

Public Environmental Report Bootu Creek Manganese Project Northern Territory

Prepared for:
Bootu Creek Resources Pty Ltd

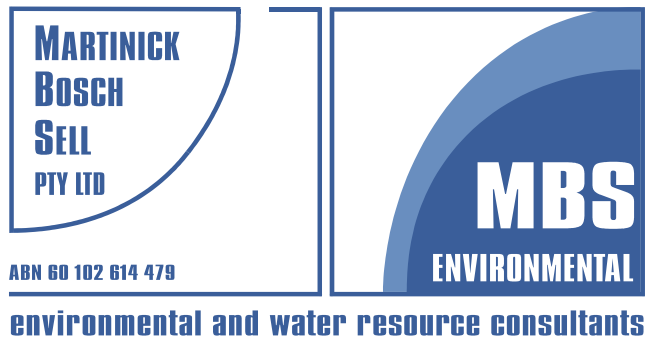
July 2004

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PUBLIC ENVIRONMENTAL REPORT
BOOTU CREEK MANGANESE PROJECT
NORTHERN TERRITORY

PREPARED FOR

BOOTU CREEK RESOURCES PTY LTD

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This report has been checked and released for transmittal to **Bootu Creek Resources Pty Ltd**.

PREPARED AND CHECKED BY:

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Signature: *Kristy Sell* . Date: 22/07/2004

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EXECUTIVE SUMMARY

1. PROJECT OWNERS

Bootu Creek Resources Pty Ltd, a fully owned subsidiary of OM Holdings Ltd, would operate the Bootu Creek Manganese Project. Bootu Creek Resources Pty Ltd has entered into a joint venture arrangement with Groote Eyland Mining Company (GEMCO) for this project whereby Bootu Creek Resources has a 75% interest and GEMCO a 25% interest.

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2. DESCRIPTION OF THE PROPOSAL

The proposed action is to establish a mining operation within the Bootu Creek mineral lease tenement. This will require development of a number of open cut pits to access the ore bodies and construction of a small processing plant. Ore will be extracted through blasting and excavation. The excavated material will be processed in a heavy media separation plant before being loaded onto trucks and transported to a storage area adjacent to the Alice Springs - Darwin Railway Line, which is located some 59 kilometres to the west of the proposed extractive area. From the storage area, lump and fines manganese product will be loaded onto suitable rail wagons and transported to Darwin for export.

A more detailed explanation of the sequential mining process is described below:

1. **Removal of Vegetation:** Any vegetation that needs to be cleared for the purposes of mining at the site, where practicable will be stockpiled for use in later rehabilitation. Clearing will be kept to the minimum required to conduct the mining project.
2. **Remove and Stockpile Topsoil:** The top 200 millimetres will be removed using scrapers or other efficient earth moving machinery and placed in low stockpiles for later re-use.
3. **Remove and Stockpile Overburden:** Typically the overburden depth varies between 0 and 40 metres. The total stripping ratio including overburden and waste is approximately eight to one by volume. Overburden will be progressively stripped along the length of the orebody advancing about 200 metres ahead of the mining face. Overburden will be stockpiled in areas adjacent to the Gogo and Shekuma pits as displayed in Figure 3. Where practicable, overburden stripped ahead of the advancing mine face will be direct placed over waste rock as part of the rehabilitation process. Approximately 800,000 tonnes of overburden is anticipated to require removal annually.
4. **Mining:** Extraction will be carried out using an excavator and a fleet of trucks. Blasting will generally be required to fracture the ore and waste rock sufficiently to allow excavation. Ore will be loaded onto haulage trucks and taken to a run of mine (ROM) stockpile adjacent to the processing plant. Given the geometry and characteristics of the ore body, ore will be mined moving progressively along the Shekuma orebody from south to north to a depth of 30 metres initially and then north to south to a final depth of 70 metres. The Gogo pit will be mined in a similar manner from north to south. A third pit, Chugga, is along strike and north of Gogo, and will mine a continuation of the Gogo mineralisation. The resultant Shekuma and Gogo pits will be about 200 metres wide and 70 metres deep and will move forward at a rate of about 400 metres per year to allow production of about 500,000 tonnes of product per annum. The Chugga pit will be 550 metres long, 200 metres wide, and will have a final depth of 70 metres. It is estimated that the total volume of the pits will be 28 million bank cubic metres. Groundwater will need to be extracted from commencement of mining to allow safe mining. A number of dewatering bores will be developed near each pit to allow abstraction.
4. **Processing:** The manganese ore will be transported to a small heavy media separation plant located adjacent to the extractive area where it will be beneficiated in a two stage process:
 - (i) Ore is blended, crushed, screened and washed.

- (ii) Ore feed is beneficiated in a heavy media separation plant to produce lump manganese product via a drum separator and fines manganese product via a cyclone. No chemicals will be required in this process.
- 5. **Transport:** Haulage trucks will be used to transport lump and fine product to stockpiles at a trans shipment facility located at a siding to be developed on the Alice Springs to Darwin Railway Line. Negotiations with traditional owners to define a road and siding easement are being finalised. The lump and fine product will be loaded into rail wagons and transported to Darwin for export.
- 6. **Disposal of Wastes:** Waste rock will be stockpiled adjacent to each pit in purpose built waste rock stockpiles. Waste rock removed during the last pass of mining in each pit will be placed behind the mining front and will reduce the final void volume. The anticipated total volume of waste and plant reject is 32 million loose cubic metres. The waste rock stockpiles will be shaped to blend with the topography and revegetated.

Waste material from processing of the manganese ore (tailings) will be discharged to a purpose built tailings storage facility (TSF) located nearby to the plant. Tailings will be thickened to 55% density prior to disposal to minimise water accumulating in the TSF. The TSF will be operated in a manner so that accumulation of freestanding water is discouraged and is removed through evaporation. Coarse waste material rejected by the heavy media plants will be stockpiled and will be rehabilitated.
- 7. **Rehabilitation:** Progressive rehabilitation will be undertaken with waste rock material deposited in adjacent waste rock stockpiles and where practicable used to backfill the voids. Overburden and topsoil will be progressively replaced over waste rock stockpiles as part of the rehabilitation process.

The TSF, used for the storage of fine wastes will be rehabilitated after closure of the processing plant

A more detailed description of the individual components of the project is included in Section 2 of this document.

3. SUMMARY OF COMMITMENTS

Commitments made throughout the PER are summarised below with the commitment number referencing the section of the document in which they were made.

Commitment Number	Commitment
2.5.2	Tailings materials will be tested to confirm design assumptions and behaviour of tailings deposition and consolidation.
2.5.4	The storage of tailings in years four to 10 will be investigated in year two of operations and the preferred disposal option designed and necessary approvals obtained to allow construction and commissioning prior to the end of year three.
2.5.4.4a	A minimum total freeboard of at least one metre will be provided within the ponding water area after making allowance for an inflow corresponding to a 1 in 100 year 72-hour duration rainfall event falling in the catchment of the TSF itself.
2.5.4.4b	A minimum operational freeboard of 0.3 metre will be provided within the western and central portions of the TSF between the coarse tailings beach and the embankment crest.
2.8	The rail wagons to be used for the task will be bottom-dump bulk wagons of a similar configuration to the ballast wagons used in the recent construction of the railway.
2.9	Bootu Creek Resources will comply with the requirements of the Port corporations EMS as these relate to their operations.
5.1.2a	All areas of proposed development will be stripped of topsoil to an average depth of about 200 millimeters.
5.1.2b	Topsoil will be removed progressively to ensure large surface areas are not left exposed.
5.1.2c	Topsoil will be direct replaced where possible or stockpiled for later use in the rehabilitation process.
5.1.2d	Topsoil stockpiles will not exceed a height of two metres to ensure topsoil viability is maximised.
5.1.2e	Rehabilitation will be undertaken progressively to minimise the disturbed area and minimise the topsoil stockpile storage period.
5.1.2f	Slope gradients will be controlled to minimise erosion and soil loss.
5.1.2g	Diversion bunds and drains will be installed as necessary to control local surface water run-off to minimise overland flow and consequential erosion.
5.1.2h	Rehabilitation areas will be ripped on the contour after placing of topsoil to remove compaction, improve soil structure and improve infiltration capacity.
5.1.2i	Rehabilitated and disturbed surfaces will be routinely inspected for erosion, particularly after significant rainfall events. If soil erosion is observed during routine inspections, appropriate remediation measures will be implemented.
5.2.2a	Process water storage structures including the TSF will be constructed to minimise seepage.
5.2.2b	Tailings will be thickened and discharged at about 55% solids to minimise free draining water contained in the TSF.
5.2.2c	The TSF will be operated in a manner to maximise evaporation of contained water.
5.2.2d	Flow meters will be fitted to groundwater abstraction bores to enable monitoring of abstraction volumes.

Commitment Number	Commitment
5.2.2e	Groundwater monitoring bores will be installed in areas close to the TSF and the Gogo, Chugga and Shekuma pits to allow evaluation of changing groundwater levels and early detection of any contaminated seepage from mining related activities.
5.3.2a	Protection bunds and diversion channels will be constructed to prevent flooding of the pits, process areas, or other mine infrastructure. The location of diversion structures is illustrated in Figure 13.
5.3.2b	Catchments within the project area will be categorised based on the potential contaminants in each. Surface water run-off in potentially contaminated catchments will be captured and treated in accordance with the potential risk. Clean water flows will be separated from potentially contaminated flows to minimise the volume of water requiring active management.
5.3.2c	Out of pit waste rock stockpiles will be constructed so that interference with natural surface water drainage is prevented or where this is not practicable, impacts are minimised.
5.3.2d	Surface water run-off from ore product stockpile areas at the rail siding will be directed through purpose built drains to a containment structure. Water in the containment structure will be allowed to evaporate. Sediments including manganese particles will be periodically removed and returned to the mine site where they will be fed into the processing plant.
5.3.2e	Release of sediments to watercourses will be prevented by installation of sediment control structures at discharge points where release of sediment is identified as a potential risk.
5.3.2f	A water release management plan will be developed for the disposal of excess mine water.
5.3.2g	Culverts and/or floodways will be installed where mining haul roads and the ore product haul road cross watercourses.
5.3.2h	All water releases to the environment will meet approved water quality criteria.
5.3.2i	Commercially available sewage treatment systems will be installed at the accommodation village and processing areas. Where solids are required to be removed, these will be placed within the TSF. Treated water will be dissipated through evaporation or irrigation of the accommodation village surrounds.
5.3.2j	Hydrocarbons and other hazardous materials will be stored in appropriately designed (e.g. bunded) areas.
5.3.2k	A minimum operational freeboard of 0.3 metre will be provided within the western and central portions of the TSF.
5.3.2l	A minimum total freeboard of at least one metre will be provided within the ponding water area of the TSF after making allowance for an inflow corresponding to a 1 in 100 year 72-hour duration rainfall event falling in the catchment of the TSF itself.
5.4.2a	Clearing of vegetation will be restricted to the absolute minimum.
5.4.2b	Topsoil will be stripped and replaced directly on areas reshaped as part of the rehabilitation process wherever possible. This will ensure the seed bank and microbes contained in the topsoil assist in rapid revegetation.
5.4.2c	If establishment of vegetation on areas reshaped and top soiled is not satisfactory after two years, seed from local plant species will be collected and spread on these areas.
5.4.2d	The effectiveness of rehabilitation programs will be assessed annually.

Commitment Number	Commitment
5.4.2e	Weeds will be controlled through prevention, monitoring and early eradication. If after construction commences spread of weeds is identified as being an issue of concern, a weed management plan will be prepared in conjunction with the Northern Territory Government Controller of Weeds and other relevant experts.
5.4.2f	Company vehicles will be confined to traveling on purpose built roads to minimise potential vehicle borne spread of weed species.
5.4.2g	Vegetation surveys will be conducted at excess water discharge points prior to discharge occurring, annually during discharge and for a period of two years after discharge ceases to determine the impacts of continual water discharge in ephemeral creek systems.
5.5.2a	Vegetation clearing will be kept to a practicable minimum.
5.5.2b	Employees and contractors would be required to attend an induction program that will include a component relating to environmental management. In particular, the induction would clearly explain employee and contractors' roles and responsibilities in terms of restricting impacts on fauna and habitat.
5.5.2c	Sightings of species of conservation significance will be reported to the Parks and Wildlife Commission.
5.5.2d	No domestic animals or firearms will be allowed on site.
5.5.2e	Haulage routes will have speed restrictions in place to minimise fauna death on roads.
5.5.2f	The area of freestanding water on the TSF will be minimised to make it less attractive for migratory water birds.
5.5.2g	A domestic waste management program will be developed to minimise the attraction of feral animals to the project area.
5.5.2h	Bootu Creek Resources will participate in feral animal control programs on Banka Banka Station if requested by owners of Banka Banka Station.
5.6.2a	All roads will be clearly marked to confine vehicle movements to areas where dust control methods can be used.
5.6.2b	Water will be applied to unsealed roads, especially haul roads to ensure dust emissions are minimised. The volume and frequency of water applied will be modified to control dust emissions in different climatic conditions.
5.6.2c	Vehicles traveling on unsealed roads will be required to travel at speeds that will not generate excessive dust.
5.6.2d	Areas will be rehabilitated progressively to minimise areas exposed to wind erosion. Vegetation established will be compatible with the post mining land use of the area.
5.6.2e	Vehicle access on rehabilitated surfaces will be prohibited except for management purposes.
5.6.2f	Employees and contractors will participate in site inductions to ensure they are aware of site rules for permanent and temporary roads.
5.6.2g	Vehicle and equipment will be regularly maintained to manufacturers specifications to minimise exhaust emissions.
5.6.2h	Topsoil stripped from the product ore stockpile area will be placed in a windrow at the edge of the stockpile area. The stockpile will be formed to assist with reduction of ground surface winds and hence minimise wind erosion.
5.6.2i	Equipment operators will remain in enclosed, air conditioned cabins to minimise exposure to dust emissions.
5.6.2j	Emissions will be reported as part of the National Pollutant Inventory.

Commitment Number	Commitment
5.6.2k	During operation of the TSF, tailings will be discharged across areas in the TSF identified as a potential dust source, thereby wetting the surface and preventing the dust problem.
5.7.2a	A register of all hazardous materials imported to the site or generated as a result of activities undertaken at the site will be developed and maintained. This will document the hazardous material name, location, approximate volume, storage method and where applicable, disposal method for the substance and containers.
5.7.2b	Hazardous materials and wastes will be stored in appropriately labeled containers within bunded areas.
5.7.2c	Processing activities will be conducted in areas where surface drainage can be captured to ensure overflows, spillages or leaks can be contained.
5.7.2d	Bunding will be maintained to prevent potential contamination of land and/or groundwater
5.7.2e	An inventory of hydrocarbon use will be maintained to allow determination of whether storage containers are leaking.
5.7.2f	Hazardous wastes generated by the operation will be transported offsite to licensed waste disposal facilities.
5.7.2g	An Emergency Response Plan will be developed for the project. This plan will contain information regarding appropriate response to chemical spillages, leaks, fires or explosions.
5.7.2h	Hazardous materials will be brought to the site in bulk packaging wherever possible. This practice will minimise the number of containers and reduce the risk of spillage.
5.7.2i	Waste rock identified as being potentially acid forming (PAF) will be disposed of in encapsulated areas within waste rock stockpiles.
5.7.2j	All mobile equipment and light vehicle servicing activities including wash down will be conducted on impermeable surfaces.
5.7.2k	The heavy vehicle workshop facility shall contain a purpose built wash down facility incorporating a triple interceptor style sediment and oil/grease removal system.
5.7.2l	Refueling of mobile equipment will primarily be conducted on a sealed surface, however some refueling will take place within the open pits using a mobile refueling vehicle.
5.7.2m	An explosives magazine will be constructed and operated in accordance with regulatory requirements.
5.8.2a	Access to the project site will be limited to employees and authorised visitors.
5.8.2b	Areas of land clearing and disturbance will be minimised.
5.8.2c	Permanent features that will remain after closure of the operation i.e. waste rock stockpiles and TSF will be contoured so that they blend in with the natural topography.
5.8.2d	Areas of disturbance will be progressively rehabilitated with local provenance vegetation.
5.9.2a	Construction activities or mining will not occur on any area of land until appropriate clearances have been obtained from the Aboriginal Area Protection Authority and/or Northern Land Council.
5.9.2b	The Northern Land Council and owners of Banka Banka Station will be kept informed of planned operations.
5.9.2c	The general site induction will include information regarding the importance of cultural sensitivity, respect for land and protection of items of heritage significance. All employees and contractors will be required to participate in this induction.

Commitment Number	Commitment
5.9.2d	All employees and contractors will be advised of the correct procedure to be followed in the case of any items of potential Aboriginal or heritage significance being discovered during mining.
5.9.2e	The Aboriginal Areas Protection Authority and Northern Land Council will be contacted immediately in the advent of items of potential Aboriginal significance being discovered during mining.
5.9.2f	If significant Aboriginal artifacts are identified during mining operations, where practicable, these will be protected to avoid unnecessary disturbance of those objects. Where protection is not practicable, Bootu Creek Resources will work with the Aboriginal Areas Protection Authority and Northern Land Council to gain consent for disturbance.
5.10.2a	Ore transportation will not be undertaken along the Stuart Highway.
5.10.2b	The ore product haul road will be fenced to the extent agreed with landowners.
5.10.2c	On completion of mining activities, infrastructure will be removed and the site rehabilitated to allow the pre mining land use to recommence. Infrastructure will not be decommissioned where agreement has been reached for post mining land users to take responsibility for infrastructure of value to them i.e. ore product haul road.
5.10.2d	Compensation agreements will be reached with landowners for loss of use of land used by Bootu Creek Resources for mining or associated infrastructure.
5.10.2e	Employment opportunities will be advised to the Northern Land Council Tennant Creek Office, and preference will be given to local candidates.
5.10.2f	Provision of goods and services will be advised to the Northern Land Council Tennant Creek Office, and preference will be given to local businesses.
5.10.2g	Accommodation for employees and subcontractors will be provided on site.
5.10.2h	First aid facilities will be established onsite for the duration of the project. These facilities will be manned by appropriately qualified employees.
5.10.2i	A relationship will be established between onsite Emergency Response and First Aid personnel and providers of equivalent services in Tennant Creek.
6.1.1a	The Shekuma and Gogo pits will be partially backfilled to about 260 metres AHD.
6.1.1b	Ensuring PAF waste rock is identified and is encapsulated within NAF waste rock as waste rock stockpiles are constructed.
6.1.1c	Contouring the Shekuma waste rock stockpile so that it ties in with the ridge west of the pit. The maximum height will be governed by the varying maximum height of the ridge so that the final design is aesthetically pleasing.
6.1.1d	The eastern side of the Shekuma waste rock stockpile being constructed with gentle slopes (18 degrees) separated by a back sloping 10 metre wide berm (two degrees fall) to facilitate controlled water shedding.
6.1.1e	Leaving of gaps within the Shekuma waste rock stockpile to prevent interference with natural drainage off the ridge.
6.1.1f	The Gogo waste stockpile height being limited to 20 metres with gentle slopes (18 degrees) separated by a back sloping 10 metre wide berm (two degrees fall) to facilitate controlled water shedding.
6.1.1g	Shaping of stockpile top surfaces to promote water absorption rather than water shedding, i.e. concave surface.
6.1.1h	Direct application of stripped topsoil to reshaped areas to maximise success of vegetation establishment.

Commitment Number	Commitment
6.1.1i	Respreding of stockpiled vegetation on reshaped surfaces.
6.1.1j	Construction of low bunds at the crest of each batter to assist with surface water control on batters.
6.1.1k	Deep ripping on the contour to assist with water adsorption and minimisation of erosion.
6.1.2	Adequate freeboard will be maintained in the TSF at all times during the wet season to ensure capacity exists to contain a one in 100, 72-hour rainfall event
6.2.1	Abstraction rates are anticipated to increase as pit depth increases. Abstraction volumes and depth to water in production bores and monitoring bores will be monitored regularly during the life of the operation to enable Bootu Creek Resources to gain a better understanding of the behaviour of the underlying aquifer systems and the impacts of abstraction.
6.2.3	Once dewatering is required in both the Skekuma and Gogo pits, an excess of water will be experienced. Prior to this situation developing, only sufficient water will be abstracted from groundwater bores as is required by water consumers.
6.2.4a	If in pit sumps are required to be developed, water will be discharged only after it has flowed through sediment removal structures.
6.2.4b	A dewatering management plan will be developed to prevent or minimise degradation of natural drainage systems as a result of water release.
6.2.4c	Quality of the groundwater will be regularly monitored to ensure that it meets water release criteria.
6.3a	Progressive rehabilitation will be undertaken wherever practicable.
6.3b	As part of obtaining all permissions necessary to commence mining, Bootu Creek Resources will submit to DBIRD a security bond in case of any unplanned failure of the project. The size of this security bond will be regularly reviewed in conjunction with DBIRD to ensure it remains consistent with the level of disturbance caused by the project at any specific time.
6.3.3a	All outer batters of the TSF embankments will be constructed with slopes of 5:1 (11.3°) and rehabilitated at the time of construction. They will be covered with five to 10 centimetres of topsoil and contour ripped.
6.3.3b	Rehabilitation of the upper surface will involve: - Covering the tailings surface with inert waste rock or overburden. - Shaping the upper surface to divert run-off from the structure in a controlled manner. Where necessary, permanent drains will be rock armoured to maximise long-term stability. - Spreading of topsoil on shaped surface. - Deep ripping on the contour to assist with water adsorption and surface water control. - Application of seed to ripped surfaces if rehabilitation monitoring shows that natural revegetation has not occurred satisfactorily within two years of rehabilitation
8.0a	As part of the design, construct and operate contracts let by Bootu Creek Resources for the ore processing and mining, HAZOP style risk assessments will be conducted for operational aspects. The results of these assessments will be used to minimise risk for the project.
8.0b	Bootu Creek Resources will develop and maintain a suitably qualified and trained Emergency Response Team for the duration of the project.

Commitment Number	Commitment
8.0c	Procedures will detail the roles and responsibilities of personnel at each stage of the response plan. Training will be provided to all personnel identified within the Emergency Response Plan to ensure they understand their individual responsibilities with regard to implementation of the plan.
8.0d	Bootu Creek Resources will establish a relationship with emergency response organisations and operators of medical facilities within Tennant Creek. Bootu Creek Resources will upgrade the existing airstrip on Banka Banka Station to enable access to the operations by the Royal Flying Doctor Service.
8.0e	Bootu Creek Resources will ensure that people with appropriate First Aid and medical training are employed at all times. A dedicated First Aid facility will be constructed and maintained for the duration of the project. First Aid kits will be maintained in all office buildings, light vehicles and mobile equipment.
8.0f	To minimise the risks associated with bushfire, firebreaks will be installed and maintained around key pieces of infrastructure.
8.0g	Fire extinguishers will be maintained in operational areas in accordance with regulatory requirements. Extinguishers will also be fitted in all light vehicles and mobile equipment.
8.0h	Mobile equipment such as water carts, graders and bulldozers will be used for fire suppression activities where necessary.

1. INTRODUCTION

1.1 PROPONENT DETAILS

Bootu Creek Resources Pty Ltd, a fully owned subsidiary of OM Holdings Ltd, would operate the Bootu Creek Manganese Project. Bootu Creek Resources Pty Ltd has entered into a joint venture arrangement with Groote Eyland Mining Company (GEMCO) for this project whereby Bootu Creek Resources has a 75% interest and GEMCO a 25% interest.

Bootu Creek Resources will operate in accordance with the requirements of the Bootu Creek Resources Environmental Policy. A copy of this is reproduced as Appendix 1.

Bootu Creek Resources can be contacted at:

Mailing Address: PO Box 279
WEST PERTH WA 6872
Phone: 08 9481 0955
Fax: 08 9481 0966
Email: capten@bigpond.com
Contact: Mr Trevor Tennant, Managing Director

Queries regarding environmental matters contained within the PER should be addressed to MBS Environmental at:

Mailing Address: 4 Cook Street
WEST PERTH WA 6005
Phone: 08 9226 3166
Fax: 08 9226 3177
Email: ksell@martinick.com.au
Contact: Ms Kristy Sell, Director – Environmental Science

1.2 LOCATION

The location of Bootu Creek is displayed in Figure 1. From this it can be seen that the project area is situated:

- 850 kilometres south of Darwin.
- 125 kilometres north of Tennant Creek.
- 15 kilometres east of the Stuart Highway.
- On Banka Banka pastoral lease.
- On the southern branch of the Ashburton Ranges.
- West of the Barkly Tablelands.
- Between the Mitchell Grasslands and the Tanami desert.

1.3 TENEMENTS

Bootu Creek Resources hold exploration tenements EL10412 and EL22428. Bootu Creek Resources and GEMCO have submitted a Mineral Lease application for a 4,000-hectare area within EL10412. Figure 2 displays the proposed location of the Mineral Lease Application Area in relation to both exploration tenements.

Bootu Creek Resources is in the process of negotiating a Mining Agreement with the Native Title Claimants. Once the Mining Agreement is executed, a Tripartite Agreement between DBIRD, Bootu Creek Resources and the Northern Land Council (on behalf of the Native Title claimants) will be entered into. This Agreement effectively formalises the Mining Agreement between Bootu Creek Resources and the Native Title Claimants and will allow granting of the Mineral Lease to proceed.

Granting of the Mineral Lease Application cannot be resolved until the outcome of the environmental assessment process has been determined.

1.4 EXISTING LAND USE

The project area is located on the Banka Banka pastoral station. Exploration licences have been issued over the project area for mineral exploration. Bootu Creek Resources holds Exploration Licences 10412 and 22428 and have applied for Mineral Lease 24031.

Pastoral activities for Banka Banka, Brunchilly and Helen Springs stations are centralised on Helen Springs Station. Banka Banka, Brunchilly and Helen Springs stations are owned by the Kidman Reid Company and are currently used for cattle breeding and grazing. The current land use of Banka Banka station is primarily pastoral although some historical mining for manganese at the Muckaty Mine did occur in the mid 1950's to the late 1960's. These mining operations are now abandoned and fall within the mining lease application area. The proposed mine site area is not used for grazing cattle.

Two small residential areas are located eight kilometres to the south-west of the leases (Banka Banka) and 25 kilometres to the south-east (Brunchilly). A small backpackers/camping accommodation facility is located at Banka Banka and is open to members of the public.

Accommodation for employees and their families (about 40 people) for the Banka Banka, Brunchilly and Helen Springs Stations is located on Helen Springs Station.

A pastoralist and employees (five to six people) reside at the Muckaty Homestead site about 27 kilometres north-west of the proposed mine site. An Aboriginal community comprising of about six houses is located on Muckaty, about two kilometres east of the Muckaty Homestead site, but this is not always occupied.

Figure 1: Location Plan

Figure 2: Tenement Plan

1.5 LEGISLATIVE CONSENT AND LICENSING REQUIREMENTS

1.5.1 Northern Territory

Bootu Creek Resources submitted a Notice of Intent document to the Department of Business, Industry and Resource Development (DBIRD) on 20 November 2003. Additional information was submitted on waste rock characterisation and hydrogeology in January 2004. The project was considered by a Project Review Committee containing representatives of DBIRD and the Department of Infrastructure, Planning and Environment (DIPE) in April 2004.

On 10 May 2004, the Minister for Environment determined that under the *Environmental Assessment Act 1982* the project was to be assessed using the Public Environmental Report (PER) process. Draft guidelines were published on 15 May 2004 and were open for comment for a 14-day period. Final guidelines were issued on 12 June 2004.

Under the *Mining Management Act* of the Northern Territory, before operations can commence the proponent is required to:

- Have a granted tenement appropriate for the proposed activity (mining).
- Appoint an operator for the site (Section 10 of the Act).
- Apply for an Authorisation to conduct mining activities on the site (Section 35).
- Submit a Mining Management Plan (MMP) to the Minerals and Energy group of DBIRD [Sections 35(3) and 40].
- Be granted an Authorisation.
- Submit any security bond (if required).

Bootu Creek Resources has applied for a mining tenement. It is anticipated that this will be granted in August 2004. Bootu Creek Resources will lodge an Indigenous Land Use Agreement (ILUA), a Mining Management Plan (MMP) including an Environmental Management Plan (EMP) after the completion of the environmental assessment process.

It is anticipated that emissions to land, air or water will be licensed according to DIPE and DBIRD requirements. An authorisation under the *Mining Management Act* licences waste rock, tailings, landfill, industrial and domestic refuse, storage of contaminated waste, land application and surface run-off. Bootu Creek Resources will implement procedures to ensure compliance with regulatory requirements at all times.

1.5.2 Federal

Commonwealth approval is required if matters of national significance as defined in the *Environmental Protection and Biodiversity Conservation Act 1999* are triggered. Such matters include presence of migratory birds, federally listed rare flora or fauna, development on Commonwealth land, nuclear actions and marine areas.

Bootu Creek Resources submitted a Referral Report to the Department of Environment and Heritage on 10 October 2003. Environment Australia decided on 14 November 2003 that the proposal is not a Controlled Action. Appendix 2 contains copies of correspondence from the Department of Environment and Heritage regarding the controlled action decision.

1.6 SCOPE AND PURPOSE

The purpose of this PER is to assess the existing environmental conditions at the proposed location and to identify actual and potential environmental effects of the proposed development. This will allow the development of appropriate management strategies aimed at minimising the environmental risks and associated adverse consequence. The PER has been prepared to facilitate environmental approval for the proposed development by the Northern Territory Government in accordance with the *Environmental Assessment Act 1982*.

This PER has nine sections structured to cover all aspects identified in the guidelines for the preparation of a PER:

- Section 1 introduces the project.
- Section 2 provides a detailed description of the proposed project.
- Section 3 describes the alternatives considered when arriving at the project design and justifications for the design described in this document.
- Section 4 describes the existing physical, biological, and socio-economic environment of the Bootu Creek area.
- Section 5 outlines the possible environmental impacts, their control measures and predicted outcomes for the project.
- Section 6 contains more detailed information on key environmental impacts of the project and management measures that will be implemented. Issues addressed include waste rock management, tailings management, groundwater management, rehabilitation and decommissioning.
- Section 7 outlines the public involvement and consultation as well as the role of government organisations in the development of the project.
- Section 8 provides a brief description of the Environmental Management Plan to be developed once approval is given for the project.
- Section 9 contains references used within this report.

Technical appendices providing detailed information on many aspects of the project are attached to the PER.

2. DESCRIPTION OF THE PROPOSED DEVELOPMENT

2.1 OVERALL PROCESS DESCRIPTION

The proposed action is to establish a mining operation within the Bootu Creek mineral lease tenement. This will require development of a number of open cut pits to access the ore body and construction of a small processing plant. Ore will be extracted through blasting and excavation. The excavated material will be processed in a heavy media separation plant before being loaded onto trucks and transported to a storage area adjacent to the Alice Springs - Darwin Railway Line which is located some 59 kilometres to the west of the proposed extractive area. From the storage area, lump and fines manganese product will be loaded into rail wagons and transported to Darwin for export.

A more detailed explanation of the sequential mining process is described below:

1. **Removal of Vegetation:** Any vegetation that needs to be cleared for the purposes of mining at the site, where practicable will be stockpiled for use in later rehabilitation. Clearing will be kept to the minimum required to conduct the mining project.
2. **Remove and Stockpile Topsoil:** The top 200 millimetres will be removed using scrapers or other efficient earth moving machinery and placed in low stockpiles for later re-use.
3. **Remove and Stockpile Overburden:** Typically the overburden depth varies between 0 and 40 metres. The total stripping ratio including overburden and waste is approximately eight to one by volume. Overburden will be progressively stripped along the length of the orebody advancing about 200 metres ahead of the mining face. Overburden will be stockpiled in areas adjacent to the Gogo and Shekuma pits as displayed in Figure 3. Where practicable, overburden stripped ahead of the advancing mine face will be direct placed over waste rock as part of the rehabilitation process. Approximately 800,000 tonnes of overburden is anticipated to require removal annually.
4. **Mining:** Extraction will be carried out using an excavator and a fleet of trucks. Blasting will generally be required to fracture the ore and waste rock sufficiently to allow excavation. Ore will be loaded onto haulage trucks and taken to a run of mine (ROM) stockpile adjacent to the processing plant. Given the geometry and characteristics of the ore body, ore will be mined moving progressively along the Shekuma orebody from south to north to a depth of 30 metres initially and then north to south to a final depth of 70 metres. The Gogo pit will be mined in a similar manner from north to south. A third pit, Chugga, is along strike and north of Gogo, and will mine a continuation of the Gogo mineralisation. The resultant Shekuma and Gogo pits will be about 200 metres wide and 70 metres deep and will move forward at a rate of about 400 metres per year to allow production of about 500,000 tonnes of product per annum. The Chugga pit will be 550 metres long, 200 metres wide, and will have a final depth of 70 metres. It is estimated that the total volume of the pits will be 28 million bank cubic metres. Groundwater will need to be extracted from commencement of mining to allow safe mining. A number of dewatering bores will be developed near each pit to allow abstraction.
5. **Processing:** The manganese ore will be transported to a small heavy media separation plant located adjacent to the extractive area where it will be beneficiated in a two stage process:
 - (i) Ore is blended, crushed, screened and washed.

- (ii) Ore feed is beneficiated in a heavy media separation plant to produce lump manganese product via a drum separator and fines manganese product via a cyclone. No chemicals will be required in this process.
- 6. **Transport:** Haulage trucks will be used to transport lump and fine product to stockpiles at a trans shipment facility located at a siding to be developed on the Alice Springs to Darwin Railway Line. Negotiations with traditional owners to define a road and siding easement are being finalised. The lump and fine product will be loaded into rail wagons and transported to Darwin for export.
- 7. **Disposal of Wastes:** Waste rock will be stockpiled adjacent to each pit in purpose built waste rock stockpiles. Waste rock removed during the last pass of mining in each pit will be placed behind the mining front and will reduce the final void volume. The anticipated total volume of waste and plant reject is 32 million loose cubic metres. The waste rock stockpiles will be shaped to blend with the topography and revegetated.

Waste material from processing of the manganese ore (tailings) will be discharged to a purpose built tailings storage facility located nearby to the plant. Tailings will be thickened to 55% density prior to disposal to minimise water accumulating in the TSF. The TSF will be operated in a manner so that accumulation of freestanding water is discouraged and is removed through evaporation. Coarse waste material rejected by the heavy media plants will be stockpiled and will be rehabilitated.
- 8. **Rehabilitation:** Progressive rehabilitation will be undertaken with waste rock material deposited in waste rock stockpiles and where practicable used to backfill the voids. Overburden and topsoil will be progressively replaced over waste rock stockpiles as part of the rehabilitation process.

The tailings storage facility, used for the storage of fine wastes will be rehabilitated after closure of the processing plant.

More details are provided for mining, ore processing, dewatering and tailings disposal in the following subsections.

2.2 SITE LAYOUT

The conceptual site layout is illustrated in Figure 3. Based on the results of recent exploration drilling, three separate north-south trending open pits will be developed.

The total footprint of the project will be about 526 hectares. Vegetation will need to be cleared from these areas progressively to allow establishment of mining, processing and associated infrastructure.

Waste rock and overburden stockpiles will be developed adjacent to the pits. On the last mining pass in the Shekuma and Gogo pits, waste will be placed within the pit providing some degree of backfilling. The out of pit Shekuma waste rock stockpile has been designed so that it ties into contours of the adjoining ridge west of the pit. The maximum height will be governed by the varying maximum height of the ridge so that the final design is aesthetically pleasing. The eastern side of the waste rock stockpile will be constructed with gentle slopes (18 degrees) separated by a back sloping 10 metre wide berm (two degrees fall) to facilitate controlled water shedding. Gaps will be left within the waste stockpile to prevent interference with natural drainage off the ridge.

The out of pit Gogo and Chugga waste rock stockpiles will be low in height (20 metres) with gentle slopes (18 degrees) separated by a back sloping 10-metre wide berm (two degrees fall) to facilitate controlled water shedding. A concave top surface will be created to promote water retention in the waste material and minimise erosion of the batters.

Where practicable, topsoil stockpile locations will be selected so that they do not cross drainage lines.

The processing plant will be located south of the open pits. A TSF of about 12 hectares in size (300 metres wide by 400 metres long) will be located east of the processing plant. The TSF will be expanded over the life of the operation to a maximum land surface area of 28 hectares. A heavy vehicle workshop will be located adjacent to the processing plant. This will be used to service mobile equipment used in the mine. Light vehicles will be serviced in an adjoining workshop. Refuelling facilities will be located adjacent to the workshops.

An accommodation village to accommodate approximately 75 people will be constructed south west of the open pits and processing plant. This location will be sufficiently removed from the operational areas to ensure potential air quality, noise and visual impacts are minimised and sufficiently elevated to avoid rise of surface waters from Bootu Creek.

2.3 MINING

Mining of the Shekuma, Gogo and Chugga orebodies will be undertaken by the conventional open cut method of drilling, blasting and excavation using a hydraulic excavator and dump trucks. Ore and waste will be mined from the Shekuma and Gogo pits using multiple mining passes. The first mining pass will remove ore to an approximate depth of 30 metres. The second mining pass will remove ore to a depth of 70 metres. Exit ramps will be constructed at approximately 300 metre spacing within the pits to allow haul trucks to transport waste to the adjacent waste rock dumps and the ore directly to the ROM pad. The Chugga pit will be progressively mined down from a final pit perimeter.

Drilling and blasting will be required to enable excavation of the waste and ore. Initially there will be an amount of free dig material, comprising mostly sandy material and weathered siltstone and sandstone. A further amount of the overburden will be able to be loosened with “paddock” blasting, which requires open spaced holes of approximately five to six metre centres with a light charge having a powder factor generally less than 0.3 kilogram per bench cubic metre of explosives. The less weathered waste and ore will require drilling with a pattern of approximately three by three metres and a powder factor of 0.3 to 0.6 kilogram of explosives per bench cubic metre.

It is expected that paddock blasting of overburden would be required once a week after the initial free dig material is removed. The extent of the free dig material is not known, but is expected to comprise of the order of four to six metres in depth. Drilling and blasting of waste and ore would proceed on a continuous basis with blasts being fired every two to three days. Two pits will be advanced at the same time so that drilling and blasting and excavation activities can be carried out independently of each other.

Plan and cross-sectional views of the proposed pit are given in Figure 4. The natural ground level of the surrounds of the proposed Shekuma, Gogo and Chugga pits is 280 metres Australian Height Datum (AHD). The length of the Shekuma pit will be about 1,700 metres with a final

surface area (the footprint of the pit at its perimeters) of 34 hectares. The Gogo pit will be about 1,500 metres in length with a surface area of 30 hectares. The Chugga pit will be about 550 metres in length with a surface area of about 11 hectares. The final pit floors will be at about 210 metres AHD, making them up to 70 metres deep. It is estimated that a total of 33 million bench cubic metres of material will be excavated from the pits. This will consist of 3.3 million bench cubic metres of ore and 30 million bench cubic metres of waste for a stripping ratio of 7.5 to 1.

The waste rock and overburden will be deposited in three purpose-built waste rock stockpiles located to the west of Shekuma pit and east of Gogo and Chugga pits. As part of the second mining pass in the Gogo and Shekuma pits, waste rock will be placed behind the mining front providing some degree of backfilling. It is estimated that about 67% of the total waste rock produced for the project (20 million loose cubic metres) will be backfilled.

The pits will be mined in 2.5-metre flitches with five metre wide berms at 15 metre intervals. Strict grade control will be in place using an on-site laboratory for the testing of all ore drill samples. An overall slope of about 65° will be applied to all pit hanging walls. The footwalls will be at approximately 35°, which is the angle of dip of the deposit.

Exploration drilling and recent groundwater investigations indicate that groundwater is present from about 26 to 35 metres below the ground surface. Dewatering will need to be undertaken on commencement of mining to ensure that as mining activities get deeper in the profile safe access can be gained. Dewatering will occur via a number of purpose-installed abstraction bores. In pit sumps may be required during the wet season, but will not be used for groundwater management. The rate of dewatering will increase substantially after year two as mining in areas beneath the water table commences. More detail on dewatering is provided in Section 6.2.

Mining is scheduled to commence in March 2005. The current life of the operation is projected to be about ten years.

2.4 PROCESSING

The process plant is designed to produce a nominal 500,000 tonnes per year of product, comprising 380,000 tonnes of lump and 120,000 tonnes of fines. Nominal yields expected dictate that the feed to the plant will be 1,150,000 tonnes per year.

Processing of manganese ore will be undertaken using a standard heavy media separation technique. Ore will be beneficiated in a two stage process:

- (i) Ore is blended, crushed, screened and washed.
- (ii) Ore feed is beneficiated in a heavy media separation plant to produce lump manganese product via a drum separator and fines manganese product via a cyclone. No chemicals will be required in this process.

Inputs into the process are ore, water and ferrosilicon. Ferrosilicon is a product derived from “atomising” a smelted ferrosilicon alloy. The product is a powder of uniform and roughly spherical particle shape having a specific gravity of approximately seven.

The proposed operating philosophy is to run the crushing circuit as a single shift operation, and the drum and cyclone plants on double shift.

The heavy media separation process relies on the separation of the high-grade ore from the lower grade reject material by the difference in density of the ore and the rejects. The plant for processing the lump ore consists of a rotating drum into which the correctly sized feed material and a heavy medium comprising a mixture of ferrosilicon and water is introduced. The denser ore sinks in the medium and the reject low-grade material floats. The separated streams of materials are collected and washed on a washing screen to remove the ferrosilicon that is returned to the process. The only loss of ferrosilicon occurs through entrapment in the pores of the ore, which remains in the product in minute quantities.

The plant for processing the fines uses a similar ferrosilicon and water mixture and correctly sized feed material introduced into a cyclone, in which the high and low grade materials are separated on the basis of their differing densities.

Waste material from processing of the manganese ore comprises rejects from the heavy media plant drum and cyclone plants. This will have a particle size of between 0.63 millimetre and 75 millimetres. It is removed from the plants by a common conveyor to a stockpile located adjacent to the plant area. Tailings from the washing and screening process having a particle size of less than 0.63 millimetre will be discharged to a purpose built tailings storage facility (TSF) located nearby to the plant and as described in 2.5 below.

A conceptual process flow sheet is included as Figure 5.

2.5 TAILINGS

Tailings production is estimated to be 200,000 tonnes per annum resulting in a total storage capacity of two million tonnes over the ten-year life of the project. Assuming a dry density for tailings of 1.43 tonnes per cubic metre, the estimated volume of tailings is 140,000 cubic metres per annum and 1.4 million cubic metres for the life of the project.

Disposal of tailings will be staged with an initial tailings storage facility (TSF) with three years' capacity being constructed. As operations progress from year four to year ten, subsequent staging of tailings disposal will consider expansion of the TSF to the north and east and potential disposal of tailings in mined out pits.

A conceptual design for the three year TSF is provided for the purposes of this report, based on treatment and disposal of tailings from manganese orebodies in similar geological settings. Geotechnical studies, design and construction of the TSF will be undertaken as part of the process design construct and operate contract.

Design objectives for the TSF are:

- Permanent and secure confinement of all solid waste materials.
- Maximisation of tailings densities using subaerial deposition.
- Minimisation of storage catchment areas.
- Maximum removal of free water for re-use in the processing plant.
- Facilitate progressive rehabilitation of the embankments of the TSF after their construction.
- Facilitate rehabilitation of the tailings surface following decommissioning of the TSF.

2.5.1 Location

The proposed three year TSF is located on a gently sloping east facing hillside with ground elevation within the layout varying from 272 metres RL in the west to 270 metres RL in the east. The nearest the TSF is to other infrastructure and operational areas is 100 metres east and downslope of the processing plant and 250 metres north and mostly downslope of the administration/workshop area. The location of the proposed TSF is shown in Figure 3.

The TSF and processing plant areas are located in the upper reach of a minor catchment area. Run-off from this catchment will be diverted around the TSF and other mine infrastructure via upstream perimeter drainage.

2.5.2 Geotechnical Considerations

Detailed geotechnical investigation will be conducted on the preferred three year plan TSF site and subsequent expansion areas to cover geology of the superficial and bedrock formations, hydrogeological properties of the site, engineering properties of the foundation and construction materials. The suitability of overburden and waste material from the pits, TSF layout and alternative borrow areas will be investigated. Tailings materials will be tested to confirm design assumptions and behaviour of tailings deposition and consolidation (**Commitment 2.5.2**).

2.5.3 Geochemical Considerations

MBS Environmental undertook an in-house geochemical evaluation on tailings slurry derived from bench scale metallurgical test work undertaken as part of the feasibility study. The minus 10 millimetre reject from a specially selected representative sample of manganese ore was set aside for analysis as representative of natural tailings. The sample was split at 1,000 microns and the finer fraction analysed. Analyses were performed on a water extract for 12 metals, three non-metals and four radicals, pH and electrical conductivity. The solids were analysed for 60 metals plus boron, selenium, sulphate-sulphur, sulphur and acid neutralising capacity (Appendix 3). A full database consisting of 973 ore samples and 4,029 low grade and waste samples analysed for 13 metals was also reviewed. Relative data is presented in Tables 8 and 9 in Section 6.1.2.1 along with a review of the geochemistry.

Results from this work concluded that:

- The percentage of clay mineral in the tailings will be of the order of 12% and always less than 20%.
- The tailings solid can be classified as Non Acid Forming. Traces of sulphur were detected but this cannot be allotted to reactive sulphides and may not be present as sulphide but as barite, an extremely insoluble sulphate of barite.
- The tailings solid had low contents of environmentally significant elements. Slight enrichments of copper, lead, zinc, gold, uranium, bismuth and molybdenum were detected.
- The tailings water is mildly alkaline (pH = 7.9) and brackish (TDS 800 milligrams per litre at 1:5 dilution). Analysis results indicate that tailings slurry water had concentrations of most minor elements less than, or close to, the respective detection limits.

- Slight enrichment of manganese was detected in water leachates (0.43 milligram per kilogram compared with a guideline for drinking water of 0.4 milligram per kilogram).
- Assessment of the overall geochemical and mineralogical information indicates that the minor elements in the tailings solids correspond to stable forms liable to be insoluble under more acid conditions than are ever likely to be encountered in the Boot Creek TSF.
- There is insufficient alkaline earth metals or sulphate content to form efflorescence's on the surface of the TSF.
- Water draining through the base of the TSF and re-entering the groundwater system will not decrease the groundwater quality. There will be a slight increase in Mn value but that should remain well within potable water guidelines.

2.5.4 TSF Layout And Description

The proposed initial three year TSF will consist of one rectangular cell approximately 300 metres by 400 metres (about 12 hectares in area). The height of the cell will vary between four metres along the western embankment and up to six metres along the eastern embankment. The discharge of tailings during years four to ten will require either one of, or a combination of expanding the TSF or in pit disposal.

An expansion of the TSF would involve construction of additional cells to the north and east of the initial three year TSF of similar size and dimension or raising the embankments of the existing TSF. The storage of tailings in years four to ten will be investigated in year two of operations and the preferred disposal option designed and necessary approvals obtained to allow construction and commissioning prior to the end of year three (**Commitment 2.5.4**).

2.5.4.1 Embankments

The embankments of the initial three-year TSF will be constructed in a single earthworks operation from geotechnically suitable material obtained from mine waste or borrow pits located within the TSF layout or in the nearby vicinity. The embankment geometry will consist of a low permeability zone (central and upstream sections) comprising of selected low permeability clayey material compacted to engineering design specifications. The downstream section of the embankment will consist of a structural zone to provide a stable slope suitable for rehabilitation and will comprise compacted sandy subsoil material. This material may be obtained from borrow areas within the TSF layout and stripped from the foundation of the low permeability zone of the embankment footprint.

The upstream slopes will be 1.5:1 (H:V) (34°) to provide a geotechnically stable inner slope and downstream slopes 5:1 (H:V) to facilitate rehabilitation. The embankment crest will be at least five metres wide to allow vehicular access. Rehabilitation of the embankments will occur at the time of construction of the embankments by respreading topsoil onto the outer batters of the embankments followed by ripping.

The upstream slopes of the eastern embankment will be covered with a layer of inert rocky waste material for scour protection. At commencement of operations, tailings will be discharged progressively around the perimeter of the northern and southern embankments to form a coarse (sandy) tailings beach against the upstream batters for scour protection.

2.5.4.2 Water Recovery

Where practically possible, water within the TSF will be minimised. Sands up to four metres thick underlie the TSF and it is expected that most of the tailings water will be lost to seepage. Water will also be lost through evaporation from the tailings surface.

A sump will be located within the north-eastern corner of the TSF to allow pumping out of tailings water and stormwater run-off that may collect within the eastern portion of the TSF. Water will be recovered with an appropriately sized pump located in the sump at the maximum possible rate to maintain the lowest possible water levels in the TSF. The quality of water pumped out of the TSF will be tested prior to release to the environment or onsite re-use.

There will be no requirement for collection of seepage outside the TSF as subsurface seepage is expected to readily drain downwards into the underlying aquifer.

2.5.4.3 Upstream Perimeter Drainage

The windrows formed from topsoil stripped at the time of construction from the TSF layout will be placed around the perimeter of the TSF and will effectively divert run-off away from the TSF. Where required, minor drains will be constructed to link into the processing plant area drainage and existing drainage lines wherever possible.

2.5.4.4 Capacity and Freeboard

The three-year plan will provide for the storage for 420,000 cubic metres of tailings based on an average beach slope for coarse tailings of two percent. The coarse tailings, which may comprise more than 70% of a medium to coarse sand fraction, are expected to settle very quickly near the discharge point and form beaching slopes of between 1.5 and 3.0 percent. The finer tailings, comprising clay, silt and fine sand fractions (estimated to be between 10 and 30% of the total tailings volume), will beach along the eastern perimeter of the tailings storage facility to form an almost flat surface.

The height of the embankments within the eastern portion of the TSF will take into account the flat surface to be formed by the fine tailings fraction.

A minimum total freeboard of at least one metre will be provided within the ponding water area after making allowance for an inflow corresponding to a 1 in 100 year 72-hour duration rainfall event falling in the catchment of the TSF itself (**Commitment 2.5.4.4a**).

A minimum operational freeboard of 0.3 metre will be provided within the western and central portions of the TSF between the coarse tailings beach and the embankment crest (**Commitment 2.5.4.4b**).

2.5.5 Construction of TSF

The TSF will be constructed for an initial three-year plan and subsequently in several stages over the remaining 10-year period.

As part of the supervision of works a quality control program for the earthworks and the associated civil engineering works will be implemented. The construction process and quality

assurance/quality control program will be documented in construction reports in accordance with requirements of DBIRD.

Prior to construction, topsoil will be removed to an approximate depth of 200 millimetres from the footprint of the TSF and stockpiled around the perimeter of the TSF for later use in rehabilitation of the embankments and top surface.

The earthworks will be supervised to ensure that:

- Embankment and drainage construction is undertaken in compliance with the approved design specifications.
- Embankments are constructed to an acceptable engineering standard.
- Only suitable fill materials (environmentally desirable, low permeability, sufficient strength) are being used for the construction of the embankments.

2.5.6 Management of TSF

Tailings will be thickened to about 55% solids density to minimise water loss and deposited subaerially into the TSF. The TSF will be operated in accordance with an operations manual that will be prepared in accordance with relevant guidelines for development and operation of tailings storages (**Commitment 2.5.6a**).

Tailings will be discharged from one or more moveable discharge points located around the perimeter of the TSF. The deposition of tailings will be managed to maximise water removal and increase *in situ* dry density. Tailings water and stormwater run-off will pond within the eastern portion of the TSF where a sump will be constructed to facilitate removal of excess water. Excess water will be primarily dissipated through seepage and evaporation. A beach of coarse tailings will be developed progressively eastwards from the western embankment with the fine tailings depositing in the eastern portion of the TSF.

The discharge methodology for the three year plan will be as follows:

- **Commencement of operations:** Discharge point moved progressively from west to east along both the northern and southern embankments to deposit a continuous beach of coarse tailings along the upstream batter of the embankments. This coarse tailings beach will further stabilise the upstream batter of these embankments by keeping run-off or ponding water away from the embankments thereby reducing the potential for erosion and seepage through the embankment.
- **Years 1 and 2:** Tailings will be discharged from the western embankment to form a beach of coarse tailings along the entire length of this embankment. The flow of discharged tailings will be directed so that an even distribution of tailings is formed in all directions.

Once the tailings beach reaches the operational freeboard of 0.3 metre below the embankment crest, then the discharge points will be advanced eastwards over the tailings beach to form a level coarse tailings surface over the western layout of the TSF. The coarse tailings will cover the fine tailings deposited previously over the central portion of the TSF.

- **Year 3:** At the end of year two it is expected that the western portion of the TSF will be filled with tailings, while the central portion will have an exposed tailings beach and the eastern portion will be partially filled with fine tailings. The discharge point will be

moved further eastwards along the southern embankment towards the south-eastern corner of the TSF, thereby directing tailings flow towards the north-eastern corner with fine tailings depositing within the north-eastern portion of the TSF.

By the end of year three, a cover of coarse tailings will have been deposited over the western, central and south-eastern portions of the TSF. In year three a decision on whether to expand the TSF will be known. In the event that the TSF is to be expanded, the location and operation of the decant pond will be determined to ensure its proper functioning.

2.6 INFRASTRUCTURE

Infrastructure necessary for operation of the mine and process plant that has not already been described in Sections 2.2 to 2.5 will include:

- A diesel fuelled power generation plant. This will be located within the processing plant area.
- An accommodation village to accommodate about 75 people. This will be located west of the mining and processing areas.
- A heavy vehicle workshop. This will be used to service both mobile equipment used for mining and light vehicles.
- Office buildings including an area for stores and a laboratory.
- A haul road to transport manganese product from Bootu Creek to the Muckaty siding. The haul road will be sealed (one lane width) and an underpass will be constructed beneath the Stuart Highway so that traffic will not be disrupted by Bootu Creek Resources product transport activities. Appendix 4 contains preliminary drawings illustrating the layout of the road and rail siding.

Infrastructure locations are displayed on Figure 3.

The predicted water usage for the project is 664 megalitres per annum. Water requirements are described in more detail in Section 6.2.3.

The predicted power usage for the project is 1.2 megawatts. This will be generated using diesel powered generators.

2.7 TRANSPORT

The product will be trucked approximately 59 kilometres along a sealed road to be constructed from Bootu Creek to the new Muckaty siding on the Alice Springs - Darwin Railway line (Figure 1).

The transport route crosses land owned by Banka Banka Station, Muckaty Aboriginal Land Trust and DIPE - Roads Development Branch (Figure 6). Negotiations have been conducted with each stakeholder to reach agreement for land access.

The product will then be stockpiled at a storage facility located adjacent to a siding to be developed on the railway line. Negotiations are currently underway with traditional owners of

the land to finalise a rail siding easement. The lump and fines product will be loaded into rail wagons and transported along the Alice Springs - Darwin Railway Line to Darwin for export.

Lump and fine manganese product will be trucked from the Bootu Creek Operations to the Muckaty siding using 125 to 250 tonne payload trucks. For an annual average ore product production of 500,000 tonnes, it will be necessary to make about 2,000 truck journeys per year. This will equate to 38 return truck journeys per week or five to six per day.

2.8 PRODUCT LOADING

Lump and fine manganese will be unloaded at the siding by side tipping from the road train trailers. Product ores will be placed to form a low stockpile of some 400 metres in length parallel to the rail where railway wagons will be loaded.

Product ore will be picked up from the stockpile with a front-end loader and placed into railway wagons. The front-end loader will be also be used to shape the stockpiles and remove any spillages.

Cycle times for the trains will be such that they will make seven trips per fortnight, or 182 trips per year. Each train will be composed of 40 rail wagons capable of carrying about 70 tonnes per wagon giving a total train load of 2,800 tonnes.

The rail wagons to be used for the task will be bottom-dump bulk wagons of a similar configuration to the ballast wagons used in the recent construction of the railway (**Commitment 2.8**).

2.9 PRODUCT UNLOADING

Trains will be unloaded at the Darwin port using a purpose built bottom dump unloading facility owned by the Darwin Port Corporation. The lump and fines products will be distributed into stockpiles on land owned by the Port Corporation and leased to Bootu Creek Resources.

Development of the Port was addressed in an Environmental Impact Statement in the mid 1990's. The port Authority is required to maintain an Environmental Management System (EMS) to ensure environmental impacts are prevented or minimised. The EMS will be required to be reviewed to ensure that it accounts for impacts associated with bulk product storage and handling.

Bootu Creek Resources will comply with the requirements of the Port corporations EMS as these relate to their operations (**Commitment 2.9**). Procedures will be developed by Bootu Creek Resources to address unloading of rail wagons and management of the product stockpiles. These procedures will include environmental information as necessary to ensure the Port corporations EMS is complied with.

2.10 PROJECT SCHEDULE

2.10.1 Construction

Construction is planned to commence at Bootu Creek in October 2004 assuming all approvals have been obtained by this time. This will allow the planned first shipment of ore product to occur in April 2005.

Tenders have recently been called for mining contracting and design and construction of the process plant. Contracts are planned to be let for each by the first week of September 2004.

Construction will commence with development of the haul road to the site, establishment of the accommodation village and construction of the processing facilities. Mining equipment is planned to be mobilised in mid February 2005 with initial ore to be placed on a ROM stockpile in March 2005. Construction of the Muckaty rail siding is planned to commence in November 2004. Ore processing is planned to commence in April 2005.

Appendix 5 contains a gant chart showing the planned construction schedule for the project.

2.10.2 Stages/Milestones

It is anticipated that the project will have a minimum of 10 years of life. Given the recognised potential of the Bootu Creek Resources exploration tenements, it is anticipated that future exploration will confirm that the project life will extend considerably beyond the initial projection of 10-year life.

Bootu Creek Resources wish to commence mining as soon as all approvals have been obtained. The current development schedule aims to allow first ship loading of manganese product in late May 2005. To meet this schedule, Bootu Creek Resources are aiming to have let key design and construct contracts by September 2004. Commissioning of the process plant is scheduled to occur in April 2005 with mining to commence in the first week of March 2005.

Figure 3: Conceptual Site Plan

Figure 4: Plan and Cross Sectional Views of Open Pits

Figure 5: Process Plant Flow Sheet

Figure 6: Transport Route Plan

3. PROJECT OBJECTIVES, ALTERNATIVES AND JUSTIFICATION

3.1 OBJECTIVES

The objectives of the project are to:

- Produce a manganese product for export to an OM Holdings owned Ferro Alloy plant.
- Produce manganese product at a low cost whilst maintaining high levels of performance in terms of quality, safety and environmental production.
- Ensure benefits of the project are shared with members of the Northern Territory and local communities.

3.2 ALTERNATIVES CONSIDERED

Alternatives considered during planning of the Bootu Creek project included:

- Not proceeding with the project.
- Reviewing alternative locations for the open pits process plant, TSF, waste stockpiles, site access road and other infrastructure. The locations shown within this document were selected after careful consideration of the environmental factors relevant to location of each component.
- Shipping ore product to Adelaide instead of Darwin.
- Transporting ore product by road instead of rail.
- Location of the rail siding.
- Sources of raw materials i.e. ore and water.
- Use of different mining and processing technologies.
- Accommodation methods.
- Power supply options and service corridors.

3.3 JUSTIFICATION AND BENEFITS

The project described in this document is a result of careful consideration of the financial, environmental, safety, social and operations aspects associated with each component of the project. The proposed design reflects the following facts:

- A feasibility study undertaken for the project demonstrated that the project was financially viable, thus the decision to mine was triggered by submission of a Notice of Intent to DBIRD in November 2003. The volume of product to be produced per annum has been refined as a result review of market demand, ongoing discussions with potential customers and review of achievable mining schedules.
- Sourcing raw materials from other locations is not technically feasible as the mining project is based wholly on identification of an economically viable source of manganese.

- Manganese mining is a relatively simple in terms of mining and processing requirements. The project as described uses common, well tested mining and processing techniques. The nature of the ore bodies does not lend itself to using other than traditional open cut mining techniques.
- Shipment of ore product to Adelaide would render the project uneconomic due to greater distance and hence unacceptable transport costs.
- Shipment of ore product by road to either Darwin or Adelaide would render the project uneconomic.
- Establishment of a permanent township at Bootu Creek was considered. The economic and environmental costs of establishing a township for the relatively small size of the workforce and short mine life duration (ten years) outweighed any social benefits that may have arisen from establishment of a township, particularly when the proximity to the township of Tenant Creek was considered.
- Location and design of the project took into consideration the existing environment and the potential environmental impacts of the project. The location of the accommodation village, TSF and site access road took into account the proximity of surface water drainages and topography. Waste rock stockpiles have been designed with regard to topography, surface water drainage and aesthetic impact.
- Construction of a railway spur line was examined in the feasibility study. The study indicated that a haul road was a more viable option for transporting product from the mine to the railway line.

Benefits that are anticipated to result from the project include:

- Bootu Creek Resources will provide direct employment for about 30 people during construction and 60 people during operation. Indirect employment is likely to be provided for an additional 180 people as a result of supplying goods and services to the project.
- Bootu Creek Resources have entered an agreement with the Northern Land Council whereby the Northern Land Council will manage the register of employment and service opportunities for the project. Employment and training opportunities for local people living in the Bootu Creek region will be maximised.
- Preference will be exhibited for engaging local businesses to provide goods and services to the project.
- Bootu Creek Resources through payment of Company tax, payroll tax and royalties will be contributing directly to the economies of the Federal and Territory governments.
- Potential exists for the Muckaty Aboriginal Land Trust to examine a range of alternative uses for their land, the haul road corridor and the new railway siding when mining operations have ceased. As part of negotiations undertaken with the Muckaty Aboriginal Land Trust, Bootu Creek Resources has agreed to leave the haul road intact on completion of mining operations if requested by them to do so at this time.

Similarly, construction of the haul road will provide Banka Banka Station with improved access to that part of its pastoral operations. While mining operations continue the haul road will be regarded as Bootu Creek Resources private road. However, Bootu Creek Resources would agree to a request from the landowners to permit alternative uses of the road, under negotiated conditions, if the local region were to gain benefit from the road being used for these alternative uses.

OM Holdings the owner of Bootu Creek Resources has constructed a Ferro Alloy plant in southern China and will use product from Bootu Creek as feed for this plant. Current tonnage of manganese ores traded worldwide is nine million tonnes. Bootu Creek Resources production will represent 5.5% of world trade

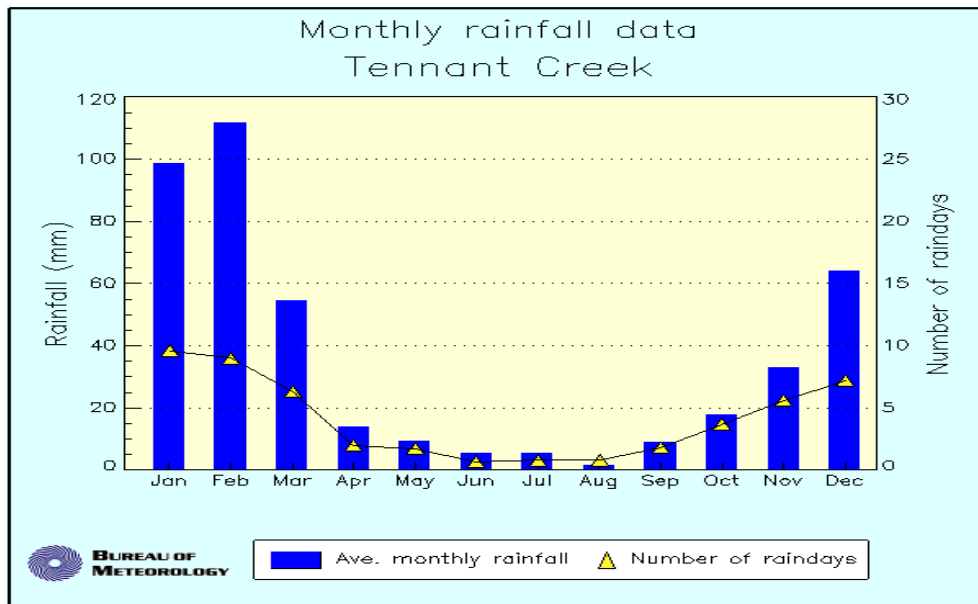
4. DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 CLIMATE

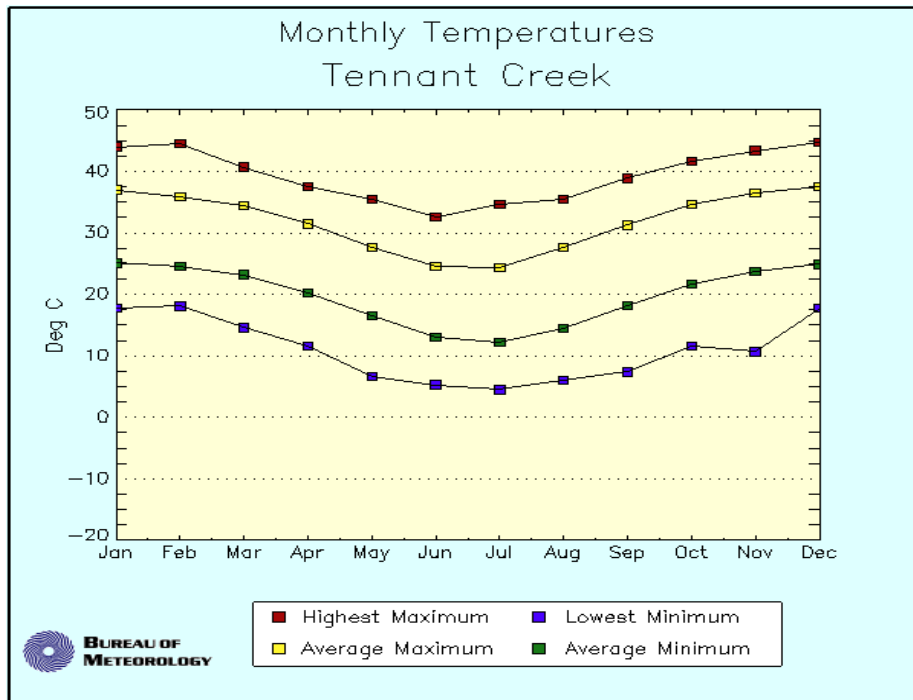
The climate of the Bootu Creek area is tropical monsoonal, with a pronounced wet season from November to April. Dry conditions are typically experienced during the remainder of the year, however a build up to the wet season does occur with rain events experienced prior to November.

Mean annual average rainfall for Tennant Creek is 320 millimetres, 95% of which falls between October and April. Records from Banka Banka Station indicate that annual average rainfall in the Bootu Creek project area is about 631 millimetres. Figure 7 displays average monthly rainfall for Tennant Creek.

Figure 7: Tennant Creek Monthly Rainfall Data (1874 – 2001)



Average daily minimum and maximum temperatures are 14 degrees Celsius in July and 38.7 degrees Celsius in January. Figure 8 displays average temperatures for Tennant Creek.

Figure 8: Tennant Creek Monthly Temperatures (1874 – 2001)

4.2 GEOLOGY

Bootu Creek forms part of the Ashburton Province consisting of Proterozoic platform cover of fluvial to shallow marine sandstone with minor volcanic rocks, siltstone and carbonate rocks of the Tomkinson Creek Subgroup conformably overlying the Flynn Subgroup. A recessive sequence of calcareous siltstone and stromatolitic dolomite, comprising the Attack Creek Formation, is overlain by a predominantly ridge-forming sandstone sequence, the Bootu Formation, containing an extensive manganese horizon near the base, within dolomitic siltstone and medium grained sandstone.

The Bootu Creek manganese horizons occur in the lower part of the Bootu Formation (Hussey *et al.*, 2001). The Bootu Formation is folded around a faulted syncline (Bootu Syncline) that plunges gently to the north-north-west. Bedding dips at low to moderate (10 to 45°) angles and averages about 30 degrees. Several north trending faults have been mapped along the western limb of the Bootu Syncline with lateral displacements up to 300 metres. The manganiferous horizon can be discontinuously traced 24 kilometres around the syncline as a series of black ridges and knolls.

At Bootu Creek, the manganese ore horizon exposed in the open cuts is up to 8.6 metres in thickness and averages six metres. Mining via shallow (to eight metres depth) open cuts has taken place over a 760-metre strike length. Metallurgical grade (>38% Mn) manganese ore is up to 2.7 metres thick and averages about 1.2 metres. This material is grey to black, massive or reniform in texture and found toward the base of the ore zone where the manganese completely replaces siltstone. Pyrolusite is present as veinlets through the massive psilomelane ore.

Medium grade ore (22 to 38% Mn) is grey to black, with numerous medium to fine grained, quartz grains and found above the metallurgical grade ore where the manganese replaces

quartz sandstone or partially replaces siltstone. Gangue minerals include quartz, barite, chalcedony, calcite and gypsum.

The manganese is believed to have been concentrated by low temperature replacement in stratabound massive manganese (+Fe) oxide lenses in the shallow marine sediments. Cryptomelane is the dominant ore mineral; pyrolusite and minor hollandite are also present with varying amounts of quartz and goethite, and minor barite, calcite and chalcedony as gangue. Manganese (+Fe) oxides replacing quartz arenite, siltstone and dolomite form lenses up to 12 metres in thickness, with massive ore confined to replacement of siltstone and dolomite lithologies.

Post mining exploration includes two percussion holes drilled by Esso Australia in 1982, rock chip sampling by Eupene Exploration in 1990 and airborne GEOTEM, ground TEM, rock chip sampling and a small drilling program by BHP Minerals in 1995 to 1996.

A limited surface (10 kilogram) sampling program by the Northern Territory Department of Mines and Energy to evaluate beneficiation characteristics of the Bootu and Mucketty manganese ores suggests significant variations in ore quality exist (Smith, 2000).

4.3 SOILS

Christian *et al.* have mapped the land systems present within the Barkly region as part of a CSIRO survey conducted in 1952. Seven land systems (Elliot, Grosse, Ashburton, Helen Springs, Barkley, Sylvester and Wonorah) have been identified as occurring within the Banka Banka pastoral lease (Conservation Commission of the Northern Territory, 1983). Of these, two, the Ashburton and Elliot Land Systems cover the project area.

Stony skeletal soils dominate the hilly areas (Ashburton Land System) to the west of the project areas. Lateritic red sands and generally light textured soils are found across the gently undulating central area of the Elliot Land System. In the drainage zones of the Elliot system, sandy loam soils predominate.

4.4 HYDROLOGY AND WATER RESOURCES

4.4.1 Surface Water

The project area is located within the Wiso catchment on the southern boundary of the Ashburton Ranges. A ridgeline runs through the project area from the north-west corner diagonally through to the south-east corner. A number of ephemeral creeks occur in the project area including Jeromah Creek, Looa Creek, Bootu Creek, Kuerschner Creek, Carmilly Creek and Mckinlay Creek. Tarrabool Lake is located some 70 to 80 kilometres to the north-east while Lake De Burgh is located some 150 kilometres to the east-south-east.

Creeks to the east of the ridgeline (Looa Creek and Bootu Creek) flow east to Tarrabool Lake. Creeks to the west of the ridgeline flow towards Tomkinson Creek. In the very north of the project area, flow is to the north-east down Jeromah and Carmilly Creek while in the far south it flows to Kuerschner Creek. Carmilly Springs and Carmilly waterhole are located in the far north of the project.

Due to the size of the catchments, the nature of the terrain and sandy surface soils, flows in the stream channels are likely to be infrequent and of short duration immediately following fairly intense rainfall (URS, 2004b).

Figure 9 illustrates the location of the watercourses that have the potential to be affected by the project.

Flooding of the mine pits could occur from three general sources as a result of heavy local rainfall and in the absence of protective measures. These sources are the northern creek, the minor catchments upstream and to the west of the Shekuma open pit and the creek to the south of the mine area.

4.4.2 Groundwater

4.4.2.1 Regional

The Bootu Creek deposits occur in the Bootu Formation, which is comprised of Palaeoproterozoic siltstone, chert, and sandstone. Mineralisation is concentrated on the western and eastern limbs of the Bootu Syncline, with the Shekuma and Gogo deposits on the eastern limb of the syncline being the focus of the proposed project.

The main aquifers are the sandstone/siltstone that overlies the orebody and the manganese orebody itself. The siltstone that underlies the orebody is also likely to form an aquifer (URS, 2004).

Carmilly bore is located in the far north of the project. Looa bore and Gap bore are located within the Bootu Creek Resources tenements. No dams exist in the project area.

4.4.2.2 Project Area

Mineral resource drilling has indicated the presence of groundwater generally below 30 metres in depth. Four test production bores were drilled in November 2003 to collect further information about groundwater in the mining area. Two of these bores were completed as production bores. Figure 10 shows the location of bores in relation to the proposed pits.

Groundwater levels were found to be about 26 to 35 metres below ground surface. Depth to water is likely to be influenced by ground elevation. Exploration drilling and test pumping indicated that large volumes of groundwater are contained in the ore body and overlying sandstone/siltstones.

Water flow rates were measured at six-metre intervals for each bore. Drilling was continued until flow rates stabilised or the depth exceeded the planned mining pit depth of 70 metres. A summary of drilling results is presented in Table 1.

Table 1: Drilling Results

Hole ID	Collar Co-ordinates		Depth Drilled (m)	Airlift Rate (L/sec)	Static Water Level (m)	Status
	Easting	Northing				
BCWS01	407160	7934634	90	6	34.53	Production
BCWS02	406800	7933934	78	6	26.37	Production
BCWS03	407310	7933600	64	5	28.20	Monitoring
BCRS04	407385	7932860	78	4	26.71	Monitoring

The production bores were test pumped to ascertain sustainable pumping rates and determine aquifer transmissivities. Siltstone and ore body aquifers were found to be transmissive and high yielding (URS, 2004).

Groundwater samples were taken from two bores (BCWS01 and BCWS02) at the end of test pumping and from BCWS04 at the end of drilling. Laboratory testing indicates that groundwater is sodium bicarbonate type and weakly alkaline (URS, 2004). Groundwater ranges in salinity from 710 milligrams per litre Total Dissolved Solids at the northern end of Shekuma pit to 2,060 milligrams per litre Total Dissolved Solids at the northern end of Gogo pit (URS, 2004).

Full details on the groundwater drilling and testing program undertaken by URS are contained in Appendix 6.

4.5 LAND CAPABILITY

The highest point in the project area is 382 metres, which occurs on the crest of the Ashburton Range. The lowest point is around 250 metres in height and is located near the eastern boundary of the project area near the Barkly Tablelands.

The Conservation Commission of the Northern Territory (1983) found the Banka Banka pastoral lease to be generally stable and identified no major land management or erosion problems.

The hilly country (Ashburton Land System) incorporating the western project area is described by Christian *et al.* (1952) as having a naturally low stock carrying capacity, a low pastoral potential and the absence of any agricultural potential. The low areas corresponding to the Elliot Land System have low pastoral potential and a low stock carrying capacity.

4.6 FLORA

The project area is located in the extreme south of the Ashburton Ranges and abuts the Barkly Tablelands to the east. The project area borders the Mitchell Grasslands to the north-east and the Eucalypt savannah and desert areas to the south-west. The vegetation consists of open Eucalypt savannah with large grassed plains. Trees are typically concentrated around the creek lines and lower lying flood plains adjacent to these creeks.

The exploration tenements covers areas mapped in the National Natural Resource Atlas as vegetation of “Eucalyptus open forest and low open forest”, “Melaleuca forest” and “Open Woodland and Heath.”

Two major vegetation types occur on the project area corresponding to the Ashburton and Elliot Land Systems. Moist microhabitats exist within the land systems in drainage zones.

1. **Low Open Eucalyptus Woodland over Hummock Grass - Ashburton Land System**

The hilly terrain to the west of the project area is dominated by a hummock grassland with scattered low trees and shrubs. *Triodia pungens* is the major grass species while low trees and shrubs such as *Corymbia aspera*, *C. dichromophloia*, *Acacia orthocarpa* and *A. retivenia* make up the overstorey.

2. **Tall Acacia Shrubland over Hummock Grasses - Elliot Land System**

The central gently undulating land to the east of the project area is characterised with a *Triodia pungens* grassland understorey whilst the taller stratum ranges from an open woodland to an open shrubland characterised by a variety of acacias (*Acacia cowlana*, *A. holosericea*) and eucalypts (*Eucalyptus odontocarpa*) as well as a number of low tree and shrub species (*Corymbia grandiflora*, *Jacksonia odontoclada*, *Ventilago viminalis*, *Carissa spinarum*).

3. **Drainage Zones**

Eucalyptus camaldulensis open woodland is found along gullies and creek beds in localised deep alluvial sandy loam soils. In rocky sections small shrubs such as *Cullen balsamicum* may occur. In addition, plant communities from neighbouring land systems often penetrate the ranges along the lower reaches of the larger watercourses (Conservation Commission of the Northern Territory, 1983 and Christian *et al.* 1952).

A search of the Parks and Wildlife Commission records and the EPBC database was conducted on 27 August 2003. No flora of conservation status has been recorded in the Bootu Creek area. A study of the Banka Banka station undertaken by the Conservation Commission of the Northern Territory in 1983 did not identify any significant flora or vegetation communities on Banka Banka station. A full list of the recorded flora of the Bootu Creek area is contained in Appendix 7.

The noxious plant *Parkinsonia aculeate* has been observed across the eastern areas of the Banka Banka pastoral lease where it forms dense stands around bores and shallow creek lines. It is less frequent across the central portion of the lease favouring the few moist habitats of this area. *Datura ferox* and *Hyptis suaveolens* also occur in localised populations on Banka Banka pastoral lease (Conservation Commission of the Northern Territory, 1983).

4.7 FAUNA

The project area lies on the boundary between the Tanami Desert and the tropics and the fauna that are expected to occur on the site are a compilation of species from both regions.

Typical of inland Australia, the fauna of the area is dominated by reptiles such as Bynoes Gecko (*Heteronotia binoei*), Leonardardi's Ctenotus (*Ctenotus leonhardii*) and Central Netted Dragon (*Ctenophorus nuchalis*). Amphibians likely to occur in the area include the Giant

Frog (*Cyclorana australis*) and the Red Tree Frog (*Litoria rubella*) (Northern Territory Parks and Wildlife Commission, 2003).

Birds recorded in the area include typically arid species such as the Spinifex Pigeon (*Geophaps plumifera leucogaster*) and the Little Button Quail (*Turnix velox*), but also include typically northern species such as the Brolga (*Grus rubicunda*) and the Black Kite (*Milvus migrans*) (Northern Territory Parks and Wildlife Commission, 2003).

Mammals recorded in the area in the area include the Little Broad-Nosed Bat (*Scotorepens greyii*), Red Kangaroo (*Macropus rufus*), Dingo (*Canis lupus dingo*) and Delicate Mouse (*Pseudomys delicatulus*) (Northern Territory Parks and Wildlife Commission, 2003), (Moorish, pers com, Conservation Commission of the Northern Territory, 1983).

The Central Rainbow Fish (*Melanotaenia splendida*) is found in the waterholes of Attack Creek Gorge (Conservation Commission of the Northern Territory, 1983). Attack Gorge is located approximately 30 kilometres south of the project area.

Non-native species known to occur on the project area include the Donkey (*Equus asinus*), Cattle (*Bos taurus*), Cat (*Felis catus*), Dog (*Canis lupus*) and Rabbit (*Oryctolagus cuniculus*) (Moorish, pers com, Conservation Commission of the Northern Territory, 1983).

A search of the EPBC database was conducted on 27 August 2003. The search indicated that no World Heritage properties, wetlands of international significance, Commonwealth marine areas or threatened ecological communities occurred within the project area or within a 15-kilometre radius of the project site.

Three threatened species as well as four migratory species were recorded from the EPBC database search. Each of the four migratory species is listed as occurring due to overflying of the project area to get to marine areas. Further details as to the threatened and migratory species arising from the EPBC database are provided in Table 2 below.

Table 2: Results from the Threatened Species EPBC Database Search

Scientific Name	Common Name	Status	Potential
Threatened Species			
<i>Rostratula australis</i>	Australian Painted Snipe	Vulnerable	Species or species habitat may occur in the area.
<i>Dasycercus cristicauda</i>	Mulgara	Vulnerable	Species or species habitat may occur in the area.
<i>Notoryctes typhlops</i>	Southern Marsupial Mouse (Yitjarritarri)	Endangered	Species or species habitat may occur in the area.
Migratory Species/Listed Marine Species			
<i>Charadrius veredus</i>	Oriental Plover/Dotterel	Migratory/Listed - overfly marine area.	Species or species habitat may occur in the area.
<i>Glareola maldivarum</i>	Oriental Pratincole	Migratory/Listed - overfly marine area	Species or species habitat may occur in the area.
<i>Numenius minutus</i>	Little Curlew, Little Whimbrel	Migratory/Listed - overfly marine area	Species or species habitat may occur in the area.
<i>Rostratula benghalensis s. lat.</i>	Painted Snipe	Migratory/Listed - overfly marine area.	Species or species habitat may occur in the area.

The Australian Painted Snipe (*Rostratula australis*) has been recorded from freshwater wetlands throughout Australia with some breeding records from the Barkly tablelands. This species inhabits shallow, vegetated or infrequently filled wetlands sometimes where *Euclayptus camadulensis* is present. The species feeds at the waters edge on invertebrates and seeds (Garnett and Crowley, 2000). While the preferred habitat of wetlands does not occur in the project area, the creek lines and waterlogged grasslands may be visited by these species during flooding. The creek lines in the project site are unlikely to provide extensive feeding habitat for the species and impacts from the proposed action on the species can thus reasonably be considered to be minimal.

The Mulgara (*Dasycercus cristicauda*) inhabits the arid sandy regions of northern Australia. It lives in burrows dug into sand dunes and feeds on small vertebrates, insects and arthropods (Strahan, 1995). Few sand dunes occur on the project area and it is unlikely that this species occurs in high numbers or is likely to be significantly impacted by the proposed action.

The Southern Marsupial Mole (*Notoryctes typhlops*) occurs in the southern parts of the Northern Territory, western South Australia and northern and central east of Western Australia. Its preferred diet consists of a range of insects and insect larvae. The Southern Marsupial Mole prefers sand dunes interdunal flats and sandy soil along riverbeds (Strahan 1995). Given the geology of the project area, with few sand dunes present, it can be considered that the likelihood of the Southern Marsupial Mole occurring on the project area is low.

The Oriental Plover (*Charadrius veredus*) moves south from breeding grounds in Mongolia and China to spend winters (southern summer) in Indonesia, Australia and sometimes New Zealand. It is found inland, generally in open grassland in arid or semi arid climates and may be found in estuarine or littoral environments. The Oriental Plover prefers flat inland plains sparsely vegetated with short grass and hard bare ground such as claypans, playing fields, lawns and cattle camps (Marchant and Higgins, 1993). Given a preference for grasslands and

bare ground such as cattle camps and claypans, it is possible the Oriental Plover may inhabit the Barkley Land System in the Bootu Creek area during the summer period. Given the land systems potentially affected by this proposal are represented widely on a regional scale, it is unlikely that a highly localised disturbance caused by this mining proposal would significantly impact on the conservation status of the Oriental Plover. No sightings have been recorded to date within the project area.

The Oriental Pratincole (*Glareola maldivarum*) spends the non-breeding season in Australia and inhabits open country often near water usually on plains, floodplains or grassland with little or no emergent vegetation. It has been recorded near floodwaters, ditches and puddles on lake margins or near billabongs, lakes creeks, lagoons, beaches, mudflats and islands. The Oriental Pratincole has also been recorded on artificial wetlands such as reservoirs, saltworks and sewage farms and it makes substantial use of cleared land such as airports and agricultural land (Higgins and Davies, 1996). Given the number of ephemeral creeks that occur in the project area (Jeromah Creek, Looa Creek, Bootu Creek, Kuerschner Creek, Carmilly Creek and Mckinlay Creek), it is possible that the Oriental Pratincole may be an occasional visitor to the area. However given a preference for plains, floodplains or grassland with little or no emergent vegetation, it can be responsibly considered that the likelihood of the Oriental Pratincole occurring on the project area is low. No sightings have been recorded to date within the project area.

The Little Curlew (*Numenius minutes*) moves south from breeding grounds in Siberia to spend winters (southern summer) in Northern Australia. It inhabits short dry grasslands and sedge lands, including dry floodplains and blacksoil plains, which have scattered shallow freshwater pools, often on artificial short-grassed flats such as mown lawns, gardens recreational areas, ovals racecourses and airstrips. The Little Curlew prefers pools with bare dry mud and without fringing vegetation (Higgins and Davies, 1996). Given a preference for short dry grasslands and sedge lands with low vegetation with proximity to water, it can be responsibly considered that the likelihood of the Little Curlew occurring on the project area is low. No sightings have been recorded to date within the project area.

The Painted Snipe (*Rostratula benghalensis s. lat*) ranges through Africa, India, China, south-eastern Asia and the Pacific. It requires shallow fresh water for breeding (Blakers *et. al*, 1984). It may be an infrequent visitor to the project area, however intermittent creek lines in the project site are unlikely to provide extensive feeding habitat for the species and impacts from the proposed action on the species can thus reasonably be considered minimal. No sightings have been recorded to date within the project area.

A search of the fauna records held by the Parks and Wildlife Commission was undertaken in September 2003. Table 3 below lists the species recorded of conservation status within the Bootu Creek area. A full species list for the Bootu Creek Area is contained in Appendix 8.

Table 3: Fauna Species of Conservation Status Recorded within Bootu Creek Area

Scientific Name	Common Name	Status	Potential
Threatened Species			
<i>Dromaius novaehollandiae</i>	Emu	Vulnerable - NT *Least Concern	Moderate An emu was recorded on the site at Bootu 1978.
<i>Ardeotis australis</i>	Australian Bustard	Vulnerable - NT *Near Threatened	Moderate Australian Bustards were recorded at Bootu Creek in 1965 and 1967.
Migratory Species/Listed Marine Species			
<i>Ardea alba</i>	Great Egret	CAMBA JAMBA	High 6 Great Egrets were recorded at Bootu Creek between 1978 and 1963.
<i>Merops ornatus</i>	Rainbow Bee-eater	JAMBA	Moderate 2 Rainbow Bee-eaters were observed at Bootu Creek in 1978.
<i>Myiagra inquieta</i>	Restless Flycatcher	BONN	A Restless Flycatcher was observed at Bootu Creek in 1966.

* Conservation status as per Garnett and Crowley (2000).

The Emu (*Dromaius novaehollandiae*) persist through out arid and semi arid Australia living in forest, woodland, through to open grassland. Emus can be highly nomadic, particularly in arid areas. It is likely that Emus may inhabit the project area, however the Northern Territory Parks and Wildlife Commission last recorded sighting was in 1978 indicating that Emus are a rarity in the area.

The Australian Bustard (*Ardeotis australis*) population is still substantial; however, there has been a patchy mix of declines in northern Australian. Australian Bustards are found in tussock grassland, *Triodia* hummock grassland, grassy woodland, low shrublands and structurally similar artificial habitats such as croplands and golf courses. They are often found near water - natural or artificial (Marchant and Higgins, 1993). It is likely that the Australian Bustard may utilise the habitat of the project area.

The Restless Flycatcher (*Myiagra inquieta*) frequents scrub and partly submerged trees and sedge beds bordering rivers in grass floodplain and open savannah (Coates, 1990). It may be an infrequent visitor to the project area, however intermittent creek lines in the project site are unlikely to provide extensive feeding habitat for the species. No sightings have been recorded to date within the project area.

The Great Egret (*Ardea alba*) inhabits terrestrial wetlands, estuarine and littorial habitats and moist grasslands. It prefers permanent waterbodies on floodplains and the shallows of deep permanent lakes (Marchant and Higgins, 1990). The Great Egret has been recorded six times in the Bootu Creek area by the Northern Territory Parks and Wildlife Commission in both 1978 and 1993. It is likely that the Great Egret is an infrequent visitor to the area. The intermittent creek lines in the project site are unlikely to provide extensive feeding habitat for the species.

The Rainbow Bee-eater (*Merops ornatus*) prefers open or lightly timbered areas, often near water and has been observed twice within the project area (Parks and Wildlife Commission, 1978). This species has been recorded in dry open sclerophyll forest, open woodlands and shrublands, including mallee, spinifex tussock grassland with scattered trees, chenopod shrubland with scattered trees and riverine or littoral assemblages. In arid and semi arid areas, the Rainbow Bee-eater is generally confined to open associations along rives, on floodplains and at edges of other wetlands such as forests dominated by *Eucalyptus camaldulensis*, *E. microtheca* or *E. largiflorens*. It is often seen around disturbed areas such as quarries, road cuttings and mines where exposed bare soil provides suitable breeding sites (Higgins, 1999). It is highly likely that the Rainbow Bee-eater may occur in the woodlands and shrublands of the project area in good seasons, particularly during flooding.

4.8 AIR QUALITY

No site-specific air quality monitoring data is available for the Bootu Creek area. The nearest data for substance emissions in the area is the National Pollutant Inventory (NPI) data for Tennant Creek, 110 kilometres south of Bootu Creek.

The only two contributing facilities to the Tennant Creek NPI are Shell and Fuelink, of which the main activities are aircraft refuelling and hydrocarbon storage and distribution respectively. Emissions from the two facilities as registered in the 2002-2003 NPI reporting year are shown in Table 4.

Table 4: NPI Total Emissions to Air (kg) from Tennant Creek Facilities

Substance	Fuelink	Shell
Benzene	43	-
Cumene (1-methylethylbenzene)	0.70	-
Cyclohexane	5.4	-
Ethylbenzene	1.9	-
n-hexane	54	-
Toluene (methylbenzene)	43	-
Total Volatile Organic Compounds	2400	150
Xylenes (individual or mixed isomers)	11	-

While there is no ambient air quality data available for the project area, existing air quality is expected to be good, given the rural nature of the area and the lack of urban populations or industry. On occasion, suspended and deposited particulate levels are expected to be elevated due to windblown dust, pastoral activities or bushfires.

4.9 NOISE

As the only current land use for the area is pastoral, there is no baseline noise data available for the project. Given the current land use, it is anticipated that the Bootu Creek project area is relatively quiet. Higher noise levels would be anticipated to occur in areas close to the Stuart Highway.

4.10 ABORIGINAL AND CULTURAL HERITAGE

4.10.1 Aboriginal Heritage

The Bootu Creek project is on lands traditionally used by Kunapa, Kurtinja, Mangirriji, Jalajirra, Yapa Yapa and Pirrtangu peoples.

The Bootu Creek project is located within an area subject to Native Title Claim (D6005/01) by the Northern Land Council on behalf of the Muckay Aboriginal Land Trust. This claim is yet to be determined.

A search of the heritage register has been undertaken. No declared heritage places or objects are present on the Bootu Creek tenements. Appendix 9 contains a copy of the Aboriginal Areas Protection Authority recorded sites search.

As part of the exploration agreement between Bootu Creek Resources, local Aboriginal Groups and the Northern Land Council, a site visit was made by an anthropologist and local Aboriginal group members in 2003 to determine whether any sites of Aboriginal significance were present. No sites were identified within the area chosen for exploration during the site visit or during exploration undertaken to date.

Bootu Creek Resources entered into an agreement with the Northern Land Council and Aboriginal Areas Protection Authority for a full clearance search to be conducted of the minesite and transport route. Clearance of the section of the transport route owned by the Muckaty Aboriginal Land Council was conducted by the Northern Land Council in late June 2004. This will result in the issue of a Clearance Certificate by the Aboriginal Areas Protection Authority, as required by the *Sacred Sites Act*. Arrangements have been made for the Northern Land Council and the Aboriginal Areas Protection Authority to jointly conduct clearances of the remainder of the transport route (Banka Banka Station pastoral land) and mining lease operational areas, so the Authority can issue Clearance Certificates covering all of Bootu Creek Resources' proposed areas of activity.

4.10.2 European Heritage

Banka Banka station was the first pastoral lease taken up in the Tennant Creek region when it was established in 1885 by Tom Nugent.

During World War II, a camp nearby was used extensively as a staging post for troops.

The area contains numerous manganese occurrences including the abandoned Muckaty mine, where between 1955 and 1969 some 13 kilotonnes of ore grading 42% manganese was mined from five shallow open cuts. Historic stockpiles of manganese ore will be removed as part of the mining process. No infrastructure of significance remains.

4.11 SOCIO-ECONOMICS

Tennant Creek is the nearest population centre to the Bootu Creek Resources project located on the Stuart Highway between Katherine and Alice Springs. Tennant Creek has a population of about 2,835 (Australian Bureau Statistics, 2001). It is considered to be the hub of the

Barkley Tablelands serving a diverse range of Indigenous communities, outstations, large pastoral properties and mines. The region also has a large number of tourism sites featuring the unique and beautiful landscape, flora and fauna.

Tennant Creek is within the homelands of the Warumungu people. After a series of indiscriminate killings and massacres, the South Australian government gazetted the Warumungu Aboriginal reserve in 1891. The Warumungu were forced to relocate themselves to the reserve or ally themselves to one of the pastoral properties. After the referendum granting citizenship rights in 1967, many Aboriginals moved back to their traditional homelands or to outstations around Tennant Creek.

There have been over 130 mines in the Tennant Creek area producing gold, copper and iron ore. The year 2000 recorded the first time in its history that Tennant Creek had no operating mines. Closure of mines has resulted in major losses of jobs in the town. In 1996 it was estimated that 9.6% of the town's population were employed or engaged in mining. Subsequent signing of Indigenous Land Use Agreements has contributed to discussions about re-opening of mines.

Review of the 1996 and 2001 census figures showed that:

- Over 40% of the population of Tennant Creek is Aboriginal or Torres Strait Islander.
- The Tennant Creek population is younger on average than other centres in the Northern Territory and Australia as a whole with about 37.8% of its population is aged 19 or less.
- Tennant Creek had a higher percentage of people out of the workforce and a higher unemployment rate than the Northern Territory as a whole.
- Projected urban growth in Tennant Creek is negative 8.2%.
- About 23.6% of the population over the age of 15 have post school qualifications.
- The median weekly household income for Tennant Creek is \$881, which is lower than the median weekly income of households in Darwin, but on par with other regional centres in the Northern Territory.
- About 22.9% of households in Tennant Creek had no motor vehicle.

Facilities available in Tennant Creek include:

- A 20 bed regional public hospital.
- Early childhood, primary and post primary education facilities.
- Police station and emergency services facilities.
- Cultural centre.
- Regional library.
- Numerous sporting facilities.

5. ENVIRONMENTAL IMPACTS AND PROPOSED SAFEGUARDS

The following subsections describe the potential impacts that the Bootu Creek project could have on the environment as well as the proposed control measures and predicted impact for each aspect. Management and mitigation measures described in these subsections have taken into account conditions negotiated between Bootu Creek Resources and the Northern Land Council as part of the Mining Agreement.

Environmental issues requiring provision of more detailed information are discussed in Section 6.

5.1 SOIL

5.1.1 Potential Issues

The management of soil, especially topsoil and the upper one metre of overburden, is important to the success of rehabilitation. The following potential issues have been identified:

- Re-establishment of a root zone suitable for plant growth for rehabilitation of waste rock stockpiles, the TSF and other disturbed infrastructure areas.
- Compaction of soil surfaces by vehicles and mining equipment.
- Erosion of rehabilitated surfaces particularly slopes of waste rock stockpiles or the TSF and the consequent impacts on revegetation success.
- Possible contamination of soils by hydrocarbons and other substances.

5.1.2 Management and Mitigation Measures

The proponent aims to conserve surface soil to assist in the long-term rehabilitation of the site and to minimise environmental degradation. Management and mitigation measures to achieve these aims include:

- All areas of proposed development will be stripped of topsoil to an average depth of about 200 millimetres (**Commitment 5.1.2a**).
- Topsoil will be removed progressively to ensure large surface areas are not left exposed (**Commitment 5.1.2b**).
- Topsoil will be direct replaced where possible or stockpiled for later use in the rehabilitation process (**Commitment 5.1.2c**).
- Topsoil stockpiles will not exceed a height of two metres to ensure topsoil viability is maximised (**Commitment 5.1.2d**).
- Rehabilitation will be undertaken progressively to minimise the disturbed area and minimise the topsoil stockpile storage period (**Commitment 5.1.2e**).
- Slope gradients will be controlled to minimise erosion and soil loss (**Commitment 5.1.2f**).

- Diversion bunds and drains will be installed as necessary to control local surface water run-off to minimise overland flow and consequential erosion (**Commitment 5.1.2g**).
- Rehabilitation areas will be ripped on the contour after placing of topsoil to remove compaction, improve soil structure and improve infiltration capacity (**Commitment 5.1.2h**).
- Rehabilitated and disturbed surfaces will be routinely inspected for erosion, particularly after significant rainfall events. If soil erosion is observed during routine inspections, appropriate remediation measures will be implemented (**Commitment 5.1.2i**).

5.1.3 Impact Assessment

By minimising surface disturbance and applying the control measures described above, erosion, loss of surface soil and increased sediment load in the creeks should not pose a significant problem.

5.2 GROUNDWATER

5.2.1 Potential Issues

The proposed mining and processing operations pose the following issues:

- Lowering of localised groundwater levels as a result of mine dewatering particularly when mining will occur beneath the water table.
- Seepage of water from the TSF causing formation of a groundwater mound beneath the TSF.
- Discharge of water from mine dewatering causing localised recharge of groundwater.
- Fate of groundwater on completion of mining and associated abstraction.

5.2.2 Management and Mitigation Measures

Bootu Creek Resources will endeavor to maintain groundwater quality and contain impacts of dewatering so that they do not affect any other beneficial users.

Management and mitigation measures that will be implemented to achieve this include:

- Process water storage structures including the TSF will be constructed to minimise seepage (**Commitment 5.2.2a**).
- Tailings will be thickened and discharged at about 55% solids to minimise free draining water contained in the TSF (**Commitment 5.2.2b**).
- The TSF will be operated in a manner to maximise evaporation of contained water (**Commitment 5.2.2c**).
- Flow meters will be fitted to groundwater extraction bores to enable monitoring of extraction volumes (**Commitment 5.2.2d**).
- Groundwater monitoring bores will be installed in areas close to the TSF and the Gogo, Chugga and Shekuma pits to allow evaluation of changing groundwater levels and early

detection of any contaminated seepage from mining related activities (**Commitment 5.2.2e**).

More details about groundwater management are contained in Section 6.2.

5.2.3 Impact Assessment

The effect of groundwater pumping will be temporary drawdown of the water table during the life of the operation. It is anticipated that a cone of depression will form around the pits, however this will dissipate after cessation of pumping. Due to the remoteness of the location, the localised drawdown of groundwater will not adversely impact any other beneficial uses of the aquifer.

Water lost through seepage in the TSF is anticipated to be minimal given the characteristics of the tailings and conceptual TSF design. As the only material added during ore processing is ferrosilicon and this is recycled wherever possible, no degradation to local groundwater quality is anticipated to result.

5.3 SURFACE WATER

5.3.1 Potential Issues

The proposed mining and processing operations pose the following issues:

- Temporary reduction in surface water volume to ephemeral creeks as a result of diversion of run-off from operational areas.
- Contamination of surface water as a result of release of pollutants associated with earthmoving, excavation and ore processing. Potential contaminants include sediment, manganese and hydrocarbons.
- Increased water flow to select ephemeral streams as a result of release of water from mine dewatering operations.
- Contamination of surface water run-off and soils as result of flow over areas containing manganese spilt during loading of ore product from the siding stockpile into rail containers.
- Contamination of surface waters due to release of sewage.
- Overflow of the TSF.
- Flooding of operational areas including the ore product haul road.

5.3.2 Management and Mitigation Measures

Bootu Creek Resources aims to prevent or minimise any deterioration in surface water quality through changes in pH, sediment load, chemicals and hydrocarbons and to minimise potential adverse effect of excess mine dewatering on natural drainage systems.

Management and mitigation measures to be implemented to achieve this will include:

- Protection bunds and diversion channels will be constructed to prevent flooding of the pits, process areas, or other mine infrastructure. The location of diversion structures is illustrated in Figure 11 (**Commitment 5.3.2a**).
- Catchments within the project area will be categorised based on the potential contaminants in each. Surface water run-off in potentially contaminated catchments will be captured and treated in accordance with the potential risk. Clean water flows will be separated from potentially contaminated flows to minimise the volume of water requiring active management (**Commitment 5.3.2b**).
- Out of pit waste rock stockpiles will be constructed so that interference with natural surface water drainage is prevented or where this is not practicable, impacts are minimised (**Commitment 5.3.2c**).
- Surface water run-off from ore product stockpile areas at the rail siding will be directed through purpose built drains to a containment structure. Water in the containment structure will be allowed to evaporate. Sediments including manganese particles will be periodically removed and returned to the mine site where they will be fed into the processing plant (**Commitment 5.3.2d**).
- Release of sediments to watercourses will be prevented by installation of sediment control structures at discharge points where release of sediment is identified as a potential risk (**Commitment 5.3.2e**).
- A water release management plan will be developed for the disposal of excess mine water (**Commitment 5.3.2f**). As described in more detail in Section 6.2, excess water will need to be discharged from commencement of mining. This plan will include monitoring requirements.
- Culverts and/or floodways will be installed where mining haul roads and the ore product haul road cross watercourses. Figure 11 shows likely locations where culverts and/or floodways will be installed (**Commitment 5.3.2g**).
- All water releases to the environment will meet approved water quality criteria (**Commitment 5.3.2h**).
- Commercially available sewage treatment systems will be installed at the accommodation village and processing areas. Where solids are required to be removed, these will be placed within the TSF. Treated water will be dissipated through evaporation or irrigation of the accommodation village surrounds (**Commitment 5.3.2i**).
- Hydrocarbons and other hazardous materials will be stored in appropriately designed (e.g. bunded) areas (**Commitment 5.3.2j**).
- A minimum operational freeboard of 0.3 metre will be provided within the western and central portions of the TSF (**Commitment 5.3.2k**).
- A minimum total freeboard of at least one metre will be provided within the ponding water area of the TSF after making allowance for an inflow corresponding to a 1 in 100 year 72-hour duration rainfall event falling in the catchment of the TSF itself (**Commitment 5.3.2l**).

5.3.3 Impact Assessment

Careful design of the project including consideration of surface water flows when siting infrastructure components will result in minimal impacts on surface water in the project area.

Design and operation of the TSF will incorporate measures to minimise the risk of overtopping during the wet season including high intensity rainfall events.

Implementation of the management and mitigation measures described above will ensure that potential for contamination of surface water is minimised, catchments containing potentially contaminated surface water flows are appropriately managed prior to release and disruption to natural flow regimes is minimised.

Consideration of the water balance for the operation indicates that discharge of excess mine water will be required from commencement of operations (see Section 6.2). Excess water is likely to be discharged to ephemeral creeks located east of the mining areas. Water discharge licences will be sought for these activities. This is discussed in more detail in Section 6.2.

5.4 FLORA

5.4.1 Potential Issues

The following potential issues are relevant in relation to native vegetation and flora:

- Clearing of vegetation from project areas. Approximately 526 hectares of vegetation will need to be cleared. The breakdown of this total is shown below in Table 5.

Table 5: Land Clearing Requirements

Infrastructure	Area (hectares)
Pits	75
Waste Rock Stockpiles	102.7
Tailings Storage Facility	12
Processing Plant	16
Offices, Workshop, Stores and Laboratory	4
Accommodation village	2.2
Haul Roads	13.8
Transport Route Road	300
Rail Siding*	<1
Total	525.7

* Area largely already cleared as a result of rail construction.

- Re-establishment of vegetation on rehabilitation areas.
- Spreading of noxious weeds as a result of mining operations and transport of ore product to the rail siding. Potential weeds include *Parkinsonia aculeate* (favours moist habitats), *Datura ferox* and *Hyptis suaveolens*.
- Discharge of excess water into ephemeral creek systems. This has potential to alter the vegetation communities found within the creek systems.

5.4.2 Management and Mitigation Measures

Bootu Creek Resources aims to minimise loss of habitat and re-establish appropriate habitat through rehabilitation. Bootu Creek Resources will also endeavor to manage and control the spread of weed species as a result of their operations.

Management and mitigation measures that will be implemented to achieve these aims include:

- Clearing of vegetation will be restricted to the absolute minimum (**Commitment 5.4.2a**).
- Topsoil will be stripped and replaced directly on areas reshaped as part of the rehabilitation process wherever possible. This will ensure the seed bank and microbes contained in the topsoil assist in rapid revegetation (**Commitment 5.4.2b**).
- If establishment of vegetation on areas reshaped and top soiled is not satisfactory after two years, seed from local plant species will be collected and spread on these areas (**Commitment 5.4.2c**).
- The effectiveness of rehabilitation programs will be assessed annually (**Commitment 5.4.2d**).
- Weeds will be controlled through prevention, monitoring and early eradication. If after construction commences spread of weeds is identified as being an issue of concern, a weed management plan will be prepared in conjunction with the Northern Territory Government Controller of Weeds and other relevant experts (**Commitment 5.4.2e**).
- Company vehicles will be confined to traveling on purpose built roads to minimise potential vehicle borne spread of weed species (**Commitment 5.4.2f**).
- Vegetation surveys will be conducted at excess water discharge points prior to discharge occurring, annually during discharge and for a period of two years after discharge ceases to determine the impacts of continual water discharge in ephemeral creek systems (**Commitment 5.4.2g**).

5.4.3 Impact Assessment

Local surface disturbance will reduce the total area of vegetation communities and thus habitat areas in the immediate project area. Vegetation communities and species found in the Bootu Creek area are widespread regionally with no recognised rare or threatened species recorded; therefore loss of vegetation due to the project will not have a significant impact.

Discharge of excess groundwater is likely to result in vegetation in ephemeral creeks changing in nature due to the permanent presence of water in these systems. Experience in similar instances has shown that this change will be limited to the duration of discharge. Vegetation adapted to the ephemeral water regime will re-establish when ephemeral water conditions resume.

5.5 FAUNA

5.5.1 Potential Issues

The proposed operations pose the following issues:

- Removal of native fauna habitats as a result of vegetation clearance. Approximately 526 hectares of land clearing is estimated to be required during the 10-year project life.
- Adverse impacts on species of conservation significance such as the Emu, Australian Bustard, Great Egret, Rainbow Bee-eater and Restless Flycatcher.
- Control of feral animals such as donkeys, cats, dogs and rabbits.
- Attraction of migratory birds to freestanding water.
- Death of animals on mine roads and the ore product transport road.

5.5.2 Management and Mitigation Measures

Bootu Creek Resources aims to minimise loss of fauna habitat and re-establish appropriate habitat through rehabilitation.

Management and mitigation measures that will be implemented to achieve these aims include:

- Vegetation clearing will be kept to a practicable minimum (**Commitment 5.5.2a**).
- Employees and contractors would be required to attend an induction program that will include a component relating to environmental management. In particular, the induction would clearly explain employee and contractors' roles and responsibilities in terms of restricting impacts on fauna and habitat (**Commitment 5.5.2b**).
- Sightings of species of conservation significance will be reported to the Parks and Wildlife Commission (**Commitment 5.5.2c**).
- No domestic animals or firearms will be allowed on site (**Commitment 5.5.2d**).
- Haulage routes will have speed restrictions in place to minimise fauna death on roads (**Commitment 5.5.2e**).
- The area of freestanding water on the TSF will be minimised to make it less attractive for migratory water birds (**Commitment 5.5.2f**).
- A domestic waste management program will be developed to minimise the attraction of feral animals to the project area (**Commitment 5.5.2g**).
- Bootu Creek Resources will participate in feral animal control programs on Banka Banka Station if requested by owners of Banka Banka Station (**Commitment 5.5.2h**).

5.5.3 Impact Assessment

Local surface disturbance will remove habitat in the immediate project area. Overall the impact will be minimal with loss of faunal habitat locally significant, but regionally minor. Recolonisation of disturbed areas will occur as vegetation is progressively re-established and as the site is decommissioned on cessation of activities.

No impact on fauna species of conservation significance is predicted as the habitat suitable for most of the species identified as existing or potentially existing in the project area is widely represented on a regional scale. Localised temporary removal of 526 hectares of habitat will not adversely impact the conservation status of these species.

5.6 AIR QUALITY

5.6.1 Potential Issues

Potential air quality issues include:

- Generation of dust from stripping and replacement of topsoil and overburden, excavation of ore and vehicle movement on unsealed roads.
- Generation of dust during transport of product ores from the mine site to the railway siding.
- Wind erosion of product ores during stockpiling at the siding.
- Wind erosion of tailings from desiccated TSF surfaces.
- Generation of dust whilst loading product ores from stockpiles into rail containers.
- Gaseous emissions from engine exhausts of earth moving equipment and mine vehicles. This includes carbon monoxide, carbon dioxide and nitrous oxides.

5.6.2 Management and Mitigation Measures

Bootu Creek Resources will aim to minimise and control air emissions that are likely to affect local air quality.

The following management and mitigation measures will be implemented to achieve this aim:

- All roads will be clearly marked to confine vehicle movements to areas where dust control methods can be used (**Commitment 5.6.2a**).
- Water will be applied to unsealed roads, especially haul roads to ensure dust emissions are minimised. The volume and frequency of water applied will be modified to control dust emissions in different climatic conditions (**Commitment 5.6.2b**).
- Vehicles traveling on unsealed roads will be required to travel at speeds that will not generate excessive dust (**Commitment 5.6.2c**).
- Areas will be rehabilitated progressively to minimise areas exposed to wind erosion. Vegetation established will be compatible with the post mining land use of the area (**Commitment 5.6.2d**).
- Vehicle access on rehabilitated surfaces will be prohibited except for management purposes (**Commitment 5.6.2e**).
- Employees and contractors will participate in site inductions to ensure they are aware of site rules for permanent and temporary roads (**Commitment 5.6.2f**).
- Vehicle and equipment will be regularly maintained to manufacturers specifications to minimise exhaust emissions (**Commitment 5.6.2g**).

- Topsoil stripped from the product ore stockpile area will be placed in a windrow at the edge of the stockpile area. The stockpile will be formed to assist with reduction of ground surface winds and hence minimise wind erosion (**Commitment 5.6.2h**).
- Equipment operators will remain in enclosed, air conditioned cabins to minimise exposure to dust emissions (**Commitment 5.6.2i**).
- Emissions will be reported as part of the National Pollutant Inventory (**Commitment 5.6.2j**).
- During operation of the TSF, tailings will be discharged across areas in the TSF identified as a potential dust source, thereby wetting the surface and preventing the dust problem (**Commitment 5.6.2k**).

5.6.3 Impact Assessment

Fugitive dust will be generated from mining activities, vehicular movement and wind erosion. Dust generated will be localised and experience with other mining operations has demonstrated that as these are relatively coarse particles (i.e. greater than 10 microns), this is highly likely to settle within a short distance of the point of generation. The predominantly large particle size of the tailings and their high moisture content should ensure that during operations the tailings surface will not develop into a dust hazard.

Given the remote location of the project and the absence of nearby residential facilities, air emissions will not have an adverse impact on human health. Management and mitigation measures outlined above will prevent adverse impacts to the environment.

Greenhouse gas emissions will result from onsite generation of power for the operation and from exhausts of vehicles and mobile equipment. Given the remoteness of the project, it is not anticipated that the additional greenhouse gas resulting from this project will have an adverse impact on local or regional air quality.

5.7 HAZARDOUS MATERIALS

5.7.1 Potential Issues

Hazardous substances to be used within the mining operation will be diesel, lubricants and explosives. A diesel storage tank will be located adjacent to a heavy vehicle workshop to allow refuelling of mining equipment. The diesel tank will be filled directly from tanker truck importing diesel to the site. Explosives will be stored in a purpose built magazine located east of Gogo waste rock stockpile.

A heavy vehicle workshop will be located south east of the processing plant (Figure 3). This facility will be used to service mining equipment (trucks, excavator, drill rigs, water cart and graders). Light vehicles will be serviced at a small workshop located adjacent to the heavy vehicle workshop refuelling facility. Construction of these facilities will require an area of about one hectare to be cleared.

Ferrosilicon is the only processing reagent required to be used in the heavy media separation plant to produce lump or fine manganese product.

Table 6 details the hazardous materials required, the area of use, likely storage amount and expected annual usage.

Table 6: Hazardous Materials Required

Substance	Area of Use	Annual Usage	Storage Type	Storage Amount
Diesel	Mining	3.0 million litres	3 x 55,000 litre tanks	165,000 litres
Diesel	Power generation	1.5 million litres	2 x 55,000 litre tanks	110,000 litres
Diesel (village)	Power generation	0.5 million litres	20,000 litre tank	20,000 litres
Lubricants	Equipment maintenance	2,000 litres	200 litre drums	
Explosives	Mining	300 tonnes	1.2 tonne Bulki Bags	50 tonnes

The proposed operations pose the following issues:

- Spillage to the environment of hydrocarbons and hazardous chemicals used in the mining or associated activities.
- Disposal of hazardous wastes generated during construction and operations including tyres, waste oil, grease and industrial waste.
- Spillage of manganese ore product during transport to the railway siding.
- Disposal of potentially acid generating waste rock.
- Storage of explosives.

5.7.2 Management and Mitigation Measures

Bootu Creek Resources will aim to effectively manage hazardous materials so as to minimise and control any potential discharges to the environment.

Management and mitigation measures to achieve this aim will include:

- A register of all hazardous materials imported to the site or generated as a result of activities undertaken at the site will be developed and maintained. This will document the hazardous material name, location, approximate volume, storage method and where applicable, disposal method for the substance and containers (**Commitment 5.7.2a**).
- Hazardous materials and wastes will be stored in appropriately labeled containers within bunded areas (**Commitment 5.7.2b**). Containment areas will be constructed in accordance with the requirements of AS1940 Storage and Handling of Flammable and Combustible Liquids.
- Processing activities will be conducted in areas where surface drainage can be captured to ensure overflows, spillages or leaks can be contained (**Commitment 5.7.2c**).
- Bunding will be maintained to prevent potential contamination of land and/or groundwater (**Commitment 5.7.2d**).
- An inventory of hydrocarbon use will be maintained to allow determination of whether storage containers are leaking (**Commitment 5.7.2e**).

- Hazardous wastes generated by the operation will be transported offsite to licensed waste disposal facilities (**Commitment 5.7.2f**). This is likely to include waste oil, grease and heavy equipment fuel filters.
- An Emergency Response Plan will be developed for the project. This plan will contain information regarding appropriate response to chemical spillages, leaks, fires or explosions (**Commitment 5.7.2g**).
- Hazardous materials will be brought to the site in bulk packaging wherever possible. This practice will minimise the number of containers and reduce the risk of spillage (**Commitment 5.7.2h**).
- Waste rock identified as being potentially acid forming (PAF) will be disposed of in encapsulated areas within waste rock stockpiles (**Commitment 5.7.2i**). Further details on management of PAF waste are contained in Section 6.1.
- All mobile equipment and light vehicle servicing activities including wash down will be conducted on impermeable surfaces (**Commitment 5.7.2j**).
- The heavy vehicle workshop facility shall contain a purpose built wash down facility incorporating a triple interceptor style sediment and oil/grease removal system (**Commitment 5.7.2k**).
- Refueling of mobile equipment will primarily be conducted on a sealed surface, however some refueling will take place within the open pits using a mobile refueling vehicle (**Commitment 5.7.2l**).
- An explosives magazine will be constructed and operated in accordance with regulatory requirements (**Commitment 5.7.2m**).

5.7.3 Impact Assessment

No chemicals are required for the heavy media separation processing of manganese ore. Hydrocarbons are the primary type of hazardous material anticipated to be required on site. Correct management through implementation of the above listed measures will ensure that adverse impacts are prevented or minimised.

Emergency Response Plans will be developed to ensure appropriate response can be made to incidents involving hazardous materials.

5.8 VISUAL AMENITY

5.8.1 Potential Issues

The main visible components of the project during operations are the process plant, waste rock stockpiles and TSF. The mine void will be partially backfilled with waste rock. The ore product transport road will cross the Stuart Highway via a purpose built underpass.

The project is located in an area that is sparsely populated and the main operations will not be visible from the Stuart Highway. Consequently there will be little impact on public visual amenity.

5.8.2 Management and Mitigation Measures

Despite the low potential for impact on public visual amenity, Bootu Creek Resources aims to minimise the impact on the visual amenity of the Project site. Management and mitigation measures that will be implemented to achieve this include:

- Access to the project site will be limited to employees and authorised visitors (**Commitment 5.8.2a**).
- Areas of land clearing and disturbance will be minimised (**Commitment 5.8.2b**).
- Permanent features that will remain after closure of the operation i.e. waste rock stockpiles and TSF will be contoured so that they blend in with the natural topography (**Commitment 5.8.2c**).
- Areas of disturbance will be progressively rehabilitated with local provenance vegetation (**Commitment 5.8.2d**).

5.8.3 Impact Assessment

The project will not have a visual impact from the Stuart Highway. No other public roads exist in the project area. The final voids will be partially backfilled with waste rock, with the waste rock stockpiles and TSF to remain at the end of the project. These will have a low visual impact following rehabilitation owing to the site's isolated location and the control measures that will be implemented.

5.9 HERITAGE AND ABORIGINAL SITES

5.9.1 Potential Issues

As no known sites of European heritage or Aboriginal cultural or archaeological significance have been identified in the project area there is no expected impact. However, potential does exist for identification of Aboriginal artifacts as operations progress.

5.9.2 Management and Mitigation Measures

Bootu Creek Resources will avoid unnecessary disturbance to any identified heritage and Aboriginal sites. Management and mitigation measures that will be implemented to achieve this will include:

- Construction activities or mining will not occur on any area of land until appropriate clearances have been obtained from the Aboriginal Area Protection Authority and/or Northern Land Council (**Commitment 5.9.2a**).
- The Northern Land Council and owners of Banka Banka Station will be kept informed of planned operations (**Commitment 5.9.2b**).
- The general site induction will include information regarding the importance of cultural sensitivity, respect for land and protection of items of heritage significance. All employees and contractors will be required to participate in this induction (**Commitment 5.9.2c**).

- All employees and contractors will be advised of the correct procedure to be followed in the case of any items of potential Aboriginal or heritage significance being discovered during mining (**Commitment 5.9.2d**).
- The Aboriginal Areas Protection Authority and Northern Land Council will be contacted immediately in the advent of items of potential Aboriginal significance being discovered during mining (**Commitment 5.9.2e**).
- If significant Aboriginal artifacts are identified during mining operations, where practicable, these will be protected to avoid unnecessary disturbance of those objects. Where protection is not practicable, Bootu Creek Resources will work with the Aboriginal Areas Protection Authority and Northern Land Council to gain consent for disturbance (**Commitment 5.9.2f**).

5.9.3 Impact Assessment

Currently there are no known sites or objects of heritage or Aboriginal significance within the Bootu Creek project area. Adverse impacts are thus unlikely to result.

5.10 SOCIO-ECONOMIC

5.10.1 Potential Issues

Potential social and economic impacts include:

- Increased local employment in the Tennant Creek area.
- Increased use of Alice Springs-Darwin Railway.
- Increased use of Darwin port.
- Increased traffic movements as material is imported and exported from the project area.
- Increased contribution to the Northern Territory and Federal economies as a result of royalties and payroll taxes.
- Increased pressure on Tennant Creek accommodation and medical services.
- Temporary change of land use from pastoral to mining.
- Increased business opportunities for local business, particularly indigenous businesses.

5.10.2 Management and Mitigation Measures

Bootu Creek Resources activities will provide employment. Where possible, Bootu Creek Resources will obtain the provision of goods and services from the local economy where appropriate services or skills exist. Preference will be made for employment of local people.

Management and mitigation measures that will be implemented will include:

- Ore transportation will not be undertaken along the Stuart Highway (**Commitment 5.10.2a**).
- The ore product haul road will be fenced to the extent agreed with landowners (**Commitment 5.10.2b**).

- On completion of mining activities, infrastructure will be removed and the site rehabilitated to allow the pre mining land use to recommence. Infrastructure will not be decommissioned where agreement has been reached for post mining land users to take responsibility for infrastructure of value to them i.e. ore product haul road (**Commitment 5.10.2c**).
- Compensation agreements will be reached with landowners for loss of use of land used by Bootu Creek Resources for mining or associated infrastructure (**Commitment 5.10.2d**).
- Employment opportunities will be advised to the Northern Land Council Tennant Creek Office and preference will be given to local candidates (**Commitment 5.10.2e**).
- Provision of goods and services will be advised to the Northern Land Council Tennant Creek Office, and preference will be given to local businesses (**Commitment 5.10.2f**).
- Accommodation for employees and subcontractors will be provided on site (**Commitment 5.10.2g**).
- First aid facilities will be established onsite for the duration of the project. These facilities will be manned by appropriately qualified employees (**Commitment 5.10.2h**).
- A relationship will be established between onsite Emergency Response and First Aid personnel and providers of equivalent services in Tennant Creek (**Commitment 5.10.2i**).

5.10.3 Impact Assessment

Local land use will change during the life of the project from pastoral (stock grazing) to active mining. It will revert to pastoral use when mining is complete with land alienation of up to 100 hectares.

There will be increased traffic on the Stuart Highway from light vehicles as well as supply trucks. This is not anticipated to be significant, particularly as traffic on the highway has been reduced as a result of commissioning of the railway.

Project development will not impact on recreational or tourist uses of the surrounding areas.

The majority of the workforce will be already living in the region. Commitments to preferentially employ local candidates, provide education and training to members of the local indigenous community and preferentially engage local goods and service providers will assist in ensuring benefits of the project are experienced by the local community. The project will also provide a significant economic boost to the local area and Northern Territory economy.

Figure 9: Surface Watercourses in Project Area

Figure 10: Location of Groundwater Bores

Figure 11: Location of Surface Water Diversions and Culverts

6. PRINCIPAL ENVIRONMENTAL ISSUES

6.1 WASTE MANAGEMENT

Waste products generated by the project will predominantly be inert waste rock and tailings (ground up rock). Management of these are discussed in more detail below.

To minimise the potential impacts of waste associated with construction, operation and decommissioning of the project, a range of mitigation commitments will be made within the Mining Management Plan.

6.1.1 Waste Rock Management

It is anticipated that about 30 million banked cubic metres of waste rock will be excavated. Eleven million banked cubic metres or 37% of this amount will be placed in three out of pit waste rock stockpiles. About 4.7 million, 6.3 million and 3.0 million loose cubic metres of waste rock will be placed in the Shekuma, Gogo and Chugga waste rock stockpiles respectively. The remainder will be used to partially backfill the open pits as part of the final mining pass in each pit. The footprint of the waste rock stockpiles will be 37.66, 46.12 and 18.94 hectares for the Shekuma, Gogo and Chugga waste rock stockpiles respectively.

6.1.1.1 Geochemical Characterisation

Waste rock generated will be predominantly siltstones with lesser amounts of medium grained sandstones. Given the low sulphide-sulphur content of these rock types, it is not anticipated that acid rock drainage will occur as a result of exposure of these materials to the environment. Chemical characterisation of samples of both waste rock types was undertaken to confirm the absence of potentially hazardous constituents. Eleven representative rock samples were sent to a NATA accredited laboratory for analysis. Results of the analysis are presented in Table 7. From this it can be seen that two of these samples have a low potential to produce acid. Given that the acid producing potential of the sample is very low, it is anticipated that the potential environmental risk is minimal, particularly given the low rainfall, high evaporation and volume of naturally occurring buffer material present in waste rock in the Bootu Creek area.

The decision as to what shall be described as Potentially Acid Forming (PAF) or Non Acid Forming (NAF) is dependent on the mineral characteristics of the waste material and the climatic conditions. Oxidisable sulphur is the primary requisite for a rock type to be capable of generating sulphuric acid during weathering. The total content of sulphur is not important, rather the amount of sulphur locked in oxidisable sulphur bearing minerals and the presence of sufficient iron to form ferric sulphate after the sulphide is oxidised.

The waste rock and ore samples at Bootu Creek have never previously been analysed for Sulphur. No sulphide minerals have been recorded in the complete database. The only minerals containing Sulphur identified have been Barite (BaSO_4) and Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$).

Barite is a significant mineral within the manganese ore, but in the overlying sandstones and siltstones (waste rock material) barite occurs in amounts averaging 0.06% with a peak value of 0.9% corresponding to a maximum sulphur content of 0.3%. Gypsum can be discounted as a potential source of oxidisable sulphur as it only occurs in the regolith due to evaporation of

rainfall and crystallisation of the dissolved salts in that rainfall or as a by-product of sulphide oxidation. Worldwide hot arid area regolith sulphur contents derived from gypsum range up to six percent.

Barite is one of the most resistant minerals to weathering known. It is insoluble in strong acids and naturally occurring organic acids. There are no natural conditions where the sulphur in barite can form sulphuric acid. It is the most benign of all sulphur-bearing minerals.

It appears that negligible oxidisable sulphur occurs in the rocks at Bootu Creek. In determination of the sulphur in rocks for ANC determination, total sulphur is normally measured by Leco combustion. This will include the sulphur inclusive in barite and gypsum. The sulphur recorded in Table 7 is probably derived from these sulphate minerals and is non-acid forming.

The Acid Forming Potential classification criteria often employed at mining-operations on a worldwide basis is:

- NAF: Sulphide-S < 0.3 %. For Sulphide-S $\geq$ 0.3 %, both, a negative NAPP value, and an ANC/MPA ratio $\geq$ 2.0.
- PAF: For Sulphide-S $\geq$ 0.3 %, any positive-NAPP value; negative-NAPP value with an ANC/MPA ratio < 2.0.

The majority of mine-wastes on which the ANC/MPA value of ≥ 2 is based come from areas with at least double the rainfall likely to be experienced at Bootu Creek, with substantially greater vegetation density, lower pH soils and shallow regolith. As rainfall decreases the effective ANC/MPA ratio also decreases.

The Nevada Mining District in south-western USA, is extremely similar to the Tennant Creek District of Australia in relation to aridity, regolith thickness, common regolith geology, and depth to water table. The US EPA (1994) set conditions such that for Sulphide-S $\geq$ 0.3 %, any positive-NAPP value, or negative-NAPP value with an ANC/MPA ratio < 1.2 as the thresholds for description of mine wastes to be recorded as Non Acid Forming.

It is understood that an ANC/MPA ratio of 1.2 is still entertained by regulators in Nevada for “screening” PAF and NAF varieties of mine-wastes in semi-arid settings. On the basis of this usage and the US EPA (1994) conditions, sample 5565 qualifies as NAF, but sample 5559 may be classifiable as PAF. Despite this, it is more likely that sample 5559 should be described as NAF as:

- The ANC/MPA ratio is 0.23 and on this basis, acid formation is expected to occur.
- The sulphur content of 0.36% is only very slightly above the threshold.
- There is no certainty that any of the sulphur is sulphide-sulphur.
- The value of sulphur is well within the range of the sulphate content of gypsum and/or barite content in the sediment.

In assessing the Potential Acid Formation of tailings and mine-waste materials, there is consensus that lithotypes with Sulphide-Sulphur contents less than 0.3% are unlikely to oxidise at rates fast enough to result in acidification. This position assumes that the gangue hosting such “trace-sulphides” is not simply quartz, and/or clays and that for a carbonate-deficient gangue the sulphide-minerals are not unusually reactive (e.g. sulphide-oxidation rates (SORs) greater than one to two kilograms SO₄/tonne/year). Such rates are generally

restricted to either sedimentary forms (e.g. framboidal-pyrite), or hydrothermal-sulphides that are atypically reactive.

At Bootu Creek, the sedimentary facies setting is inimical to formation of framboidal pyrite and there is no geochemical or other evidence to support the presence of hydrothermal sulphides. Whilst no SORs have been measured, evidence is strongly against rapid reaction rates. Despite the fact that the NAPP value is positive, and the ANC/MPA ratio very low, it is unlikely that sample 5559 will actually be acid generating.

6.1.1.2 Rehabilitation

All waste rock stockpiles will be progressively rehabilitated.

The Shekuma and Gogo pits will be partially backfilled to about 260 metres AHD (**Commitment 6.1.1a**). Volume calculations undertaken as part of the mine design have demonstrated that due to the swell factor experienced because of the blasting necessary to remove waste rock, the total loose volume of excavated materials that will remain in the Shekuma and Gogo pits is 8.54 and 11.46 million loose cubic metres respectively.

Waste rock stockpiles developed adjacent to each pit will be shaped so that they form stable landforms. This will involve:

- Ensuring PAF waste rock is identified and is encapsulated within NAF waste rock as waste rock stockpiles are constructed (**Commitment 6.1.1b**).
- Contouring the Shekuma waste rock stockpile so that it ties in with the ridge west of the pit. The maximum height will be governed by the varying maximum height of the ridge so that the final design is aesthetically pleasing (**Commitment 6.1.1c**).
- The eastern side of the Shekuma waste rock stockpile being constructed with gentle slopes (18 degrees) separated by a back sloping 10 metre wide berm (two degrees fall) to facilitate controlled water shedding (**Commitment 6.1.1d**).
- Leaving of gaps within the Shekuma waste rock stockpile to prevent interference with natural drainage off the ridge (**Commitment 6.1.1e**).
- The Gogo waste stockpile height being limited to 20 metres with gentle slopes (18 degrees) separated by a back sloping 10 metre wide berm (two degrees fall) to facilitate controlled water shedding (**Commitment 6.1.1f**).
- Shaping of stockpile top surfaces to promote water absorption rather than water shedding, i.e. concave surface (**Commitment 6.1.1g**).
- Direct application of stripped topsoil to reshaped areas to maximise success of vegetation establishment (**Commitment 6.1.1h**).
- Respreading of stockpiled vegetation on reshaped surfaces (**Commitment 6.1.1i**).
- Construction of low bunds at the crest of each batter to assist with surface water control on batters (**Commitment 6.1.1j**).
- Deep ripping on the contour to assist with water adsorption and minimisation of erosion (**Commitment 6.1.1k**).

Further details regarding rehabilitation of waste rock stockpiles are contained in Section 6.3. Conceptual waste rock stockpile designs are shown in Figure 12.

Table 7: Waste Rock Geochemical Characterisation Results

Sample No.	Drill Hole No.	Description	Pit	ANC (measured)	NAG (measured)	NAPP (measured)	MPA	Equivalent Sulphide-Sulphur (calculated)	ANC/MPA Ratio	Classification
				kg H ₂ SO ₄ / t*	kg H ₂ SO ₄ /t*	kg H ₂ SO ₄ /t*	[calc]			
5556	BCPC 508: 2-12m	White siltstone	Shekuma	22	<0.5	-21.5	0.5	0.02%	44.00	NAF
5557	BCPC 508: 12-18m	White sandstone	Shekuma	7.5	<0.5	-6.5	1	0.03%	7.50	NAF
5558	BCPC 502: 3-18m	White siltstone	Go-Go	9	<0.5	-7	2	0.65%	4.50	NAF
5559	BCPC 502: 18-27m	White sandstone	Go-Go	2.5	<0.5	8.5	11	0.36%	0.23	PAF
5560	BCPC 483: 7-24m	White siltstone	Go-Go	9.5	<0.5	-7	2.5	0.08%	3.80	NAF
5561	BCPC 483: 24-29m	White siltstone with sandstone interbeds	Go-Go	7.5	<0.5	-4	3.5	0.11%	2.14	NAF
5562	BCPC 498: 7-15m	White sandstone	Go-Go	14.5	<0.5	-8.5	6	0.20%	2.42	NAF
5563	BCPC 495: 8-18m	White and grey siltstone	Go-Go	81.5	<0.5	-81.5	<0.5	0.00%	>200	NAF **
5564	BCPC 526: 4--9m	Sand, clay and gravel	Shekuma	12	<0.5	-12	<0.5	0.00%	>30	NAF **
5565	BCPC 412: 4-16m	Yellow, limonitic, jasper bearing horizon	Shekuma	12	<0.5	-4.5	7.5	0.25%	1.60	PAF ***
5566	BCPC 429: 7-15m	White siltstone	Shekuma	7.5	<0.5	-6	1.5	0.05%	5.00	NAF

* Detection Limit of 0.5 kilogram.

** Actual MPA is zero, but assumed to be 0.4kg/tonne for calculation as lowest detection limit is 0.5kg H₂SO₄ per tonne. Probably lower than 0.4%, increasing the ratio.

*** Ratio is less than 2.0, but with a negative NAPP. Sample 5565 can possibly be described as Potentially Acid Forming. See explanation in text.

Definitions:

ANC = Acid Neutralising Capacity

NAG = Net Acid Generation

MPA = Maximum Potential Acid

NAPP = Net Acid Producing Potential

Relationship is $NAPP = MPA - ANC$

Comments in relation to the classification criteria are discussed in the text.

6.1.2 Tailings Management

Tailings produced will be inert as no chemicals are utilised during ore processing. The tailings or supernatant will contain no chemicals and minimal heavy metals that could adversely affect plant growth or present environmental contamination problems.

Tailings will be disposed of in a purpose built disposal facility that will be rehabilitated on completion of its use.

The TSF is designed for subaerial deposition. Tailings deposited will contain about 55% solids. The TSF will be operated in a manner to minimise accumulation of free draining water in the facility.

Details on the TSF conceptual design, construction and operation are given in Section 2.5.

6.1.2.1 Geochemical Considerations

MBS Environmental undertook an in house geochemical evaluation of tailings to determine the potential environmental impacts associated with management of tailings solids and leachates. Data available from Bootu Creek Resources for 973 ore samples as was reviewed to determine the average chemical composition of the material to be processed. Similarly the chemical characteristics of groundwater in the area were examined, as this will form the water source for processing. Typical ore and groundwater characteristics are shown in Table 8.

Table 8: Chemical Characteristics of Bootu Creek Ore and Groundwater

Ore Constituent	Content (%)	Process Water Constituent	Content (mg/kg)
Manganese as Mn	41.4	Mn	0.02
Iron as Fe	7.1	Fe	no data
Al ₂ O ₃	3.84	Al	no data
SiO ₂	20.5		no data
CaO	0.44	Ca	51
MgO	0.25	Mg	78
BaSO ₄	4.00	Ba	no data
K ₂ O	1.30	K	17
Na ₂ O	0.17	Na	281
P	0.04	P	no data
TiO ₂	0.20	Cl	305
		SO ₄	194
		HCO ₃ as CaCO ₃	464
		TDS (gravimetric)	1450
		pH	7.89
		EC µS/cm	2045

As part of this review a sample of manganese ore that had undergone metallurgical testing was reserved for tailings testing. The sample was split at 1,000 microns and the fines analysed as

representative of natural tailings. Water extracts, metals analysis and Acid Neutralising Capacity tests were performed.

Analyses were performed by mixed acid, XRF and ICP techniques for the solids portion to establish the presence/absence and concentrations of expected and possible contaminant metals. Results of this testing are presented in Table 9.

Review of the overall data suggests that the fines, with relatively low manganese (14.1%) and iron (3.60%), are reasonably representative of the expected tailings, though around 50% too high in manganese. Thus the sample tested effectively represents a worst case scenario for potentially contaminant metals.

Elements expected to associate with the manganese are iron, chromium, cobalt, nickel, TiO_2 , a proportion of the barium and tungsten. At the levels present, considering their solubilities in circum-neutral waters, none of these will present any problems in the proposed TSF. ICP determinations on the leachate for iron, chromium, barium and tungsten indicate that none of these elements will pose any problem. Given the sample analysed is considered as a worst case scenario, it is likely that the concentrations of these elements will decrease slightly in tailings.

Table 9: Water Extracts and Metals Analytical Data on Tailings Sample

Tailings Solids Sample	Content (mg/kg) or (%)	Leachate Constituent	Content (mg/kg) ICP Lab 1.	Content (mg/kg) Lab 2.
Manganese as Mn	14.1%	Mn	0.43	2.0
Iron as Fe	3.60%	Fe	0.61	3.0
Al ₂ O ₃	7.90%			
SiO ₂	53.3%			
CaO	0.06%	Ca	1.1	5.0
MgO	0.10%	Mg	0.65	3.2
Ba	3.20%	Ba	0.51	3.0
K ₂ O	0.66%	K	2.1	10
Na ₂ O	0.07%	Na	46	230
P	0.03%	P	0.6	3.0
TiO ₂	0.36%			
Cu	0.23%	Cu	0.025	0.1
Pb	0.15%			
Zn	125	Zn	0.03	0.15
Cr	<50	Cr	0.005	<0.05
B	<20	B	0.17	0.9
Se	<5	Se	<0.1	<0.5
U	9.5	U	<0.2	<0.01
As	21	As	<0.02	<0.1
Co	483	Hg		<0.5
Mo	3.3	Cl (1:5 water)		58
Ni	27	HCO ₃		350
S (total)	0.47%	NO ₃ (1:5 water)		260
SO ₄ -S (gypsum)	0.31%	SO ₄ (1:5 water)		39
Sulphide-Sulphur	0.16%	EC (µS/cm)		250
Sb	1.1	pH (1:5 water)		7.5
Th	8.9			
W	1			

Potential issues associated with the presence of several elements and radicals in the waste part of the ore (gangue) were reviewed. Arsenic, copper, lead, zinc, molybdenum and antimony could partition partially with the manganese and partially with the gangue minerals. Uranium, thorium, boron, a large proportion of the barium, sulphate, nitrate and chloride should all partition with the gangue minerals. ICP determinations on the leachate for arsenic, barium, boron, copper, antimony and zinc and the determinations for sulphate and chloride indicate that none of these elements pose any problem in drinking water and should not affect the groundwater. The cause of the nitrate values needs to be established as to whether it is natural or due to explosives.

The uranium and selenium contents in the leachate are both recorded as below detection limits which themselves are above accepted drinking water limits. The 9.5 milligram per kilogram value for uranium in the solids is very low given that natural uranium regolith values for the geological environment at Bootu Creek are expected in the range of four to ten milligrams per kilogram. Given the lack of uranium and the low sulphur, selenium values in excess of 0.001 milligrams per kilogram, two orders of magnitude lower than permissible in drinking water, are unlikely. Alkali and alkaline earth metals are low and pose no problems. The very low calcium and magnesium values indicate very low carbonate content. With such low values there will be little or no surface efflorescence formation.

Alumina and silica values in the solids give important data. With this level of Al_2O_3 , the maximum possible clay content in the solids is below 20% wet weight. At the existing pH, at least half the alumina will be present as gibbsite ($\text{Al}(\text{OH})_3$) reducing probable clay to less than 10%. This indicates that tailings will not be subject to capillary rise of moisture once the water level in the TSF is 40 to 50 centimetres below the surface. Thus surface encrustations are unlikely to form.

A negative feature of the low alumina is that there will be insufficient clay in the tailings to naturally seal minor seepages in the base and embankments of the TSF.

Basic acid generation tests were undertaken on the tailings sample to determine whether potential exists for tailings solids to be acidic or to generate acidic leachate. These results are presented in Table 10.

Table 10: Acid Neutralising Capacity of the Tailings Sample

Analyte	Value
Total Sulphur	0.47%
Sulphate Sulphur	0.31%
Sulphide Sulphur	0.16%
ANC (kg H_2SO_4 /tonne)	1.8
NAG (kg H_2SO_4 /tonne)	1.3
NAPP (kg H_2SO_4 /tonne)	3.1
MPA	4.9
ANC/MPA Ratio	0.37
Classification	PAF

The classification is provisionally described as PAF as the NAPP value is positive, the NAG value is positive and the ANC/MPA ratio exceeds 1.2 (see Section 6.1.1.1). However, the calculated maximum sulphide-Sulphur is only 0.16% prior to allotting sulphur to the copper, lead and zinc values and sulphur to barium sulphate. The copper, lead and zinc if present as sulphides, which is possible, considering their insolubility in the water leachate, use all the available sulphur. The barium would itself use all of the sulphur, without the copper, lead and zinc.

It is likely that little or no sulphur is actually present in minerals which will produce sulphuric acid and iron hydroxide ($\text{Fe}(\text{OH})_3$) and this sample, as with the eleven waste rock samples described in Section 6.1.1.1 are unlikely to form any acid.

In assessing the potential acid formation of tailings and mine-waste materials, there is consensus that lithotypes with sulphide-Sulphur contents less than 0.3% are unlikely to oxidise at rates fast enough to result in acidification. This position assumes that the gangue hosting such "trace-sulphides" is not simply quartz, and/or clays and that for a carbonate-deficient gangue, the sulphide-minerals are not unusually reactive (e.g. sulphide-oxidation rates greater than one to two kilograms of sulphate per tonne per annum). Such rates are generally restricted to either sedimentary forms (e.g. framboidal-marcasite), or hydrothermal-sulphides that are atypically reactive. The very small amount of sulphide in Bootu Creek ore is likely to be chalcopyrite, galena and sphalerite, all of which have low reaction rates compared with pyrite and extremely low reaction rates compared with marcasite.

To have any chance of acidification, calculation indicates that the total sulphur in tailings with the composition of this sample would need to oxidise in a period of less than eight months from time of deposition.

6.2 GROUNDWATER EXTRACTION

6.2.1 Extraction Requirements

Hydrogeological assessment of the project area indicated that groundwater is present from 26 to 35 metres below ground surface. The mine pits are expected to extend to a depth of 70 metres below ground surface level, thus the water table will be intersected in both pits.

Water extraction will be undertaken prior to mining intersection the water table to provide a water supply for the processing plant, other ancillary uses and to commence dewatering of the pits. Limited information has been collected on groundwater characteristics of the project area. Investigation undertaken in late 2003 by URS indicates that pumping rates of about 11 litres per second can be sustained for production bores (Appendix 6). Water will be extracted from a number of production bores to be established along the length of the orebodies. Water will be pumped to the processing plant in HDPE pipelines located adjacent to the haul roads.

Dewatering will commence from the start of mining to lower groundwater levels ahead of the second pass of mining in both the Skekuma and Gogo pits.

Shekuma and Gogo pits will be dewatered by progressively lowering the water level by 40 metres from about 260 to 220 metres Australian Height Datum to create a dry pit floor for the excavation of waste and ore. Dewatering will be undertaken from a number of purpose drilled abstraction bores. Ingress of groundwater into mine workings will be actively prevented.

Extraction rates are anticipated to increase as pit depth increases. Table 11 displays the anticipated pumping rate and cumulative volume of water extracted from commencement of mining to year 6.5.

Table 11: Simulated Pumping for Global Mine Dewatering

Date	Model Stress Period	Duration (years)	Pumping Rate (kilolitres/day)	Cumulative Pumpage (kilolitres)
June 2005	1	0	4,200	Start Mining
December 2005	2	0.5	4,200	1,533,000
June 2006	3	1.0	4,400	2,336,000
December 2006	4	1.5	4,400	3,139,000
June 2007	5	2.0	10,200	5,000,500
December 2007	6	2.5	9,400	6,716,000
June 2008	7	3.0	8,700	8,303,750
December 2008		3.5	8,600	9,873,250
June 2009	8	4.0	7,800	11,296,750
December 2009		4.5	7,800	12,720,250
June 2010	9	5.0	7,300	14,052,500
December 2010		5.5	7,300	15,384,750
June 2011	10	6.0	7,300	16,717,000
December 2011		6.5	Mining Complete	

(Source: URS 2004, in progress)

Abstraction volumes and depth to water in production bores and monitoring bores will be monitored regularly during the life of the operation to enable Bootu Creek Resources to gain a better understanding of the behaviour of the underlying aquifer systems and the impacts of abstraction (**Commitment 6.2.1**).

6.2.2 Extraction Impacts

URS were commissioned to undertake water modelling studies to determine what the likely impacts of dewatering of the Shekuma, Gogo and Chukka pits would be.

The modelling indicates that pumping rates above that required for ore processing will be required to advance the mine dewatering with sufficient lead time to meet the planned mine schedule. The resulting cone of depression is expected to extend from bores located alongside the Gogo pit, across to the Shekuma pit and beyond to the west (URS 2004, in progress).

After two years, the modelling indicates that the pumping rate will need to be increased, to deepen and widen the drawdown cone in preparation for Stage 2 mining in the northern end of the Gogo pit. Dewatering pumping will then progress southwards with the use of additional bores in advance of mining to extend the developed cone of depression. Pumping will need to continue behind the active mining operations in the Gogo pit to maintain dewatering and also assist with the initial stages of dewatering the Shekuma pit (URS 2004, in progress).

The drawdown will extend well beyond the mining areas to the north, west and south of the open pits. It is expected that these effects will be significantly less in the Attack Creek Formation that lies beneath and to the east in the footwall. This formation is understood to be of lower permeability than both the Bootu Creek Sandstone and manganese ore (URS 2004, in progress).

Based on the hydrogeological investigation undertaken by URS, it is estimated that within 12 months of cessation of dewatering of the Shekuma and Gogo pits, groundwater within the pit will have returned to half the pre-mining levels. Groundwater levels will continue to recover after this period.

6.2.3 Water Balance

An estimated 473,000 kilolitres (473 megalitres) per annum or 15 litres per second (1,296 kilolitres per day) is required for processing of ore. It is anticipated that a further 190,675 kilolitres per annum or six litres per second (522 kilolitres per day) will be required for ancillary uses such as mining (dust suppression, vehicle maintenance, drilling) and accommodation village usage. This gives a total usage per annum of about 666,715 kilolitres per annum or 21 litres per second (1,818 kilolitres per day).

Water will be lost from the operation as a result of retention of water within tailings, evaporation from the TSF surface, rainfall infiltration within the pits and use of water within the camp. It is estimated that about 473,751 kilolitres of water will be lost per annum.

A basic water balance was developed each year of the operation. Results of the water balance are displayed in Table 12. From this it can be seen that dewatering for mining purposes will produce an excess of water in all years with a maximum excess of 2,292 mega litres anticipated to occur in year four. Full details of the water balance are contained in Appendix 10.

Table 12: Summarised Water Balance Calculations

Year	Mine Dewatering Requirement (ML/annum)	Rainfall Capture (ML/annum)	Water Losses (ML/annum)	Water Usage (ML/annum)	Water Balance (ML/annum)
1	1,533	254.4	473.7	663.7	650
2	1,606	254.4	473.7	663.7	723
3	3,577	254.4	473.7	663.7	2,694
4	3,175	254.4	473.7	663.7	2,292
5	2,847	254.4	473.7	663.7	1,964
6	2,664	254.4	473.7	663.7	1,781
7	2,664	254.4	473.7	663.7	1,781
Total	18,066	1780.8	3315.9	4645.9	11,885

6.2.4 Water Discharge

It is proposed to discharge excess water to unnamed creeks located south east of the Gogo pit and waste rock stockpile. As described in Section 4.4.1, these creeks are ephemeral in nature and are likely to carry water only immediately after high intensity rainfall.

Preliminary analysis of the groundwater indicates that it is of sufficient quality for discharge to the environment. As ground water will be abstracted from bores, it is not anticipated that issues related to total suspended solids would occur. Table 13 compares water quality of Bootu

Creek groundwater with ANZECC 2000 freshwater guideline values for moderately disturbed ecosystems and Northern Territory groundwater use guidelines for both use by cattle and domestic use. From this it can be seen that water if released to the environment would be unlikely to cause deleterious effect to stock, wildlife or humans. Elevated TDS, chloride, sulfate or sodium concentrations would result in the water having an unacceptable taste for human consumption, but would not pose health problems.

If in pit sumps are required to be developed, water will be discharged only after it has flowed through sediment removal structures (**Commitment 6.2.4a**).

A dewatering management plan will be developed to prevent or minimise degradation of natural drainage systems as a result of water release (**Commitment 6.2.4b**). Quality of the groundwater will be regularly monitored to ensure that it meets water release criteria (**Commitment 6.2.4c**).

Table 13: Comparison of Bootu Creek Groundwater with Use Criteria

Parameter	Unit	Bootu Creek Groundwater ⁺	ANZECC Limit [*]	Groundwater for Use by Cattle Criteria [#]	Groundwater Domestic Use Criteria [^]
pH		7.89	6.5 – 7.5	5.5 – 9.0	6.5 – 8.5
Conductivity	uS/cm	2045	20 - 250	-	-
TDS	mg/L	1450		10,000	500
Calcium	mg/L	51	-	1,000	-
Magnesium	mg/L	78	-	-	-
Sodium	mg/L	281	-	-	180
Potassium	mg/L	17	-	-	-
Bicarbonate (CaCO ₃)	mg/L	464	-	-	-
Sulphate	mg/L	194	-	2,000	250
Chloride	mg/L	305	-	-	250
Manganese	mg/L	0.02	1.9	-	-

+ Average results

Northern Territory Groundwater Quality for Cattle (April, 2002).

^ Northern Territory Groundwater Quality for Domestic Use Guideline (May, 2002).

* ANZECC 2000 guidelines for fresh waters

6.2.5 Post Mining Water Balance

As part of the groundwater modeling studies undertaken by URS (see Section 6.2.2), the post-mining situation was considered.

On completion of mining, water levels in each pit will return to the static water level. Given groundwater flow rates it is anticipated that water levels will reach half this point within 12 months of cessation of dewatering for the Shekuma, Gogo and Chukka pits respectively. Water levels will continue to rise over time.

Partial backfilling of the Shekuma and Gogo pits will mean that waste rock and groundwater will interact. Potential issues associated with this include leaching of salts or metals from waste rock into groundwater. Material that will be used as backfill will be waste rock from mining areas along strike and from below the original water level. Therefore, it is not anticipated the groundwater salinities will increase as a result of backfilling the pits. Backfilling will reduce the likelihood of the salinity of the groundwater in the pits increasing due to evaporation (URS 2004, in progress).

6.3 REHABILITATION

Progressive rehabilitation will be undertaken wherever practicable (**Commitment 6.3a**). As described in Section 2.3, on the final mining pass in each pit, the pits will be progressively backfilled with waste rock. Placement of about 63% of the total waste rock generated by the project within the Shekuma and Gogo pits will result in minimisation of the operational footprint requiring rehabilitation.

Rehabilitation will be undertaken to allow the pre mining land use (pastoral) to be restored once full decommissioning has been completed.

Indigenous species will be used for rehabilitation of disturbed areas. Ideally revegetation will occur through careful management of topsoil and its contained seed resource. Supplementary seeding or planting may occur if rehabilitation monitoring demonstrates that revegetation is not proceeding in line with expected results.

As part of obtaining all permissions necessary to commence mining, Bootu Creek Resources will submit to DBIRD a security bond in case of any unplanned failure of the project. The size of this security bond will be regularly reviewed in conjunction with DBIRD to ensure it remains consistent with the level of disturbance caused by the project at any specific time (**Commitment 6.3b**).

6.3.1 Open Pits

Rehabilitation of the pit voids will involve:

- Progressive placement of waste rock within each pit as part of the final mining pass.
- Partial flooding of the pits with groundwater.
- Construction of a safety bund to prevent vehicle entry to mined areas.

6.3.2 Waste Rock and Overburden Stockpiles

Rehabilitation of the waste rock stockpiles is described in Section 6.1.1.

6.3.3 Tailings Storage Facility

All outer batters of the TSF embankments will be constructed with slopes of 5:1 (11.3°) and rehabilitated at the time of construction. They will be covered with five to 10 centimetres of topsoil and contour ripped (**Commitment 6.3.3a**).

On closure of the facility, the tailings will be allowed to dry out and consolidate prior to rehabilitation of the top surface. Tailings distribution infrastructure will be removed.

The final TSF will comprise a gently undulating to level landform of coarse tailings within the western and central portions of the TSF with gentle east facing slopes within the eastern portion of the TSF. The low lying areas of exposed fine tailings within the north-eastern portion of the TSF will be infilled with inert waste rock once the tailings have dried and consolidated sufficiently for vehicular access.

Rainwater falling within the layout of the TSF will be retained within the rehabilitated TSF and either drain rapidly beneath the topsoil and coarse tailings or temporarily pond in the north-eastern corner of the TSF before being dissipated through seepage and evaporation.

Rehabilitation of the upper surface will involve:

- Covering the tailings surface with inert waste rock, overburden or mill rejects.
- Shaping the upper surface to divert run-off from the structure in a controlled manner. Where necessary, permanent drains will be rock armoured to maximise long-term stability.
- Spreading of topsoil on shaped surface.
- Deep ripping on the contour to assist with water adsorption and surface water control.
- Application of seed to ripped surfaces if rehabilitation monitoring shows that natural revegetation has not occurred satisfactorily within two years of rehabilitation (**Commitment 6.3.3b**).

These measures allow for a safe, stable and aesthetically acceptable facility on decommissioning. The proposed rehabilitation will result in a landform with a water harvesting surface to maximise rainfall retention, promote growth of vegetation and reduce run-off down the batters of the embankments.

6.3.4 Infrastructure Areas

Infrastructure will be removed from the site as it becomes redundant. This will include the accommodation village, administrative offices, workshops, fuel storage tanks, generators, water diversion structures, power lines and water pipes.

Disturbed surfaces will be rehabilitated after removal of infrastructure. This will involve:

- Treating any localised contamination i.e. hydrocarbon spillages. Depending on the contaminant type and concentration, contaminated material may be removed or treated in situ.
- Deep ripping compacted surfaces.
- Spreading of topsoil on deep ripped and reshaped surfaces.
- Contour ripping to assist with water adsorption and surface water control.
- Application of seed to ripped surfaces if rehabilitation monitoring shows that natural revegetation has not occurred satisfactorily within two years of rehabilitation.

6.4 DECOMMISSIONING

Bootu Creek Resources will prepare a Closure Plan as part of the Mining Management Plan. The Closure Plan will be a dynamic document that is reviewed regularly to ensure the plan remains relevant to the activities being and planned to be undertaken. Post mining land use will be discussed with landowners, Native Title claimants and regulatory authorities. The most likely post mining land use for the majority of the land area affected by this project will be pastoral use.

On final decommissioning, plant and infrastructure will be dismantled, made safe and removed from the site. Infrastructure such as bores and roads will not be decommissioned if post mining land users request their retention.

Figure 12: Waste Rock Stockpile Design

7. PUBLIC INVOLVEMENT AND CONSULTATION

Consultation with Stakeholders has been undertaken by senior representatives of Bootu Creek Resources throughout development of the project.

Stakeholders were identified after preliminary discussions with the Department of Business Industry and Resource Development and Department of Infrastructure Planning and Environment. Stakeholders identified include:

- Darwin Port Authority.
- Mr Elliott McAdam, MLA for Barkley.
- Department of Business, Industry and Resource Development.
- Department of Infrastructure Planning and Environment – Office of Environment and Heritage.
- Department of Infrastructure Planning and Environment - Roads Development Branch.
- Northern Land Council (acting as agents for the traditional landowners of the Muckaty Aboriginal Land Trust and Native Title claimants).
- Kidman Reid Company (owners of Banka Banka Station).
- Aboriginal Areas Protection Authority.
- Telstra.
- NT Gas.
- Freightlink.

Discussions were had with each group of stakeholders individually to identify their concerns. Where practical, individual components of the project have been redesigned to incorporate requests and suggestions and to avoid areas of sensitivity.

Bootu Creek Resources are negotiating with the Northern Land Council for permission to conduct the project on land owned by the Muckaty Aboriginal Land trust and on Banka Banka Station. A formal agreement is expected to be entered into between the two parties in August 2004. This agreement is encompassing in that it addresses employment, training, provision of goods and services, environmental management and compensation.

A public meeting is scheduled to be held on 22 July 2004 in Tennant Creek to provide details of the project to interested parties. Local businesses will be given the opportunity at this meeting to register their interest in providing goods or services for the project. Individuals will also be able to register their interest in employment with the project.

8. RISK MANAGEMENT

As part of the design, construct and operate contracts let by Bootu Creek Resources for the ore processing and mining, HAZOP style risk assessments will be conducted for operational aspects. The results of these assessments will be used to minimise risk for the project (**Commitment 8.0a**).

The potential for adverse impacts from the TSF on human life, economic loss and the environment has been considered. Based on the proposed low embankment height, the remoteness of the project area and the absence of areas of environmental significance, the risk has been assessed as being low.

Similarly the risk of TSF embankment failure was considered. Using the embankment design and implementation of accepted engineering practices in the construction of the embankment, it is considered that there is a very low risk of embankment failure. Given that the nearest portion of the TSF is located 100 metres east and downslope of the processing plant area, 250 metres north and mostly downslope of the administration/workshop area and that there are no residential facilities or other infrastructure downslope of the TSF, in the unlikely event of embankment failure, no loss of life is expected, nor any significant economic loss associated with agricultural land, roads, mine infrastructure or disruption to mining and processing operations.

Bootu Creek Resources will develop and maintain a suitably qualified and trained Emergency Response Team for the duration of the project (**Commitment 8.0b**). Specific procedures will be developed to ensure appropriate and effective response will be provided for a range of potential emergency situations. This will include response to:

- Fire – bush, equipment or plant.
- Floods.
- Explosions.
- Medical emergencies.
- Chemical spillages.
- Pit wall failure.
- Vehicle accidents.

Procedures will detail the roles and responsibilities of personnel at each stage of the response plan. Training will be provided to all personnel identified within the Emergency Response Plan to ensure they understand their individual responsibilities with regard to implementation of the plan (**Commitment 8.0c**).

Bootu Creek Resources will establish a relationship with emergency response organisations and operators of medical facilities within Tennant Creek. Bootu Creek Resources will upgrade the existing airstrip on Banka Banka Station to enable access to the operations by the Royal Flying Doctor Service (**Commitment 8.0d**).

Bootu Creek Resources will ensure that people with appropriate First Aid and medical training are employed at all times. A dedicated First Aid facility will be constructed and maintained

for the duration of the project. First Aid kits will be maintained in all office buildings, light vehicles and mobile equipment (**Commitment 8.0e**).

To minimise the risks associated with bushfire, firebreaks will be installed and maintained around key pieces of infrastructure (**Commitment 8.0f**). This will include the accommodation village, generators and process plant. Fire extinguishers will be maintained in operational areas in accordance with regulatory requirements. Extinguishers will also be fitted in all light vehicles and mobile equipment (**Commitment 8.0g**). Mobile equipment such as water carts, graders and bulldozers will be used for fire suppression activities where necessary (**Commitment 8.0h**).

9. ENVIRONMENTAL MANAGEMENT PLAN

An Environmental Management Plan will be developed for the proposed operations as it is a legislative requirement of the Mining Management Plan under section 40 of the *Mining Management Act*.

The Environmental Management Plan will:

- Detail Bootu Creek Resources environmental policy.
- Define environmental performance objectives.
- Describe resources to be used in meeting environmental objectives.
- Outline operating, monitoring and reporting procedures to achieve the objectives.
- Outline procedures for progressive rehabilitation throughout its life.
- Discuss environmental responsibilities.

Among other issues the Environmental Management Plan will address:

- Minimising vegetation clearing.
- Water management, specifically extraction of groundwater and discharge of excess water to ephemeral creeks..
- Noise management.
- Dust management.
- Waste management including waste rock and tailings.
- Education of the workforce to protect native flora and fauna.
- Environmental monitoring.
- Site rehabilitation (progressive and final).
- Decommissioning and closure (including long term residential concept plan and costs).

The Environmental Management Plan will be developed and implemented as soon as approval is given for the project.

10. REFERENCES

Blakers, M., Davies, S.J.J.F. and Reilly, P.W. (1984). *The Atlas of Australian Birds*. Melbourne University Press, Melbourne.

Bureau of Meteorology, On-line climate records (<http://www.bom.com.au>), September 2003.

Christian, C.S., Noakes, L.C., Perry, R. A., Slatyer, R. O., Stewart, G. A. and Traves, D. M (1953). *Surveys of Barkly Region 1947-48* Land Research Series No 3. CSIRO Melbourne.

Coates, B.J. (1990). *The Birds of Papua New Guinea - Volume II*. Dove Publications, Hong Kong.

Conservation Commission of the Northern Territory (October 1983). *Report on Application for a Perpetual pastoral Lease for Banka Banka, Pastoral Lease 755*. Alice Springs, Northern Territory.

Garnett, S.T. and Crowley, G.M. (2000). *The Action Plan for Australian Birds 2000*. Environment Australia.

Higgins, P.J. Ed. (1999). *Handbook of Australian, New Zealand and Antarctic Birds - Volume 4 Parrots to Dollar Birds*. Oxford University Press, Melbourne.

Higgins, P.J. and Davies, S.J.J.F. - Eds (1996). *Handbook of Australian, New Zealand and Antarctic Birds - Volume 3 Snipes to Pigeons*. Oxford University Press, Melbourne.

Marchant, S. and Higgins, P.J. – Eds (1993). *Handbook of Australian, New Zealand and Antarctic Birds -Volume 2 Raptors to Lapwings*. Oxford University Press, Melbourne.

Moorish, R (Pers comm.), September 2003. Personal communications with Banka Banka station Manager.

Northern Territory Parks and Wildlife Commission (2003a). Database search of the Fauna of Bootu Creek area. Unpublished data.

Northern Territory Parks and Wildlife Commission (2003b). Database search of the Flora of Bootu Creek area. Unpublished data.

Strahan, R. (1995). *The Mammals of Australia*. Reed Books, Australia.

URS (January 2004). *Dewatering and Water Supply Investigation Bootu Creek Manganese Project*. Unpublished report prepared for Bootu Creek Resources.

URS (May 2004). *Surface Water Management Review Bootu Creek Manganese Project*. Unpublished report prepared for Bootu Creek Resources.

URS (2004 in progress). *Groundwater Extraction Requirement Modelling Report Bootu Creek Manganese Project*. Unpublished report prepared for Bootu Creek Resources.

APPENDICES

APPENDIX 1

Bootu Creek Resources Environmental Policy

APPENDIX 2

Correspondence with Federal Department of Environment and Heritage

APPENDIX 3

TSF Geochemical Laboratory Results

APPENDIX 4

Planned Ore Product Haul Road Information

APPENDIX 5

Construction Schedule Gant Chart

APPENDIX 6

URS Dewatering and Water Supply Investigation

APPENDIX 7

Flora Lists for Banka Banka Station

APPENDIX 8

Fauna Species List for Banka Banka Station

APPENDIX 9

Aboriginal Areas Protection Authority Database Search Results

APPENDIX 10

Water Balance Information

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