities arise.

Pit Lake Level

Aquaterra (2008) has confirmed that the pit void will remain a sink for groundwater, based on mass-balance calculations.

At the completion of mining and the cessation of pumping, pits will fill with water to a level defined by the long-term balance between inflows and outflows. The inflows will be groundwater flow and incident rainfall recharge. The principal outflow mechanism will be evaporation losses from the free water surface in the pit and from seepage faces on the pit walls. Outflow to groundwater may occur if the pit water level recovers sufficiently to be higher than the water table on the down-gradient side.

Based on published figures for Onslow and Port Hedland, average pan evaporation for the area is around 3,150 mm/yr, while average rainfall is around 260 mm/yr. Allowing for a pan factor of 0.6, this results in a potential deficit (or net loss) of around 1,630 mm/yr. If this is applied to the pit floor area (i.e. assuming the base of the pit were covered with water) average net losses would be around 4,700 kL/d, significantly higher than predicted inflows of around 800 kL/d. This will result in a net loss from the pit at the end of mining and the pit void will remain dry, although small pools may develop in depressions in the pit floor.
As the open pit will remain dry, it is proposed that it be managed in line with current DoIR guidance, which requires the installation of safety and abandonment bunds. If in the unlikely event that the pit develops a standing lake, monitoring of the water quality and implementation of remedial actions (i.e. water treatment) would occur, if there is potential to influence surrounding aquifers.

**Groundwater Flows**

Post-mining local and regional groundwater levels are predicted to be similar to active pit dewatering. Thus, it is predicted that the final void would continue, indefinitely, to intercept most of the groundwater throughflow in the basement rock aquifers in the pit area together with up to around 2% of the estimated throughflow in the Fortescue River alluvium.

**Groundwater Quality**

As a result of high predicted evaporative losses from the pit surface in relation to groundwater inflow the pit is predicted to remain mostly dry. Evaporation from near surface water will result in minor increasing salinity within any water ponding on the pit floor and in the adjacent groundwater. The pit will become a long-term groundwater sink, with groundwater flow into, but not out of the pit. Thus, regardless of the salinity of the in-pit water, there will be little to no migration of this water into the regional groundwater regime.

However, there may be potential for density flow out of the bottom of the pit in the very long term if sub-pit water salinity becomes sufficiently high that density differences (between sub-pit groundwater and regional groundwater) are sufficient to overcome normal hydraulic gradients. That is, saline water could "sink" out of the pit and into the surrounding basement rocks. The saline plume could then migrate away from the pit under the influences of gravity and hydraulic gradients. However, as the pit is a groundwater sink, the hydraulic gradients over a large area will be towards the pit. As such, it is expected that any such plume would tend to remain beneath the pit and not migrate to any significant extent.

**Hydrogeological Aspects of the Waste Disposal Facilities**

It is proposed that waste generated in the mining process will be stored in waste dumps, and dewatered fine tailings from ore processing (including a concentrator process) will also be incorporated into these waste dumps; resulting in combined Waste Disposal Facilities (WDFs).

The fine tailings deposited in the WDFs are expected to have a residual water content of approximately 15%. The bulk of the residual water content of tailings will be lost to evaporation. However, there will be some water that remains entrained in the tailings. The retained water combined with incident rainfall may result in seepage from the WDFs. Seepage losses would result in a water table mound beneath the WDFs and initial flow would be outwards in an almost radial pattern. As mining progresses and the dewatering cone develops, groundwater flow paths from the WDFs will be captured by the dewatering cone and transported towards the pit void.

It is anticipated that any seepage water will be fresh (since the process water will be a combination of desalinated water and fresh groundwater) and would result in a fresh water plume within the marginal to brackish Basement Rock and local superficial aquifers. There will likely be some minor evaporative concentration of salts in any open water present within the WDFs and where the phreatic surface within the tailings is close to the surface. However, incident rainfall over the WDFs will also act to offset any potential salinity build up within the WDFs.

### 7.8.2.3 Hydrogeological Impacts

**Introduction**

Pit dewatering to maintain dry mining conditions, will intercept groundwater throughflow in the basement rocks in the vicinity of the pit, has the potential to intercept throughflow in both the Fortescue River and Du Boulay Creek alluvium, and will result in a “cone of depression” in groundwater levels around the dewatered pits.
Dewatering Discharge

Pit dewatering is anticipated to yield up to 1.7 GL/annum over the life of the mine. Dewatering discharge will be used preferentially to supplement mining operations water supply requirements and will reduce overall demand on desalination. There are no anticipated impacts associated with dewatering discharge, as all water produced through dewatering will be used in the operations.

Du Boulay Creek Alluvium

The Balmoral South pit may intersect saturated alluvial sediments within the Du Boulay Creek system. If the pit perimeter intersects these sediments then there is the potential for long-term inflows to the pit and dewatering of these alluvial sediments, unless inflows are controlled through engineered measures. In addition, if hydraulic connection exists between the alluvium and the underlying basement rocks, then regardless of whether the pit intersects the alluvial sediments there is the potential that these alluvial sediments will be dewatered. Further hydrogeological investigation is required in order to more accurately assess the potential impacts associated with the inflows from, and dewatering of, the Du Boulay Creek alluvial sediments.

Groundwater Level Drawdown

Dewatering of the Central and Balmoral South ore bodies will produce a “cone of depression” in the regional groundwater table which will be elongated along strike, with the predicted impacts extending up to 14 km to the north, 5 km to the south, 7 km to the east and 2 km to the west of the Balmoral South pit. The drawdown predictions are considered to be conservative and in practice it is likely that there will be a steeper hydraulic gradient towards the pit with a much smaller (overall extent) cone of depression. However, in order to be conservative the “worst case” scenario has been adopted.

Impacts on Existing Groundwater Users

There are thirteen existing pastoral wells located in the Balmoral South Project area. Modelling previously completed for the Central Block Project only (using the initially developed model) predicted that seven pastoral wells (Figure 7-10) were sufficiently within the dewatering induced cone of depression that continued operation may be impacted by drawdown in groundwater levels (either as a result of water levels dropping below existing pump inlets and/or the base of the bores/wells). At six of these wells drawdown was anticipated to be greater than 0.5 m. Under cumulative abstraction conditions (with both the Balmoral South and Central Block Projects operating) the upgraded model now predicts that up to eight pastoral wells may be impacted, seven of which lie within the 0.5 m drawdown contour (Figure 7-11). One of these wells (Violet Well) was previously predicted to be impacted; however, the new modelling now indicates minimal impacts at this location. Two new wells (Diorite and Du Boulay Wells) are now incorporated into the area of predicted drawdown. Pastoral well location and predicted drawdown are summarised in Table 7-12: Summary of Pastoral Wells and Effects of Dewatering.

**Table 7-12: Summary of Pastoral Wells and Effects of Dewatering**

<table>
<thead>
<tr>
<th>Well</th>
<th>Easting</th>
<th>Northing</th>
<th>Central Block only (old model): predicted water level decline after 20 years (m)</th>
<th>Central &amp; Balmoral South (upgraded model): predicted water level decline after 28 years (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balmoral Well</td>
<td>408646</td>
<td>7659590</td>
<td>23</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Tarquin Well</td>
<td>412353</td>
<td>7663112</td>
<td>8</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Fortescue Bore</td>
<td>408033</td>
<td>7666784</td>
<td>5</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Woolie Paddock Well</td>
<td>406977</td>
<td>7658168</td>
<td>7</td>
<td>1-5</td>
</tr>
<tr>
<td>Neera Well</td>
<td>415363</td>
<td>7677498</td>
<td>5</td>
<td>1-5</td>
</tr>
<tr>
<td>Marda Well</td>
<td>415653</td>
<td>7673781</td>
<td>3</td>
<td>1-5</td>
</tr>
<tr>
<td>Diorite Well</td>
<td>412611</td>
<td>7658469</td>
<td>nil</td>
<td>1-5</td>
</tr>
</tbody>
</table>
## Section 7

### Biophysical Issues and Their Management

<table>
<thead>
<tr>
<th>Well</th>
<th>Easting</th>
<th>Northing</th>
<th>Central Block only (old model): predicted water level decline after 20 years (m)</th>
<th>Central &amp; Balmoral South (upgraded model): predicted water level decline after 28 years (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Du Boulay Well</td>
<td>409499</td>
<td>7656034</td>
<td>nil</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Violet Well</td>
<td>407168</td>
<td>7655697</td>
<td>&lt;0.5</td>
<td>nil</td>
</tr>
<tr>
<td>Currangi Well</td>
<td>408712</td>
<td>7651946</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Jilan Jilan Well</td>
<td>403834</td>
<td>7659382</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Carrawar Well</td>
<td>415995</td>
<td>7656575</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Waralee Well</td>
<td>404302</td>
<td>7655314</td>
<td>nil</td>
<td>nil</td>
</tr>
</tbody>
</table>

Modelling completed for the Central Block Project only (using the initially developed model) predicted significant drawdown to occur at the majority of pastoral wells in the immediate vicinity of the pit. Modelling completed for the cumulative operation of both the Balmoral South and Central Projects (using the upgraded model) suggests that in the vicinity of the pits the predicted drawdown will increase in addition to that resulting from the Central Block only, as demonstrated in Table 7-12.

In addition, under cumulative abstraction conditions (using the upgraded model) predicted drawdown in some of the eastern pastoral wells (e.g. Tarquin and Diorite Wells) show a marked increase in drawdown with the inclusion of the Balmoral South Project. Conversely drawdowns in wells to the north (e.g. Neera and Marda Wells) and to the south (e.g. Woolie Paddock and Violet Well) under cumulative abstraction conditions (using the upgraded model) are predicted to be less than initially predicted for the Central Project only (using the initially developed model).

In terms of the Fortescue River alluvium, there are no existing pastoral wells down-hydraulic gradient of the pit that might be impacted. In fact, it is considered unlikely that the impact of the diversion (towards the pit) of such a small proportion of the total groundwater throughflow could be measured. The range of natural variations in groundwater throughflow, as a result in variations in river flow (and recharge) will greatly exceed the small proportion of average flow that could be captured by the pit dewatering.

The interference drawdown impacts of the Balmoral South dewatering operations will result in some minor reduction in dewatering requirements at the Central Block.

### Impacts on Future Groundwater Users

The main future groundwater use in the area would be if a borefield was developed in the Fortescue River alluvial aquifers. The resulting cone of depression from both the Balmoral South and Central Block dewatering operations is predicted to intercept some 2% of the groundwater flow through the alluvial aquifers. However, any losses of water from the Fortescue River alluvial aquifers back towards the pits would most likely be made up from seasonal recharge from the Fortescue River, and little to no long term impact on sustainable aquifer / borefield yield is expected.

### Impacts on Groundwater Dependent Ecosystems

This issue is addressed in Section 7.2.2.

### Pit Void

The final pit void will act as a groundwater sink and remain mostly dry in the long term (although some small pools may develop in depressions in the pit floor). The post-mining potential impacts on groundwater level are predicted to be similar to active dewatering. Also there may be some salinity build-up in shallow groundwater beneath the pit, but this water will largely remain confined to the immediate pit area with the possibility of some long-term density flow of hypersaline water at very low rates downwards out of the bottom of the pit.
Section 7 Biophysical Issues and Their Management

Waste Disposal Facilities

It is not expected that the WDFS will have any adverse impact on local or regional groundwater. However, if free water is allowed to remain on the WDFS for extended periods, the salinity of the water within the dump could increase due to evaporative concentration. Seepage quality may then be poorer than the surrounding groundwater and a more brackish plume might develop. Although this is likely to decrease over the long-term as percolation of rainwater through the dump will gradually dilute and disperse any minor salinity build-up. The retention of moisture from fine materials contained within the dump may also enhance vegetation regrowth following rehabilitation.

7.8.3 Management

The PEMP has been prepared to document the management measures and monitoring actions associated with the potential impacts on groundwater (Refer Section 13 of PEMP in Appendix A). The Balmoral South Project will implement the following management practices to minimise impacts on groundwater:

- maintaining the quantity and quality of water supply to existing pastoral users;
- limiting the impact to fauna and phreatophytic vegetation to predicted areas;
- maintaining the integrity, functions and environmental values of watercourses and sheet flow;
- minimising the risk of spillage or escape of fuels or chemicals (Refer Section 21 of PEMP in Appendix A);
- ensuring storage and handling of fuels and chemicals at the site does not pose a threat to the environment (Refer Section 21 of PEMP in Appendix A);
- ensuring that any spill or incident associated with fuels and chemicals will be cleaned up quickly and effectively (Refer Section 21 of PEMP in Appendix A);
- monitoring the effectiveness of management measures;
- adaptively responding to inadequacies in controls through preventative action; and
- adaptively responding to results of the groundwater monitoring programme.
Section 7  
Biophysical Issues and Their Management

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Section 8

Pollution Issues and their Management

8.1 Introduction

This Section addresses the potential pollution factors relating to the development and operation of the Balmoral South Project. The relevant objectives and standards relating to each factor are identified, the issues and impacts, both for the Balmoral South Project in isolation and cumulatively with the Central Block Project, are discussed, and the proposed management measures outlined. The PER outlines the significant management issues that will be addressed by International Minerals with detailed information on management and monitoring contained in the Project Environmental Management Plan (PEMP) (Appendix A). The PEMP also covers other issues that, although not significant for the project, are still required to be addressed.

8.2 Process Emissions

This Section addresses process emissions from the Balmoral South Project (“Project”). The specialist assessment of air quality is provided in Appendix I. Fugitive dust emissions are addressed in Section 8.3.

8.2.1 Objectives and Standards

The Project objectives in regard to atmospheric emissions are to:

- minimise atmospheric emissions to as low as reasonably practicable; and
- ensure that emissions do not adversely affect environment values or the health, welfare and amenity of surrounding land users by meeting statutory requirements and acceptable standards.

Relevant legislation and standards include:

- National Environment Protection Council (NEPC) National Environmental Protection Measure (NEPM) for Ambient Air Quality 1998. The standards defined in this measure are concentrations set to ensure that public health, amenity and the environment are protected;
- EPA (2000a). Guidance for the Assessment of Environmental Factors No. 15: Emissions of Oxides of Nitrogen from Gas Turbines; and

In order to control the release of contaminants to the atmosphere and achieve what is regarded as an acceptable air quality, most environmental authorities set air quality standards for a small number of common or so-called “criteria” contaminants.

For ambient ground level concentrations, the WA EPA does not have State-wide standards, but is in the process of implementing a State-wide Environmental Protection Policy which will most likely apply the NEPM Standards throughout the state. The NEPM standards are listed in Table 8.1: Ambient Air Quality NEPM Goals.
Section 8

Pollution Issues and their Management

Table 8-1: Ambient Air Quality NEPM Goals

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging period</th>
<th>Maximum concentration (ppb)</th>
<th>Maximum concentration (µg/m³)</th>
<th>Goal within 10 years - maximum allowable exceedances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>1-hour</td>
<td>200</td>
<td>571</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td>24-hours</td>
<td>80</td>
<td>229</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td>1-year</td>
<td>20</td>
<td>57</td>
<td>None</td>
</tr>
<tr>
<td>Nitrogen dioxide (NO₂)</td>
<td>1-hour</td>
<td>120</td>
<td>230</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td>1-year</td>
<td>30</td>
<td>60</td>
<td>None</td>
</tr>
<tr>
<td>Particulate (PM₁₀)</td>
<td>24-hours</td>
<td>-</td>
<td>50</td>
<td>5 days a year</td>
</tr>
<tr>
<td>Photochemical oxidants (as O₃)</td>
<td>1 hour</td>
<td>100</td>
<td>210 (100 ppb)</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td>4 hours</td>
<td>80</td>
<td>170 (80 ppb)</td>
<td>1 day a year</td>
</tr>
</tbody>
</table>

Note: Concentrations of gaseous pollutants have been converted from the NEPM standard quoted at 0°C and 101.3 kPa.

There are no WA guidelines / standards for assessing the potential impacts of SO₂ and NOₓ on vegetation. As a result, the WHO air quality guidelines for Europe (WHO 2000) are used. These are considered applicable outside the lease area and are listed in Table 8-2: World Health Organisation Air Quality Guidelines for Europe.

Table 8-2: World Health Organisation Air Quality Guidelines for Europe

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Vegetation category</th>
<th>Guideline (µg/m³)</th>
<th>Time period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur dioxide</td>
<td>Agricultural crops</td>
<td>30</td>
<td>Annual and winter mean</td>
</tr>
<tr>
<td></td>
<td>Forests and native Vegetation</td>
<td>20</td>
<td>Annual and winter mean</td>
</tr>
<tr>
<td></td>
<td>Lichens</td>
<td>10</td>
<td>Annual mean</td>
</tr>
<tr>
<td>Oxides of nitrogen</td>
<td>All vegetation</td>
<td>75</td>
<td>24-hour</td>
</tr>
<tr>
<td></td>
<td>All vegetation</td>
<td>30</td>
<td>Annual mean</td>
</tr>
</tbody>
</table>

Note: Concentrations are expressed at 0°C and 101.3 kPa.

8.2.2 Definition of Issues and Impacts

8.2.2.1 Emission Sources

Balmoral South Project

Air emission modelling is included in Appendix J.

Air emissions from the pelletising process will occur from:

- combustion products from the burners used in the induration process. Emissions of concern are NOₓ from nitrogen and a small amount of SO₂ from sulphur present in the fuel and concentrate;
- particulates primarily from particles entrained in the air during the screening process; and
- hydrogen fluoride (HF) and hydrogen chloride (HCl) if present in the iron ore.

Under normal operations, air emissions will only occur through the main stack after passing through a dust control device to limit the particulate concentrations to 50 mg/m³. The NOₓ emissions of 433 mg/m³ are based on maximum emissions per tonne of product. This estimate is conservative with emissions expected to be much lower once the final technology is implemented. Emissions of HF and HCl are negligible for this plant and ore.
Section 8

Pollution Issues and their Management

Emissions of dioxins are also considered to be negligible. This is achieved through reducing chloride in the process by use of potable water to process ore in the concentrator and by the use of natural gas as the fuel, compared with the use of heavy fuel oil or coal at plants elsewhere. Therefore as per the European experience, dioxin emissions are considered to be small and of no concern.

Under start up conditions emissions from the pellet plant will be less than under normal operation. Start-up is anticipated to occur twice per year for each plant with a duration of up to 8 hours on each start-up.

Combustion products from vehicles are considered to have a minor impact because they occur over a relatively large area.

The other major source of air emissions is the power station which will consist of two gas-fired combined cycle units. Pollutants of concern from the power station are primarily NO\textsubscript{X}, with small amounts of SO\textsubscript{2}, CO and particulates.

Other sources are not considered significant such as combustion products from vehicles. There are no processes in the desalination plant that would generate gaseous emissions.

Emissions from the Balmoral South Project are summarised in Table 8-3: Emissions from the Balmoral South Project.

Table 8-3: Emissions from the Balmoral South Project

<table>
<thead>
<tr>
<th>Stack</th>
<th>Emission rate (g/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SO\textsubscript{2}</td>
</tr>
<tr>
<td>Power station (normal operation) – 2 x 240 MW (each)</td>
<td>0.845</td>
</tr>
<tr>
<td>Pellet plant main stack (normal operation) - 2 x 7 Mtpa (each)</td>
<td>21.6</td>
</tr>
<tr>
<td>Pellet plant (start up) – 2 x 7 Mtpa (each)</td>
<td></td>
</tr>
<tr>
<td>Preheat stack</td>
<td>0.4</td>
</tr>
<tr>
<td>Tempered preheat stack</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Nk – Not known, Negl. - Negligible

Existing and Approved Sources

Existing emissions in the region were used for the regional photochemical smog assessment. These include:

- Hamersley Iron;
- Woodside Domestic Plant;
- NWSJV LNG Plant;
- Burrup Fertilisers Ammonia Plant; and
- Pluto LNG Development.

Biogenic (NO\textsubscript{X} and VOC) and gridded surface emissions (i.e. non-industrial) were supplied by CSIRO.

Emission sources from the approved Central Block Project include the pellet plant, DRI plant and a combined cycle power station. Emissions from the power station are sourced from CP Mining Management Pty Ltd, with emissions for the pellet and DRI plants taken from the original 2000 and 2002 studies. For this study it is conservatively assumed that two 7 Mtpa pellet plants and a 1.35 Mtpa DRI plant will be constructed.

Emissions of SO\textsubscript{2} and CO for the Central Block Project were not provided and for consistency have been scaled from the Balmoral South project.

It is assumed that emissions from existing and approved sources are continuous.
Section 8 Pollution Issues and their Management

8.2.2.2 Dispersion Modelling

Local Impacts Modelling

Modelling methodologies employed in this study have conformed to the Air Quality and Air Pollution Modelling Guidance Notes (DoE 2006).

The USEPA regulatory model AERMOD was used for modelling local air quality impacts. This model can more realistically model convective dispersion and plume impacts on hills than the other dispersion models in use, namely ISC3Prime and AUSPLUME.

The following model settings and input data were used:

- building downwash using the PRIME algorithms with site buildings derived from site plans and elevation views;
- a 500 m grid over a 22 by 27 km area centred on the site;
- sensitive receptors the work camps and public camping grounds;
- terrain;
- meteorological files using the local onsite meteorological measurements (see below); and
- no chemical transformation or deposition, except for the prediction of NO$_2$ (see below).

The above data are from the Cape Preston Main and Island sites. Table 8-4: Meteorological monitoring Station Locations provides the coordinates of the metrological monitoring station locations.

<table>
<thead>
<tr>
<th>Station</th>
<th>Lat/Long (deg, min, sec)</th>
<th>GDA94 (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Station</td>
<td>116° 8’ 59.82”E</td>
<td>411,688 E</td>
</tr>
<tr>
<td></td>
<td>21° 3’ 35.27”S</td>
<td>7,670,999 N</td>
</tr>
<tr>
<td>Preston Island Station</td>
<td>116° 11’ 38.27”E</td>
<td>416,130 E</td>
</tr>
<tr>
<td></td>
<td>20° 49’ 28.57”S</td>
<td>7,697,054 N</td>
</tr>
</tbody>
</table>

The distances from the Main Station to the following locations are approximately:

- Central Block Project’s Camp: 1.5 km
- Balmoral South Project’s Proposed Camp: 14.1 km
- Public Camp Sites (near Fortescue river mouth): 7.9 km

An annual file containing hourly meteorological data for AERMOD was created using the surface winds, temperature and humidity measurements for 2007 from the onsite weather station at Cape Preston. The surface measurements from the site are supplemented by offsite cloud observations from Port Hedland and Learmonth. The dispersion model TAPM was used to provide the mixing heights and fill in missing wind data.

To estimate the proportion of NO$_x$ in the form of NO$_2$, a NO to NO$_2$ relationship is required. The ozone limiting method (OLM), as specified by the USEPA and the NSW modelling regulations, is adopted in this assessment. The OLM assumes that all of the ozone in the plume can be consumed immediately by the photochemical reaction to produce NO$_2$. Consequently, at times when there is a low concentration of ozone, only small amount of NO$_2$ will be produced above that which exists in the emitted plume.
Regional Impacts Modelling

Modelling of the regional formation of photochemical smog (NO₂ and ozone) was performed using TAPM, which is a three dimensional meteorological and air pollution model produced by the CSIRO Division of Atmospheric Research. The air pollution component of TAPM includes gas-phase photochemical reactions based on the Generic Reaction Set (GRS). The GRS offers smog formation modelling with low data requirements and low computational overheads.

TAPM incorporates the following databases for input to its computations:

- gridded database of terrain heights on a longitude / latitude grid of 30 second grid spacing, (approximately 1 km). This default dataset is supplemented by finer resolution data at 9 second spacing for this study;
- Australian vegetation and soil type data at 3 minute grid spacing (approximately 5 km);
- Rand's global long term monthly mean sea-surface temperatures on a longitude / latitude grid at 1 degree grid spacing (approximately 100 km); and
- six-hourly synoptic scale analyses on a longitude/latitude grid at 0.75-degree grid spacing (approximately 75 km), derived from the LAPS analysis data from the Bureau of Meteorology.

TAPM was used in a nested mode with 45 x 45 x 17 grid points and 15 km, 5 km and 2.5 km spaced grids for meteorology and for pollution, and was run for the period 1 January 2007 to 12 December 2007. To improve model accuracy, observed wind conditions from Cape Preston mainland and Island were used to nudge the TAPM solution. Nudging a model forces it towards the meteorological observations, thereby correcting possible drift of the large-scale winds calculated by model.

Ground level concentrations were calculated over a grid of uniformly spaced receptor points 2.5 km apart over an area of approximately 12,656 km². Sensitive receptors for three permanently inhabited locations in the region (Mardie, Karratha and Dampier) were considered.

8.2.2.3 Results

Project Specific

Predicted concentrations of the pollutants (NOₓ, NO₂, SO₂, CO and PM₁₀) from the Balmoral South power station and two pellet plants are presented in Table 8-5: Predicted Concentrations from the Balmoral South Project. Contour plots of the pollutants closest to their adopted criteria (NOₓ, NO₂ and PM₁₀) are also presented in Figure 8-1: Predicted Maximum 24-Hour NOₓ Concentration (µg/m³), Figure 8-2: Predicted 2nd Highest 1-Hour NO₂ Concentration (µg/m³), and Figure 8-3: Predicted 6th Highest PM₁₀ Concentration (µg/m³).

Highest 24-hour NOₓ and 1-hour NO₂ concentrations occur within the first 500 to 1000 m of the proposed pellet plant. There are also elevated levels on the hills to the east although these are lower than in the vicinity of the pellet plant. The elevated concentrations are mainly due to the pellet plant as a result of the larger emission from that source and the plume from the main stack being affected by building downwash from this large building. The contribution from the power station to the predicted ground level concentrations is low.

At the nearest residential camp sites, the incremental contribution to pollution levels would be generally small with the largest increase coming from NO₂ with predicted levels at 39% of the 1-hour NO₂ criterion. Comparison to the NOₓ vegetation criteria indicates that this would be exceeded within 800 m of the pellet plant but that the concentrations would decrease rapidly with distance.
### Table 8-5: Predicted Concentrations from the Balmoral South Project

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging period</th>
<th>Criteria (µg/m³)</th>
<th>Applicability</th>
<th>Predicted concentrations (µg/m³)</th>
<th>Anywhere</th>
<th>Nearby camps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxides of nitrogen</td>
<td>24-hour (max)</td>
<td>75</td>
<td>Vegetation</td>
<td>262</td>
<td>19.5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>1-hour (max)</td>
<td>-</td>
<td>Residential / campsites</td>
<td>175</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-hour (2nd)</td>
<td>246</td>
<td></td>
<td></td>
<td>96</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-year</td>
<td>62</td>
<td></td>
<td></td>
<td>19.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Sulphur dioxide</td>
<td>1-hour (max)</td>
<td>-</td>
<td>Residential / campsites</td>
<td>74</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-hour (2nd)</td>
<td>572</td>
<td></td>
<td></td>
<td>73</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>24-hour (max)</td>
<td>-</td>
<td></td>
<td></td>
<td>24</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>24-hour (2nd)</td>
<td>228</td>
<td></td>
<td></td>
<td>12.4</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>57</td>
<td></td>
<td></td>
<td>1.8</td>
<td>0.13</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>24-hour (max)</td>
<td>-</td>
<td>Residential / campsites</td>
<td>30</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24-hour (6th)</td>
<td>50</td>
<td></td>
<td></td>
<td>11</td>
<td>1.4</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>8-hour Average</td>
<td>11,240</td>
<td>Residential / campsites</td>
<td>157</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

Note: The maximum 1-hour and 24-hour concentrations at the campsites were taken as that which occurred in that general area to account for uncertainty in wind directions.

### Figure 8-1: Predicted Maximum 24-Hour NOₓ Concentration (µg/m³)
Section 8

Pollution Issues and their Management

Figure 8-2: Predicted 2\textsuperscript{nd} Highest 1-Hour NO\textsubscript{2} Concentration (\(\mu g/m^3\))

Figure 8-3: Predicted 6\textsuperscript{th} Highest PM\textsubscript{10} Concentration (\(\mu g/m^3\))
Cumulative

The predicted cumulative concentrations of the pollutants (NOₓ, NO₂, SO₂, CO and PM₁₀) taking into account emissions from the Balmoral South project, emissions from the approved Central Block project and background concentrations, are presented in Table 8-6: Cumulative Concentrations from Balmoral South and Central Block Projects. Contour plots of the pollutants closest to their adopted criteria (NOₓ, NO₂ and PM₁₀) are also presented in Figure 8-4: Predicted Maximum 24-Hour NOₓ Concentration (µg/m³), Figure 8-5: Predicted 2nd Highest 1-hour NO₂ Concentration (µg/m³), and Figure 8-6: Predicted 6th Highest PM₁₀ Concentration (µg/m³).

Modelling shows that at nearest residential places (campsites) the concentrations will be well below the criteria. Pollutant concentrations closest to the criteria are PM₁₀ at 59% of the 24-hour NEPM standard and NO₂ at 50% of the 1-hour standard.

There is predicted to be an area up to about 1 km from the pellet plants where the 24-hour NOₓ vegetation criterion is exceeded.

Table 8-6: Cumulative Concentrations from Balmoral South and Central Block Projects

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging period</th>
<th>Criteria (µg/m³)</th>
<th>Background (µg/m³)</th>
<th>Predicted concentrations (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Anywhere</td>
</tr>
<tr>
<td>Oxides of nitrogen</td>
<td>24-hour (max)</td>
<td>75</td>
<td>5</td>
<td>267</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>30</td>
<td>3</td>
<td>26</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>1-hour (max)</td>
<td>-</td>
<td>4.2</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td>1-hour (2nd)</td>
<td>246</td>
<td></td>
<td>176</td>
</tr>
<tr>
<td></td>
<td>1-year</td>
<td>62</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Sulphur dioxide</td>
<td>1-hour (max)</td>
<td>-</td>
<td>Negligible</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>1-hour (2nd)</td>
<td>572</td>
<td></td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>24-hour (max)</td>
<td>-</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>24-hour (2nd)</td>
<td>228</td>
<td></td>
<td>12.3</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>57</td>
<td></td>
<td>1.9</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>24-hour (max)</td>
<td>-</td>
<td>22</td>
<td>113</td>
</tr>
<tr>
<td></td>
<td>24-hour (6th)</td>
<td>50</td>
<td></td>
<td>94</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>8-hour average</td>
<td>11,240</td>
<td>Negligible</td>
<td>157</td>
</tr>
</tbody>
</table>

Note: The maximum 1-hour and 24-hour concentrations at the campsites were taken as that which occurred in that general area to account for uncertainty in wind directions.
Section 8

Pollution Issues and their Management

Figure 8-4: Predicted Maximum 24-Hour NO\textsubscript{X} Concentration (\(\mu\text{g/m}^3\))

Figure 8-5: Predicted 2\textsuperscript{nd} Highest 1-hour NO\textsubscript{2} Concentration (\(\mu\text{g/m}^3\))
Section 8

Pollution Issues and their Management

Regional

The predicted regional NO₂ and O₃ concentrations due to emissions from existing and approved projects in the region are shown for the sensitive receptors in Table 8-7: Predicted Ozone Concentrations (Existing and Approved Sources).

The predicted annual average ground-level NO₂ concentration contours are presented in Figure 8-7: Predicted Annual Average NO₂ Concentrations (ppb). Highest concentrations of 6 ppb are predicted to occur over the Central Block Project. Areas of concentrations exceeding 3 ppb include parts of the Burrup Peninsula. Concentrations are well within the relevant air quality guideline.

Predicted 2nd highest 1-hour NO₂ concentrations are shown in Figure 8-8: Predicted 2nd Highest 1-hour NO₂ Concentrations (ppb). Modelling indicates that the 2nd highest 1-hour concentration of 90 ppb occurs over the Central Block Project. Over parts of the Burrup Peninsula, predicted 1-hour concentration is approximately 50 ppb. The NEPM guideline of 120 ppb is not exceeded at any location in the study domain.

The predicted 2nd highest 4-hour O₃ concentration is shown in Figure 8-9: Predicted 2nd Highest 4-hour O₃ Concentrations (ppb). The highest 4-hour concentration of 51 ppb occurs approximately 25 km to the east of the Central Block Project. The relevant air quality criterion is not exceeded at any location in the study domain. Similarly, the predicted 2nd highest one-hour O₃ concentration is within the criterion Figure 8-10: Predicted 2nd Highest 1-hour O₃ Concentrations (ppb).

Predicted O₃ concentration at the sensitive receptors will be well below the criteria.
Section 8

Pollution Issues and their Management

Table 8-7: Predicted Ozone Concentrations (Existing and Approved Sources)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging period</th>
<th>Criteria (µg/m³)</th>
<th>Predicted Concentrations (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mardie</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>1-hour Annual</td>
<td>246 (120 ppb)</td>
<td>71 (34.6 ppb)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>62 (30 ppb)</td>
<td>2 (1.0 ppb)</td>
</tr>
<tr>
<td>Ozone</td>
<td>1-hour (2nd)</td>
<td>210 (100 ppb)</td>
<td>108 (50.5 ppb)</td>
</tr>
<tr>
<td></td>
<td>4-hour (2nd)</td>
<td>170 (80 ppb)</td>
<td>97 (45.3 ppb)</td>
</tr>
</tbody>
</table>

Figure 8-7: Predicted Annual Average NO₂ Concentrations (ppb)
Section 8

Pollution Issues and their Management

Figure 8-8: Predicted 2nd Highest 1-hour NO₂ Concentrations (ppb)

Figure 8-9: Predicted 2nd Highest 4-hour O₃ Concentrations (ppb)
Section 8

Pollution Issues and their Management

Figure 8-10: Predicted 2nd Highest 1-hour O₃ Concentrations (ppb)

The predicted regional NO₂ and O₃ concentrations due to emissions from existing, approved and proposed projects in the region are shown for the sensitive receptors in Table 8-8: Predicted Ozone Concentrations (Existing, Approved and Proposed Sources).

Highest annual average NO₂ concentrations of 19 ppb are predicted to occur over the Central Block Project (Figure 8-11: Predicted Annual Average NO₂ Concentrations (ppb)). Areas of concentrations exceeding 3 ppb increase to include a large part of the Burrup Peninsula. Concentrations are within the relevant air quality guideline over the Central Block and Balmoral South Project sites, and well within the guideline elsewhere.

Modelling indicates that the 2nd highest 1-hour NO₂ concentration of approximately 100 ppb occurs over a very small area to the north of the Central Block Project (Figure 8-12: Predicted 2nd Highest 1-hour NO₂ Concentrations (ppb)). The area predicted to experience 1-hour concentration exceeding 50 ppb increases to include most of the coastline between Cape Preston and the Burrup Peninsula. The air quality guideline of 120 ppb is only exceeded over a very small area north of the Central Block.

Modelling indicates that there is only a marginal increase in O₃ concentration likely with addition of the Balmoral South project emissions to the air shed (Figure 8-13: Predicted 2nd Highest 4-hour O₃ Concentrations (ppb) and Figure 8-14: Predicted 2nd Highest 1-hour O₃ Concentrations (ppb)). The relevant air quality criteria are not exceeded at any location in the study domain.

Predicted O₃ concentrations at the sensitive receptors do not increase significantly with addition of the Balmoral South project emissions to the air shed. The concentrations at the sensitive receptors remain well within the relevant air quality guidelines.
### Section 8

Pollution Issues and their Management

**Table 8-8: Predicted Ozone Concentrations (Existing, Approved and Proposed Sources)**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging period</th>
<th>Criteria (µg/m³)</th>
<th>Predicted Concentrations (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mardie</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>1-hour Annual</td>
<td>230 (120 ppb) 60 (30 ppb)</td>
<td>89 (43.1 ppb) 3 (1.5 ppb)</td>
</tr>
<tr>
<td>Ozone</td>
<td>1-hour (2nd) 4-hour (2nd)</td>
<td>210 (100 ppb) 170 (80 ppb)</td>
<td>109 (50.8 ppb) 97 (45.1 ppb)</td>
</tr>
</tbody>
</table>

**Figure 8-11: Predicted Annual Average NO₂ Concentrations (ppb)**

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International Minerals Pty Ltd
February 2009
Section 8

Pollution Issues and their Management

Figure 8-12: Predicted 2\textsuperscript{nd} Highest 1-hour NO\textsubscript{2} Concentrations (ppb)

Figure 8-13: Predicted 2\textsuperscript{nd} Highest 4-hour O\textsubscript{3} Concentrations (ppb)
Section 8

Pollution Issues and their Management

8.2.3 Management

Based on a reference document on best available techniques in the Iron and Steel Industry from European Commission (March 2000), the Balmoral South Project has applied world’s best practice to reduce emissions from the pellet plants, power station, mine site, concentrator, etc.

**Power Station**

- Incorporation of thermal efficient gas turbines in combined cycle operation to reduce emissions. Turbines considered at present are Alstom 13 E 2 and Siemens SGT 2000 E. Both machines in combined cycle operation have a thermal efficiency in excess of 50%. The 13 E 2 is considered the most thermal efficient turbine available for its class size. This compares to open cycle operation of 35% and sub critical coal of 36%.
- Incorporation of dry low NOX burner technology to limit emissions to less than 25ppm @ 15% O2 dry.
- Incorporation of sponge ball cleaning systems to maintain cleanliness of the steam turbine condenser to optimise heat transfer and maintain thermal efficiency.
- Incorporation of multi cell evaporative cooling with integrated control logic to switch off fans/pumps depending on the changing climatic conditions to reduce auxiliary power load.
- Use of only natural gas for the generation of base load electricity.
- Incorporation of inlet air evaporative cooling to maintain efficiency during high ambient temperature conditions.
- Collection of all water wastes for processing and reuse in the concentrator plant.
Section 8  Pollution Issues and their Management

Pellet Plants

- Incorporation of heat recovery systems to maximise the recovery of sensible heat
- Incorporation of dust recovery systems to minimise particulate emissions
- Incorporate recycling of solid wastes to reduce emissions
- Use of low sulphur fuel gas and concentrate to reduce SO\(_x\) emissions
- Collection of all water wastes for processing and reuse in the concentrator plant
- Incorporation of latest technology process control technology to optimise efficiency and reduce emissions

Concentrator

- Incorporation of dust collection systems to minimise particulate emissions
- Incorporation of Large Ball, HPGR and Tower Grinding Mills to achieve economy of scale and reduce energy use/emissions.
- Incorporation of water spray and wet circuit processing to reduce particulate emissions.
- Incorporation of waste water collection for reuse in the process plant to reduce waste and emissions
- Incorporation of latest technology process control technology to optimise efficiency and reduce emissions

Mining

- Use of new diesel/electro mining equipment with thermal efficient engines to reduce fuel use/emissions
- Incorporation of in pit crushing at year 7 of mining to reduce truck haul use to reduce fuel consumption/emissions
- Optimise blast pattern to optimise grinding efficiency and reduce emissions
- Undertake best practice dust control measures to reduce particulate emissions.
- Use of latest mining software technology to optimise mining operations and reduce energy use/emissions.
- Incorporation of GPS tracking systems in all mining equipment in conjunction with latest mine operation software technology to optimise vehicle use and reduce fuel use/emissions.

Miscellaneous

- Use of 5 star energy efficient heat pump water heaters to reduce energy/emissions
- Use of 5 star WELS water efficient appliances to reduce water and energy use.
- Use of best practice building insulation materials to reduce energy use and emissions
- Adopt a recycle and reuse policy to minimise waste and reduce emissions

Section 15 of the PEMP (Appendix A) presents management strategies to minimise impacts from process emissions. Management techniques have been directed at minimising NO\(_x\) emissions from the Project activities wherever practicable, as this will in turn also reduce most other air emissions. The key management measure for minimising process emissions is to ensure that the low NO\(_x\) burner and turbine control system maintains the firing temperature, fuel to air ratio, and inlet humidity to minimise NO\(_x\) emissions.

The management approach of the Balmoral South Project relevant to process emissions is:

- ensuring that emissions do not adversely affect environmental values or the health, welfare and amenity of surrounding land users;
- minimising greenhouse gas emissions in absolute terms and reduce emissions per unit of product to as low as reasonably practicable;
Section 8

Pollution Issues and their Management

- utilising best engineering technology and management practices to minimise process emissions in design, construction and operating the plant;
- minimising airborne emissions through all reasonable and practicable measures;
- monitoring the effectiveness of process emissions management measures; and
- adaptively responding to inadequacies in controls through preventative action.

A monitoring programme for process emissions will be implemented and will include:

- measuring $O_2$, $NO_X$, and $CO_2$ levels exiting the turbine exhaust stacks; and
- monitoring stack and ground levels in order to ensure that emissions comply with guideline levels.

8.3 Dust Emissions

8.3.1 Objectives and Standards

The objectives for the Project in regard to dust emissions are to:

- ensure that emissions do not adversely affect environment values or the health, welfare and amenity of surrounding land users by meeting statutory requirements and acceptable standards;
- protect the surrounding vegetation from particulate emissions; and
- use all reasonable and practicable measures to minimise airborne dust.

Relevant legislation and standards include:

- National Environment Protection Council (NEPC) National Environmental Protection Measure (NEPM) for Ambient Air Quality 1998. The standards defined in this measure are concentrations set to ensure that public health, amenity and the environment are protected;
- DEC (2008). Draft guideline for development and implementation of dust management program.
- National Pollutant Inventory NEPM (2001) Emission Estimation Technique Manual for Mining Version 2.3; and
- AS/NZS 3580.1.1:2007 Methods for the sampling and analysis of ambient air.

8.3.2 Definition of Issues and Impacts

Dust has the potential to be generated from construction and operational activities including:

- vegetation clearing, topsoil clearing and replacement;
- vehicle movements on the access roads and site roads during construction and operations;
- mining activities (blasting, earthmoving and dumping);
- materials handling and processing activities including crushing, screening, stacking and reclaiming of ore; and
- dust pick-up (wind erosion) from exposed areas including the pit, areas cleared for the process plant and offices, access roads, stockpiles, waste disposal facilities, tailings storage facility and the accommodation camp.
The limited vegetation cover in the region and the arid environment results in the natural generation of dust in high wind conditions. Vegetation in areas where dust generation is high may be adversely affected by repeated deposition of dust on foliage reducing the plant’s ability for photosynthesis.

Fugitive dust emissions (PM$_{10}$ and TSP) from the mining, processing, transportation and stockpiling of ore have been calculated using the default emission factors within the National Pollutant Inventory (NPI) Emission Estimation Technique Manual for Mining (version 2.3). The use of these techniques for estimation is in line with the NPI National Environmental Protection Measure, 2008.

NPI-based emissions estimation techniques do not allow for concentration-based values, such as those presented above in Section 8.2.2.3, but report gross emissions in kg/annum.

Point source dust emissions (PM$_{10}$) from the power station and pellet plant have been estimated, and modelled concentrations presented in Section 8.2.2.3.

Fugitive dust emissions (PM$_{10}$ and TSP) are presented in Table 8-9: Dust Emissions Estimation below.

<table>
<thead>
<tr>
<th>Operation / Activity</th>
<th>Estimated Dust Emission (kg/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust Generation Total TSP</td>
<td></td>
</tr>
<tr>
<td>Pre-strip (year 3)</td>
<td>12,070,763</td>
</tr>
<tr>
<td>Initial Production (year 4 to 6 and 29 to 31)</td>
<td>27,791,921</td>
</tr>
<tr>
<td>Initial Production (year 7 to 28)</td>
<td>49,422,780</td>
</tr>
<tr>
<td>Dust Generation Total PM$_{10}$</td>
<td></td>
</tr>
<tr>
<td>Pre-strip (year 3)</td>
<td>4,146,080</td>
</tr>
<tr>
<td>Initial Production (year 4 to 6 and 29 to 31)</td>
<td>5,968,371</td>
</tr>
<tr>
<td>Initial Production (year 7 to 28)</td>
<td>10,554,601</td>
</tr>
</tbody>
</table>

Negligible emissions are expected from the concentrator as this is a wet process.

Modelling of the point source PM$_{10}$ emissions has shown that the NEPM ambient air quality standard, expressed as a maximum concentration of 50ug/m$^3$ will not be exceeded at any point of public utility or residential accommodation. This NEPM standard has been adopted by the Western Australian Department of Environment and Conservation (DEC) for off-site criteria (DEC, May 2008).

Review of the estimated total dust emissions for the Project against those reported within the NPI public database for the 2007/2008 reporting year indicates that the anticipated emissions from the Project are not dissimilar to those experienced by similarly sized mining operations in Western Australia.

The accommodation camps are located 7 km south and 9 km north east of the pit and the public camping ground at the mouth of the Fortescue River is located 11 km to the north west of the mine. No impact from airborne dust is expected at these receivers.

### 8.3.3 Management

Dust management will be an essential component of site environmental performance and the dust management procedures that will be implemented for the project are detailed in the Section 16 of the PEMP (Appendix A). The key management measures for minimising dust include:

- keeping the area of exposed surfaces (such as stockpiles and cleared areas) to the minimum required for construction activities;
- stabilising all cleared/exposed surfaces to prevent lift-off;
Section 8 Pollution Issues and their Management

- using water trucks and chemical suppressants on the access and site roads and enforcing speed limits to minimise dust generation;
- maintaining the moisture content of the ROM and crushed ore stockpiles in the processing plant through the use of water sprays; and
- applying water to exposed stockpiles when there is potential for dust lift off.

A monitoring programme that examines the performance of the dust management actions for the construction and operational phases of the development will be implemented. The dust monitoring programme will include:

- visually monitoring the level of offsite dust emissions and using dust suppression techniques, when necessary. Contingency actions will be initiated when problems are identified;
- inspecting vegetation adjacent to working areas to ensure that there is no significant build-up of dust on vegetation;
- using portable continuous particle monitors (High Volume or Tapered Element Oscillating Membrane) to monitor PM<sub>10</sub> and TSP in accordance with AS/NZS 3580;
- placement of monitors in accordance with AS/NZS 3580 to ensure that sampling is representative of operational and meteorological conditions; and
- implementation of Quality Assurance and Quality Control principles on data collection and analysis, such as the use of NATA accredited laboratories.

A Dust Management Program will be developed as part of the environmental management system as outlined in Section 16 of Appendix A (PEMP), and this program will be designed to comply with the Western Australian DEC (May 2008) draft Guideline for development and implementation of dust management program. This program will outline the requirements for dust monitoring both upwind and downwind of the Project Area. Monitoring will also be undertaken within the plant and mining areas where dust generation has the potential to affect the health and safety of personnel. The program will include specific measures for dust management during construction as well as operations.

8.4 Greenhouse Gas Emissions

8.4.1 Objectives and Standards

The Project is committed to minimising greenhouse gas emissions to as low as reasonably practicable during both Project design and throughout the life of the Project. Project objectives are to:

- mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with Australia’s National Greenhouse Strategy as endorsed by the State Government (EPAWA 2002a);
- minimise greenhouse gas emissions in absolute terms and reduce emissions per unit of product to as low as reasonably practicable; and
- estimate the gross amounts of greenhouse gases that may be further reduced by offset measures, including tree planting, CO<sub>2</sub> re-injection or carbon trading (EPAWA 2002b).

Relevant legislation and standards include:

- United Nations Framework Convention on Climate Change (United Nations 1992);  
- Western Australian Greenhouse Strategy (Western Australian Greenhouse Taskforce 2004);  
Section 8  

Pollution Issues and their Management

- Environmental Protection Authority (2006). Environmental Offsets. Position Statement No. 9;
- Australian Department of Climate Change (2008) – National Greenhouse and Energy Reporting (Measurement) Technical Guidelines 2008 v1.0; and

8.4.2 Definition of Issues and Impacts

Greenhouse Gas Assessment Methods

An assessment of the greenhouse gas emissions (Appendix N) associated with the Project was conducted by Kewan Bond Pty Ltd. The assessment involved:

- identification of the likely sources of greenhouse gas emissions.
- calculation and interpretation of the likely quantities of greenhouse gases from these sources; and
- identification of emission abatement measures currently planned.

Emissions of greenhouse gases were calculated in accordance with methods provided by the Australian Greenhouse Office (AGO) and Australian Department of Climate Change, which are generally in accordance with the World Business Council for Sustainable Development (WBCSD) / World Resources Institute (WRI) Greenhouse Gas Protocol. Therefore, the calculation is consistent with the National Greenhouse Accounts Factors.

Greenhouse Gasses Included

The calculation of greenhouse gas emissions from project construction and operation has considered emissions of the six Kyoto greenhouse gases:

- carbon dioxide (CO₂);
- methane (CH₄);
- nitrous oxide (N₂O);
- hydrofluorocarbons (HFC’s);
- perfluorocarbons (PFC’s); and
- sulphur hexafluoride (SF₆).

Each gas has a differing capacity to contribute to global warming, which is known as its global warming potential (GWP). Total emissions are expressed as carbon dioxide equivalents (CO₂-e), which considers the quantity of each gas and its GWP.

Greenhouse Gas Emission Sources

The following greenhouse gas emission sources were included in the assessment:

- fuel consumption by mobile construction equipment;
- fuel consumption by mining equipment;
Section 8

Pollution Issues and their Management

- fuel consumption by light vehicles;
- combustion of Ammonium Nitrate Fuel Oil (ANFO) for blasting;
- natural gas consumption by electricity generators;
- natural gas consumption by the pellet plant;
- the use of limestone in the process;
- the use of dolomite in the process;
- losses of synthetic gases used in refrigeration and electrical switchgear;
- deposition of solid waste to on-site landfill; and
- waste water treatment.

Minor emissions are also expected from the decomposition of cleared vegetation. However, these emissions have not been included in the greenhouse gas assessment for the following reasons:

- the vegetation in the Project area is sparse and does not meet the Kyoto criterion for classification as a forest (i.e. a potential height of at least two metres and crown cover of at least 20 per cent). This criterion is also adopted by the Australian Department of Climate Change in determining whether emissions associated with land use change are included in the Australian National greenhouse accounts;
- the majority of the disturbance area associated with the Project will be revegetated to replicate current vegetation communities. This will, over time, sequester the majority of greenhouse gas emissions resulting from the original clearing; and
- the National Carbon Accounting System does not currently contain soil or soil carbon information for the proposed location of the Project.

Greenhouse Gas Emissions Calculation

Estimated greenhouse gas emissions include both direct and indirect emissions. Consistent with Australian and international protocols for reporting greenhouse gases, emissions are separated into Scope 1 and Scope 3 emissions.

Scope 1 emissions are direct from sources within an organisation’s boundary such as fuel combustion and manufacturing processes (Australian Department of Climate Change 2008). For this Project, this includes emissions from diesel combustion on site (e.g. Mining equipment and diesel generators).

Scope 3 emissions include all other indirect emissions that are a consequence of an organisation’s activities but are not from sources owned or controlled by the organisation. For this Project, this includes emissions associated with the extraction, refinement and delivery of the diesel and natural gas that is consumed on site.

The Project is expected to generate annual Scope 1 emissions of 2,341,497 tonnes CO$_2$-e and annual Scope 3 emissions of 287,236 tonnes CO$_2$-e as shown in Table 8-10: Project Energy and Emissions and Figure 8-15: Project Lifecycle Emission.

The breakdown of these emissions between the broad activities is shown in Table 8-10: Project Energy and Emissions and Figure 8-16: Emissions Breakdown.

Total Scope 1 emissions associated with the Project are estimated to be 59,381,509 tonnes CO$_2$-e over the 31 year life of the Project (including construction). Scope 3 emissions are estimated to be 7,242,275 tonnes CO$_2$-e over the life of the Project. Total lifecycle emissions are therefore estimated to be 66,621,991 tonnes CO$_2$-e. The majority of these emissions are associated with the consumption of natural gas for electricity generation and heating in the pellet plant and diesel consumption by the mining fleet.
Section 8

Pollution Issues and their Management

Table 8-10: Project Energy and Emissions

<table>
<thead>
<tr>
<th>Source</th>
<th>Annual Energy (TJ)</th>
<th>Scope 1</th>
<th>Scope 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual (t CO2-e)</td>
<td>Project (t CO2-e)</td>
<td>Annual (t CO2-e)</td>
</tr>
<tr>
<td>Diesel - Construction</td>
<td>n/a</td>
<td>n/a1</td>
<td>404</td>
</tr>
<tr>
<td>Diesel – Pre-Strip</td>
<td>n/a1</td>
<td>n/a1</td>
<td>404</td>
</tr>
<tr>
<td>Diesel - Mining</td>
<td>4,632</td>
<td>323,314</td>
<td>8</td>
</tr>
<tr>
<td>Diesel – LV’s</td>
<td>772</td>
<td>53,886</td>
<td>1</td>
</tr>
<tr>
<td>Diesel - Generators</td>
<td>37</td>
<td>2,549</td>
<td>63</td>
</tr>
<tr>
<td>Nat. Gas – Elect Generation</td>
<td>28,900</td>
<td>1,482,570</td>
<td>37</td>
</tr>
<tr>
<td>Nat. Gas – Pellet Plant</td>
<td>5,100</td>
<td>261,630</td>
<td>6</td>
</tr>
<tr>
<td>ANFO</td>
<td>n/a</td>
<td>196,518</td>
<td>4</td>
</tr>
<tr>
<td>Limestone &amp; Dolomite</td>
<td>n/a</td>
<td>13,430</td>
<td>344</td>
</tr>
<tr>
<td>Synthetic gases</td>
<td>n/a</td>
<td>774</td>
<td>19</td>
</tr>
<tr>
<td>Waste Water Treatment</td>
<td>n/a</td>
<td>284</td>
<td>10</td>
</tr>
<tr>
<td>Waste to Landfill</td>
<td>n/a</td>
<td>6,544</td>
<td>187</td>
</tr>
<tr>
<td>TOTAL</td>
<td>39,441</td>
<td>2,341,497</td>
<td>59</td>
</tr>
</tbody>
</table>

Note: 1 Construction and pre-strip activities are not included in the aggregation of annual operational emissions as they occur prior to the operation phase.
According to the State and Territory Greenhouse Gas Inventories 2006 (Australian Government – Department of Climate Change, 2008a), Australia's National Greenhouse Gas emission for 1990 was estimated at 552.6 Mt and Western Australia's Greenhouse Gas emission for 1990 was estimated at 58.8Mt. A comparison of predicted direct emissions for the Project with the 1990 estimate demonstrates that the Project would cumulatively represent an additional 0.42% of the total baseline Australian emissions and approximately 3.98% of the total Western Australian emissions.

8.4.3 Management

The Project has considered several emission mitigation initiatives, as it will be a significant energy user. Consideration will be given during planning phases to the following options to maximise energy efficiency.

- combined cycle gas turbine generation (will be implemented);
- process plant waste heat capture (will be implemented);
- geothermal energy (not currently viable);
- solar energy (will be implemented wherever possible);
- wind energy (not currently viable);
- biofuels (not considered viable);
- renewable energy certificates (will be implemented in line with Federal scheme);
- emission trading (will be implemented in line with Federal scheme);
- progressive revegetation (will be implemented);
- solid waste management (will be implemented); and
Section 8

Pollution Issues and their Management

- building design (will be implemented).

Section 15 of the PEMP contains a detailed discussion on the use of best available technology (BAT) and management strategies to minimise emissions to levels as low as reasonably practicable on an ongoing basis. The Project is also committed to minimising emissions to levels as low as reasonably practicable on an ongoing basis consistent with the Section 16 of the PEMP (Appendix A). The Project will:

- assess alternative waste and ore disposal technologies, such as in-pit crushing and conveyor to reduce fuel burn;
- focus on the quality of fuel / lubricants used with an objective to reduce hydrocarbon waste and increase productivity per truck;
- aim to improve fuel consumption efficiency per tonne of ore hauled;
- undertake a greenhouse gas emission review with calculations of emissions per tonne of product;
- set and review greenhouse emission targets at project start-up and at each major project stage;
- monitor actual emission rates once the project is in the operational phase and setting realistic and achievable CO$_2$-e targets;
- continually monitor renewable energy technologies and government subsidy programmes to determine future viability;
- establish comprehensive monitoring, calculation and reporting systems to satisfy the requirements of the National Greenhouse and Energy Reporting Scheme (NGERS) and Energy Efficiency Opportunities (EEO) programmes;
- allocate sufficient resources and establish internal procedures and processes to satisfy the requirements of the EEO programme; and
- establish the range of carbon abatement options available to International Minerals and determine the costs of each option.

8.5 Marine Water Quality

This section addresses the operational impacts associated with brine outfall (discharge) and the seawater return outfall, and cumulative impacts of a second outfall at Cape Preston. Potential impacts associated with construction of the brine outfall and the seawater intake pipelines are addressed in Section 7-6, which also includes a description of the proposed intake and outfall installations and their construction strategy. A full report is provided in Appendix F.

8.5.1 Objectives and Standards

The project objectives for the desalination plant's brine and seawater discharges are to:

- maintain an adequate level of water quality in the waters surrounding Cape Preston; and
- to limit the area required for brine mixing surrounding the diffuser.

Relevant legislation and standards include:

- ANZECC & ARMCANZ (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality; and
Section 8

Pollution Issues and their Management

- Ministerial Condition 000635 for the Austeel Project at Cape Preston, which stipulates the acceptable brine outfall water quality for a similar desalination plant at Cape Preston.

Pilbara Coastal Waters – Environmental Values And Environmental Quality Objectives

In late 2004, the former Department of Environment (now DEC) ran a series of targeted workshops on the establishment of environmental values (EVs) and environmental quality objectives (EQOs) for the State marine waters from Exmouth Gulf to Cape Keraudren. This consultation also included comment on the application of these EVs and EQOs to these waters.

The results of consultation undertaken and recommendations to the EPA are published in Pilbara Coastal Water Quality Consultation Outcomes – Environmental Values and Environmental Quality Objectives (DEC 2006). The recommendations of this report have now been endorsed by the EPA as a framework for environmental impact assessment, waste discharge regulation and natural resource management. The report and associated ecological protection maps should act as a guiding document until such time as more formal government policy, such as a State Environmental Policy, is developed.

The EVs and their associated EQOs as endorsed by the EPA are as follows:

- Ecosystem Health (ecological value)
  - Maintain ecosystem integrity.

- Recreation and Aesthetics (social use value)
  - Water quality is safe for recreational activities in the water (e.g. swimming)
  - Water quality is safe for recreational activities on the water (e.g. boating)
  - Aesthetic values of the marine environment are protected.

- Cultural and spiritual (social use value)
  - Cultural and Spiritual values of the marine environment are protected.

- Fishing and Aquaculture (social use value)
  - Seafood (caught or grown) is of a quality safe for eating
  - Water quality is suitable for aquaculture purposes.

- Industrial Water Supply (social use value)
  - Water quality is suitable for industrial supply purposes.

In developing the ecosystem health EV, different levels of ecological protection have been developed for application to Pilbara coastal waters, as outlined in Table 8-11: Levels of Ecological Protection for Maintenance of Ecosystem Integrity. The spatial application of the EVs and EQOs to the waters around Cape Preston is outlined in (Figure 8-17: Zones of Ecological Protection).

Table 8-11: Levels of Ecological Protection for Maintenance of Ecosystem Integrity

<table>
<thead>
<tr>
<th>Level of Ecological Protection</th>
<th>Environmental Quality Condition (Limit of acceptable change)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contaminant concentration indicators</td>
</tr>
<tr>
<td>Maximum</td>
<td>no contaminants - pristine</td>
</tr>
<tr>
<td>High</td>
<td>very low levels of contaminants</td>
</tr>
<tr>
<td>Moderate</td>
<td>elevated levels of contaminants</td>
</tr>
<tr>
<td>Low</td>
<td>high levels of contaminants</td>
</tr>
</tbody>
</table>
Section 8

Pollution Issues and their Management

8.5.2 Definition of Issues and Impacts

8.5.2.1 Assessment

Description of Brine Discharge and Seawater Return

The desalination plant’s brine will contain concentrated dissolved solids (TDS) and concentrated suspended solids (TSS) as well as chemical additives used in the desalination process. The brine composition will remain constant over various flow rates. The maximum TDS discharged will be 78.8 g/L at a temperature no greater than 2° C above the temperature of the intake seawater. TSS concentration however will vary between 10 and 34 mg/L according to the ambient TSS range of 2 to 10 mg/L.
Section 8

Pollution Issues and their Management

The brine outfall will be sized to enable a discharge of 252,000 m³/d (91 GLpa) for short durations during ramp-up either after break-down or start-up conditions. The desalination plant will be designed to operate continuously using multiple parallel production trains. Single train shutdowns as a result of breakdown or planned maintenance will only have a proportional effect. For conservative design, full plant ramp up conditions are considered likely to occur twice a year for 30 minute durations. However, for most of the time under normal operating conditions 157,000 m³/d (57 GLpa) will be discharged.

In breakdown and start-up situations, the pre-treatment filters of the desalination plant may overflow, discharging the full feed stream of raw seawater for short periods. The raw seawater overflow will be directed to the brine discharge system, and will be returned to the sea via the brine discharge pipeline.

The overflow outfall will discharge up to 3.62 m³/s of filtered, untreated seawater for periods up to 30 minutes duration. The salinity, temperature, and ionic composition of the seawater will be the same as the ambient waters but may also include dosing from the coagulant and flocculation process (ferric sulphate or polymer). Such short infrequent discharges are most unlikely to affect water quality even locally.

Potential Impacts of Brine Discharge and Seawater Return

The discharge of approximately 157,000 m³/d of brine has the potential to:

- reduce local marine water and sediment quality;
- adversely affect individual marine biota within the vicinity of the outfall; and
- reduce the abundance of sensitive benthic primary producer habitat, including coral communities.

The most appropriate way to avoid the above impacts is to select a disposal site that does not currently support a high abundance of corals, seagrass or algae, ensure that sufficient depth of water is available at low tide for initial dilution to occur rapidly, and ensure that the waters above the outfall are well flushed and mixed.

The high volume discharge resulting from any intermittent addition of raw seawater return to the brine flow has the potential to cause localised erosion to nearby benthic habitats, unless the discharge diffuser is appropriately located and installed such that local erosion is mitigated. The proposed appropriate design and location are described in Section 7.6 and this Section 8.5.2.1.

Brine Discharge Diffuser Site Selection

Extensive modelling of hydrodynamics in the vicinity of Cape Preston has been undertaken in order to find a suitable brine discharge location which was both technically feasible and adequate from a flushing perspective. Detailed information of modelling activities and results is provided in GEMS (2008).

Site selection investigations were based on three key elements in order to meet the proposal's objectives:

- that the brine discharge mixing zone be limited to an area of four hectares or less;
- that sensitive habitats are protected from the operation of the outfall pipeline and diffuser; and
- that the diffuser and outfall pipeline can be adequately stabilised to protect against cyclone damage.

Site selection investigations identified that the outfall had to be located in at least 5 m of water at low tide to provide the initial dilution required to reduce the scale of the mixing zone. Three sites were investigated in relatively deep (5-10 m) water to the north and east of the Cape Preston port. All sites selected were located away from coral habitat and over relatively barren sand–veneered limestone seafloor. The preferred site was chosen on the basis of achieving adequate brine dilution, being located a suitable distance away from sensitive benthic habitats, and being technically feasible to construct.

Modelling was undertaken on the basis of a brine discharge rate of 252 ML/d. Noting that the plant will normally discharge brine at a rate of 157 ML/d, the modelling results can be interpreted as a very conservative estimate.
Modelling of the outfall diffuser mixing zone included plans for the infrastructure for the proposed Central Block transhipment harbour which have now been discarded. Furthermore, the studies did not include the new planned infrastructure for the transhipment harbour recently proposed for the Central Block. It is IM’s position that the changes in this infrastructure will not impact upon the validity of the outfall modelling due to location and the depth of the discharge (>7 m LAT), high current flow and predominant current directions which we believe will not be significantly affected by the proposed infrastructure.

Brine Dilution

The proposal objective is to limit the area required for brine dilution as much as is practicable. This will then ensure an adequate level of water quality is maintained for surrounding waters.

In order to achieve these objectives it was stipulated that the brine discharge mixing zone be limited to an area of no more than four hectares. More specifically, it was deemed that salinity variation resulting from the discharge of the plant should be no greater than 5% above the ambient level for more than one percent of the time anywhere around Cape Preston (except within the 4 ha mixing zone).

Modelling interpreted that salinity concentrations were 5% of ambient salinity at the edge of the mixing zone. Given that ambient salinity at the site is between 35 ppt and 40 ppt, this equates to approximately 2 ppt above background. Given that the brine discharge will have a concentration close to app 80 ppt, 40 dilutions are required to achieve acceptable mixing. Therefore, the objective of the modelling was to ensure the diffuser location would provide 40 dilutions within a 4 ha area for 99% of the time.

Discharge of Chemicals Used in the Desalination Plant

A number of chemicals are required for efficient operation of the desalination plant. These are included in Table 8-12: Chemicals Used in the RO Process and Dilutions in the Marine Environment, along with their predicted dilutions at the end of pipe and in the marine environment.

<table>
<thead>
<tr>
<th>Dosing chemical</th>
<th>Purpose</th>
<th>Dosing concentration ppm</th>
<th>Discharge concentration ppm</th>
<th>Modelled Mixing-zone boundary concentration ppm (refer Appendix F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Hypochlorite NaOCl</td>
<td>Intake. Intermittent oxidiser</td>
<td>5</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Sulphuric Acid H2SO4</td>
<td>Pre-treatment. Continuous</td>
<td>29</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Ferric Sulphate Fe2(SO4)3</td>
<td>Pre-treatment. Continuous</td>
<td>12</td>
<td>8.0 – discharged as Ferrous Hydroxide</td>
<td>0.3 0.2</td>
</tr>
<tr>
<td>Polymer (anionic polyacrylic such as Nalco 8103 Plus or equivalent)</td>
<td>Flocculant. Continuous</td>
<td>0.3</td>
<td>0.5</td>
<td>Nil</td>
</tr>
<tr>
<td>SBS (Sodium Bisulphite)</td>
<td>Pre-treat intermittent oxidiser</td>
<td>10</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Anti-scalant (Permatreat PC 191 or equivalent)</td>
<td>RO. Continuous</td>
<td>1.5 ppm = 120 tonnes/year</td>
<td>2.2 ppm</td>
<td>0.05</td>
</tr>
<tr>
<td>Lime</td>
<td>Pre-treatment. Continuous</td>
<td>46</td>
<td>2 – discharges silicate impurities</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Section 8

Pollution Issues and their Management

The above chemicals are required in the process as follows:

- ferric sulphate for pre-treatment of intake water to maximise the sedimentation process. This reacts with bicarbonates in the seawater to form ferric hydroxide flocs which are removed during sedimentation along with seawater borne suspended solids and discharged with the brine;
- sulphuric acid may be added when needed to adjust the seawater pH;
- polymer (anionic polyacrylic): a flocculating chemical used in the seawater purification process and is removed from the system along with finer suspended solids during sedimentation and discharged with the brine;
- anti-scalant (mixed organic and inorganic chemicals such as Permatreat PC 191 or equivalent) will be continuously dosed into the RO feed line to prevent scale build-up. The anti-scalant is concentrated along with the seawater brine, but even so is discharged at very low levels; and
- if hypochlorite is used as a biocide, sodium metabisulphite will be added to the discharge to destroy residual chlorine. Both these chemicals are neutralised in the system resulting in no residual discharge.

Both anti-scalant and polymer are developed to have negligible biological toxicity because RO systems are typically designed to supply domestic needs in most cases. Material Safety Data Sheets, which include toxicity information showing that the material is non-toxic, are provided in Appendix F.

Modelling Results

The hydrodynamic model GCOM3D was run for a 12 month period using data collected at Cape Preston by GEMS during the period January to December 2007. This period has been determined by GEMS to represent a “normal” year as far as seasonal wind strength and direction are concerned.

The GEMS model was run with an underlying assumption that Central Block Project Desalination Plant brine discharge would be located at the south-eastern point shown in Figure 8-18: Percentage Compliance of the Two Proposed Brine Discharges, and the Balmoral South Project Desalination Plant brine discharge would be located at the north-western point shown in Figure 8-18. The locations of both the Central Block Project and Balmoral South Project brine discharge points were determined by a combination of the site selection described above and practical constructability values assuming that both outfall pipes could be extended seaward from the breakwater constructed for a marina facility planned for this area by the Central Block Project. The outline of the marina facility can be seen in Figure 8-18.

The GEMS PLUME3D model was used to determine the number of dilutions obtained and the maximum area of mixing zone required for 40 dilutions to occur for 100%, 99% and 95% of the time for both an assumed but yet to be built Central Block Project outfall and for the proposed Balmoral South Project outfall.

Modelling results show that both outfalls could operate for 99% of the time within individual separate mixing zones each of 4 ha or less in area at the sites chosen for each outfall. Results also confirm that the mixing zone occurs locally to the diffuser and that the zone does not impact on coral habitats located in the vicinity of the outfall (Figure 8-18).

The discharge of 252 ML/d of brine has been modelled for each of the two outfall locations shown in Figure 8-18. The south-eastern outfall for the Central Block Project achieves the required number of dilutions within 3.9 ha, whilst the north-western site proposed for the Balmoral South Project requires only 3.5 ha to achieve the same dilutions because it is approximately 3 m deeper than the Central Block Project outfall site (which is about 7 m deep).

Subsequent to completion of this GEMS model, the Central Block Project has discontinued its plan to construct the marina facility, and has also determined that its brine outfall point will not be located at the south-eastern location shown in Figure 8-18. The discharge pipeline constructability advantages discussed above are therefore no longer available, and the Balmoral South Project now proposes to place its brine discharge diffuser at the minimum cost location (closest to shore) located at the south-eastern discharge model point shown in Figure 8-18., in 7 m of water LAT.
Section 8
Pollution Issues and their Management

8.5.2.2 Impacts

Whilst desalination plants are a relatively recent introduction to Western Australia, they have been operating elsewhere in the world for over 20 years. At the beginning of 2006, more than 12,000 desalination plants were in operation throughout the world, producing about 40 million m$^3$ of water per day. Slightly over 1% of this capacity is produced in Australia (WHO 2007).

Despite the vast amount of desalination plants operating around the world, there are many knowledge gaps and uncertainties regarding the impacts of desalination projects on the environment, as monitoring results of operating plants are only available to a limited extent (WHO 2007). It is however known that impacts are possible from operation of a Reverse Osmosis (RO) desalination plant associated with the discharge of the brine into the sea (Münk 2008), and with residual chemicals from pre and post-treatment processes (Latteman and Höpner 2008), particularly where flushing of the receiving waters is not high. Such potential impacts can arise either from the salinity, density and pH of the brine, or from additives to the brine such as oxygen scavengers, antiscalant compounds, biocides such as chlorine used to inhibit biofouling, coagulants, or from metals leached from internal pipeworks.

Table 8-13: Possible Operational Impacts of RO Plants and Applicability to the Project (modified after Lattemann and Höpner 2008) provides an overview of potential sources of operational impacts normally associated with RO Plants and whether or not they are applicable to the proposed Project plant at Cape Preston. Further discussion on potential impacts is provided below and in further detail in Appendix F.
Table 8-13: Possible Operational Impacts of RO Plants and Applicability to the Project

<table>
<thead>
<tr>
<th>Source of potential impact</th>
<th>Associated concern</th>
<th>Relevance to IM plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity and density of brine</td>
<td>Brine typically has a concentration of ~80 ppt. Where effluent at this concentration accumulates on the seafloor for any length of time it can cause localised mortality of certain marine organisms.</td>
<td>Brine will be ~80 ppt. However flushing and mixing at the outfall site is high and unlikely to enable accumulation of high brine concentrations over seafloor for any appreciable length of time.</td>
</tr>
<tr>
<td>De-aeration and application of oxygen scavengers to intake waters</td>
<td>Can cause reduced oxygen concentration in brine.</td>
<td>Receiving waters are saturated in oxygen and the effluent will be re-oxygenated very soon after discharge.</td>
</tr>
<tr>
<td>Use of chlorine for biofouling control in intake waters</td>
<td>Use of hypochlorite can result in residual chlorine being discharged with the brine.</td>
<td>If hypochlorite is used as a biocide, sodium metabisulphite will be added to the discharge to destroy residual chlorine. Both these chemicals are neutralised in the system resulting in no residual discharge.</td>
</tr>
</tbody>
</table>
| Addition of antiscalant and flocculant to intake waters | Some early antiscalants and flocculants were potentially toxic to marine organisms. Modern compounds have now been developed to be non-toxic. | Modern compounds will be used that have been demonstrated to be non-toxic as follows:  
  - Antiscalant: PermaTreat® PC-191. A phosphonate;  
  - Flocculant: polymer (anionic polyacrylic). |
| Coagulants and coagulant aids                       | Ferric sulphate (Fe₂(SO₄)₃) reacts with bicarbonates in the seawater to form ferric hydroxide flocs. Can colour effluent with orange stain. | The possible effect of the coagulant on the environment (visibility of plume, TSS and precipitate) is minimised by the diffuser design and location, which has been subject to extensive modelling to ensure adequate dispersion of brine within the designated 4 ha mixing zone. Risk of any impacts on ecosystem in the proposed area is low, as the ecosystem falls in the category of “non-sensitive”. |
| pH                                                  | Lowered pH can affect marine biota                                                 | Brine will be treated before discharge to raise pH.                                    |
| Heavy metals                                        | Early plants discharged metals from pipework installed for the desalination process, thereby leading to elevated metals in receiving waters and sediments around the outfall. | The seawater-contact surfaces for the desalination plant will be either concrete, PVC, fibreglass or high grade stainless steel. There will therefore be no discharge of trace metals form the plant blowdown. |

**Salinity**

Typically, the range of natural salinity fluctuation is at least +/- 10% of the average annual ambient seawater concentration. The actual salinity tolerance of most marine organisms is usually significantly higher than this level (WHO 2007). However, there are limited documented studies or experiments on the impacts of salinity fluctuation on marine organisms and the outcome of studies undertaken vary according to the environment and the organisms examined.

In summary, it appears that sensitivity to marine organisms associated with salinity fluctuation depends on a variety of factors including the environmental setting, range of salinity fluctuation and the organism itself. As previously stated, the proposal objective is to ensure that the salinity increase outside the mixing zone is no greater than 5% (~2 ppt) above the ambient salinity for more than one percent of the time anywhere around Cape Preston. Hence if any impacts occur, they will be restricted to within the mixing zone and the brine effluent will pose no risk to the broader marine environment outside this zone.
Section 8

Pollution Issues and their Management

Density

The density difference between brine and seawater can induce the formation of a stratified system, with the brine forming a bottom layer that can affect the benthic communities which are used to stable salinity environments.

However, as described in Section 4.12, the receiving waters of Cape Preston are highly energetic and no evidence of stratification has been found in over 12 months of ADCP monitoring. Given the 4.75 m range of the semi-diurnal tides in the area, it is considered unlikely that stratification will develop at either of the proposed outfall sites. Diffuser design and location have been subject to extensive modelling to ensure adequate dispersion of brine within the designated 4 ha mixing zone during the most challenging worst-case dispersion conditions, this being slack water during low neap and spring tides (GEMS 2008).

Antiscalant

The antiscalant product proposed to be used (PermaTreat® PC-191) is a phosphonate, which despite being effective against scaling, it is also claimed to inhibit corrosion (Falbe and Regitz 1995). The proposed desalination plant will dose 1.5 ppm antiscalant. The estimated concentration at discharge will be 2.2 ppm and at the mixing zone boundary, approximately 0.05 ppm.

A variety of toxicological and ecotoxicological tests have been undertaken for this product (see Material Safety Data Sheets Appendix F). All tests showed that the product is non-toxic. Furthermore, ecotoxicological test have been undertaken for the desalination plant in Cockburn Sound. The Whole of Effluent Toxicity Testing was performed on a suite of bioassays using marine species representative of the receiving ecosystem in Cockburn Sound, as recommended by the ANZECC and ARMCANZ (2000) water quality guidelines. No toxicological effects have been found (Woodworth, 2008).

Flocculant

The flocculant, an anionic polyacrylic NALCO 8103 Plus is used in the seawater purification process. The proposed desalination plant will dose 0.3 ppm of the polymer NALCO, the estimated concentration at discharge will be 0.5 ppm and at the mixing zone boundary it will be nil. A variety of toxicological and ecotoxicological tests have been done which demonstrate that the flocculant is non-toxic.

Coagulant and TSS

TSS concentration on discharge is estimated to vary between 10 and 34 mg/L under normal ambient conditions of 2-10 mg/L.

The coagulant (ferric sulphate) will be added to incoming seawater to ensure optimal conditions for the coagulation process is reached. This reacts with bicarbonates in the seawater to form ferric hydroxide flocs which are removed during sedimentation along with seawater borne suspended solids and discharged with the brine. If required, sulphuric acid may be added to adjust the pH to the range required for ferric sulphate. The proposed desalination plant will dose 12 ppm ferric sulphate. The estimated concentration at discharge will be 8.0 ppm and at the mixing zone boundary after receiving 40 dilutions will be approximately 0.2 ppm.

Ferric hydroxide forms a precipitate, is reddish brown in colour and might cause a discoloration of seawater as well as a decrease in light penetration (Lattemann and Höpner 2003).

Therefore, the brine discharge will be turbid and coloured. Turbidity near the outlets might impair photosynthesis and if the suspended solids settled out, may cause sedimentation of benthos.

Field surveys and benthic habitat mapping conducted in the proposal area identified low coral cover (URS 2007). Most of the habitats in the shallows adjacent to Cape Preston are relatively barren intertidal sand flats or shallow algae dominated pavements. Any possible impact on the sparse corals and the algal pavement will be minimised if the solids are discharged continuously into well mixed water (Lattemann and Höpner 2003), which is the situation which occurs at the proposed outfall site.
Pollution Issues and their Management

Coagulant and Visibility

A study undertaken in the mid seventies on a trial disposal of iron rich effluent into the sea off Bunbury WA, from the Laporte titanium factory at Australind (Murphy 1981) suggested that a reasonable limit of visual detection of a ferric plume is probably 0.1 mg/L ferric directly at the outfall location, which will become invisible a short distance from the outfall. Given this finding, it is anticipated that the ferric stain will only be visible within the mixing zone which has been located away from sensitive benthic habitats.

Overall Effects on the Ecosystem

Höpner and Windelberg (1996) presented a list which ranks 15 coastal sub-ecosystems according to their sensitivity to brine discharge (Table 8-14: Coastal Sub-ecosystems and Characteristics Ranked by Sensitivity). Criteria for this classification included the sensitivity towards desalination effluent characteristics, the water exchange capacity of the outfall location and the natural recovery potential of the receiving environment. The greater the number of the ecosystem (Rank Nr) the more sensitive it is and the more adverse effects can be expected from brine discharges. Conversely low rankings indicate low sensitivity.

The characteristics of the marine ecosystem around Cape Preston are those that are described for the lowest rankings of 1-3. Given the low sensitivity of the outfall site, the excellent flushing provided by semi-diurnal macro-tides, the low sensitivity of the receiving environment in the vicinity of the outfall, and the negligible toxicity of the effluent components, the likelihood of any adverse effects arising from the brine discharge on the marine environment outside the mixing zone is considered extremely low. Similarly, the risk of causing long term environmental harm to the receiving waters inside the mixing zone is also considered extremely low.

Table 8-14: Coastal Sub-ecosystems and Characteristics Ranked by Sensitivity

<table>
<thead>
<tr>
<th>Rank Nr</th>
<th>Sub-ecosystem</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High energy oceanic coast rocky or sandy, with coast parallel currents</td>
<td>Plenty of oxygen, nutrients and energy; efficient biodegradation.</td>
</tr>
<tr>
<td>2</td>
<td>Exposed rocky coasts</td>
<td>Good water exchange in all areas.</td>
</tr>
<tr>
<td>3</td>
<td>Mature shorelines</td>
<td>Low particle accumulation through high sediment mobility.</td>
</tr>
<tr>
<td>4</td>
<td>Coastal upwelling</td>
<td>High water exchange, but seasonally limited.</td>
</tr>
<tr>
<td>5</td>
<td>High energy soft tidal coast</td>
<td>Still high sediment mobility, but accumulation tendency in certain areas.</td>
</tr>
<tr>
<td>6</td>
<td>Estuaries and estuary-similar systems</td>
<td>Seasonally changing water quality and turbidity.</td>
</tr>
<tr>
<td>7</td>
<td>Low energy sand-, mud- and beach rock-flats</td>
<td>Limited water exchange; house many species and tend to accumulation.</td>
</tr>
<tr>
<td>8</td>
<td>Coastal sabkahs</td>
<td>Exposed to wind, dust and solar radiation; rarely capable of degradation.</td>
</tr>
<tr>
<td>9</td>
<td>Fjords</td>
<td>Shelter for many animals; limited exchange and tendency to oxygen deficits.</td>
</tr>
<tr>
<td>10</td>
<td>Shallow low-energy bays and semi-enclosed lagoons</td>
<td>Endangered by load concentrations; low water exchange.</td>
</tr>
<tr>
<td>11</td>
<td>Algal (cyanobacterial) mats</td>
<td>Lower sensitivity, but reactions to many stress factors are still unknown.</td>
</tr>
<tr>
<td>12</td>
<td>Seaweed bays and shallows</td>
<td>Sanctuary for breeding animals; tendency to load concentration; sensitive.</td>
</tr>
<tr>
<td>13</td>
<td>Coral reefs</td>
<td>Shelter for a big variety of species; many species with high sensitivity.</td>
</tr>
<tr>
<td>14</td>
<td>Saltmarsh</td>
<td>Sensitive macrophytes and animals; very vulnerable to load concentration.</td>
</tr>
<tr>
<td>15</td>
<td>Mangrove flats</td>
<td>Rapid decline through pollution and changing conditions; plants and animals can hardly tolerate any pollution.</td>
</tr>
</tbody>
</table>
Section 8

Pollution Issues and their Management

Interactions and Cumulative Impacts of Brine Discharges

The GEMS model referred to in Section 8.5.2.1 above assumed the Balmoral South Project proposed brine discharge would be located approximately 1,000 m to the north-west of the proposed Central Block Project brine outlet and diffuser. As also discussed in Section 8.5.2.1 above, the Central Block Project no longer intends to construct its brine outfall in the south-eastern location shown in Figure 8-18, and that is now the proposed location for the Balmoral South Project brine discharge diffuser. It is understood the new proposed location for the Central Block Project brine discharge diffuser will be some 2,000 m to the west of the location shown in Figure 8-18.

GEMS modelling to assess whether there would be any detrimental interactions or cumulative impacts from both discharges operating simultaneously was based on the locations shown in Figure 8-18, which, when considering proximity, is considered to be a worst case scenario than the likely proposed new discharge locations. For this worst case scenario:

- modelling was undertaken on the conservative basis of a brine discharge rate of 252,000 m$^3$/d from each outlet, whereas the design basis for desalination is that each outlet would only normally discharge brine at a rate of 157,000 m$^3$/d;
- modelling concluded that each diffuser will achieve 40 dilutions within a 4 ha mixing zone for 99% of the time. This would ensure that salinity as a result of each discharge is no greater than 5% above the ambient level for more than one percent of the time anywhere around Cape Preston (except within the two (4 ha) mixing zones around each diffuser); and
- Figure 8-18 highlights that both discharge diffusers will essentially operate independently of each other and for 99% of the time brine will be mixed to the required dilutions within each individual 4 ha mixing zone. Interactions between brine discharged from each diffuser are therefore deemed to be negligible and it is believed that there will be no cumulative risk from both discharges operating simultaneously.

Therefore, it is considered that there will be no cumulative risk from two discharges operating simultaneously if the Balmoral South Project discharge is to be located in the south-eastern location on Figure 8-18, and the Central Block Project discharge is located a minimum of 1,000 m away, in similar bathymetry and tidal flow conditions, and with similar design parameters, which is the likely case.

8.5.3 Management

The brine outfall (discharge) management objectives include to:

- provide a high level of protection to the waters in the region of Cape Preston, except for the mixing zone surrounding the outfalls;
- develop monitoring and feedback programmes for the wastewater stream within the outfall to provide an early warning of potential risks to environmental quality;
- monitor the effectiveness of wastewater outfall management measures; and
- adaptively respond to inadequacies in controls through preventative action.

The preparation and application of a Water Quality Management Framework (WQMF) will be the key tool in achieving the objectives of the proposal. It will be developed within Section 17 of the PEMP (Appendix A) to ensure that an adequate level of water quality within the Cape Preston region is maintained as a result of the brine discharge.
Section 8

Pollution Issues and their Management

The WQMF will include:

- establishing (Environmental Quality Objectives) EQOs for uses and values and where they will be protected;
- establishing appropriate (Environmental Quality Criteria) EQC required to sustain each EQO; and
- providing a high level of ecological protection to waters in the region of Cape Preston, except for the mixing zone surrounding the brine discharge and the moderate protection zone within the proposed port and surrounding operational areas.

The basic elements of the WQMF for this project are provided in Section 17 of the PEMP (Appendix A). Specific management measures for the protection of marine water quality are the same as those presented in Section 7.6.3.

A monitoring programme will be implemented as part of the WQMF. The established EQC will be the benchmarks against which the level of achievement of the EQOs is measured. If EQC are being met it will be deemed that the EQOs, and by extension the EVs, are being maintained. The monitoring programme will include the following:

- real-time physical parameters will be measured on-line within the outfall stream to ensure that percentile deviations from intake water are not exceeded. Water samples will be analysed for toxicants at the intake and outfall sites;
- monitoring programme for salinity will be completed around the brine discharge diffusers. This monitoring will be undertaken to validate the modelling results and ensure that an adequate level of dilution is being achieved within the 4 ha mixing zone, and that the salinity criteria are being met at the boundary of the mixing zone and the moderate ecological protection area;
- diffuser compliance monitoring to be undertaken. Real-time, in-line monitoring of both ambient and discharge physical seawater parameters (pH, temperature and salinity) will enable data verification of compliance. Any exceedance will be quickly acted upon to ensure the 5% limit is not exceeded;
- an automated system will be installed for withdrawing and maintaining samples from both the desalination intake and discharge for later analysis of toxicants including metals, metalloids and desalination chemical; and
- an annual monitoring program will be conducted to verify the compliance with established EVs and EQOs.

If monitoring identifies a breach of an established EQC, further investigations will be undertaken to assess the status of the relevant EQO and an appropriate management response will be implemented if required.

8.6 Noise

This Section addresses noise emissions from the project. The specialist assessment of noise is provided in Appendix K.

8.6.1 Objectives and Standards

The primary objective for the Project is to ensure that noise emissions, both individually and cumulatively, do not adversely impact on local amenity. The relevant legislation and standards include:

- *Environmental Protection (Noise) Regulations 1997*;
Section 8

Pollution Issues and their Management

Operational Noise

Table 8-15: Assigned Noise Levels identifies the allowable noise emissions as specified by the
Environmental Protection (Noise) Regulations 1997.

Table 8-15: Assigned Noise Levels

<table>
<thead>
<tr>
<th>Type of premise receiving noise</th>
<th>Time of day</th>
<th>Assigned Level (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( L_{A10} )</td>
</tr>
<tr>
<td>Noise sensitive premises at locations within 15 m of a building directly associated with a</td>
<td>7:00 to 19:00 Monday to Saturday</td>
<td>45 + IF</td>
</tr>
<tr>
<td>noise sensitive use</td>
<td>9:00 to 19:00 Sundays and public holidays</td>
<td>40 + IF</td>
</tr>
<tr>
<td></td>
<td>19:00 to 22:00 any day</td>
<td>40 + IF</td>
</tr>
<tr>
<td></td>
<td>22:00 on any day to 7:00</td>
<td>35 + IF</td>
</tr>
<tr>
<td>Noise sensitive premises at locations further than 15 m of a building directly associated with</td>
<td>All hours</td>
<td>60</td>
</tr>
<tr>
<td>a noise sensitive use</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Commercial premises</td>
<td>All hours</td>
</tr>
<tr>
<td>Industrial and Utility premises</td>
<td>All hours</td>
<td>65</td>
</tr>
</tbody>
</table>

IF - The influencing factor is applied to account for higher noise areas as a result of nearby industrial and commercial areas and major roads. The influencing factor is determined by considering the land use within two circles having a radius of 100 m and 450 m from the noise sensitive premises of concern.

According to the policy the noise emissions must not significantly contribute to a level of noise which exceeds the assigned level (as shown in Table 8-15). The Environmental Protection (Noise) Regulations 1997 suggest that a noise emission is taken to "significantly contribute to" a level of noise if the noise emission is greater than a level which is 5 dB below the assigned level at the point of reception. Therefore, the design target shall be 5 dB less than the assigned noise level as set out by the Environmental Protection (Noise) Regulations 1997 in order to not significantly contribute to the overall noise environment.

Penalties for the character of the noise may be applicable according to the policy. A 5 dB(A) penalty is to be applied for each of the characteristics of tone and modulation, and a 10 dB(A) penalty is applied to impulsiveness. The noise emission is expected to be broadband in nature and hence no penalty is warranted. However, "track slap" can be produced by the tracked dozers, which would attract a penalty for modulation. This can be minimised with operational management, for example, by restricting the dozers to 2nd gear in reverse, and therefore no penalty has been applied.

The noise criteria will be applicable at the following locations:

- miners’ camp 9 km to the north east of the proposed mine;
- miners’ camp 7 km to the south of the proposed mine; and
- public camping area at the mouth of the Fortescue River, 11 km to the north west of the mine.
Section 8

Pollution Issues and their Management

Since the miners’ camps are associated with the mines, they are considered to be a caretakers premises or the like, attached to or forming part of the mine. Therefore the applicable assigned levels fall under the “Industrial and Utility” category. The design target for the miners camps is therefore $L_{A10} 60 \text{ dB(A)}$, which is 5 dB(A) below the assigned noise level so as not to significantly contribute to the overall noise environment.

The public camping area on the other hand falls under the “noise sensitive” category. The design target for the public camping area is most stringent at night, and as the mine will operate for 24 hours per day the applicable criterion is 30 dB(A), since no influencing factor is applied.

Construction Noise

The *Environmental Protection (Noise) Regulations 1997* provide guidance for construction noise; however there are no specific criteria. The guidelines for construction work carried out between 7am and 7pm on any day which is not a Sunday or public holiday are:

- the construction work must be carried out in accordance with control of noise practices set out in section six of Australian Standard 2436-1981 “Guide to Noise Control on Construction, Maintenance and Demolition Sites”;
- the equipment used for the construction work must be the quietest reasonably available; and
- the chief executive officer may request that a noise management plan be submitted for the construction work at any time.

For construction work done outside the hours shown above:

- the work must be carried out in accordance with section six of AS 2436-1981;
- the equipment used must be the quietest reasonably available;
- the proponent must advise any nearby occupants of the work to be done at least 24 hours before it commences;
- the proponent must show that it was reasonably necessary for the work to be done out of hours; and
- the proponent must submit to the chief executive officer (CEO) of the EPA (or their representative) a noise management plan at least seven days before the work starts, and the plan must be approved by the CEO.

It is intended that construction work will be 24 hours per day, 7 days per week.

Given that there are no occupants in the surrounding area, the construction noise criteria applicable to this project would be the same as the operational (environmental) noise criteria, unless exceedances are predicted, in which case an application for an exemption must be submitted to the EPA.

Blasting Noise

The *Environmental Protection (Noise) Regulations 1997* specify allowable airblast levels resulting from blasting when received at any other noise sensitive premises. For blasting carried out between 7am and 6pm on any day, which is not a Sunday or a public holiday, the airblast level received on any other premises must not exceed:

- 125 dB(LIN) $L_{\text{peak}}$ for any one blast; and
- 120 dB(LIN) $L_{\text{peak}}$ for nine in any 10 consecutive blasts (irrespective of interval between blasts).

For blasting carried out between 7am and 6pm on a Sunday or public holiday, the airblast level received on any other premises must not exceed:

- 120 dB(LIN) $L_{\text{peak}}$ for any one blast; and
Section 8

Pollution Issues and their Management

- 115 dB(LIN) $L_{peak}$ for nine in any 10 consecutive blasts (irrespective of interval between blasts).

The airblast level is limited to 90 dB(LIN) for any period outside these specified times.

EPA Guidance Statement No.8 Criteria

The aspirational goal recommended in EPA Guidance Statement No.8 for a construction camp located on the same premises as the proposal should be used as the design target for the miners’ camps. According to the Guidance Statement, the aspirational goal based on indoor levels inside the accommodation sleeping areas of $L_{A10}$ 40dB(A) and $L_{Amax}$ 50dB(A) should be considered. For the general building structure of an operation camp, this goal normally equals to $L_{A10}$ 50dB(A) and $L_{Amax}$ 60dB(A) outside.

The applicable external noise criteria in accordance to the EPA Guidance Statement No.8 are therefore as shown in Table 8-16: EPA Guidance Statement.

Table 8-16: EPA Guidance Statement

<table>
<thead>
<tr>
<th>Receiver Location</th>
<th>EPA Guidance Statement No 8 Noise Criteria dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$L_{A10}$</td>
</tr>
<tr>
<td>Miners camp (east)</td>
<td>50</td>
</tr>
<tr>
<td>Miners camp (south)</td>
<td>50</td>
</tr>
<tr>
<td>Public camping area (Fortescue River)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

8.6.2 Definition of Issues and Impacts

8.6.2.1 Investigations and Results

The proposed mine site is approximately 2 km south of the proposed Central Block Project. The closest noise sensitive receivers are the two miners’ camps located 9 km to the north east and 7 km to the south of the proposed mine, and the public camping area at the mouth of the Fortescue River located 11 km to the north west. The approved Central Block Project is located 4 km closer to the Fortescue River mouth.

Four separate scenarios were considered for the assessment of the mining noise, the worst of which was selected for detailed modelling. The scenarios considered include a construction scenario and three operational scenarios including initial, future and final. The potentially worst case, 24 Mtpa options were considered for all operational scenarios.

The environmental noise emission was predicted using CONCAWE algorithms in the SoundPLAN noise propagation software. Noise levels were predicted for “worst case” night time meteorological conditions as required by the Noise Regulations. The modelled weather conditions are: 3 m/s wind speed blowing from source to receiver, 15°C temperature, 50% relative humidity, 1013 mbar atmospheric pressure, Pasquill Stability Category ‘F’.

Operational Noise

The worst case operating scenario at Balmoral South was determined to be a production level of 24 Mtpa during years 3 to 24, due to the largest number of equipment being present in both the pit and waste / processing areas. Details of this scenario and the noise characteristics of plant and equipment are provided in Appendix K. Compliance of the noise emissions associated with the worst case scenario would ensure compliance associated with all other scenarios.

The noise study considered the cumulative operational noise levels at the critical (worst case) night time scenario at the nearest noise sensitive receivers and compared them with the appropriate environmental noise criteria.
Section 8  
Pollution Issues and their Management

The corresponding Mining (Future) (Conveyor) Central Block pit operational sources (Lloyd Acoustics 2005, 2005a) were reproduced in this assessment and added to the Balmoral South operations to provide a cumulative assessment.

The results of the study together with the applicable assessment criteria are shown in Figure 8-19: Noise Contour Plot for the Worst Case Operational Scenario.

Table 8-17: Predicted Environmental Noise Levels

<table>
<thead>
<tr>
<th>Receiver location</th>
<th>Night time noise emission – $L_{A10}$ dB(A)</th>
<th>Noise Criteria</th>
<th>Allowed from additional sources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Predicted worst case (future)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miners camp (east)</td>
<td>37</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Miners camp (south)</td>
<td>23</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Public camping area (Fortescue River)</td>
<td>23</td>
<td>30</td>
<td>29</td>
</tr>
</tbody>
</table>

The results in Table 8-17: Predicted Environmental Noise Levels show that the noise emission criteria are achieved at all sensitive receivers for the proposed Balmoral South mine.

The noise contour plot for the worst case operational scenario is shown in Figure 8-19: Noise Contour Plot for the Worst Case Operational Scenario.

Construction Noise

Construction noise emissions are expected to be significantly less than the worst-case operational scenario. Compliance with the worst case operational scenario therefore ensures that construction noise levels are below the assigned noise levels set out in the Environmental Protection (Noise) Regulations 1997.

Blasting Noise

Blasting noise at the receiver locations will vary depending on the stage of the mining operations, blast configuration and site specific conditions. The noise from blasting is likely to be higher during construction and the initial stages of mining. Blasting noise will be managed by monitoring blast noise for the initial blasts and determining the typical maximum permissible charge size.

Blasting noise is not an issue at other Pilbara mines of similar size (e.g. Mt Whaleback at Newman). Wherever possible, blasting will be at the same time each day.
Figure 8-19: Noise Contour Plot for the Worst Case Operational Scenario
**Section 8**

### Pollution Issues and their Management

**8.6.2.2 Potential Impacts**

Results of the study show compliance with the relevant *Environmental Protection (Noise) Regulations 1997* criteria at all potentially impacted noise-sensitive receivers surrounding the site.

Furthermore, given that the combined noise level at the Fortescue River camping area from the planned operations is 23 dB(A), there is ample scope for future expansion / development in the area. The allowable cumulative noise emission from all future developments at the camping area is 29 dB(A).

New operations of a similar magnitude to be constructed to the south of Balmoral South will provide insignificant noise level contribution due to the large distances involved. The largest contributor from those developments would be from the conveyor belts / transport corridor and these would be expected to comply with the design criterion of 30 dB(A). New developments to the north of Balmoral South have the potential to make a larger noise contribution to the camping area as they are nearer the camp.

**8.6.3 Management**

Noise management strategies will be implemented to minimise the potential for environmental impacts from noise emissions. The management actions are presented in detail in Section 19 of the PEMP (Appendix A). The key noise management measures include:

- undertaking construction work in accordance with Section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites;
- using the quietest reasonably available equipment, machines and vehicles during construction and operational activities;
- ensuring equipment, machines and vehicles are maintained on a regular basis to ensure the effectiveness of noise suppression systems;
- in the event that any blasting is required to facilitate construction, initial blasts will minimized and measurements will be undertaken near both the river mouth camps and the accommodation camp site as a basis for determining the typical maximum permissible charge;
- maintaining a register of any noise-related complaints received during the construction phase and modifying practices in response to complaints if required.

The Project will monitor noise levels at noise sensitive sites during project development in order to ensure compliance with the *Environmental Protection (Noise) Regulations 1997*. The monitoring sites will include the Fortescue River mouth camping area, Mardie Homestead and accommodation villages.

### 8.7 Solid and Liquid Wastes

**8.7.1 Objectives and Standards**

The primary objectives in regard to Project waste are as follows:

- minimise any solid and liquid wastes produced as a result of the mining process;
- integrate a waste hierarchy (i.e. avoid, reuse, reduce, recycle, treat, dispose) for waste minimisation and establish a ‘closed loop’ within as many waste streams as possible; and
- ensure no release of hydrocarbons to the environment, either from storage or handling incidents.

Relevant legislation and guidelines include:

- *Health Act 1911 – Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste Regulations) 1974*;
- *Environmental Protection (Controlled Waste) Regulations 2001*;
Section 8
Pollution Issues and their Management

- Environmental Protection (Rural Landfill) Regulations 2002;
- Department of Environment Guidelines for Acceptance of Solid Waste to Landfill (2002); and

8.7.2 Definition of Issues and Impacts

Project activities will generate waste that can be broadly categorised into the following types:

- dewatered tailings produced during ore concentration. These are inert;
- industrial waste including oil filters, hydraulic hose, workshop waste, waste oil, tyres, etc;
- putrescibles (general domestic waste);
- inert waste including asphalt, concrete, etc;
- wastewater including sewage, grey water and washdown water;
- hazardous waste including hydrocarbons; and
- recyclable waste including aluminium products, scrap metals, wire, etc.

If these wastes are not appropriately managed, potential impacts could include land contamination, change in quality of surface water and groundwater, and / or contamination of ecological habitats.

8.7.3 Management

The strategies for managing solid and liquid wastes are provided in Section 20 of the PEMP (Appendix A). The storage, handling and disposal of waste materials will comply with local and State regulations. The key management measures for the management of solid and liquid wastes include:

- instructing all personnel in individual responsibilities in regards to waste management with emphasis on avoidance, re-use and recycling, such that all personal rubbish and incidental construction rubbish generated is properly disposed of in designated disposal facilities;
- providing appropriate waste collection and disposal facilities (e.g. bins, landfill, landfarm, segregation facility) in strategic locations on-site. Facilities will contain waste, provide for recycling and prevent waste from blowing out;
- providing a recycling area for on-site storage of recyclable materials prior to transferring material off-site. Recyclable materials storage on-site will include:
  - high grade metals to be stored in skip bins;
  - low grade metals to be stored in drums;
  - batteries on bunded pallets;
  - waste oil and fuel and other oily materials such as rags, filters, etc to be stored in bunded tanks;
  - aluminium cans; and
  - recyclable plastics.
- storing hydrocarbon products in approved bunded facilities located in the workshop compound at the mine site.
Section 8  

Pollution Issues and their Management

- should a spill occur, any hydrocarbon contaminated soils will be bioremediated on-site. The bioremediation of the contaminated area would be undertaken in accordance with the Contaminated Sites Management Series Bioremediation of Hydrocarbon - Contaminated Soils in Western Australia (DoE 2004). All waste oils will be collected by a contractor and recycled. Oily rags and filters will be recycled or disposed of at an appropriate hydrocarbon disposal facility;
- collecting and disposing putrescibles, non-recyclable domestic and industrial waste to an on-site landfill constructed to the Environmental Protection (Rural Landfill) Regulations 2002;
- treating sewage and grey water via package treatment plants which will be established to service the mine, processing plant and camp. Treated wastewater will be used for irrigation;
- collecting and transferring hydrocarbon contaminated soil to a Contaminated Soil Bioremediation Landfarm;
- discharging process water from the processing plant to a process water pond for recycling (to the process water circuit);
- filtering tailings from ore processing and conveying to the waste disposal facilities for co-disposal with the mine waste; and
- disposing of waste rock to waste disposal facilities.

Acid Mine Drainage (AMD) and Fibrous Materials

Analysis of table cuttings taken from the Balmoral South core samples has been completed by an independent laboratory using polarised light microscopy (SGS 2008). This analysis did not detect any asbestos fibres.

IM has however, recognised that it is possible that some minerals may give rise to fibrous minerals, and management strategies have been developed to cater for this possibility.

The strategies for managing AMD are provided in Section 22 of the PEMP (Appendix A), including:

- ongoing sampling to confirm assumed correlations to Central Block Project AMD characteristics;
- the development of a detailed waste rock block model that includes the estimated volumes and types of waste that will be mined according to the mine plan; and
- inclusion of waste management in the material handling schedule to ensure that potentially problematic waste can be isolated or blended as planned and is transported to the correct location to avoid unplanned mixing of PAF and NAF materials.

The strategies for managing fibrous materials are provided in Section 20 of the PEMP (Appendix A).

Pyritic black shales, which can give rise to acid mine drainage, and fibrous forming minerals if present will be identified during drilling.

In the event that pyritic shales or fibrous forming minerals are identified, the appropriate methods for managing the materials will be determined through consultation with relevant regulatory authorities. IM recognises that to undertake appropriate measures to manage such materials it will be necessary to:

- identify areas in advance that may contain pyritic shales or fibrous mineralisation;
- use protective equipment in areas where fibrous material is encountered;
- use water to wet down potentially affected areas;
- inject water during drilling to suppress dust liberation in potentially affected areas;
- wet affected areas during blasting; and
- seal the pyritic shales or fibrous materials within waste stockpiles.
Section 9
Social Issues and their Management

9.1 Introduction
This section addresses the potential social factors relating to the development and operation of the Balmoral South Project. The relevant objectives and standards relating to each factor are identified, the issues and impacts, both for the Balmoral South Project in isolation and cumulatively with the Central Block Project, are discussed, and the proposed management measures outlined. The PER outlines the significant management issues that will be addressed by International Minerals with detailed information on management and monitoring contained in the Project Environmental Management Plan (PEMP) (Appendix A). The PEMP also covers other issues that, although not significant for the project, are still required to be addressed.

9.2 Adjacent Land Users

9.2.1 Objectives and Standards
The objective for the Balmoral South Project in relation to adjacent land users is to minimise any direct or indirect impacts from the operations.

9.2.2 Definition of Issues and Impacts
Potential impacts on recreation users are discussed in Section 9.3. Pastoral grazing is the most significant activity in the Balmoral South Project Area. The potential issues that may impact upon this land use include:

- disruption to cattle mustering operations;
- damage or removal of fencing;
- interruption to the water supply for cattle;
- access to sites within the Pastoral Lease and possible interference with pastoral infrastructure.

Water supply to eight wells is likely to be affected by groundwater drawdown from dewatering (Section 7.8.2.3).

The tenements which incorporate the Balmoral South ore body were acquired by Mineralogy Pty Ltd from Hanna Mining in 1986. The land of the Balmoral South Project has been set aside for mining with various mining leases being awarded to Mineralogy Pty Ltd.

9.2.3 Management
Management strategies for minimising impacts on adjacent users are provided in Section 23 of the PEMP (Appendix A). The key management actions that will be implemented include:

- liaising with the pastoralist to determine the most appropriate actions to be taken during any mustering activity;
- implementing a fence removal permit, where the pastoralist must be notified prior to the removal of any existing fencing. If the fencing is determined to be of importance to the pastoralist activities, alternative fencing will be provided; and
- liaising with the pastoralist to determine the most appropriate actions to be taken to maintain access to sites within the Pastoral Lease.

Any complaints received from the pastoralist will be recorded and investigated. If required, corrective actions will be implemented in consultation with the pastoralist.
Section 9 Social Issues and their Management

9.3 Recreation

9.3.1 Objectives and Standards

The objectives for management of recreational activities are to:

- minimise the impact of mine employees and contractors on the “visitor locations” within the vicinity of the Balmoral South Project site;
- ensure that access to popular “visitor sites” is maintained for the use of the general public; and
- ensure that recreational activities do not significantly increase pressure on the natural resources of the area.

Relevant legislation includes:

- Conservation and Land Management Act 1984 for the protection and management of land vested for conservation purposes;
- Wildlife Conservation Act 1957 which governs human interaction with native wildlife;
- Maritime Archaeology Act 1973 which governs human interaction with shipwrecks; and
- Aboriginal Heritage Act 1972 for the protection of Aboriginal heritage sites.

9.3.2 Definition of Issues and Impacts

The construction and operations workforces will operate on a fly-in / fly-out basis and consequently there will be limited time available for the workforce to significantly increase recreational pressures in the area. Nonetheless, the influx of a sizable construction and operations workforce has the potential to increase recreation activity in the area placing added pressures on:

- existing recreational users;
- areas protected in reserves;
- nesting birds and turtles using sandy beaches in the area;
- sensitive areas such as marine habitats and mangrove communities;
- fishing (open water, river and beach);
- boating;
- pastoral and other commercial activities.

The main recreational node in the area is the camping ground at the mouth of the Fortescue River. This area is used locally by day trippers and for longer term camping. A boat ramp has been constructed and the area is generally maintained by the Roebourne Shire. Potential impacts are associated with increased use of the facilities by the workforce.

Islands of the Great Sandy Island Nature Reserve contain areas used by birds for nesting. Some species build nests on the beach sand above the high water mark, which can be very difficult to identify. Visitors to the islands during nesting season have the potential to unwittingly trample the nests and disturb brooding adults. For this reason, the islands are closed to access during nesting periods.

Turtle nesting season occurs between August and March. Human activities can impose significant pressure on nesting turtles. The most serious threat results from increased human night time presence on beaches used by the turtles. This can result in nesting females shifting their nesting sites, sometimes being forced to use less suitable beaches, or aborting or delaying egg laying.
Section 9

Social Issues and their Management

Several marine habitats occur within the proposed Regnard Marine Management Area. Habitats in the vicinity of Cape Preston include:

- rocky shores, shoreline reef platforms and offshore intertidal reefs;
- intertidal mud / sand shoals and beaches;
- mangrove and salt marsh communities;
- coral communities; and
- subtidal sand/silt/rubble and limestone pavement with macroalgae and seagrass.

Mangrove communities are susceptible to a number of disturbances, namely alterations to tidal movements, aggregation of non degradable waste materials within their extensive and complex root systems and trampling by fishing for mud crabs. Four wheel drive (4WD) activity and overfishing can also cause a decline in the health of the community.

Recreational fishing is a popular pastime along the entire Pilbara coast. The Pilbara region has one of the highest boat ownership rates in Australia (CALM 2003). The formation of the Regnard Marine Management Area will create certain ‘no take’ zones to provide a point of reference for monitoring and research. Apart from depleting natural fish stocks, increased fishing pressure also has the potential to cause damage to submerged habitats through poor deployment of anchors and moorings.

Dugongs feed primarily on seagrass beds. The most significant populations of dugong occur further south at Shark Bay, however, there have been several reported sightings of individuals grazing around the Dampier Archipelago. Dugongs are susceptible to injury from boat propellers, particularly in the more shallow waters where they tend to graze. They are listed under “other specially protected fauna” in Schedule 4 of the Wildlife Conservation Act 1957 (CALM 2000).

The Pilbara scenery is renowned for its spectacular and rugged beauty and is an attractive drawcard to many 4WD owners. The use of 4WDs allows for greater access to the coast line, opening up more fishing locations to exploitation. They also enable people to travel well off the beaten track, providing opportunities for tourism and sightseeing. 4WD vehicles have the potential to cause damage to native vegetation and soil structure when travelling off-road.

The land surrounding the proposed Balmoral South Project site is subject to the Mardie Station Pastoral Lease. Impact on pastoral operations as a result of Balmoral South Project related recreational activity is likely to be low. The greatest potential impact in this regard would arise from Balmoral South Project personnel accessing particular sites within the Pastoral Lease and possibly interfering with pastoral infrastructure.

Commercial fishing, including pearling, crabbing, prawning and collection of corals and aquarium species occurs throughout the Cape Preston area. Indian Ocean Pearls operates from a base at the mouth of the Fortescue River, with their pearling lease located about 3 km west of Cape Preston. Increased boating traffic could impinge on those operations.

9.3.3 Management

Management measures for minimising impacts on the environment from recreational use by Balmoral South Project personnel are provided in Section 25 of the PEMP (Appendix A). The key management strategy will be education, whereby all Balmoral South Project personnel will be inducted before accessing site, and provided with information regarding the responsibilities and expected behaviour of all personnel toward the environment. The induction will also raise awareness of recreational impacts and how those impacts will be managed. The recreational use management components of the induction will include:

- providing a map of the marine environment around Cape Preston, indicating no-take zones, conservation status of the various marine management areas and location of other industries and any associated exclusion zones;
Section 9

Social Issues and their Management

- providing a map of the terrestrial environment, including visitor locations, access tracks and any prohibited areas;
- providing guidance on appropriate behaviour at visitor nodes and advice regarding minimising impacts;
- advising of appropriate behaviour around large marine organisms including (but not limited to) whales, dugongs and turtles;
- providing clear guidance on regulations regarding boat handling within nature reserves, such as moorings and anchorages;
- advising of the rules and regulations governing access to islands within the Great Sandy Island Nature Reserve and Regnard Marine Management Area;
- advising of ‘good neighbour’ behaviour with regards to other land users, including pastoralism, tourism and aquaculture;
- advising of appropriate 4WD behaviour with regard to protection of mangroves and native vegetation;
- providing clear information of bag and size limits for recreational fishing, including netting, spearfishing, coral collecting, shell fishing and aquarium fish collecting; and
- encouraging record keeping with regards to fish catches, marine mammal, turtle and bird sightings.

In addition to providing employees and contractors with induction guidelines, International Minerals will:

- realign and maintain any access tracks currently utilised to access visitor nodes that will be disrupted by the Balmoral South Project;
- rehabilitate any exploration or construction phase tracks within the Balmoral South Project area no longer required, in order to limit vehicular movements in any sensitive areas; and
- maintain a register of complaints relating to Balmoral South Project related recreational activities.

Regular toolbox meetings will be held to reinforce a positive attitude towards recreational use management and to highlight any issues that arise during the life of the Balmoral South Project. A record of all training will be maintained.

9.4 Indigenous Heritage

9.4.1 Objectives and Standards

The objectives for the Balmoral South Project in relation to Aboriginal heritage are to:

- protect heritage and culturally sensitive sites;
- comply with the requirements of the *Aboriginal Heritage Act 1972*;
- ensure that changes to the biological and physical environment resulting from the Balmoral South Project do not adversely affect the cultural associations of the area.

The relevant legislation and standards are:

- *Aboriginal Heritage Act 1972*, and
9.4.2 Definition of Issues and Impacts

Impacts on Aboriginal heritage can arise from:

- lack of recognition of the presence and importance of Aboriginal heritage material;
- uncontrolled movement of vehicles other than on designated roads or tracks; and
- inadvertent disturbance of Aboriginal heritage material.

The consequences of such impacts include:

- loss or damage to important historical and cultural material;
- contravention of laws governing the treatment of Aboriginal heritage material; and
- loss of co-operation of the Aboriginal community.

Archaeological and ethnographic studies (O’Connor 2001, Quartermaine Consultants 2001) have previously been conducted in the Cape Preston region, including the Balmoral South Project area. The studies identified the Aboriginal Heritage values of the area and the presence of a number of sites of heritage significance. Further ethnographic and archaeological surveys have been undertaken for the adjacent Central Block Project including portions of the infrastructure corridor that will be used by International Minerals.

International Minerals has met with all Claimant Groups and is currently consulting on arrangements to progress relevant requirements under the Aboriginal Heritage Act. These groups have suggested a number of strategies to ensure that heritage values in the Balmoral South Project area are recognised including:

- undertaking further survey work prior to any ground disturbing activities;
- recording and, where possible, avoiding heritage sites;
- inviting indigenous custodians to advise on the management of the heritage conservation process and to contribute to the long term care of the sites;
- providing controlled access to sites for traditional purposes and incorporating access provisions into long term heritage management strategies;
- induction of all staff to improve the appreciation of heritage and cross-cultural sensitivity; and
- ongoing consultation with Claimant Groups in relation to the protection of Aboriginal Heritage values on the Balmoral South Project Site.

9.4.3 Management

International Minerals is committed to the protection of Aboriginal heritage sites and commits to finalising Heritage Agreements, management plans or other agreements following further consultation with the Claimant Groups and the Department of Indigenous Affairs.

Management actions have been developed to reduce the potential impact of construction activities on Aboriginal heritage sites and these are presented in Section 24 of the PEMP (Appendix A). The key management measures include:

- making personnel aware through inductions of the presence of Aboriginal heritage sites and how to avoid damage to the sites and other material which may be of Aboriginal heritage significance;
- engaging a qualified archaeologist who will obtain an Aboriginal Heritage Act 1972 Section 16 permit to conduct monitoring of ground disturbing activities;
Section 9  Social Issues and their Management

- implementing Aboriginal heritage contingency actions should any potential Aboriginal heritage site, artefact or skeletal remains be discovered;
- arranging for Aboriginal monitors from relevant groups to be present during ground disturbing activities;
- avoiding known Aboriginal sites, and if avoidance is not possible, the sites will salvaged and/or relocated on advice from the local Aboriginal groups and in accordance with Section 18 of the Aboriginal Heritage Act 1972; and
- keeping the local Aboriginal groups and the various interest groups informed of the progress of the Balmoral South Project.

A monitoring programme will be implemented to ensure that construction and operational activities are not impacting on Aboriginal heritage sites, and will include:
- undertaking a pre-disturbance site inspection; and
- undertaking site inspections during clearing or earthworks.

9.5  European Heritage

9.5.1  Objectives and Standards

The objective for the Balmoral South Project in relation to the protection of European heritage is to ensure that changes to the biological and physical environment resulting from the Balmoral South Project do not adversely affect historical and cultural associations with the area and comply with relevant heritage legislation.

The applicable standards for European heritage are:
- Environment Protection and Biodiversity Conservation Act 1999;
- Australian Heritage Commission Act 1975;
- World Heritage Convention; and

9.5.2  Definition of Issues and Impacts

There are no European heritage sites known to occur within the Balmoral South Project Area.

9.5.3  Management

No specific management is required.

9.6  Public Health and Safety

9.6.1  Objectives and Standards

The objectives of managing public health and safety for the Balmoral South Project are to ensure that:
- risk to the public is as low as reasonably practicable (ALARP) and complies with appropriate standards;
- traffic activities resulting from the Balmoral South Project do not adversely impact on the social surroundings; and
Section 9  Social Issues and their Management

- risk is managed to comply with DoIR requirements and EPA criteria in respect of public health and safety.

The legislation and guidelines relevant to public health and safety include:

- *Australian Code of Practice for the Transport of Dangerous Goods by Road and Rail 1992*;
- *Dangerous Goods Regulations 1992*; and

On-site risks to employees are managed under the *Occupational Safety and Health Act 1984*, the *Mines Safety and Inspection Act 1994* and *Mines Safety and Inspection Regulations 1995*.

9.6.2 Definition of Issues and Impacts

The potential health and safety issues for the Balmoral South Project are:

- increased traffic volume on the access road to the mouth of the Fortescue River;
- public access to the Balmoral South Project area;
- spillage of fuel, chemicals and explosives on public roads;
- process emissions from the pellet plant and power station; and
- dust from exposed areas and materials handling.

The closest residence is the Fortescue River Roadhouse which is located over 25 km from the plant site. A public camping ground is located at the mouth of the Fortescue River, 13 km from the pellet plant.

Fortescue River Access Road

The Fortescue River mouth is used by Pilbara residents and tourists for recreational pursuits, particularly fishing. Long term campers regularly stay at the river mouth for periods of up to several months.

Access to the public camping ground is via a dirt road that runs from the North West Coastal Highway through the Central Block project area. As a component of the Central Block approvals, a portion of this road will be realigned to separate the public from the operational areas of the project and to maintain public access to the camping ground. A grade separation will be provided where the International Minerals conveyor crosses this road.

Public Access to the Balmoral South Project Area

Once construction commences, the public will be excluded from the immediate Balmoral South Project area.

All deliveries to the Balmoral South Project will be by road transport, entering the leaving the site via the Southern Access Road. The process plant will have approximately 1,800 heavy vehicle road movements per year transporting limestone, dolomite, grinding media, and bentonite. The mining operation is expected to generate approximately 1,900 road movements per year comprising project waste, food, chemicals, oil, spare parts and gas bottles. Bus and car movements for personnel will total around 5,100 movements per year. There will be approximately 800 road movements per year for the transport to site of explosives.
Spillage

The bulk of vehicle movements on the Fortescue River Access Road are confined to five types of goods: limestone / dolomite, grinding balls, bentonite, diesel fuel and explosives. These items will be procured on a manufacture or supply and deliver basis. It is expected that the limestone and bentonite will come by ship into the Port of Dampier and the grinding media from Perth by truck (though grinding media could well be imported as well). Both the diesel fuel and explosives will be delivered from the Port of Dampier.

Acids, caustic soda and oxides will constitute 120 vehicle movements per year (60 return). They will be delivered in sealed containers or by tanker.

Limestone / dolomite, grinding balls and bentonite are inert materials and, in the event of a spillage, would not pose a risk to the general public or the environment. Procedures will be put in place for the notification of a spill and a rapid response for clean up.

Fuel and explosives will be delivered by licensed vehicle. The adoption of safety procedures for the rapid clean up of any spillage are standard practice with these types of vehicles.

Process emissions

The Balmoral South Project will generate a variety of process emissions including:

- sulphur dioxide;
- nitrogen dioxide;
- particulate matter (PM_{10});
- carbon monoxide; and
- noise.

Modelling has indicated (Sections 8.2 (Process Emissions) and 8.3 (Dust)) that emissions from the Balmoral South Project, in isolation and in combination with the Central Block Project, will be within acceptable standards.

Dust Emissions

Dust emissions from the Balmoral South Project could occur from:

- vegetation clearing, topsoil clearing and replacement;
- vehicle movements on the access roads and site roads during construction and operations;
- mining activities (blasting, earthmoving and dumping);
- materials handling and processing activities including crushing, screening, stacking and reclaiming of ore; and
- dust pick-up (wind erosion) from exposed areas including the pit, areas cleared for the process plant and offices, access roads, stockpiles, waste dumps, tailings storage facility and the accommodation camp.

Assessment of the potential for dust to cause an impact is discussed in Section 8.3. The assessment concludes that construction and operational dust impacts can be managed.
Section 9
Social Issues and their Management

9.6.3 Management

Strategies will be implemented for the management of public health and safety for the Balmoral South Project. These management actions include:

- excluding general public from the immediate Balmoral South Project area to eliminate potential hazards associated with traffic;
- maintaining the Southern Access Road by undertaking repairs on an ongoing basis to ensure the road condition is safe for use, particularly following cyclones or large rainfall events;
- restricting vehicle speeds; and
- installing spill kits on transport vehicles as appropriate, and providing training in their use.
10.1 Sustainability Assessment

In August 2004, the EPAWA released its position paper on sustainability (Position Statement No. 6 ‘Towards Sustainability’), which outlines the EPAWA’s views on matters of environmental importance in relation to sustainability. The position paper also defines a range of questions to be asked when proposals are undergoing environmental assessment to determine whether the proposed activities are consistent with attaining the goal of sustainability (EPAWA 2004). These questions, along with International Minerals (IM) response, are listed in Table 10-1: Sustainability Checklist.

Table 10-1: Sustainability Checklist

<table>
<thead>
<tr>
<th>Question</th>
<th>Proponent’s Response</th>
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</thead>
<tbody>
<tr>
<td>Does the proposal deplete non-renewable resources significantly?</td>
<td>No. Every effort has been made to minimise energy use in the design and operation of the Balmoral South Project. Energy for the Balmoral South Project will be from combustion of natural gas in a combined cycle power station which is more efficient than open cycle generation. Total gas consumption is relatively small in comparison to the total volume of gas extracted, exported and consumed in WA. Iron ore mineralisation is extensive throughout the Pilbara and IM is committed to optimising the development of the orebody.</td>
</tr>
<tr>
<td>Does the proposal deplete assimilative capacity significantly?</td>
<td>No. Opportunities for the off-site release of contaminants from the Balmoral South Project are minimal. Waste rock and dewatered tailings will be co-disposed in the designated disposal areas. The tails stream consists of inert materials comprising a fine and coarse fraction. The moisture content in dewatered tails will be less than saturation level and no drainage is expected from the disposal area. It is not anticipated that significant quantities of high sulphur material will be mined, however if any potential Acid Mine Drainage waste is encountered it will be separately encapsulated in the waste disposal facilities, surrounded by low permeability material or blended with neutralising waste in accordance with guidelines. The construction of the waste disposal facilities will ensure that as much surface water as possible is shed.</td>
</tr>
<tr>
<td>Does the proposal use natural resources responsibly?</td>
<td>Yes. The Balmoral South Project has been designed to maximise the re-use of water from mine dewatering and tails disposal. Tails will be filtered to 15% moisture content. Seawater will be desalinated to provide most of the processing water requirements.</td>
</tr>
<tr>
<td>Does the proposal satisfactorily restore any disturbed land?</td>
<td>Yes. Progressive rehabilitation and effective mine closure has been a key aspect in every part of the Balmoral South Project development plans. The waste disposal facilities will be rehabilitated progressively and contoured to provide a stable state. Growth medium will be collected and stored for rehabilitation. Progressive rehabilitation will occur as much as practicable over the Balmoral South Project area, and a closure plan will be implemented for final rehabilitation works. The pit will be left as a void.</td>
</tr>
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### Section 10  
#### Sustainability

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<tr>
<th>Question</th>
<th>Proponent’s Response</th>
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<tbody>
<tr>
<td>Does the proposal follow the waste hierarchy and manage satisfactorily any waste produced?</td>
<td>Yes. A fully integrated waste management and recycling programme will be implemented from the outset, based on the principles of avoid, reduce, reuse and recycle. Examples include use of treated domestic waste water in landscaping. Scrap metal and other waste materials such as glass, bottles and aluminium cans will be collected for recycling. Waste hydrocarbons will be collected by a contractor and recycled.</td>
</tr>
<tr>
<td>Does the proposal incorporate best practice in water and energy efficiency?</td>
<td>Yes. As outlined above, the Balmoral South Project maximises the reuse of all water. Power for the Balmoral South Project will be provided by a combined cycle gas fired power station to maximise efficiency. Reverse osmosis desalination technology has been proposed.</td>
</tr>
</tbody>
</table>
| Does the proposal make good use of best practice to prevent pollution?   | Yes. All potential pollutants will be contained and managed within the footprint of the operation, making use of natural topography, using containment bunding and installing cut off trenches to recover seepage should it arise.  
Fugitive dust emissions along the roads and at the plant and mine will be minimised with water sprays and dust suppressants. Water sprays will also be utilised at the ROM pad and ore stockpiles. |
| Does the proposal increase use of non-renewable transport fuels?        | Yes. However, the impact of the use of non-renewable fuels will be minimised by:  
- road trains for bulk transport;  
- use of conveyors to the port (30 km) for product transport; and  
- fuel efficient diesel engines for power generation. |
| Does the proposal use energy efficiency technologies?                    | Yes. The proposal utilises the following energy efficient technologies:  
- combined cycle power generation;  
- reverse osmosis desalination technology over mechanical vapour compression (subject to final technology selection being determined by local water conditions);  
- in the pellet plant, reuse of hot gasses from the cooling zone to provide preheated air to the burners in the firing zone; and  
- gravity flows where possible. |
| Does the proposal result in net improvements in biodiversity?            | Yes. The Balmoral South Project has already contributed to the body of knowledge on the biodiversity of the Pilbara. Management of weeds and cessation of cattle grazing during construction and operations will add to this contribution. |
## Section 10

### Sustainability

<table>
<thead>
<tr>
<th>Question</th>
<th>Proponent’s Response</th>
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<tbody>
<tr>
<td>Does the proposal increase greenhouse gas emissions?</td>
<td>Yes. It is estimated that greenhouse gases generated by the Balmoral South Project will increase WA emissions by 3.98% over the 1990 baseline. This will occur primarily through the consumption of gas for power generation, which accounts for around 76% of total greenhouse gas emissions for the Balmoral South Project.</td>
</tr>
<tr>
<td>Does the proposal involve acceptable levels of risk?</td>
<td>Yes. Risk to members of the public using the area for recreation will be managed by excluding the public from the immediate Balmoral South Project area. Environmental risk associated with a small encroachment of the western waste disposal facility into the flood plain of the Fortescue River will be managed by ensuring that the dumps are engineered and protected with rock armour to avoid failure.</td>
</tr>
<tr>
<td>Does the proposal have a secure foundation of scientific understanding of its impacts?</td>
<td>Yes. Detailed scientific investigations have been undertaken in relation to flora, fauna, surface water, groundwater and atmospheric emissions and noise. Marine modelling has been undertaken to demonstrate the acceptability of the brine discharge.</td>
</tr>
<tr>
<td>Does the proposal minimise the ecological footprint?</td>
<td>Yes. The footprint of the Balmoral South Project has been minimised through the use of existing tracks for roads and the use of shared infrastructure and facilities where practicable.</td>
</tr>
<tr>
<td>Does the proposal avoid or minimise adverse impacts and promote beneficial impacts on the surrounding community?</td>
<td>Yes. Construction and operations personnel will be housed on site which will minimise impacts on Karratha. The Balmoral South Project will give consideration to the employment of local people (subject to availability and required skills) and will support commercially competitive local suppliers and contractors wherever possible.</td>
</tr>
<tr>
<td>Does the proposal produce sustainable net economic benefits?</td>
<td>Yes. There will be benefits to the local community through employment. Weed control will increase biodiversity.</td>
</tr>
<tr>
<td>Does the proposal produce sustainable net social benefits?</td>
<td>Yes. IM is committed to ensuring local communities gain long term benefits from its operations both directly and indirectly. There will be employment opportunities for local indigenous people where possible and longer term benefit through education and health initiatives.</td>
</tr>
<tr>
<td>Does the proposal add to heritage protection and provide a sense of place?</td>
<td>Yes. Surveys have been conducted that identify Aboriginal heritage values in the Balmoral South Project area. IM is committed to finalising heritage agreements, management plans or other agreements with claimant groups. Management plans will provide information and training to employees and contractors.</td>
</tr>
<tr>
<td>Does the proposal produce net environmental benefits?</td>
<td>Yes. In addition to rehabilitation of disturbed areas by mining operations, the Balmoral South Project will contribute to the understanding of the ecology and biodiversity of the Pilbara area and will contribute to the management of feral fauna and weeds in the Balmoral South Project area.</td>
</tr>
</tbody>
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Section 10  Sustainability

<table>
<thead>
<tr>
<th>Question</th>
<th>Proponent’s Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the proposal contribute to a more equitable and just society?</td>
<td>Yes. IM is committed to ensuring local communities gain long term benefits from its operations both directly and indirectly. It is committed to providing employment to local indigenous people where possible and to provide longer term benefit through education and health initiatives.</td>
</tr>
<tr>
<td>Does the proposal interact positively with other likely developments?</td>
<td>Yes. Improved access and greater presence will increase the opportunity to exploit other mineral resources known to occur in the area. Related parties will continue to look for opportunities to maximise the sharing of infrastructure and facilities. Third party access agreements are being negotiated (by others) to ensure maximum use of the Cape Preston port site, to which this Balmoral South Project will also gain access.</td>
</tr>
<tr>
<td>Does the proposal provide new opportunities (social, economic or environmental)?</td>
<td>Yes. As above.</td>
</tr>
</tbody>
</table>

10.2  Assessment against EPAWA Principles of Environmental Protection

In 2003, the Environmental Protection 1980 Act was amended to include five sets of principles which form the core set of environmental protection principles for the EPAWA. These principles are:

- The precautionary principle.
- The principle of intergenerational equity.
- The principle of conservation of biological diversity and ecological integrity.
- Principles relating to improved valuation, pricing and incentive mechanisms.
- The principle of waste minimisation.

These principles are outlined in EPAWA Position Statement No. 7 ‘Principles of Environmental Protection’, which was issued in August 2004 (EPAWA 2004a). Table 10-2: Principles of Environmental Protection presents information on these principles along with an indication as to how IM has, or proposes to, address these during Balmoral South Project development and implementation.
### Table 10-2: Principles of Environmental Protection

<table>
<thead>
<tr>
<th>EPAWA Principle</th>
<th>Project Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. The precautionary principle</strong></td>
<td>Investigations of the biological and physical environments provided background information to assess risks and identify measures to avoid or reduce potential impacts. These investigations demonstrate that impacts can be avoided or, where this is not possible, mitigated to ensure that an acceptable level of impact is achieved.</td>
</tr>
<tr>
<td>Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.</td>
<td></td>
</tr>
<tr>
<td>In the application of the precautionary principle, decisions should be guided by:</td>
<td></td>
</tr>
<tr>
<td>(a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and</td>
<td></td>
</tr>
<tr>
<td>(b) an assessment of the risk-weighted consequences of various options.</td>
<td></td>
</tr>
<tr>
<td><strong>2. The principle of intergenerational equity</strong></td>
<td>IM has demonstrated its commitment to sustainable development through:</td>
</tr>
<tr>
<td>The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.</td>
<td>• measures to protect the biodiversity of the Balmoral South Project Area;</td>
</tr>
<tr>
<td></td>
<td>• progressive rehabilitation of disturbed areas and establishment of stable land forms at the conclusion of the Balmoral South Project;</td>
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<td></td>
<td>• contribution to feral animal and weed control;</td>
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<td></td>
<td>• purchasing policies to support local businesses; and</td>
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<tr>
<td></td>
<td>• careful assessment and exploitation of the resource to maximise the yield of ore from the deposit and to gain maximum use and benefit from the plant and infrastructure.</td>
</tr>
<tr>
<td><strong>3. The principle of the conservation of biological diversity and ecological integrity</strong></td>
<td>Scientific studies have contributed to the understanding and management of the impacts of mining operations on the biodiversity and ecological integrity of the area. The biological diversity of the region will not be adversely affected as a result of the Balmoral South Project proceeding.</td>
</tr>
</tbody>
</table>
## Section 10
### Sustainability

<table>
<thead>
<tr>
<th>EPAWA Principle</th>
<th>Project Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4. Principles relating to improved valuation, pricing and incentive mechanisms</strong></td>
<td>Environmental factors have played a major role in decision making for the Balmoral South Project and have accounted for considerable costs. Environmental factors have been considered when locating infrastructure such as the processing plant, roads and waste disposal facilities. Collection ponds have been installed to capture contaminated water for reprocessing or evaporation. Pollution impacts have been minimised with encapsulation of any potential acid forming (PAF) waste rock, water collection ponds, and containment of all materials with the potential to pollute or contaminate within the footprint of the operations.</td>
</tr>
<tr>
<td>(a) Environmental factors should be included in the valuation of assets and services.</td>
<td></td>
</tr>
<tr>
<td>(b) The “polluter pays” principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement.</td>
<td></td>
</tr>
<tr>
<td>(c) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets, and the ultimate disposal of any wastes.</td>
<td></td>
</tr>
<tr>
<td>(d) Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and response to environmental problems.</td>
<td></td>
</tr>
<tr>
<td><strong>5. The principle of waste minimisation</strong></td>
<td>All reasonable and practicable measures will be undertaken to minimise the generation of waste and its discharge to the environment. Waste management principles (avoid, reuse, reduce and recycle) have been applied to the design of the Balmoral South Project.</td>
</tr>
<tr>
<td>All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.</td>
<td></td>
</tr>
</tbody>
</table>
Section 11  

Matters of National Environmental Significance

11.1 Overview

Under the environmental assessment provisions of the EPBC Act, an action requires approval from the Commonwealth Minister for the Environment, Water, Heritage and Arts (DEWHA) if the action has, will have, or is likely to have a significant impact on any Matters of National Environmental Significance (MNES).

The MNES are:

- World Heritage Properties;
- National Heritage places;
- Ramsar wetlands of international significance;
- Nationally listed threatened species and ecological communities;
- Listed migratory species;
- Commonwealth marine areas; and
- Nuclear actions.

The Administrative Guidelines (DEWHA, 2006) state that:

“In order to decide whether an action is likely to have a significant impact it is important to consider matters such as:

- the sensitivity of the environment which will be impacted;
- the timing, duration and frequency of the action and its impacts;
- all on-site and off-site impacts;
- all direct and indirect impacts;
- the total impact which can be attributed to the action over the entire geographic area affected, and over time;
- existing levels of impact from other sources; and
- the degree of confidence with which the impacts of the action are known and understood”.

In May 2008, International Minerals referred the Balmoral South Project (the “Project”) to the Department (EPBC Ref 2008/4236). On 2 July 2008, the Project was determined to be a “controlled action”, and therefore require approval under the EPBC Act. The controlling provisions were that the Project was likely to have a significant impact on listed threatened species and communities (Section 18 and 18A) and listed migratory species (Section 20 and 20A).

A search of the Protected Matters Search tool from the DEWHA was conducted for the area. The search identified the possible presence of ten Threatened Species (one bird species, two whale species, one bat species, five turtle species and the Whale Shark) and 23 Migratory Species (10 bird species, four whale species, Dugong, two dolphin species, five turtle species and the Whale Shark (Table 11-1: Fauna Species Listed by the EPBC Act). Many of the species are common to both categories and some are repeated within the category. One place on the Register of the National Estate (RNE) was also recorded - Coastal Islands Mary Anne to Regnard. No Threatened Ecological Communities (TEC) were identified. A further 58 Listed Marine Species and 12 Whales and Other Cetaceans were listed as Other Matters Protected by the EPBC Act (Table 11-1). Again, many of these species are also identified through the Protected Matters Search. Additionally, one state and territory reserve, the Great Sandy Island Nature Reserve, was listed as Extra Information.
### Table 11-1: Fauna Species Listed by the EPBC Act

<table>
<thead>
<tr>
<th>Species</th>
<th>MNES (Status)</th>
<th>Other Matters Protected by the EPBC Act</th>
<th>Type of Presence</th>
<th>Marine Species</th>
<th>Terrestrial Species</th>
<th>Wetland Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birds</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><em>Macronectes giganteus</em> (Southern Giant-Petrel)</td>
<td>Threatened (Endangered / Migratory)</td>
<td>Listed</td>
<td>Species or species habitat may occur within area</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Haliaeetus leucogaster</em> (White-bellied Sea-Eagle)</td>
<td>Migratory (Migratory)</td>
<td>Listed</td>
<td>Species or species habitat likely to occur within area</td>
<td>X X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Hirundo rustica</em> (Barn Swallow)</td>
<td></td>
<td>Listed – overfly marine area</td>
<td>Species or species habitat may occur within area</td>
<td>X X</td>
<td>X X</td>
<td></td>
</tr>
<tr>
<td><em>Ardea alba</em> (Great Egret or White Egret)</td>
<td></td>
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<tr>
<td><em>Ardea ibis</em> (Cattle Egret)</td>
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<tr>
<td><em>Charadrius veredus</em> (Oriental Plover or Oriental Dotterel)</td>
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<tr>
<td><em>Glareola maldivarum</em> (Oriental Pratincole)</td>
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<tr>
<td><em>Numenius minutus</em> (Little Curlew or Little Whimbrel)</td>
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<tr>
<td><em>Apus pacificus</em> (Fork-tailed Swift)</td>
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</tr>
<tr>
<td><strong>Mammals</strong></td>
<td></td>
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</tr>
<tr>
<td><em>Dasycercus cristacauda</em>” (Mulgara)</td>
<td>Threatened (Vulnerable)</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><em>Balaenoptera musculus</em> (Blue Whale)</td>
<td>Threatened (Endangered / Migratory)</td>
<td>Cetacean</td>
<td>Species or species habitat may occur within area</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Megaptera novaeangliae</em> (Humpback Whale)</td>
<td></td>
<td></td>
<td>Species or species habitat known to occur within area</td>
<td>X</td>
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</tbody>
</table>
### Section 11

#### Matters of National Environmental Significance

<table>
<thead>
<tr>
<th>Species</th>
<th>MNES (Status)</th>
<th>Other Matters Protected by the EPBC Act</th>
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<th>Marine Species</th>
<th>Terrestrial Species</th>
<th>Wetland Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhinonicteris aurantius (Pilbara Leaf-nosed Bat)</td>
<td>Threatened (Vulnerable)</td>
<td>-</td>
<td>Community likely to occur within area</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Balaenoptera edeni (Bryde's Whale)</td>
<td>Migratory (Migratory)</td>
<td>Cetacean</td>
<td>Species or species habitat may occur within area</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Dugong dugon (Dugong)</td>
<td>Listed</td>
<td>Species or species habitat likely to occur within area</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orcinus orca (Killer Whale or Orca)</td>
<td>Cetacean</td>
<td>Species or species habitat may occur within area</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sousa chinensis (Indo-Pacific Humpback Dolphin)</td>
<td></td>
<td>Cetacean</td>
<td>Species or species habitat likely to occur within area</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tursiops aduncus (Spotted Bottlenose Dolphin -Arafura/Timor Sea Populations)</td>
<td></td>
<td>Species or species habitat likely to occur within area</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balaenoptera acutorostrata (Minke Whale)</td>
<td></td>
<td>Species or species habitat may occur within area</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Delphinus delphis (Common Dolphin)</td>
<td></td>
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<tr>
<td>Grampus griseus (Risso's Dolphin or Grampus)</td>
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<tr>
<td>Stenella attenuate (Spotted Dolphin or Pantropical Spotted Dolphin)</td>
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<tr>
<td>Tursiops truncatus s. str. (Bottlenose Dolphin)</td>
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<td>X</td>
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<tr>
<td><strong>Reptiles</strong></td>
<td></td>
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</tr>
<tr>
<td>Morelia olivacea barroni * (Olive Python)</td>
<td>Threatened (Vulnerable)</td>
<td>-</td>
<td>-</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Caretta caretta (Loggerhead Turtle)</td>
<td>Threatened (Endangered / Migratory)</td>
<td>Listed</td>
<td>Species or species habitat may occur within area</td>
<td>X</td>
<td></td>
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</tbody>
</table>
## Section 11

**Matters of National Environmental Significance**

<table>
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<th>Wetland Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Chelonia mydas</em> (Green Turtle)</td>
<td>Threatened (Vulnerable / Migratory)</td>
<td>Breeding likely to occur within area</td>
<td>X</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><em>Dermochelys coriacea</em> (Leatherback Turtle)</td>
<td></td>
<td>Species or species habitat may occur within area</td>
<td>X</td>
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<tr>
<td><em>Eretmochelys imbricate</em> (Hawksbill Turtle)</td>
<td></td>
<td>Breeding likely to occur within area</td>
<td>X</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><em>Natator depressus</em> (Flatback Turtle)</td>
<td></td>
<td>Species or species habitat may occur within area</td>
<td>X</td>
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<tr>
<td><em>Acalyptophis peronii</em> (Horned Seasnake)</td>
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<tr>
<td><em>Aipysurus apraefrontalis</em> (Short-nosed Seasnake)</td>
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<tr>
<td><em>Aipysurus duboisii</em> (Dubois' Seasnake)</td>
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<tr>
<td><em>Aipysurus eydouxii</em> (Spine-tailed Seasnake)</td>
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<tr>
<td><em>Aipysurus laevis</em> (Olive Seasnake)</td>
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<tr>
<td><em>Aipysurus tenuis</em> (Brown-lined Seasnake)</td>
<td>-</td>
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<tr>
<td><em>Astrotia stokesii</em> (Stokes' Seasnake)</td>
<td>-</td>
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<tr>
<td><em>Disteira kingii</em> (Spectacled Seasnake)</td>
<td>-</td>
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<tr>
<td><em>Disteira major</em> (Olive-headed Seasnake)</td>
<td>-</td>
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<tr>
<td><em>Emydocephalus annulatus</em> (Turtle-headed Seasnake)</td>
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<tr>
<td><em>Ephalophis greyi</em> (North-western Mangrove Seasnake)</td>
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<tr>
<td><em>Hydrelaps darwiniensis</em> (Black-ringed Seasnake)</td>
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<tr>
<td><em>Hydrophis czeblukovi</em> (Fine-spined Seasnake)</td>
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<tr>
<td><em>Hydrophis elegans</em> (Elegant Seasnake)</td>
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<tr>
<td><em>Hydrophis mcdowelli</em></td>
<td>-</td>
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<tr>
<td><em>Hydrophis ornatus</em></td>
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</tbody>
</table>
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<th>Wetland Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pelamis platurus</em> (Yellow-bellied Seasnake)</td>
<td>-</td>
<td>-</td>
<td>Species or species habitat may occur within area</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sharks</strong></td>
<td></td>
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</tr>
<tr>
<td><em>Rhincodon typus</em> (Whale Shark)</td>
<td>Threatened (Vulnerable / Migratory)</td>
<td>-</td>
<td>Species or species habitat may occur within area</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ray-finned Fishes</strong></td>
<td></td>
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<tr>
<td><em>Bulbonaricus brauni</em> (Braun's Pughead Pipefish or Pug-headed Pipefish)</td>
<td>-</td>
<td>Listed</td>
<td>Species or species habitat may occur within area</td>
<td>X</td>
<td></td>
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</tr>
<tr>
<td><em>Campichthys tricarinatus</em> (Three-kee1 Pipefish)</td>
<td>-</td>
<td></td>
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<td>X</td>
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<tr>
<td><em>Choerichthys brachysoma</em> (Pacific Short-bodied Pipefish or Short-bodied Pipefish)</td>
<td>-</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Doryrhamphus janssi</em> (Cleaner Pipefish or Janss' Pipefish)</td>
<td>-</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
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</tr>
<tr>
<td><em>Doryrhamphus negrosensis</em> (Flagtail Pipefish or Negros Pipefish)</td>
<td>-</td>
<td></td>
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<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Festucalex scalaris</em> (Ladder Pipefish)</td>
<td>-</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Filicampus tigris</em> (Tiger Pipefish)</td>
<td>-</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><em>Halicampus brocki</em> (Brock's Pipefish)</td>
<td>-</td>
<td></td>
<td></td>
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<tr>
<td><em>Halicampus grayi</em> (Mud Pipefish or Gray's Pipefish)</td>
<td>-</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><em>Halicampus nitidus</em> (Glittering Pipefish)</td>
<td>-</td>
<td></td>
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</tr>
<tr>
<td><em>Halicampus spinirostris</em> (Spiny-snout Pipefish)</td>
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<td></td>
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</tr>
<tr>
<td><em>Halicthys taeniophorus</em> (Ribboned Seadragon or Ribboned Pipefish)</td>
<td>-</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td><em>Hippichthys penicillus</em> (Beady Pipefish or Steep-nosed Pipefish)</td>
<td>-</td>
<td></td>
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<tr>
<td><em>Hippocampus angustus</em> (Western Spiny Seahorse or Narrow-bellied Seahorse)</td>
<td>-</td>
<td></td>
<td></td>
<td>X</td>
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</tr>
<tr>
<td><em>Hippocampus histrix</em> (Spiny Seahorse)</td>
<td>-</td>
<td></td>
<td></td>
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</tr>
</tbody>
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</thead>
<tbody>
<tr>
<td><em>Hippocampus kuda</em> (Spotted Seahorse or Yellow Seahorse)</td>
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<tr>
<td><em>Hippocampus planifrons</em> (Flat-face Seahorse)</td>
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<td></td>
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<tr>
<td><em>Micrognathus micronotopterus</em> (Tidepool Pipefish)</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><em>Solegnathus hardwickii</em> (Pipehorse)</td>
<td>-</td>
<td></td>
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*Note:* * indicates that this species was revealed only through conducting a broader EPBC Act search with a buffer of ten and 20 km.
Section 11

Matters of National Environmental Significance

11.2 Marine Species

Marine activities associated with the Project will involve the construction of a seawater intake line to supply the desalination plant and an outfall to carry the concentrated brine to a discharge diffuser located 1,900 m offshore in 8 m of water at LAT. The intake system water flow streamlines will be controlled so that the take off velocities of the extreme bottom and the extreme top streamlines would have no suction effect on the floor and top sediments. At maximum plant capacity, the maximum entrance velocity is 0.091 m/s rising from a maximum approach velocity of 0.0025 m/s, which is well within the ability of most species to swim against the current if they approach the intake. The outfall pipeline (1.8 m diameter) will be installed in a trench, with the trench then filled in with rock. The pipelines will be constructed in areas of low environmental sensitivity, and modelling has predicted that a mixing zone of less than four hectares is required to ensure that a salinity increase of no more than 5% of ambient occurs for more than 1% of the time for the brine outfall locations chosen.

It also needs to be noted that by the time the outfall is constructed there will be a port in operation at Cape Preston, with daily shipping movements, for the export of 27.6 million tonnes per annum of magnetite concentrates and pellets. Hence by the time the Balmoral South Project outfall is constructed and operational, marine and migratory species’ local abundance may have already declined as a consequence of an avoidance reaction to the additional disturbance in the region.

Irrespective of background disturbance, the scale of disturbance from just the construction of the outfall is small, temporary and short term. The scale of disturbance from the operation of the outfall is permanent but small (4 ha), and localised.

It is considered highly unlikely that the habitat that will be disturbed by construction and operation of the outfall is “important habitat for a migratory species”. The location is mobile sand veneered limestone pavement which supports little to no seagrass. Habitat mapping undertaken by URS indicates that Halophila sp. seagrass patches have been recorded in the shallow sand habitat on the western side of SW Regnard Island as well as in the lee of Fortescue Island. Sparse seagrasses also occur on the shallows to the west of Cape Preston. Surprisingly, the areas which support the densest and largest patches of Halophila sp occur in the deep water basin (>15 m) which is located some 8-10 km to the north of Cape Preston.

It is also considered most unlikely that the construction and operation of the outfall will seriously disrupt the lifecycle of an ecologically significant proportion of the population of marine migratory or marine species. By the time the outfall is built, there will already be a port in operation at Cape Preston and it is likely that the effects of this background disturbance will outweigh the effects of the outfall. It is therefore considered that construction and operation of an additional brine outfall at Cape Preston poses little to no risk to populations of migratory species in the region.

The Southern Giant-Petrel (Macronectes giganteus) is a large pelagic seabird with a circumpolar range from Antarctica to approximately 20°S and is known to breed on six subantarctic islands in Australian territory with no known breeding colonies within the Balmoral South Project area; it is believed that the Balmoral South Project will have minimal impact on this species.

11.3 Terrestrial and Avian Species

11.3.1 Overview

It has been determined by field surveys (Appendix C) that fauna habitats within the Project area are well represented in the region and none are regarded as regionally significant or unique. The remaining terrestrial and avian species that have not been discussed comprise:

- Rhinonicteris aurantius (Pilbara Leaf-nosed Bat);
- Dasycercus cristicauda (Crest-tailed Mulgara);
- Morelia olivacea barroni (Olive Python);
- Haliaeetus leucogaster (White-bellied Sea-Eagle);
Section 11

Matters of National Environmental Significance

- *Hirundo rustica* (Barn Swallow);
- *Merops ornatus* (Rainbow Bee-eater);
- *Ardea alba* (Great Egret or White Egret);
- *Ardea ibis* (Cattle Egret);
- *Charadrius veredus* (Oriental Plover or Oriental Dotterel);
- *Glareola maldivarum* (Oriental Pratincole);
- *Apus pacificus* (Fork-tailed Swift); and
- *Numenius minutus* (Little Curlew or Little Whimbrel).

Of these, only the Bee-eater and the White-bellied Sea Eagle were recorded during field surveys of the Project area. An assessment of the potential impact on these protected fauna species is provided below.

11.3.2 Pilbara Leaf-nosed Bat

The Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) is restricted to caves and abandoned mines. Colonies have been found in three distinct areas: in the mines of the eastern Pilbara; scattered throughout the Hamersley Range in smaller colonies; and in sandstone formations south of the Hamersley Range. The extent of the occurrence of the Pilbara Leaf-nosed Bat is 122,447 km², bounded by records from red Hill Station and Barlee Range Nature Reserve in the west; Cattle George and surrounding areas in the north; Copper Hills mine near Nullagine in the east; and Mt Vernon Station and Paraburdoo in the South. The foraging range of the Pilbara Leaf-nosed Bat is considered to be typical of that exhibited by other species of bats, e.g. within 10 km from their roost.

Maunsell (2008) (Appendix C) concluded that it is unlikely that the Project area supports colonies of the Pilbara Leaf-nosed Bat due to:

- there being no caves or abandoned mines within the Project area, nor were there any sightings of the Pilbara Leaf-nosed Bat despite targeted searches;
- colonies are confined to three distinct areas within the Pilbara, specifically in the Hamersley Ranges, south of the Hamersley Ranges and in the Eastern Pilbara. These areas are located hundreds of kilometres east and south of the Project area and exhibit different landforms to those identified in the Project area;
- given the distance between known colony sites and the Project area, and the bat’s short range (10 km from their roosts), it is highly unlikely that the bat would utilise the Project area for foraging; and
- there have been no recordings of the Pilbara Leaf-nosed Bat within the Project area during the Anabat echolocation survey undertaken by Phoenix Environmental Services (2008b). Historical data indicate that the extent of their occurrence is limited to the 122,447 km² identified above, hundreds of kilometres from the Project area.

11.3.3 Mulgara

The Mulgara (*Dasycercus cristicauda*) is a carnivorous marsupial that is distributed throughout the arid and semi-arid central regions of Australia. It is primarily a nocturnal species, spending the majority of the daylight hours below ground. The Mulgara is known to occur in Spinifex, principally within drainage lines in sandplain or sand dune habitat. The distribution of Mulgara within the Pilbara region is poorly known. Mulgara have been recorded to occur in the Pilbara approximately 300 km east of the Project area within the sandy arid region.
A recent survey (Phoenix Environmental Sciences, 2008b) targeted these potential habitats and has determined that it is highly unlikely that Mulgara will be present within the project area. No individuals, or secondary evidence of individuals, were recorded within the project area. A closer inspection of the dune system on which it was thought possible that Mulgara may exist determined that it was, in fact, unsuitable as habitat.

11.3.4 Olive Python

The Olive Python (*Morelia olivacea barroni*) is known to inhabit deep gorges and waterholes in the ranges of the Pilbara region. Previous field studies have shown that individuals spend the cooler winter months in caves and rock crevices away from water sources, whilst in summer they move around widely, usually in close proximity to water and rock outcrops. Due to the cryptic nature of the python, the lack of reliable trapping or census techniques, and the narrow range of reliable surveys, there is little information available on the Olive Python’s actual population size, distribution and ecological requirements. Despite targeted searches of potentially suitable Olive Python habitat this species has not been recorded from the Project area.

Maunsell (2008) (Appendix C) concluded the Project area could be inhabited by the Olive Python due to:

- both the Newman and Rocklea Land Systems may contain rocky outcrops, which, if in close association to waterholes and drainage lines, may form suitable habitat for the Olive Python; and
- the distribution of the Olive Python in the Pilbara region is poorly known and therefore it cannot be stated with confidence that the Project area is unlikely to support populations of Olive Python.

A desktop assessment of habitat requirements (Phoenix Environmental Sciences, 2008a), followed by a targeted survey in September 2008, concluded that the chance of encountering the Olive Python in the project area is considered low.

Little evidence was found to suggest that Pilbara Olive Python occurs within the Project area during the 2008 fauna survey; there are virtually no permanent water bodies adjacent to suitable habitat within the Project area. One permanent artificial pool was observed, however this water body is not considered to have been present long enough to have supported local colonisation by the species.

11.3.5 Rainbow Bee-eater

The distribution of the Rainbow Bee-eater (*Merops ornatus*) is widespread throughout Australia with the exception of the arid interior of WA and west of South Australia. The Rainbow Bee-eater has been observed in the Project area, particularly along the river and creek lines. Bee-eaters prefer to excavate burrows for breeding and they are described as quite common in the region (Flegg 2002).

As the Project does not directly impact significantly on rivers and streams, the potential for impacts on this species is considered minimal.

11.3.6 Barn Swallow and Fork-tailed Swift

The Barn Swallow (*Hirundo rustica*) is widespread throughout much of the Northern Hemisphere (Cayley 1990), and visits northern Australia during the monsoon season (Frith 1982). The barn swallow breeds from March to June in Asia. Their wintering grounds are situated in tropical South America, south and south eastern Asia, Indonesia, New Guinea and northern Australia. The barn swallow occurs in all types of open country, including cultivated land and urban areas (Simpson and Day 1993). They avoid thickly forested country but are attracted to areas close to water.
Section 11

Matters of National Environmental Significance

The Fork-tailed Swift (Apus pacificus) breeds from May to August in the Northern Hemisphere. They have an extensive breeding range across Siberia, Mongolia, Korea, northern China, Japan, Taiwan and associated islands (Frith 1982; Cayley 1990). They do not breed in Australia but regularly visit the western and central regions of Australia. Regions where rainfall is between 130 and 225 mm per year are preferred by these birds, which favour zones of low pressure. Large flocks often appear in unsettled weather conditions (Cayley 1990). They arrive in Western Australia about mid October and leave again by the end of April (Frith 1982).

To date, no observations have been made of either species in the Project area. The Barn Swallow (Hirundo rustica) may be attracted to any pools and standing water contained within the Project area. However, the potential for impacts on these species is considered minimal.

11.3.7 White Bellied Sea Eagle,

Simpson and Day (1999) describe the habitat of the White Bellied Sea Eagle as being large rivers, lakes, coastal seas and islands. This species is considered widespread but erratic in distribution and rarely common (Flegg 2002). An individual sighted was considered to be making opportunistic use of standing water within the Fortescue River.

As the Project does not directly impact significantly on rivers and streams, the potential for impacts on these species is considered minimal.

11.3.8 Migratory Shorebirds

Migratory shorebirds (or wading) birds utilise Pilbara coastal habitats such as beaches, tidal flats and other intertidal wetlands during the non-breeding period when they migrate to Asian and Pacific countries from the breeding grounds in eastern Russia (i.e. to avoid the northern hemisphere winter). Shorebird surveys undertaken in the Cape Preston area (Hassell 2002) determined that the numbers of migratory shorebirds present at Cape Preston were well below the twenty thousand figure used for identifying areas of international importance. However, two species, Ruddy Turnstone and Sanderling, were present in numbers greater than the 1% criteria used to determine an area of international importance (Hassell 2002). While little is known about shorebird movements along the Pilbara coast, shorebird species are very mobile and the availability of similar habitat to that occurring at Cape Preston is extensive. It is therefore unlikely that the Cape Preston area represents a major wintering location for shorebirds but rather a stopover point for feeding and resting while they move up and down the coastline.

To reduce the impact of the Project on migratory waders and their habitat, the proposed infrastructure at Cape Preston will be located away from the main roosting and feeding areas for migratory shorebirds on the western shoreline of Cape Preston. Localised disturbance within tidal flat habitats may occur during construction activities; however, this would be minor when consideration is given to the mobility of shorebirds and the extensive areas of tidal flats habitat available for shorebird in the Cape Preston area and the broader region (many kilometres of tidal flats occur along the Pilbara coast between Karratha and Onslow).

It is concluded that the project is unlikely to impact on these species.

11.4 Conclusion

Based on the findings of the fauna surveys and the environmental assessment described above, there is a low potential for the Project to have a bioregional impact on the species listed under the EPBC Act. Analysis of the potential impacts of the Project on the listed threatened species has shown that there is a low risk to these species within the Project area.

Additionally, the search of the Protected Matters Search tool from the DEWHA indicated that one place on the RNE, the Coastal Islands Mary Anne to Regnard was listed. These Islands are outside of the area to be impacted by the Project. Equally, the Great Sandy Island Nature Reserve listed as Extra Information in the Other Matters Protected by the EPBC Act incorporates Preston Island off the northwest tip of Cape Preston and will not be impacted by the Project.
Section 12

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Section 12

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Section 12

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Section 12

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Section 12

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Section 12

References


Section 12 References


References


Section 13  Abbreviations

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<td>Annual Environmental Report</td>
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<td>ALARP</td>
<td>As Low As Reasonably Practicable</td>
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<td>ANC</td>
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<td>ammonium nitrate / fuel oil</td>
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Section 13

Abbreviations

DEW  Department of Environment and Water Resources
DEWHA  Department of the Environment, Water, Heritage and the Arts (Formerly DEW)
DIA  Department of Indigenous Affairs
DMA  Decision Making Authority
DoCEP  Department of Consumer and Employment Protection
DoE  Department of Environment
DoH  Department of Housing
DoIR  Department of Industry and Resources
DoW  Department of Water
DPI  Department of Planning and Infrastructure
DRF  Declared Rare Flora
DRI  Direct Reduced Iron
EC  Electrical Conductivity
EIA  Environmental Impact Assessment
EMP  Environment Management Plan
EMS  Environmental Management System
EPAWA  Environmental Protection Authority of Western Australian
EPBC Act  Environment Protection and Biodiversity Conservation Act 1999
EQC  Environmental Quality Criteria
EQO  Environmental Quality Objectives
ESD  Environmental Scoping Document
EV  Environmental Values
FEL  Front End Loader
GDE  Groundwater Dependent Ecosystem
GHG  Greenhouse Gas
GJ  Gigajoule
GL  Gigalitre
GL/pa  Gigalitres per annum
g/s  Grams Per Second
GSINIR  Great Sand Island Nature Reserve
GSWA  Geological Survey of Western Australia
ha  Hectare
HAT  Highest Astronomical Tide
### Section 13

#### Abbreviations

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## Section 13

### Abbreviations

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<td>Mean Low Water Neap Tide</td>
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<tr>
<td>MLWS</td>
<td>Mean Low Water Spring Tide</td>
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<tr>
<td>NPEC</td>
<td>National Environment Protection Council</td>
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<tr>
<td>NEPM</td>
<td>National Environment Protection Measure</td>
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<tr>
<td>NES</td>
<td>National Environmental Significance</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Government Organisation</td>
</tr>
<tr>
<td>NOₓ</td>
<td>Nitrogen Oxide</td>
</tr>
<tr>
<td>NO₂</td>
<td>Nitrogen Dioxide</td>
</tr>
<tr>
<td>NTU</td>
<td>Nephelometric Turbidity Unit</td>
</tr>
<tr>
<td>OLM</td>
<td>Ozone Limiting Method</td>
</tr>
<tr>
<td>PAF</td>
<td>Potential Acid Forming (waste rock)</td>
</tr>
<tr>
<td>PER</td>
<td>Public Environmental Review</td>
</tr>
<tr>
<td>PFC's</td>
<td>Perfluorocarbons</td>
</tr>
<tr>
<td>pH</td>
<td>Potential Hydrogen (Measure of Acidity / Alkalinity)</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>Particulate Matter With an Aerodynamic Diameter of 10 Microns or Less</td>
</tr>
<tr>
<td>PNTS</td>
<td>Pilbara Native Title Services</td>
</tr>
</tbody>
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## Section 13

### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>P$_{X}$</td>
<td>“X”% Passing (e.g. P$_{80}$ = 80% of the material is less than a specified size after passing through a sizing device)</td>
</tr>
<tr>
<td>ppb</td>
<td>Parts Per Billion</td>
</tr>
<tr>
<td>ppm</td>
<td>Parts Per Million</td>
</tr>
<tr>
<td>ppt</td>
<td>Parts Per Thousand</td>
</tr>
<tr>
<td>RL</td>
<td>Reduced Level</td>
</tr>
<tr>
<td>RO</td>
<td>Reverse Osmosis</td>
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<tr>
<td>RNE</td>
<td>World Heritage Management Principles Register of National Estate</td>
</tr>
<tr>
<td>ROKAMBA</td>
<td>Republic of Korea - Australia Migratory Bird Agreement</td>
</tr>
<tr>
<td>ROM</td>
<td>Run-of-Mine</td>
</tr>
<tr>
<td>SF$_6$</td>
<td>Sulphur hexafluoride</td>
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<tr>
<td>SO$_x$</td>
<td>Sulphur Oxide</td>
</tr>
<tr>
<td>t</td>
<td>Tonne</td>
</tr>
<tr>
<td>TBT</td>
<td>Tributyltin</td>
</tr>
<tr>
<td>TDS</td>
<td>Total Dissolved Solids</td>
</tr>
<tr>
<td>TEC</td>
<td>Threatened Ecological Community</td>
</tr>
<tr>
<td>t/hr</td>
<td>Tonnes Per Hour</td>
</tr>
<tr>
<td>tpa</td>
<td>Tonnes Per Annum</td>
</tr>
<tr>
<td>TSF</td>
<td>Tailings Storage Facility</td>
</tr>
<tr>
<td>TSP</td>
<td>Total Suspended Particulates</td>
</tr>
<tr>
<td>Tjpa</td>
<td>Terajoules Per Annual</td>
</tr>
<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
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<tr>
<td>UNFCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<td>WA</td>
<td>Western Australia</td>
</tr>
<tr>
<td>WAPC</td>
<td>Western Australian Planning Commission</td>
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<tr>
<td>WBCSD</td>
<td>World Business Council for Sustainable Development</td>
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<tr>
<td>WRI</td>
<td>World Resources Institute</td>
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<tr>
<td>WDF</td>
<td>Waste Disposal Facility</td>
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<td>WHO</td>
<td>World Health Organisation</td>
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<td>WQMF</td>
<td>Water Quality Management Framework</td>
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<tr>
<td>VOC</td>
<td>Volatile Organic Compounds</td>
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</table>