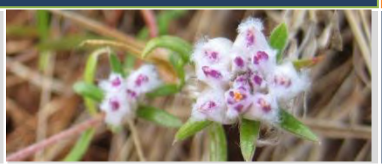
Appendix D - Social and Cultural Aspects Report

Australian Ilmenite Resources Pty Ltd

SILL80 Project





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Executive Summary

This Social and Cultural Aspects Report takes into account likely social impacts on stakeholders and the wider community as a result of the development of the Australian Ilmenite Resources SILL80 Project, in the Roper River region of the Northern Territory.

A community consultation workshop was held on the 5th of September 2011, which was attended by pastoral landholders, EcOz Environmental Services, AIR representatives, Northern Land Council members and approximately 40 members of the broader Roper Valley Community.

It is likely that increased opportunities for training and employment for the local community will help to offset the disturbance to the local landscape (referred to as 'country' by Traditional Owners) caused by mining and AIR has commenced negotiations to employ three local community members at the mine site.

Monitoring of potential impacts of the development on social and cultural aspects will be carried out through continued consultation with stakeholders and members of the local community, including pastoralists and Traditional Owners.

Key aspects of monitoring will include:

- Consultation feedback;
- Internal and external auditing;
- Feedback received ad hoc, both positive and negative; and
- Assessment of the level and type of support and services provided to local communities.

Results and findings from monitoring will be fed back into the annual update of the Mining Management Plans, to facilitate continual improvement and adaptive management.

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Acknowledgements

We would like to thank the Northern Land Council for advice and support during development of this Social and Cultural Aspects Report, particularly with the consultation meetings.

We also wish to extend thanks to the Roper Valley and Ngukurr communities and the managers of Numul Numul station for participating in the consultation and providing valuable input concerning the SILL80 Project.

1 Introduction

1.1 Background and Scope

Australian Ilmenite Resources Pty Ltd (AIR) proposes to develop its SILL80 Ilmenite Project, within Mining Lease (ML)27422 and Mineral Lease Application (MLA)29042, located in the Roper River Region of the Northern Territory.

The Public Environmental Report (PER) is a formal assessment under the *NT Environmental Assessment Act 1982* at the request of the Northern Territory Minister for Natural Resources, Environment and Heritage (the Minister). The Social and Cultural Aspects Report is one of many complimentary reports required to support the PER for the SILL80 Ilmenite Project.

The Roper River Region has several large new mining proposals and other developments that are likely to be a significant shift in land use from the traditional tourism and pastoral activities. Although sparsely populated, there are likely to be impacts, both positive and negative, to people living in communities across the region from the establishment of these proposals.

The aim of this document is to develop and implement a process for estimating, before development, any social consequences potentially resulting from this proposal and to identify methods for management and mitigation.

1.2 Project and Surrounding Environment

AIR's SILL80 Ilmenite Project, within ML27422 and MLA29042 (Figure 1-1), is located within the Roper Gulf Shire, Perpetual Pastoral Lease 1161, Land Parcel NT Portion 4970 Chatterhoochee (Numul Numul). The Indigenous Land Corporation (ILC) acquired Numul Numul Station in 2000, granting it to the Traditional Owners (Namul-Namul Aboriginal Corporation). The area was sub-leased in 2001 to the O'Brien family, who continue to manage the property as a cattle station. The area is under Native Title Claim Chatterhoochee, lodged with the Federal Court in 2001 by the Traditional Owners (TO's) represented by the Northern Land Council (NLC).

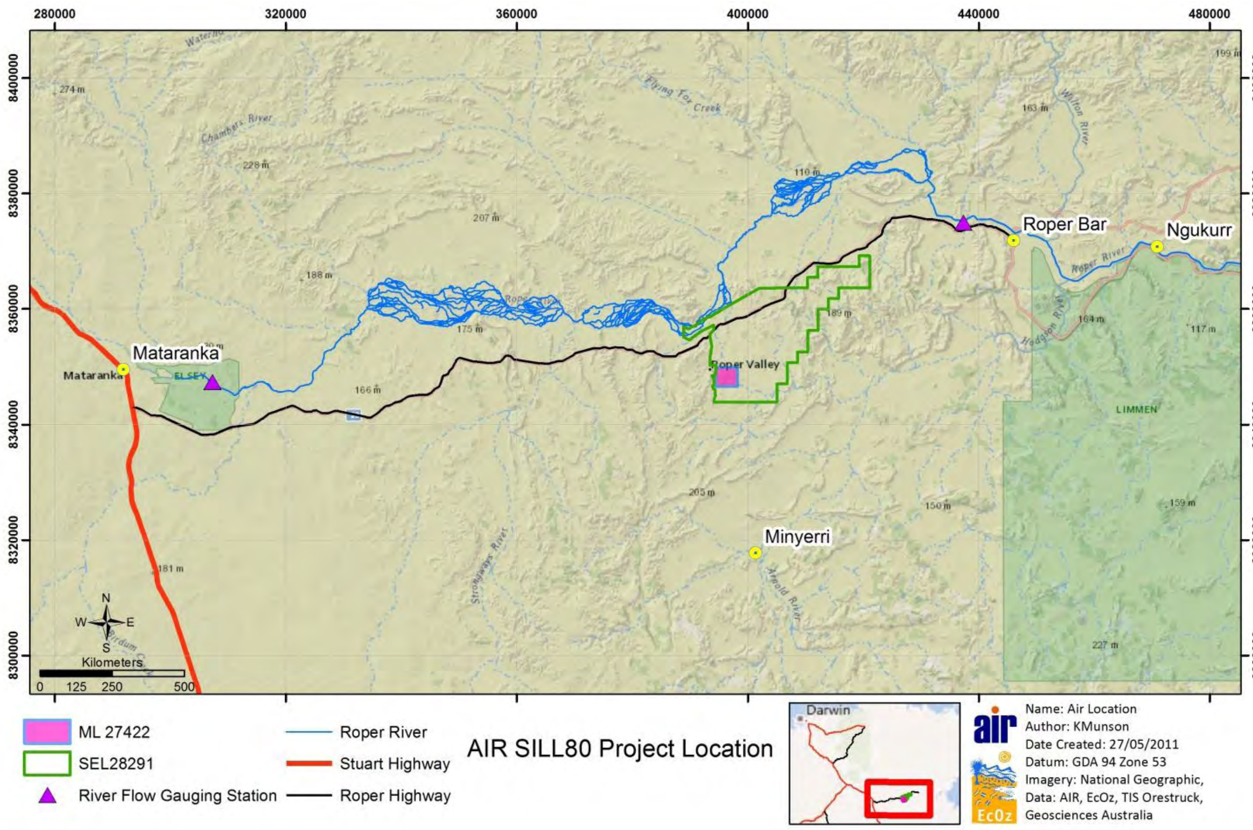

Figure 1-1. Location of SILL80 Project

The Roper River Region is sparsely populated. Only 3 500 people live in the catchment, of which 70% are Indigenous. The largest population centres are Ngukurr (1589), Mataranka (~600) and Minyerri (340) (Northern Territory Government Website 2007). People of the Jawoyn, Mangarayi, Ngalakan, Ngandi, Nunggubuyu, Mara, Alawa and Yangman language groups live in the region (AIATSIS 2000). English is not the first language for the majority of the Indigenous population and Kriol is commonly spoken.

Consultation was undertaken with community members from Minyerri and Roper Valley, who are the Indigenous communities most likely to be affected by the development. For ease of interpretation within this document, these groups are collectively referred to as the broader Roper Valley Community.

2 Methodology

This Social and Cultural Aspects Report identifies potential social impacts on stakeholders and the wider community caused by the establishment of the SILL80 Ilmenite Project, including potential cumulative impacts. For the purposes of this report, cumulative impacts associated with the SILL80 Ilmenite Project are defined as the successive, incremental and combined impacts of an activity on society, the economy and the environment, either directly or indirectly by the projects' activities (either positive or negative) over the duration of the project and beyond.

2.1 General Approach and Timeframes

The process of identifying social and cultural impacts for the SILL80 Ilmenite Project followed a basic process consisting of identifying potential impacts in the context of the project scope, determining affected groups and conducting consultation, followed by evaluation of success and review, as illustrated in Figure 2-1. Although a step-by-step process is outlined, it is essentially an iterative process which allows for adaptive change over time, as knowledge increases and management strategies evolve.

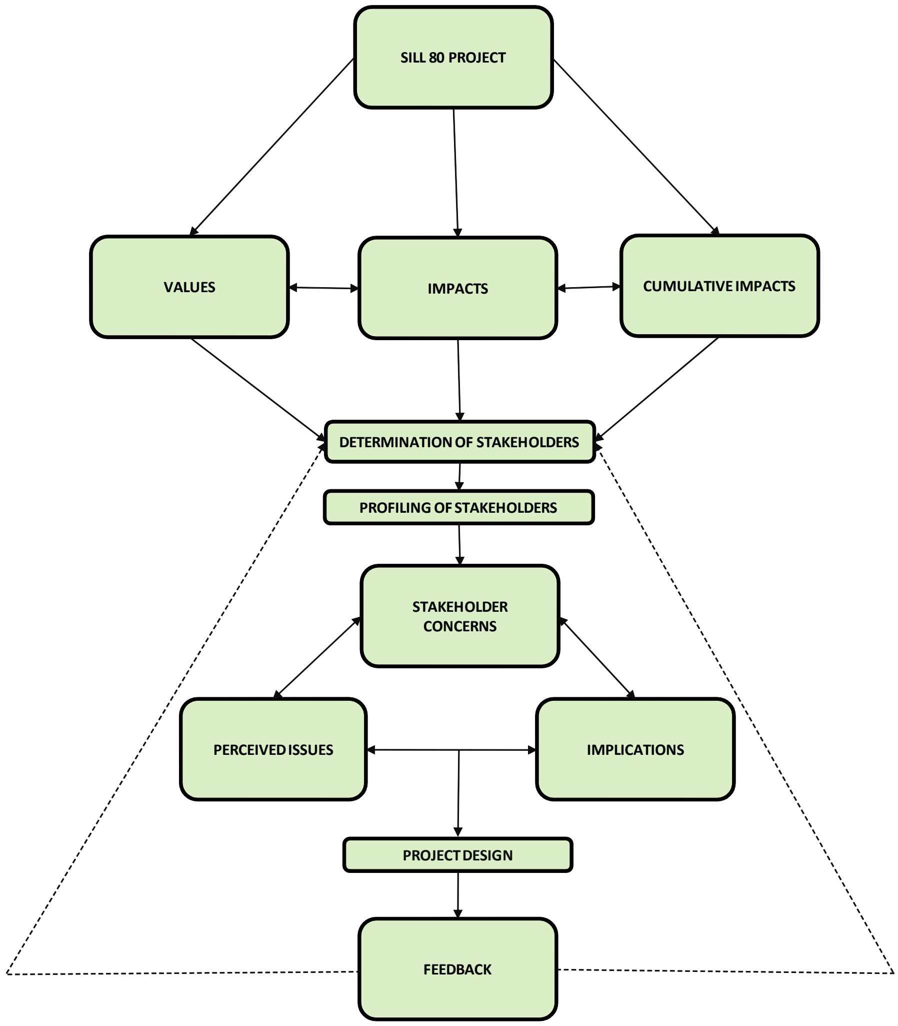

Figure 2-1. Process for Conducting Social Impact Assessment and Management

EcOz Environmental Services (EcOz) were employed to undertake the community consultation for the SILL80 Ilmenite Project.

Some of the key stakeholders for the region include TO's who hold unique values associated with the affected area, and who also commonly have English as a second language. Special consideration was given to enhancing the two way communication with this stakeholder group. The NLC Major Projects Branch facilitated some of the communications and assisted with organising a workshop for TO's within the project area.

Local stakeholders were identified primarily through a desktop study to find land and lease holders within the vicinity, followed by direct liaison with stakeholders to establish what other groups were likely to have an interest in the proposal. The key steps and their time-frames are detailed in Table 1.

Table 1. Details of Steps Involved in Consultation

Phase	Key steps and those involved	Time Frames
1. Scope	a) Identification of the values and general potential (including cumulative) impacts of the overall project including environment, social and economic impacts. b) An initial **identification** and **profile of the key stakeholders,** including their likely values and perceptions of how the SILL80 Ilmenite Project may impact on their values. Key stakeholders were identified as groups of people with similar concerns/interest. This process was assisted by the NLC. c) Identification of the potential **project impacts and the implications** for each stakeholder group. This step was largely undertaken by the project managers and consultants, in consultation with key organisations (e.g. NLC).	May – July 2011 May – July 2011
2. Consult	d) Provided the NLC with the scope of works for consultation. e) **One on One Liaison** or informal contact with key stakeholders to initiate communication on the scope of the project, the potential impacts and identify some of their initial concerns and/or needs for more information. This stage of consultation was aided by NLC in communicating a "story book" (Appendix D1) of ideas for the project (developed by EcOz). f) **Stakeholder group workshop** engaging with stakeholders to complete more focused communication regarding the project impacts and potential concerns. This process was assisted by the NLC.	May – July 2011 August 2011
3. Evaluate and Respond	g) **Refinement of the key stakeholder list** and their **profiles,** based on feedback from liaison with stakeholders. h) **Refinement of the communication of the project** and its potential impacts, based on feedback from the community consultation. i) **Refinement of the project design,** based on feedback from the community consultation. Communication of the modifications with additional consultation (through stakeholder workshops or one-on-one liaison). j) **Identification of ongoing communication needs** and processes between the project manager and stakeholders and how this is best managed, monitored and refined over time.	August – September 2011

2.2 Stakeholder Workshop

A workshop was held on the 5th of September 2011. The workshop was designed to facilitate discussion on potential impacts and mitigation strategies. A 'story book' was developed (see Appendix D1) to detail the proposal through providing a largely visual description of the project, and included detail on potential risks and impacts, rehabilitation scenarios, and company contact details. Prior to the workshop, advice on the proposed date/location of the workshop and a copy of the story book were forwarded to stakeholders. Where necessary, NLC Regional Officers assisted in conveying messages to remote aboriginal communities.

The workshop ran for two hours and approximately 50 people attended, including EcOz Consultants, AIR representatives, Northern Land Council members and around 40 members of the broader Roper Valley Community. The 'story book' formed the basis of discussion, with the proposal broken up into distinct sections i.e. construction, transportation, processing, and rehabilitation, and then further discussion held on specific impacts (i.e. dust, noise, access etc.) and how each of these might impact (positive and negative) on regional values and the various stakeholders. .

2.3 Key Principles of Engagement

Stakeholder engagement was guided by a series of key principles. This included, but was not limited to:

- Building of long term relationships which can develop and adapt over the life of the project;
- Determination of realistic timeframes while ensuring that all stakeholder enquiries and views were responded to in a timely manner;
- Developing an understanding of who is involved and how each group may be affected by decisions;
- Working closely with all interested parties to seek mutually beneficial outcomes;
- Ensuring transparency internally and externally regarding plans, decisions and changes;
- Incorporating, where possible, the knowledge, skills and experience of stakeholders; and
- Being flexible in how information is sourced and provided and being adaptable to change.

Government agencies, key stakeholders and the public will also have the opportunity to comment on the Social Cultural Aspects Report to be contained within the publicly available PER. It is envisaged that stakeholder meetings will be bi-annual, with meeting minutes and outcomes to be reported in the Mining Management Plan (MMP). AIR will have a 'Complaints Register' and will address and/or mitigate identified issues and complaints in the annual MMP update.

2.4 Determining Impact Significance

A qualitative risk assessment was undertaken by EcOz to assess the significance of potential social and cultural impacts of the project. This involved consideration of the likelihood and consequence of a particular impact occurring. The likelihood of a given impact was assessed according to the following criteria:

- R - The social/cultural impact rarely occurs;
- U - The social/cultural impact is unlikely to occur;
- P - The social/cultural impact will possibly occur;
- L - The social/cultural impact is likely to occur; and
- AC - The social/cultural impact is almost certain to occur.

The consequences of a given impact were assessed according to the following criteria:

- Low (L) - No impact on social or cultural value either locally or regionally;
- Minor (Mi) - Only very localised impact on minor social or cultural value;
- Moderate (Mo) – Moderate impact of a social or cultural value or minor impact on multiple social or cultural values;
- Major (Ma) – Significant impact of important social or cultural value; or moderate impact on multiple social or cultural values
- Catastrophic (C) – Catastrophic impact (destruction) of significant social or cultural values at a local scale and/or regional scale.

The resulting risk level was calculated, using both the likelihood and consequence scores, within a risk matrix depicted in Table 2. Moderate Risk levels and above were prioritised for active risk management and mitigation.

Table 2. Risk Assessment.

		Likelihood				
		Rare (R)	Unlikely (U)	Possible (P)	Likely (L)	Almost Certain (AC)
Consequences	Low (L)	Low	Low	Low	Low	Low
	Minor (Mi)	Low	Low	Low	Moderate	Moderate
	Moderate (Mo)	Low	Moderate	Moderate	High	High
	Major (Ma)	Moderate	Moderate	High	High	Extreme
	Catastrophic (C)	Moderate	High	High	Extreme	Extreme

Table 3. Preliminary Social and Cultural Impacts Risk Assessment

<table>
<tr><th rowspan="2">Aspect</th><th rowspan="2">Potential Impact</th><th colspan="3">Inherent Risk</th><th>Management Measures</th><th colspan="3">Residual Risk</th></tr>
<tr><th>Cons*</th><th>L/hood*</th><th>Risk Ranking</th><th></th><th>Cons</th><th>L/hood</th><th>Resid Risk*</th></tr>
<tr><td rowspan="13">Heritage</td><td rowspan="4">Disturbance and/or loss of known archaeological and/or historical sites. Loss of identity with the area, impact on historical records and recording.</td><td rowspan="4">Mo</td><td rowspan="4">P</td><td rowspan="4">High</td><td>Regular inspections to assess effectiveness of archaeological/historical site management</td><td rowspan="4">Mo</td><td rowspan="4">R</td><td rowspan="4">Low</td></tr>
<tr><td>Non-compliance and incident reporting</td></tr>
<tr><td>Immediate assessment of archaeological or historic discoveries during works</td></tr>
<tr><td>Regular audits</td></tr>
<tr><td rowspan="4">Known heritage sites within the mining lease can be impacted on directly or indirectly by both the mining operation and employees/contractors</td><td rowspan="4">Ma</td><td rowspan="4">P</td><td rowspan="4">High</td><td>Site Induction</td><td rowspan="4">Mo</td><td rowspan="4">U</td><td rowspan="4">Low</td></tr>
<tr><td>Regular inspection of work areas conducted to assess effectiveness of protection measures</td></tr>
<tr><td>Immediate assessment of archaeological / cultural sites found during activity</td></tr>
<tr><td>Non-compliance and incident reporting</td></tr>
<tr><td rowspan="5">Damage of cultural site not identified in the Archaeological Report</td><td rowspan="5">Ma</td><td rowspan="5">P</td><td rowspan="5">High</td><td>Regular inspections to assess effectiveness of archaeological/historical site management</td><td rowspan="5">Mo</td><td rowspan="5">U</td><td rowspan="5">Low</td></tr>
<tr><td>Non-compliance and incident reporting</td></tr>
<tr><td>Site Induction</td></tr>
<tr><td>Stop work if potential archaeological or historic sites discovered</td></tr>
<tr><td>No disturbance to known features</td></tr>
</table>

Aspect	Potential Impact	Inherent Risk			Management Measures	Residual Risk		
		Cons*	L/hood*	Risk Ranking		Cons	L/hood	Resid Risk*
Access	Potential damage to existing fences and gates during construction of access roads	Mo	P	Mod	Maintenance of landowner property access at all times Minimise disruption to landowners and third parties where possible	L	P	Low
	Aboriginal sites of significance within and near the mining lease, possible that this land may be required for cultural / traditional purposes but reduced accessibility during mining	Ma	P	High	Regular communication with TO's to ensure access is not an issue Minimise disruption to TO's where possible Clear communication and prior warning of any works likely to limit access	Mo	U	Low
	Access to the site is likely to be via non bitumen roads and therefore damage, particularly during the wet season, is likely. Higher risk of accidents.	Ma	P	High	Site induction Speed limit of <40 km/hr on all access roads Grading and maintenance work carried out regularly, particularly following the wet season	Mo	P	Mod
Social and Visual Amenity	Changes to surface drainage, standing water in pits and water retaining infrastructure may all lead to provision of breeding grounds for biting insects leading to increase in associated disease risk.	Mo	P	Mod	Site induction Biting Insect Management Plan Ensure all equipment (e.g. tyres) are disposed of from site to reduce incidence to standing water in / on infrastructure	Mo	U	Low
	Changes to land appearance reducing attachment to the land. Impacts on	Mo	U	Mod	Rehabilitation Management Plan	Mi	U	Low

Aspect	Potential Impact	Inherent Risk			Management Measures	Residual Risk		
		Cons*	L/hood*	Risk Ranking		Cons	L/hood	Resid Risk*
	tourism/recreational values if the mine is perceived as a negative factor/influence.							
Water	Roper River - Changes to flow and potential increase of cease to flow events and timing Reduction in availability of water for other purposes (stock watering, cultural, recreation)	Ma	P	High	Water Management Plan	Mo	P	Mod
Noise	Increase in noise and vibration caused by trucks on access roads and highways impacting on communities/wildlife/tourism	Mo	P	Mod	Noise mufflers and regular servicing of vehicles	Mi	U	Low
Dust	Impacts to the health and wellbeing of workers onsite Potential impacts on tourism / amenity values	Mo	P	Mod	Increase use of water trucks, seal roads if required	Mi	U	Low

Aspect	Potential Impact	Inherent Risk			Management Measures	Residual Risk		
		Cons*	L/hood*	Risk Ranking		Cons	L/hood	Resid Risk*
Cumulative	Increased risk of traffic accidents	Ma	P	High	Education, training and road rules	Mo	P	Mod
					Consultation and collaboration with other miners in the region			
	Impacts on social amenity due to large number of trucks frequenting highway				Mining Management Plan			
	Roper River - Increased cease to flow events	Ma	P	High	Water Management Plan	Mo	P	Mod
	Roper River - Reduction in availability of water for other purposes (stock watering, cultural, recreation)							
	Impacts on social amenity and tourism	Mo	P	Mod	Consultation and review of commitments	Mi	U	Low

* Cons: Consequence

L/hood: Likelihood

Resid Risk: Residual Risk

3 Impact Assessment

3.1 Identified Values

In such a remote region, which experiences extreme wet season weather coupled with a sparse population, industrial and economic options can be limited. Mining, conservation, and indigenous tourism based industries are the main areas of activity within the Region.

With a 67% indigenous population within the Mataranka Basin (Stoeckl et al. 2007), traditional practices and connections to land and water are high.

3.1.1 Water Features

Much of the riparian vegetation along the fringes of the Roper River and tributaries derive flow from the regional aquifers and are potential groundwater dependent ecosystems, obtaining their moisture from groundwater during the dry season. Riparian lands occupy only a small proportion of the landscape but they frequently have a much higher species richness and abundance of animal life than adjacent habitats (Knapton 2009).

Extraction of water from the Roper River has the potential to impact on the values of the river, both ecologically and socially. Reduction in available water can impact on the tourism values, cultural and pastoral uses and values, and the habitat available to fauna.

Other significant water features in this region are:

- Mataranka Thermal Pools;
- Elsey National Park;
- Red Lily Lagoon / 57 Mile Waterhole;
- Flying Fox Creek;
- Mainoru River;
- Wilton River; and
- Billabongs (e.g. Nulawan).

3.1.2 Water Supply

Residential communities and the ecological value of the area rely heavily on the quality, quantity and timing of water in the Roper River. Changes to the flow regime and/or quality of water from the Roper River caused by the extraction for AIR has the potential to impact on these communities.

3.1.3 Tourism

Tourism, whilst not major in this region, is becoming more significant with people visiting national parks, the Roper River and parts of Arnhem Land. Continued growth of tourism is possible in the future, particularly with increasing opportunities for ecotourism and indigenous tourism ventures run by indigenous communities.

Well known features frequented by tourists in the region include:

- Mataranka Thermal Pools;
- Fishing near Mataranka and on the Roper River;

- Elsey Station, made famous by Jeannie Gunn's book "We of the Never Never"; and
- Art and craft at the Aboriginal community of Manyallaluk.

3.1.4 Pastoralism

Local rivers support the pastoral industry which is the largest land use in the region, as well as a number of indigenous communities. Pastoralism is the dominant land use in terms of area and although not considered to be intensively managed, the land is still important as pastoral land and impacts to the river or surrounding landscape could have a negative impact on this industry. The project falls within the Numul Numul Pastoral Lease.

3.1.5 Indigenous Sites of Significance

Some sites of significance exist close to the proposed works area, and further studies will be initiated to determine any other sites that have potential to be impacted by the proposed mine. An Aboriginal Areas Protection Authority certificate has already been received but an updated certificate will be sought to encompass additional areas that have since been included in the proposal.

Archaeological Survey

An archaeological survey was conducted of the site in September 2011. The survey was carried out over one and a half days by Christine Crassweller accompanied by representatives from EcOz and the Roper Valley Community (refer to PER Appendix E Archaeology Survey Report).

No archaeological or historic sites or objects were identified during the survey. A stone cairn was observed on the summit of an isolated hill but as the hill was located within the restricted area of a sacred site, it was not possible to examine the cairn closely.

The absence of any archaeological material is consistent with previous findings of other surveys in the region and is most likely related to the environmental conditions and processes that occur in the area. There were no rock outcrops present containing a suitable raw material that could have been used in the manufacture of stone artefacts. The undulating plains consisted of either black cracking soils or red silty soils. These two surfaces result in a very low archaeological visibility as any stone artefacts that had been discarded in the past would have been covered by the silts in the wet season floods or soil during the expanding and contracting of the clays in the wet and dry seasons. The surface has also been churned up by cattle, as the area has been used as holding paddocks.

Consequently, while surface visibility was extremely poor at the time of the survey, it was assessed that there was only a low potential for the presence of any unidentified significant archaeological material within the subject land.

No further action was deemed to be required for compliance with the provisions of the *Northern Territory Conservation Act 1991*.

3.2 Identified Impacts

AIR recognises the importance of identifying responsibility for the reduction of impacts and developing methods for effective engagement with interested / impacted parties.

Impacts likely to result either directly or indirectly from the SILL80 Project include, but are not limited to:

- Increased sedimentation and erosion;
- Changes to access, including reduction in accessibility to traditional or farming lands;
- Direct impacts to the operation and management of Numul Numul Station;

- Clearing of native vegetation impacting visual amenity of the area;
- Fragmentation of fauna habitat;
- Increase in feral animals which may come into the disturbance area;
- Water extraction from Roper River leading to changes in flow regime and timing as well as impacting on tourism, recreation and indigenous cultural activity/beliefs;
- Increases in noise, air pollution (dust) and vibration;
- Increased vehicular movement on site and nearby roads can lead to an increase risk of accidents, increased issues with erosion and general road condition, and visual amenity and road kill; and
- Impacts on indigenous sites of significance within and in close proximity of the mining lease. There is some risk of increased awareness leading to increased visitation and potential vandalism, and impacts from mining such as dust and direct impacts (destruction).

AIR has been in consultation with stakeholders from early in the planning stage to determine an acceptable closure plan and will work towards this as mining progresses. Options have been presented to the community to date, such as leaving infrastructure behind to assist in future endeavours (e.g. storage sheds and roads).

3.3 Cumulative Impacts

The Roper Gulf Region has several mining operations either currently in operation or going through the planning stages. Cumulative impacts can occur from the compounding activities of a single operation or multiple mining operations, as well through the interaction of mining impacts with other past, current and future activities not related to mining (Franks et al. 2009). Assessing and managing cumulative impacts will require strong coordination between all stakeholders within the catchment.

Some cumulative impacts that may occur within the Roper River Region include:

Transportation

The SILL80 Ilmenite Project will transport product by road (Roper and Stuart Highways) to the Port of Darwin. Up to 20 trucks will travel to and from the site per day when production capacity is reached. This could impact on the level of road safety in the region, impacting both tourists and residents of the NT, and well as reducing the overall condition of the road, increasing incidents of road kill, and creating visual impacts, vibration and noise.

Roper River

AIR proposes to extract water for processing operations from the Roper River. Other communities and pastoralists also extract from the river. Currently ‘cease to flow’ events occur for an average of 18 days per year. This will potentially be impacted on by increased water extraction from the Roper River, impacting on users and visual and social amenity.

Concentration of proposals within the Roper River Region

This can affect the region as a whole, in particular tourism, recreation and cultural values, but can also be a positive influence, bringing training and employment opportunities to the region.

3.4 Outcomes from Workshop

A workshop was held on the 5th of September 2011. Information booklets (‘story books’) were distributed and four key issues were discussed.

Cumulative impacts of water extraction from the Roper River and increases in traffic were considered the most significant potential social and cultural impacts for this region.

In identifying potential social and cultural impacts, particular consideration was given to:

- The life of the project and potential accumulation of impacts over time;
- Changes in access to land for commercial, traditional or recreational purposes;
- Environmental impacts that may cause permanent or temporary loss of culturally important natural resources, such as significant flora and fauna (e.g. medicinal plants);
- Any cultural importance placed on the Roper River, or by people that may be affected by the extraction of water from the river;
- Impacts on the communities of Minyerri and Roper Valley such as access and visual amenity; and
- Increases in traffic in the region associated with transport impacting on quality and safety of roads and tourism.

3.4.1 Site Access and Traffic

Issues were raised concerning access to the mine lease (ML27422) through the existing Hodgson River Road and existing Numul Numul Station tracks. The volume of traffic and its proximity to Roper Valley and a nearby sacred spring were highlighted as concerns.

Discussion centred on:

- Traffic volume on Hodgson River Road;
- Road degradation resulting in reduced access to Roper Valley and Minyerri;
- Current tracks through Numul Numul Station exist in an exclusion area – no road development through this area would be allowed;
- Drainage issues and dust on roads;
- Dust management near living areas; and
- The need to widen the Hodgson River Road would affect a sacred spring near Roper Valley.

Potential management tools identified included:

- Warning signs;
- Speed limits of less than 40km per hour near living areas; and
- Continued grading and dust suppression activities.

Alternative access to ML27422

During the discussion, it was proposed that a new track could be developed south of ML27422 to prevent the use of existing Numul Numul station tracks passing through identified exclusion zones, although this would not mitigate the issues concerning the Hodgson River Road. This option was discussed further following the meeting and a new access road route was identified through aerial surveys and then ground truthed with TO's from Roper Valley (Figure 3-1). This option has been selected as the best outcome for the broader Roper Valley Community, Numul Numul Station and AIR. See Section 0 for information regarding the Formal Access Agreement between Flying Fox Station and Numul Numul Station.

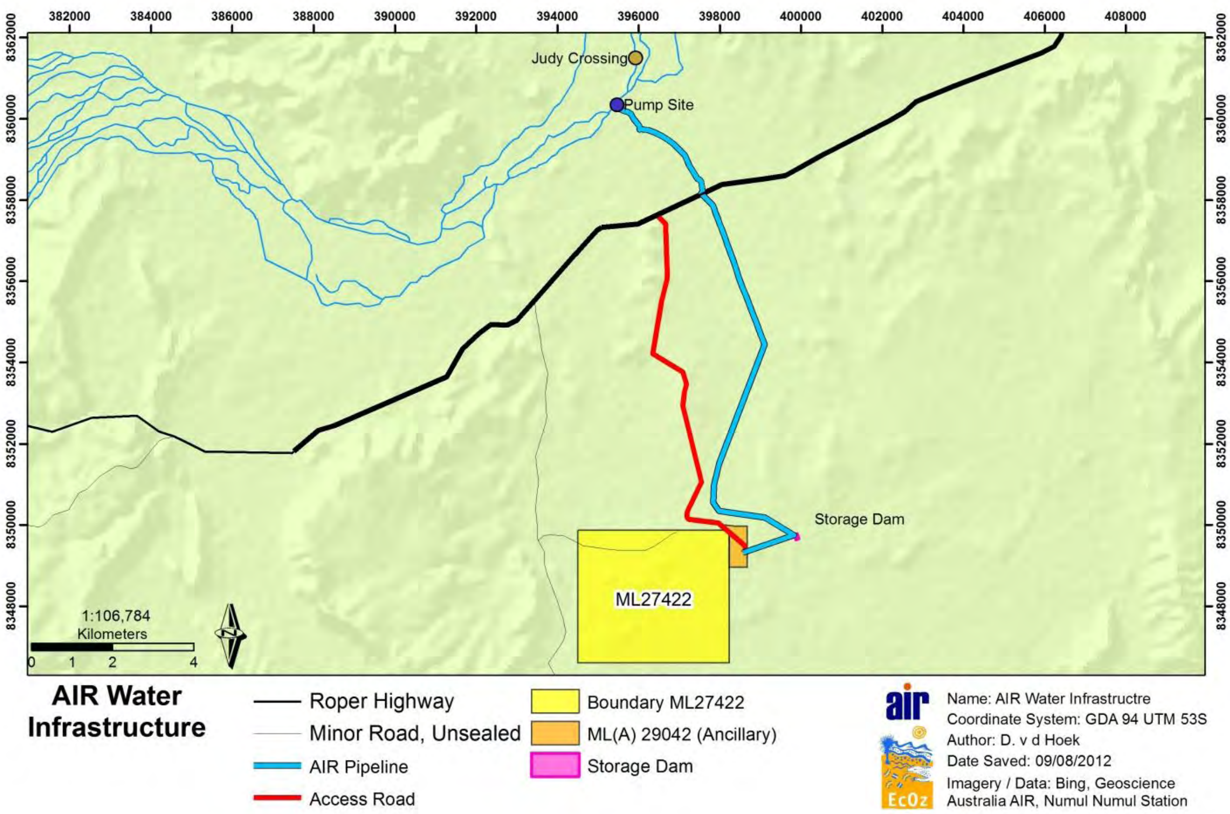

Figure 3-1. Proposed access route to ML27422

3.4.2 Infrastructure

Options were discussed regarding AIR returning the site to its original state or retention of some infrastructure such as sheds and roads.

Stakeholders indicated that the shed may be of use, although it would need to be moved to Roper Valley.

Stakeholders highlighted the difficulty in planning so far in advance (in excess of 20 years) or being able to visualise future requirements. Further discussion would be essential to confirm requirements, and stakeholders indicated that this should occur closer to closure date.

3.4.3 Rehabilitation

Stakeholders were provided with details of planned rehabilitation including the plan to mine and progressively rehabilitate over the course of mining, involving an area of approximately 25 hectares at a time.

Stakeholders detailed some recommended processes for rehabilitation with native bush recruited from seed stock in the top soil, complimented with some improved pasture species such as Sabi Grass. This was further adapted post meeting and it was determined that land would be rehabilitated to a healthy perennial grass rangeland with a diverse mix of plants, both native and introduced (i.e. non-declared species) (refer to PER Appendix K Rehabilitation Management Plan).

All stakeholder groups agreed to this rehabilitation approach.

3.4.4 Water Extraction

The concept of water extraction for mining purposes was discussed, however as details were yet to be finalised it was agreed that further meetings would be necessary at a later date.

3.4.5 Other

Members of the broader Roper Valley Community informed AIR that an existing rubbish dump requires work to be upgraded or may require relocation, as it is currently subjected to seasonal inundation. It has since been agreed that AIR will establish their own landfill, subject to design specifications and compliance with the *Waste Management and Pollution Control Act 1998.* Air may negotiate short term use of the existing landfill at Numul Numul Station prior to establishment of the AIR operated landfill.

3.4.6 On-going Consultation

AIR will undertake half yearly committee meetings with Traditional Owners and representatives from the Northern Land Council to discuss project operation, issues and commitments.

Consultation with Numul Numul Station land managers will be performed on a regular informal basis concerning access and daily operations to be detailed in the Formal Agreement with the current Land Manager.

4 Mitigation, Management and Monitoring

4.1 Mitigation and Management

4.1.1 Social and Cultural Commitments

AIR have made the following commitments to ensure appropriate mitigation and management of social and cultural impacts (also refer to Commitments PER Appendix M):

Commitment	Beneficiary
AIR will employ at minimum 3 people for local communities equating to a 12% indigenous employment commitment	Local communities
AIR will provide a list of local businesses and individuals with relevant skills and services to all contractors to promote local economic growth; list will also be displayed within the camp for employee use and updated annually	Local businesses
AIR will erect fences to exclude stock and other large animals, from hazardous areas such as the processing area, mine pit and internal roads.	Land Managers
AIR will monitor water extraction and Roper River flows at the extraction point as well as information obtained from Red Rock and Mataranka Gauging stations as detailed in the WMP	All stakeholders
Bi-annual consultation with TO's and affected land holders	Local communities and land managers
Relevant stakeholder input or concerns will be addressed within the annually updated Mining Management Plan (MMP)	All stakeholders
AIR will have a complaints register and a corrective actions procedure outlining the handling of complaints	All stakeholders
Maintain land-owner and land-manager property access at all times, and where fences are breached temporary stock proof gates will be provided;	Land owner and land managers
All staff will undergo an induction which includes details on social and cultural impacts and management, 'cease work' protocols and access limitations.	All stakeholders
Whilst on site, workers, contractors and visitors will be restricted from accessing culturally sensitive areas. Any inappropriate behaviour will be responded to promptly, and the induction revised if necessary.	Traditional Owners
No disturbance to archaeological, historical or cultural features;	All stakeholders
Maintain a current Aboriginal Areas Protection Authority Certificate to protect areas of cultural importance from disturbance by the SILL80 Project.	Traditional Owners
Immediate cease of work and assessment of any new archaeological, historic or cultural discoveries during works; Notification of relevant authorities in accordance with the Northern Territory *Heritage and Conservation Act* and the *Sacred Sites Act*.	Traditional Owners
Roads will be maintained for use by the pastoral station as per the land use agreement. If complaints are made about this, it will be handled through the complaints register.	Land managers
No AIR employees will be allowed to use roads other than approved mine access roads unless appropriate permission from mine and pastoral staff is given or in the event of an emergency	Land managers and land owners
AIR will revegetate mined areas with the aim of the land going back to pastoral production as detailed in the Rehabilitation Management Plan and in close consultation with pastoral	Land managers and

managers.	land owners
Commitment regarding development of mine closure plan – two years before planned closure – and submitted for approval (DoR) - Prior to the completion of mining operations, consultation with landowners will be undertaken to determine the fate of all mining infrastructure, including the processing plant, concrete pad, sheds, office, roads and any other infrastructure in place	Land managers and land owners
All employees, contractors and site visitors will undergo inductions which will include information on environmental, social, cultural impacts and management, 'cease work' protocols and access limitations. AIR will also maintain an induction register specifying persons and dates of inductees.	All stakeholders
Annual external audits of AIR's performance against the MMP and EMP, commitments stated in this PER, and all relevant and current legislative requirements will be conducted.	All stakeholders
All applicable legislation will be followed and all applicable licences and permits will be obtained before the relevant aspects of the project commence.	All stakeholders

4.1.2 Additional Employment Opportunities

AIR will initially purchase a series of trucks to transport concentrated Ilmenite to Darwin. Additional employees will be required to operate these vehicles. AIR envisages contracting the transportation requirements to a private company once processing rates have stabilised, therefore providing additional employment opportunities for the broader community.

4.2 Formal Agreement with Landholders

AIR are in the process of developing a formal agreement with the current land managers of both Numul Numul Station and Flying Fox Station. There have been recent meetings between the parties with proposed terms and conditions being developed into a draft agreement, good faith negotiations are continuing. The agreement is expected to contain detail concerning;

- Protocol of Entry;
- Contracted Work;
- Agreement to ensure operation of pastoral lease will be maintained despite AIR's operations;
- Shared infrastructure, agreement of use and communication methods and procedures; and
- Annual Compensation.

4.3 Complaints Register

AIR will establish an incidents and complaints register. All complaints received and incidents reported will be logged within the Incidents and Complaints Register (see example template below, Figure 4-1), information contained in the report will be, at minimum:

- Date and time of the complaint or incident;
- Contact details of the complainant if known, or where no details are provided a note to that effect;
- The nature of the complaint or incident;
- The nature of the events that gave rise to the complaint or incident;
- Prevailing weather conditions and any other factors of note at the time of the complaint or incident;

- Detail of the actions taken in relation to the complaint or incident, including follow-up contact with any complainant; and
- If no action was taken, detail explaining why actions were not warranted.

Incidents that cause or are threatening to cause pollution resulting in material or serious environmental harm will be reported to NRETAS as soon as practicable and in any case within 24 hours after first becoming aware of the incident as per the *Waste Management and Pollution Control Act.* All identified issues and outcomes will be detailed in the annual MMP update.

INCIDENTS REGISTER			
Complaint/Incident #		**Date Received**	
Time Received	**Received By**	**phone/email/letter etc**	**Date Acknowledged**
CUSTOMER INFORMATION IF APPLICABLE			
Complainants Name if Applicable	**Address**	**Phone**	
Email Address			
COMPLAINT/INCIDENT DETAILS			
Date Problem Occurred			
Area affected by Complaint/Incident	**Business Area**	**Responsible Person/s**	
Complaint/Incident Details			
Recommendations			
Outcome (e.g. what actions taken, referred, declined action, complaint withdrawn etc)			
Date of feedback to Client if applicable		**Approved By**	

Figure 4-1 Incidents and Complaints Register

5 Definitions and Acronyms

Acronyms

AIR	Australian Ilmenite Resources
ILC	Indigenous Land Corporation
NLC	Northern Land Council
PER	Public Environmental Report
RWA	Restricted Works Area
SCAR	Social Cultural Aspects Report
TO	Traditional Owner

Definitions

Archaeological Material	Assemblage of artefacts / material / cultural remains of a particular past human society
Capacity Building	Understanding the obstacles that inhibit groups of people from realising their developmental goals while enhancing the abilities that will allow them to achieve measurable and sustainable results. Encouraging participation and responsibility for the outcome and sustainability of developments. Engaging stakeholders who are directly affected by the situation allows for more effective decision-making, it also makes development work more transparent.
Cumulative Impact	Cumulative impacts associated with the SILL80 Ilmenite Project are defined as the successive, incremental and combined impacts of an activity on society, the economy and the environment either directly or indirectly by the projects' activities (either positive or negative) over the duration of the project and beyond
Custodian / Traditional Owner	The term traditional owners is often used when describing Aboriginal peoples' connection to the land, but also in the native title process. The roots of the term traditional owner seem to lay in the Aboriginal Land Rights (Northern Territory) Act 1976, which established ways for Aboriginal people to claim land in the territory on the basis that they were the "traditional Aboriginal owners" of the land [29]. According to the Act the definition of 'traditional Aboriginal owners' is "...a local descent group of Aboriginals who: (a) have common spiritual affiliations to a site on the land, being affiliations that place the group under a primary spiritual responsibility for that site and for the land; and (b) are entitled by Aboriginal tradition to forage as of right over that land."

Stakeholder	A party that has an interest in an enterprise or project. This can include the primary stakeholders in a typical corporation such as investors, employees, customers and suppliers. However, stakeholders can also be widened to include the community, government and trade associations.

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Appendix D1 – Story Book

* Information presented on 5th September 2011 – some of this information is now out-dated

Australian Ilmenite Resources

SILL80 Project (Numul Numul Station)

Purpose

- This booklet is provided to detail the AIR SILL80 project.
- The booklet outlines the planned development of the Ilmenite mine
- Group meetings will be arranged to discuss the issues from this booklet further

Ilmenite

Ilmenite ($FeTiO_3$), is a mineral, most commonly used to produce titanium dioxide (TiO_2), which is an important base pigment in paint, paper, and plastics.

Australian Ilmenite Resources plans to export ilmenite to China.

This mine would operate for about 20 years.

Mining

Ilmenite minerals occur near the surface.

Excavations will be down to 3 meters.

Pits will be 500 meters long and 50-100 meters wide.

After each pit has been mined – unused material will be placed back into the pit and planted out with either grasses or bush vegetation.

Processing

Excavated material will be refined to an Ilmenite concentrate onsite.

The refinement process requires water to be mixed with the excavated material.

This mixture is then run through a series of spirals called "Wash Trommels".

Ilmenite concentrate will then be put into 2 tonne bags before being trucked to Port Darwin.

Processing Plant

The processing plant will consist of;

- Processing shed (50m x 35m)
- 3 spiral wash trommels
- Water recycling unit
- Site office
- 3,000,000 litre water storage in a sealed rubber bladder
- 75,000 volt diesel generator
- Diesel fuel tank and pump

Transport

Ilmenite will be trucked from the mine to Darwin, everyday except during the wet season.

Trucks will use the Stuart Highway, Roper Highway and the Hodgson River Road.

At full production;

• 26 x 107 tonne road trains going out and into the mine site

= 2.6 road trains (with up to 3 trailers each) every 1 hour.

26 trucks per day

Map of Truck Route

Water

Water for the mine will come from the Roper River.

600,000 litres of water (¼ of an Olympic swimming pool) will be taken everyday.

Water use will be limited to make sure the Roper River always has water flowing.

Water will be pumped from the river to the mine.

The mine will have a recycle system so that 60% of water can be used again.

Rehabilitation

After an area has been mined – it will be backfilled with remaining material.

These areas will then be planted with species to revegetate. This can either be;

- A mixture of species to return the area to bush or/
- Pasture grasses to increase the productivity of the land as a pastoral property (i.e sabi grass)

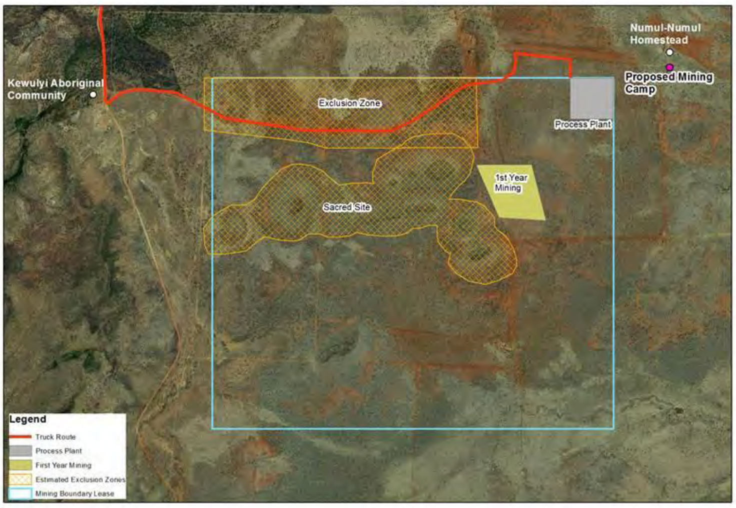
Employment

The mine will employ between 5 and 10 full time staff.

2 staff will be from Roper Valley.

Up to 30 more jobs will be made to truck the Ilmenite to Darwin.

Mining Lease Layout



Mining Camp

To be located off Mining Lease (near the Numul Numul Homestead).

The camp will accommodate 10 people.

Camp will comprise;

- Relocatable Donga buildings with en-suite
- Communal mess area
- Camp Kitchen
- Workshop area
- Car park for 15 vehicles

Animals

Surveys have been performed to see what animals are present at the mine site.

Measures will be made to minimise the impact on native animals.

Mine Closure

After mining has finished – the area will be rehabilitated.

Buildings and tracks built for the mine can be left in place – or removed.

Things to Discuss

- Transport
- Noise and Dust
- Rehabilitation (returning country back to the way it was or improved pasture for cattle).
- Water – (Roper River flows)
- Site Access – sacred sites
- Jobs
- Mine closure – things (roads, shed etc) to leave in place

Notes:

Contacts

- Australian Ilmenite Resources, PO Box 947, Darwin, NT 0801 – (08) 89 41 32 13
- EcOz Environmental Services, PO Box 381, Darwin, NT 0801 – (08) 89 81 11 00
- Northern Land Council, PO Box 396, Katherine, NT 0851 – (08) 89 72 27 99

ARCHAEOLOGY REPORT

A CULTURAL HERITAGE SURVEY

FOR THE PROPOSED

SILL 80 PROJECT ON NUMUL NUMUL STATION, NT

A report for EcOz VDM

On behalf of Australian Ilmenite Resources.

Begnaze Pty Ltd
Christine Crassweller
8 Wanguri Tce
Wanguri NT 0810

September, 2011

SUMMARY

No archaeological or historic sites or object were identified during the survey. A stone cairn was observed on the summit of an isolated hill. However as the hill was located within the restricted area of a sacred site, it was not possible to examine the cairn closely.

Therefore no further action is required for compliance with the provisions of the *Northern Territory Conservation Act, 1991.*

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FIGURES

PHOTOS

1.0. INTRODUCTION

This report describes a cultural heritage survey that was carried out over sections of Numul Numul and Flying Fox Pastoral Leases that may be disturbed by Australian Ilmenite Resources for their proposed Sill 80 Project. The project intends to mine ilmenite which is found in the top three metres of the surface. Begnaze Pty Ltd was engaged by EcOz VDM Environmental Services to undertake the survey, the result of which will be included in a PER for Australian Ilmenite Resources.

The proposed mine is located approximately one kilometre east of the Roper Valley Community which is nine kilometres south of the Roper Highway and 110 kilometres from the Stuart Highway. The land proposed for mining covers an area of 3.75 x 3.25 kilometres. A proposed access road from the Roper Highway to the mine site and a proposed pipeline route from the Roper River to the highway were also surveyed. The pipeline will run adjacent to the access road from the highway south to the mine (see Figure 1).

The survey was carried out over one and a half days by Christine Crassweller accompanied by Casey Hawkey from EcOz and two traditional owners, Estelle Farrar and Mildred Ponto from the Roper Valley Community

2.0 BACKGROUND INFORMATION

2.1. Environmental

The area is located within the Dissected Gulf Fall physiographic division consisting of broad valleys lying between strike ridges of sandstone (Aldrick and Wilson 1992). The majority of the subject land consists of either flat to gently undulating plains, or undulating to rolling hills and low rises. The underlying geology consists of Derim Derim Dolerite and there are hills to the east and south made up of the Kyalla Formation of embedded siltstone mudstone and very fine grained quartz sandstone, which are suitable materials for manufacturing stone artefacts (Abbott *et al*. 1992).

Drainage in the region is controlled by the series of sandstone ridges which results in the accumulation of sediments in broad shallow valleys. There appears to be only one creek, the headwaters of Blackwater Creek, in the southeastern section of the survey area.

The vegetation consists of Vegetation Unit 16 of woodlands of *Eucalyptus tectifica* (Northern Box) and *Eucalyptus terminalis* (Bloodwood) with a grassland understorey (Wilson *et al.* 1991).

2.2. Ethnographic / historic background

The first recorded description of the inhabitants of the region was by the explorer Leichhardt (1964: 442-451) who crossed the area in 1845. Evidence of Aboriginal occupations included fish traps, camps sites with the remains of fish and mussels, well-worn footpaths, burnt areas and frequent grinding stones used to pound seeds. He also noted that the camps near the Roper River appeared older than those surrounding the billabongs from the freshness of mussel shells and the evidence that burning had occurred earlier in the season. These descriptions correspond with the earliest research in northern Australia investigating Aboriginal subsistence strategies and material culture, which was carried out by Basedow (1907), Foelsche (1882), Thomson (1983) and Spencer (1914). Their observations describe general information regarding Aboriginal life including the various weapons and other implements used during the contact period in the Top End. The early accounts (Basedow 1907, Foelsche 1882) describe swamps and lagoons as being focal points of subsistence activities providing sources of fish, geese, ducks, turtles, crocodiles and their eggs, shellfish and the roots of water lilies and rushes. Away from the lagoons, wallabies, snakes, goannas and other small game were hunted. Seasonal factors were a key determinant on camp locations, types of residential grouping, the degree of mobility and the nature of subsistence activities. During the wet season groups of people would have been able to access resources over a wider area, as water was readily available, and higher uplands used to avoid the rivers and tributaries. In the dry season as water receded, the location of camps would have contracted to more permanent sources of water.

The finding of gold in Pine Creek in the early 1870s and the beginning of the pastoral industry in the late 1870s resulted in the movement of cattle and people through the region from Queensland. During the period of pastoral expansion Aboriginal inhabitants started to leave their traditional life style and work on the stations. It was also a time when there were a number of violent conflicts because of the loss of access by Aboriginals to resources and the pollution of waterholes by cattle. The Aboriginals fought back by cattle spearing at waterholes and the pastoralists retaliated by denying access to the water holes by patrolling these areas and shooting Aborigines (McGrath 1987).

2.4. Archaeological background

There have only been two archaeological surveys in the vicinity of the subject area. The Kinhill (1995) archaeological survey along the northern side of the Roper Highway consisted of vehicular surveys along the route to assess the areas of higher archaeological potential. The survey identified a quarry / stone artefact scatter and three stone artefact scatters which were located in eroded areas near a source of fresh water. Kinhill (1994) concluded that as the banks of the creeks along the route were not raised above the level of the surrounding landscape, the banks would consequently be subjected to frequent flooding which tends to remove any artefacts deposited on them. It also means that there would be no higher ground along the creeks that could act as a focal point for campsites.

The Kinhill report (1995:4-10) also stated that 'the lack of artefacts close to the numerous creeks and rivers crossed …was surprising". However, as the survey found that approximately 50% of the northern boundary of the Roper Highway had been disturbed by gravel pits, top soil mounds, vegetation clearance and fence construction (Kinhill 1995:4-8) this could also explain the lack of archaeological material.

Guse (1998) carried out a survey near the Wilton River near Urapunga and identified a stone artefact scatter and grinding stone on a stony surface on an alluvial plain, and several isolated stone artefacts. The site was a medium density artefact scatter containing chert, siltstone, quartzite, silcrete and tuff flakes.

The Archaeological Sites Register held by the Heritage Branch lists only one other site in the region, a stone artefact scatter eroding from a levee of the Roper River.

Another survey (Crassweller 2008) between Ngukurr and the Wilton River and along 20 kilometres of a proposed power line on a flat to undulating plain with low stony / rock outcrops line, failed to identify any archaeological material.

Further afield, previous archaeological surveys in the Mataranka region (Thorley and Blackwood 1993: Hermes 1986: Guse and Niemoeller 1998: Kinhill 1994 and 1995) found that all identified sites and isolated stone artefacts were clustered around major creek systems especially where these are abutted by high ground such as terraces or hill slopes, or outcrops of Tindal limestone containing chert nodules.

An archaeological survey along a proposed pipeline route in the Bulman region (Crassweller 2004), which has a similar environment to the study area, identified very few archaeological sites. However there was a regular frequency of isolated stone artefacts. There was a 34 kilometre section along the pipeline route where no archaeological material was located.

2.5. Predictive model for distribution of archaeological material

The ethnographic data indicate that the banks of creeks and billabongs were frequently used as camp sites in the past. The archaeological background information suggests that any archaeological material will be distributed along eroded surfaces or higher ground near creeks and rivers. Due to the high sedimentation rate on the plains and undulating terrain there is only a very low potential for archaeological material in this environment and, as the majority of the higher ground is located within the boundaries of a sacred for there is only a low potential for archaeological material in the remaining low hills which do not contain a suitable raw material for manufacturing stone artefacts.

3.0. FIELDWORK PROCEDURES

3.1. Field survey

The aim of the archaeological field survey is to locate and record any archaeological objects or places to ensure that the provisions of the *Northern Territory Heritage Conservation Act 1991* are not contravened. The archeological survey was carried out as follows:

- The survey was carried out by both pedestrian and vehicular transects in a manner that ensured the highest possible coverage of the area. Approximately a third of the subject land was not surveyed, as access is not permitted due to several sacred sites in the area. These areas consisted of a section along the east west track in the northern section of the survey area and a series of hills in the mid to western section of the survey area.

  Pedestrian transects were made over all the remaining hills and rises on the alluvial plain. As surface visibility was extremely poor (average visibility was less than 5%), small areas where visibility was higher were targeted. Vehicle transect were made along all existing station roads.

- Any archaeological or heritage places, objects or classes of objects located during the survey were recorded in such detail as to permit independent assessment of their significance. The location of any archaeological places and objects included coordinates obtained by a hand-held Global Positioning System using GDA94 datum.

- After assessing the significance of the archaeological place or object, recommendations are made regarding compliance with the provisions of the *Northern Territory Heritage Conservation Act 1991.*

The following section consists of the definitions used to describe the archaeological material located during the survey.

3.1. Types of archaeological sites.

On the basis of previous archaeological studies in the region, it was considered possible that at least three types of sites might be discovered during the survey:

- *Artefact scatters.* These may contain flaked or ground artefacts and hearthstones. They occur as surface scatters of materials or as stratified deposits when there have been repeated occupations.

- *Art sites* that include engravings or poundings where the pictures or designs are produced by the removal of material from the rock surface.
- *Stone quarries* are generally sites where stone for flaked or edge ground artefacts have been extracted from an outcropping source of rock.

3.2. Site definition.

An archaeological site is defined for this survey as a concentration of artefactual material, such as stone artefacts, with an average density that is 5 times greater than the average density of the background scatter and there are more than ten artefacts that cover an area of at least $2m^2$. A site will have an identifiable boundary where either artefact densities decrease to the extent as to be classified as background scatter or environmental features determine the boundary.

Background scatter is generally a very low density, more or less continuous distribution of isolated artefacts or shell over the landscape. Although these artefacts do not constitute a site they will be given location details for research purposes.

3.3. Artefact identification.

A requirement for a successful archaeological project involves the accurate identification of archaeological materials. For an object to be identified as a flaked object it needs to possess one or more of the following:

- A positive or negative ring crack;
- A distinct positive or negative bulb of percussion;
- A distinct eraillure scar in an appropriate position below the platform; and
- Definite remnants of flake scars on dorsal surface or ridges.

Stone artefacts are divided into 4 main types (Hiscock 1984:128-129). They are defined as follows:

- *Cores* are pieces of stone that have one or more negative scars and the absence of positive flake scars
- *Unretouched flakes* are pieces of stone that have been struck off another piece of stone and ideally possess platforms, positive bulbs of percussion, concentric ripples, ring cracks and /or eraillure scars on the ventral surface.
- *Retouched flakes* are flaked flakes. They are identified by the presence of negative scars that must have been created after the ventral surface of the flake had been created. There will be either negative scars on the ventral surface or negative scars on the dorsal surface, which have been formed by the flake being hit on the ventral surface.
- *Flaked piece*s are stone artefacts that have been formed by knapping but cannot be identified as either a core or a flake.

Other artefact and implement types that have been identified in the region are listed below following characteristics outlined by McCarthy (1976) and Holdaway and Stern (2004).

- *Unifacial points* are flakes that have been retouched along the margins from one surface, either ventral or dorsal to give or enhance its pointed shape. They are sometimes symmetrical or leaf shaped.
- *Bifacial points* are retouched along both ventral and dorsal surfaces of a flake to enhance or give the artefact its pointed shape. They may have the platform removed and the proximal end rounded.
- *Edge ground axes* have been shaped by the process of flaking, pecking and polishing. They generally have only one working edge that has been ground to a sharp margin although occasionally they may have two leading edges.

- *Grindstones* are characterized by a worn and abraded surface or surfaces. There also may be a concave surface.
- *Hammerstones* display use-wear on the surface in the form of the abrasion, pitting, edge fracturing with some negative scarring.
- *Manuports* are stone material that are not found naturally in an area and must have been carried in by humans.

3.4. Assessment of significance and heritage management principles

According to Sullivan and Bowdler (1984) archaeological significance means that it has scientific, archaeological or research value, that is, it has the potential to assist current or future research into problems of human history or other areas of enquiry. The Australian ICIMOS Charter for the Conservation of Places of Cultural Significance, otherwise known as the Burra Charter (Maquis-Kyle and Walker 1992:73) states that the scientific value or research potential of a place depends upon the importance of the data involved, on its rarity, quality or representativeness, and on the degree to which the place or object may contribute to further substantial information. Therefore the significance of a site is firstly related to the intactness or integrity of a site, that is, the state of preservation as well as the stratigraphic reliability of the cultural material. Secondly, the representativeness of a site is important either because a site is unusual or because the site has research potential when taken in conjunction with other sites. Thirdly a site may provide chronology extending back into the past.

4.0. RESULTS

The survey area was covered in dense grass and there were only small areas which were denuded of vegetation from either sheet wash on lower slopes of rises or from cattle damage. Also the area does not appear to have been burnt for many years resulting in an average surface visibility of less than 5%. There was a series of low rises and hills in the southwest corner which were examined in detail. Another pedestrian transect was made within the banks of Blackwater Creek as visibility on top of the banks was negligible.


Blackwater Creek


Surface around creek

Estelle on summit of hill Estelle and Mildred on a low stony rise

The proposed access road runs along slightly higher ground across the undulating plain, and the lower stony slopes of several hills in the area. The survey for the proposed access road was carried out by driving along station tracks to identify any higher ground or areas where surface visibility appeared to be high enough to see the surface. Approximately two kilometres of the proposed access road runs along an existing fence line.

Sheet wash area along proposed access road. Lower slopes along proposed access road

A pedestrian transect was made along 85% of the proposed 3.5 kilometre pipeline route from the Roper Highway to the Roper River. This area consisted of low levy banks near the river and a cracking clay plain for the reminder of the route. Average surface visibility over the route was on average higher than 40%.

Cracking clays and small wash away near Roper River.

No archeological material was identified in the survey areas. Both Estelle Farrar and Mildred Ponto used to walk the country when they were young and when asked if they knew of any areas where there were stone artefacts, they said that yes there were two areas where the 'sharp stones' are found. One was south of the survey area in the vicinity of Blackwater Creek and another site was located near the Roper Highway and the Roper River. They did not know of any sites within the subject land.

A stone cairn was sighted on the summit of a steep sided circular hill within the area designated as a sacred site. It was located at approximately 396850E 8348500N. As the cairn is in a no access are for the proposed project, the cairn will not be disturbed.

5.0. CONCLUSIONS AND RECOMMENDATIONS

As no archaeological sites or objects were identified during the survey of the proposed Ilmenite mine, access route and pipeline corridor, it is recommended that no further action is required for compliance with the provisions of the *Northern Territory Heritage Conservation Act 1991.*

The absence of any archaeological material is consistent with previous findings to other surveys in the region and is most likely related to the environmental conditions and processes that occur in the area. There were no rock outcrops present which contained a suitable raw material that could have been used in the manufacture of stone artefacts. The undulating plains consisted of either black cracking soils or red silty soils. These two surfaces result in a very low archaeological visibility as any stone artefacts that had been discarded in the past would have been covered by the silts in the wet season floods or lost in the clays during the expanding and contracting of the clays in the wet and dry seasons. The surface has also been churned up by cattle as the area has been used as holding paddocks.

Consequently, while surface visibility was extremely poor at the time of the survey, it is assessed that there is only a low potential for the presence of any unidentified significant archaeological material within the subject land.

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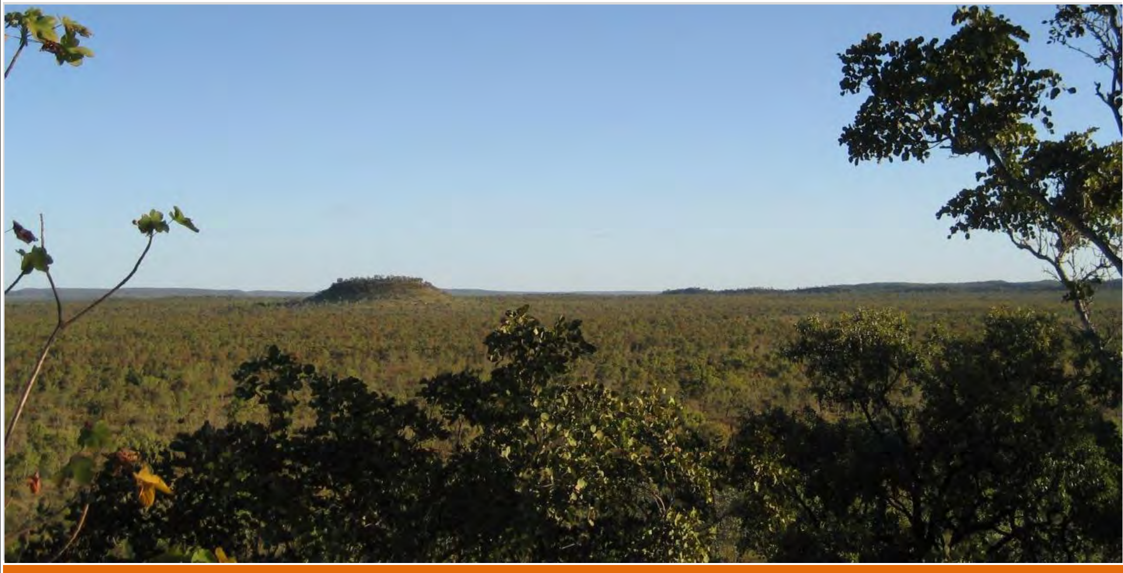
Appendix F - Radiation Survey

Australian Ilmenite Resources Pty Ltd

SILL80 Project,



2012



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1 Introduction

Australia has extensive deposits of mineral sands which comprise of titanium minerals (rutile and ilmenite) and zircon. Traditionally most of Australia's mineral sands occur on the east coast of Australia between Sydney and Fraser Island or on the southern section of the west coast. These mineral sands have been mined since 1934 and Australia has a major share of the world market for both titanium minerals and zircon.

Australia Ilmenite Resources Pty Ltd (AIR) is an Australian registered propriety company with significant assets of ilmenite and possesses mining rights in the Northern Territory. The AIR ilmenite resource of interest is the SILL80 deposit (ML27422) located on the Roper Highway, approximately 100 km east of the Stuart Highway. The SILL80 deposit covers an area of 1225 hectares, located entirely within Numul Numul Station (Figure 1-1).

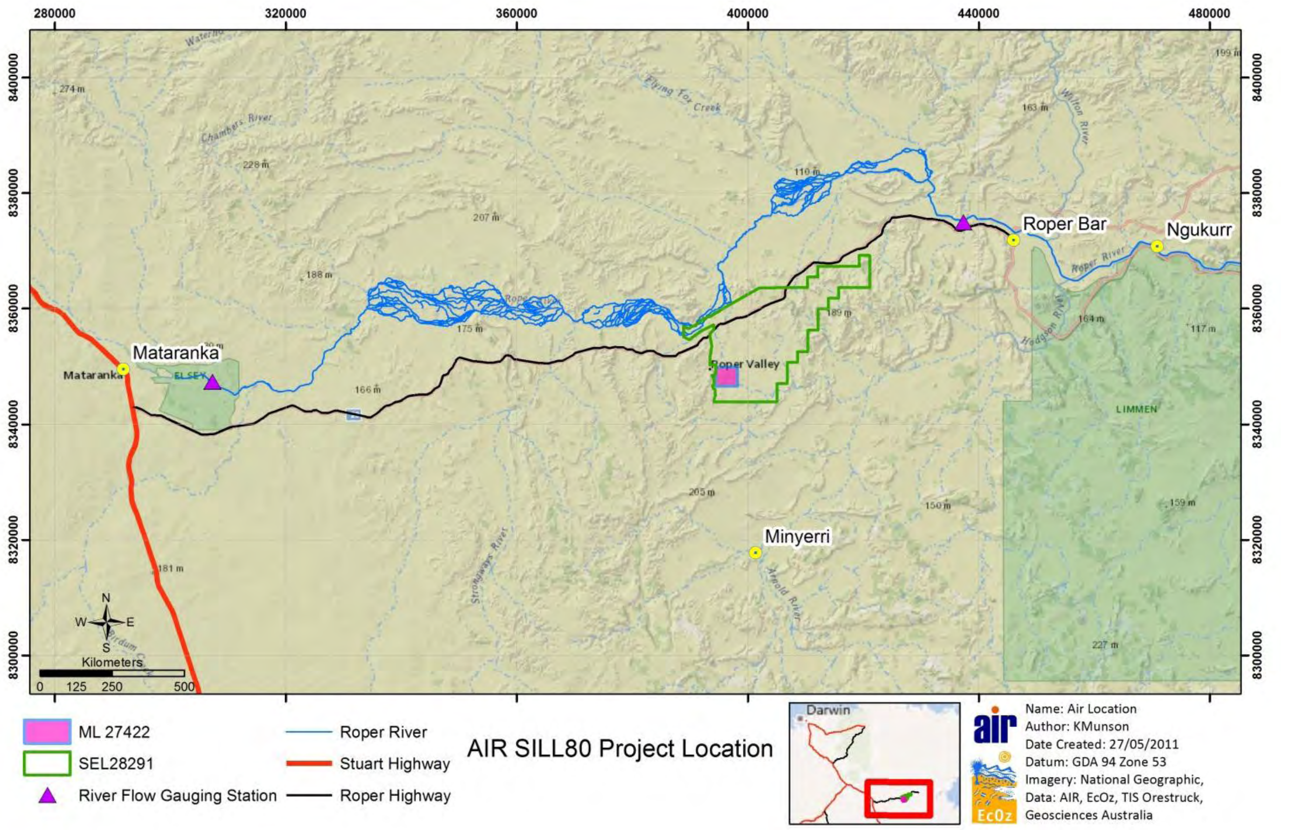

Figure 1-1 Location of the AIR Mining Lease.

1.1 Geological Setting

Ilmenite is a weakly magnetic titanium-iron oxide mineral which is iron-black or steel-grey (Figure 1-2). It is a crystalline iron titanium oxide ($FeTiO_3$). Ilmenite can occur in sedimentary detrital deposits known as "*placers"* and be concentrated into useable ores. Placers occur when a heavy, resistant mineral is mechanically and gravitationally sorted by natural processes into a recoverable deposit. Placers occur in river bends or behind river obstacles and in ocean shoreline mineral sand deposits where slower water currents allow the heavier minerals to settle.

The heavy minerals contained within the SILL80 project are still predominantly in-situ. The ore is believed to be at its original source and has not been reworked and transported as seen in many other classic heavy mineral sand systems These minerals have resulted from the breakdown of the original rock to form a soil in which it has retained the heavy mineral. The encompassing soils are either pisolitic or clay rich and as a consequence, the deposit has a heavy mineralised soil profile that requires simple extraction and processing.

Although the slime content of the Roper heavy minerals is high by industry standards (>50%), the unique characteristic of being derived from a single source lends to low variation (both chemical and physical) in the heavy mineral itself. Significantly, the soils are mineralised from the surface to in excess of 2-3m depth where the rock decomposition process is still underway.

Figure 1-2 Ilmenite is the dark grey material as seen here at the SILL80 deposit

Mineral sands can consist of up to 10% heavy minerals, of which 1-3% is monazite. Monazite is a rare earth phosphate containing a variety of valuable rare earth oxides (particularly cerium) and thorium oxide xenotime, containing yttrium. This subsequently means it can contain 5-7% of radioactive thorium and 0.1 - 0.3% of uranium, which has low radioactivity.

In the mineral sands ore, or general heavy mineral concentrate, the radiation levels are usually too low for radioactive classifications. However, when the material is concentrated in the process of separation and production the radiation levels are increased because of the subsequent concentration of radiation material, usually monazite. However, the SILL80 deposit has limited monazite content which means that radiation levels in the deposit are low. This is illustrated by the results in Table 4-2 and is discussed in the results section.

2 Project Description

EcOz Environmental Services was contracted by AIR Pty Ltd to conduct a baseline gamma dose survey of their SILL80 ilmenite resource located at ML27422 prior to the commencement of mining in this area. As the mine area is reasonably large, 1225 hectares, a gridded ground gamma survey over a portion of the area was conducted (Figure 2-2). A Thermo Scientific RadEye GX survey meter with calibrated MC 70 Geiger Mueller tube and Garmin CP60cx GPS mounted on tripod were used. This area has been identified by AIR as the first area of the mining lease to be developed and mined.

Multi-purpose radiological survey meters were used with external MC70 Geiger Mueller Tubes (Table 3-1). Measurements were taken 1 metre above the ground surface (Figure 2-1). Over 400 measurements were taken (Appendix F1, Table 7-3) to establish the baseline gamma radiation levels over this portion of the mineral lease.

Figure 2-1 Survey meter and Garmin GPS mounted on tripod

Once the mining operation and processing begins it will be necessary to conduct a radiological survey over the stockpile and processing area. This survey will establish the activity and the activity concentrations of the possible radionuclides of interest in the ore concentrates allowing the establishment of their radiation levels and if they fall below exemption levels.

Figure 2-2 Survey points at the SILL80 ilmenite deposit.

As stated in the Northern Territory Radiation Protection Act

*"The new legislation replaces the Radiation (Safety Control) Act. All current licenses and registrations issued under this Act continued at the start of the new legislation. The new legislation covers safe control of the use of all radiation sources (radiation apparatus or radioactive material). Natural sources of radiation may be included when exposure results directly from a practice. Generally, unmodified concentrations of radioactive material in most raw materials are **not** included, unless there is a possibility of significant radiation exposure.*

Activity and activity concentrations below exemption levels are obtained from the National Directory for Radiation Protection, published by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)".

The relevant clause and exemption levels from National Directory for Radiation Protection (ARPANSA) are

3.2.2 The criteria to exempt radioactive material 10 or practices from notification, registration and licensing are:

(a) The radioactive material has an activity concentration11 less than that prescribed in Schedule 412 or consists of or contains less than the activity prescribed in Schedule 4 as shown in Table 2-1.

Table 2-1 Exemption levels from National Directory for Radiation Protection.

Isotope	Activity Concentration (Bq/g)	Activity (Bq)
Th natural (includes ^{232}Th)	**1**	**1000**
^{238}U	**1**	**10000**
^{232}U	**10**	**1000**
U natural	**1**	**1000**

3 Radiological Survey Method

The survey was conducted over four days from Monday 4th to Thursday 7th July 2011. Baseline gamma radiation levels were measured at the selected gridded survey area. (Figure 4-1). There were no boundaries marked for the zone and all survey points were taken using a GPS and were referenced to co-ordinates, supplied by AIR.

Figure 3-1 Weed infestations on the AIR SILL80 ilmenite deposit.

The grid survey was carried out at regular spacing on a North - South, East - West grid over the mineralized zone; this zone covers an area of approximately 1225 hectares. The survey area was approximately 500 metres by 600 metres in size and encompassed the highest mineral content area as per the AIR assay data. This area was chosen by AIR as the area that would be developed initially and subsequent areas will be surveyed (radiological) before being developed.

Table 3-1 Specifications of the radiological measuring equipment used in the survey

Instrument Description	Manufacturer	Model	S/N	measurement	Range	Sensitivity
Multipurpose survey meter	Thermo Scientific	RadEye Gx	0314	Cps,cpm,Bq dps dpm Bq/cm^2 R/h Sv/h/ rem/h	9999kcps 9999kcpm 9999kBq 9999kdps 9999kdpm 9999 kBq/cm^2	
Geiger Mueller Tube	Mini Instruments	MC70	00828	55 keV to 2 MeV	<25% deviation	18 counts /second per 1μGy/hr[1]

A small proportion of the deposit was under thick, impassable vegetation, with dense weed infestations and vine growth (Figure 3-1). The area is also a working cattle station and an active grazing paddock. The initial grid survey was slightly modified to accommodate these factors and the survey point locations can be seen in Figure 2-2.

The spacing of the survey point measurements was approximately 20 to 30 m depending on accessibility. Measurements were taken with two gamma survey instruments and absorbed gamma dose rates measured at a height of 1 m above the ground level over a 60 second interval giving total counts. The geospatial coordinates (UTM WGS 84) of each measurement point were determined by a Garmin GPS 60cx. The precision of each GPS reading is typically ± 5 m (Figure 4-1).

Two soil samples were collected from the mineral lease area. These samples were taken from AIR Hole 407 and AIR Hole 447 and the associated AIR assay data for Ti and TiO_2. A radiological analysis on these samples was performed at the Commonwealth Government Department of Sustainability, Environment, Water, Population and Community Environmental Research Institute of the Supervising Scientist radiological laboratory using high-purity high resolution germanium gamma detectors and the results illustrated in Table 4-2.

Table 3-2 Statistical summary of absorbed gamma dose rates (μGy h^{-1}) from ML27422.

Statistic	Value
Mean	0.11
Standard Error	0.00
Median	0.11
Mode	0.10
Standard Deviation	0.02
Minimum	0.07
Maximum	0.17
Count	415

Details of the gamma spectrometry methods are described in Murray et al. (1987), Marten (1992) and Pfitzner (1994). Errors provided in the radionuclide summary Table 4-2 are one estimated standard deviation based upon counting statistics only. Detection limits for each sample vary depending on sample size, detector efficiency and background, and background concentrations of the given nuclide.

4 Results and Discussion

The co-ordinates for the background readings can be found in Table 7-1 in Appendix F1 as well as a summary table below (Table 4-1). Figure 4-2 also illustrates the locations for AIR auger Hole 407 and auger Hole 447 with Table 4-2 giving a summary of the radiological results for these holes and associated soil samples. Appendix F1, Table 7-3 and Table 7-2, show the raw data and the calculated absorbed gamma dose rates based on the measured counts and the instruments response as determined from previous calibration against a 137Cs source (Bollhöfer et al 2009; Bollhöfer & Fawcett 2009). The reported uncertainty in the calculated dose rates is one standard deviation based on counting statistics alone.

Figure 4-1 Survey points, soil samples, hole 407 and 447 and location of background readings.

Figure 2-2 gives a representation of the geospatial location of the individual measurement points. Figure 4-1 displays survey points for the SILL80 ilmenite deposit (red points) and soil samples, hole 407 and 447 from AIR assay information (green points) giving the relative position of these points in regard to the background measurement location (blue point). Figure 4-2 shows the magnitude of the calculated absorbed gamma dose rates (terrestrial component only) using contours over the designated survey area selected by AIR. It can be seen from these contour plots and the associated calculated absorbed gamma dose rates that radiation levels over the mineralized zone is low.

The low gamma dose rates over the mineralized zone are illustrated in a summarized form in Table 3-2 as standard statistics. It can be seen from these that the statistical mean over the mineralized zone was 0.11 $\mu Gy{\cdot}hr^{-1}$ and the maximum reading was 0.17 $\mu Gy{\cdot}hr^{-1}$. These measurements are still low and when compared to the background levels in Table 4-1 highlight the low radiological levels of the area. The background absorbed gamma dose rates were taken 3.5km from the SILL80 Ilmenite deposit.

Table 4-1 Background absorbed gamma dose rates ($\mu Gy\ h^{-1}$).

X	y	Calculated	Uncertainty	Mean	Standard Deviation
393533	8349659	0.15	0.011		
393533	8349659	0.13	0.011		
393533	8349659	0.15	0.011		
				0.14	**0.01**

The low gamma dose rates are assumed to be caused by two main factors. Firstly, the area does not have high concentrations of naturally occurring radionuclides in the surface materials. Secondly, the ilmenite is low in monazite sands, the source of radiation in most mineral sands. As previously stated this is not a placer deposit, it is an in-situ deposit that has not been transported away from its parent rock and therefore has not had the concentration mechanisms of nature that most mineral sand deposits have experienced and consequently the introduction and concentration of monazites. This has led to very low levels of radionuclides which are reflected in the results of the radionuclide analysis illustrated in Table 4-2 which calculated gamma dose rates from the survey and activity concentrations (Bq/kg dry weight) of radio-isotopes for the sampled holes with a comparison to AIR assay data for titanium (%) and titanium oxide (%) at the AIR SILL80 ilmenite deposit.

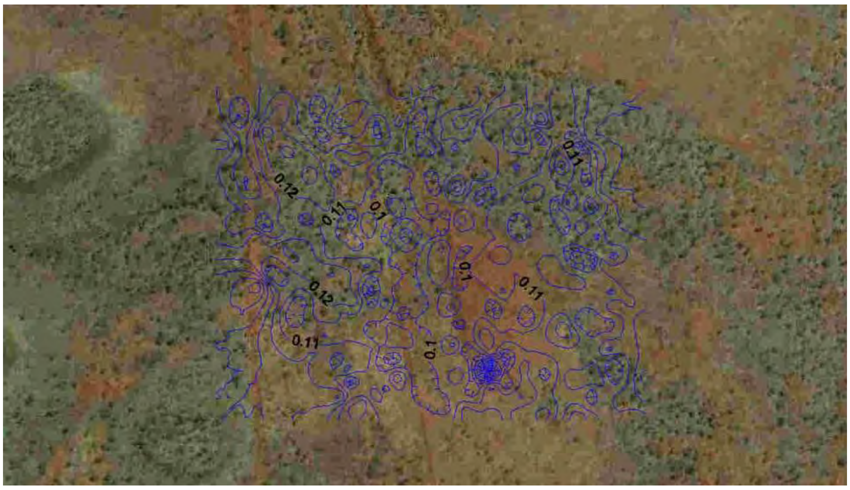

Figure 4-2 Contour map for the surveyed area

It should also be noted before any post mining work is conducted that similar surveys should be completed during similar climatic conditions. This is because if there is a significant amount of moisture present in the surface and subsurface material, emanation of radon from the ground can be significantly prohibited, thus reducing the response to the radon decay product Bi-214.

Table 4-2 Gamma dose rates and activity concentrations of radio-isotopes for the sampled holes.

Hole Id	Calculated µGy h^{-1}	^{238}U	^{228}Th	^{226}Ra	^{210}Pb	^{228}Ra	^{40}K	TiO_2	Ti
407	0.11	24 ± 7	38 ± 2	21 ± 1	73 ± 7	36 ± 2	219 ±14	6.7	4.0
447	0.12	< 17	27 ± 1	11 ± 1	< 13	31 ± 2	235 ± 12	13.8	8.3

5 Conclusions

The radionuclide activity concentrations in the soils associated with the ilmenite deposit surveyed are low. The gamma dose rate over the deposit is also low and is equal to or less then background levels in the area. With the above analysis in Table 4-2 there does not seem to be a significant correlation between Ti content and radionuclide levels in the survey area.

6 Glossary and Acronyms

Bq	The Becquerel (symbol Bq) (pronounced: 'be-kə-rel) is the SI-derived unit of radioactivity. One Bq is defined as the activity of a quantity of radioactive material in which one nucleus decays per second. The Bq unit is therefore equivalent to an inverse second, s^{-1}. 1 Becquerel (Bq) = 1 count per second = 1 event per second
cpm	Counts per minute
cps	Counts per second
dpm	Disintegrations per minute
dps	Disintegrations per second
$FeTiO_3$	Iron titanium oxide / Ilmenite
gamma	Electromagnetic radiation of high frequency (very short wavelength)
in-situ	Has not been moved from its original place of deposition
kBq	Kilobecquerel
kcpm	kilo counts per minute
kcps	kilo counts per second
kdpm	kilodisintegrations per minute
kdps	kilodisintegrations per second
KeV	Kilo electron volts / thousand electron volts, a measure of radiation beam energy
MeV	Million electron volts, a measure of radiation beam energy
placer deposit	In geology, a placer deposit or placer is an accumulation of valuable minerals formed by gravity separation during sedimentary processes
R/h	Roentgens per hour / The exposure rate expresses the rate of charge production per unit mass of air and is commonly expressed in roentgens per hour (R/h)
radio-isotopes	A version of a chemical element that has an unstable nucleus and emits radiation during its decay to a stable form.
radionuclides	A radionuclide is an atom with an unstable nucleus, which is a nucleus characterized by excess energy available to be imparted either to a newly created radiation particle within the nucleus or to an atomic electron. The radionuclide, in this process, undergoes radioactive decay, and emits gamma ray(s) and/or subatomic particles. These particles constitute ionizing radiation. Radionuclides occur naturally, and can also be artificially produced.

Sv/h/rem/h	The sievert (symbol: Sv) is the International System of Units (SI) SI derived unit of dose equivalent radiation. It attempts to quantitatively evaluate the biological effects of ionizing radiation as opposed to just the absorbed dose of radiation energy, which is measured in gray Frequently used SI multiples are the millisievert (1 mSv = 0.001 Sv) and microsievert (1 μSv = 0.000001 Sv). An older unit for the equivalent dose, is the rem,[3] still often used in the United States. One sievert is equal to 100 rem: 1 rem = 0.01 Sv = 10 mSv 1 mrem = 0.01 mSv = 10 μSv 1 Sv = 100 rem 1 mSv = 100 mrem = 0.1 rem 1 μSv = 0.1 mrem
uGy.hr^{-1}	Micrograys per hour

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Appendix F1

Table 7-1 Results of the background measurements.

X	Y	Time	Counts	Calculated	Uncertainty
393533	8349659	60	173	0.15	0.011
393533	8349659	60	156	0.13	0.011
393533	8349659	60	175	0.15	0.011

Table 7-2 Results of the radiological measurements.

Hole	X	Y	Time	Counts	Calculated	Uncertainty
407	397100	8348900	60	134	0.11	0.01
447	397300	8348900	60	138	0.12	0.01

Table 7-3 Results of the gamma survey conducted at ML27422 (μGy h^{-1})

X	**Y**	**Time**	**Counts**	**Calculated**	**Uncertainty**
397240	8348848	60	90	0.07	0.007589
397403	8348642	60	90	0.07	0.007589
396963	8349036	60	94	0.08	0.007811
397220	8348641	60	95	0.08	0.007866
397149	8348602	60	97	0.08	0.007974
397227	8348892	60	99	0.08	0.008081
397242	8348828	60	99	0.08	0.008081
397181	8348752	60	100	0.08	0.008133
397152	8348874	60	101	0.08	0.008186
397234	8348711	60	102	0.08	0.008238
397170	8348569	60	102	0.08	0.008238
397004	8348857	60	103	0.08	0.00829
396962	8349058	60	104	0.09	0.008341
397386	8348719	60	104	0.09	0.008341
397528	8348986	60	104	0.09	0.008341
397549	8348804	60	104	0.09	0.008341
397203	8348683	60	106	0.09	0.008444

X	Y	Time	Counts	Calculated	Uncertainty
397065	8348734	60	106	0.09	0.008444
397296	8348852	60	106	0.09	0.008444
396979	8348916	60	107	0.09	0.008494
396974	8348937	60	107	0.09	0.008494
397340	8348655	60	107	0.09	0.008494
397278	8348993	60	107	0.09	0.008494
397441	8348701	60	107	0.09	0.008494
397054	8348710	60	107	0.09	0.008494
397326	8348766	60	108	0.09	0.008545
397521	8348811	60	108	0.09	0.008545
397192	8348908	60	109	0.09	0.008595
397160	8348831	60	109	0.09	0.008595
397306	8348876	60	109	0.09	0.008595
397291	8348918	60	109	0.09	0.008595
397409	8348597	60	109	0.09	0.008595
397143	8348561	60	109	0.09	0.008595
397106	8349007	60	110	0.09	0.008645
397209	8348962	60	110	0.09	0.008645
397349	8348586	60	110	0.09	0.008645
397259	8349035	60	110	0.09	0.008645
397208	8348841	60	111	0.09	0.008694
397199	8348638	60	111	0.09	0.008694
397208	8348591	60	111	0.09	0.008694
397234	8348869	60	111	0.09	0.008694
397266	8348682	60	111	0.09	0.008694
397327	8348788	60	111	0.09	0.008694
397380	8348916	60	111	0.09	0.008694
397249	8348641	60	112	0.09	0.008744
397100	8349053	60	112	0.09	0.008744
397186	8348773	60	112	0.09	0.008744
396969	8349014	60	112	0.09	0.008744
397269	8348727	60	112	0.09	0.008744
397471	8348613	60	112	0.09	0.008744

X	Y	Time	Counts	Calculated	Uncertainty
397229	8348732	60	113	0.09	0.008793
397189	8348732	60	113	0.09	0.008793
397472	8348552	60	113	0.09	0.008793
397457	8349015	60	113	0.09	0.008793
397258	8348591	60	114	0.09	0.008841
397253	8348616	60	114	0.09	0.008841
397226	8348755	60	114	0.09	0.008841
397274	8348658	60	114	0.09	0.008841
397216	8348798	60	115	0.10	0.00889
396975	8348961	60	115	0.10	0.00889
396974	8348992	60	115	0.10	0.00889
397250	8348765	60	115	0.10	0.00889
397191	8349030	60	116	0.10	0.008938
397221	8348916	60	116	0.10	0.008938
397242	8348806	60	116	0.10	0.008938
397247	8348790	60	116	0.10	0.008938
397251	8348747	60	116	0.10	0.008938
397305	8348573	60	116	0.10	0.008938
397472	8348998	60	116	0.10	0.008938
397210	8348711	60	116	0.10	0.008938
397201	8348663	60	117	0.10	0.008986
397107	8348679	60	117	0.10	0.008986
397197	8349005	60	117	0.10	0.008986
397311	8348554	60	117	0.10	0.008986
397286	8348942	60	117	0.10	0.008986
397175	8348686	60	117	0.10	0.008986
397319	8348700	60	117	0.10	0.008986
397014	8348782	60	118	0.10	0.009034
397337	8348700	60	118	0.10	0.009034
397291	8348988	60	118	0.10	0.009034
397353	8348905	60	118	0.10	0.009034
397422	8348964	60	118	0.10	0.009034
397547	8348891	60	118	0.10	0.009034

X	Y	Time	Counts	Calculated	Uncertainty
397581	8348634	60	118	0.10	0.009034
397262	8348567	60	119	0.10	0.009081
397199	8348885	60	119	0.10	0.009081
397323	8348810	60	119	0.10	0.009081
397238	8349082	60	119	0.10	0.009081
397362	8348879	60	119	0.10	0.009081
397125	8348848	60	119	0.10	0.009081
397246	8348948	60	119	0.10	0.009081
397349	8348820	60	119	0.10	0.009081
397206	8348619	60	120	0.10	0.009129
397278	8348636	60	120	0.10	0.009129
397296	8348588	60	120	0.10	0.009129
397340	8348678	60	120	0.10	0.009129
397379	8348741	60	120	0.10	0.009129
397433	8348726	60	120	0.10	0.009129
397587	8348607	60	120	0.10	0.009129
397273	8349062	60	120	0.10	0.009129
397273	8349016	60	121	0.10	0.009176
397427	8348941	60	121	0.10	0.009176
397519	8349006	60	121	0.10	0.009176
397031	8348850	60	121	0.10	0.009176
397240	8348687	60	122	0.10	0.009223
397032	8348767	60	122	0.10	0.009223
397320	8348834	60	122	0.10	0.009223
397406	8348619	60	122	0.10	0.009223
397406	8348619	60	122	0.10	0.009223
397321	8348637	60	122	0.10	0.009223
397433	8348549	60	122	0.10	0.009223
397584	8348809	60	122	0.10	0.009223
397204	8348863	60	123	0.10	0.009269
397184	8348951	60	123	0.10	0.009269
397130	8348637	60	123	0.10	0.009269
397321	8348992	60	123	0.10	0.009269

X	Y	Time	Counts	Calculated	Uncertainty
397372	8349031	60	123	0.10	0.009269
397428	8348853	60	123	0.10	0.009269
397506	8348858	60	123	0.10	0.009269
397543	8348936	60	123	0.10	0.009269
397189	8348816	60	123	0.10	0.009269
397140	8348825	60	123	0.10	0.009269
396962	8348859	60	123	0.10	0.009269
396926	8349060	60	123	0.10	0.009269
397172	8348997	60	124	0.10	0.009316
397104	8349030	60	124	0.10	0.009316
397155	8348852	60	124	0.10	0.009316
396986	8348866	60	124	0.10	0.009316
397315	8348856	60	124	0.10	0.009316
397420	8348748	60	124	0.10	0.009316
397460	8348634	60	124	0.10	0.009316
396947	8348960	60	124	0.10	0.009316
397314	8348954	60	124	0.10	0.009316
397003	8349047	60	124	0.10	0.009316
397264	8348551	60	125	0.10	0.009362
397125	8348946	60	125	0.10	0.009362
397171	8348813	60	125	0.10	0.009362
397200	8348709	60	125	0.10	0.009362
397344	8348612	60	125	0.10	0.009362
397333	8348723	60	125	0.10	0.009362
397278	8348967	60	125	0.10	0.009362
397350	8348927	60	125	0.10	0.009362
397367	8348830	60	125	0.10	0.009362
397523	8348701	60	125	0.10	0.009362
397491	8348901	60	125	0.10	0.009362
397491	8348901	60	125	0.10	0.009362
397556	8348842	60	125	0.10	0.009362
397582	8348750	60	125	0.10	0.009362
397072	8349034	60	125	0.10	0.009362

X	Y	Time	Counts	Calculated	Uncertainty
397355	8348762	60	125	0.10	0.009362
397324	8348893	60	125	0.10	0.009362
397115	8348810	60	125	0.10	0.009362
397244	8348665	60	126	0.11	0.009408
397297	8349011	60	126	0.11	0.009408
397070	8348680	60	126	0.11	0.009408
397299	8348896	60	127	0.11	0.009453
397394	8348688	60	127	0.11	0.009453
397547	8348566	60	127	0.11	0.009453
397529	8348791	60	127	0.11	0.009453
397433	8349051	60	127	0.11	0.009453
397538	8348960	60	127	0.11	0.009453
397582	8348702	60	127	0.11	0.009453
396957	8348927	60	127	0.11	0.009453
397324	8348581	60	127	0.11	0.009453
397405	8349034	60	127	0.11	0.009453
397458	8348948	60	127	0.11	0.009453
397547	8348686	60	127	0.11	0.009453
397550	8348713	60	127	0.11	0.009453
397077	8348871	60	127	0.11	0.009453
397021	8348907	60	127	0.11	0.009453
397211	8348820	60	128	0.11	0.009499
397143	8348897	60	128	0.11	0.009499
397078	8348719	60	128	0.11	0.009499
397326	8348745	60	128	0.11	0.009499
397471	8348595	60	128	0.11	0.009499
397468	8348571	60	128	0.11	0.009499
397244	8348547	60	128	0.11	0.009499
397214	8348664	60	128	0.11	0.009499
397137	8348715	60	128	0.11	0.009499
397113	8348983	60	129	0.11	0.009544
397121	8348962	60	129	0.11	0.009544
397220	8348571	60	129	0.11	0.009544

X	Y	Time	Counts	Calculated	Uncertainty
397267	8348704	60	129	0.11	0.009544
397368	8348858	60	129	0.11	0.009544
397182	8348617	60	129	0.11	0.009544
397360	8348732	60	129	0.11	0.009544
397341	8348850	60	129	0.11	0.009544
397289	8349032	60	129	0.11	0.009544
397426	8348658	60	129	0.11	0.009544
397140	8348687	60	129	0.11	0.009544
397220	8348778	60	130	0.11	0.009589
397161	8348587	60	130	0.11	0.009589
397093	8348699	60	130	0.11	0.009589
397377	8348788	60	130	0.11	0.009589
397398	8348663	60	130	0.11	0.009589
397404	8349001	60	130	0.11	0.009589
397421	8348780	60	130	0.11	0.009589
397519	8348743	60	130	0.11	0.009589
397485	8349042	60	130	0.11	0.009589
397076	8349008	60	130	0.11	0.009589
397267	8348917	60	130	0.11	0.009589
397387	8348838	60	130	0.11	0.009589
397411	8348716	60	130	0.11	0.009589
397543	8348657	60	130	0.11	0.009589
397610	8348541	60	131	0.11	0.009634
397215	8348688	60	131	0.11	0.009634
397118	8348605	60	131	0.11	0.009634
396938	8349026	60	131	0.11	0.009634
397390	8349053	60	131	0.11	0.009634
397452	8348972	60	131	0.11	0.009634
397337	8348633	60	132	0.11	0.009679
397301	8349060	60	132	0.11	0.009679
397413	8348984	60	132	0.11	0.009679
396951	8348893	60	132	0.11	0.009679
397331	8349062	60	132	0.11	0.009679

X	Y	Time	Counts	Calculated	Uncertainty
397397	8348782	60	132	0.11	0.009679
397187	8348929	60	133	0.11	0.009723
397346	8348948	60	133	0.11	0.009723
397351	8349065	60	133	0.11	0.009723
397431	8348826	60	133	0.11	0.009723
397476	8348972	60	133	0.11	0.009723
397543	8348911	60	133	0.11	0.009723
397579	8348679	60	133	0.11	0.009723
397180	8348839	60	133	0.11	0.009723
397127	8349061	60	133	0.11	0.009723
397183	8348657	60	133	0.11	0.009723
397437	8348605	60	133	0.11	0.009723
397377	8348763	60	134	0.11	0.009767
397511	8348834	60	134	0.11	0.009767
397501	8349027	60	134	0.11	0.009767
397386	8348571	60	134	0.11	0.009767
397480	8348825	60	134	0.11	0.009767
397511	8348727	60	134	0.11	0.009767
397043	8349020	60	134	0.11	0.009767
397118	8348658	60	135	0.11	0.009812
396979	8348891	60	135	0.11	0.009812
397408	8348576	60	135	0.11	0.009812
397519	8348723	60	135	0.11	0.009812
397201	8349079	60	135	0.11	0.009812
397233	8348983	60	135	0.11	0.009812
397434	8348629	60	135	0.11	0.009812
397467	8348876	60	135	0.11	0.009812
397504	8348635	60	135	0.11	0.009812
397556	8348768	60	135	0.11	0.009812
397500	8349068	60	135	0.11	0.009812
397152	8348658	60	135	0.11	0.009812
397195	8348788	60	136	0.11	0.009855
397162	8348900	60	136	0.11	0.009855

X	Y	Time	Counts	Calculated	Uncertainty
397217	8349052	60	136	0.11	0.009855
397491	8348743	60	136	0.11	0.009855
397571	8348547	60	136	0.11	0.009855
397549	8348739	60	136	0.11	0.009855
397078	8348896	60	136	0.11	0.009855
397005	8348967	60	136	0.11	0.009855
397485	8348923	60	137	0.12	0.009899
397159	8348926	60	137	0.12	0.009899
397098	8348622	60	137	0.12	0.009899
397417	8348680	60	137	0.12	0.009899
397517	8348578	60	137	0.12	0.009899
397552	8348976	60	137	0.12	0.009899
397166	8349019	60	138	0.12	0.009943
397447	8348681	60	138	0.12	0.009943
397529	8348624	60	138	0.12	0.009943
397522	8348659	60	138	0.12	0.009943
397321	8348610	60	138	0.12	0.009943
397357	8348974	60	138	0.12	0.009943
397385	8348888	60	138	0.12	0.009943
397567	8348577	60	138	0.12	0.009943
397479	8349011	60	138	0.12	0.009943
397614	8348731	60	138	0.12	0.009943
397095	8348833	60	138	0.12	0.009943
397013	8348942	60	138	0.12	0.009943
397133	8348921	60	139	0.12	0.009986
397203	8348983	60	139	0.12	0.009986
397428	8348916	60	139	0.12	0.009986
396969	8348828	60	139	0.12	0.009986
397372	8348701	60	139	0.12	0.009986
397307	8348981	60	139	0.12	0.009986
397388	8348865	60	139	0.12	0.009986
397535	8348827	60	139	0.12	0.009986
397633	8348548	60	139	0.12	0.009986

X	Y	Time	Counts	Calculated	Uncertainty
397185	8349050	60	140	0.12	0.010029
397373	8348810	60	140	0.12	0.010029
397285	8349014	60	140	0.12	0.010029
397087	8348982	60	140	0.12	0.010029
397158	8348782	60	140	0.12	0.010029
397502	8348922	60	140	0.12	0.010029
397179	8349069	60	141	0.12	0.010072
397245	8349058	60	141	0.12	0.010072
397427	8348896	60	141	0.12	0.010072
397556	8348819	60	141	0.12	0.010072
397148	8348954	60	141	0.12	0.010072
397286	8348885	60	141	0.12	0.010072
397519	8349046	60	141	0.12	0.010072
397573	8348894	60	141	0.12	0.010072
397121	8348715	60	141	0.12	0.010072
397008	8348805	60	142	0.12	0.010115
397481	8348950	60	142	0.12	0.010115
397555	8348866	60	142	0.12	0.010115
397574	8348783	60	142	0.12	0.010115
397588	8348582	60	142	0.12	0.010115
397476	8348850	60	142	0.12	0.010115
397203	8348732	60	142	0.12	0.010115
397381	8348648	60	142	0.12	0.010115
397353	8348788	60	142	0.12	0.010115
397499	8348662	60	142	0.12	0.010115
397165	8348639	60	142	0.12	0.010115
397098	8348753	60	142	0.12	0.010115
397332	8348969	60	143	0.12	0.010158
397476	8349059	60	143	0.12	0.010158
397112	8348885	60	143	0.12	0.010158
397192	8348580	60	143	0.12	0.010158
397089	8348652	60	143	0.12	0.010158
397598	8348759	60	143	0.12	0.010158

X	Y	Time	Counts	Calculated	Uncertainty
397009	8348991	60	143	0.12	0.010158
397160	8349043	60	144	0.12	0.0102
397175	8348868	60	144	0.12	0.0102
397304	8348783	60	144	0.12	0.0102
397555	8348628	60	144	0.12	0.0102
397596	8348559	60	145	0.12	0.010242
397430	8348579	60	145	0.12	0.010242
397120	8348756	60	145	0.12	0.010242
397082	8348778	60	145	0.12	0.010242
397176	8348792	60	146	0.12	0.010284
397300	8349034	60	146	0.12	0.010284
396946	8348993	60	146	0.12	0.010284
397330	8349004	60	146	0.12	0.010284
397371	8348942	60	146	0.12	0.010284
397487	8348772	60	146	0.12	0.010284
397052	8348957	60	146	0.12	0.010284
397027	8348738	60	147	0.13	0.010326
397403	8348751	60	147	0.13	0.010326
397563	8348600	60	147	0.13	0.010326
397064	8348916	60	147	0.13	0.010326
397143	8348622	60	148	0.13	0.010368
397546	8348547	60	148	0.13	0.010368
397229	8349029	60	148	0.13	0.010368
397319	8348663	60	148	0.13	0.010368
397435	8349000	60	148	0.13	0.010368
397580	8348836	60	148	0.13	0.010368
397177	8348975	60	149	0.13	0.01041
396996	8348846	60	149	0.13	0.01041
397445	8349037	60	149	0.13	0.01041
397299	8348826	60	149	0.13	0.01041
397339	8348556	60	149	0.13	0.01041
397381	8348596	60	149	0.13	0.01041
397380	8349078	60	149	0.13	0.01041

X	Y	Time	Counts	Calculated	Uncertainty
397423	8349012	60	149	0.13	0.01041
397562	8348799	60	150	0.13	0.010451
397317	8348725	60	150	0.13	0.010451
397299	8349009	60	151	0.13	0.010492
397269	8349090	60	150	0.13	0.010451
397457	8348918	60	150	0.13	0.010451
397527	8348859	60	150	0.13	0.010451
397562	8348948	60	150	0.13	0.010451
397129	8348978	60	151	0.13	0.010492
397103	8348915	60	151	0.13	0.010492
397157	8348737	60	151	0.13	0.010492
397577	8348862	60	151	0.13	0.010492
397524	8348765	60	152	0.13	0.010534
397386	8348545	60	152	0.13	0.010534
397377	8348622	60	152	0.13	0.010534
397332	8348869	60	152	0.13	0.010534
397485	8348798	60	152	0.13	0.010534
397513	8348609	60	152	0.13	0.010534
397493	8348985	60	152	0.13	0.010534
397449	8349057	60	152	0.13	0.010534
397517	8348675	60	153	0.13	0.010575
397371	8348676	60	153	0.13	0.010575
397592	8348785	60	153	0.13	0.010575
397035	8349046	60	153	0.13	0.010575
397583	8348727	60	154	0.13	0.010615
396975	8348800	60	154	0.13	0.010615
397534	8349023	60	154	0.13	0.010615
397630	8348648	60	154	0.13	0.010615
397056	8348801	60	154	0.13	0.010615
397540	8348609	60	155	0.13	0.010656
397226	8348609	60	155	0.13	0.010656
397396	8348811	60	155	0.13	0.010656
397118	8348783	60	155	0.13	0.010656

X	Y	Time	Counts	Calculated	Uncertainty
397039	8348822	60	155	0.13	0.010656
397088	8348948	60	157	0.13	0.010737
397637	8348679	60	157	0.13	0.010737
397633	8348581	60	157	0.13	0.010737
397047	8348983	60	157	0.13	0.010737
397332	8349034	60	158	0.14	0.010777
397576	8348657	60	159	0.14	0.010817
397127	8349031	60	159	0.14	0.010817
397131	8348579	60	159	0.14	0.010817
397507	8348898	60	159	0.14	0.010817
397626	8348704	60	159	0.14	0.010817
397007	8349016	60	159	0.14	0.010817
397360	8349047	60	160	0.14	0.010857
397543	8349002	60	161	0.14	0.010897
397502	8348693	60	163	0.14	0.010976
397523	8348545	60	163	0.14	0.010976
397569	8348920	60	163	0.14	0.010976
397630	8348611	60	166	0.14	0.011094
397324	8348924	60	171	0.15	0.011287
397498	8348960	60	175	0.15	0.01144
397464	8349034	60	180	0.16	0.011628
396999	8348762	60	193	0.17	0.012103

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Appendix G - Water Management Plan

Australian Ilmenite Resources Pty Ltd
SILL80 Project



2012

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Document Control Record

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Position:	Hydrogeologist
Signed:	
Date:	27/04/2012

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Revision No.	Description of Revision	Date	Approved
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Executive Summary

Australian Ilmenite Resources (AIR) intends developing an ilmenite mine and processing plant at the Numul Numul Station, approximately 105km east of Mataranka Township and 8km south of the Roper Highway, in the Roper River Region, Northern Territory (Australian Ilmenite Resources Pty Ltd SILL80 Project Mineral Lease 27422).

This Water Management Plan (WMP) describes a framework for the management of water at the proposed SILL80 Ilmenite Project which entails open pit mining to a depth of 4m below surface and processing by gravity separation of the ilmenite after which the tailings is returned to the mined out open pits. The plant has a capacity of 300,000t/a refined ilmenite with an expected mine life exceeding 20 years.

The principal intent of this WMP, which details surface and groundwater management, is to address the key risks identified as:

- Cease to flow events in the Roper River may increase with abstraction.
- Impacts may be caused to water quality and supply for other downstream users and wildlife.

The primary objectives of the WMP are to ensure that mitigation measures are implemented to minimise any potential negative impacts to downstream users including wildlife and ensure that surface and groundwater resources at the mine site are not impacted. Specific targets include no increase in the number of cease-to-flow events and no negative impact on water quality.

Water Resource Modelling, NRETAS Alice Springs, indicated that 133L/s could safely be abstracted from the Roper River without increasing cease to flow events at Red Rock. The detailed project water balance ascertained that the maximum required abstraction rate approximates 64L/s, well within the rate recommended by NRETAS. As a precautionary measure AIR commits to install a pump with a capacity not exceeding 100L/s.

With regard to potential impacts on the water quality in the river downstream of Roper Bar, NRETAS indicated that *the dynamics of this system are poorly understood* and that *it is likely that water quality changes in this pool will result from the saline interface moving back up into the pool from Kangaroo Island as a result of evaporative losses exceeding inflows from upstream*. NRETAS advised that flow at a rate of *0.9*m^3*/sec is required to keep the system in steady state*. As an additional precautionary measure AIR commits to install a calibrated measuring plate/gauge at the abstraction point and to cease abstraction when stream flow reaches this rate/level.

This document details extensive monitoring and reporting requirements and programs to ensure that mining and operations meet their objectives and targets without adversely impacting local and downstream environments. AIR is committed to continual improvement of operations including its water balance to minimise reliance on and abstraction of water from the Roper River.

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Note

The Water Resources Modelling office of NRETAS was consulted to provide modelling of flow regimes near the abstraction site in order to define abstraction limits and abstraction regimes (hereafter referred to as Modelling Report 2012). The primary objective was to use the existing coupled surface water groundwater model (Knapton, 2009) to model and report the flow dynamics in the Roper River as a consequence of surface water abstraction from the river between Judy Crossing (G9030010/G9035122) and Red Rock (G9030250). At the time of submission of the SILL80 Project PER, the report detailing methodology and results had not been finalised. Post-publication copies of the report can be made available upon request.

Abbreviations

Abbreviations

AAPA	Aboriginal Areas Protection Authority
AIR	Australian Ilmenite Resources Proprietary Limited
AIR	Australian Ilmenite Resources
ANZECC	Australia and New Zealand Environment Conservation Council
CEMP	Construction Environmental Management Plan
DoR	Department of Resources
EMP	Environmental Management Plan
ESCP	Erosion Sediment Control Plan
MLA	Mineral Lease Application
MSDS	Material Safety Data Sheet
NATA	National Association of Testing Authorities
NOHSC	National Occupational Health & Safety Commission
NOI	Notice of Intent
NRETAS	NT Department of Natural Resources, Environment, the Arts and Sport
EMP	Environmental Management Plan
SOP	Standard Operating Procedure
TO	Traditional Owner
WCD	Water Control District
WMP	Water Management Plan

Units of measurement

mg/L	Milligrams per litre
µg/L	Micrograms per litre
m	metre
km	kilometre
mbgl	metre below ground level
°C	Degrees Celsius
ha	Hectares
pH	Measure of acidity (<7) or alkalinity (>7) of a (water) sample
t	tonne

Chemical Symbols

EC	Electrical Conductivity
TDS	Total Dissolved Solids
Tot.Alk.	Total Alkalinity
Tot.Hardness	Total Hardness
Ca	Calcium

Mg	Magnesium
Na	Sodium
SO_4	Sulfate
Al	Aluminium
As	Arsenic
Cd	Cadmium
Co	Cobalt
CO_2	Carbon dioxide
Cr	Chromium
Cu	Copper
Fe	Iron
FeS_2	Pyrite
Mn	Manganese
Mo	Molybdenum
Pb	Lead
NO_x	Oxides of nitrogen
Se	Selenium
Zn	Zinc

Explanation of Terms

Berm	Horizontal strip or shelf built into an embankment or cut to break the continuity of the slope
Colloidal material	Finely divided solids that will not settle but which may be removed by coagulation.
Tailings	Fine waste rock material arising from the processing operation.

1 Introduction

1.1 Purpose of the Water Management Plan (WMP)

As part of the environmental approvals process Australian Ilmenite Resources (AIR) has submitted a Notice of Intent (NOI) to the Northern Territory government which provided in response the *Guidelines for the Preparation of a Public Environmental Report* (Guidelines) indicating that a Public Environmental Report (PER) process is required and also identified their concerns about the development. One of the expressed concerns was in relation to water extraction from the Roper River and consequently development of a Water Management Plan (WMP) to address these concerns.

The WMP is a designated stand-alone plan which documents how environmental issues associated with surface and groundwater at the proposed ilmenite mine and processing facility (SILL 80) of Australian Ilmenite Resources (AIR) at the Numul Numul Station in the Roper River Region, Northern Territory (Figure 1.1), will be managed through all aspects of current operations clearly set out in the context of the overall framework of life of mine development. As such the WMP is designed to support the approval process for Mining Management Plans (MMP) by resolving issues relating to water in a consistent framework. The WMP effectively becomes part of the MMP.

In addition the WMP addresses and details the requirements of the legislation for the mine site authorisation and (water) waste discharge licences i.e. all relevant legislation, codes of practice, standards and guidelines applicable to the mining operation. The WMP outlines how performance against the objectives and requirements of this plan will be measured, monitored and reported.

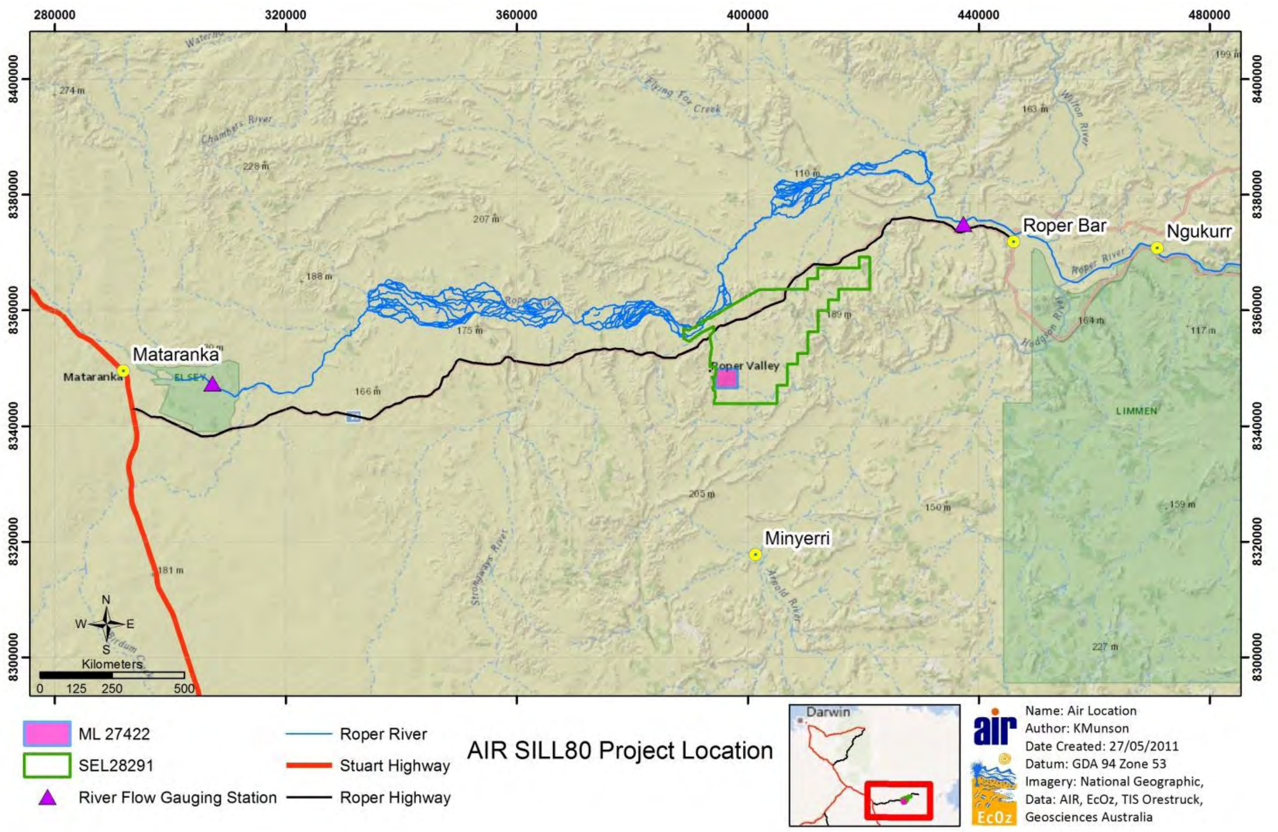

Figure 1.1: Location of the SILL80 Project with reference to the Roper River.

1.2 Objectives and Targets

The primary objectives of the WMP are to ensure that:

- Withdrawal of water from the Roper River will not impact detrimentally on downstream users including wildlife.

  Specific targets are:

  - No increase in the number of cease-to-flow events; and
  - No negative impact on water quality.

- Surface water resources at the mine site are not impacted.
- Groundwater resources at the mine site are not impacted.

The NT Water Allocation Planning Framework nominates that at least 80% of flow at any one time in any part of a river is allocated as water for environmental and other public beneficial water provision. It also nominates that extraction for consumptive uses will not exceed the threshold level of 20% of instantaneous flow at any time in any part of the river (NT Government, 2006). For the SILL 80 Project it is a stated objective to abstract less than 20% of instantaneous flow.

This WMP aims to:

- Develop abstraction practices to mitigate any potential negative impacts for downstream users including wildlife.
- Provide a framework for monitoring and reporting abstraction of water to the Northern Territory Government.

Other objectives include:

- To define the statutory obligations that must be met.
- To present a range of specific management actions necessary to meet the primary objectives.
- To provide a clear framework for effective water management during construction and operational activities.
- To assign clear and appropriate responsibilities for the implementation of the WMP.
- To specify monitoring regimes to enable assessment and ensure performance.
- To facilitate self-assessment to ensure that mitigation measures are implemented.

The WMP will be used by:

<u>Managers:</u>

- For planning and resourcing of functions and for assessment of necessary skills, competencies and training.

<u>Site Supervisor:</u>

- For selection of workforce and equipment and to identify specific training, competencies and resources.
- For clear understanding of specific requirements of specific tasks at specific locations.

1.3 Term of this Water Management Plan

Whilst under the NT Water Act (1992) the WMP provides the necessary information and framework to ensure operations cause minimal disruption to the environment and downstream users, under the Mining Management Act (2011) the operator of a mine site is required to submit a Mining Management Plan (MMP) with regard to the management and mitigation of potential environmental impacts of the proposed operations. It is anticipated that the Department of Resources (DoR) will request details of water management at the site and therefore this document will be provided and updated as required to fulfil the requirements of the MMP. Nevertheless, this WMP is valid for the 12 month period commencing July 2012.

Generally, a revised and updated WMP will be submitted 3 months prior to the MMP in March 2013 with a timeframe to facilitate a 12-month retrospective reporting of activities and a further 12-month operational plan. Thus the WMP will be updated annually and will remain valid until the subsequent plan is accepted.

The WMP will be reviewed annually to reflect changes to mine planning or in response to incidents and investigations, or whenever significant changes are required. It is also possible that the Mataranka Groundwater Allocation Plan (MGAP), currently being developed by the Northern Territory Government and which will detail abstraction limits for groundwater systems that contribute to flow in the Roper River, may have a bearing on the availability of surface water in the Roper River due to the interaction between the Tindall Limestone Aquifer and the Roper River upstream of the proposed water abstraction point. Increased groundwater extraction will potentially impact surface water resources within the Roper River catchment and therefore affect availability to surface water users which may require a substantial review of this document.

All reviews and amendments to the plan will be undertaken in consultation with the relevant authorities.

2 Site Conditions

2.1 Climate

The SILL80 Project is located within the monsoonal tropics dominated by the occurrence of two distinct seasons: an almost rainless dry season from May to September and a warmer and more humid wet season from November to March. April and October are transitional months (Woodroffe *et al* 1986). The nearest weather stations are Mataranka Homestead to the west and Roper Bar Store and Ngukurr to the east (Bureau of Meteorology BoM, 2012).

The wet season begins around October and ends around April. Over the course of the wet season, Roper Bar Store Station receives around 753.7mm of rain. By comparison, in the dry season from May to September, rainfall totals less than 32.8mm. At the height of the wet season in January it rains on average 12 days in that one month.

Table 1: Climatic Data (BoM, 2012).

Site Name:	Mataranka Homestead Resort	**Number:**	14610	**Latitude:**	14.92° S	**Longitude:**	133.13° E	**Elevation:**	150m	**Commenced:**	1916	**Operational Status:**	Open
Statistics	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean rainfall (mm)	210.1	187.2	152.9	32.1	8.2	1.4	1.4	1.3	4.0	22.5	64.3	158.9	870.4
Mean number of days of rain													
Mean daily evaporation (mm)													
Site Name:	Ngukurr	**Number:**	14609	**Latitude:**	14.73° S	**Longitude:**	134.73° E	**Elevation:**	34m	**Commenced:**	1910	**Operational Status:**	Open
Statistics	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean rainfall (mm)	184.3	178.3	174.2	55.4	10.7	5.1	1.1	0.7	1.8	13.3	40.9	131.2	815.2
Mean number of days of rain	12.1	11.4	9.6	3.7	1.1	0.5	0.4	0.2	0.3	1.2	3.9	8.8	53.2
Mean daily evaporation (mm)	5.8	6.2	5.7	6.2	5.6	5.3	5.5	6.7	7.7	9.0	8.6	7.4	6.6
Site Name:	Roper Bar Store	**Number:**	14633.0	**Latitude:**	14.74° S	**Longitude:**	134.53° E	**Elevation:**	18m	**Commenced:**	1976.0	**Operational Status:**	Closed 2003
Statistics	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean maximum temperature (°C)	36.9	35.3	35.1	34.3	32.7	30.4	30.2	32.4	35.3	38.3	39.3	38.6	34.9
Mean minimum temperature (°C)	24.8	24.5	23.9	21.8	18.6	15.0	14.3	15.4	18.4	22.2	24.9	25.2	20.8
Mean rainfall (mm)	223.0	216.3	139.3	32.2	13.3	0.4	5.9	1.7	4.6	6.9	45.2	97.7	786.5
Mean number of days of rain	14.0	13.4	10.6	4.1	1.8	0.2	0.4	0.2	0.7	1.1	5.2	8.6	60.3
Mean daily evaporation (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-

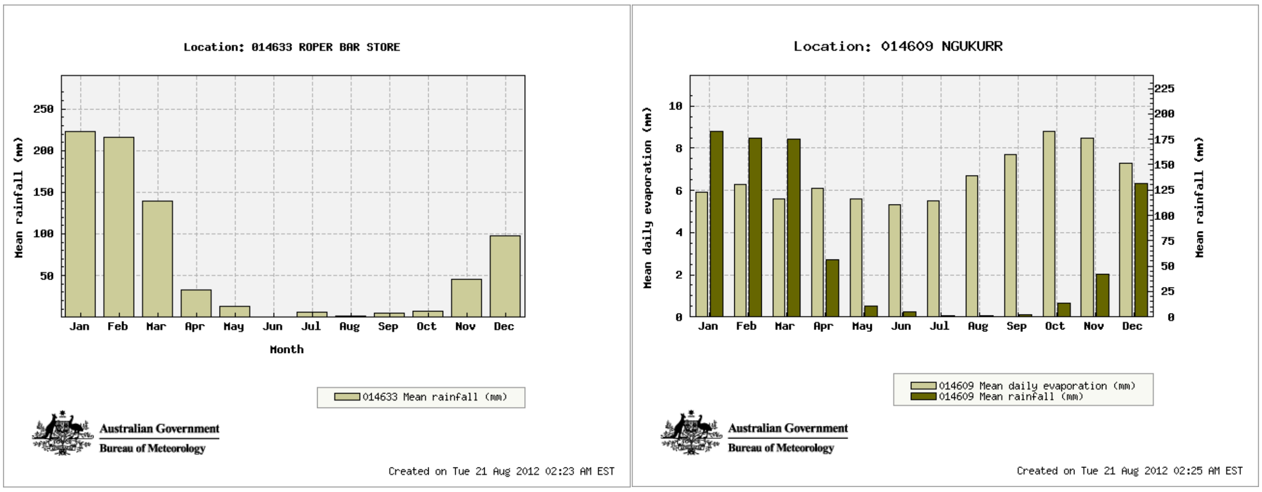

Figure 2.1: Rainfall and Evaporation (BoM, 2012).

From the above it is evident that the project is located in a water deficit climate in which evaporation at 2,409mm/a exceeds rainfall at 786.5mm/a by more than three times.

2.2 Surface Water Catchments

2.2.1 The Roper River Catchment

The Roper River is a large perennial flowing river with a catchment area of 81,794km^2 in the wet/dry tropics of the Northern Territory (Faulks, 2001) and contains ten rivers and three major creeks. It is one of the largest rivers in the Northern Territory, extending for over 500km. The river originates near Mataranka as Roper Creek (Little Roper River), where it flows eastward to join the Waterhouse River and become the Roper River. The Roper River flows generally eastward, before discharging into the Gulf of Carpentaria.

The surface and groundwater resources of the Roper River Catchment are detailed in:

- Faulks, JJ 2001, *An Assessment of the Physical and Ecological Condition of the Roper River and its Major tributaries,* Technical Report No.36/2001, Natural Resources Division, Department of Lands, Planning and Environment.
- Knapton, A 2009, *Gulf Water Study Integrated Surface Groundwater Model of the Roper River Catchment Part A: Coupled Surface – Groundwater Model,* NT Department of Natural Resources, Environment, The Arts and Sport, Darwin.
- Knapton, A 2009, *Gulf Water Study An Integrated Surface Groundwater Model of the Roper River Catchment Part B: MIKE11 Surface Water Model,* NT Department of Natural Resources, Environment, The Arts and Sport, Darwin.
- Zaar U, 2009, *Water Resources Of The Roper River Region,* Technical Report No.16/2009D, NT Department of Natural Resources, Environment, the Arts and Sport, Darwin.
- Karp, 2008, *Water Resources Surface and Groundwater Interaction the Mataranka Area,* Technical Report No.17/2008D, NT Department of Natural Resources, Environment, the Arts and Sport, Darwin.
- NT Government 2006, *Northern Territory Water Allocation Planning Framework,* NT Department of Natural Resources, Environment, the Arts and Sport, Darwin.
- NT Government undated, *Determination of Extraction Limits, Reliability and Announced Allocations for Tindall Limestone Aquifer, Mataranka,* NT Department of Natural Resources, Environment, the Arts and Sport, Darwin.

These documents, in addition to additional modelling by NRETAS, were used in setting abstraction limits for the SILL80 Project.

The Roper River and tributaries yield large wet season surface water flows with the highest mean monthly discharge occurring in March ranging from 83m^3/s near Mataranka to 509m^3/s at Red Rock. However, most of the tributaries cease to flow in the dry season. During the dry season, base flows and water dependent ecosystems in the Roper River are maintained primarily by discharge from the Tindall Limestone Aquifer, located in the river's headwaters near Mataranka, and the Dook Creek Dolomitic Aquifer via the Wilton and Flying Fox Creeks (Zaar 2009). The lowest mean monthly discharge occurs in September and October; ranging from 1.5m^3/s near Mataranka, to 1.0m^3/s at Red Rock.

The SILL80 Project is situated near the central section of the Roper River (Figure 2.2 overleaf) due south of Judy's Crossing and approximately 65km upstream of Roper Bar and the Red Rock Gauging Station. The Roper River along these middle reaches is highly braided, resulting in substantial evaporation losses and rendering the river a *losing stream* characteristic. The limit of the tidal influence of the Roper River extends to Roper Bar, a natural rock bar extending across the river, approximately 200km east of Mataranka and some 145km from the river mouth discharging into the Gulf of Carpentaria. However, the actual saltwater/freshwater interface in the river depends on stream flow and therefore may vary considerably. *The hydrodynamic nature of the pools in the Roper River downstream of Roper Bar and its response to allocated* *flows warrants further study. The long term quality of water within these pools is highly dependent on the upstream flows that maintain it* (Knapton, 2009).

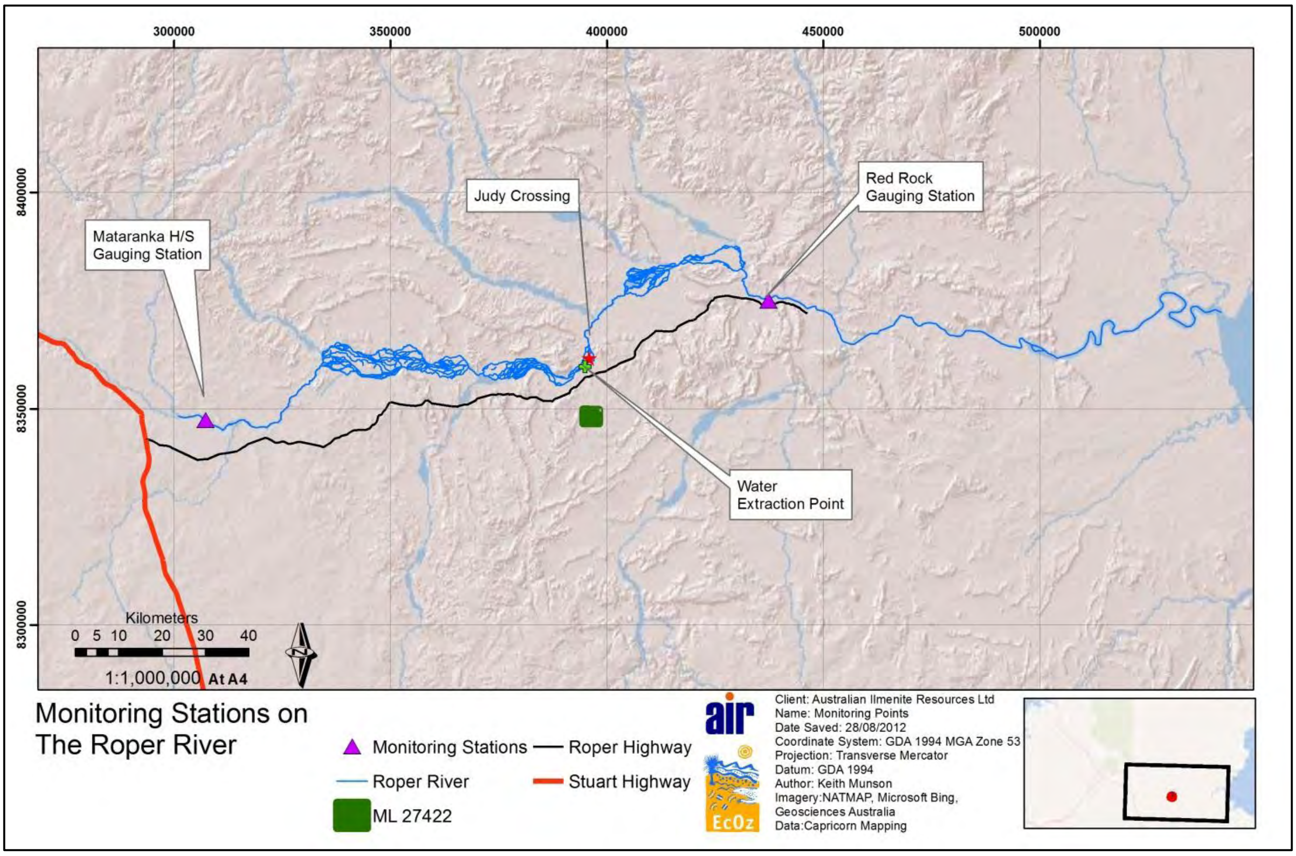

Figure 2.2: Location of the SILL80 Project (MLA 27422).

The Roper River is a losing system, with flows decreasing with distance downstream, except for areas of groundwater interaction (Knapton, 2009). Flow records reveal that cease to flow conditions may occur at Roper Bar. During very dry periods, such as during the 1950s and 1960s, cease to flow events occurred at Judy Crossing close to the proposed water abstraction point for the SILL80 Project. In contrast, the last decade has been a relatively wet period with high rainfall and flows at Red Rock generally above 0.9m^3/s:

Table 2: Minimum and Maximum Flows in the Roper River.

Parameter	Mataranka Homestead: G9030176		Red Rock: G9030250	
	Flow m^3/s	Quality µS/cm	Mean m^3/s	Quality µS/cm
Minimum	2.3	41	0.9	150
Maximum	4,004.2	255	3,243.5	255

Two flow gauging stations (NRETAS) currently operate on the Roper River (Figures 2.2 & 2.3 and Table 3):

- <u>G9030176 at the Mataranka Homestead with flow records from 1961 is 80km upstream of SILL80.</u>
  - This gauging station is 9km (by river) downstream of Mataranka Homestead and is incorporated in the Flood Warning Telemetry Network, providing near *real time* river height and rainfall data. This data is available for the prediction of flood events that may affect downstream communities.
  - The Roper River at this site has a base flow of approximately 2m^3/s maintained through the dry season by local spring flows. The largest event recorded at this site was in March 2000, reading 9m on the gauge. The highest known gauge height of the river was 11.27m (from surveyed flood marks) in January 1998 which destroyed the original instrumentation. Top of

bank at this site is approximately 9.5m.

- G9030250 at Red Rock with flow records from 1967 is 147km upstream and east of Mataranka, 8km upstream of Roper Bar and 60km downstream of SILL80.
    - This gauging station is also incorporated into the Flood Warning Telemetry Network, providing near *real time* river height data and rainfall.
    - The maximum recorded river height at this station was 18.516m, recorded on 20th March 1976.

Table 3: Summary of Flows at Mataranka Homestead and Red Rock Gauging Stations.

Flow Station	Lowest Recorded Flow (m^3/s)	Highest Recorded Flow (m^3/s)	Mean Daily Flow (m^3/s)	Median Daily Flow (m^3/s)	Mean Daily Flow Rate <$1m^3/s$	Mean Daily Flow Rate <$0.02m^3/s$
Mataranka Homestead G9030176	0.72000	4,117	21.6	2.4	25 days/annum	0 days/annum
Red Rock G9030250	0.00002	4,292	99.8	5.1	71 days/annum	3 days/annum

Modelling of integrated surface and groundwater flows and their response to rainfall (Knapton, 2009) show that cease to flow conditions at Red Rock are relatively common, occurring in 48 of 107 years since 1900. The model also showed that no flow occurred for approximately 5 per cent of the time, equating to 18 days of no flow in an average year. Cease to flow events at Roper Bar were predicted to occur when flows at Red Rock fall below $0.02m^3/s$.

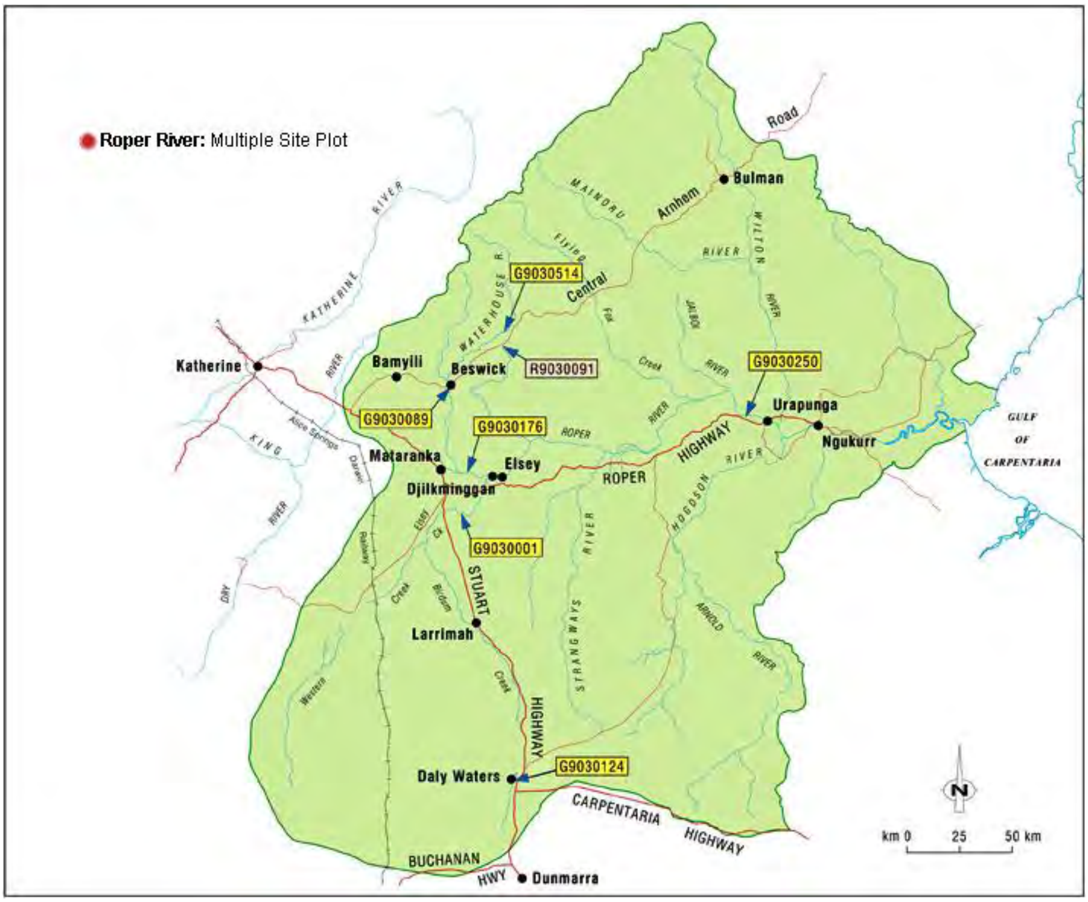

Figure 2.3: Gauging Stations on the Roper River.

2.2.2 Water Control Districts and Entitlements

The Daly-Roper Water Control District was declared by the Minister for Natural Resources, Environment and Heritage in December 2008 under the NT *Water Act of 1992* and is a statutory instrument that allows a greater level of water management to be implemented:

- All groundwater and surface water abstraction, excluding for stock and domestic purposes must be licensed.
- Bore construction permits are required, with minimum construction standards designed to prevent contamination of groundwater resources.
- Water Allocation Plans can be declared.

A Groundwater Allocation Plan is currently being developed for the Tindall Limestone Aquifer immediately surrounding Mataranka. This plan seeks to manage the groundwater resource for sustainable future demand. Although the plan will relate to groundwater abstraction only, consideration will be given to the hydraulic interconnection between the Tindall Aquifer and the Roper River.

Prior to declaration of Water Control Districts, groundwater licenses were required only if abstraction exceeded 0.015m^3/s (15L/s). Since declaration all new applications have been classified as pending so that the resource can be assessed prior to additional licenses being issued. Whilst the Mataranka Groundwater Allocation Plan only covers the Tindall Limestone Aquifer at Mataranka, it is anticipated that the plan will impact permitted downstream surface water abstractions.

Current surface and groundwater license entitlements in the Roper River Region (NRETAS Water Licensing Register, June) include:

- Three surface water licenses with a combined water entitlement of 88.2ML/a.
- Fifteen groundwater licenses with a combined water entitlement of 4,937ML/a.

Communities and cattle stations adjacent to the Roper River utilise stream flow to supplement surface and groundwater supplies during dry season characterised by extended periods of no or little rain and high evaporation. Historically Numul Numul and Flying Fox stations have drawn water from permanent water holes in the Roper River.

2.2.3 Local Surface Water Catchment

The *in situ* soils are dark brown and red Volcanic Soils, some 4m deep, overlying dolerite hard rock. Their characteristics are:

- Generally structured.
- Higher clay content than soils formed from sandstone, limestone and laterite and contain significant amounts of rock.
- Low to moderate erosion risk.
- Higher fertility than soils formed from sandstone, limestone and laterite.

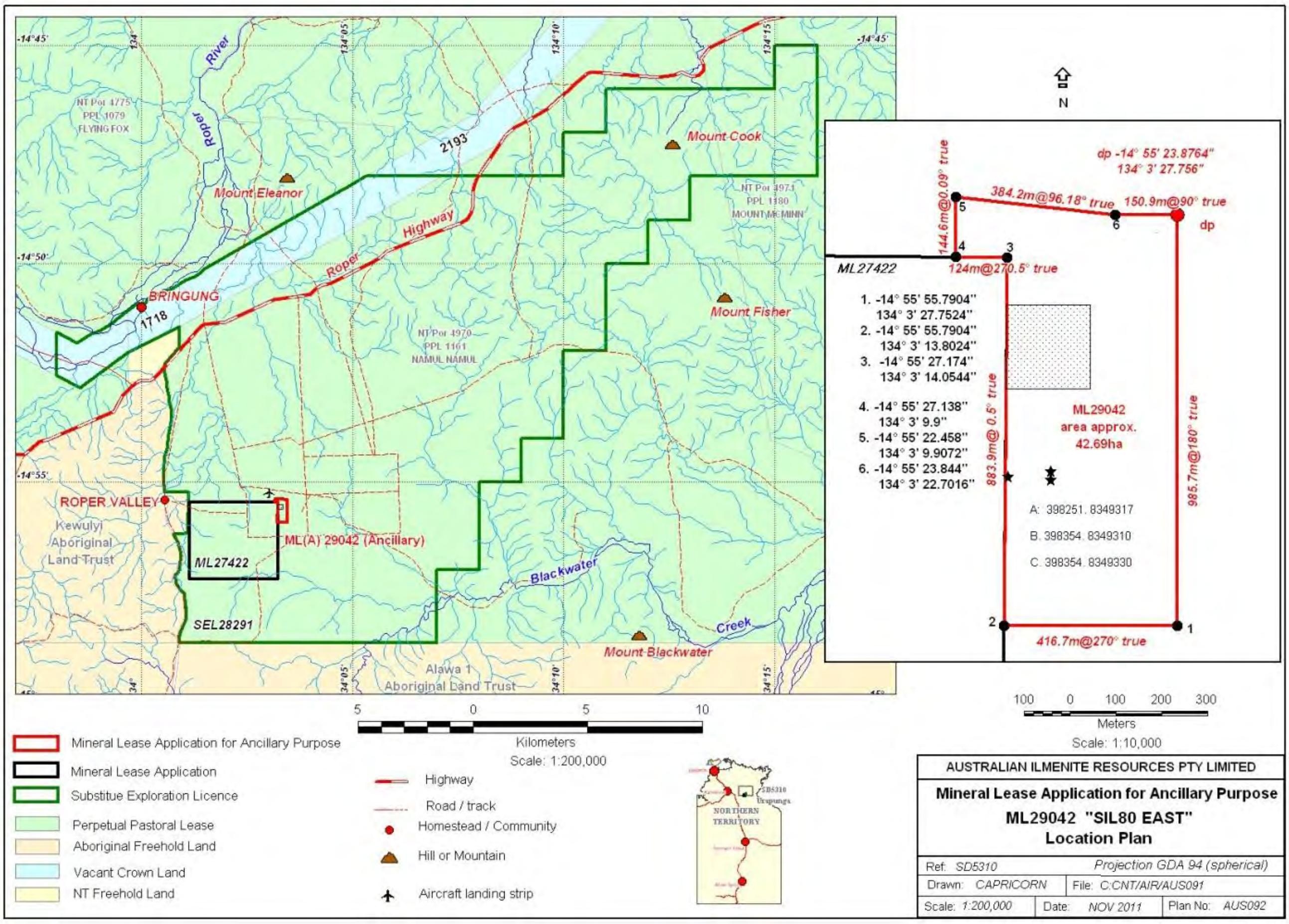

Figure 2.4: Catchments at the SILL80 Project.

The SILL80 Project is some 9km due south of the Roper River (Figure 2.4). Surface drainage is radially away from the proposed mining and plant area as it is located at the heads of three relatively small drainage features/lines:

- The south-eastern portion of the mining area drains in a south-easterly direction towards an un-named tributary of the Blackwater Creek some 5km to the south-east.
- The south-western portion drains due west towards an unnamed tributary of the Roper River.
- The north-eastern portion drains north and north-east to a different branch of the unnamed tributary of the Roper River.

2.3 Groundwater Resources

Groundwater is generally the preferred source for potable domestic water. The main population centres near the SILL80 Project (Minyerri, Urapunga, and Ngukurr) all rely on groundwater supplies, although Ngukurr supplements groundwater with water from the Roper River. The Kewulyi (Old Roper Valley) Community, 4km north-west of SILL80 at the old Roper Valley Homestead, sources water from a nearby spring. Cattle stations also utilise groundwater resources for stock watering purposes, dependent on availability and reliability.

NRETAS Maps indicated that there are two bores within 1km of the SILL80 Project boundary (Figure 2.4 and Table 4). There are several bores at the Kewelyi (Old Roper Valley) Community as well as at the Numul Numul Station; however, they are greater than 1km from the mining area and thus outside the zone that may be impacted by mining and processing.

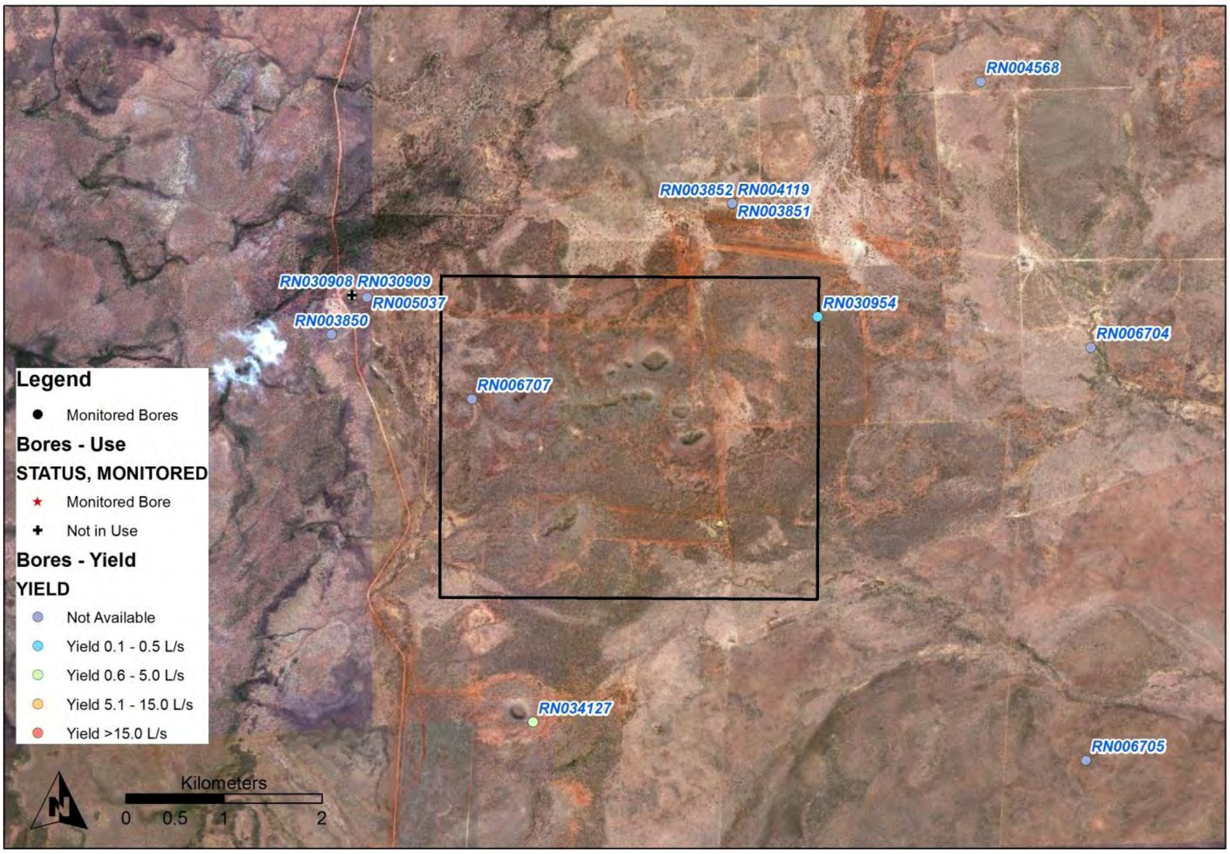

Figure 2.5: Bores at the SILL80 Project.

Table 4: Summary of Bore Data.

Bore ID	Date	Latitude	Longitude	Depth (m)	Water Strike (mbgl)	Ground Water Level (mbgl)	Yield (L/s)
Bore 68/69: Roper Valley Station; R006707	Sep 1969	14° 56' 7" S	134° 1' 19" E	70.5	35.4	31.16	4.5
Lithology: from surface to 3m: Alluvium/Weathered Dolerite; to 13m Weathered Dolerite; to 62m Dolerite; to 72m Quartzite.							
Water Quality: EC 1,320uS/cm; TDS 920mg/L; pH 7.0; Ca 42mg/L; Mg 70mg/L; HCO_3 395mg/L; Tot.Alk. 324mg/L; Tot.Hardness 374mg/L; Cl 110mg/L; Na 175mg/L; SO_4 291mg/L; F 1.5mg/L; Fe 1.2µg/L.							
Bore 68/168: Airstrip Bore No. 2 RN030954 (600m from airstrip bore RN3852)	Oct 1996	14° 55' 39" S	134° 3' 13" E	120.0	74.0	23.00	0.4
Lithology: from surface to 3m Brown Clay; to 6m Clay Basalt; to 51m Basalt; to 72m Shale; to 81m Sandstone; to 120m Shale.							
Water Quality: EC 475uS/cm; TDS 265mg/L; pH 7.3; Ca 30mg/L; Mg 23mg/L; HCO_3 278mg/L; Tot.Alk. 228mg/L; Tot.Hardness 169mg/L; Cl 22mg/L; Na 33mg/L; SO_4 9mg/L; F 0.2mg/L; Fe <0.1mg/L.							

Generally groundwater was encountered in fractured hard rock strata at depths below 35m and 74m below ground level resulting in deep groundwater levels well below the depth of mining at 4m. Groundwater yields and water quality is variable.

3 Water Management System

3.1 Water Use in Operations

- Process/Plant Water Requirements: The Roper River.
  Return water from tailings disposal into mined out open pits.
  Rainfall/runoff from open pits.
- Potable Water Requirements: Bottled water and rain water tanks.
- Discharge from Operations: Zero discharge.

In the absence of groundwater resources with capacities sufficiently large to meet the anticipated project water demand, water for processing will be obtained from the Roper River about 1km upstream of Judy's Crossing. Additional sources of water comprise rainfall/runoff into the open pits and return waters from tailings disposal. Potable water requirements will be met by bottled water and rain water tanks.

AIR will implement a policy of zero discharge.

3.2 Water Management Infrastructure

- Pump: Diesel driven submersible pump with caged foot valve and a capacity less than 100L/s.
- Dam/Water Storage: Existing 50ML storage dam at Numul Numul.
- Sedimentation Basins: Three 3,435m^3 ponds at plant storage area (infiltration of storm water).
- Pipelines: 12.5km 225mm diameter polyethylene pipeline from the abstraction point to the existing 50ML dam on pastoral land and from dam 1.5km east of plant to 689kL feeder tank at the plant.
- Open Cut Pits: Three 200m by 300m and 4m deep pits open at any given point in time. One pit used for collecting rainfall/runoff and tailings return water for recycling to plant.
- Chemical Treatment: None.
- Waste Water Treatment: Septic tank and skid mounted Ozziekleen RP10 Sewerage Treatment Plant.

Water management infrastructure (Figure 2.5 overleaf) include a diesel driven submersible pump to pump water from the Roper River to an existing 50ML storage dam from where the water is to be pumped to a steel feeder tank at the plant. The process entails gravity separation of the ilmenite from slurried soils and after separation, tailings will be returned to the open pits; excess water will be drained and returned to the feeder tank.

3.3 Water Balance

The detailed water balance of the SILL80 Project appears in Table 5 overleaf. It currently includes disposal of wet tailings into the mined out open pits. AIR is committed to a program of continual improvement which includes investigations into dewatering of the tailings prior to disposal to improve water efficiencies and to assist in the rehabilitation process.

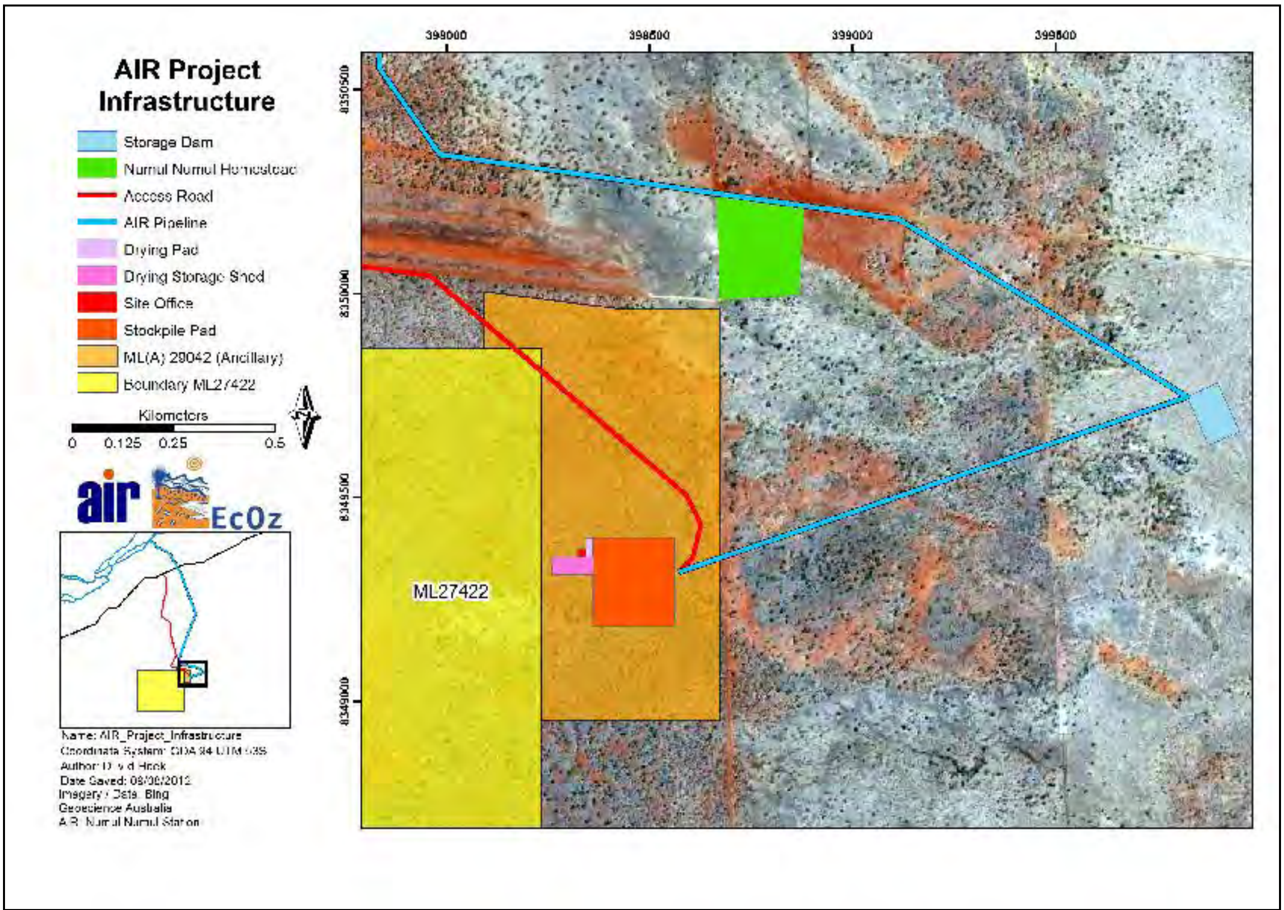

Figure 3.1: Water Infrastructure.

Table 5: Water Balance.

Sources or Inputs (ML/a)			Annual Water Balance (ML/a)			Losses or Discharges (ML/a)
			Average Rain at Roper Bar Store 786.5mm/a and Evaporation at Ngukurr 2,409mm/a			
			Open Pits			
Rain/Runoff	259.5		(Total Open Pit Area: 33ha)		101.2	Evaporation
Ground Water Influx	0.0				567.6	Seepage
Tailings Disposal (Plant)	900.0				96.0	Moisture Retention
		1,159.5		1,159.5	394.7	Plant
			50ML Storage Dam			
Roper River	1,264.4		(Area: 0.7ha)		16.9	Evaporation
Rain/Runoff	78.7				307.6	Seepage
		1,343.0		1,343.0	1,018.6	Plant
			Plant			
50ML Storage Dam	1,018.6		(Plant and Stockpiles: 42.7ha)		360.0	Process Losses
Open Pits	394.7		(Plant: Gravity Separation: 300kt/a)		900.0	Tailings Disposal (Open Pits)
			(Sediment Basins: 10,305m^3 storage capacity)		153.3	Dust Suppression
		1,413.3		1,413.3		
			No Rain			
			Open Pits			
Rain/Runoff	0.0		(Total Open Pit Area: 33ha)		144.5	Evaporation
Ground Water Influx	0.0				567.6	Seepage
Tailings Disposal (Plant)	900.0				96.0	Moisture Retention
		900.0		900.0	91.8	Plant
			50ML Storage Dam			
Roper River	1,649.0		(Area: 0.7ha)		24.1	Evaporation
Rain/Runoff	0.0				307.6	Seepage
		1,649.0		1,649.0	1,317.3	Plant
			Plant			
50ML Storage Dam	1,317.3		(Plant and Stockpiles: 42.7ha)		360.0	Process Losses
Open Pits	96.0		(Plant: Gravity Separation: 300kt/a)		900.0	Tailings Disposal (Open Pits)
			(Sediment Basins: 10,305m^3 storage capacity)		153.3	Dust Suppression
		1,413.3		1,413.3		

Open Pits:

In the absence of groundwater influx due to a shallow mining depth (≤4m) and deep groundwater level (>35m below surface) the primary inputs are rain/runoff whilst receiving wet tailings after mining. The primary losses from the open pits during rehabilitation are limited to:

- Tailings moisture retention estimated at 40% of volume;
- Evaporation (using the average evaporation rate measured at Ngukurr); and
- Seepage based upon a permeability of 10^{-6}m/s obtained from grading analyses.

50ML Storage Dam:

This existing dam will receive rain and runoff but will act as the primary storage facility for process water from the Roper River. Losses comprise evaporation and seepage estimated as indicated above.

Gravity Separation Plant:

The primary sources will be water from the 50ML Storage Dam and tailings return water from the open pits. The plant water demand is based on a requirement of 3m^3 of water per tonne of soil to be processed. Losses comprise consumptive losses estimated at 40% of volume, water for dust suppression (at 3L/m^2/d) in and around the plant and the access road and tailings disposal.

Water Balance:

A *worst case* water balance which excludes rain inputs were prepared to assess the maximum water requirement from the Roper River (bottom section of Table 5). In essence the water balances for average rainfall and no rain inputs indicate that the 24-hour water requirement from the Roper River approximates:

- 49L/s during an average rainfall year; and
- 64L/s when rain inputs are excluded.

There seems to be little scope to improve water balance efficiencies as:

- Mining will not be undertaken during the wet season when processing of stockpiles will be undertaken and when the 50ML storage dam and the open pit returning water to the plant will be full as a result of rainfall; and
- There is currently no provision for returning water from the sedimentation basins as these will be dry when the dry season and mining commences;

AIR will investigate efficiency improvements such as limiting seepage losses from the 50ML storage dam, and the open pits, by either clay and/or synthetic liners.

The potable water requirement (camp and plant) is 1.3ML/a based upon 12 persons using 300L/c/day and was excluded from Table 5 as this water will not be sourced from the Roper River but will be met by bottled water and rain water tanks collecting roof runoff.

There will be no discharge from either the plant and/or the mine and there is no interaction between surface and groundwater.

4 Surface Water Management

4.1 Potential Contaminants

Abstraction from the Roper River will not cause deterioration in water quality at the abstraction point and/or its immediate surrounds. SILL80 will not discharge water other than disposal of tailings into the mined out pits from where water is to be returned to the plant for reuse and is located at the heads of relatively small and dry drainage lines/features. Detailed erosion and sediment control plans for mining and plant operations have been developed and are to be implemented. Thus, the SILL80 Project is unlikely to cause contamination of surface water resources.

4.2 Potential Impacts

Impacts on surface waters downstream of the abstraction point pertain to:

- Reduction in flows and abstractions to downstream users causing increase in cease to flow events.
- Deterioration of surface water qualities downstream of the abstraction point as a result of:
    - Reduced flows and increasing evaporative losses and as a consequence increasing salt loads; and/or
    - Tidal influences creeping further inland.

These impacts can be controlled effectively by limiting abstraction to a level where downstream values can be maintained and/or sustained.

4.3 Surface Water Management Infrastructure

Water will be pumped by a submersible pump (to be sized to abstract less than 100L/s) and discharge into an existing 50ML storage dam from where the water will be pumped to a 689kL feeder tank at the processing plant. Here, water is mixed with soil to form slurry to cyclones/spiral separators to extract the ilmenite after which the slurry will be returned to the open pit and the water drained and returned to the feeder tank at the plant.

The most important part of the surface water management infrastructure will be a measuring plate at the abstraction point. This plate is to be calibrated against flows at the upstream (Mataranka) and downstream (Red Rock) gauging stations to ensure that abstraction is curtailed when flows reach a level where downstream flows and/or water qualities may be impacted.

4.4 Discharge

There will be no surplus water and/or disposal at SILL80 and a Waste Discharge Licence will not be required.

4.5 Abstraction

- A statistical assessment of the flow data in the Roper River obtained from NRETAS indicates that the last decade has been a relatively wet period with high rainfall and flows above 2.3m^3/s at Mataranka Homestead and 0.9m^3/s at Red Rock (Table 2). The minimum flow at Judy's Crossing is estimated to be at least 1.0m^3/s.
- Thus, should the 20-80 rule be applied, the SILL80 Project may apply for abstraction of some

0.2m^3/s or 200L/s. A detailed water balance indicated that the water requirement of the SILL80 Project may vary, conservatively, between 49L/s (average rain) and 64L/s (no rain). This is substantially less than the stated objective of the project *to abstract less than 20% of instantaneous flow*. To demonstrate that abstraction from the Roper River would not exceed the threshold level of 20% of flow at any time in any part of the river (NT Water Allocation Planning Framework, 2006), the yield capacity of the submersible pump is to be limited to less than 100L/s. This limitation is to be complemented by monitoring a calibrated measuring plate and curtail abstraction when a pre-determined level is reached.

Owing to a large (up to 64L/s) project water requirement and the inability of the local dolerite aquifers to meet this water demand (single bores may yield up to 5L/s), there are no alternative water sources with suitable capacities. The 50ML storage dam is sufficient to meet the plant water requirement for 22 10-hour days after which processing would have to be curtailed until flows within the Roper River improve.

The Water Resources Modelling office of NRETAS has been consulted in providing modelling of flow regimes near the abstraction site to define abstraction limits and abstraction regimes (Modelling Report 2012). Three estimated mine water usage scenarios, assuming a 12-hour schedule, were modelled:

- 108m^3/hr or 30L/s (15.0L/s over 24 hours) as a minimum.
- 480m^3/hr or 133L/s (66.5L/s over 24 hours) as an average.
- 1200m^3/hr or 333L/s (166.5L/s over 24 hours) peak usage.

The primary objective was to model and report the resultant flows in the Roper River due to surface water abstraction on river flow dynamics of the Roper River between Judy Crossing (G9030010/G9035122) and Red Rock (G9030250) using the existing coupled surface water groundwater model (Knapton, 2009). The salient findings of the modelling study (Modelling Report 2012) are:

- *The 24 hour pumping schedule will have a much lower impact on minimum observed instantaneous flows at Judy Crossing and probably Red Rock.*
- *The effects of pool storage are poorly represented in the model in the region between Judy Crossing and Red Rock. Evapotranspiration (ET) losses along the section from Judy Crossing to Red Rock are approximately 600L/s ± 100L/s which should show a diurnal response, although the observed record at Red Rock shows no such daily variation. It is suggested that there is considerable buffering due to pool storage and the ET losses are observed as an averaged response. Based on this assumption it would be expected that the 12 hour pumping regime would create a similar averaged response at Red Rock and flows to the pool downstream of Roper Bar.*
- *Based on observed and simulated flows at Judy Crossing under recent climatic conditions (1970-2008)* ***the maximum pumping rate should be no more than 480m^3/hr (instantaneous extraction of 0.133 m^3/s or 133L/s)****. This means that an upstream cut-off of 0.67m^3/s should be applied.*
    - *Based on the 1970-2008 historic exceedances a cut-off of 0.67m^3/s will result in extraction being stopped for less than 1% of the time.*
    - *Based on the historic exceedances a cut-off of 0.67m^3/s will result in extraction being stopped for 5% of the time (i.e. 18 days).*

Pertaining to water quality, Water Resources Modelling indicated that:

- Abstraction is unlikely to have any impact on the water quality in the river upstream of the Roper Bar (Figure 4.1 overleaf).
- There is less certainty with regard to the large pool downstream of Roper Bar as the dynamics of this system are poorly understood. It is likely that water quality changes in this pool will result from the saline interface moving back up into the pool from Kangaroo Island as a result of evaporative losses exceeding inflows from upstream. The Gulf Water Study (Knapton, 2009) assumed a surface area of 14.x10^{6}m^2 as the surface area of this pool from Roper Bar to Kangaroo Island and an evaporation

rate of 6mm/d which suggests about 0.9m^3/s is required to keep the system in steady state. As the inflow from upstream declines below this rate a simple assumption that a volume equal to the deficit is taken up by the migration of salt water upstream.

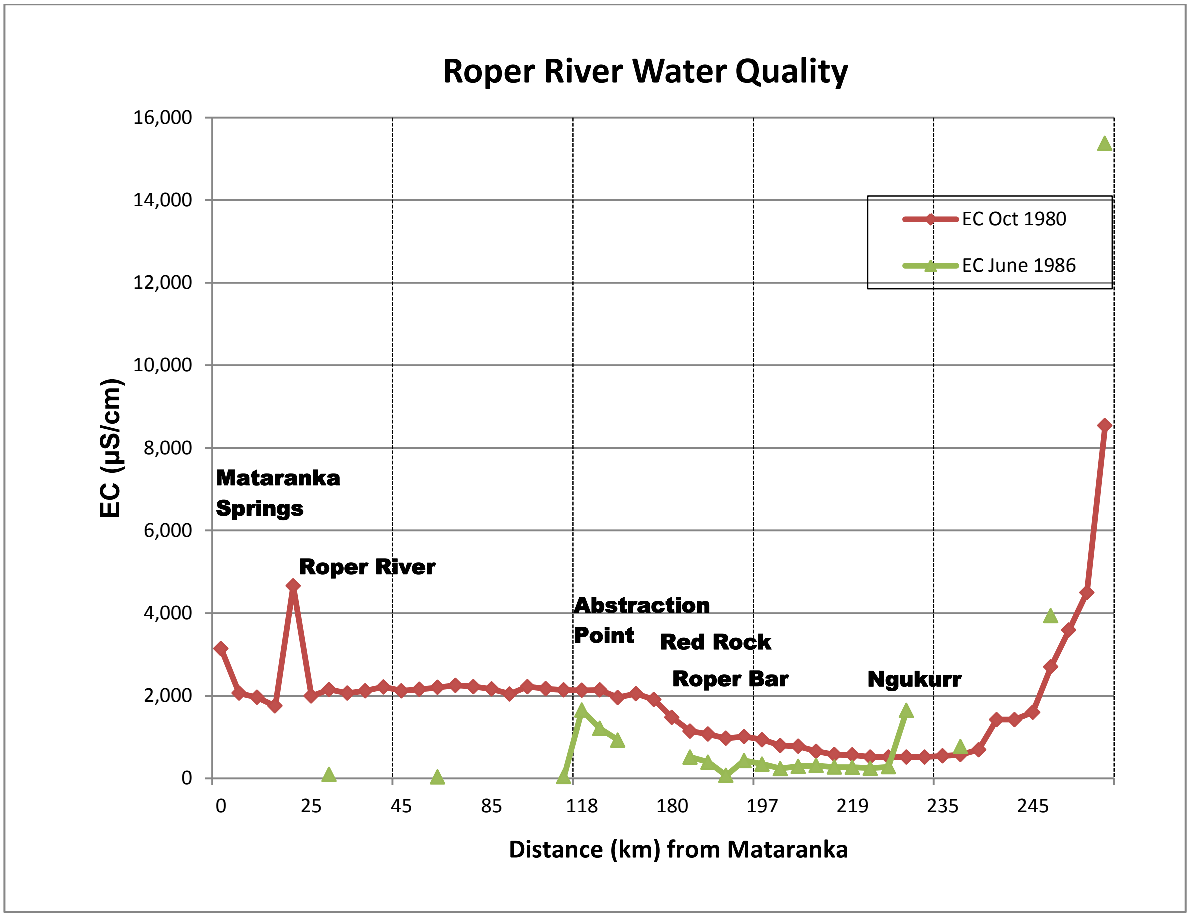

Figure 4.1: Roper River EC Profile.

In conclusion, Water Resources Modelling NRETAS recommended an abstraction rate of 133L/s (Modelling Report 2012) as the rate at which AIR could safely abstract from the Roper River without increasing cease to flow events at Red Rock. The detailed water balance for the SILL80 Project indicated that the maximum required abstraction rate would be 64L/s without rain inputs. To maintain water quality downstream of Roper Bar a minimum flow of 900L/s is required. As a precautionary measure AIR will install a pump with a capacity of less than 100L/s and cease abstraction when the flow within the Roper River reaches 900L/s.

4.6 Contingency Planning and Mitigation Measures

The measures to manage and mitigate the potential impacts entail:

- Maintaining the 50ML storage dam at full capacity.
- Limit abstraction to less than 100L/s over 24 hours.
- Observing the measuring plate at the abstraction point daily during low flows and cease abstraction when flows reach 0.90m^3/s or 900L/s (in excess of the recommended cut-off of 0.67m^3/s to ensure that downstream water qualities are maintained).
- Should abstraction be required at a flow of 900L/s or less, AIR will initiate a water quality monitoring program at Ngukurr to ascertain the impact of abstracting water and permanently cease abstraction if any deterioration in water quality is observed.

5 Groundwater Management

5.1 Potential Contaminants

Groundwater will not be used as mining will extend to 4m below ground level only and well above the groundwater level expected to be no less than 35m below surface. However, water from the Roper River will be used to facilitate gravity separation and return of the tailings to the mined out pits. Mining of the pits are to be scheduled such that the lowermost pit is used to collect water draining from the tailings for return to the plant feed tank.

Leachate testing (leaching soils with deionized water; Appendix N) indicated that:

Table 6: Leachate (Process) Water Quality.

Analyte	Average	Maximum	Minimum
pH Value	7.1	7.3	6.9
Electrical Conductivity @ 25°C	40	53	17
Total Dissolved Solids @180°C	32	58	14
Total Alkalinity as $CaCO_3$	8	10	5
Ca, Calcium	2	2	1
Mg, Magnesium	<1	0	0
Na, Sodium	7	11	3
K, Potassium	<1	0	0
Leachable Metals			
Aluminium	0.7	1.7	0.3
Arsenic	<0.01	0.0	0.0
Cadmium	<0.005	0.0	0.0
Chromium	<0.01	0.0	0.0
Cobalt	<0.01	0.0	0.0
Copper	<0.01	0.0	0.0
Iron	1.83	9.04	0.07
Lead	<0.01	0.0	0.0
Manganese	0.03	0.05	0.01
Selenium	<0.01	0.0	0.0
Zinc	0.35	0.62	0.09
Molybdenum	<0.01	0.00	0.00

- **pH, EC and TDS**

  Soil/DI leaching solutions are predominantly circumneutral with pHs ranging from 6.9 to 7.3, having low average electrical conductivities between 17µS/cm and 53µS/cm and Total Dissolved Solids concentrations between 14mg/L and 58.0mg/L.

- **Major Cations**

  Major cations including Ca, Mg, Na and K are relatively low with Na dominant ranging between 3mg/L to 11mg/L.

- **Trace Metals and Metalloids**

  Most of the trace metals are below their detection limits. Aluminium, iron and zinc leach in elevated concentrations averaging 0.7mg/L, 1.8mg/L and 0.4mg/L respectively. Maximum concentrations are at 1.7mg/L, 9.0mg/L and 0.6 mg/L, found in near surface soils. Cobalt and manganese are relative high in soils but do not mobilise or mobilise in the case of manganese in low concentrations.

- **Management of Leachates**

  The behaviour of the trace metals indicates that soils do not have readily available solutes and loading in leaching solutions would be insignificant and low risk. Long term management of these soils would be restricted to monitoring of potential seepages from the rehabilitated open pits.

5.2 Potential Impacts

Potential impacts pertain to marginally elevated concentrations of trace metals, particularly aluminium, iron and zinc in leachates from the rehabilitated open pits. The average permeability of the soils in the open pits from ten composite samples is estimated 1.9e-6m/s (Table 7). Using an average porosity of 42%, the velocity of groundwater is estimated at 4.5e-8m/s, or 1.4m/a, which in turn implies that a potential contaminant plume would only migrate some 28m away or below the open pit during the life of the mine.

Table 7: Soil Permeability.

Hydraulic Parameters		1 - Composites	2 - Composite	3 - Composite	4 - Composite	5 - Composite	6 - Composite	7 - Composite	8 - Composite	9 - Composite	10 - Composite
Residual Water Content	cm^3/cm^3	0.07	0.07	0.08	0.05	0.07	0.06	0.07	0.07	0.05	0.07
Saturated Water Content	cm^3/cm^3	0.42	0.43	0.44	0.40	0.43	0.41	0.43	0.43	0.39	0.42
α	1/cm	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
n	[-]	1.58	1.59	1.59	1.45	1.59	1.55	1.59	1.59	1.40	1.57
k	m/s	1.74E-06	1.65E-06	1.48E-06	1.80E-06	1.65E-06	1.79E-06	1.64E-06	1.64E-06	3.61E-06	1.80E-06

5.3 Groundwater Management Infrastructure

No groundwater management infrastructure will be required.

5.4 Abstraction

Neither groundwater abstraction nor dewatering of the mining pits will be required.

5.5 Contingency Planning and Mitigation Measures

Contingency planning and mitigation measures pertain to monitoring the impacts of migrating leachates from the rehabilitated open pits. Should these leachates migrate further than current predictions and/or contain concentrations of heavy metals in excess of trigger levels, then further investigations and assessments are to be undertaken which may employ compaction of the floors of the open pits and/or the addition of bentonite clay to the floors of the open pits to manage and mitigate the potential impacts on groundwater resources.

6 Monitoring

6.1 Statutory and Non-Statutory Monitoring Programs

This monitoring program includes statutory and operational monitoring of the surface and groundwater regimes and particularly aims at:

- Providing early warning when to cease abstraction from the Roper River.
- Detecting and mitigating potential impacts from process waters seeping from the tailings placed in mined out open pits.
- Assessment and review of water management infrastructure and practices.

In addition, the monitoring program is designed to:

- Demonstrate that abstraction limits and monitoring will show that natural river flow is not reduced by more than 100L/s over 24 hours at any time.
- Confirm that abstraction at 100L/s or less (the maximum project water requirement is 64L/s) is adequate to prevent unacceptable impacts on downstream users including water supplies to the community at Ngukurr.

6.1.1 Surface Water

Water quality at the extraction point will not be monitored, however, sampling data for Ngukurr will be obtained from Power and Water and will be correlated with abstraction and flow data to ascertain whether abstraction impacts on downstream water quality. Monitoring will pertain to measuring abstraction and flow in the Roper River.

Table 8: Surface Water Monitoring.

Activity	Monitoring abstraction and flow in the Roper River.
Objectives and Targets	Ensure abstraction from the Roper River does not negatively impact downstream users, including wildlife. No increase in cease to flow events downstream of the abstraction point.
Where	At the abstraction point. Biological/Aquatic Biodiversity Monitoring at to-be-selected site(s) upstream (reference site) and downstream of the water abstraction point
Parameters	**Surface Water Abstraction:** Rainfall. Abstraction rates and volumes with an inline flow meter at the abstraction point and from the 50ML storage dam. River flow height (rate) on measuring/gauging plate. Monitor remotely (NRETAS Website) and record data for the gauging stations at Mataranka Homestead (G9030176) and Red Rock (G9030250). Obtain and record water quality data for Ngukurr from Power and Water Corporation. Initiate water quality monitoring program (pH and EC) at Ngukurr if abstraction below a flow of 900L/s at the abstraction point is required. **Biological/Aquatic Biodiversity.** Since riffle habitats are vulnerable to reduced flows, the aquatic biodiversity monitoring program

	will annually monitor, in the late dry season, riffle ecological conditions by monitoring habitat extent and spatial heterogeneity, fish and macro-invertebrate abundance, and benthic algal biomass. A number of physical parameters will also be measured including: water depth, flow velocity, flow, temperature, pH, dissolved oxygen, conductivity, total and soluble nitrogen and phosphorus, turbidity and suspended phytoplankton as chlorophyll-a.
Sampling/Measuring Frequency	**General Surface Water Abstraction:** Weekly. **Biological/Aquatic Biodiversity:** September 2012: establish monitoring site(s), and undertake first survey. From September 2013 (and ongoing): resurveys.
Methodology	Limit abstraction by installing a submersible pump with a rating of less than 100L/s and fit with an in-line flow meter. Abstraction from the 50ML storage dam is to be measured Install a measuring/gauging plate at the abstraction point. Calibrate the measuring/gauging plate using flow data from the gauging stations at Mataranka Homestead (G9030176) and Red Rock (G9030250) using flow data and surveyed cross sections upstream, at and downstream of the abstraction point. Set level at which measuring frequencies will become daily. Set level equivalent to a flow of 900L/s at which abstraction will cease. Initiate water quality monitoring program (pH and EC) if abstraction below a flow of 900L/s at the abstraction point is required. Biological/Aquatic Biodiversity Monitoring Program: this program, aimed at contributing to the understanding of the impact of water abstraction on the biodiversity of the Roper River, will be undertaken, managed and reported on by NRETAS (Simon Townsend, 2012).
Auditing	An engineer/scientist will audit all monitoring data to ensure compliance with objectives, targets and performance criteria.
Assessment and Reporting	An engineer/scientist and the Site Manager shall record all monitoring results of which a record will be kept on site for inspection and review by DoR and/or NRETAS. Tabulations and graphs will be compiled on all monitoring parameters with brief notes on trends and exceptions. These will be included in any site audits to be undertaken. Records and reports, including a final summary, are to be submitted annually. Reporting on the biological/aquatic biodiversity monitoring program will be annual. Over the life time of monitoring, and with each annual monitoring event, the relationship between flow and (1) aquatic biota, (2) water quality and (3) habitat physical features will be assessed and reported. Where a potential non-conformance event with potential environmental impacts has occurred, the Site Manager shall immediately notify the DoR and NRETAS (by telephone to be followed by e-mail within 24 hours) of the nature of the event, the measures implemented to prevent recurrence and any outcomes.
Incident/Failure	Cease to flows and/or deteriorating water quality downstream of the abstraction point as a direct cause of abstraction.
Corrective Action	Should any environmental non-conformances, incident and/or impact occur as a direct result of the abstraction of water from the Roper, abstraction will be curtailed until suitable and appropriate mitigating/corrective measures have been implemented. These are to be agreed with DoR and NRETAS.
Contingency Plan	Limit and/or cease abstraction.

6.1.2 Groundwater

The groundwater monitoring program entails sampling of (Figure 6.1):

- Shallow bores (6m to 10m deep) to be drilled around and downstream of the open pits.
- Tailings return water from the collection pit.

Table 9: Groundwater Monitoring.

<table>
<tr><td>Activity</td><td>Monitoring and sampling the quality and impact of Tailings Return Water.</td></tr>
<tr><td>Where</td><td>Figure 6.1.</td></tr>
<tr><td>Parameters</td><td>Rainfall.
Depth to groundwater level.</td></tr>
<tr><td>Analytical Parameters</td><td>
<table>
<tr><th>Analyte</th><th>Assessment or Trigger Value (mg/L where applicable)</th></tr>
<tr><td>pH Value</td><td>6.5 – 8.5</td></tr>
<tr><td>EC, TDS, TA and Major Cations and Anions</td><td>no more than 15% above ambient level</td></tr>
<tr><td>Leachable Metals</td><td>ADWG 2011 level below or no more than 15% above ambient concentration where the latter exceeds the ADWG</td></tr>
<tr><td>Aluminium</td><td>0.200</td></tr>
<tr><td>Arsenic</td><td>0.007</td></tr>
<tr><td>Cadmium</td><td>0.002</td></tr>
<tr><td>Chromium</td><td>-</td></tr>
<tr><td>Cobalt</td><td>-</td></tr>
<tr><td>Copper</td><td>2.000</td></tr>
<tr><td>Iron</td><td>0.300</td></tr>
<tr><td>Lead</td><td>0.010</td></tr>
<tr><td>Manganese</td><td>0.500</td></tr>
<tr><td>Selenium</td><td>0.010</td></tr>
<tr><td>Zinc</td><td>3.000</td></tr>
<tr><td>Molybdenum</td><td>0.050</td></tr>
</table>
</td></tr>
<tr><td>Sampling/Measuring Frequency</td><td>Daily: rainfall
Monthly: groundwater levels.
Quarterly: water quality.</td></tr>
<tr><td>Auditing</td><td>An engineer/scientist will audit all monitoring data to ensure compliance with objectives, targets and performance criteria.</td></tr>
<tr><td>Reporting</td><td>An engineer/scientist and the Site Manager shall record all monitoring results of which a record will be kept on site for inspection and review by DoR and/or NRETAS. Tabulations and graphs will be compiled with brief notes on exceptions. These will be included in any site audits to be undertaken.
Records and reports, including a final summary, are to be submitted annually.
Where a potential non-conformance event with potential environmental impacts has occurred, the Site Manager shall immediately notify the DoR and NRETAS (by telephone to be followed by e-mail within 24 hours) of the nature of the event, the measures implemented to prevent recurrence and any outcomes.</td></tr>
<tr><td>Incident/Failure</td><td>Water with elevated metal concentrations in the shallow bores.</td></tr>
<tr><td>Corrective Action</td><td>Should any environmental non-conformances, incident and/or impact occur due to the disposal of tailings, mitigating/corrective measures will be implemented.
Corrective actions will be implemented where an identified action or situation has the potential to impact on the environment.</td></tr>
</table>

Contingency Plan	Line open pits with a mixture of bentonite and soil to inhibit seepage of tailings water.

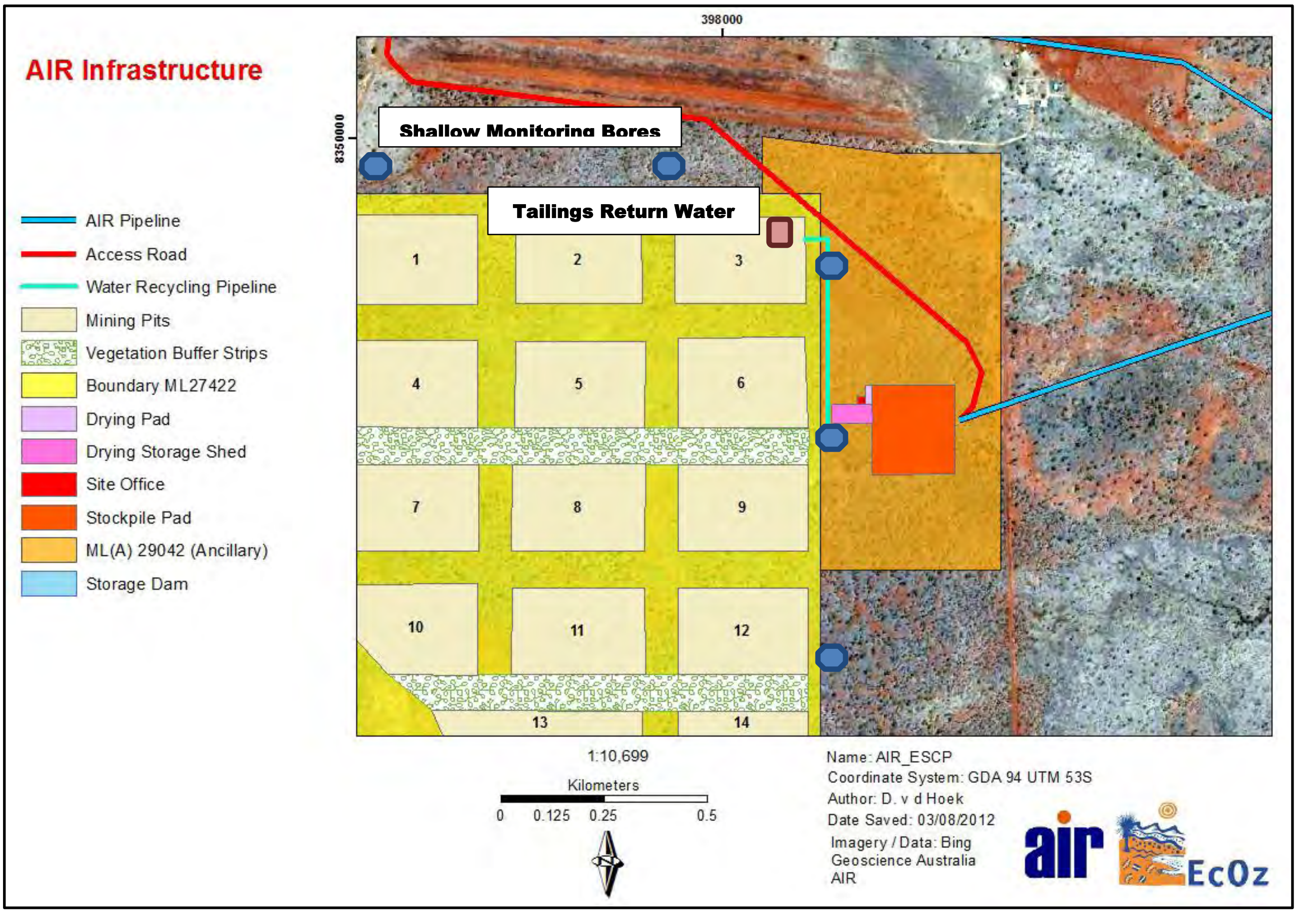

Figure 6.1: Water Quality Sampling Locations.

6.1.3 Biological

Included in the surface water monitoring program – refer Section 6.1.1 above.

6.2 Quality Control

Quality assurance and control measures ensure that:

- Sampling methods are of the highest quality and reproducible.
- Samples are representative, of the highest quality and integrity.
- Analyses are completed with the highest accuracy.

6.2.1 Field QA/QC

Table 10: Field QA/QC.

Component	Description
Standard:	AS 4482.1: 2005.
Procedure (not included in this document):	EcOz Environmental Services Standard Environmental Sampling Protocol. EcOz Environmental Services Health, Safety and Environmental Plan (HSEP).
Accreditation:	Laboratories will be accredited by the National Association of Testing Authorities (NATA) and laboratory certificates will be NATA endorsed reports. Drilling contractors are to hold an appropriate National Water Well Drillers Licence. Competent professionals possessing the relevant knowledge, skills, experience and judgement are to supervise intrusive investigations. All site workers are to be made familiar with the EcOz Environmental Services HSEP. All work is to be undertaken and executed in accordance with the applicable Australian Standards, Guidelines and Codes of Practice.
Pre-sampling activity:	Consult with analysing laboratory to ensure that samples are taken, handled, packaged, stored, transported and delivered with an appropriately completed chain of custody, using the correct labels, container type with sufficient volume, preserved (if required), and to facilitate scheduling of laboratory analysis within stipulated holding times. Prior to use, field equipment will be cleaned, inspected and calibrated in accordance with the specifications of the manufacturer; the calibration results are to be recorded
Record keeping:	Full details of all field activities including soil profiles, bore construction and sample collection are to be recorded on field data sheets requiring detailed and relevant descriptions (with photo evidence), e.g. data and time, location (coordinates, elevations and depths where relevant), type of sampling point, methods used and equipment for sampling and sample appearance (colour, odour, clarity, sheen, etc). These data sheets are to be recorded electronically (scan) and the data captured in an electronic database.
Sampling and decontamination to prevent cross contamination:	Samples are to be obtained by personnel wearing new disposable nitrile gloves replaced between each sample/sampling location. Field drilling and/or sampling equipment will be triple washed/rinsed and a rinsate blank will be collected for verification of cross contamination. Bore water samples are to be obtained with disposable bailers, subsequent to purging with a low flow bore pump fitted with disposable discharge tubing if required, one for each sample. Equipment used in the sampling process is to be decontaminated using Decon 90, a phosphate free detergent, followed by rinsing with laboratory grade distilled water, on arrival at site and between sampling locations, to reduce the risk of cross contamination.
QA/QC Samples:	In addition to the primary samples, QA/QC samples are to be obtained to assess aspects of field protocols and laboratory performance, to assess the representativeness, precision and validity of the data set: • Blind replicate (field duplicate) samples to identify the variation in analyte concentrations between samples collected from the same location and/or the repeatability of laboratory analysis: one for every twenty investigative samples (individual samples are to be marked such that there is no indication of duplication). • Split samples to ascertain analytical proficiency of laboratories: one for every twenty investigative samples. • Rinsate samples where cross contamination from sampling equipment is possible; one for each piece of field equipment. • Transport blanks for contamination during transportation and storage; one for each container/ cooler. Samples of water are to be prepared on site by removing/decanting floating organic material, if present, and by removing sediment, if present, by using a 45micron filter. Syringes and/or filters are to be used once only to eliminate the potential for cross-contamination. Samples for organic analyses are not to be filtered.
Sample labelling:	Samples will be clearly marked with unique identification details, sampling date, sampler initials, project name and number and analyses required.
Sample storage and delivery:	Soil samples will be placed into new (or clean) sterile glass jars with Teflon seals prepared and

Component	Description
	provided by the analysing laboratory. Samples of water will be obtained in sample bottles of the correct type (e.g. plastic for metals; glass for pesticides, TPH and BTEX) and with appropriate preservatives (e.g. nitric acid for heavy metals) prepared and provided by the analysing laboratory. All samples will be placed on ice (1kg of ice per 10L of cooler to achieve a temperature of 4°C) in an insulated cooler. The samples are to be delivered to the analysing laboratory the same day or refrigerated overnight and delivered within 24 hours to the analysing laboratory.
Chain of Custody	Chain of Custody (CoC) procedures are to be adhered to for all sample transfers. CoC's are to detail all relevant contact details, sample numbers, sampling date and time, condition of sample, description of sample containers and sizes (including details of filtration and preservation), analyses required, detection or reporting limits and specific instructions (e.g. special safety precautions, analysis of both solid and liquid phases, notification of possible contaminants to minimise laboratory staff contact and to ensure analysing equipment is appropriately calibrated), and are signed by each person transferring and accepting custody.

6.2.2 Laboratory QA/QC

Samples are to be analysed by a National Association of Testing Authorities (NATA) accredited laboratory, employing approved methods. NATA endorsed laboratory reports, including Sample Receipt Notifications, Certificates of Analysis, Quality Control Reports and Interpretive Quality Control Reports are to be provided.

Laboratory QA/QC is to include, over and above internal reviews prior to finalising the laboratory reports, further analysis to determine whether errors have been made, surrogates, duplicates, method blanks, laboratory control and matrix spikes, parameter frequencies and summaries of outliers.

6.2.3 Data Evaluation and Validation

Strict field and laboratory QA/QC programs in accordance with the requirements of AS4482.1, 2005, will be implemented prior to and adhered to throughout sampling events. These programs will be assessed and detailed in terms of an Analytical Data Validation process for water in a prescribed format which will accompany CoC's, detailed laboratory analytical certificates and associated QA/QC reports.

The validation process will include a thorough review of all field and laboratory data with particular reference to:

- Processes and/or methods that may interfere with the integrity of the samples.
- Cross contamination in sampling procedures.
- Cross contamination from borehole construction.
- Interferences from preservatives.
- Interferences from laboratory processes.
- Accuracy and precision of laboratory results.

The validity of analytical data will be assessed by a critical review of all QA/QC processes and QC samples and their results in accordance with the USEPA Guidelines of 1999 which included a comparison with the stated DQO's, taking due cognisance of documentation/data completeness, comparability, representativeness and the precision and accuracy of both sampling and analysis for each analyte in each matrix with the objective to ensure that the data reported is most suitable to be used to achieve the objectives of the site assessment.

6.3 Water Quality Trigger Values

Where, and if required, cognisance will be taken of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) and the Australian Drinking Water Guidelines (NHMRC/NRMMC, 2011).

6.3.1 Level of Protection

Where, and if required, past and current land uses, declared Beneficial Uses and sites of conservation status will be used to set an appropriate level of protection in accordance with the ANZECC guidelines. The level of protection will be determined in consultation with all relevant stakeholders including DoR, NRETAS and downstream users.

6.3.2 Surface Water

Since the primary activity pertains to abstraction of surface water from the Roper River and since no water will be discharged, coupled with the absence of streams in close proximity to SILL80, water quality will not be monitored.

6.3.3 Groundwater

In the absence of a hydraulic connection between surface and groundwater at the site, but since the surrounding land uses pertain to livestock coupled with domestic/potable water supplies, water quality trigger values will be set taking cognisance of ambient water qualities and the Australian Drinking Water Guidelines (ADWG, 2011):

Table 11: Water Quality Assessment or Trigger Levels.

Analyte	Assessment or Trigger Value (mg/L where applicable)
pH Value	6.5 – 8.5
EC, TDS, TA and Major Cations and Anions	no more than 15% above ambient level
Leachable Metals	**ADWG 2011 level below or no more than 15% above ambient concentration where the latter exceeds the ADWG**
Aluminium	0.200
Arsenic	0.007
Cadmium	0.002
Chromium	-
Cobalt	-
Copper	2.000
Iron	0.300
Lead	0.010
Manganese	0.500
Selenium	0.010
Zinc	3.000
Molybdenum	0.050

6.3.4 Application of Trigger Values and Incident Reporting

Details pertaining responses to results triggering assessment levels, including investigations, impact and risk assessments and the corrective actions taken to prevent recurrence will be reported at the time of the incident to DoR and included in the annual report.

7 Reporting

An annual water quality report will be compiled to include:

- Water level and flow data, assessments and interpretations entailing comparisons with upstream and downstream data using trend diagrams.
- Identification of any issues and their potential causes.
- Details of any incidents potentially affecting water levels and quality.
- Details of actions taken to address any water level and/or quality issues.
- Commitments to specific areas for improvement in the next reporting period.

8 Strategic Planning

Upon approval of this document the Water Management System (WMS) is to be implemented in accordance with this document.

The primary short term 1-year objectives, priority actions and initiatives entail implementing and calibrating of a monitoring and recording system of the water level and flows in the Roper River at the abstraction point to ensure that the SILL80 Project does not impact on downstream users.

The SILL80 Project is committed to continual improvement of its water balance, and as such, minimising abstraction from the Roper River. Operations will therefore investigate the feasibility of using clay and/or synthetic liners to inhibit seepage from the 50ML storage dam and open pits used for returning tailings water to the plant.

9 Changes since last WMP

This is the first issue of this document.

10 References

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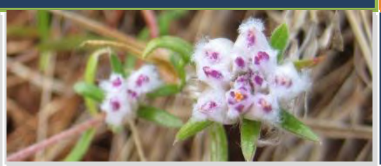
Appendix H - Erosion and Sediment Control Plan

Australian Ilmenite Resources Pty Ltd

SILL80 Project

2012






Document Control Record

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REVISION STATUS

Revision No.	Description of Revision	Date	Approved
1-3	Internal Review	06/12/2011	Justine Shailes
A-B	Internal Review	13/07/12	Jeff Richardson
C	Submit to NTG	29/08/12	Jeff Richardson

Recipients are responsible for eliminating all superseded documents in their possession.

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Executive Summary

This Erosion and Sediment Control Plan (ESCP) outlines strategies for works to be undertaken as part of the AIR SILL80 project to minimise soil erosion and the discharge of sediment to land and waterways as a result of mine development or operations. Specifically, this plan details the following:

- Stormwater Management Controls;
- Maintenance and Monitoring Programs; and
- Site specific Erosion and Sediment Control Plans

The overall objectives of this ESCP are to:

- Control soil erosion and sediment generation from areas disturbed by construction and mining activities; and
- Minimise potential project related activities resulting in decreased water quality (particularly suspended solids) in downstream local watercourses.

Construction design and management will comply with the Department of Natural Resources, Environment, the Arts and Sport (NRETAS) *Erosion and Sediment Control Plan Content* (2006) and the guidelines put forth by the International Erosion Control Association (IECA 2008). As such, principles of effective erosion and sediment control will be employed to minimise the extent and duration of any erosion and sediment generating activities and ensure the prompt stabilisation of land.

Where possible, stormwater will be diverted around any active or rehabilitated mine areas. This will minimise both the flow rate and volume of runoff to be handled by on-site water management structures and enable them to perform more effectively.

Water quality analyses will be performed with results used as indicators of success for the construction and operational phases. Should deterioration in water quality be evident, remedial actions will be triggered.

The integrity of receiving water bodies will not be adversely impacted as a result of this development, provided that the sediment control measures described herein are implemented.

Contents

Figures

Tables

1 Introduction

1.1 Background

EcOz Environmental Services was engaged by Australian Ilmenite Resources Pty Ltd (AIR) to prepare an Erosion and Sediment Control Plan (ESCP) for the SILL80 project within ML27422 in the Roper River Region. This ESCP has been prepared for clearing of the mining lease and construction of the processing plant and open cut mining operations, to address key risks outlined in the *Guidelines for the Preparation of a Public Environmental Report, SILL 80 Project, Roper River area, NT, Australian Ilmenite Resources Pty Ltd, April 2011* as prepared by the Northern Territory Department of Natural Resources, Environment, The Arts and Sport (NRETAS).

Figure 1-1 shows the location of ML27422. The area to be cleared encompasses approximately 800ha from a total of 1225ha within the Mining Lease.

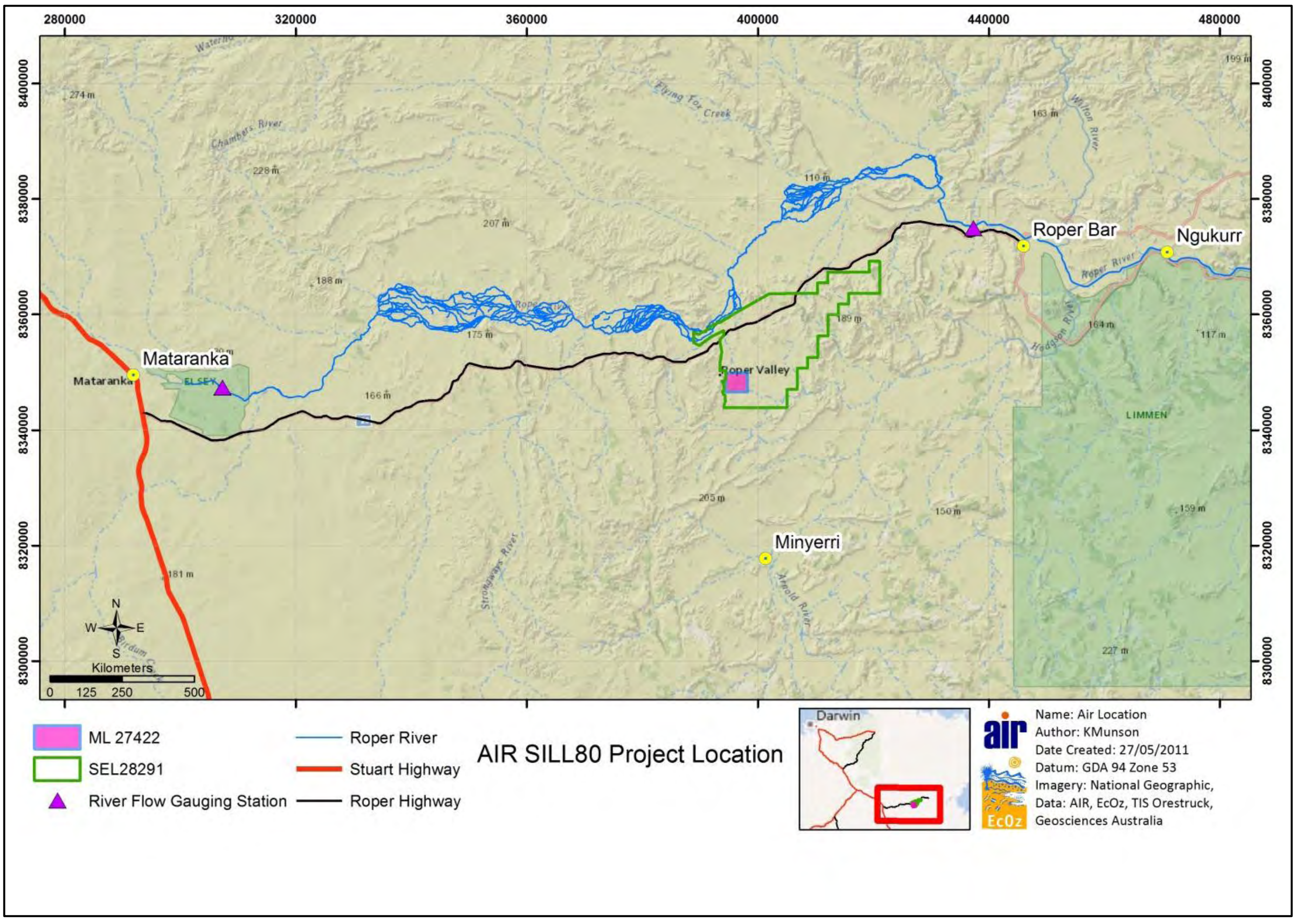


Figure 1-1: Location of SILL80 Project

1.2 Scope

This ESCP outlines strategies for works to be undertaken as part of the AIR SILL80 project to minimise soil erosion and the discharge of sediment to land and waterways as a result of mine development or operations. Specifically, this report details the following:

- Stormwater management controls;

- Maintenance and monitoring programs; and
- Site Specific Erosion and Sediment Control Plans.

To minimise the impact of the proposed development on the surrounding environment, this ESCP shall be developed and implemented throughout the life of the mine. To avoid significant and/or sustained deterioration in downstream water quality, this ESCP may be amended as required, in response to the Maintenance and Monitoring Program described herein (Section 3.3).

1.3 Objectives

The overall objectives of this ESCP are to:

- Control soil erosion and sediment generation from areas disturbed by construction and mining activities; and
- Minimise potential project related activities resulting in decreased water quality (particularly suspended solids) in downstream local watercourses.

1.4 Relevant Legislation and Guidelines

The following legislation and guidelines were used to prepare this ESCP:

- *Water Act* (NT);
- *Waste Management and Pollution Control Act* (NT);
- *Soil Conservation and Land Utilisation Act* (NT);
- NRETAS *Erosion and Sediment Control Plan Content* (2006);
- Department of Health and Families *Guidelines for preventing mosquito breeding sites associated with mining sites, NT* (2005);
- Institute of Engineers Australia (IEAust). *Soil Erosion and Sediment Control Engineering Guidelines for Queensland Construction Sites* (June, 1996); and
- Managing Urban Stormwater Soils and Construction Volume 2E Mines and quarries. Department of Environment and Climate Change NSW.
- Guidelines put forth by the International Erosion Control Association (IECA 2008)

1.5 Performance Criteria

In accordance with NRETAS requirements, the following performance criteria have been set for the AIR SILL80 Project development:

- Stable embankments and drainage lines;
- No obvious accumulation of sediment within natural watercourses or drainage lines outside of the construction area;
- No unnecessary disturbance of earth or vegetation outside areas to be cleared or disturbed;
- No new biting insect breeding habitats created and no increase in mosquito numbers; and
- All batters or embankments to have slopes greater than 1:4.

2 Site Characteristics

2.1 Locality

AIR proposes to develop its SILL80 Ilmenite Project, within Mining Lease Application ML27422, located within the Roper Gulf Shire, Perpetual Pastoral Lease 1161, Land Parcel NT Portion 4970 Chatterhoochee (Numul Numul). The Traditional Owners of the land are the Namul-Namul Aboriginal Corporation who sub-leases the area to the O'Brien family, who manage the property as a cattle station. The property is located in the Roper River Region of the Northern Territory, 8 km south of the Roper Highway. The major townships in the area are Mataranka Township (Population ~ 600) 105km to the East and Ngukurr (Population ~ 1,600) 80km to the West. The proposed mine site is approximately 10km south of the Roper River, 4 km south-east of the Kewulyi Aboriginal Community Outstation (old Roper Valley Homestead) and 3 km south-west of Numul Numul homestead.

2.2 Proposal

The SILL80 Project forms part of AIR's larger Roper Heavy Minerals Project. ML27422 contains an estimated ilmenite (FeTiO3) resource of approximately 4.5 million tonnes. Based on this, the life of the mine is expected to be in excess of 20 years.

The ilmenite mineralisation results from the weathering of dolerite sills within the top three metres of regolith. As such, ilmenite recovery will require strip mining using excavators to remove the regolith to a maximum depth of four metres. Pits will be constructed 300m long and 200m wide. Once the ilmenite has been removed from regolith through the processing plant, residual material will be used to backfill pits allowing for successive rehabilitation of mined strips.

2.3 Topography

The Project Area lies principally within the physiographic province of the Gulf Fall, a dissected terrain from which almost all of the old Tertiary land surfaces have been eroded. This terrain is characterised by broad alluvial valleys between low rubbly hills and prominent strike ridges of resistant Roper Group strata. The flat-floored ridges form part of the vast Roper River floodplain and its associated tributaries (Wilton, Maiwok, Flying Fox and Jalboi Rivers) and are largely developed on incompetent shales, fine-grained sediments, volcanics and carbonate rocks. Local relief is variable ranging from 20 to 120 metres. The target dolerite sills are prominent in their deep red soil colour and rounded boulder-strewn outcrops.

2.4 Soils

The AIR SILL80 Project is confined to the Roper Group, specifically targeting the ilmenite-bearing dolerite sill horizons and their possible erosional transport trails. The strata are generally flat lying to undulating although secondary folding and reactivation of older faults result in steepening of dips and stratigraphic dislocation in places; west-north-west trending Urapunga Tectonic Ridge in the central area and north-south trending Strangeways Fault in the southwest.

ML27422 has an absence of Cambrian flood basalts and only remnant outliers of Cretaceous sandstones. These are extensive to the south, west and north of the project, suggesting significant uplift and erosion within the area permitting exposure of the underlying Proterozoic sediments and dolerite sills. Extensive deposits of Quaternary to recent sediments comprising alluvium, colluvium, unconsolidated gravel and sand overlain by mud-rich soils are mapped in the project area and reflect material derived from prolonged weathering and erosion during the Tertiary.

Sills of the Derim Derim Dolerite were emplaced at various stratigraphic horizons from a primary magma source at depth. Extensive lateritised outcrops, sub-crops and regolithic soils of the dolerite have been mapped throughout AIR tenements. The dolerite outcrops as low-relief medium to coarse grained, variably altered and weathered ('onion-skin' weathering) rounded boulders. Composition is dominated by plagioclase (40%), clinopyroxene (40%), amphibole (7%), opaques (ilmenite & magnetite 5%) and clay (7%). The associated regolith soils are deep red-purple-brown, clay-rich and contain abundant liberated ilmenite and, locally, with accessory titanomagnetite, magnetite and haematite grains. In some areas these dolerite sills have only been recently exhumed (at higher elevations) and in other instances, larger areas of dolerite sills have been exposed for a longer geological time resulting in pisolitic laterite formation and attendant erosion (at lower elevations). These areas are considered highly erodible, especially the sloping red soils.

The following images were taken within each of the quadrats that were surveyed as part of a biological survey of the project area; Quadrat A (QA) through to Quadrat F (QF) (Figure 2-1).

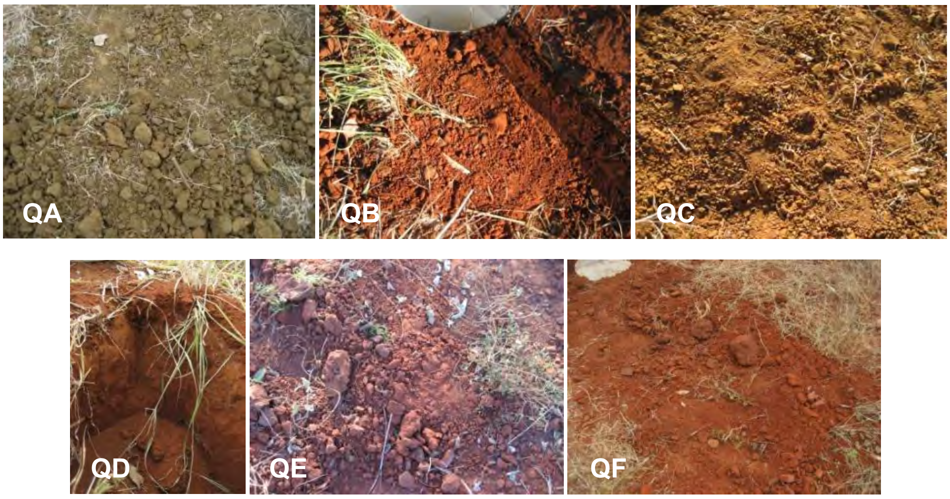


Figure 2-1. Soils Types Within ML 27422

2.5 Land Systems

Land system classification and mapping (1:250,000 scale) of the project area and surrounds was undertaken by Aldrick and Wilson (1992). Three land systems were identified (Table 2-1 below) within the project area footprint. Figure 2-2 shows the location of each land system within the project area and Table 2-1 describes each system and details the percentage of the total area that is represented within the project area.

Table 2-1. Land System Summary

Code	Land System	Description	% of Project Area
Ibc	Cliffdale	Gently undulating to undulating rises with abundant, often linear rocky outcrops and shallow sandy soils. Lithosols, minor siliceous and earthy sands. Mid-high open woodland of *Eucalyptus miniata*, *E. tetrodonta*, *E. ferruginea*, with *E. dichromophloia*.	~56%
Als	Seigal	Gently undulating to hilly terrain on basalt, dolerite, agglomerate and other volcanic and sometimes non-volcanic rocks. Lithosols with rock outcrop, euchrozems, red and black earths and red clays. Highly erodible, especially the sloping red soils. Mid-high open woodland of *E. tectifica* and *Erythrophleum chlorostachys*.	~1%
Tam	McArthur	Broad or narrow fluvial corridors conducting regional drainage across various land systems towards the coast. Grey and brown clays, red and yellow earths and siliceous sands. Mid-high open woodland of E. microtheca with some E. papuana and E. polycarpa. Tall fringing riparian vegetation often includes Melaleuca spp.	~0.5%
Ibn	Nutwood	Plains and low rises on basalt and associated basic igneous rocks. Brown, grey and red clays, euchrozems and brown and red earths. Mid-high open woodland of *Lysiphyllum cunninghamii* and *E. terminalis* with some *E. patellaris*.	~42.5%

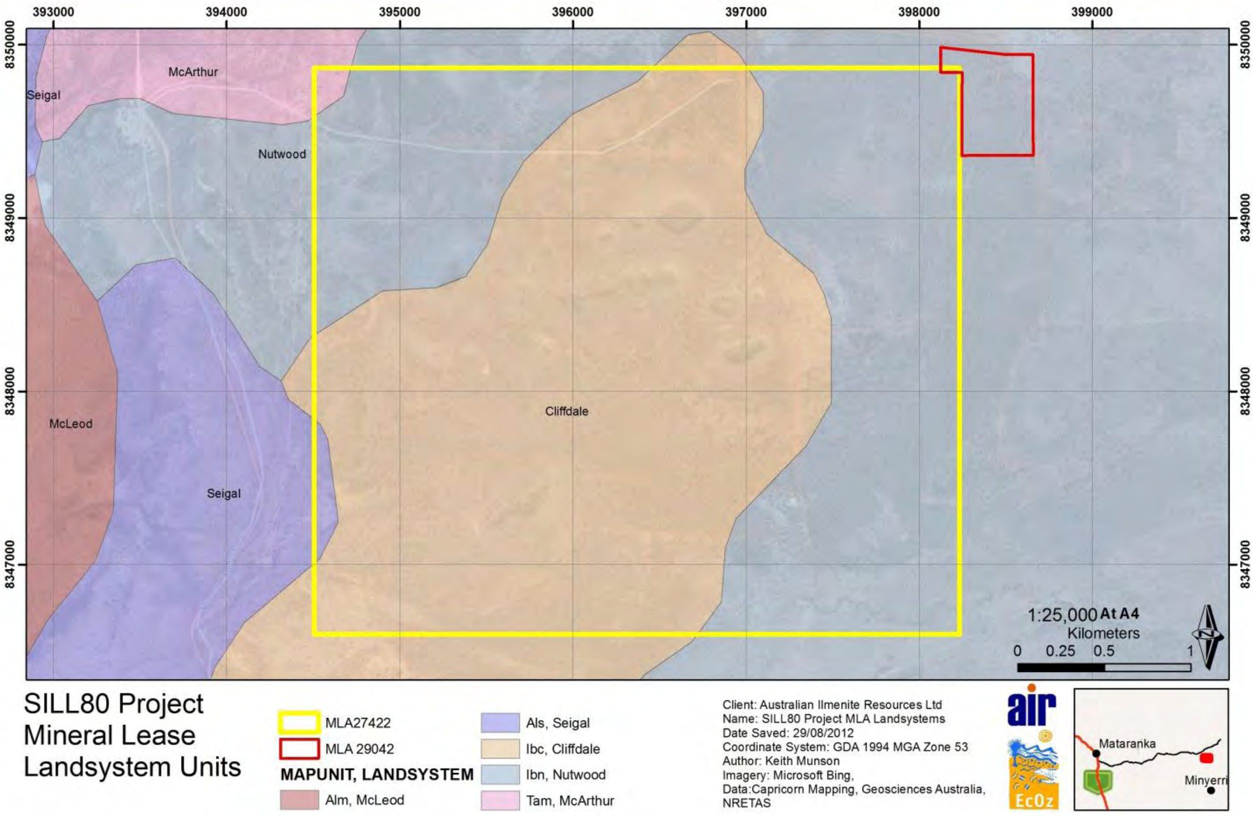


Figure 2-2: Land Units at the Proposed Development Site

2.6 Vegetation

Most of the site consists of native vegetation common to the region. EcOz Environmental Services performed flora surveys in the area in May 2011 (Flora and Fauna Report PER Appendix B). The major vegetation communities identified in the survey are as follows:

- Low *Eucalyptus pruinosa* open woodland, with or without *Corymbia terminalis*, over tall closed tussock grass;
- Medium height *Corymbia terminalis, Eucalyptus tectifica* open woodland, with or without *Corymbia confertiflora*, over tall mid-dense tussock grass; and
- Low *Corymbia terminalis, Eucalyptus tectifica* Woodland, with or without *Corymbia confertiflora* over medium height / mid-dense closed tussock grass.

2.7 Existing Disturbance

As the area encompassing ML27422 is currently a pastoral station, disturbance through cattle stocking is evident (e.g. pugging and soil compaction). Weed species (e.g. *Hyptis suaveolens* and *Sida acuta*) are present throughout the property and laneways and tracks have been developed for mustering and maintenance purposes. The laneways and tracks are maintained annually through grading practices post-wet season. Extensive fencing for stock management as well as the development of multiple stock dams has occurred within the lease area.

3 Erosion and Sediment Control

The purpose of this section is to provide a set of best practice site management procedures to control the severity and extent of soil erosion and transport during the clearing and operational phases of the proposed development.

Open cut mining involves topsoil stripping, overburden removal, handling, and stockpiling, resulting in potential erosion and sedimentation issues, not only within the mining area but also into the surrounding environment. The slope of the mining lease is 0.98% and while relatively flat, there would still be a degree of runoff and sedimentation potential. Velocities of flows over land (chiefly stormwater) are expected to be $0.4ms^{-1}$.

Erosion and sedimentation control measures will be employed throughout the site to control stormwater. Any water which falls within the site will be captured within open pits and directed back to a water storage pit for re-use back on site. Mulch bunding on the downward side of pits will act to capture sediment, reduce water velocity and divert to overland flows. Rehabilitation of pits will spread mulch berms over refilled pits to aid revegetation and reduce the erosion potential. Increased permeability of replaced material will also result in reduced runoff in the short term before soils have been compacted back to natural ground level. Water flowing around the site will be diverted to overland flows via a level spreader to minimise the risk of erosion. Vegetation buffers will also be utilised to both aid in rehabilitation and capture sediment. Only one significant drainage line is located in close proximity to the project in the south eastern corner of ML27422. A 100m vegetation buffer has been proposed around this feature to further insure the integrity of receiving waters. The following sections detail erosion and sedimentation control measures, including construction design and management to comply with the NRETAS *Erosion and Sediment Control Plan Content* (2006). AIR will be responsible for the implementation, inspection, repair, and modification of the controls and will be subjected to annual internal audits as part of the Mining Management Plan.

3.1 Principles of Erosion and Sediment Control

The principles of effective erosion and sediment control for the proposed clearing activity on site are based on the following:

- Appropriately integrate the development into the site;
- Integrate erosion and sediment control issues into site and construction planning;
- Develop effective and flexible erosion and sediment control plans based on anticipated soil, weather and construction conditions;
- Minimise the extent and duration of soil disturbance;
- Minimise soil erosion;
- Maximise sediment retention on site;
- Maintain all erosion and sediment control measures in proper working order, at all times;
- Monitor the site and adjust erosion and sediment control practices to maintain the required performance standard;
- Control water flow from the top of and through the project area by diverting up-slope 'clean' water away from disturbed areas and ensuring that concentrated flows are below erosive levels and sediment is retained from disturbed areas;
- Rehabilitate disturbed lands quickly.

3.1.1 Site Installation Sequence

Effective erosion and sediment control for the mine site requires appropriate activities to be carried out over the life of the project including:

- Planning and design;
- Operations; and
- Closure and rehabilitation.

Planning and Design Strategies:

The effectiveness of erosion and sediment controls during the operational and rehabilitation stages can be optimised through effective mine planning and design. Suitable strategies include:

1. Designing any drainage systems operating for the life of the mine so that they do not cause erosion. This will involve the construction of a level spreader at the point of discharge into intact vegetation;
2. Diverting runoff around the mine site where possible, to minimise water flowing from upstream catchments to operational areas;
3. Designing the final mine geometry to create a landform that allows free drainage of surface runoff while minimising erosion;
4. Staging open cut mining during the dry season so pit areas are either, open and capturing water during the wet season or rehabilitated to greatly minimise the erosive potential of the refilled pit surface.;
5. Capturing stormwater infiltrating into pits for reuse as part of the overall water-management strategy for the site to avoid or reduce discharge of polluted water. There are commonly a range of non-potable water uses on a mine site such as dust suppression and irrigation of revegetation areas. This may be more cost effective than treatment of polluted runoff and will also reduce consumption from other water sources.

Operational Phase Strategies:

Activities will vary throughout the life of the mine, and it is expected that erosion and sediment control measures and activities will evolve over time. Erosion control strategies for mines should normally comprise the following:

1. Minimisation of extent and duration of disturbed areas draining to waterways, and prompt revegetation of non-operational disturbed areas;
2. Ensuring both temporary earthworks and permanent land-shaping provide a landform which minimises erosion hazard;
3. Prompt stabilisation of land following land reshaping (both temporary and permanent); and
4. Design of temporary surface-water collection, conveyance and disposal systems in a manner which minimises erosion.

Where possible, stormwater should be diverted around any active or rehabilitated mine areas. This will minimise both the flow rate and volume of runoff reducing erosion and sediment transport from these areas and maintain local hydrology within surrounding areas.

The following sediment and erosion control devices and stormwater management controls will be implemented on the site;

- Construction Entry/Exit Shake Down – Used to prevent the tracking of sediment from tyres of vehicles to public roads;
- Catch drain – Used to convey clean water flows toward a level spreader for discharge into intact vegetation and flows from disturbed areas to sediment basins and water storage pits;
- Diversion banks – Used to convey clean water flows toward a level spreader for discharge to intact vegetation
- Sediment Basin – Used to trap and retain sediment via settlement of suspended particles;

* Mulch Bund (Batter) – Used to reduce the velocity of treated water discharged from the sediment basins in addition to providing a further degree of treatment; and
* Silt fences.

3.2 Erosion and Sediment Controls

The following erosion and sediment controls will be adopted for the proposed development.

3.2.1 Construction Entry/Exit Shake Down

A construction entry/exit is used to prevent the tracking of sediment from the tyres of vehicles to public roads. Only one construction entry/exit should be provided for the site unless site access or topography requires more. Any sediment transported onto roadways must be removed and corrective measures applied so as to ensure no recurrence.

Figure 3-1 below represents a typical construction entry/exit shake down area used to prevent the transport of sediment off site.

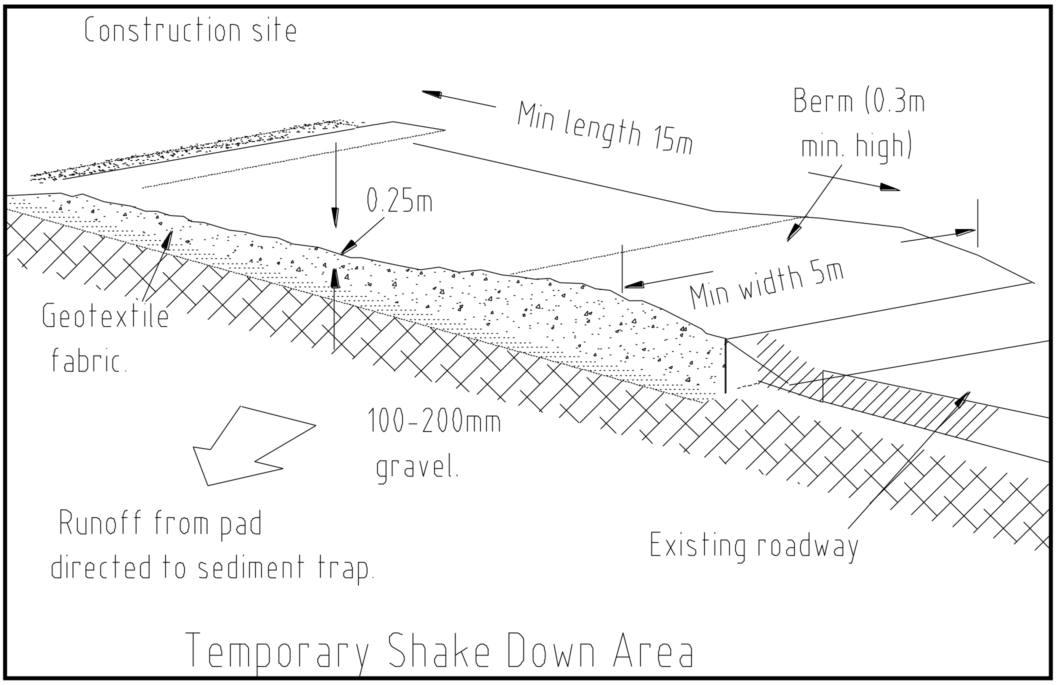


Figure 3-1: Typical Construction Entry/Exit Shake Down area

3.2.2 Catch Drain and Diversion Banks

Catch drains and diversion banks are used to convey flow within disturbed areas to sediment basins and divert clean water around disturbed areas. Catch drains should be regularly inspected and any damage from onsite vehicles should be repaired immediately. Any build-up of sediment should be removed as soon as practicable. Figure 3-2 below shows a typical cross-section of a catch drain.

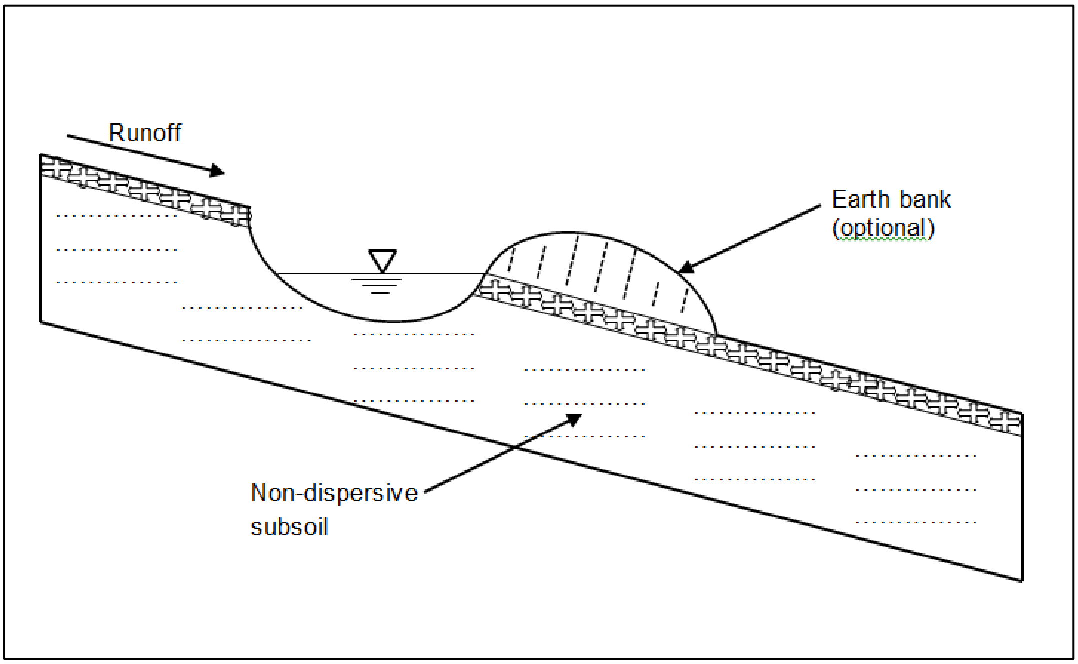


Figure 3-2: Typical Cross-Section of a Catch Drain

3.2.3 Sediment Basin

Sediment basins are generally required where:

- The disturbed area is greater than 1 ha;
- The disturbed solids are dispersive; and/or
- Where there is a need to control runoff, suspended solids and/or turbidity.

As mining pits will either be open and directing water towards the water storage pit or rehabilitated, reducing surface erosion potential and increasing soil permeability, sediment dams will not be required for the mining area. However, sediment dams are required to prevent sediment discharge from the stockpile pads.

The size of the sediment pond will be designed to retain expected quantities of contaminated water plus stormwater for a 1 in 10 year storm event, at any one time. .

Chemicals and hydrocarbons used on site will be captured in bunded areas to ensure spills are contained to reduce the likelihood of contaminated water entering the environment. Water collected from these bunds will be directed to the sediment pond.

The sediment pond will be fenced to limit access by native or feral animals.

Any release of water from the sedimentation pond will be tested prior to discharge if possible, to ensure water meets water quality guidelines (e.g. ANZECC 2000).

It is unlikely that a Waste Discharge Licence will be required as water will only discharge from the sediment catchment basin during high rainfall events and there are no nearby waterways likely to be impacted by the discharged water.

Further detail on site management of stormwater and contaminated water will be detailed in the Mining Management Plan (MMP). Management and prevention of pollution will be carried out in compliance with relevant Northern Territory legislation.

Figure 3-3 below shows a sediment basin in use at a construction site.

Figure 3-3: Example of a Sediment Basin (photo: http://krominco.com/)

3.2.4 Mulch Bund (Batter)

Mulch bunds are used to temporarily reduce the velocity of contaminated sheet flow and to induce gravitational settlement of sediment. Regular inspections and maintenance are required to repair damage caused by the movement of on-site vehicles or stockpile material.

3.2.5 Silt Fences

Stockpiles will be confined to a designated area that will be surrounded by catch drains for the downslope areas. Sediment basins will be present in the catchment area adjacent to stockpiles.

3.3 Maintenance and Monitoring Program

3.3.1 Construction Phase Monitoring

Prior to construction on site, AIR will undertake a series of data collection exercises to define the existing stormwater quality. This will comprise the collection of water samples after the following rainfall events:

- 3 storm events of greater than 25 mm; and
- 3 smaller rainfall events.

Samples will be analysed for total suspended solids (TSS), pH, dissolved oxygen (DO) and hydrocarbons with the results being used as water quality indicators for construction phase monitoring. Monitoring during the construction phase will be conducted to determine the impact of activities on the subject site only. Sampling by the proponent will be undertaken in accordance with procedures set out in the Environmental Protection Authority's Water Quality Sampling Manual. A NATA (National Association of Testing Authorities) registered laboratory will be used to perform the analysis of collected samples. Monitoring reports will be compiled upon request or as part of the annually reviewed MMP.

3.3.2 Investigation Indicators

The following indicators are used to identify if the objectives of the ESCP are being met:

- Visible evidence of deterioration of water quality of downstream watercourses that is directly attributable to the site (e.g. high turbidity);
- Visible significant erosion; and/or
- Failure of control measures.

The triggering of an investigation indicator will require the following remedial actions:

- Locate source of water quality deterioration;
- Prevent continuing deterioration with temporary controls;
- Repair existing controls, construct additional controls or modify procedures to prevent future deterioration in water quality; and
- During the operational phase of the development, if there is a significant deterioration in water quality, the management plan and strategies will be reviewed.

4 Site Specific Erosion and Sediment Control Plans

4.1 ESCP for the Mining Area (ML27422)

The below outline is dependent on progress made each year. This information should be considered a guide as figures and mining areas may change dependent on factors such as weather, mining efficiency, and foreign markets. This information will be updated and reported to DoR on an annual basis through the MMP so that Government Authorities are always aware of the progress and planning expectations for the project.

4.1.1 First Years Mining

- The first years clearing will be undertaken within the area shown in Figure 4-1. This area encompasses pit 1 through to pit 6. Clearing will be undertaken prior to significant monsoon rainfall forecast at the beginning of November.
- Type C catch drains (see Appendix H-1 for specifications) will be constructed around the northern and eastern sides of the cleared area to divert surface water runoff generated from within the cleared area toward pit 3. A diversion bank (see Appendix H-2 for specifications) with a10m maximum width of disturbance will be constructed on the western side of pit 1 and pit 4 and will direct clean water to a level spreader (see Appendix H-3 for specifications) for overland discharge north of the lease area.
- Trees pushed over during clearing will be mulched while green to provide material for mulch berms. Grass and shrubs will be pushed into piles and burnt to destroy Hyptis (*Hyptis suaveolens*) and Rattle Pod (*Crotalaria goreensis*) seed stock.
- Mulch will be formed into a mulch berm (see Appendix H-4 for specifications) shown in Figure 4-1. This will act to trap sediment and direct surface water toward overland flow.
- Pit 3 and pit 6 will be excavated to a depth of 4m and will be 200m wide x 300m long, with the resulting material transported via a portable conveyer belt system to the stock pile area for processing through the plant. Processing will be conducted for 11 hours per day. A separated ESCP has been developed for the stockpile pad (see Appendix H-7). Mining and processing will occur for 11 months of the year.
- Mined material will be processed through the processing plant with the resulting waste material pumped back into pit 6. Placement of waste material will take place continually throughout the year. Waste soil will be dried and returned to the mining void. Any excess water will be decanted and returned to the processing circuit. Ilmenite is expected to average 5% of the total extracted material, however swelling of excavated soil has been calculated to require placement of soil to a height 1.2m above the natural ground level (a swell factor of 30% has been adopted). Over time, refilled pits will settle back to the natural ground height.
- A pit drainage channel will be dug between pit 6 and pit 3 to direct excess pumping water back to pit 3 for recycling through the processing plant. Pit 3 will remain open and be utilised as a water storage pit for the entirety of the mining operation. Water will be pumped from the water storage pit into the water feeder tank to circulate water back through the processing plant.
- Upon completion of refilling pit 6, the mulch berm will be removed from over pit 1and pit 2 and one sixth of the total mulch will be spread over the surface of pit 6 (see Appendix H-5 for specifications).

- Temporary fencing will be constructed around pit 6, with a suitable grass seed and hay spread over the site. Cattle are then let on site to eat the hay, trampling the grass seed into the ground in the process and helping to settle the soil surface. Cattle are then removed. Upcoming wet season rains will germinate grass and provide extra cover to the site. For additional information on revegetation methods see Appendix H-6. Refilled pits will have an increased permeability so surface water runoff will be reduced.
- Weed monitoring and control will take place over rehabilitated areas to ensure that that weed species don't establish.

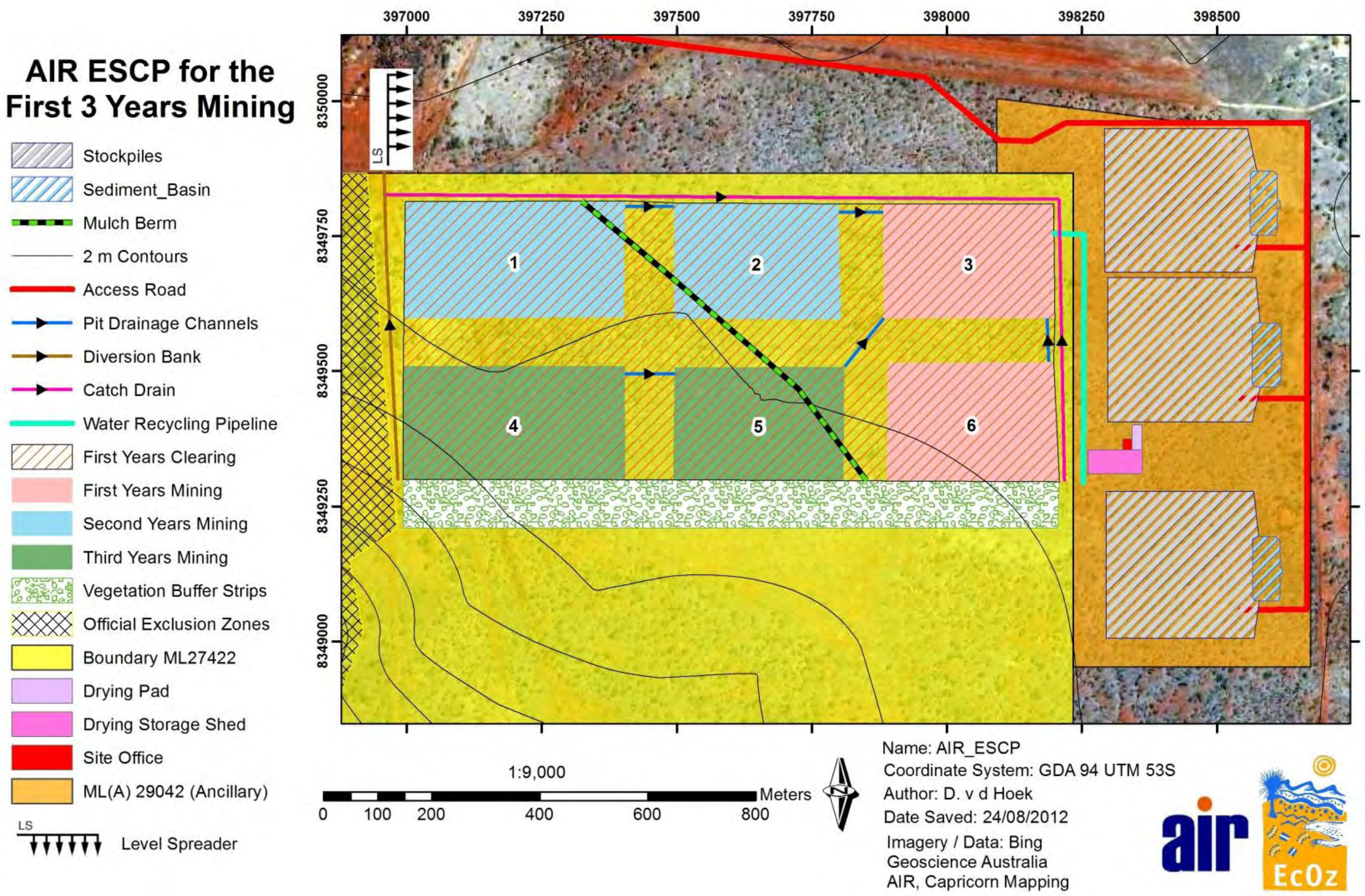


Figure 4-1: Mining and Stockpile design for the first three years of operations

4.1.2 Second Years Mining

- Pit 1 and pit 2 will be excavated in year 2 with both pits transported to and stored on the stockpile pad for processing. Pits will be excavated during the dry season, the material processed and pumped back into pit 1 and then pit 2 using the techniques outlined above for pit 6 (see Section 4.1.1).
- Pit drainage channels will be dug between pit 1, pit 2 and pit 3 to direct excess water back to pit 3 for reprocessing.
- Once pit 1 and pit 2 are refilled they will be rehabilitated using the methods outlined for pit 6 with the application of mulch, grass seed, hay and cattle to re-establish a grass cover on the site. Weed monitoring and control will insure that weed species do not establish on the site.

4.1.3 Third Years Mining

- The third year of mining will mine pit 4 and pit 5, following the same method as outlined above for the second year (see Section 4.1.2).
- A 100m vegetation buffer will be left intact running parallel with the southern edge of pit 4, pit 5 and pit 6. This will assist with rehabilitation of the site and trapping of sediment from overland surface water flows. Vegetation buffers will be left in place along every second lane way as shown in Figure 4-1.
- Once pits 1 through to pits 6 have been refilled and rehabilitated, catch drains will be removed from the perimeter and the area rehabilitated in line with pit rehabilitation methods. Diversion banks will be progressively constructed in line with Figure 4-1 to divert clean water around the mining area. Clean diverted surface water will be discharged toward overland flow aided by a level spreader as specified in Appendix H-3.

4.1.4 Fourth Years Mining

- Clearing will be undertaken during the dry season across the areas of pit 7 pit 8 and pit 9.
- Trees pushed over during clearing will be mulched while green to provide for mulch berms. Grass and shrubs will be pushed into piles and burnt to destroy Hyptis (*Hyptis suaveolens*) and Rattle Pod (*Crotalaria goreensis*) seed stock.
- Mulch will be formed into a mulch berm (as per the specifications supplied in Appendix H-4) as shown in Figure 4-2. Mulch berms will be placed downslope of cleared areas to trap sediment and direct surface water toward overland flow.
- Pits will be excavated with the resulting material stored on the stockpile pad for processing (see Figure 4-2).
- Pit drainage channels will be dug between pit 7, pit 8 and pit 9. A drainage channel will then be constructed to allow water to flow back to the water storage pit 3 for recycling through the processing plant.
- Pits will be progressively refilled and rehabilitated using methods outlined above for previously mined pits (see Section 4.1.1).

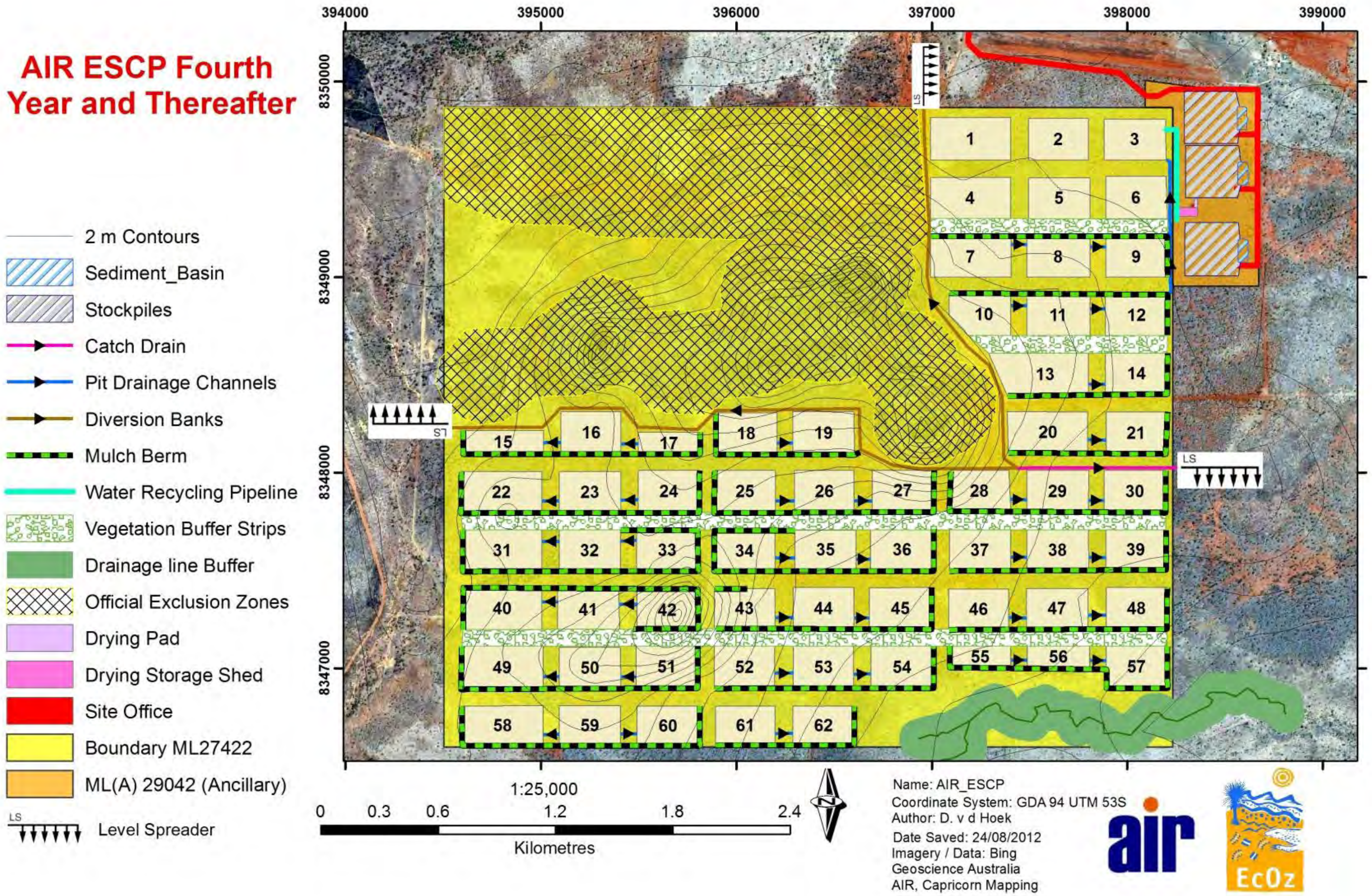


Figure 4-2: Mine Design for the life of the Project at ML27422 and MLA29042

4.1.5 Fifth Years Mining

- Clearing will be undertaken during the dry season across the areas of pit 10, pit 11 and pit 12 and include the laneway to the north of the pits. The laneway to the south of the pits will be left intact.
- Clearing, mining and rehabilitation of pits will be undertaken using the methods outlined in Section 4.1.4.

4.1.6 Sixth Years Mining

- Clearing will be undertaken in the dry season across pit 13 and pit 14.
- At this stage of the mining process, the ground surface begins to slope toward the south eastern corner of the lease. At this point, pit water will need to be pumped from pit 14 back to pit 3 for water storage and recycling.
- The water diversion bank (see Appendix H-2) situated along the western side of the pits will be constructed alongside pit 13, continuing south alongside pit 20 and discharge into a type C catch drain (see Appendix H-1) running along the southern edge of pit 20 and pit 21. Surface water will be discharged along the eastern edge of the lease via a level spreader (see Appendix H-3) as shown in Figure 4-2
- Clearing, mining and rehabilitation for pit 13 and pit 14 will be undertaken using the methods outlined for the fourth years mining, shown in Section 4.1.4.

4.1.7 Seventh Years Mining

- Clearing will be undertaken in the dry season across pit 20 and pit 21.
- The laneway to the south of the active pits will also be cleared as shown in Figure 4-2.
- Clearing, mining and rehabilitation will be undertaken using the methods outlined for the fourth years mining, shown in Section 4.1.4.

4.1.8 Eighth Years Mining

- Clearing will be undertaken in the dry season across pit 15, pit 16 and pit 17 situated on the western side of the lease.
- The diversion bank (see Appendix H-2) to the north of the active pits will be progressively constructed alongside active pits and discharge clean water via a level spreader located on the western side of the lease as shown in Figure 4-2.
- Pit drainage channels will direct water to the downslope pit (pit15) where it will be pumped to storage pit 3 for recycling through the processing plant.
- Clearing, mining and rehabilitation will be undertaken using the methods outlined for the fourth years mining, shown in Section 4.1.4.

4.1.9 Ninth Years Mining

- Clearing will be undertaken in the dry season across pit 18 and pit 19.
- A diversion bank (see Appendix H-2) will be constructed down the eastern edge of pit 19 and continue around north of pit 27 and pit 28, discharging clean surface water into the type C catch drain for discharge to overland flow via a level spreader as shown in Figure 4-2.
- Clearing, mining and rehabilitation will be undertaken using the methods outlined for the fourth years mining, shown in Section 4.1.4.

4.1.10 Tenth Years Mining and Thereafter

- Clearing will be undertaken in the dry season across pit 22, pit 23 and pit 24.
- Clearing, mining and rehabilitation will be undertaken using the methods outlined for the fourth years mining, shown in Section 4.1.4.
- Mining will continue thereafter with 3 pits cleared, mined and rehabilitated in numerical order (25 to 62) per annum during the dry season. Clearing, mining and rehabilitation of pits will be undertaken as outlined in the fourth years mining method, shown in Section 4.1.4.
- 100m vegetation buffer strips will be left in place as outlined in in Figure 4-2.
- A 100m vegetation buffer will be left in place to protect drainage line in the south eastern corner of the lease as shown in Figure 4-2.
- When all pit have been mined the 100m laneways will be mined, including the laneways with vegetation left intact. Mulch berms will be placed on the downward slope of these areas with mulch acquired from vegetation on laneways that were originally left vegetated.

4.2 ESCP for the Stockpile Area

For an ESCP of the Stockpile area located on MLA29042, please refer to Appendix H-7.

5 Conclusions

This study has reviewed the potential impact of the proposed development on erosion and sediment processes within ML27422. Based on this study, the following erosion and sediment control measures have been developed:

- Construction Entry/Exit Shake Down;
- Catch Drains;
- Sediment Basins;
- Mulch Bunds (Batters); and
- Silt Fences.

Prior to construction on site, AIR will undertake a series of data collection exercises to define the existing stormwater quality. This will comprise the collection of water samples after the following rainfall events:

- 3 storm events of greater than 25 mm; and
- 3 smaller rainfall events.

Samples will be analysed for total suspended solids (TSS), pH, dissolved oxygen (DO) and hydrocarbons with the results being used as water quality indicators for construction phase monitoring.

In summary, it is expected that the integrity of receiving water bodies will not be adversely impacted as a result of this development provided the sediment control measures described herein are implemented.

6 Glossary

Average Reoccurrence Interval (ARI)	The average number of years within which an event will be equalled or exceeded. If the frequency of an event is 1 in 10 years, its probability is 0.1 (1/10) and its percentage probability is 10% which means that there is a 10% probability of the event being equalled or exceeded in each and every year.
Bunding	Liquid containment facilities that prevent leaks and spillage from tanks and pipes.
Embankment	An artificial bank raised above the immediately surrounding land to redirect or prevent flooding by a river, lake or sea. an elongated naturally occurring ridge or artificially constructed fill or wall, which regulates water levels.
Erosion	Materials are removed from the surface and changed into something else. It only works by hydraulic actions and transport of solids (sediment, soil, rock and other particles) in the natural environment, and leads to the deposition of these materials elsewhere.
ESCP	Erosion and Sediment Control Plan.
Gradient	The gradient of a slope is expressed as a ratio between the height (rise) of the slope and the length of the slope (run).
NATA	National Association of Testing Authorities.
Open Cut Mining	A method of extracting rock or minerals from the earth by their removal from an open pit or borrow. Open-pit mines are used when deposits of commercially useful minerals or rock are found near the surface.
Overburden	Overburden is the material that lies above an area of economic or scientific interest in mining and archaeology; most commonly the rock, soil, and ecosystem that lies above a coal seam or ore body. It is also known as 'waste' or 'spoil'.
Regolith	A layer of loose, heterogeneous material covering solid rock. It includes dust, soil, broken rock, and other related materials.
Sediment	Naturally occurring material that is broken down by processes of weathering and erosion, and is subsequently transported by the action of fluids such as wind, water, or ice, and/or by the force of gravity acting on the particle itself.
Slope	The slope describes the steepness of an incline or decline in the landscape. It is generally expressed as a percentage (derived from change in height or elevation over a set distance). The slope is generally calculated for an area where the slope is relatively consistent.
Topsoil	The upper, outermost layer of soil, usually the top 2 inches (5.1 cm) to 8 inches (20 cm). It has the highest concentration of organic matter, including seeds, and microorganisms.

7 References

Aldrick, JM & Wilson, PL 1992, *Land Systems of the Roper River Catchment, Northern Territory,* Technical Report No. 52, Conservation Commission of the Northern Territory, Darwin, NT.

ANZECC & ARMCANZ 2000, *Australian guidelines for water quality monitoring and reporting,* National Water Quality Management Strategy Paper No 7, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

EcOz 2011, *Flora and Fauna Survey*, Unpublished.

Institution of Engineers Australia (QLD Division) 1996, *Soil Erosion and Sediment Control Engineering Guidelines for Queensland Construction Sites*, June 1996.

IECA 2008, Best Practice Erosion and Sediment Control. International Erosion Control Association (Australasia), Picton NSW.

NRETAS 2010, *Erosion and Sediment Control Plan Fact Sheet Model,* The NT Government Department of Natural Resources Environment the Arts and Sports, Darwin, NT.

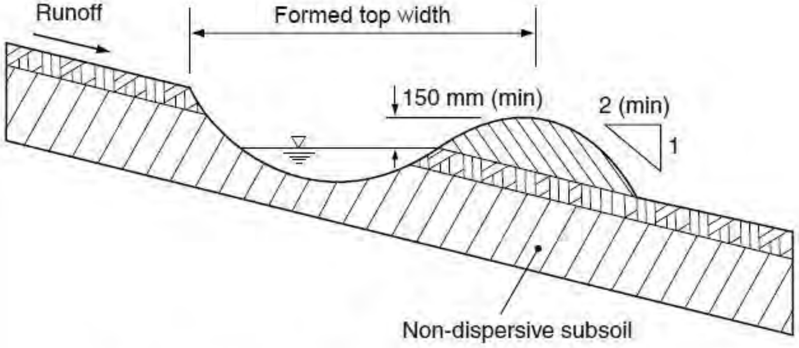
Appendix H1

Catch Drain Specification

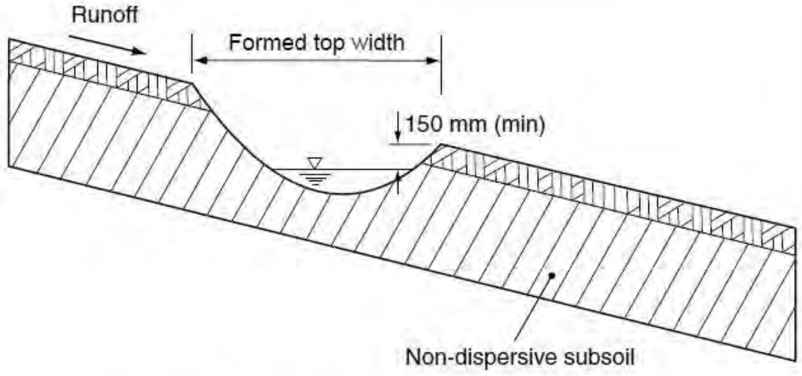
Source: Catchments and Creeks 2011

Client: Australian Ilmenite Resources

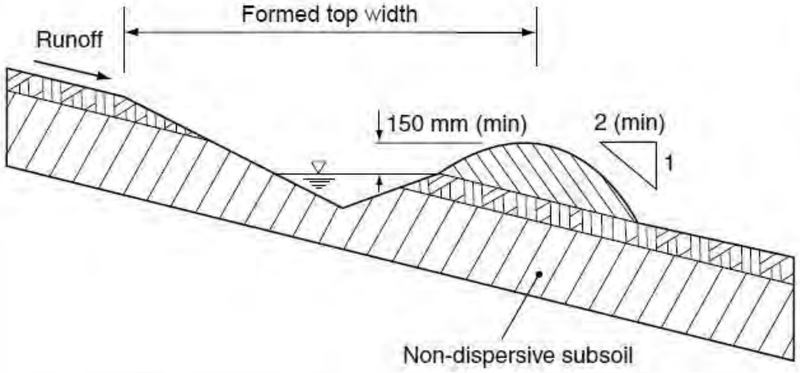
Doc Title: Appendix H - Erosion and Sediment Control Plan



(a) Parabolic catch drain with down-slope bank



(c) Parabolic catch drain without bank



(b) Triangular V-drain with down-slope bank

Constructed dimensions of parabolic catch drains

Drain type	Formed top width with or without bank	Formed depth with or without bank
Type-A	1.6 m	0.30 m
Type-B	2.4 m	0.45 m
Type-C	3.6 m	0.65 m

Constructed dimensions of triangular V-drains

Drain type	Formed top width with or without bank	Formed depth with or without bank
Type-AV	2.0 m	0.30 m
Type-BV	2.7 m	0.45 m
Type-CV	3.9 m	0.65 m

NOT TO SCALE

Drawn:	Date:		
GMW	Dec-09	Catch Drains	CD-01

INSTALLATION (EARTH-LINED)

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE CATCH DRAIN, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT FOR INSTALLATION.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. GRADE THE DRAIN TO THE SPECIFIED SLOPE AND FORM THE ASSOCIATED EMBANKMENT WITH COMPACTED FILL. NOTE THAT THE DRAIN INVERT MUST FALL 10cm EVERY 10m FOR EACH 1% OF REQUIRED CHANNEL GRADIENT.

5. ENSURE THE SIDES OF THE CUT DRAIN ARE NO STEEPER THAN A 1.5:1 (H:V) SLOPE AND THE EMBANKMENT FILL SLOPES NO STEEPER THAN 2:1.

6. ENSURE THE COMPLETED DRAIN HAS SUFFICIENT DEEP (AS SPECIFIED FOR THE TYPE OF DRAIN) MEASURED FROM THE DRAIN INVERT TO THE TOP OF THE EMBANKMENT.

7. ENSURE THE DRAIN HAS A CONSTANT FALL IN THE DESIRED DIRECTION FREE OF OBSTRUCTIONS.

8. ENSURE THE DRAIN DISCHARGES TO A STABLE OUTLET SUCH THAT SOIL EROSION WILL BE PREVENTED FROM OCCURRING. SPECIFICALLY, ENSURE THE DRAIN DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT ALL CATCH DRAINS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND REPAIR ANY SLUMPS, BANK DAMAGE, OR LOSS OF FREEBOARD.

2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE DRAIN. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

3. DISPOSE OF ANY SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE CATCH DRAIN IS FINISHED AND THE AREA IS STABILISED, THE TEMPORARY DRAIN AND ANY ASSOCIATED BANKS SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED WITHIN THE APPROVED SITE REHABILITATION PLAN.

Drawn:	Date:		
GMW	Dec-09	Catch Drains - Earth Lined	CD-02

Appendix H2

Diversion Bank Specification

Source: Catchments and Creeks 2011

Client: Australian Ilmenite Resources

Doc Title: Appendix H - Erosion and Sediment Control Plan

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE BANK, CLEARING ONLY THE AREA THAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. FORM THE BANK FROM THE MATERIAL, AND TO THE DIMENSION SPECIFIED IN THE APPROVED PLANS.

5. IF EARTH IS USED, THEN ENSURE THE SIDES OF THE BANK ARE NO STEEPER THAN A 2:1 (H:V) SLOPE, AND THE COMPLETED BANK MUST BE AT LEAST 500mm HIGH.

6. IF FORMED FROM SANDBAGS, THEN ENSURE THE BAGS ARE TIGHTLY PACKED SUCH THAT WATER LEAKAGE THROUGH THE BAGS IS MINIMISED.

7. CHECK THE BANK ALIGNMENT TO ENSURE POSITIVE DRAINAGE IN THE DESIRED DIRECTION.

8. THE BANK SHOULD BE VEGETATED (TURFED, SEEDED AND MULCHED), OR OTHERWISE STABILISED IMMEDIATELY, UNLESS IT WILL OPERATE FOR LESS THAN 30 DAYS OR IF SIGNIFICANT RAINFALL IS NOT EXPECTED DURING THE LIFE OF THE BANK.

9. ENSURE THE EMBANKMENT DRAINS TO A STABLE OUTLET, AND DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT FLOW DIVERSION BANKS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. INSPECT THE BANK FOR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD. MAKE REPAIRS AS NECESSARY.

3. CHECK THAT FILL MATERIAL OR SEDIMENT HAS NOT PARTIALLY BLOCKED THE DRAINAGE PATH UP-SLOPE OF THE EMBANKMENT. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

4. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

5. REPAIR ANY PLACES IN THE BANK THAT ARE WEAKENED OR IN RISK OF FAILURE.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE BANK IS FINISHED AND THE AREA IS STABILISED, THE FLOW DIVERSION BANK SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED IN THE APPROVED PLAN.

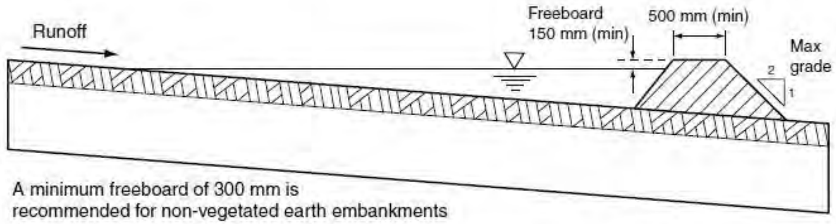


Figure 1 - Typical profile of flow diversion bank formed from earth

Table 1 - Recommended dimensions of flow diversion banks

Parameter	Earth banks	Vegetated banks	Compost berms	Sandbag berms
Height (min)	500 mm	500 mm	300 mm	N/A
Top width (min)	500 mm	500 mm	100 mm	N/A
Base width (min)	2500 mm	2500 mm	600 mm	N/A
Side slope (max)	2:1 (H:V)	2:1 (H:V)	1:1 (H:V)	N/A
Freeboard	300 mm	150 mm	100 mm	50 mm

Drawn: GMW	Date: Dec-09	Flow Diversion Banks	DB-01

Appendix H3

Level Spreader Specification

Source: Catchments and Creeks 2011

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, DIMENSIONS AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEREVER PRACTICAL, LOCATE THE LEVEL SPREADER ON UNDISTURBED, STABLE SOIL.

3. ENSURE FLOW DISCHARGING FROM THE LEVEL SPREADER WILL DISPERSE ACROSS A PROPERLY STABILISED SLOPE NOT EXCEEDING 10:1 (H:V) AND SUFFICIENTLY EVEN IN GRADE ACROSS THE SLOPE TO AVOID CONCENTRATING THE OUTFLOW.

4. THE OUTLET SILL OF THE SPREADER SHOULD BE PROTECTED WITH EROSION CONTROL MATTING TO PREVENT EROSION DURING THE ESTABLISHMENT OF VEGETATION. THE MATTING SHOULD BE A MINIMUM OF 1200mm WIDE EXTENDING AT LEAST 300mm UPSTREAM OF THE EDGE OF THE OUTLET CREST AND BURIED AT LEAST 150mm IN A VERTICAL TRENCH. THE DOWNSTREAM EDGE SHOULD BE SECURELY HELD IN PLACE WITH CLOSELY SPACED HEAVY-DUTY WIRE STAPLES AT LEAST 150mm LONG.

5. ENSURE THAT THE OUTLET SILL (CREST) IS LEVEL FOR THE SPECIFIED LENGTH.

6. IMMEDIATELY AFTER CONSTRUCTION, TURF, OR SEED AND MULCH WHERE APPROPRIATE, THE LEVEL SPREADER.

MAINTENANCE

1. INSPECT THE LEVEL SPREADER AFTER EVERY RAINFALL EVENT UNTIL VEGETATION IS ESTABLISHED.

2. AFTER ESTABLISHMENT OF VEGETATION OVER THE LEVEL SPREADER, INSPECTIONS SHOULD BE MADE ON A REGULAR BASIS AND AFTER RUNOFF-PRODUCING RAINFALL.

3. ENSURE THAT THERE IS NO SOIL EROSION AND THAT SEDIMENT DEPOSITION IS NOT CAUSING THE CONCENTRATION OF FLOW.

4. ENSURE THAT THERE IS NO SOIL EROSION OR CHANNEL DAMAGE UPSTREAM OF THE LEVEL SPREADER, OR SOIL EROSION OR VEGETATION DAMAGE DOWNSTREAM OF THE LEVEL SPREADER.

5. INVESTIGATE THE SOURCE OF ANY EXCESSIVE SEDIMENTATION.

6. MAINTAIN GRASS IN A HEALTH CONDITION WITH NO LESS THAN 90% COVER UNLESS CURRENT WEATHER CONDITIONS REQUIRE OTHERWISE.

7. GRASS HEIGHT SHOULD BE MAINTAINED AT A MINIMUM 50mm BLADE LENGTH WITHIN THE LEVEL SPREADER AND DOWNSTREAM DISCHARGE AREA, AND A MAXIMUM BLADE LENGTH NO GREATER THAN ADJACENT GRASSES.

REMOVAL

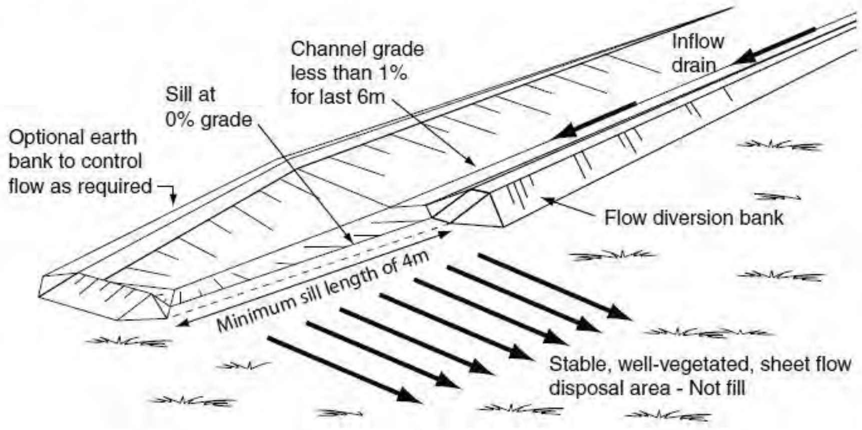
1. TEMPORARY LEVEL SPREADERS SHOULD BE DECOMMISSIONED ONLY AFTER AN ALTERNATIVE STABLE OUTLET IS OPERATIONAL, OR WHEN THE INFLOW CHANNEL IS DECOMMISSIONED.

2. REMOVE COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

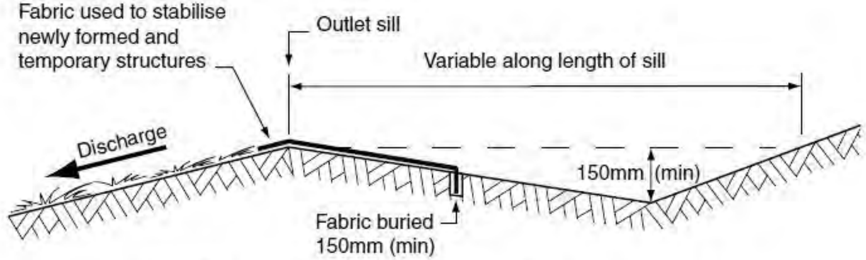
3. REMOVE AND APPROPRIATELY DISPOSE OF ANY EXPOSED GEOTEXTILE.

4. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

5. STABILISE THE AREA AS SPECIFIED ON THE APPROVED PLAN.



(a) Typical layout of level spreader



(b) Typical profile of the the outlet weir

Drawn:	Date:		
GMW	Dec-09	Level Spreaders	LS-01

Appendix H4

Mulch Berm Specification

Source: Catchments and Creeks 2011

MATERIALS

(i) MULCH MUST COMPLY WITH THE REQUIREMENTS OF AS4454.

(ii) MAXIMUM SOLUBLE SALT CONCENTRATION OF 5dS/m.

(iii) MOISTURE CONTENT OF 30 TO 50% PRIOR TO APPLICATION.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND EXTENT. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, MATERIAL TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEN SELECTING THE LOCATION OF A MULCH FILTER BERM, TO THE MAXIMUM DEGREE PRACTICAL, ENSURE THE BERM IS LOCATED:

(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;

(ii) ALONG A LINE OF CONSTANT ELEVATION (PREFERRED, BUT NOT ALWAYS PRACTICAL);

(iii) AT LEAST 1m, IDEALLY 3m, FROM THE TOE OF A FILL EMBANKMENT;

(iv) AWAY FROM AREAS OF CONCENTRATED FLOW.

3. ENSURE THE BERM IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE BERM, OR THE UNDESIRABLE DISCHARGE OF WATER AROUND THE END OF THE BERM.

4. ENSURE THE BERM HAS BEEN PLACED SUCH THAT PONDING UP-SLOPE OF THE BERM IS MAXIMISED.

5. ENSURE BOTH ENDS OF THE BERM ARE ADEQUATELY TURNED UP THE SLOPE TO PREVENT FLOW BYPASSING PRIOR TO WATER PASSING OVER THE BERM.

6. ENSURE 100% CONTACT WITH THE SOIL SURFACE.

7. WHERE SPECIFIED, TAKE APPROPRIATE STEPS TO VEGETATE THE BERM.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT ALL BERMS AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR OR REPLACE ANY DAMAGED SECTIONS.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 100mm OR 1/3 THE HEIGHT OF THE BERM.

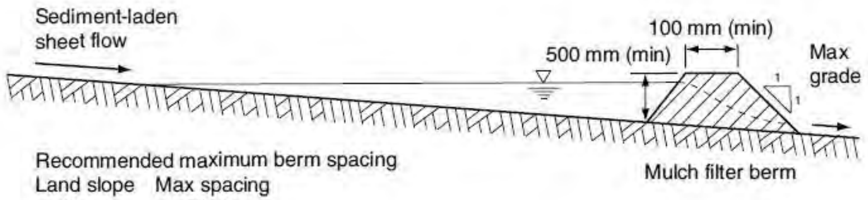
5. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL (IF REQUIRED)

1. WHEN DISTURBED AREAS UP-SLOPE OF THE BERM ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE BERM MAYBE REMOVED.

2. REMOVE ANY COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.



Recommended maximum berm spacing

Land slope	Max spacing
< 2%	30 m
5%	25 m
10%	15 m
20%	8 m

Figure 1 - Typical placement of mulch filter berm

Drawn:	Date:		
GMW	Apr-10	Mulch Filter Berms	MB-01

Appendix H5

Light Mulching Specification

Source: Catchments and Creeks 2011

MATERIALS (GENERAL)

MULCH: TO THE MAXIMUM DEGREE PRACTICAL THE MULCH SHALL BE FREE OF WEED SPECIES ESPECIALLY PROHIBITED NOXIOUS WEED SEED. DO NOT USE WOODY OR OTHER HEAVY MATERIALS THAN MAY INTERFERE WITH THE EMERGENCE OF SEEDLINGS.

APPLICATION (GENERAL)

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE THE SURFACE IS FREE OF DEEP TRACK MARKS OF OTHER FEATURES THAT MAY RESULT IN FLOW CONCENTRATION DOWN THE SLOPE. WHERE NECESSARY, ESTABLISH UP-SLOPE DRAINAGE CONTROLS TO LIMIT RUN-ON WATER THAT MAY DISTURB THE MULCH.

3. SPREAD ENOUGH MULCH TO COMPLETELY COVER THE SURFACE OF THE SOIL AT THE DENSITY OR THICKNESS SPECIFIED IN THE APPROVED PLANS, BUT NOT GREATER THAN 50mm.

4. MACHINE APPLICATIONS SHALL COMPRISE A MINIMUM OF TWO PASSES IN OPPOSITE DIRECTIONS UNLESS OTHERWISE SPECIFIED.

5. DURING APPLICATION, ALL REASONABLE EFFORTS SHALL BE TAKEN TO AVOID SPRAY ONTO ROADS, PATHWAYS, DRAINAGE CHANNELS NOT INTENDED FOR APPLICATION, AND EXISTING VEGETATION.

6. SUITABLE ANCHORAGE OF THE MULCH MUST BE ACCOMPLISHED IMMEDIATELY AFTER THE MULCH HAS BEEN PLACED.

7. ENSURE THE MULCH IS RESTRAINED FROM EXCESSIVE MOVEMENT BY WIND OR STORMWATER RUNOFF BY THE APPROPRIATELY APPLICATION OF AN APPROVED TACKIFIER. ON FLAT OR GENTLE SLOPES, STRAW MULCH MAY BE FIXED TO THE SOIL BY MECHANICAL CRIMPING.

8. IF THE TREATED AREA WAS SEEDED, CONTINUE TO WATER AFTER MULCHING IN ACCORDANCE WITH WEATHER CONDITIONS, OR AS REQUIRED TO OBTAIN SUITABLE GERMINATION AND PLANT ESTABLISHMENT.

9. APPLICATION (SPRAYING) OF A TACKIFIER MUST NOT BE PERFORMED DURING PERIODS OF WINDY CONDITIONS THAT WOULD PREVENT THE PROPER PLACEMENT OF ADHESIVE.

10. THE CONTRACTOR MUST TAKE APPROPRIATE STEPS TO PROTECT ALL TRAFFIC, SIGNS, STRUCTURES, AND OTHER OBJECTS FROM BEING MARKED OR DISFIGURED BY THE TACKIFIER MATERIAL.

APPLICATION (HYDROMULCHING)

THE FOLLOWING SPECIFICATION APPLIES TO GRASS SEEDING, NOT THE APPLICATION OF NATIVE TREE OR SHRUB SEED.

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE THE SURFACE IS FREE OF DEEP TRACK MARKS OF OTHER FEATURES THAT MAY RESULT IN FLOW CONCENTRATION DOWN THE SLOPE. WHERE NECESSARY, ESTABLISH UP-SLOPE DRAINAGE CONTROLS TO LIMIT RUN-ON WATER THAT MAY DISTURB THE MULCH.

3. PRIOR TO APPLICATION, ROUGHEN THE SOIL SURFACE AND FILL AREAS BY ROLLING WITH A CRIMPING OR PUNCHING TYPE ROLLER OR BY TRACK WALKING WHERE PRACTICAL.

4. IF THE SOIL IS DRY, WATER THE TREATMENT AREA BEFORE HYDROSEEDING TO INCREASE PENETRATION OF THE ADHESIVE AND FERTILISER ADDITIVES.

5. ADD STRAW, WOOD OR PAPER CELLULOSE FIBRE MULCH TO THE SLURRY AT THE SPECIFIED RATE, OTHERWISE AT A RATE OF 2 TO 3 TONNES PER HECTARE.

6. MACHINE APPLICATIONS SHALL COMPRISE A MINIMUM OF TWO PASSES IN OPPOSITE DIRECTIONS UNLESS OTHERWISE SPECIFIED.

7. DURING APPLICATION, ALL REASONABLE EFFORTS SHALL BE TAKEN TO AVOID SPRAY ONTO ROADS, PATHWAYS, DRAINAGE CHANNELS NOT INTENDED FOR APPLICATION, AND EXISTING VEGETATION.

8. THE CONTRACTOR MUST TAKE APPROPRIATE STEPS TO PROTECT ALL TRAFFIC, SIGNS, STRUCTURES, AND OTHER OBJECTS FROM BEING MARKED OR DISFIGURED BY THE MULCH AND/OR ASSOCIATED TACKIFIER.

9. CONTINUE TO WATER AFTER ALLOWING 24 HOURS DRYING TIME. WATER IN ACCORDANCE WITH THE WEATHER CONDITIONS, OR AS REQUIRED TO MAINTAIN SUITABLE GERMINATION AND PLANT GROWTH. THE WOOD-FIBRE SHOULD BE KEPT MOIST UNTIL GERMINATION OCCURS.

MAINTENANCE

1. INSPECT ALL MULCHES FORTNIGHTLY AND AFTER RUNOFF-PRODUCING RAINFALL AND STRONG WINDS.

2. CHECK FOR RILL EROSION, OR DISLODGMENT OF THE MULCH.

3. REPLACE ANY DISPLACED MULCH TO MAINTAIN THE REQUIRED COVERAGE.

4. IF STORMWATER RUNOFF DISPLACES MORE THAN 10% OF THE MULCH, THEN INVESTIGATE THE NEED FOR ADDITIONAL DRAINAGE CONTROLS TO PREVENT FURTHER DISPLACEMENT.

5. CONTINUE INSPECTIONS UNTIL VEGETATION IS SUITABLY ESTABLISHED OR EROSION CONTROL IS NO LONGER REQUIRED.

6. IF THE MULCHING IS NOT EFFECTIVE IN CONTAINING THE SOIL EROSION IT SHOULD BE REPLACED, OR AN ALTERNATIVE EROSION CONTROL PROCEDURE ADOPTED.

Drawn:	Date:		
GMW	Dec-09	Mulching (light)	M-01

Appendix H6

Additional Revegetation Information

Source: Catchments and Creeks 2011

Client: Australian Ilmenite Resources

Doc Title: Appendix H - Erosion and Sediment Control Plan

CAUTION; SPECIFICATIONS FOR SITE REVEGETATION VARY CONSIDERABLY FROM SITE TO SITE. SITE SUPERVISORS SHOULD OBTAIN SITE SPECIFIC PLANTING SPECIFICATIONS.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER, LANDSCAPE ARCHITECT OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE ALL NECESSARY SOIL TESTING (e.g. SOIL pH, NUTRIENT LEVELS) AND ANALYSIS HAS BEEN COMPLETED, AND REQUIRED SOIL ADJUSTMENTS PERFORMED PRIOR TO PLANTING.

3. APPLY SOIL CONDITIONERS AND FERTILISER AS SPECIFIED ON THE APPROVED PLANS. RIP THE SOIL 100 TO 150mm TO MIX THE COMPONENTS INTO THE SOIL AND TO LOOSEN AND ROUGHEN THE SOIL SURFACE BEFORE SEEDING.

4. WHERE POSSIBLE, THERE SHOULD BE SUFFICIENT SOIL DEPTH TO PROVIDE AN ADEQUATE ROOT ZONE. THE DEPTH TO ROCK OR IMPERMEABLE LAYERS SUCH AS HARDPANS SHOULD BE 300mm OR MORE, EXCEPT ON SLOPES STEEPER THAN 2:1(H:V) WHERE SUCH SOIL DEPTH MAY NOT BE FEASIBLE.

5. ENSURE THE SOIL pH IS WITHIN THE SPECIFIED RANGE.

6. APPLY SEED UNIFORMLY BY HAND OR WITH A CYCLONE SEEDER, DROP-TYPE SPREADER, DRILL, HYDROSEEDER, HYDROMULCHER, OR OTHER SUITABLE EQUIPMENT AS SPECIFIED.

7. WHEN USING BROADCAST-SEEDING METHODS, SUBDIVIDE THE AREA INTO WORKABLE SECTIONS AND APPLY ONE-HALF THE SPECIFIED QUANTITY OF SEED WHILE MOVING BACK AND FORTH ACROSS THE AREA, MAKING A UNIFORM PATTERN. THEN APPLY THE SECOND HALF IN THE SAME WAY, BUT MOVING AT RIGHT ANGLES TO THE FIRST PASS. COVER BROADCAST SEED BY RAKING OR CHAIN DRAGGING; THEN FIRM THE SURFACE WITH A ROLLER TO PROVIDE GOOD SEED CONTACT.

8. APPLY SEED AT THE RECOMMENDED RATE, AND DISC OR OTHERWISE MECHANICALLY TREAT THE SURFACE TO BRING THE SEED INTO CONTACT WITH THE SOIL.

9. THE SEEDED AREA SHOULD BE MULCHED AS SPECIFIED IN THE APPROVED PLAN.

MAINTENANCE

1. DURING THE CONSTRUCTION PHASE, INSPECT THE TREATED AREA FORTNIGHTLY AND AFTER RUNOFF-PRODUCING RAINFALL. MAKE REPAIRS AS NEEDED.

2. WATERING THE VEGETATION PERIODICALLY IS ESSENTIAL, ESPECIALLY IN THE FIRST 7 DAYS AFTER ESTABLISHMENT. USE LOW-PRESSURE SPRAYS BECAUSE HIGH-PRESSURE JETS CAN WASH AWAY THE SEED AND MULCH COVER.

3. WATERING SHOULD START IMMEDIATELY AFTER PLANTING. WATERING SHOULD COMPLY WITH SPECIFICATIONS PROVIDED WITH THE APPROVED PLANS. GENERALLY WATERING SHOULD VARY ACCORDING TO WEATHER AND SOIL CONDITIONS. A TYPICAL WATERING SCHEDULE MAY CONSIST OF THE FOLLOWING:
(i) 25mm EVERY SECOND DAY FOR THE FIRST THREE WATERINGS;
(ii) 25mm TWICE A WEEK FOR THE NEXT THREE WEEKS; AND
(iii) 25mm ONCE WEEKLY FOR A FURTHER TWO WEEKS.

4. MONITOR SITE REVEGETATION, PARTICULARLY AFTER RAINFALL, AND APPROPRIATE MAINTENANCE AND/OR AMENDMENT TO ENSURE THAT THE REVEGETATION IS CONTROLLING EROSION AND STABILISING SOIL SLOPES AS REQUIRED.

5. WHERE PRACTICABLE, FILL IN, OR LEVEL OUT, ANY RILL EROSION BETWEEN PLANTS. IF EXCESSIVE EROSION OCCURS, THEN CONSIDER INCREASING THE PLANTING DENSITY, APPLYING APPROPRIATE EROSION CONTROL MEASURES, OR INTRODUCING ALTERNATIVE, NON-CLUMPING PLANT SPECIES.

6. AREAS MUST BE RE-SEEDED AND MULCHED IF THE VEGETATION FAILS TO ESTABLISH OR IS DAMAGED BY RUNOFF OR CONSTRUCTION ACTIVITIES.

7. IF THE TEMPORARY VEGETATION COVER OR EROSION CONTROL MEASURE (e.g. MULCH COVER) SHOULD FAIL FOR ANY REASON BEFORE ESTABLISHMENT OF THE PERMANENT VEGETATION COVER, THEN IT MUST BE REPLACED WITH AN APPROPRIATE TYPE OF COVER SUFFICIENT TO CONTROL SOIL EROSION.

8. IF THE PERMANENT VEGETATION SHOULD FAIL TO ESTABLISH OR TO ADEQUATELY RESTRAIN EROSION FOR ANY REASON DURING THE CONSTRUCTION OR MAINTENANCE PERIOD, THE AREA SHOULD BE REVEGETATED OR PROTECTED WITH OTHER EROSION CONTROL MEASURES AS APPROPRIATE.

9. IN AREAS WHERE THE OBTAINED VEGETATION COVER IS CONSIDERED INADEQUATE FOR EROSION CONTROL, THE AFFECTED AREA SHOULD BE OVER-SEEDED AND FERTILISED USING HALF THE ORIGINALLY SPECIFIED RATES, OR AS DIRECTED.

10. MAINTAIN GRASS BLADE LENGTH AT A MINIMUM 50mm HEIGHT WITHIN MEDIUM TO HIGH VELOCITY DRAINAGE AREAS, AND 20 TO 50mm WITHIN LOW VELOCITY FLOW PATHS.

11. WHERE NECESSARY, OR AS DIRECTED BY THE SITE SUPERVISOR, SLASH THE TEMPORARY CROP/GRASS COVER TO ALLOW THE SUCCESSFUL GROWTH OF THE UNDERLYING PERMANENT VEGETATION COVER.

12. CONTROL WEED GROWTH WITHIN 1m OF I-MMATURE TREES FOR 6 TO 12 MONTHS FOR FAST GROWING SPECIES, AND 18 TO 20 MONTHS FOR SLOWER GROWING SPECIES, OR UNTIL THE END OF THE SPECIFIED MAINTENANCE PERIOD.

13. WHERE MULCH IS USED TO CONTROL WEED GROWTH, INSPECT AND WHERE NECESSARY, RENEW AT MAINTENANCE PERIODS NOT EXCEEDING 4 TO 6 MONTHS.

14. APPLY ADDITIONAL SEED, MULCH AND/OR SOIL CONDITIONING AS REQUIRED. MULCHES USUALLY NEED TO BE MAINTAINED OR RENEWED (AS NECESSARY) 2 TO 3 TIMES A YEAR.

15. INSPECT AND WHERE NECESSARY REPAIR PROTECTIVE FENCING AT MAINTENANCE PERIODS NOT EXCEEDING 1 MONTH.

16. RE-FIRM PLANTS LOOSENED BY WIND-ROCK, LIVESTOCK OR WILDLIFE.

17. REPLACE DEAD OR SEVERELY RETARDED PLANTS.

18. PRUNE ANY PLANTS OF DEAD OR DISEASED PARTS. CUT OFF ALL DAMAGED TREE LIMBS ABOVE THE TREE COLLAR AT THE TRUNK OR MAIN BRANCH. USE SEVERAL CUTS INCLUDING UNDERCUTTING TO AVOID PEELING BARK FROM THE HEALTHY AREAS OF THE TREE.

19. DISPOSE OF CLEARED VEGETATION IN AN APPROPRIATE MANNER SUCH AS CHIPPING OR MULCHING, ON-SITE BURIAL, OR OFF-SITE DISPOSAL. CLEARED VEGETATION SHOULD NOT BE DUMPED NEAR A WATERCOURSE OR ON A FLOODPLAIN WHERE IS COULD BE REMOVED BY FLOODWATERS. VEGETATION SHOULD NOT BE BURNT ON-SITE WITHOUT SPECIFIC APPROVAL FROM THE LOCAL AUTHORITY.

20. REPAIR DAMAGED TREE ROOTS BY CUTTING OFF THE DAMAGED AREAS AND SEALING THEM WITH AN APPROVED PRODUCT. SPREAD MOIST TOPSOIL OVER EXPOSED ROOTS.

Drawn:	Date:		
GMW	Dec-09	Revegetation - General	R-01

Appendix H7

Stockpile Area Erosion and Sediment Control Plan

Source: VDM Consulting

Client: Australian Ilmenite Resources

Doc Title: Appendix H - Erosion and Sediment Control Plan

Erosion Sediment Control Plan

Australian Ilmenite Resources Stockpile

Ecoz Environmental Services

Project No: GC120202

Program Name: Australian Ilmenite Resources Stockpile

Document No: GC120202-ESCP-R-W-01

August 2012

Document Control Record

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Recipients are responsible for eliminating all superseded documents in their possession.

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QMS APPROVED COMPANY ISO 9001 Quality Management Systems

Executive Summary

VDM Consulting has been engaged by Ecoz Environmental Services on behalf of Australian Ilmenite Resources to prepare an Erosion and Sediment Control Plan (ESCP) for the proposed bulk material stockpiles, to be located at the Numul Numul Station processing facility. The ESCP details the following:

- Erosion and Sediment Control measures for the each stockpile; and
- Maintenance and Monitoring Program.

Sediment and erosion control devices for the site have been developed in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines. The following sediment and erosion control devices and stormwater management controls are to be implemented:

- Catch Drains; and
- Sediment Basins.

Catch drains will direct any sediment laden water into the sediment basins where manual flocculation will occur prior to mechanical pump out. This will ensure that downstream receiving environments are protected.

Sediment basins have been modelled as having a length to width ratio of 3:1 and sized in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines. Table E1 and Table E2 provide a summary of the annual sediment loss prediction and the sediment basin sizing configuration respectively.

Table E1 Annual Sediment Loss Prediction

Area (ha)	Slope Grade (%)	Intensity $^{6}I_{2}$(mm/hr)	R (Rainfall Erosivity Factor)	K (Soil Erodibility Factor)	LS (Topographic Factor)	C (Cover & management Factor)	P (Erosion Control Practice Factor)	A (t/ha/yr)	Yield (m^3/yr)
5.76	1	12.4	13738	0.047	0.24	1	0.8	124.0	476.0

Table E2 Sediment Basin Configuration

Area (ha)	Settling Zone Volume (m^3)	Storage Zone Volume (m^3)	Surface Area (m^2)	Length (m)	Width (m)	Total Depth (m)	Total Volume (m^3)
5.76	2,065	1032	3,942.3	105.2	37.5	1.19	3,097

The implementation of these control measures will ensure the receiving environment will not be adversely impacted as a result runoff from the bulk material stockpiles.

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1. Introduction

VDM Consulting has been commissioned by Ecoz Pty Ltd on behalf of Australian Ilmenite Resources to prepare an Erosion and Sediment Control Plan (ESCP) for the proposed bulk material stockpiles, to be located at the Numul Numul Station processing facility.

A comprehensive review of available Erosion and Sediment Control devices and Best Management Practices (BMP) was undertaken as part of this investigation. The following sections provide a summary of the mitigation measures required to meet best practice in accordance with the International Erosion Control Association Australasia Best Practice Erosion and Sediment Control Guidelines during the construction phases of the development.

1.1 Background

Australian Ilmenite Resources (AIR) intends on developing an ilmenite mine and processing facility at the Numul Numul Station, approximately 105 km east of Mataranka Township and 8 km south of the Roper Highway, in the Roper River Region, Northern Territory (Australian Ilmenite Resources Pty Ltd SILL80 Project Mining Lease 27422). The SILL80 Project is a proposed open cut mine and processing facility, which entails gravity separation of the ilmenite, to produce 300,000 t of refined ilmenite per annum, with an expected mine life exceeding 20 years. Figure 1.1 shows the locations of the proposed mine site.

Mining operations will involve the extraction of source material from mining pits located to the west of the stockpiling area and operations plant. Excavation will occur to a depth of 4 m with excavated material, approximately 240,000 m^3 for each pit, and transport to the stockpiling area. It is understood that a maximum of three (3) stockpiles will be required at any one time. Each stockpile will be approximately 5 m in height and have a surface area of around 67,600 m^2.

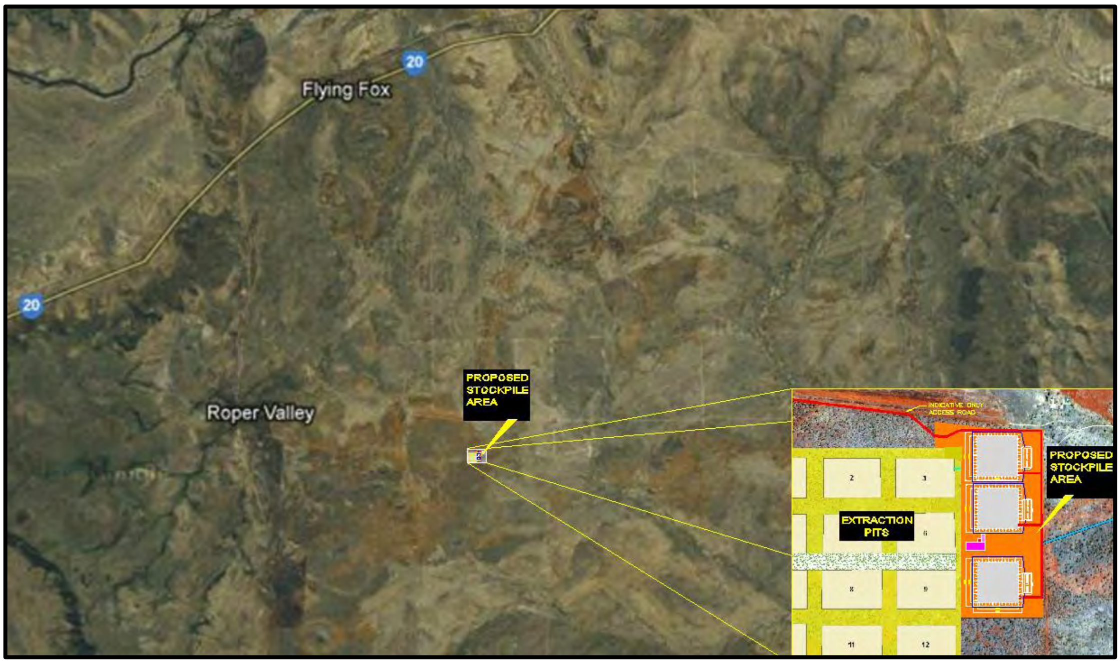

Figure 1.1 Proposed Ilmenite Mine Locations

1.2 Scope

Specifically, this report details the following:

- Erosion and Sediment Control measures for each stockpiles; and
- Maintenance and Monitoring Program.

To minimise the impact of the potential sediment laden runoff from entering the downstream environment the proponent shall implement this ESCP. To avoid significant and/or sustained deterioration in downstream water quality this ESCP may be amended as required, in response to the Monitoring and Maintenance Program described herein.

1.3 Objectives

The objectives of this ESCP are to:

- Ensure stormwater is managed to protect the downstream environment;
- Reduce the potential for sedimentation (soil particles >1 mm are retained onsite);
- Ensure adequate drainage and pollution control measures are implemented to manage runoff from disturbed areas of the site; and
- Prevent soil erosion on site.

1.4 Relevant Legislation and Guidelines

The following legislation and guidelines were used to prepare this ESCP:

- *Water Act (NT);*
- *Waste Management and Pollution Control Act (NT);*
- *Soil Conservation and Land Utilisation Act (NT);*
- *NRETAS Erosion and Sediment Control Plan Content (2006);*
- *Department of Health and Families guidelines for preventing mosquito breeding associated with construction practice near tidal areas in the NT (2005); and*
- *IEAust. Soil Erosion and Sediment Control Engineering Guidelines for Queensland Construction Sites (June, 1996).*

1.5 Performance Criteria

The following performance criteria in accordance with NRETAS requirements have been set:

- Stable embankments and drainage lines;
- No obvious accumulation of sediment within receiving environment outside of the stockpile area;
- No new biting insect breeding habitats created and no increase in mosquito numbers;
- Soil particles >1 mm do not leave the site; and
- All batters or embankments to have slopes greater than 1:4.

2. Site Characteristics

The mining lease area is characterised by broad alluvial valleys between low rubbly hills and prominent strike ridges of resistant Roper Group strata. The flat-floored ridges form part of the vast Roper River floodplain and its associated tributaries (Wilton, Maiwok, Flying Fox and Jalboi Rivers) and are largely developed on incompetent shales, fine-grained sediments, volcanic and carbonate rocks. Local relief is variable ranging from 20 to 120 metres. The target dolerite sills are prominent in their deep red soil colour and rounded boulder-strewn outcrops. The general area of interest comprises flat to undulating terrain with scattered low, steep hills and rugged dissected plateau on Proterozoic and Palaeozoic sedimentary rocks, often overlain by lateralized Tertiary material. The stockpile area is situated on a relatively flat (85 m AHD) area.

2.1 Soils and Land Units

Extensive deposits of Quaternary to recent sediments comprising alluvium, colluvium, unconsolidated gravel and sand overlying mud-rich soils are mapped in the project area and reflect material derived from prolonged weathering and erosion of dolerite sills. The land units found on this site are shown below in Figure 2.1 and are described in Table 2.1. The entire site is within the land unit Ibn which consists of brown, red and grey clays.

Table 2.1 Land Unit Types on the Subject Site (VDM Consulting EcOz)

Land Unit	Land Form	Soils	Vegetation
Ibn	Plains and low rises on basalt and associated basic igneous rocks.	Brown, grey and red clays, euchrozems and brown and red earths.	Mid-high open woodland of Lysiphyllum cunninghamii and E. terminalis with some E. patellaris.

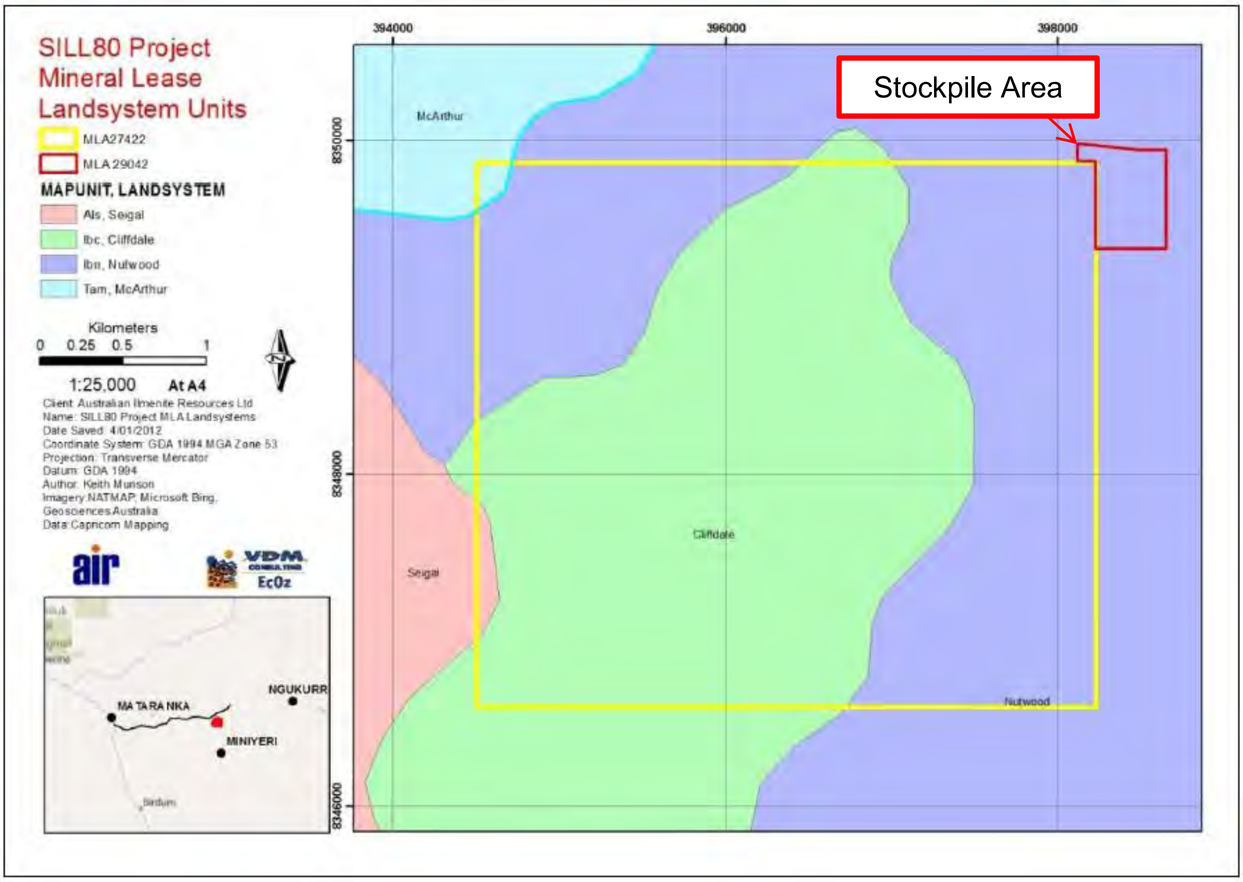

Figure 2.1 Land Units at the Proposed Development Site (VDM Consulting EcOz)

3. Erosion and Sediment Control

The purpose of this section is to provide a set of best practice site management procedures to control the severity and extent of soil erosion and pollutant transport from each stockpile during operation.

Any site clearing required for the construction of erosion and sediment controls is to comply with the NT Government Department of NRETAS's Erosion and Sediment Control Plan Content dated 2006. Due consideration should be given to stripped topsoil being retained and reused in drains, and disturbed areas. The construction contractor will be responsible for the implementation, inspection, repair and modification of the specified erosion and sediment controls.

The climate in the vicinity of the site is characterised by distinct wet and dry seasons. During the wet season from December to March rainfall can be intense. In order to reduce erosion and sediment transport strict adherence to maintenance and monitoring of sediment and erosion controls will therefore be required throughout the wet season.

3.1 Principles of Erosion and Sediment Control

The principles of effective erosion and sediment control for the proposed stockpile operation have been based on the following:

- Intergradation of erosion and sediment control issues into site operations and planning;
- Development of effective and flexible erosion and sediment control (ESC) plans based on anticipated soil, weather and construction conditions;
- Control of water movement through the site;
- Minimise soil erosion;
- Prompt stabilisation of disturbed areas;
- Maximise sediment retention on site;
- Maintenance of all ESC measures in proper working order at all times; and
- Monitoring of the site and adjust ESC practices to maintain the required performance standard.

3.1.1 Site Installation Sequence

The following sediment and erosion control devices and stormwater management controls will be implemented:

- Catch Drain – Used to divert sediment laden water from each stockpile to sediment basins; and
- Sediment Basin – Used to trap and retain sediment via settlement of suspended particles.

These controls have been developed in accordance with IECA Best Practice Erosion and Sediment Control guidelines and the location of these devices is presented in Appendix A.

3.2 Management of Erosion and Sediment Control

The following measures are to be implemented to maintain the current environmental values onsite.

Issue:	Runoff - Stormwater Management - Contamination of Surface water - Erosion and Sedimentation.
Objectives:	• To ensure that there is no deterioration in stormwater quality or any reduction in the environmental values; • To control stormwater runoff to minimise sediment loss from each stockpile and pollution of the receiving environment; • To comply with relevant governing statutory requirements; • To prevent soil erosion; • To prevent sediment from being deposited off site; and • Compliance with Environmental Protection Policies.
Management Procedure:	• Site personnel informed of the erosion and sediment controls; • Minimise vegetation removal to areas designated for clearing. Clearly identify “No Go Areas” where vegetation is to be maintained; • Catch drains to be installed at the base of the stockpiles so as not to undermine the batter to prevent sediment laden stormwater migrating away from source; • Sediment basins to be located on the downstream side of each stockpile to retain sediment laden runoff and allow for manual flocculation and pump out; • Regular inspections as soon as practicable after storm events to check and maintain controls; • Inspection dates and actions taken to be recorded and available for review upon request; • Sediment to be removed from basins when controls are 40% full and at the completion of construction/mine rehabilitation. All material to be returned to the plant; for processing; • Visual Monitoring of water quality to determine the effectiveness of the sediment and erosion control management practices; and • Progressive re-vegetation of filled and disturbed areas.
Performance Indicators:	• Visual evidence of sediment and/or erosion downstream on the receiving environment directly attributable to the site; and • Failure of control measures.
Responsibility:	• Site Foreman and Environmental Management Officer.
Critical Dates:	• Prior to commencement of work/construction safety induction (include training, awareness of commitments, directives, working hours and approval conditions for stormwater management, and sediment and erosion control).
Monitoring:	• Regular inspection as soon as practicable after storm events to check and maintain controls. • Site visits from Environmental Management Officer during operation. • Monitoring regime to be in accordance with regulatory requirements.
Reporting:	• Report incidents to Site Foreman. • Upon notification of Environmental Management Officer (EMO). EMO

	to certify compliance of measures by way of letter upon completion, and if necessary notify Project Manager of non-compliance. • Site Manager (during construction and mining operations) to report to relevant authority.
Corrective Action:	All corrective actions shall be agreed upon, dependent upon the severity of non-conformance, between Construction Engineering, the Environmental Consultant and relevant authority. Remove sediment from basins when storage depth (0.59 m) is full. Observations shall be used to guide implementation of additional measures, if and when required. The triggering of a performance indicator will require: • Locate source of sediment and/or erosion; • Prevent continuing deterioration by repairing existing measures, construct additional measures or modify procedures; • Review strategies/management plans in consultation with relevant authority; and • Repair existing controls, construct additional controls or modify procedures to prevent future deterioration in water quality.

3.3 Erosion and Sediment Control Measures

The following erosion and sediment control measures have been developed and adopted for the proposed development.

3.3.1 Catch Drains

Catch drains are to be constructed around the base of each stockpile. These control measures will serve two main functions. Firstly they will divert clean runoff from upstream catchments around each stockpile. This will help minimise the volume of water which will require treatment.

Secondly these measures will contain untreated runoff from the stockpiles and direct it toward sediment basins. These catch drains should be regularly inspected and any damage from onsite vehicles should be repaired immediately. Any build-up of sediment should be removed as soon as practically possible. Details of the catch drains and locations are provided in Appendix A.

These catch drains will remain in place during the operational phase of each stockpile. Refer to Table 3.1 for sizing details and Appendix A for cross sections.

Table 3.1 Catch Drain Sizing

Manning (n)	Slope Grade (%)	Width (m)	Batter slope	Depth (m)	Permissible Q10 (m^3/s)
0.022	1	0.5	2	0.3	0.47

3.3.2 Sediment Basins

The major sediment control for the site will be the installation of sediment basins. Sediment basins are generally required where:

- Areas with exposed highly erodible soils;
- Areas with exposed slopes greater than 2%; and
- Areas with exposed soils after 30 September or before May 1.

Each stockpile will contain unconsolidated soils and will have batter slopes greater than 2%, therefore considered highly erodible. It is also understood that stockpiles may be in operation during the wet season.

It is proposed that treated runoff from each stockpile within a dedicated sediment basin. Sediment basins are required to be sized to capture the Q10 runoff volume of the contributing catchments and allow for 3 months of sediment storage based on the Universal Soil Loss Equation.

Table 3.2 and Table 3.3 provide a summary of the annual sediment loss prediction and the sediment basin sizing configuration respectively.

Table 3.2 Annual Sediment Loss Prediction

Area (ha)	Slope Grade (%)	Intensity $^6I_2$(mm/hr)	R (Rainfall Erosivity Factor)	K (Soil Erodibility Factor)	LS (Topographic Factor)	C (Cover & management Factor)	P (Erosion Control Practice Factor)	A (t/ha/yr)	Yield (m^3/yr)
5.76	1	12.4	13738	0.047	0.24	1	0.8	124.0	476.0

Table 3.3 Sediment Basin Configuration

Area (ha)	Settling Zone Volume (m^3)	Storage Zone Volume (m^3)	Surface Area (m^2)	Length (m)	Width (m)	Total Depth (m)	Total Volume (m^3)
5.76	2,065	1032	3,942.3	105.2	37.5	1.19	3,097

The configuration of each sediment basin is to have a minimum length to width ratio of 3:1. The minimum depth of the "settling zone" is to be 0.6 m. The side batters of the basins will be at a slope of 1:3.

If and when required artificial flocculation will be applied on retained runoff to assist in the settling process. This will be completed via the application of Gypsum within 24 hours of the conclusion of each storm event and before any pumping out of the basin. Application of the Gypsum will occur by broadcasting it over the surface by hand, ensuring an even spread over the basin surface at a rate of 32 kg per 100 m^3 of water. Prior to pumping out of the sediment basin the following water quality objectives need to be met.

Table 3.4 Water Quality Objectives

Parameter	Water quality Objective (WQO)
Turbidity	15 NTU (based on ANZECC lowland rivers NT)
PH	6.5-8.5

The above readings shall be measured using an appropriate hand held water quality meter.

3.4 Investigation Indicators

The following indicators are to be used to identify if the objectives of this ESCP have been met:

- Visible significant erosion and/or sedimentation; and/or
- Failure of control measures.

The triggering of an investigation indicator will require the following remedial actions:

- Locate source of water quality deterioration;
- Prevent continuing deterioration with temporary controls;
- Repair existing controls, construct additional controls or modify procedures to prevent future deterioration in water quality; and
- During the operational phase of the development, if there is a significant deterioration in water quality, the management plan and strategies will be reviewed.

3.5 Contingencies

During operations, the Contractor/Principal/Site Foreman shall allocate sufficient resources (personnel, plant, equipment and materials) to the site and store on-site, at suitable locations and at all times sufficient quantities of materials to immediately attend to any non-conformance.

Corrective actions may be agreed upon, dependent upon the severity of non-conformance and/or emergency and parameter involved, between the Principal, Construction Contractor, Environmental Consultant, and relevant Government Representatives.

3.6 Responsibilities

It should be noted that the basic responsibility for environmental protection rests with all employees and sub-contractors. Table 3.4 presents the specific responsibilities that pertain to this ESCP.

Table 3.5 Party Responsibilities

Party	Primary Responsibility
Project Manager	• Overall implementation of the ESCP and management of environmental impacts and risks. • Responsible for reporting any incidents to relevant authorities if required. • Issue and distribution of ESCP. • Revision of the ESCP, as required, to reflect the status quo. • Revisions are to be made by replacing the entire document by consecutively numbered amendments. • Implementation, monitoring, reporting and corrective actions within the ESCP.
Construction Manager/Site Manager **Safety Officer**	• Implementation of strategies, requirements, procedures and measures to ensure that appropriate environmental protection is in place. • Induction, supervising and monitoring of the ESCP. • To attend construction at all times during working hours. • Site inspections (random, daily) to ensure adherence to the different plans and procedures. • Direct actions, as required, to protect the environment and to minimise and/or rectify any environmental concerns.
All other site personnel	• Adherence to Site Safety Rules and ESCP.

3.7 Environmental Complains and Incidents

The Site Manager shall investigate all environmental complaints. Where considered appropriate and/or required, the Site Manager shall notify the relevant statutory authority. Complaints received by external parties will also be subject to investigation by the Site Manager or EMO.

Should an environmental incident occur during the course of construction, the Landowner shall take prompt action to minimise any impact and, where necessary, seek the advice of the relevant authorities.

All complaints will be treated with respect. The Site Manager shall maintain a Complaints Register (refer Appendix B) and shall direct an appropriate course of action relating to the complaint. The Complaints Register will be included in any audit reports during construction and shall record the date, time and nature of any complaint, the name and contact details of the complainant, action taken, person responsible for action, and resolution of complaint. The Site Manager shall certify each entry on the record.

3.7.1 Environmental Notifications

In the event of a major incident/non-conformance that may cause or causes environmental harm, as soon as practicable after being made aware of the incident, the following people have a duty to notify the relevant authority of the incident:

- The person carrying on the activity;
- An employee or agent carrying on the activity;
- An employer carrying on the activity; and
- The occupier of the premises where the incident occurs.

Notification must be given as soon practicable after the person becomes aware of the incident.

The Site Manager shall furnish the following details:

- The time, date, nature, duration and location of the incident;
- The location of the place where non-conformance occurred;
- The nature of the non-conformance;
- The circumstances in which the incident occurred (including the cause of the incident, if known);
- The action taken or proposed to be taken to deal with the incident; and
- Other information prescribed by the regulations.

3.8 Awareness and Training

A copy of this document will be available from the following officers at the site:

- Site Manager; and
- Safety Officer.

Awareness and Training forms part of Safety Inductions conducted prior to site work. It is a requirement that no person shall undertake any site work unless properly inducted. As part of their site induction and training all personnel engaged in construction shall be made aware of the provisions of this document in order to promote a general awareness of the environment and to minimise any potential impact and/or disturbances to the environment. Evidence of environmental induction of personnel in this project shall be maintained on project records.

4. Conclusions

This study has reviewed the potential impact involved with the operation of the bulk material stockpiles on receiving waters. Based on this study the following erosion and sediment control measures have been developed:

- Catch Drains; and
- Sediment Basins.

Sediment basins have been sized to capture the Q10 runoff volume of the contributing catchments and allow for 3 months of sediment storage based on the Universal Soil Loss Equation. The configuration of each sediment basin has been designed using the IECA Best Practice Erosion and Sediment Control Guidelines and will have a minimum length to width ratio of 3:1, a minimum depth “settling zone” of 0.6 m and side batters at a slope of 1:3.

In summary, the integrity of the receiving environment should not be adversely impacted as a result of the operation of the bulk material stockpiles provided the sediment control measures described herein are implemented.

Appendix A – Erosion and Sediment Control Plan and Details

ROPER VALLEY STOCKPILE

CONTRACT GC120202

EROSION AND SEDIMENT CONTROL

LOCALITY PLAN

SCHEDULE OF DRAWINGS	
Drawing No.	Drawing Title
GC120202-N000	COVER SHEET, SCHEDULE OF DRAWINGS
GC120202-N001	OVERALL LAYOUT PLAN
GC120202-N002	EROSION AND SEDIMENT CONTROL PLAN
GC120202-N003	EROSION AND SEDIMENT DETAILS
GC120202-N004	EROSION AND SEDIMENT DETAILS AND NOTES

PREPARED FOR

AUSTRALIAN ILMENITE RESOURCES

PREPARED BY

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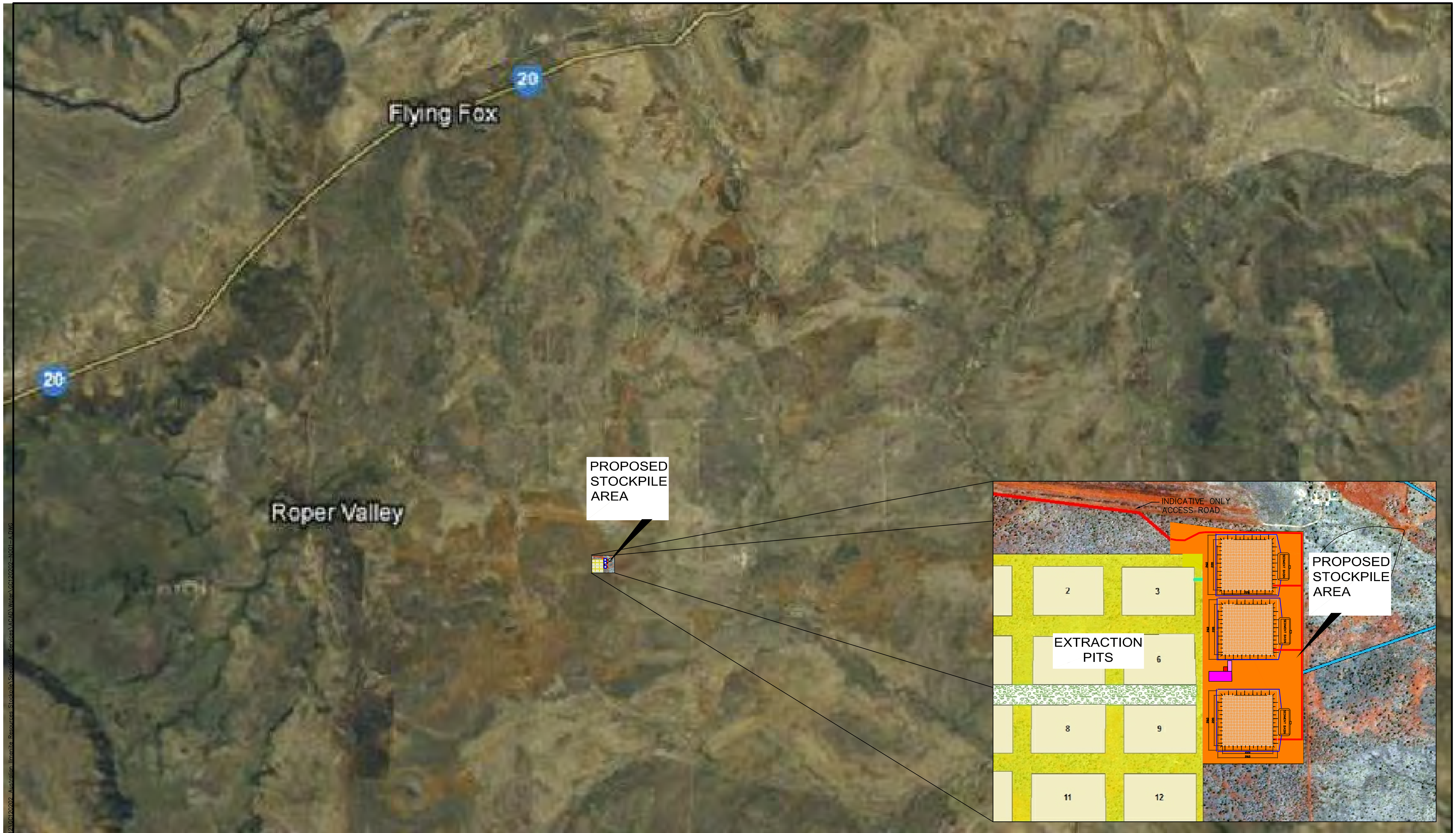
VDM Engineering (Eastern Operations) Pty Ltd
ABN 91 087 601 296

		DATE : 20-08-2012
PROJECT No.: GC120202	DRAWING No. : N000	VERSION: A



DATUM
HORIZONTAL DATUM: MGA ZONE 53 (GDA94)
VERTICAL DATUM: AHD

OVERALL LAYOUT PLAN

ROPER VALLEY STOCKPILE
FOR
AUSTRALIAN ILMENITE RESOURCES

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE	BC	20-08-12

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PROJECT:
EROSION AND SEDIMENT CONTROL for ROPER VALLEY STOCKPILE

DRAWING TITLE:
OVERALL LAYOUT PLAN

DEVEL. APPLIC. No.:
DATE: 20-08-12
PROJECT LEADER: BRAD COMLEY
DESIGNER: ERIN HOGAN
DRAFTSPERSON: ERIN HOGAN
CHECKED: BRAD COMLEY
APPROVED FOR AND ON BEHALF OF VDM ENGINEERING (EASTERN OPERATIONS) PTY LTD ACN 087 601 296
RPEQ No.:
SCALE: AS SHOWN
DATUM: AHD
FULL SIZE: A1
PROJECT No.: GC120202
DRAWING No.: N001
VERSION: A

PLOTTED: 28 Aug 2012
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PLOTTED: 28 Aug 2012

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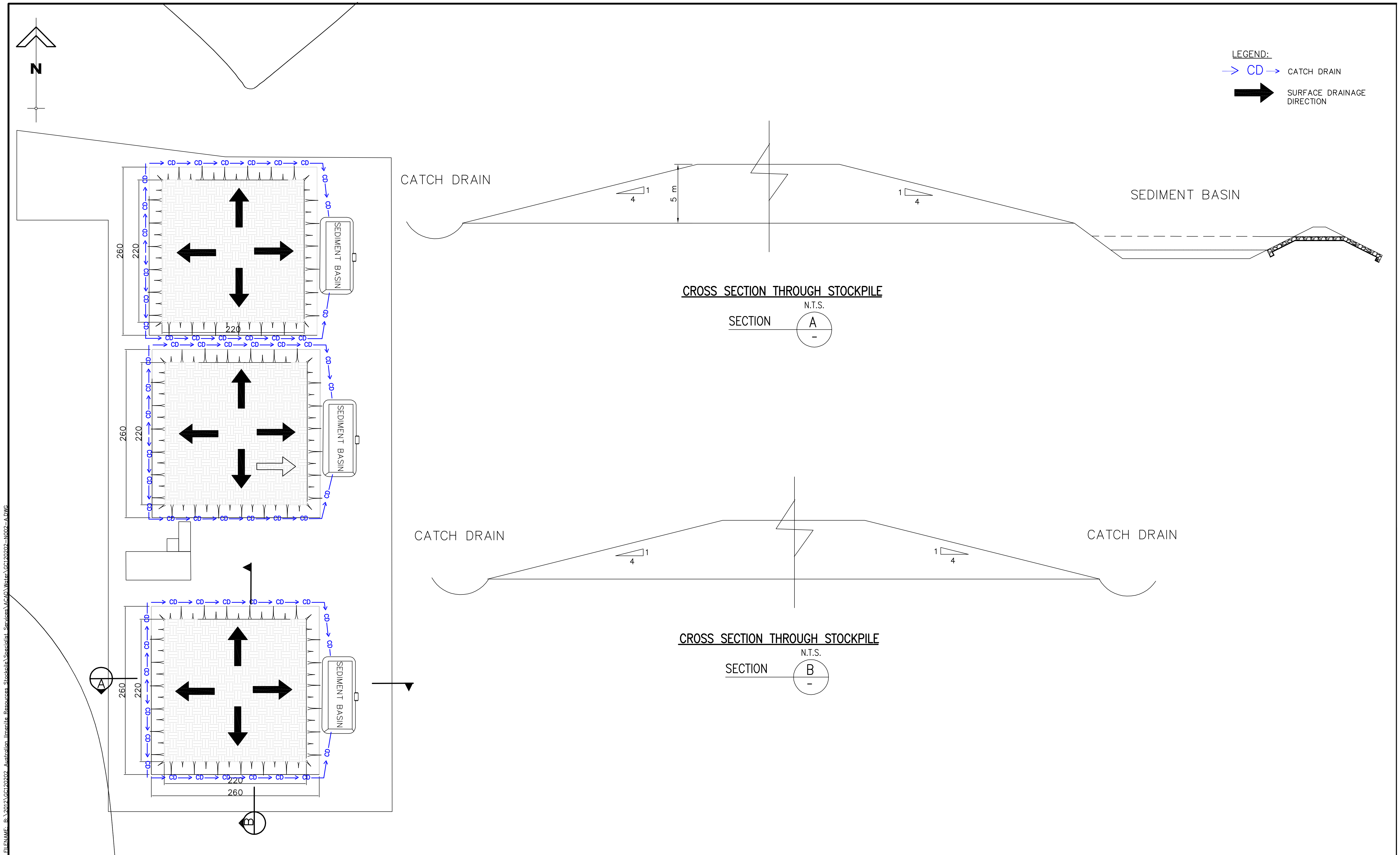

ROPER VALLEY
STOCKPILE
FOR
AUSTRALIAN ILMENITE RESOURCES

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE	BC	21-08-12

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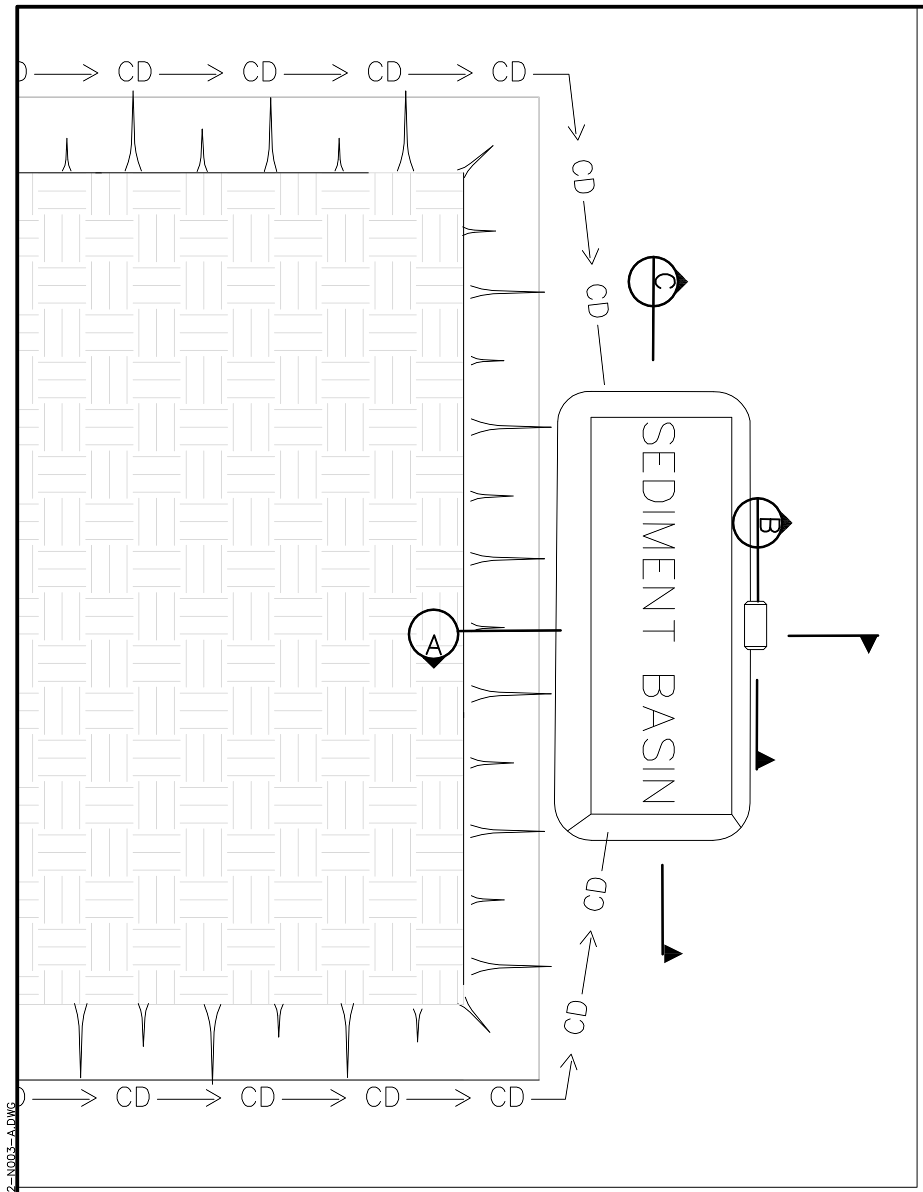
PROJECT:
EROSION AND SEDIMENT CONTROL for ROPER VALLEY STOCKPILE

DRAWING TITLE :
EROSION AND SEDIMENT CONTROL PLAN

DEVEL. APPLIC. No. :
DATE : 21-08-12
PROJECT LEADER : BRAD COMLEY
DESIGNER : ERIN HOGAN
DRAFTSPERSON : ERIN HOGAN
CHECKED : BRAD COMLEY
APPROVED FOR AND ON BEHALF OF VDM ENGINEERING (EASTERN OPERATIONS) PTY LTD ACN 087 601 296
RPEQ No. :
SCALE : AS SHOWN
DATUM : AHD
FULL SIZE : A1
PROJECT No.: GC120202
DRAWING No. : N002
VERSION: A



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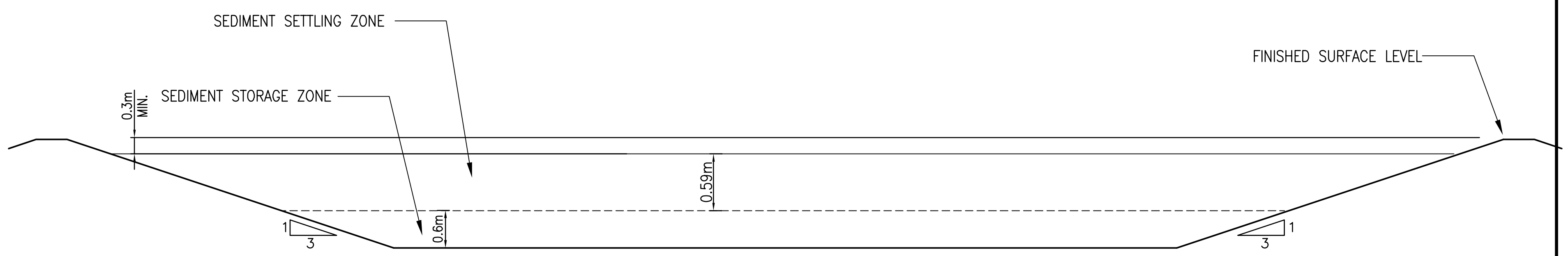

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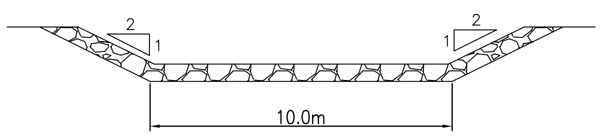
N.T.S.
SECTION C –



OUTLET WEIR SECTION
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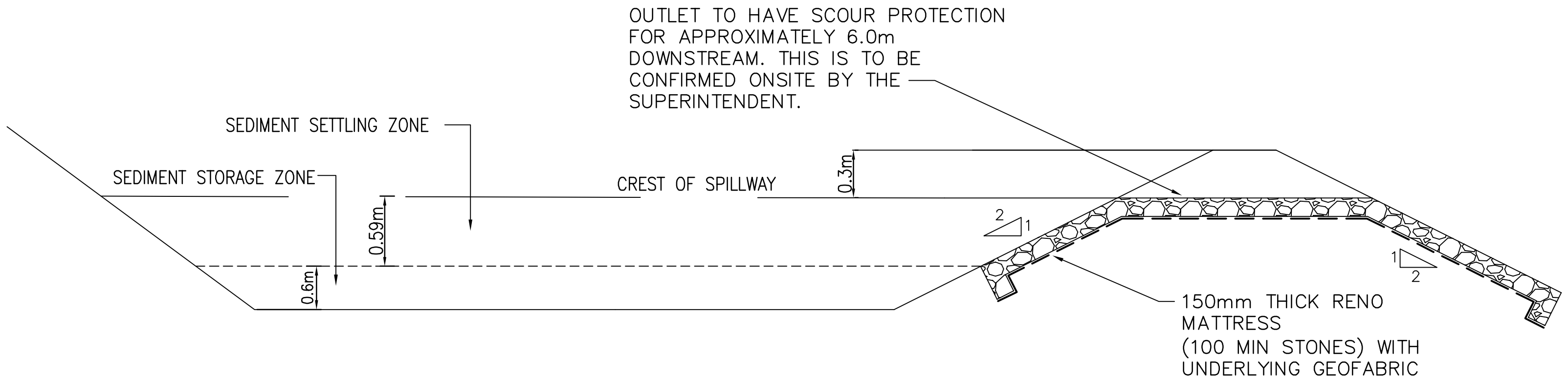
SECTION B –



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SECTION A –

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ROPER VALLEY
STOCKPILE
FOR
AUSTRALIAN ILMENITE RESOURCES

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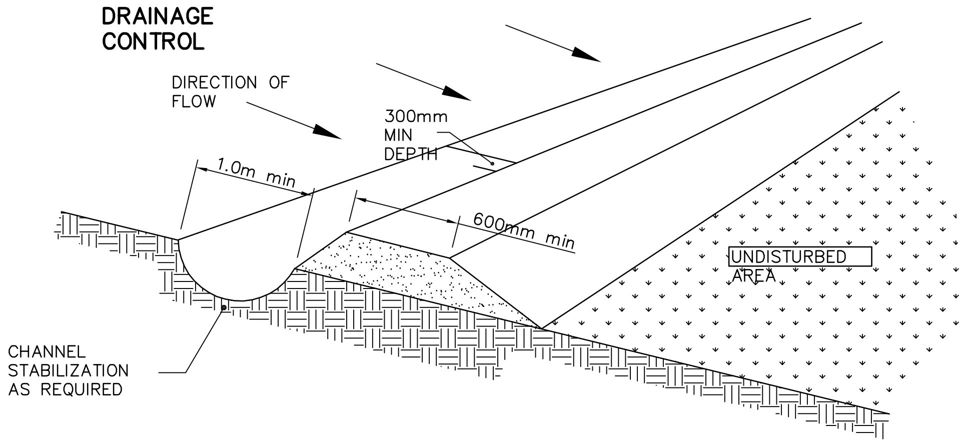
PROJECT:
EROSION AND SEDIMENT CONTROL for ROPER VALLEY STOCKPILE

DRAWING TITLE:
SEDIMENT BASIN DETAILS

DEVEL. APPLIC. No. :
DATE : 21-08-12
PROJECT LEADER : BRAD COMLEY
DESIGNER : ERIN HOGAN
DRAFTSPERSON : ERIN HOGAN
CHECKED : BRAD COMLEY
APPROVED FOR AND ON BEHALF OF VDM ENGINEERING (EASTERN OPERATIONS) PTY LTD ACN 087 601 296
RPEQ No. :
SCALE : AS SHOWN
DATUM : AHD
FULL SIZE : A1
PROJECT No.: GC120202
DRAWING No. : N003
VERSION: A



CATCH DRAIN (TYPICAL)
N.T.S.

GENERAL NOTES:

EROSION AND SEDIMENT CONTROL DEVICES AND INFRASTRUCTURE TO BE INSTALLED PRIOR TO SITE DISTURBANCE. STRIP TOP SOIL ONLY FROM CONSTRUCTION AREAS AND STOCKPILE AT NOMINATED SITE. STRIPPED TOP SOIL MUST BE KEEP SEPARATE FROM OTHER SOIL/FILL.
ALL SEDIMENT CONTROL STRUCTURES/TRAPS TO BE INSPECTED AFTER EACH RAINFALL EVENT FOR DAMAGE AND ALL TRAPPED SEDIMENT TO BE REMOVED TO A NOMINAL STOCKPILE.
PRIOR TO ANY WORKS THE PROPOSED CLEARING AREA MUST BE FLAGGED ON THE GROUND AND INSPECTED TO CONFIRM ACCURACY PRIOR TO ANY WORKS COMMENCING.
ALL AREAS TO BE CLEARED SHOULD BE PROVIDED TO CLEARING CONTRACTORS, DOWNLOADED ONTO CONTRACTORS GPS UNITS PRIOR TO ANY CLEARING ACTIVITIES COMMENCING.
FLAGGING MUST BE MAINTAINED THROUGHOUT THE DEVELOPMENT PHASE TO RESTRICT ACCESS TO NO-GO AREAS.
CONSTRUCTION COMPOUND MUST BE LOCATED IN THE APPROVED CLEARING AREA.
ANY CHANGES TO THE EROSION AND SEDIMENT CONTROL PLAN SHALL BE SUBMITTED AND APPROVED BY NATURAL RESOURCE MANAGEMENT DIVISION, NRETAS PRIOR TO COMMENCEMENT.

ADDITIONAL EROSION CONTROLS MAY BE REQUIRED DURING CONSTRUCTION AS DETERMINED BY THE SUPERINTENDENT IN CONSULTATION WITH THE NATURAL RESOURCE MANAGEMENT DIVISION, NRETAS.

ALL EROSION AND SEDIMENT CONTROLS TO BE IMPLEMENTED TO THE SATISFACTION OF NRETAS.

ROPER VALLEY
STOCKPILE
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ABN 91 087 601 296

PROJECT:
EROSION AND SEDIMENT CONTROL for ROPER VALLEY STOCKPILE

DRAWING TITLE:
EROSION AND SEDIMENT DETAILS AND NOTES

DEVEL. APPLIC. No.:
DATE: 21-08-12
PROJECT LEADER: BRAD COMLEY
DESIGNER: ERIN HOGAN
DRAFTSPERSON: ERIN HOGAN
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APPROVED FOR AND ON BEHALF OF VDM ENGINEERING (EASTERN OPERATIONS) PTY LTD ACN 087 601 296
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FULL SIZE: A1
PROJECT No.: GC120202
DRAWING No.: N004
VERSION: A

Appendix B – Complaints Register

Complaints Register

For the recording of any complaint pertaining to construction and the environment.

Date:	**Time:**
Name and Contact Details of Complainant: ……… ……………	
Details of Complaint: …………………………………………………………………………………………………… ……………………………………………………………………………………………………	
Action Taken:…………………………………………………………………………………………	
Responsible Person:	
Resolution/Notes:	
Site Manager:	**Date:**
Date:	**Time:**
Name and Contact Details of Complainant: ……… ……………..…	
Details of Complaint: …………………………………………………………………………………………………… ……………………………………………………………………………………………………	
Action Taken:…………………………………………………………………………………………	
Responsible Person:	
Resolution/Notes:	
Site Manager:	**Date:**
Date:	**Time:**
Name and Contact Details of Complainant: ……… ……………	
Details of Complaint: …………………………………………………………………………………………………… ……………………………………………………………………………………………………	
Action Taken:…………………………………………………………………………………………	
Responsible Person:	
Resolution/Notes:	
Site Manager:	**Date:**

Appendix C – Incident/Non-Conformance Notification Form

Incident/Non-Conformance Notification Form

Name of Designated Contact:	
Telephone Number:	
Location of the Incident:	
Date and Time of Incident:	
Cause of the Incident:	
Environmental Harm: (Caused/threatened/suspected)	
Details of Actions: (to prevent further incidents and/or recurrence)	
Mitigation: (actions to mitigate any environmental harm)	
Site Manager:	**Date**

6 References

ANZECC, 2000: *An Introduction to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

Basta, N.T., Ryan, J.A., Chaney, R.L., 2005: Trace Element Chemistry in Residual-Treated Soil: Key Concepts and Metal Bioavailability. Journal of Environmental Quality, 34, pp 49–63.