Volume 7

Balranald Mineral Sands Project

NSW Environmental Impact Statement

Prepared for Iluka Resources Limited
May 2015

Appendix M - Rehabilitation and Closure Strategy
Appendix N - Transport Assessment
Appendix O - Social Assessment

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Volume 1

Table of contents
Part A Introduction, site and context, regulatory framework and consultation
Part B Environmental impact assessment
Part C Commitments and justification
References
Acronyms and abbreviations

Volume 2

Appendix A Secretary's Environmental Impact Assessment Requirements
Appendix B Study Team
Appendix C Agricultural Impact Statement
Appendix D Noise Assessment
Appendix E Air Quality and Greenhouse Gas Assessment

Volume 3

Appendix F Biodiversity Assessment

Volume 4

Appendix G Aboriginal Cultural Heritage Assessment

Volume 5

Appendix H Surface Water Management Report
Appendix I Balranald Mineral Sands Project Groundwater Assessment
Appendix J Groundwater Dependant Ecosystems Assessment Report

Volume 6

Appendix K Water Assessment
Appendix L Soil Resource Assessment

Volume 7

Appendix M Rehabilitation and Closure Strategy
Appendix N Transport Assessment
Appendix O Social Assessment

Volume 8

Appendix P Economic Assessment
Appendix Q Geochemistry Assessment
Appendix R Non-Aboriginal Cultural Heritage Assessment
Appendix S Radiation Risk Assessment

Appendix M

Rehabilitation and Closure Strategy

Balranald Mineral Sands Project

Rehabilitation and Closure Strategy

Prepared for Iluka Resources Limited
May 2015

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Balranald Mineral Sands Project

Closure and Rehabilitation Strategy

Iluka Trim Reference No: 1305953

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Balranald Mineral Sands Project

Final

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Table of Contents

Chapter 1 Introduction 1

1.1 Overview 1

1.2 Approval process 1

1.3 Secretary's environmental assessment requirements 2

1.4 Other relevant legislation, guidelines and standards 6

1.4.1 Mining Act 1992 6

1.4.2 Protection of the Environment Operations Act 1997 6

1.4.3 Guidelines 6

1.4.4 Iluka standards 8

1.5 Purpose of this report 9

1.6 Report structure 10

Chapter 2 Proposed activities 11

2.1 Project schedule 11

2.2 Balranald project and area of disturbance 11

2.2.1 West Balranald and Nepean mines 13

2.2.2 Injection borefields 14

2.2.3 Access roads 14

2.2.4 Accommodation facility 14

2.2.5 Water supply pipeline 14

2.2.6 Gravel extraction 15

2.3 Overburden chemistry, mining method and overburden and ore handling 15

2.3.1 Overburden chemistry 15

2.3.2 Overburden and ore handling 18

2.4 Environmental management 24

2.5 Rehabilitation strategies 24

2.5.1 Seed collection 24

2.5.2 Vegetation clearing 24

2.5.3 Surface soil stripping, stockpiling and management 25

2.5.4 Overburden removal, handling and backfilling 28

2.5.5 Acid metaliforous drainage management implications for rehabilitation 28

2.6 Decommissioning 30

2.6.1 Mine services 30

2.6.2 Infrastructure and buildings 31

2.6.3 Roadways, car parks and hardstands 31

2.6.4 Fuel and chemical storage areas 31

2.6.5 Storages and surface water management 31

2.6.6 Surrounding lands 31

Table of Contents *(Cont'd)*

2.6.7 Borrow pits 32

Chapter 3 Post mining land use 33
3.1 Regulatory requirements 33
3.2 Rehabilitation objectives 33
3.3 Land use options following closure 33
3.4 Final landform design 34
3.5 Domain selection 35
3.6 Domain rehabilitation intent 40
3.6.1 Final void (Domain 1a) 40
3.6.2 Mine path – backfilled (Domains 1b and 2a) 41
3.6.3 Final NSOB stockpiles (Domains 1c) 41
3.6.4 Residual mine area (external to pit) (Domains 1d and 2b) 42
3.6.5 Processing area (Domains 3 and 4) 42
3.6.6 Access roads (Domains 5, 6 and 7a) 43
3.6.7 Injection borefields (Domain 7b) 44

Chapter 4 Rehabilitation methods for closure 45
4.1 Progressive rehabilitation 45
4.1.1 Control of surface water inflow to final void 45
4.1.2 Top soil and sub soil reinstatement 45
4.1.3 Drainage and erosion control 46
4.1.4 Revegetation 47
4.1.5 Brush/ timber spreading 49
4.1.6 Rehabilitation and post-closure maintenance 49
4.1.7 Weed management 50
4.1.8 Feral species management 50
4.1.9 Infill planting seeding 50
4.1.10 Fire control 50
4.1.11 Access 50
4.1.12 Public safety 51
4.2 Rehabilitation Schedule 51
4.3 Rehabilitation resources 57
4.3.1 Professional advice and services 57
4.3.2 Staff 57

Chapter 5 Performance indicators and completion/relinquishment criteria 59
5.1 Rehabilitation criteria and reporting 59
5.2 Rehabilitation monitoring and research 61
5.2.1 Rehabilitation monitoring 61

Table of Contents *(Cont'd)*

5.2.2 Research and continual improvement 63

References 65

Appendices

A Preliminary Environmental risk assessment - rehabilitation and closure

B Sub soil and overburden geochemistry

Tables

2.1	Area and disturbance area	12
2.2	Volumes of material to be mined	22
2.3	Summary of rehabilitation material volumes	22
2.4	Recommended top soil stripping depth	25
2.5	Summary of overburden and ore geochemistry and storage strategies	29
3.1	Primary and secondary domains and final land use	36
4.1	Potential species for rehabilitation	47
4.2	Indicative rehabilitation schedule	52
5.1	Interim rehabilitation criteria for the Balranald Project	60
5.2	soil surface conditions assessed using LFA	62
A.1	Qualitative measure of likelihood	A.2
A.2	Qualitative measures of maximum reasonable consequence	A.2
A.3	Risk ranking matrix	A.3
A.4	Risk assessment	A.8

Figures

1.1	Balranald Project pre-mining environment	3
1.2	West Balranald project area	4
1.3	Nepean project area	5
2.1	Conceptual mining progression - long section	16
2.2	Conceptual mining progression – aerial view	17
2.3	West Balranald site layout	20
2.4	West Balranald final stockpiles and final void	21
2.5	Nepean site layout	23
3.1	Rehabilitated domains –West Balranald	38
3.2	Nepean site layout	39
4.1	Planned rehabilitation for West Balranald Mine - Year 1	53
4.2	Planned rehabilitation for West Balranald Mine – Year 4	54
4.3	Planned rehabilitation for West Balranald Mine - Year 8	55
4.4	Planned rehabilitation for Nepean Mine - Year 8	56
B.1	Met10: sub soil and overburden geochemistry	B.1
B.2	Geochem 2: Met10: sub soil and overburden geochemistry	B.2
B.3	Geochem 3: sub soil and overburden geochemistry	B.3

1 Introduction

1.1 Overview

Iluka Resources Limited (Iluka) proposes to develop a mineral sands mine in south-western New South Wales (NSW), known as the Balranald Mineral Sands Project (the Balranald Project). The Balranald Project includes construction, mining and rehabilitation of two linear mineral sand deposits, known as West Balranald and Nepean. These mineral sands deposits are located approximately 12 kilometres (km) and 66 km north-west of the town of Balranald (Figure 1.1).

Iluka is seeking development consent under Part 4, Division 4.1 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) for the Balranald Project, broadly comprising:

- open cut mining of the West Balranald and Nepean deposits, referred to as the West Balranald and Nepean mines refer Figure 1.2 and Figure 1.3 respectively), including progressive rehabilitation;
- processing of extracted ore to produce heavy mineral concentrate (HMC) and ilmenite;
- road transport of HMC and ilmenite to Victoria;
- backfilling of the mine voids with overburden and tailings, including transport of by-products from the processing of HMC in Victoria for backfilling in the mine voids;
- return of hypersaline groundwater extracted prior to mining to its original aquifer by a network of injection borefields;
- an accommodation facility for the construction and operational workforce;
- gravel extraction from local sources for construction requirements; and
- a water supply pipeline from the Murrumbidgee River to provide fresh water during construction and operation.

Separate approvals, are being sought for:

- the construction of a transmission line to supply power to the Balranald Project; and
- Balranald Project components located within Victoria.

1.2 Approval process

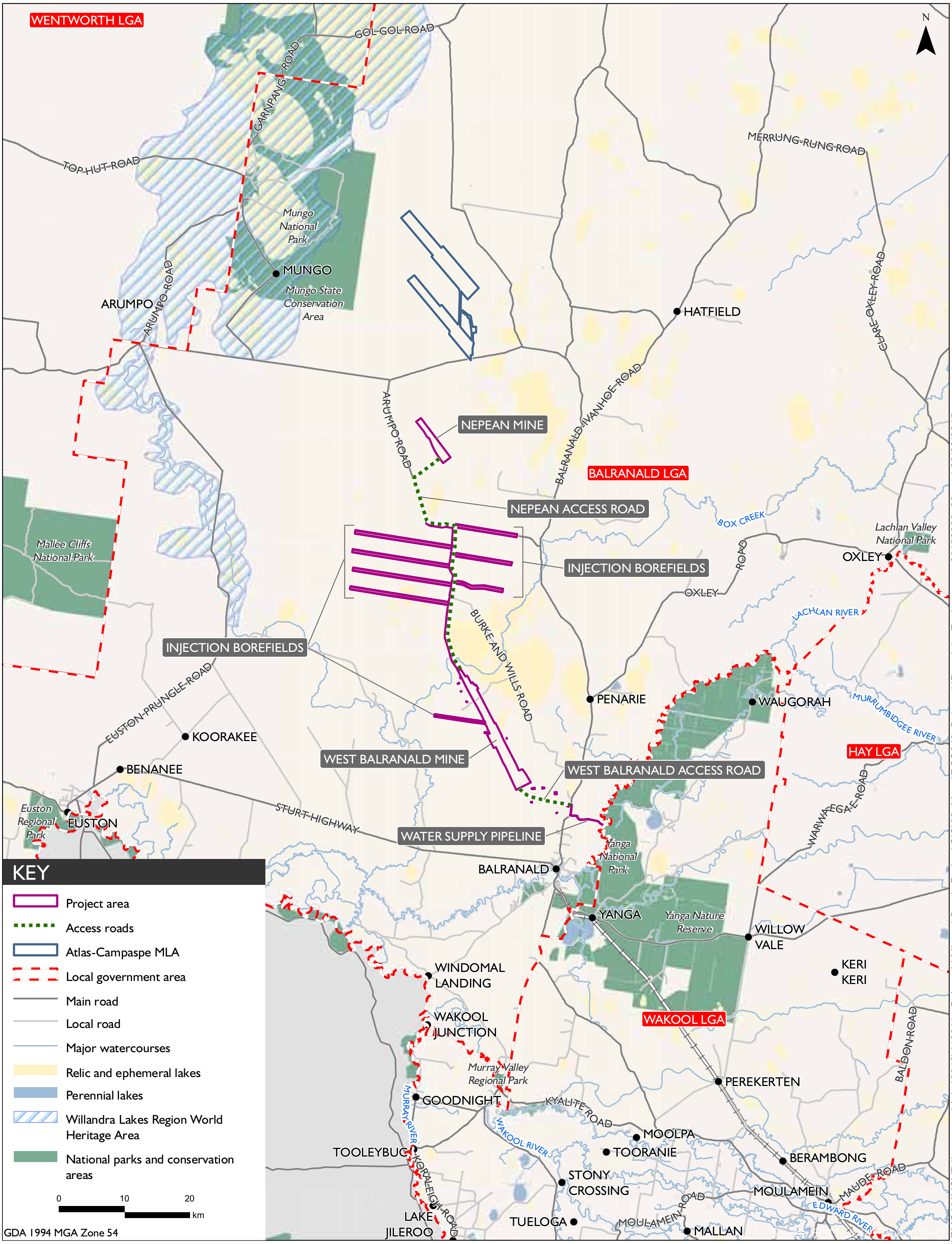
In NSW, the Balranald Project requires development consent under Part 4, Division 4.1 of the EP&A Act. Part 4 of the EP&A Act relates to development assessment. Division 4.1 specifically relates to the assessment of development deemed to be State significant development (SSD). The Balranald Project is a mineral sands mining development which meets the requirements for SSD.

An application for SSD must be accompanied by an environmental impact statement (EIS), prepared in accordance with the NSW *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation).

An approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is required for the Balranald Project (with the exception of the transmission line which will be subject to a separate EPBC Act referral process). A separate EIS will be prepared to support an application in accordance with the requirements of Part 8 of the EPBC Act.

1.3 Secretary's environmental assessment requirements

This closure and rehabilitation strategy has been prepared to address specific requirements provided in the Secretary's environmental assessment requirements (SEARs) for the SSD application, issued on 2 December 2014. The SEARs state that the EIS must include "a rehabilitation strategy, dealing with NSW Trade and Investment's requirements".



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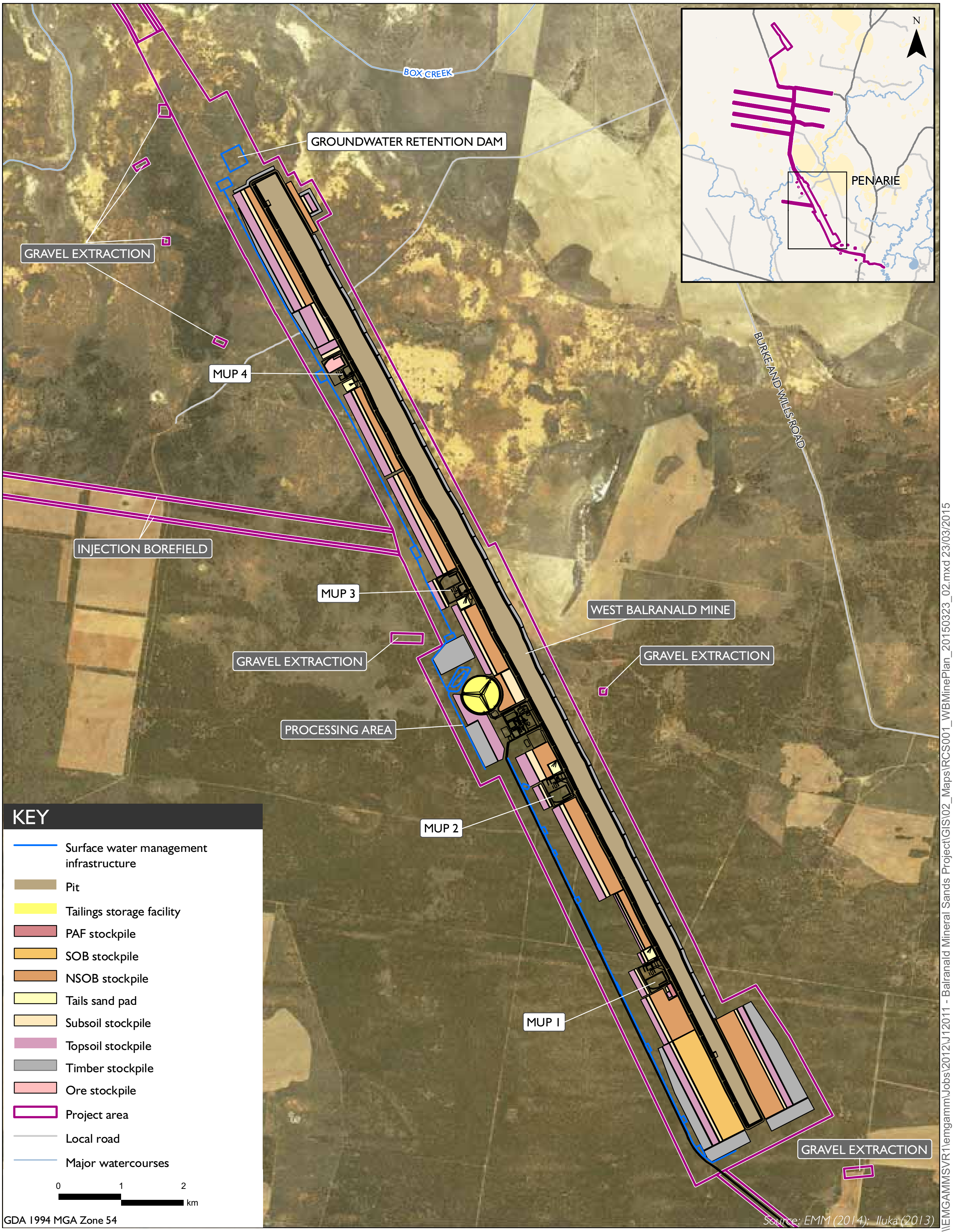
Balranald Project pre-mining environment

Balranald Mineral Sands Project
Rehabilitation and Closure Strategy
Figure 1.1



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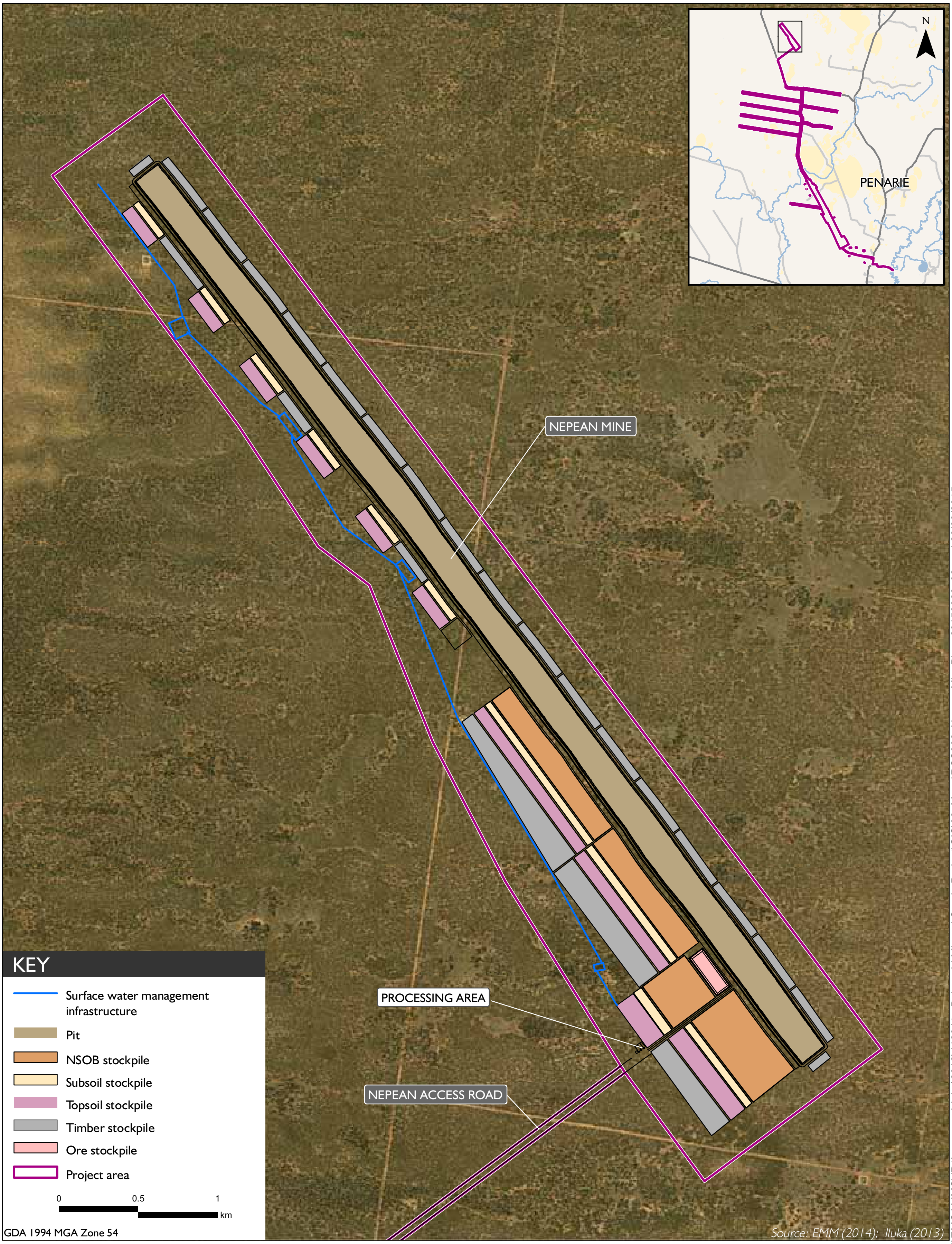
West Balranald project area
Balranald Mineral Sands Project
Rehabilitation and Closure Strategy
Figure 1.2



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Nepean project area

Balranald Mineral Sands Project

Rehabilitiation and Closure Strategy

Figure 1.3

1.4 Other relevant legislation, guidelines and standards

1.4.1 Mining Act 1992

The NSW *Mining Act 1992* regulates environmental protection, closure and rehabilitation conditions included in all mining leases. Iluka currently holds an exploration licence issued under the *Mining Act 1992* over the Balranald Project. The relevant provisions of the *Mining Act 1992* have been considered during the preparation of this closure and rehabilitation strategy. Specifically it addresses Section *239 -* Rehabilitation of area damaged by mining:

> *"(1) The conditions subject to which an authority or mineral claim is granted or renewed may include such conditions relating to:*
>
> *(a) the rehabilitation, levelling, re-grassing, reforesting or contouring of such part of the land over which the authority or claim has effect as may have been damaged or adversely affected by prospecting operations or mining operations, and*
>
> *(b) the filling in, sealing or fencing off of excavations, shafts and tunnels…".*

The mining operations must be carried out in accordance with a Mining Operations Plan (MOP) (see Section 1.4.3).

1.4.2 Protection of the Environment Operations Act 1997

The NSW *Protection of the Environment Operations Act 1997* (POEO Act) establishes the State's environmental regulatory framework and includes licensing requirements for certain activities. The objectives of the POEO Act that relate to decommissioning and rehabilitation include '…*to protect, restore and enhance the environment, to reduce risks to human health and prevent degradation of the environment.*

These objectives been considered in the preparation of this rehabilitation and closure strategy.

1.4.3 Guidelines

The following guidelines provide a strategic overview for rehabilitation and, where relevant, principles of each have been have been adopted in the preparation of this closure and rehabilitation strategy:

- *ESG3 – Mining Operations Plan (MOP) Guidelines , September 2013* (NSW Department of Trade and Investment – Division of Resources and Energy 2013);
- The *Strategic Framework for Mine Closure* (ANZMEC and MCA 2000);
- *Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry* (Commonwealth of Australia 2006); and
- *Mine Closure and Completion - Leading Practice Sustainable Development Program for the Mining Industry* (Commonwealth of Australia 2006).

The relevance of each of the guidelines is discussed briefly below.

i Mining Operations Plan Guidelines

The *MOP Guidelines* (NSW Department of Trade and Investment – Division of Resources and Energy 2013) provide an overview of the approval process for mining developments in NSW and provides content and formatting requirements for MOPs and Annual Reviews. The purpose of these documents is to *"ensure that all mining operations are safe, the resources are efficiently extracted, the environment is protected and rehabilitation achieves a stable and satisfactory outcome."*Specifically, the MOP must meet the content and format as set out in the Guidelines as well as:

- be consistent with any development consent requirements;
- be consistent with safety management plans;
- be based on objectives and outcomes developed with stakeholder involvement;
- provide sufficient detail, supported by scientific and engineering assessment and/or peer review where appropriate, to clearly demonstrate that the objectives and outcomes defined in the MOP will be met; and
- where necessary, contain an environmental assessment of any impacts associated with the implementation of the MOP, where the activities have not been previously assessed under the EP&A Act.

This closure and rehabilitation strategy has been prepared to address the various requirements of the closure and rehabilitation aspects of MOP requirements. It is expected that a complete MOP will be prepared and submitted to DRE following approval of the project. An approved MOP must be in place prior to commencing any significant surface disturbing activities.

As noted in the Guidelines, a MOP is intended to fulfil the function of both a rehabilitation plan and a mine closure plan. It should document the long-term mine closure principles and outcomes whilst outlining the proposed rehabilitation activities during the MOP term (typically 5 years).

A MOP also forms the basis for the estimation of the security deposit imposed to ensure compliance with conditions of authorisation granted under the Mining Act. This estimation of costs will be presented in the MOP.

ii Strategic Framework for Mine Closure

The *Strategic Framework for Mine Closure* (Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia, 2000) (SFMC) was developed to promote nationally consistent mine closure management. The SFMC provides guidelines for the development of a mine closure plan to ensure that all stages of mine closure are conducted appropriately, including stakeholder engagement, development of mine closure methodology, financial planning, and implementation of mine closure. The SFMC also describes the expected standards for mine closure and relinquishment of the mine to a responsible authority. Whilst the objectives generally relate to mine closure, there are key elements that are relevant to Balranald Project rehabilitation, in particular the allocation of appropriate resources and the establishment of key rehabilitation criteria which have been included in this closure and rehabilitation strategy. The main objectives of the SFMC are:

- *"To enable all stakeholders to have their interests considered during the mine closure process;*
- *To ensure the process of closure occurs in an orderly, cost-effective and timely manner;*

- *To ensure the cost of closure is adequately represented in company accounts and that the community is not left with a liability;*

- *To ensure there is clear accountability, and adequate resources, for the implementation of the closure plan;*

- *To establish a set of indicators which will demonstrate the successful completion of the closure process";* and

- *"To reach a point where the company has met agreed rehabilitation criteria to the satisfaction of the Responsible Authority."*

i. Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry

The aim of *Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry* (NSW Department of Industry, Tourism and Resources, 2006) (MR Handbook) is to provide guidelines to promote 'leading practice' sustainable mine plan and rehabilitation design, considering environmental, economic, and social aspects to support on-going sustainability of a mining development. The MR Handbook recommends procedures and mitigation measures that should be considered during mine plan and rehabilitation design, including stakeholder consultation, material and handling, water balance, final landform design, top soil management, vegetation and fauna habitat re-establishment and rehabilitation, and agriculture / commercial forestry suitability. The MR Handbook also provides relevant mine development case studies supporting the recommended procedures and mitigation measures. Where relevant to the Balranald Project, the above principals have been addressed in this closure and rehabilitation strategy.

iii Mine Closure and Completion - Leading Practice Sustainable Development Program for the Mining Industry

The aim of *Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry* (NSW Department of Industry, Tourism and Resources, 2006) (MCC Handbook) is to provide guidelines to promote 'leading practice' sustainable mine closure and completion, minimising any long-term environmental, economic, and social impacts and resulting in a suitable final land form for an agreed land use. Specifically, the MCC Handbook provides that a progressive rehabilitation plan, which is a key principle of this closure and rehabilitation strategy, should be developed for mine closure.

1.4.4 Iluka standards

Iluka has its own internal standards that would apply to closure and rehabilitation of the Balranald Project. These include:

- STD4443 – Environmental Management Standard;

- STD6925 – EHS Standard – Rehabilitation and Closure;

- STD6922 – EHS Group Standard – Stakeholder Relations;

- PRC3077 – Major Risk Procedure – Tailings; and

- Iluka Environment, Health and Safety Policy, 2012.

This closure and rehabilitation strategy includes a commitment to progressive rehabilitation which is a key part of the closure planning process that is ultimately integrated with the mine planning and operations. The closure plan is generally prepared at the PFS phase of the project and as the project moves through the project life cycle (ie PFS, detailed feasibility study (DFS), operation, closure), the closure plan is progressively updated with increasing detail.

The development of the closure plan includes closure options, with the preferred option nominated that may be subject to change as studies progress. The closure plan should progressively increase in detail until it reaches a stage where it contains sufficient detail to allow closure execution.

The underlying principal is that a whole of mine/operation process that culminates in the relinquishment of a mining tenement/lease or licence (which usually occurs after a legally binding sign-off of liability).

For the purposes of this closure and rehabilitation strategy, the following definitions have been adopted.

- Rehabilitation – the return of disturbed land to a stable, productive and/or self-sustaining condition, taking into account beneficial uses of the project area and surrounding land. This includes all revegetation activities.

- Decommissioning – The process that begins near, or at, the cessation of mineral production or processing and ends with the removal of all unwanted infrastructure and services. For example, building demolition, removal of plant and equipment, removal of services and other infrastructure.

- Closure – a whole of mine life process that typically culminates in tenement relinquishment. It includes decommissioning and rehabilitation.

1.5 Purpose of this report

The purpose of this report is to prepare a conceptual closure and rehabilitation strategy that addresses the SEARs, appropriate sections of *ESG3: Mining Operations Plan (MOP) Guidelines,* focussing on those sections of this guideline relevant to rehabilitation, closure and post mining land uses (ie Sections 3 to section 9 of the guideline).

This report has been prepared in recognition that, once conditions of consent are available for the Balranald Project to proceed, a complete MOP will then be prepared in accordance with legislative requirements and submitted to DRE.

The key objectives of this closure and rehabilitation strategy are:

- To describe the means by which acceptable post-mining land use suitability will be achieved. Rehabilitation will aim to create a stable landform with the capability to support sustainable native vegetation communities and maximise the post mining land use capability. This will be achieved by setting rehabilitation criteria and outlining the monitoring requirements that assess whether or not these criteria are being accomplished.

- Present the proposed stable post-mining landforms. Disturbed land will be rehabilitated to a safe, stable and non-polluting condition. Land will be self-sustaining or one where maintenance requirements are consistent with the agreed post-mining land use(s).

- Describe methods to preserve downstream water quality. Rehabilitation will aim to ensure that any surface water that leaves the Balranald project area will not be degraded to a significant extent.

To achieve these objectives, this closure and rehabilitation strategy presents:

- rehabilitation strategies for areas that will be disturbed;
- objectives for the rehabilitation;
- a revegetation program;
- a monitoring program to assess performance of rehabilitated areas; and
- objectives and preliminary rehabilitation criteria for mine closure.

The rehabilitation concepts presented in this closure and rehabilitation strategy should be regarded as provisional to allow for consideration of the outcomes from future rehabilitation trials and research. Final rehabilitation and mine closure requirements would ultimately be formulated in consultation with key government agencies and other relevant stakeholders. These will be presented in the MOP for the Balranald Project.

1.6 Report structure

The report has been structured to follow a similar format (in terms of content) to the ESG3 Guidelines with a focus on closure and rehabilitation strategies, specifically addressing:

- Rehabilitation objectives, domains and post-mining land use (refer Chapter 3).
- Rehabilitation methodology and post-closure maintenance (refer Chapter 4).
- Rehabilitation completion criteria, monitoring and research (refer Chapter 5).

An assessment of rehabilitation and closure risks has been undertaken with the outcome (as a preliminary risk assessment) presented in Appendix A. A complete project risk assessment will be presented in the MOP.

2 Proposed activities

2.1 Project schedule

The Balranald Project will have a life of approximately 15 years, including construction, mining, backfilling of all overburden material, rehabilitation and decommissioning.

Construction of the Balranald Project will commence at the West Balranald mine, and is expected to take about 2.5 years. Operations will commence at the West Balranald mine in Year 1 of the operational phase, which will overlap with approximately the last six months of the construction. The operational phase would include mining and associated ore extraction, processing and transport activities, and would be approximately nine years in duration. This would include completion of backfilling overburden into the pits at both the West Balranald and Nepean mines. Construction of infrastructure at the Nepean mine will commence in approximately Year 5 of the operational phase, with mining of ore starting in Year 6, and being complete by approximately Year 8.

Rehabilitation and decommissioning is expected to take a further two to five years following Year 9 of the operational phase while monitoring and maintenance may extend beyond this period.

2.2 Balranald project and area of disturbance

All development for the Balranald Project that is the subject of the SSD application is within the project area. The project area is approximately 9,964 ha, and includes the following key project domains, described in subsequent sections:

- West Balranald and Nepean mines;
- West Balranald access road;
- Nepean access road;
- injection borefields;
- gravel extraction;
- water supply pipeline (from the Murrumbidgee River); and
- accommodation facility.

Within the project area, the land directly disturbed for the Balranald Project is referred to as the disturbance area. For some project domains in the project area, a larger area has been surveyed than would actually be disturbed. This enables some flexibility to account for changes that may occur during detailed design and operation. The project area and disturbance area for each project domain are presented in Table 2.1.

Table 2.1 Area and disturbance area

Element	Domain[1] Number	Area (ha)	Disturbance area (ha)	Purpose
West Balranald mine	1(a to d) and 3a and b	3,059	3,059	Mining Unit Plant (MUP), mine void, mine void access roads, stockpiles, infrastructure corridors, dewatering / reinjection infrastructure, processing plant, tailings storage facility (TSF), maintenance areas / workshops, final product stockpiles and truck load-out area, administration offices and amenities, top soil and other material stockpiles, internal road network and ancillary infrastructure.
Nepean mine	2 (a and b)and 4	805	805	Mine void, mine void access roads, stockpiles, infrastructure corridors, dewatering / reinjection infrastructure. Maintenance areas / workshops, administration offices and amenities, top soil and other material stockpiles, internal road network and ancillary infrastructure.
West Balranald access road	5	128	52[2]	Greenfield access road.
Nepean access road	6	173	156[3]	Greenfield access road.
Injection borefields	7	5,721	1,214[4]	Reinjection infrastructure and associated access.
Gravel extraction	-	42	42	Borrow material for construction and operation.
Water supply pipeline	-	29	11[5]	Supply of water from the Murrumbidgee River.
Accommodation facility	-	7	7	Accommodation for workforce.
Total		**9,964**	**5,346**	**-**

Notes: *1. These domains are defined later as Primary Domains (refer Section 3.5).*

2. 60 m wide corridor within project area.

3. 40-50 m wide corridor within project area.

4. 100 m wide corridors within project area.

5. 15 m wide corridor within project area.

Figure 1.1 presents the existing pre-mining environment conditions for the Balranald Project while Figure 1.2 and Figure 1.3 present the project elements for the West Balranald and Nepean mine areas respectively.

2.2.1 West Balranald and Nepean mines

The West Balranald and Nepean mines include:

- open cut mining areas (ie pit/mine void) that would be developed using conventional dry mining methods to extract the ore;
- soil and overburden stockpiles;
- ore stockpiles and mining unit plant (MUP) locations;
- a processing area (at the West Balranald mine), including a mineral processing plant, tailings storage facility (TSF), maintenance areas and workshops, product stockpiles, truck load-out area, administration offices and amenities;
- groundwater management infrastructure, including dewatering, injection and monitoring bores and associated pumps and pipelines;
- surface water management infrastructure;
- services and utilities infrastructure (eg electricity infrastructure);
- haul roads for heavy machinery and service roads for light vehicles; and
- other ancillary equipment and infrastructure.

The location of infrastructure at the West Balranald and Nepean mines would vary over the life of the Balranald Project according to the stage of mining.

For example, relevant components of the pit design for both pits may include:

- slope angle ranging between of 32.5° and a maximum slope angle of 39.5;
- berms on the longitudinal pit walls;
- a minimum pit floor width;
- Dewatering bore(s) on top of the saline overburden (SOB);
- wellpoints on the pit floor and benches as required; and
- swell factors of 0 - 5 vol.% (excluding ore) are expected in the mine backfill.

Figure 2.1 and Figure 2.2 show the conceptual mining long section and conceptual mining progression in an aerial view respectively.

2.2.2 Injection borefields

The Balranald Project requires a network of injection borefields in the project area for the return of hypersaline groundwater to the Loxton Parilla Sands aquifer. Within each borefield, infrastructure is generally located in two 50 m wide corridors (approximately 350 m apart) and typically comprises:

- a network of pipelines with a graded windrow on either side;
- access roads for vehicle access during construction and operation;
- rows of injection wells; and
- a series of water storage dams to store water during well development.

2.2.3 Access roads

There are two primary access roads within the project area to provide access to the Balranald Project:

- West Balranald access road – a private access road to be constructed from the Balranald Ivanhoe Road to the West Balranald mine.
- Nepean access road – a route comprising private access roads and existing public roads. A private access road would be constructed from the southern end of the West Balranald mine to the Burke and Wills Road. The middle section of the route would be two public roads, Burke and Wills Road and Arumpo Road. A private access road would be constructed from Arumpo Road to the Nepean mine.

The West Balranald access road would be the primary access point to the project area, and would be used by heavy vehicles transporting HMC and ilmenite. The Nepean access road would primarily be used by heavy vehicles transporting ore mined at the Nepean mine to the processing area at the West Balranald mine.

During the initial construction phase, existing access tracks through the project area from the local road network may also be used temporarily until the West Balranald and Nepean access roads and internal access roads within the project are established.

2.2.4 Accommodation facility

An accommodation facility would be constructed for the Balranald Project workforce. It would operate throughout the construction and operation phases of the project. It would be located adjacent to the West Balranald mine near the intersection of the West Balranald access road with the Balranald Ivanhoe Road.

2.2.5 Water supply pipeline

A water supply pipeline would be constructed to supply water from the Murrumbidgee River for operation of the Balranald Project.

2.2.6 Gravel extraction

Gravel would be required during the construction and operational phases of the Balranald Project. Local sources of gravel (borrow pits) have been included in the project area to provide gravel during the construction phase. During the construction phase, gravel would be required for the construction of the West Balranald access road, internal haul roads and service roads, and hardstand areas for infrastructure. Processing operations, such as crushing and screening activities (if required) would also be undertaken at the borrow pits.

2.3 Overburden chemistry, mining method and overburden and ore handling

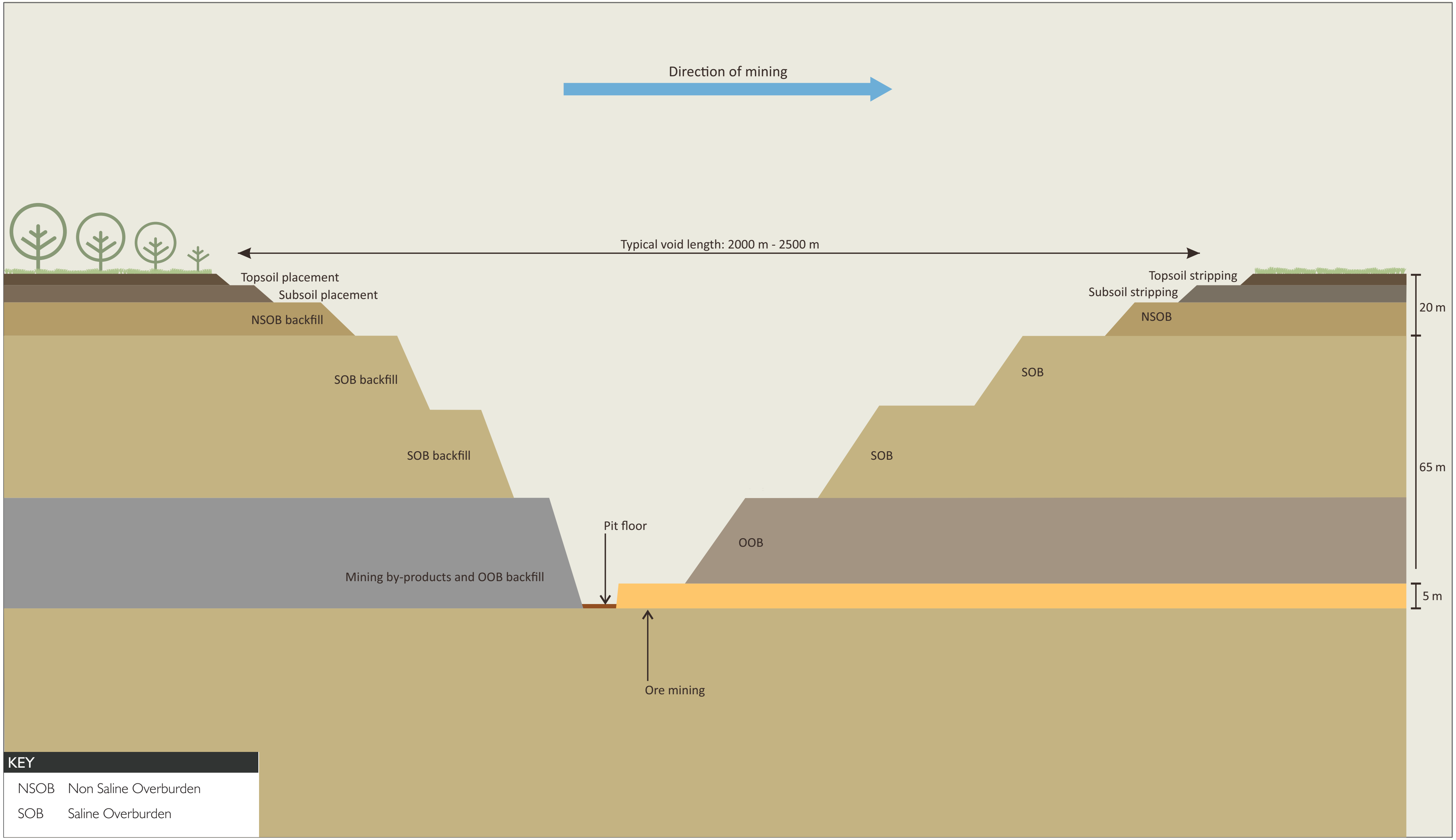
2.3.1 Overburden chemistry

Mining will produce the following overburden types and mining by-products (MBP):

- Top soil (of variable depth for use in the rehabilitation program).
- Subsoil (up to 1 m thick, suitable for use for capping in the rehabilitation program).
- Non-Saline Overburden (NSOB, approximately 13 m thick) – defined as material below the top soil but above the groundwater table. Consists of Shepparton Formation sands, clayey sands and clays.
- SOB (approximately 36 m thick) – defined as material below the groundwater table and comprising largely Shepparton Formation Sands and the Loxton Parilla Sand Formation Upper Marine Sequence (foreshore zone).
- Organic Overburden (OOB, approximately 3-20 m thick) – defined as carbonaceous sandy material largely associated with the Loxton Parilla Sands Formation Upper Marine Sequence (lower shore zone).
- Ore (ORE, approximately 5m thick) – defined as the mineralised strand within the Loxton Parilla Sands Lower Marine Sequence.
- MBP 'reject' material from mineral processing. This comprises sand tails to be stockpiled adjacent to pre-concentrator plant (PCP) and modified co-disposal materials (ModCod) and dried on surface in an ex-pit Tailings Storage Facility (TSF) and for progressive placement into backfill dumps.

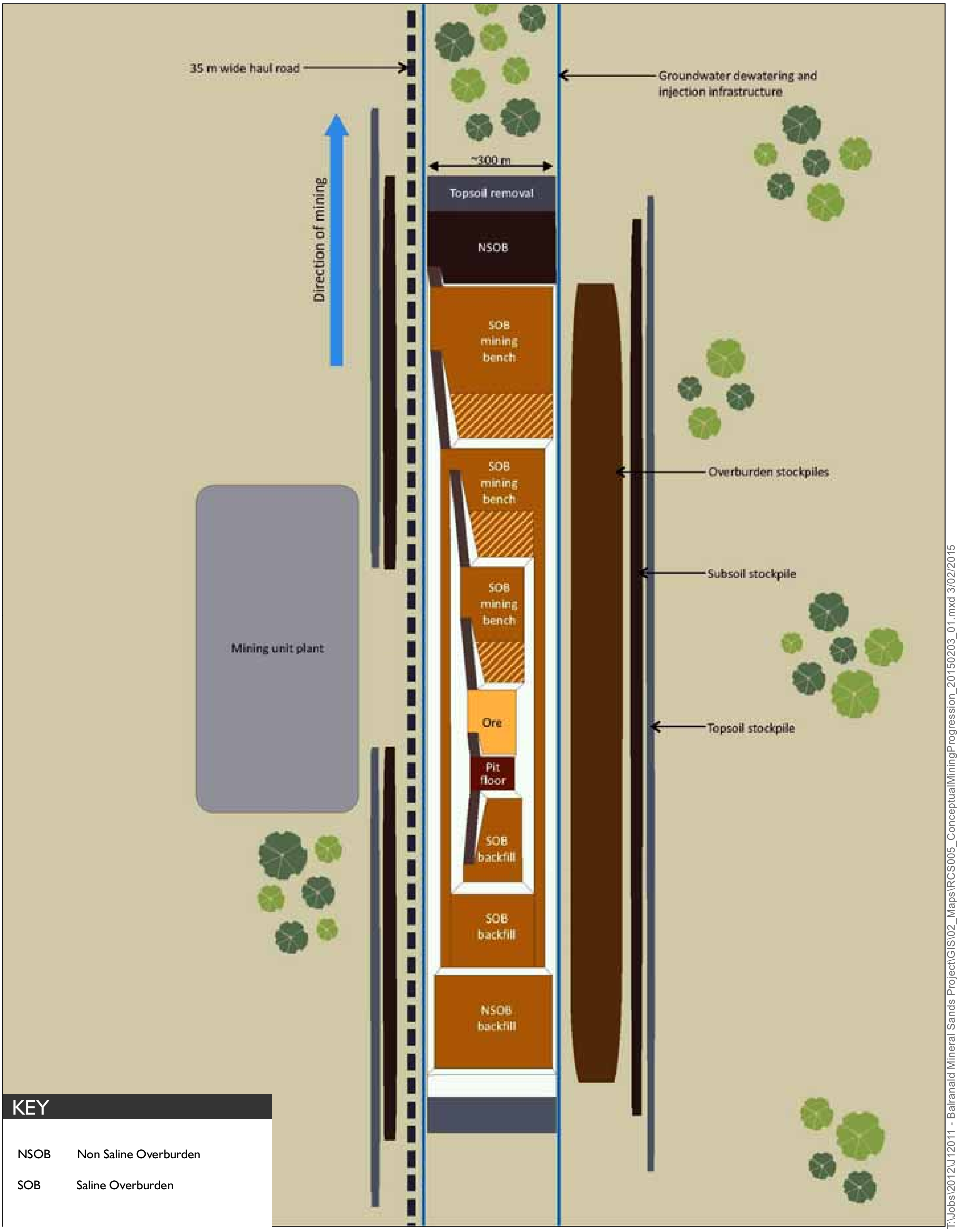
The overburden types and MBPs comprise both potentially acid forming (PAF) and non acid forming (NAF) materials (refer to the Geochemistry Assessment prepared by Earth Systems Pty Ltd 2015).

NSOB and SOB overburden are primarily differentiated by depth. The former is overburden that is located above the prevailing water table depth (approximately 13 to 16 m bgl) and with a salinity around 350 to 5300 mg/L. Overburden below this depth will have a salinity reflecting that of the prevailing groundwater salinity (ie around 14,000 to 100,000 mg/L. Such levels are clearly highly saline. NSOB has an exchangeable sodium percentage (ESP typically of 20 to 50% while the ESP of subsoil (ie that material below the top soil, but above the SOB) has been found to be highly variable but typically between 15 and 30%).



Note: Not to Scale

Conceptual mining progression - long section
Balranald Mineral Sands Project
Environmental Impact Statement
Figure 2.1



EMM

Conceptual mining progression – aerial view

Balranald Mineral Sands Project

Rehabilitation and Closure Strategy

Figure 2.2

2.3.2 Overburden and ore handling

Full details on the mining method are presented in the Balranald Project EIS. During open-cut mining operations, the groundwater level will be lowered by dewatering, exposing the overburden and allowing dry mining. The mining of the West Balranald deposit will require the initial stripping of top soil and sub soil. After top soil and sub soil is stripped approximately 60 m of overburden will be stripped to expose the high grade ore. Overburden will include, around 13 to 15 m of NSOB, approximately 26 m SOB and then a 3 to 20 m depth of organic overburden (OOB). Below the OB will be approximately 5 m depth of ore.

The Nepean deposit is geologically similar but shallower and with no OOB. Figure 2.1 presents a typical long section through the West Balranald pit indicating the various depths of mine benching to be followed by the progressive backfilling comprising (in order of placement):

- the tailings and MBP/OOB material (West Balranald pit only);
- the SOB backfill;
- the NSOB backfill;
- the top soil and sub soil; and
- stockpiled timber, where required for ecological enhancement.

Refer to Table 2.2 for progressive volumes for SOB, NSOB, sub soil, top soil to be mined from the West Balranald mine and rehabilitated progressively during mining. Table 2.3 presents a summary of the rehabilitation material volumes necessary to complete the earthworks associated with site rehabilitation.

Mining at the West Balranald mine will be as follows:

- mining will commence at the southern extremity of the proposed mine path and then extend in a north-westerly direction;
- initial cut will involve the placement of SOB (to SOB#1) and NSOB on separate stockpiles;
- SOB#1 will be shaped and sub soiled and top soiled. This SOB (following stripping of the placed top soil and sub soil will be returned to the void at a later stage of the pit development. No SOB will be stockpiled following cessation of mining and backfilling;
- NSOB stockpiles #1 to #5 will be reshaped with 1:10 batter slopes and then sub soiled and top soiled and rehabilitated. Approximately 16,000,000 m^3 of NSOB will remain on stockpile following the completion of mining and backfilling. This includes approximately 10,000,000m^3 attributable to swell;
- NSOB stockpile #6 and the adjacent sub soil and top soil stockpiles will be used for the capping of the TSF;
- all MBP from both the West Balranald and Nepean pits will be returned to the West Balranald pit void;
- all PAF material will be returned to the pit and capped with NAF material;

- NSOB stockpiles #7 to #11 will be returned to the pit void and capped, sub soiled and top soiled;
- there will be a final void which will be re-profiled along the strike of the pit. This will be shaped to have final slopes of 1V:10H or less; and
- the final void will be backfilled to above the prevailing depth to groundwater.

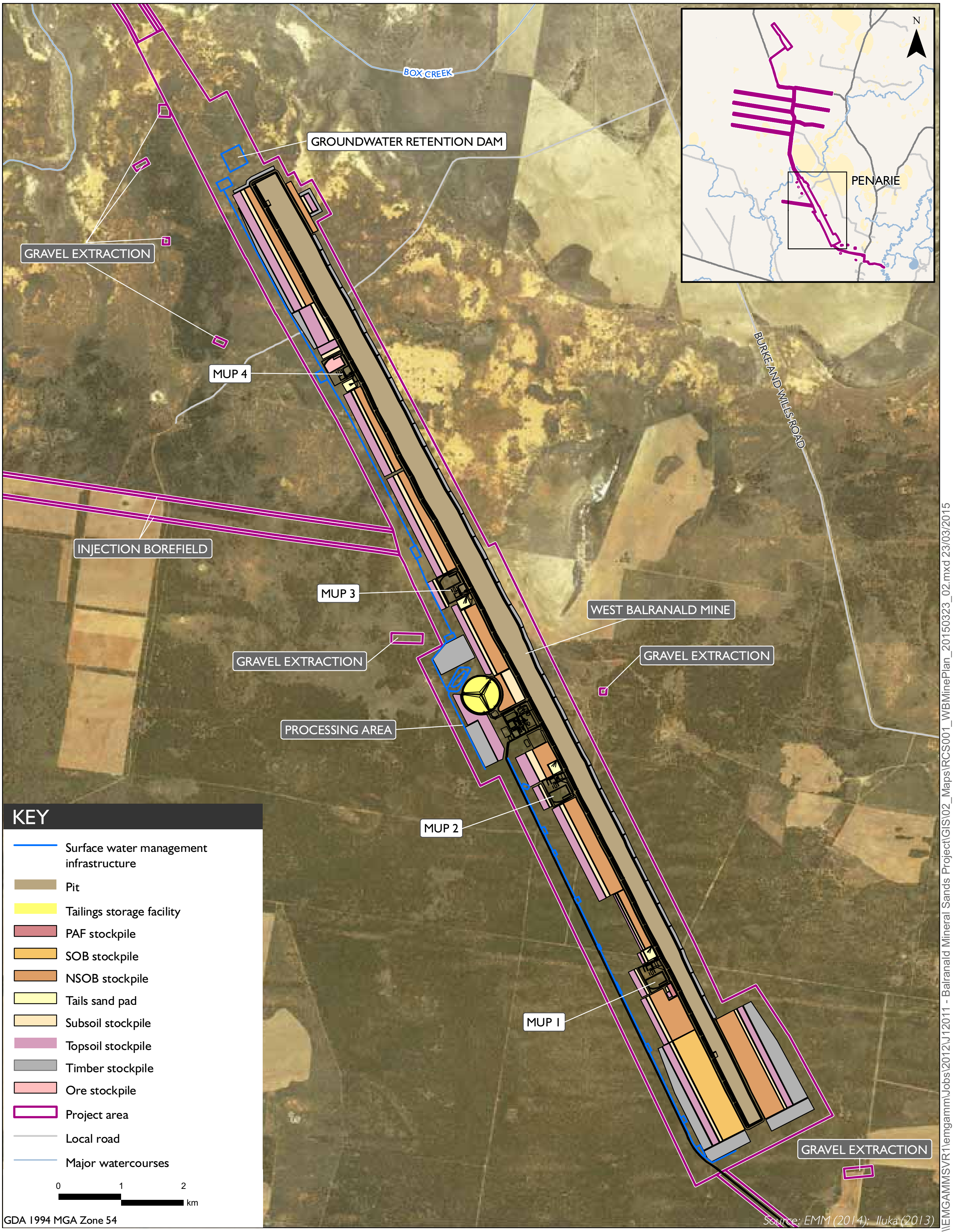
Figure 2.3 presents proposed site layout (for the ultimate disturbance) for the West Balranald mine area with the extent of each of the timber, top soil, sub soil, NSOB and SOB (one only) stockpiles (both temporary and permanent) placed during the West Balranald mining program.

Figure 2.4 presents the proposed final aerial plan of the West Balranald mine area showing the final extent of rehabilitated stockpiles and final void prior to rehabilitation of the process plant area.

Refer to Table 2.2 for progressive volumes for SOB, NSOB, sub soil, top soil to be mined from the Nepean mine and rehabilitated progressively during mining. Table 2.3 presents a summary of the approximate rehabilitation material volumes necessary to complete the earthworks associated with site rehabilitation.

Mining at the Nepean mine will be as follows:

- mining will commence at the southern limits and progress in a north westerly direction;
- there is no PAF material in the Nepean pit;
- there will be no SOB to be stockpiled;
- all NSOB will be returned to the pit void; and
- The final landform will be gently undulating and below the pre-mining ground level.



EMM
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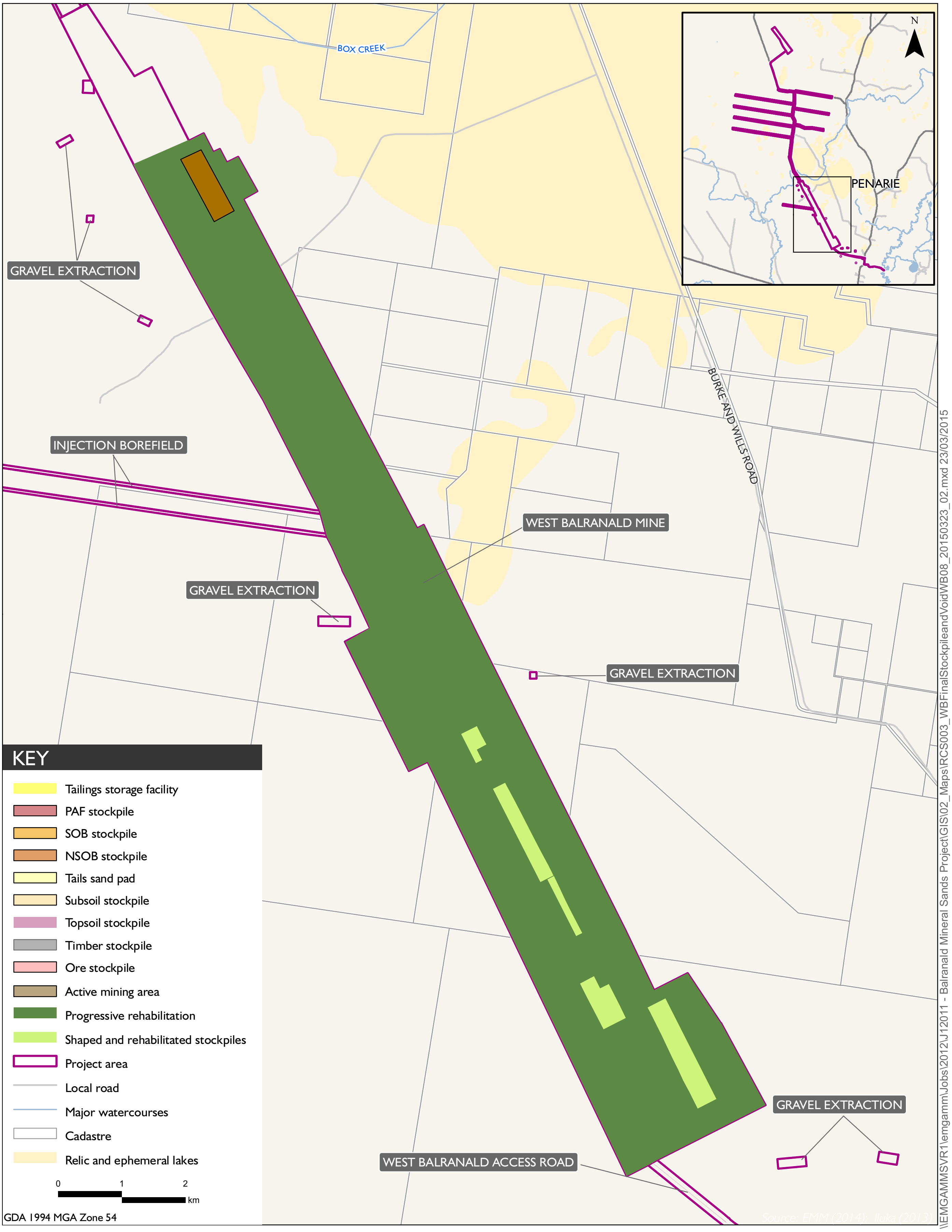
West Balranald site layout

Balranald Mineral Sands Project

Rehabilitation and Closure Strategy

Figure 2.3



West Balranald final stockpiles and final void

Balranald Mineral Sands Project

Rehabilitation and Closure Strategy

Figure 2.4

Figure 2.5 presents the extent of each of the temporary timber, top soil, sub soil, NSOB and SOB stockpiles placed during the Nepean mining program.

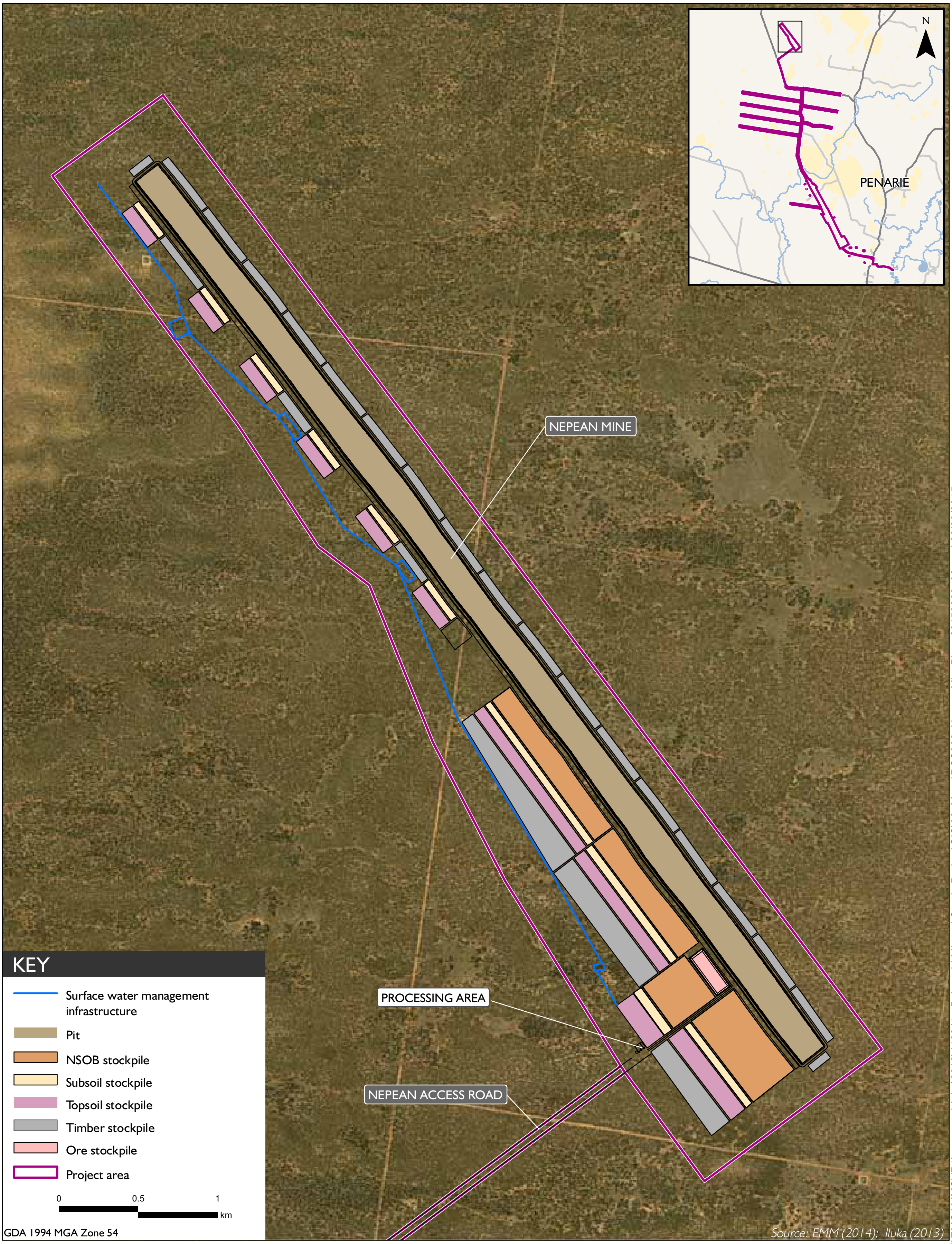
Table 2.2 presents the volumes of different material to be mined for the life of each mine area while Table 2.3 presents a summary of the rehabilitation material volumes necessary to complete the earthworks associated with site rehabilitation.

Table 2.2 Volumes of material to be mined

Mine	Operations - primary movements only - excludes rehandle (ie return of material from stockpile to pit) (Mm^3)						
	Total Pit Volume (in-situ)	SOB mined[1]	NSOB mined[2]	Top soil/sub soil stripped	PAF[3]	Ore	Tailings/MBP
West Balranald	234.9	133.6	53.6	5.2	32.2	10.2	8.3
Nepean	38.9	n/a	35.1	1.0	n/a	2.6	2.3

Table 2.3 Summary of rehabilitation material volumes

Mine	Rehabilitation (Mm^3)							
	SOB		NSOB			Tailings	MBP[4]	Final void volume (following reshaping to 1:10)
	Stockpiled and then backfilled	Backfilled immediately	Stockpiled and then backfilled	Backfilled immediately	Stockpiled - part of final landform	capped	All backfilled - at West Balranald	
West Balranald	5.5	128.0	26.8	26.7	15.1	NSOB #6	8.3	5Mbcm
Nepean	n/a	n/a	5.9	29.2	n/a	n/a	2.3	<1 Mbcm



Nepean site layout

Balranald Mineral Sands Project
Rehabilitiation and Closure Strategy

Figure 2.5

2.4 Environmental management

Environmental management during the Balranald Project will be in accordance with an environmental management strategy (EMS). The EMS will contain a suite of management plans which detail the site-specific management measures and procedures to be implemented during construction, operation and rehabilitation and closure of the Balranald Project. Management plans under the EMS will be prepared in consultation with relevant government agencies where required. The EMS will be consistent with the conditions of the Balranald Project development consent and other planning approvals, should they be granted.

2.5 Rehabilitation strategies

The following identifies the general strategies and methods that will be progressively implemented prior to and during operations in order to facilitate an effective rehabilitation program (described separately in Chapter 4).

2.5.1 Seed collection

Where possible, seed will be collected from within the relevant disturbance area prior to ground disturbing activities. Calendars providing indicative timing, by species, for collection of seed can be generated. Seed collected from the Balranald Project will either be used directly on rehabilitated surfaces, or stored in a designated seed storage facility prior to its eventual use for revegetation. Seed quality parameters of viability, germinability and purity will be assessed while the seed is in storage. Seed quality determination provides a useful indication of a species potential regenerative capacity.

It is possible that not all plant species required for rehabilitation will be able to be grown from seed collected from the Balranald Project. If such is the case, a separate approval to use off-site plant material will be sought from NSW Office of Environment and Heritage (OEH) and/or NSW Department of Trade and Investment, Regional Infrastructure and Services – Division of Resources and Energy (DRE).

2.5.2 Vegetation clearing

Clearing of native vegetation will be performed in compliance with on-site procedures. Vegetation clearing will be minimised as far as practicable to areas essential for mining operations and essential support activities.

Cleared overstorey timber will be retained and stockpiled for habitat enhancement purposes (brushing, habitat creation). Clearing of overstorey species will be via chaining or pushing with a dozer, excavator or loader. The location of proposed timber stockpiles (as progressively established) are shown on Figure 2.3 for West Balranald mine and Figure 2.4 for Nepean mine.

For low open shrubland areas where it is not practical due to vegetation height, health or density, it may be appropriate to clear the understorey with the top soil layer. In other areas, the understorey may be cleared separately to the top soil. A loader, dozer or grader will use their blade to cut off the shrubs close to ground level and push them into a windrow. The windrows will then be carted away for placement in stockpiles for later use. An alternate approach may be to mulch the chenopod shrubs, leaving a litter layer on the ground that can be stripped with the top soil. Alternatives will be considered for trialling during operations.

2.5.3 Surface soil stripping, stockpiling and management

i Soils and implications for stripping depths and stripping procedures

The Balranald Mineral Sands *Soil Resource Assessment* (EMGA Mitchell McLennan Pty Ltd 2015) provides a full description of the soils (top soil and sub soil) that will be directly impacted by the Balranald Project, their quality and suitability for rehabilitation.

All areas to be disturbed as a result of construction and operations of the Balranald Project will require soil stripping for reuse in rehabilitation.

The top soils have (by assessment against Elliott and Reynolds 2007) adverse characteristics for stripping in most cases. Sub soils have undesirable characteristics in all cases. The soils nevertheless demonstrably provide a suitable growth medium for the predominant chenopod (saltbush and bluebush) and mallee vegetation. Table 2.4 presents the recommended top soil stripping depths for each of the soil types based on the assessment presented in the *Soil Resource Assessment Report*. The basic principle in determining useable depths of soil for rehabilitation is its quality in comparison to the spoil requiring rehabilitation and as such the quality of soil should exceed that of the spoil. Where constraining factors occur, suitable subsoil can sometimes be appropriate for amelioration and direct rehabilitation without the need for topsoil.

Table 2.4 Recommended top soil stripping depth

Soil type	Top soil stripping depth recommendations (m)
Calcarosol- hypercalcic and hypocalcic	Typical: 0.3 Maximum depth : 0.4
Chromosol	Typical:0.4 Maximum depth: 0.7
Dermosol	Typical:0.15 Maximum depth: 0.45
Kandosol	Typical:0.3 Maximum depth: 0.75
Sodosol	Typical: 0.1 Maximum depth: 0.1
Vertosol	Typical:0.1 Maximum depth: 0.4

The expected volumes of top soil and sub soil reserves to be stripped in the West Balranald and Nepean mine areas are 6.3 M m^3.

Top soil and sub soil from different vegetation communities (where practicable) will be maintained in separate stockpile categories. Records will be maintained of top soil movements including soil type, quality, location, vegetation community, weeds present (if any), removal date, storage location and dust suppression treatment (if any).

Soil stripping will be done with the principle aim of retaining biological activity in the top soil (which in turn will aid rehabilitation). Field trials will be ongoing during operations to assess the effectiveness of different stripping methodologies in ensuring optimal preservation of the seed bank.

Subject to further trialling of suitable techniques for handling top soil, landplanes and or graders will be used to strip the top soil. These machines have been used successfully for rehabilitation of other Iluka operations at Douglas, Eneabba and Kulwin. Both machines are able to maintain a precise cut, thus ensuring the depth of the top soil cut is accurate with the aid of visual inspection. Soil will be stripped in consideration of the following:

- The volume of soil retained and subsequently required for rehabilitation is determined by availability (ie area available to be stripped and depth of stripping).
- Earthmoving plant operators will be trained and supervised to ensure that stripping operations are conducted in accordance with stripping plans and in situ conditions. Soil, where possible, should be stripped in a slightly moist condition and appropriate machinery must be used to minimise structural degradation. It should not be trafficked or deep ripped prior to stripping.
- For deeper layers following topsoil removal, deep ripping may be necessary, followed by dozing or scraping to remove the remainder of the soil with care taken not to mix any remaining top soil with sub soil.
- During the stripping process, there may be some unexpected changes in the depth and the nature of the soil. Where practical the inclusion of obviously poorer quality material will be avoided eg material dominated with stones.
- All machinery used in the stripping operation should be clean of weeds.
- Disturbance areas will be stripped progressively (ie only as required) so as to reduce erosion and sediment generation, to reduce the extent of stockpiles and to utilise stripped soil as soon as possible for rehabilitation.
- Rehabilitation of disturbed areas (ie roads, mine void, embankments and batters) will be undertaken as soon as practicable after these structures are completed or as areas are no longer required.

ii Sub soil stripping

As noted above, it is expected that sub soil to varying depths will be useable for rehabilitation purposes. This layer will be stripped separately to the top soil and stockpiled in separate piles to top soil and NSOB.

An assessment of the geochemistry of sub soil for the purposes of determining its use for rehabilitation purposes has been undertaken for this report. Three separate cores (ie Met 10, Geochem 2 and Geochem 3) were established in the project area with samples for laboratory analysis collected at 1 m intervals to an overall core depth of 20 m below ground level (bgl). Samples were assessed for pH, electrical conductivity (EC) and Exchangeable Sodium Percentage (%) with the results summarised in Appendix B.

This assessment found that:

- pH levels were generally acceptable in all samples to 4 m depth (ie pH 6 to 9.5) but could become acidic (<6) below this level;
- EC levels were highly variable throughout the profiles but could be elevated (>1500 uS/cm) at certain depths;

- ESP levels were consistently very high (>15%) below 3 m depth; and
- Cation exchange capacity (CEC) levels were (expectedly) high in the surface material to 0.5 m depth and low in material below this depth.

Based on this assessment, Stripping of additional subsoil depth of up to 3 m bgl may provide more beneficial material for use in rehabilitation activities (the assessment of volumes presented in Table 2.3 has been based on a top soil plus sub soil stripping depth of an average of 1 m).

These sub soils will be stripped and stored separately from, but in the same manner as top soil, with depths determined by results of testing. The placement of sub soil during rehabilitation activities needs to be assessed with reference to the landscape position it was stripped from.

Stockpiling of stripped soil will be necessary initially as areas will only become available for rehabilitation once mining activities in those areas have concluded. As mining activities progress, areas may become available for direct placement of soil following stripping. Once stripped, top soil and sub soil (where appropriate for use in rehabilitation) will be stockpiled as follows:

- soil types with significantly different properties should be stockpiled separately;
- stockpiles will be located so that they will not be further disturbed by mining activities and positioned to avoid surface water flow;
- erosion and sediment controls will be installed around stockpile areas and regularly maintained;
- locations of stockpiles will be recorded using GPS and an inventory of data relating to the soil type, volumes and use in rehabilitation maintained by appropriate Balranald Project personnel;
- topsoil stockpiles will be retained at a height of no more than 2 m while subsoil can be stockpiled to a maximum of 10 m dependent on soil properties;
- slopes of both top soil and sub soil stockpiles no greater than a grade of approximately 1V:3H and a slightly roughened surface to minimise erosion;
- where ameliorants such as lime, gypsum or native suitable fertiliser are needed to improve the condition of stripped soil, it should either be applied to the stockpiles in-between the application of separate layers from the scrapers, or be spread on the soil prior to scraping;
- vehicle access on soil stockpiles will be prohibited except when necessary for soil quality monitoring; and
- weed management will be applied to stockpiles to minimise the accumulation of weed seed in the soil.

Opportunities for direct soil replacement are likely to commence approximately two years after mining starts. The top soil and sub soil balances will be regularly reviewed to ensure appropriate final soil replacement depths.

Stabilisation of spread soil may include the use of a water cart, timber and ripping or clay fines that will be spread with a low ground pressure water truck.

2.5.4 Overburden removal, handling and backfilling

Overburden will be removed using conventional earthmoving equipment such as scrapers, excavators and dump trucks.

The SOB and NSOB overburden will be removed and stockpiled for as short a time as possible, up to a 6 month period, and then returned to the pit as backfill, or, in the case of the NSOB stockpiles #7 to #11, and SOB #1 stockpile, temporarily capped if required, retained in stockpile and rehabilitated. Groundwater will return to pre-mining levels and saturate the SOB. Dewatering and stockpiling of the overburden will expose the reactive sulfide layers within some of the overburden and will be susceptible to atmospheric oxidation. Similarly, the ore-body at the bottom of the pit is expected to be exposed to atmospheric oxidation for short periods of time, while also being in contact with saline groundwater. The ore will be removed and transported to the Run-of-Mine (ROM) pad where it will again be susceptible to atmospheric oxidation. Methods to control and manage oxidation of all materials during operations have been identified in the geochemistry assessment (Earth Systems 2015).

Saline groundwater will not be used to control dust during top soil or sub soil stripping from mining areas, or during stripping of NSWOB. Groundwater may be used to control dust during the removal of SOB, OOB and ore (as may be appropriate).

The majority of backfilling will occur in mining areas. Most areas of ancillary infrastructure will not require significant backfill, with only minor depths of fill, sub soil and top soil required to be replaced. The intention for these areas will be to return the top soil and sub soil horizons to their pre-mining location.

Backfill and material placement within the TSF will be dominated by co-disposed sand and clay tailings. This backfill or material placement will occur to a design level, followed by the placement of a capillary break (if required), then a capping layer of sub soil and top soil.

2.5.5 Acid metaliforous drainage management implications for rehabilitation

Assessment of the geochemical characteristics of the ore body and overburden has been undertaken in the geochemistry assessment (Earth Systems 2015). The report has identified acid mine drainage implications associated with Balranald Project and management strategies that are recommended to be applied during mining and consequential rehabilitation program. Table 2.5 provides a summary of the handling and storage methods to mitigate any effect from acid mine drainage.

Table 2.5 Summary of overburden and ore geochemistry and storage strategies

Material		PAF/NAF	General geochemical properties	Storage Infrastructure	
				Operational storage (Short-Term)	Final storage (post-mining)
West Balranald mine	Overburden-Non Saline (NSOB)	NAF	Shallow, high in natural organic matter, above water table, low potential for leaching salts or metals.	Stockpiled (~6 months).	Used for revegetation or final covers where possible (as identified in rehabilitation methods).
	Overburden-Saline (SOB)		Below water table, high in salinity, leaching of constituents elevated in saline groundwater including Na, Cl and Sulphate.	Stockpiled (~6 months).	Returned to the pit.
	Overburden Organics (OOB)	PAF	Highly reactive; testing shows a strong tendency to acidify rapidly. May generate acid, sulphate and metals.	Stockpiled (boxcut) 3 - 4 months.	This material is preferentially placed (over the overburden) into the pit void. It will remain dry for a brief period prior to rewetting due to groundwater recovery.
	Ore	PAF	Highly reactive; testing shows a strong tendency to acidify rapidly. May generate acid, sulphate and metals.	Transferred to ROM pad for ~4 weeks prior to processing.	Transferred to the Mining Unit Plant for processing.
Nepean mine	Overburden	NAF	Non-reactive, showing a rapid leaching of soluble salts at moderate concentrations.	Stockpiled (~6 months).	Returned to the pit.
	Ore	NAF	Non-acid forming but initially elevated in macro constituents.	Transferred to ROM pad for ~4 weeks prior to processing.	Transferred to the Mining Unit Plant for processing.
Process Stream Materials (underflow, sand tails, modified co-disposal (ModCoD), MBP)		All PAF	Most are acid forming with variable rates of reactivity.	Refer geochemical assessment report.	Once dried, are mostly placed into lower levels in the West Balranald pit void. Some will remain in TSF to be capped with NAF material.

2.6 Decommissioning

Decommissioning of the Balranald Project will involve the following activities with further detail presented for each of the domains in Chapter 3:

- decommissioning of processing plant areas following removal of plant;
- decommissioning of mine services and infrastructure;
- removal of mining infrastructure, materials and rubbish;
- top soil and sub soil testing of all potentially contaminated areas;
- removal of any contaminated top soil and sub soils to the pit with provision for at least 1 m of cover following treatment (as may be required);
- top soil and sub soil groundwater testing to validate potentially contaminated sites to ensure benign material is present before rehabilitation programs commence and potentially contaminated water is removed;
- contouring earthworks to rip up compacted areas and blend disturbed mining surfaces into surrounding topography; and
- application of top soil and subsoil and/or seed mix to promote establishment of endemic vegetation suitable for pastoral uses.

The following sections summarise the key aspects related to the decommissioning and closure of the various infrastructure components of the Balranald Project. It assumes that all buildings and other infrastructure are demolished and removed despite the potential for them being used after mining (subject to the landholder's requirements). It is considered likely that at least some aspects of the existing infrastructure will be used post mining (eg roads). These options will be considered in greater detail during stakeholder engagement, which will be done closer to closure.

2.6.1 Mine services

All services including power, water and data on the mine will be isolated, disconnected and terminated to make them safe. Generally all underground services will be made safe and left buried in the ground (where appropriate). Overhead power lines will be removed and the materials (ie poles and wire) recovered for potential re-sale or recycling as applicable.

2.6.2 Infrastructure and buildings

All sumps will be de-watered and de-silted prior to the commencement of demolition. In addition, all items of equipment will be de-oiled, degassed, depressurised and isolated and all hazardous materials removed. All buildings, including the administration building, workshop and processing facilities will be dismantled and removed. Where possible, assets may be re-used or sold. The remaining items will be dismantled, removed and transported from the Balranald Project as required. All recoverable scrap steel will be sold and recycled, with the remaining inert non-recyclable wastes either being taken to a licensed landfill or buried in the areas being backfilled if approved and available at the time of closure. Prior to disposal, all wastes will be assessed and classified in accordance with the *Waste Classification Guidelines* (DECC 2008). All concrete footings and pads will be broken up to at least 1.5 m below the surface. The waste inert concrete will be crushed and then buried in the final void. All areas will then be reshaped, deep ripped, top soiled and subsoiled and seeded as required.

2.6.3 Roadways, car parks and hardstands

The roadways, car parks and hardstand areas around the workshop and administration areas will be ripped up and the inert waste material placed in the final void. All areas will then be reshaped, deep ripped, top soiled and subsoiled and seeded as required.

2.6.4 Fuel and chemical storage areas

Leading up to closure, a preliminary sampling and analysis program will be implemented to determine whether a more detailed contamination assessment is required. This will quantify the amount of contaminated material requiring bio-remediation on-site or needing to be sent off-site for disposal at a licensed facility.

2.6.5 Storages and surface water management

All sedimentation basins which assist in water flow from the final rehabilitated surface will be retained following closure. All dams will be assessed for structural integrity and upgrade works completed if the basin is to be retained. Any of the remaining basins that are not required will be removed and the original drainage paths re-established wherever possible.

In general, drainage lines will be restored with adequate controls to minimise the erosion within the channel, along with controls to prevent the migration of any erosion upstream or downstream.

2.6.6 Surrounding lands

This land includes all unmined lands owned or managed by Iluka that are not used for purposes related to mining. It includes a significant proportion of the land immediately around the project area. The surrounding land primarily comprises grazing land.

These areas will be assessed in accordance with the proposed post-mining land use (as presented in Chapter 3) to ensure that they are compatible.

Iluka is committed to the establishment and management of an offsets package that is commensurate with the disturbance area of the Balranald Project. The management of the biodiversity offset areas will be undertaken in accordance with the Biodiversity Offset Management Plan.

2.6.7 Borrow pits

Borrow pits will be closed and rehabilitated earlier if the resource is exhausted prior to mine closure. Rehabilitation of borrow pits will typically include:

- removal of all infrastructure from site;
- deep ripping of compacted areas;
- placement of any material that was not suitable for construction purposes back into the excavation;
- pit walls will be battered to an appropriate angle to ensure they are safe, stable and suitable for the surrounding landuse;
- previously stockpiled topsoil will be spread over the final landform and disturbed areas; and
- revegetation, seeding and/or planting (depending on the final landuse).

3 Post mining land use

3.1 Regulatory requirements

The guidelines (ESG3) require that the final MOP must identify all regulatory requirements that specifically affect the progress toward the proposed post mining land use. Regulatory requirements specific to land use and rehabilitation are typically found in the mining lease conditions. Once these become available, the MOP for the Balranald Project will be prepared which will address these specific legislative requirements.

Explanatory Note 2 in ESG3 presents the broad aims of rehabilitation and mine closure expected by the NSW Government, including the commitment to Ecologically Sustainable Development (ESD). This report has been prepared (in its conceptual form) to comply with this commitment with full details to be provided in the MOP once approvals are in place.

3.2 Rehabilitation objectives

The overarching primary objectives of the Balranald Project rehabilitation strategy are:

- the creation of safe, stable and non-polluting landforms;
- restoring self-sustaining ecosystems suitable for a final use determined in consultation with landholders and relevant government agencies; and
- progressive rehabilitation of the mine path scheduled to make best use of favourable climatic and intrinsic conditions.

The secondary objectives are to:

- establish a 'base-case' plan that can be reviewed and updated during the life of the project;
- provide relevant information upon which stakeholders can comment and have input through the approval process; and
- ensure that closure planning (including accountability and resourcing) is incorporated into the on-going project operations.

The above objectives are considered consistent with the NSW *Mining Act 1992* and relevant Government guidelines (refer to Section 1.4).

3.3 Land use options following closure

Land use on properties surrounding the actual Balranald Project is primarily agricultural (very low quality grazing), or native vegetation for conservation. Considerations for final land uses would take into account this current land use, any infrastructure to be developed on mine, and the proximity of the mine to existing agricultural industry, residences and general rural type infrastructure.

Final land uses considered include:

1. **Return to grazing:** At present, the Balranald Project is subject to low productive grazing uses due to exclusion fencing, the previous disturbances and poor quality of the existing vegetation, reflecting the generally low quality of the soil and semi-arid climate. Nevertheless, reinstatement of vegetation types that are compatible with rural uses (notably saltbush) is an option for rehabilitation. However, due to the inherently poor condition of the country, grazing pressure would need to be maintained at very low levels once a suitable cover had been established, especially given current grazing pressures by kangaroos and feral goats (which are a regional land management issue).

2. **Industry development including waste disposal:** Given the proposed status as a mining operation, some form of industrial development could be developed however the mine is too isolated and services too poor to enable a viable concern to become established. This use has thus been removed from further consideration.

3. **Conservation:** There are no areas within or in close proximity to the Balranald Project that are considered worthy of statutory conservation protection in their current condition. While rehabilitation measures will aim to re-establish a viable native ecosystem, the outcome (in terms of overall extent) is unlikely to be of significant statutory conservation interest or value.

4. **Tourism:** On the closure of the Balranald Project, the mine is unlikely to be of any interest to tourists travelling in the general region. However, the constraints of isolation of the mine from other support services, general security issues and the availability of other examples of mining in the region preclude this option from further consideration.

Based on the above assessment, it is considered that establishment of conditions that have native vegetation communities suitable for intermittent and low intensity grazing uses is the preferred land use option. However, most areas are unlikely to be suitable for any form of grazing until such time that a successful and sustainable coverage of vegetative rehabilitation has been achieved.

3.4 Final landform design

It is the intent to replicate the original landform as much as possible. The landform design for the West Balranald and Nepean mines will be modified compared to the pre-mining surface. Areas disturbed for the construction of other infrastructure including injection borefields, stockpile footprints (where not used for backfill), access roads and accommodation facility will generally be the subject of superficial disturbance. Consequently, the objective for these areas will be to reinstate the pre-mining contours and drainage.

The most significant variation in the post-mining landform compared to pre-mining conditions will be the rehabilitated mine pits. However, as addressed below, these landforms will be compatible with the surrounding environment.

3.5 Domain selection

As defined in ESG3, a domain is defined as a land management unit within the Balranald Project, usually with similar geophysical characteristics. It is the responsibility of the proponent to determine the most appropriate domains (based on the list provided in Table 4 in ESG3) after considering the specific requirements of location and environment.

In accordance with ESG3, the process of identifying domains has been broken into three steps, ie:

1. identification of mining domains according to the way an area of land is managed in a mining context;

2. identification of primary (operational) mining domains. These are management units within the Balranald Project with a unique operational and functional purpose; and

3. identification of secondary (post mining land use) domains. These are land management units characterised by a similar post mining land use objective.

The proposed post mining domains will require a different rehabilitation methodology to achieve the intended post-mining land use.

When allocating a primary domain to a parcel of land, ESG3 requires that an assessment is undertaken in terms of:

- the purpose of the parcel of land;

- the activities taking place eg earthmoving, storage of water, handling of a raw product; and

- the risks associated with the area eg storage of hazardous material, management of vegetation etc.

For allocating a secondary domain to a parcel of land, an assessment is required in terms of:

- residual risk;

- the ongoing land use post mining eg what activities will take place on the mine in 10 years time; and

- the maintenance activities required.

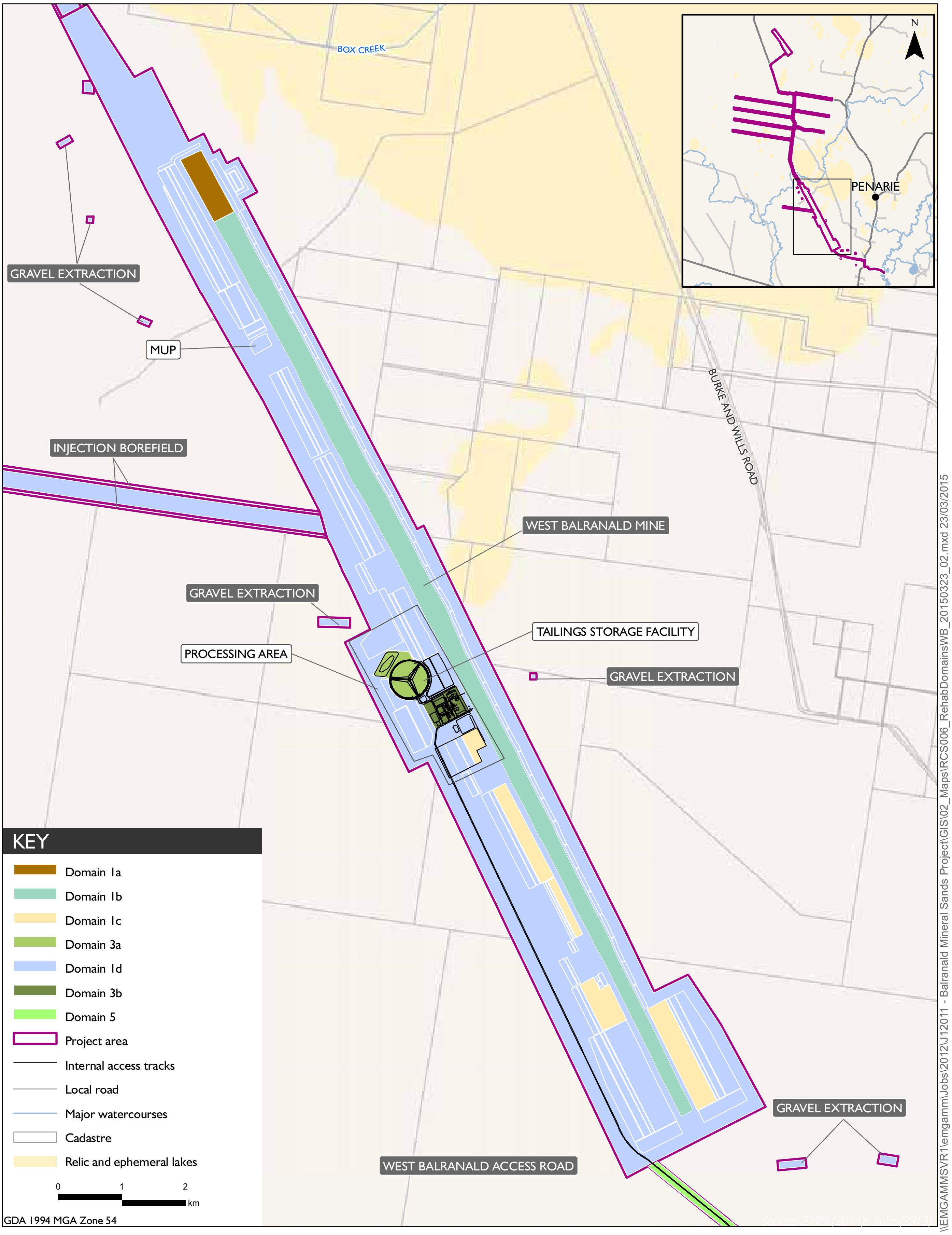
The seven proposed primary domains and secondary domains and their respective areas in terms of operational impact area, as also described in Section 2.2, and final landform area are listed in Table 3.1 and shown (as Secondary Domains) for both the West Balranald and Nepean mine areas on Figure 3.1 and Figure 3.2 respectively.

Table 3.1 Primary and secondary domains and final land use

Domain Number	Domain (Primary)	Description of uses	Area (ha)	Secondary Domain	Secondary Domain Description	Area (ha)	Pre-mining Land Use	Final land use
1	West Balranald Mining Area	Mine path/mine void, associated access roads, stockpiles, dewatering infrastructure	2,987	1a:Final Void	Final pit battered to 1:10 plus associated runoff controls and public/stock access protection	40	Grazing on pasture and shrublands	Chenopod shrublands- not grazed (fenced) until stable
				1b: Mine path - backfilled	Backfilled pit- subject to ongoing consolidation – residual depression	506	Grazing on pasture and shrublands	Grazing on chenopod shrublands Native woody vegetation
				1c: NSOB stockpiles	Final rehabilitated stockpiles #1 to #5	151	Grazing on pasture and shrublands	Grazing on chenopod shrublands Native woody vegetation
				1d:Residual mine area (external to pit)	Access pathways/service roads, former stockpile site footprints	2,290	Grazing on pasture and shrublands	Grazing on chenopod shrublands Native woody vegetation
2	Nepean Mining Area	Mine path, associated access roads, dewatering infrastructure	804	2a:Final mine path backfilled including residual depression	Backfilled pit- subject to ongoing consolidation	136	Grazing on pasture and shrublands	Grazing on chenopod shrublands Native woody vegetation
				2b:Residual mine area (external to pit)-	Access pathways/service roads, former stockpile footprints	668	Grazing on pasture and shrublands	Grazing on chenopod shrublands
3	West Balranald Processing/Infrastr ucture Area	Central processing plant, tailings storage facility, maintenance areas / workshops, final product stockpiles and truck load-out area, administration offices and amenities, top soil and other material stockpiles, internal road network and ancillary infrastructure	71	3a: TSF	Capped TSF and associated main collection dam	26	Grazing on pasture and shrublands	Grazing on chenopod shrublands (refer text)
				3b: Other infrastructure	Concentrator and all other infrastructure	45	Grazing on pasture and shrublands	Grazing on chenopod shrublands

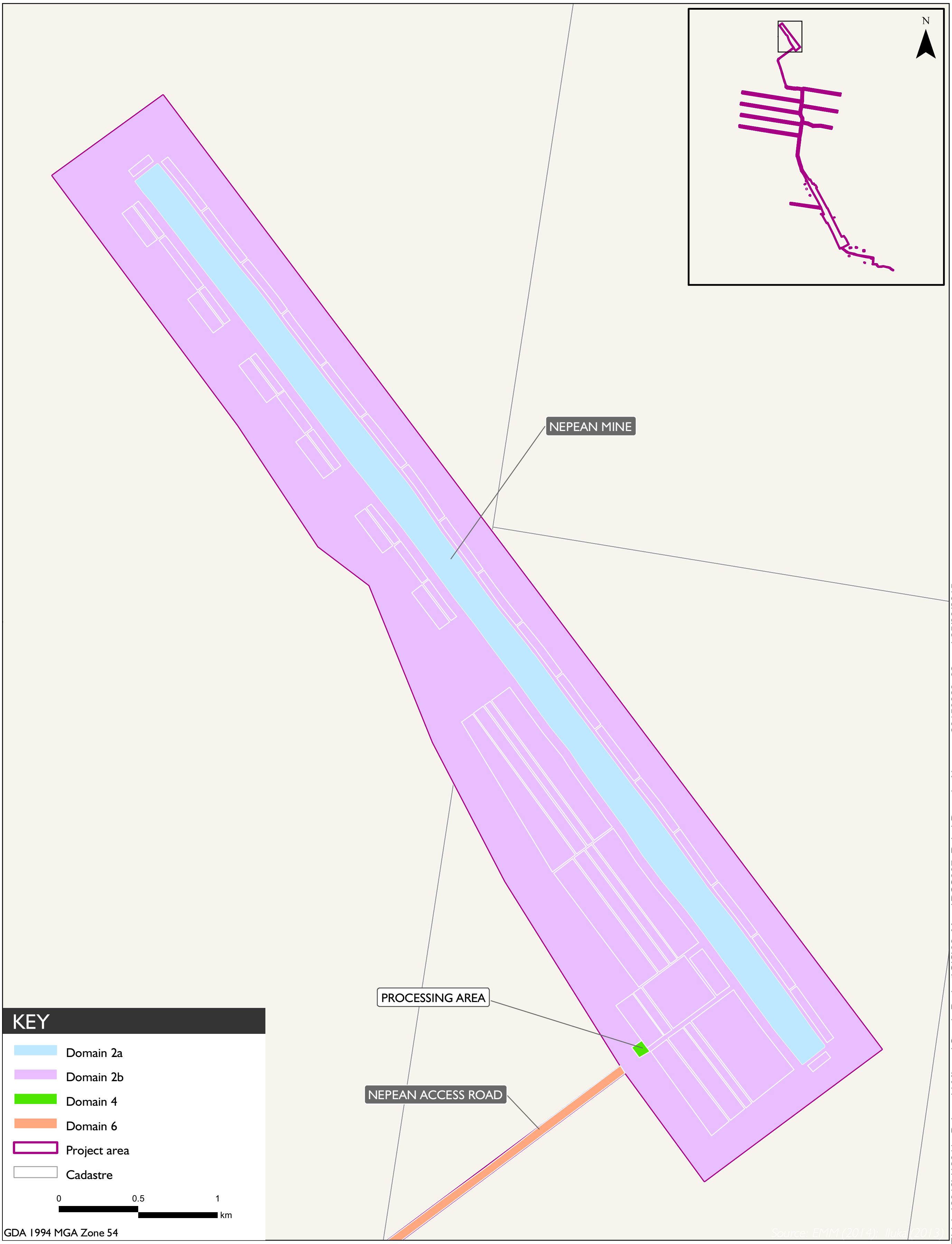
Table 3.1 Primary and secondary domains and final land use

Domain Number	Domain (Primary)	Description of uses	Area (ha)	Secondary Domain	Secondary Domain Description	Area (ha)	Pre-mining Land Use	Final land use
4	Nepean Infrastructure Area	Maintenance areas / workshops, truck load-out area, offices and amenities, top soil and other material stockpiles, internal road network and ancillary infrastructure	0.62	n/a	n/a	-	Grazing on pasture and shrublands	Grazing on chenopod shrublands Native woody vegetation
5	West Balranald Access Road	Access road	72	n/a	n/a	-	Grazing on pasture and shrublands	Grazing on chenopod shrublands or access road left in place
6	Nepean Access Road	Access Road	15	n/a	n/a	-	Grazing on pasture and shrublands	Grazing on chenopod shrublands or access road left in place Minor area of native woody vegetation establishment
7	Borefield	Access tracks and borefield infrastructure	1,348	7a:Access Roads and pipelines	n/a	220	Grazing on pasture and shrublands	Grazing on chenopod shrublands. Access road left in place as may be negotiated with landholder
				7b:Borefield infrastructure	n/a	1,215	Grazing on pasture and shrublands	Grazing on chenopod shrublands



Rehabilitation domains - West Balranald

Balranald Mineral Sands Project
Rehabilitation and Closure Strategy
Figure 3.1



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Nepean site layout

Balranald Mineral Sands Project
Rehabilitiation and Closure Strategy
Figure 3.2

3.6 Domain rehabilitation intent

The rehabilitation domain objectives have been based on the rehabilitation objectives for the Balranald Project (Section 3.3) which are applicable to each domain.

The following describes the conceptual final landforms and rehabilitation concepts relevant to each rehabilitation (secondary) domain. Note that because the mining and rehabilitation intents for the West Balranald and Nepean mines are similar, these have been grouped in the descriptions provided below where relevant.

The concepts presented in the following may be refined in the MOP and subsequently over the life of the Balranald Project based on results of rehabilitation trials and research and rehabilitation performance in consultation with relevant government agencies and key stakeholders. A Rehabilitation Management/Closure Plan will be developed as part of the MOP to provide a more detailed description of the proposed measures for each domain provided below.

3.6.1 Final void (Domain 1a)

At the cessation of mining, a final void would remain at the northern extent of the West Balranald mine path footprint. There will be no final void with the Nepean mine as the pit will be backfilled to approximate the original ground level (see Domain 2a).

The final void at the West Balranald mine would be partially backfilled with saline overburden (SOB) and non-saline overburden (NSOB) material pushed down from the void batters and replaced overburden.

The depths of the final void would remain above the pre-mining groundwater table which is estimated to be approximately 16 m bgl at West Balranald mine. A permanent water body would thus not form however significant and/or prolonged rainfall events would likely result in the formation of temporary ponding in the base of this void prior to evaporating or infiltrating to the groundwater table.

Capillary rise is expected to be less than 1 m. The minimum depth to the groundwater table from the floor of the final voids will incorporate a capping layer designed to prevent direct evaporation from the groundwater aquifer.

The surface catchment of the final void would be reduced to the minimum practicable by maximising backfilling and installing a bund around the perimeter. The void batter slopes will be profiled to an angle of 1(V):10(H).

The cover system concept for the re-profiled surface of the backfilled final void would include:

- spreading growth medium material including a layer of stockpiled sub soil and (typically) a 200 mm layer of top soil (gypsum treated if necessary) on top of replaced overburden to support revegetation establishment (depths replaced will depend on the volume stockpiled);
- ripping the growth medium material on the contour using conventional tines (instead of winged tines) to reduce erosion potential; and

- revegetating by direct seeding an initial cover crop to stabilise the growth medium material and hand-planting tube-stock including selected native revegetation species following backfilling of the final void (subject to climatic conditions or water availability).

To maintain the stability of the rehabilitated final void in the long-term, the rehabilitated final void would be fenced to exclude access by livestock. Removal would be considered once a self sustaining cover had been achieved.

3.6.2 Mine path – backfilled (Domains 1b and 2a)

The mine path would be progressively backfilled with overburden as mining advances and would include cells of process waste materials buried at depth.

The rehabilitated mine path will be backfilled to levels similar to pre-mining where possible, however mine scheduling will at times require pit areas to be backfilled above the original surface. Where elevated backfill is necessary, it will be gently contoured into surrounding areas so that it is sympathetic to the regional landscape. The backfilled mine path re-profiled to natural ground surface level would also be deep ripped to ameliorate the effects of compaction and spread with sub soil and top soil (gypsum treated if necessary) and revegetated by direct seeding or hand-planting tube-stock including selected native revegetation species. It is planned that areas of belah woodland, dune Mallee and Sandplain Mallee will be established in each of the rehabilitated mine areas as indicated on Figure 3.1 and Figure 3.2.

Over time, there would be some minor settlement of the final landforms associated with the mine paths; however, this process would be unlikely to affect the stability of the landforms.

The Nepean mine would comprise a depression along the centre of the mine path due to the shortfall in overburden backfill. This depression would be up to 1 m deep and comprise a broad internally draining swale.

3.6.3 Final NSOB stockpiles (Domains 1c)

There will be no SOB stockpiles at the end of the mining program.

NSOB stockpiles will be located off-path within the West Balranald mine. For both mines, the operational NSOB stockpiles will be located immediately to the side of the mine path as shown on Figure 2.3 and Figure 2.4. The NSOB stockpiles would be constructed to a maximum height of approximately 15 m above the natural ground surface and the batters would have an approximate 1(V):7(H) slope or an appropriate alternative determined by slope and erodibility investigations. Slopes may be increased for lower stockpile heights but will not exceed 1(V):5(H).

The remaining NSOB stockpiles #1 to #5 (ie those not returned to the pit as backfill) are shown as Domain 1c on Figure 3.1. The top surface of the NSOB stockpiles would be divided into a series of cells areas surrounded by bunded walls (up to approximately 1 m in height). These catchment areas would contain incident rainfall and prevent surface water runoff from the top surface of the NSOB stockpiles down the batters. This aims to minimise erosion on NSOB stockpile batters and maximise rainfall storage and infiltration and enhance vegetation establishment within the catchment areas.

The cover system concept for the top surface of the final NSOB stockpiles would include:

- spreading growth medium material including a layer of sub soil and top soil (gypsum treated if necessary) on top of replaced overburden to support revegetation establishment (depths to be determined by stockpile volumes);
- ripping the growth medium material using conventional tines to reduce erosion potential; and
- revegetating by direct seeding an initial cover crop to stabilise the growth medium material and then seeding chenopods and other selected native revegetation species following completion of landform construction (subject to climatic conditions or water availability).

The concept for the batters of the NSOB stockpiles would be similar to above and include spreading woody debris salvaged during vegetation clearance activities to stabilise the growth medium material and assist revegetation growth.

A toe drain will be constructed on the downstream face of the NSOB stockpile batters to collect surface water runoff. This will be directed into small evaporation/sediment sumps for containment. As revegetation develops, it is expected that surface water runoff would reduce and the toe drain would eventually become redundant.

3.6.4 Residual mine area (external to pit) (Domains 1d and 2b)

The residual mine areas (comprising mainly former stockpile footprints, service roads and monitoring sites) will be regraded to the original ground level, top soiled and reseeded/replanted as appropriate. Deep ripping is likely to be required for heavily trafficked routes.

3.6.5 Processing area (Domains 3 and 4)

i Processing area (Domain 3a)

The TSF is expected to contain a high percentage of sulfide bearing minerals and will be dominated by clay sized particles once deposition is completed. It is proposed to return the TSF to the pit, buried at depth.

ii Other infrastructure (Domain 3b and 4)

Following dismantling and decommissioning of Infrastructure, the disturbed areas would be deep ripped to ameliorate the effects of compaction as a result of operational activities. The area would then be spread with approximately 200 mm of top soil or sub soil material and gypsum treated if necessary. Revegetation will be primarily by direct seeding or hand-planting tube-stock including selected native revegetation species, being primarily saltbush with a minor area of native woody species.

All groundwater bores (and associated infrastructure) installed during development would be permanently decommissioned (except as otherwise agreed with the landholder and NSW Department of Primary Industries – NSW Office of Water (NOW)) in accordance with the relevant conditions.

As the mine path advances, water management infrastructure (including process water storages and water disposal dams) would be rehabilitated once no longer required.

Decommissioning and rehabilitation of process water storage dams and water disposal dams would include:

- draining and/or decanting the dam;
- pushing in the dam walls and re-profiling the area generally consistent with the surface of the rehabilitated mine path as far as practicable;
- deep ripping the base of the dam to facilitate infiltration and minimise the potential effects of compaction; and
- spreading top soil and sub soil material and revegetating.

General overland flow management within these infrastructure areas will require a coordinated response in terms of final landforms and flow direction. A key rehabilitation objective is to maintain overland flow to minimise disturbance. This would be achieved by:

- re-profiling the area generally consistent with pre-mining topography at the completion of mining;
- ripping the re-profiled surface to minimise the effects of compaction and maximise infiltration following rainfall;
- installing diversion banks/channels (where necessary) to direct overland flow to as close as possible to the original flow path; and
- spreading top soil and sub soil and revegetating by direct seeding or hand-planting tube-stock including selected native revegetation species.

3.6.6 Access roads (Domains 5, 6 and 7a)

Once it had been confirmed that no further use was required for the roads (either for monitoring purposes or by rural landholders), rehabilitation would be achieved by:

- re-profiling the area to be generally consistent with pre-mining topography at the completion of mining;
- ripping the re-profiled surface to minimise the effects of compaction and maximise infiltration following rainfall;
- installing diversion banks/channels (where necessary) to direct overland flow to as close as possible to the original flow path. Care will be required where such roads traversed concentrated flow paths in which case some form of temporary erosion protection may be required at these points; and
- spreading top soil and sub soil and revegetating by direct seeding or hand-planting tube-stock including selected native revegetation species.

3.6.7 Injection borefields (Domain 7b)

Rehabilitation of the borefields will generally comprise:

- removal of the pipelines and re-profiling the pipeline routes and associated access tracks by the means described above; and
- decommissioning the borefield infrastructure including the injection pumps and associated power generation units. Decontamination of any areas of diesel spillage may be required as well as capping of the bores.

Rehabilitation will then be similar to measures described for the access roads.

4 Rehabilitation methods for closure

4.1 Progressive rehabilitation

Section 2.1 presents the indicative progressive rehabilitation timeframe. Iluka is committed to adopting a progressive approach to the rehabilitation of disturbed areas within the domains.

4.1.1 Control of surface water inflow to final void

The control of surface water inflow into the final void is essential for the long term management of water quality within the final void and will also aid in the control of erosion of batter slopes. Surface water has the potential to cause slope deterioration and ultimate failure. Drainage will be directed away from the void batters (wherever possible) through the construction of interceptor channel drains around the perimeter of the final void batters.

4.1.2 Top soil and sub soil reinstatement

Top soil and sub soil will be applied to landforms once they are recontoured and drainage works are complete. Contour or diversion banks with stable discharge points will be constructed to limit slope lengths and control runoff. Collection drains and sedimentation basins will be installed to collect runoff and remove suspended sediment.

Areas identified for top soil or sub soil application will no longer be required for mining activities and must have an identified post-mining land capability and landuse to inform proposed rehabilitation activities. The following matters will be addressed:

- All soil used in rehabilitation (top soil plus replaced sub soil) should be applied to a thickness of at least 700 mm. This provides sufficient depth for ripping, should follow-up maintenance work be required;
- the volume of growth media material available (top soil and sub soil stockpile volumes) will be reconciled with the estimated volume needed for successful rehabilitation for each area;
- scrapers are preferred for the placement procedures, although other methods can be used, with care taken not to unduly compact the growth media;
- top soil and sub soil placement is to commence from the top of slopes or top of sub drainage catchment to minimise erosion damage created by stormwater run-off from bare upslope areas;
- top soil and sub soil placement is to be conducted along the general run of the contour to minimise the incidence of erosion. It will not be placed in the invert of active drainage lines or drainage works;
- prior to seeding, top soil and sub soil may be cross ripped to encourage rainfall infiltration and minimise runoff;
- seeding of vegetation (with species determined by the landform and post-mining land use) will be undertaken soon after top soil and sub soil respreading to establish cover and minimise erosion potential;

- ongoing inspection of rehabilitated areas for declared weeds will be undertaken and weeds controlled via chemical spraying, fire management, grazing management and hygiene management as appropriate; and

- ongoing inspection, monitoring and maintenance of rehabilitation areas in accordance with the Rehabilitation and Closure Plan (to be prepared subsequent to MOP approval) to ensure sediment and erosion control and revegetation success.

i Top soil and sub soil compaction and remediation

Upon decommissioning of infrastructure and hardstand areas at closure, compacted top soil and sub soil will be ripped under dry conditions to break up hard layers and provide a favourable root zone. These areas will be seeded with species appropriate to the identified post-mining land use.

To alleviate any compaction that may have been caused by the movement of heavy machinery, all mined areas may be ripped to aid in reducing compaction of earth. Specifications for ripping will be developed in response to onsite trials, and the ripping requirement will be tailored to suit specific rehabilitation areas.

In areas of native vegetation rehabilitation, the timing of deep ripping can influence seedling regeneration. It has been observed at other mines that deep ripping after top soil and sub soil spreading can reduce plant densities by 40-60% due to burial effects. Therefore, subject to a mine specific evaluation, deep ripping may be implemented after the replacement of sub soil, but prior to replacement of the top soil.

4.1.3 Drainage and erosion control

Restored surfaces will be stabilised as soon as practicable to reduce potential wind erosion and subsequent dust.

Wind erosion represents a greater risk than water erosion of damaging rehabilitation within the Balranald Project. The area is subject to frequent strong south easterly winds during summer, and infrequent strong westerly winds during winter. By contrast, rainfall is very low and infrequent.

All rehabilitation areas and stockpiles will require stabilisation to protect them against the risk of erosion from wind or water. The most effective strategy for stabilisation will be trialled during the early stages of mining, however the options currently being considered include:

- ripping of ground to increase surface roughness and slow wind speed at ground level;
- establish and protect surface and batters of the retained NSOB stockpiles;
- spread of timber as wind breaks to slow wind speed;
- spreading of timber and shrub debris harvested during clearing. This method will only be considered for use on rehabilitation and top soil and sub soil stockpiles;
- application of a commercial stabilising product (eg Gluon) at potentially highly erosive sites; and
- establish a cover crop. Native chenopod species are considered the most likely to be suitable as their seed is readily available and they germinate with little water.

Drainage zones will not receive special erosion control treatments due to the infrequency of rainfall and subsequent flow events. Sediment movement associated with stream flow is a natural phenomenon in the region, however if excessive sediment movement occurs then supplementary earthworks will be undertaken to return the drainage channels to design levels. This may include the application of rock armouring.

4.1.4 Revegetation

Disturbed areas will be revegetated predominantly from the top soil seed store. Direct seedling, planted seedlings and transplanting of seedlings will be introduced into the revegetation program if considered necessary, after assessment of rehabilitation germination success.

Revegetation practices are expected to evolve over the life of the Balranald Project, as part of the process of continual improvement. If required, seedlings shall be propagated from seed, cuttings or tissue culture. Fertiliser will be applied at an appropriate rate with seed-mixes to increase the likelihood of initial revegetation success. The species to be planted as seedlings will include (based on current propagation and recruitment knowledge) species sourced from the following list:

Table 4.1 Potential species for rehabilitation

Plant Community	Tree Layer	Shrub layer	Ground layer
Spinifex Dune Mallee Woodland (Plant Community 1)	***Eucalyptus dumosa***	***Maireana pentatropis***	***Triodia scariosa***
	E. socialis	*M. brevifolia*	***Austrostipa scabra***
	E. gracilis	*M. appressa*	*A. nodosa*
	E. leptophylla	*M. pyramidata*	***Lachnagrostis filiformis***
	E. oleosa	*M. astrotricha*	***Sclerolaena diacantha***
	E. costata	*M. erioclada*	***S. brachyptera***
	Callitris verrucosa	***Senna artemisioides***	***S. parviflora***
	Santalum acuminatum	***Dodonaea viscosa* subsp. *angustissima***	***Zygophyllum apiculatum***
		D. bursariifolia	*Z. angustifolium*
		Westringia rigida	***Halgania cyanea***
		Grevillea huegelii	***Ptilotus seminudus***
		Olearia muelleri	***Vittadinia dissecta* var. *hirta***
		O. pimeleoides	*V. pterochaeta* ***Lomandra effusa***
		Myoporum platycarpum	***L. collina***
		Atriplex semibaccata	***Schoenus subaphyllus***
		A. eardleyae	*Goodenia willisiana*
		Rhagodia spinescens	*Daucus glochidiatus*
		Chenopodium curvispicatum	*Dissocarpus paradoxus*
			Enchylaena tomentosa
			Xerochrysum bracteatum
			Helichrysum leucopsideum
			Schoenus subaphyllus
			Thysanotus baueri

Table 4.1 Potential species for rehabilitation

Plant Community	Tree Layer	Shrub layer	Ground layer
Chenopod Sandplain/Swale Mallee Woodland (Plant Community 2)	***Eucalyptus dumosa***	***Maireana pyramidata***	***Sclerolaena brachyptera***
	E. oleosa	***M. sedifolia***	***S. diacantha***
	E. gracilis	***M. pentatropis***	*S. divaricata*
	E. socialis	*M. brevifolia*	*S. parviflora*
	Exocarpos aphyllus	***Enchylaena tomentosa***	***Dissocarpus paradoxus***
	Myoporum platycarpum	***Atriplex nummularia***	***Austrostipa scabra***
	Duboisia hopwoodii	***A. vesicaria***	***A. elegantissima***
		A. semibaccata	*A. nodosa*
		A. eardleyae	*Rytidosperma setacea*
		A. stipitata	***Eragrostis dielsii***
		Chenopodium curvispicatum	***Vittadinia pterochaeta***
		C. desertorum	***Einadia nutans***
		Geijera parviflora	***Zygophyllum apiculatum***
		Nitraria billardierei	***Z. angustifolium***
			Actinobole uliginosum
			Sarcozona praecox
			Xerochrysum bracteatum
			Ptilotus seminudus
Belah – Pearl Bluebush Woodland (Plant Community 7)	***Casuarina pauper***	***Maireana sedifolia***	***Zygophyllum apiculatum***
		M. pyramidata	***Sclerolaena brachyptera***
		M. pentatropis	*S. diacantha*
		Atriplex vesicaria	***Dissocarpus paradoxus***
		A. nummularia	***Einadia nutans***
		Enchylaena tomentosa	***Austrostipa scabra***
		Chenopodium desertorum	***A. elegantissima***
		Olearia muelleri	***Rytidosperma caespitosa***
		Nitraria billardierei	***Tetragonia tetragonioides***
		Eremophila longifolia	***Vittadinia pterochaeta***
		Rhodanthe floribunda	***Bulbine semibarbata***
			Teucrium racemosum

Notes: Bold: Dominant species.

The target species for nursery propagation and method of planting will subject to ongoing trials. Options for planting that will be considered include:

- planting conventional stock from cell trays;
- planting advanced plants with deep roots grown in “Carrol tree tubes”. The use of deep rooted seedlings may increase their chances of survival; and
- use of tree guards to protect plants from desiccation and damage from windblown sand particles.

Tube stock is expected to be used only in strategic landscape planting in certain domains where native woody vegetation is to be established. Large areas will be seeded by direct seeding methods if mine conditions allow, and may require the purchase of bulk seed mixes. Seedlings will generally be planted during the early winter period. This will allow the seedlings to establish under conditions of low evaporative stress and a higher likelihood of receiving rainfall.

Species selected will encourage the re-establishment of the pre-agricultural vegetation communities in those areas defined for woody vegetation establishment (refer Figure 3.1 and Figure 3.2) and, in the medium to longer term, create habitat and corridors for native fauna. All areas identified for shrublands chenopod re-establishment will have stock excluded until it can be demonstrated that the vegetation is stable and self-sustaining, and that grazing will not impact upon its establishment.

4.1.5 Brush/ timber spreading

Revegetation will include the spreading of brush and timber across the rehabilitated land, focussing on those areas where woody native vegetation is to be established. This mulch is beneficial in reducing wind erosion, 'kick-starting' ecosystem processes and providing habitat and protection for small mammals and invertebrates.

Subject to availability of material, the timber and or mulch will be spread thick enough to provide the desired benefits, but not so thick as to inhibit germination of seed.

Mulch will be spread following top soil replacement. Methods for spreading the understorey brush will be trialled and refined as rehabilitation progresses. Initially it is expected that the brush will be spread over the top soil using a rake attachment on a front-end loader.

Larger stockpiled timber may also be utilised to develop fauna habitat.

4.1.6 Rehabilitation and post-closure maintenance

Rehabilitated areas will be assessed against performance indicators (refer Chapter 5) and regularly inspected for the following key aspects:

- evidence of any erosion or sedimentation;
- success of initial establishment cover and seeding/plantings;
- natural regeneration of native species;
- weed infestation (primarily noxious weeds, but also where rehabilitation areas are dominated by other weeds);
- integrity of graded banks, diversion drains, waterways and sediment control structures; and
- general stability of the rehabilitation areas.

Where rehabilitation criteria have not been met, maintenance works will be undertaken. This may include the following:

- re-seeding and, where necessary, re-top soiling and/or the application of specialised treatments;
- use of materials such as composted mulch to areas with poor vegetation establishment;

- installation of tree guards around planted seedlings or construction of temporary fencing suitable for excluding native and feral fauna species should grazing and browsing by animals be excessive;
- replacement of drainage controls if they are found to be inadequate for their intended purpose, or compromised by vegetation or wildlife; and
- de-silting or repair of sediment control structures.

4.1.7 Weed management

The presence of weed species has the potential to have a major impact on revegetation and regeneration outcomes. Additionally, any significant weed species within the surrounding land has the potential to impact on the biodiversity value of the rehabilitated areas. Weed management will be a critical component of rehabilitation activities.

Weeds will be managed across the Balranald Project through a series of control measures, including:

- hosing down equipment in an approved wash down area before entry to the project area;
- herbicide spraying or scalping weeds from top soil stockpiles prior to re-spreading top soil;
- rehabilitation inspections to identify potential weed infestations; and
- identifying and spraying existing weed populations together with ongoing weed spraying over the life of the mine.

The spread of declared noxious weeds will be managed by using the measures above. Records will be maintained of weed infestations and control programs will be implemented according to industry best management practice for the weed species concerned.

4.1.8 Feral species management

A feral animal control strategy will be implemented to contain the spread of weeds and other detrimental impacts on rehabilitation areas by feral animals.

4.1.9 Infill planting seeding

Rehabilitated areas may be planted and/or seeded opportunistically to take advantage of infrequent rainfall events. Monitoring of rehabilitation will identify any areas of low plant recruitment to be targeted for such supplementary seeding/planting programs.

4.1.10 Fire control

Developing vegetation within the revegetation areas will not be able to withstand fire for many years. Prior to the completion of mining, Iluka will consult with the appropriate agencies to ensure appropriate fire control strategies are developed.

4.1.11 Access

Access tracks will need to be required to facilitate the revegetation and ongoing maintenance of the mine. These tracks will be kept to a practical minimum and will be designated prior to the completion of mining in consultation with agencies.

4.1.12 Public safety

Controls will be implemented in the Balranald project to minimise the potential for impacts on public safety, this may include maintenance of fencing around those sections of the final void or any graded areas that have the potential to cause harm and are that are accessible to the public. Measures will include:

- suitable signs, clearly stating the risk to public safety and prohibiting public access, will be erected at intervals along the entire length of the fence;
- a physical barrier will be constructed at a safe distance from the perimeter of the final void until reshaping is completed. A trench and berm will be constructed in such a way that will physically stop most vehicles; and
- surface runoff from land surrounding the final void will be diverted so as to prevent any potential development of slope erosion.

4.2 Rehabilitation Schedule

The progressive formation of the post-mining landform and the establishment of a vegetative cover will vary throughout the operation of the Balranald Project due to the annual disturbance areas and the availability of land for rehabilitation once mining activities have ceased. A progressive rehabilitation schedule over the planned 15 year mine life will be continually reviewed and revised as required.

Table 4.2 presents a proposed progressive rehabilitation schedule over the planned 15 year mine life. Figure 4.1, Figure 4.2 and Figure 4.3 provide an indicative plan of the extent of progressive rehabilitation works at certain intervals at the West Balranald Mine and Figure 4.4 provides indicative plans of progressive rehabilitation at the Nepean mine following commencement.

Table 4.2 Indicative rehabilitation schedule

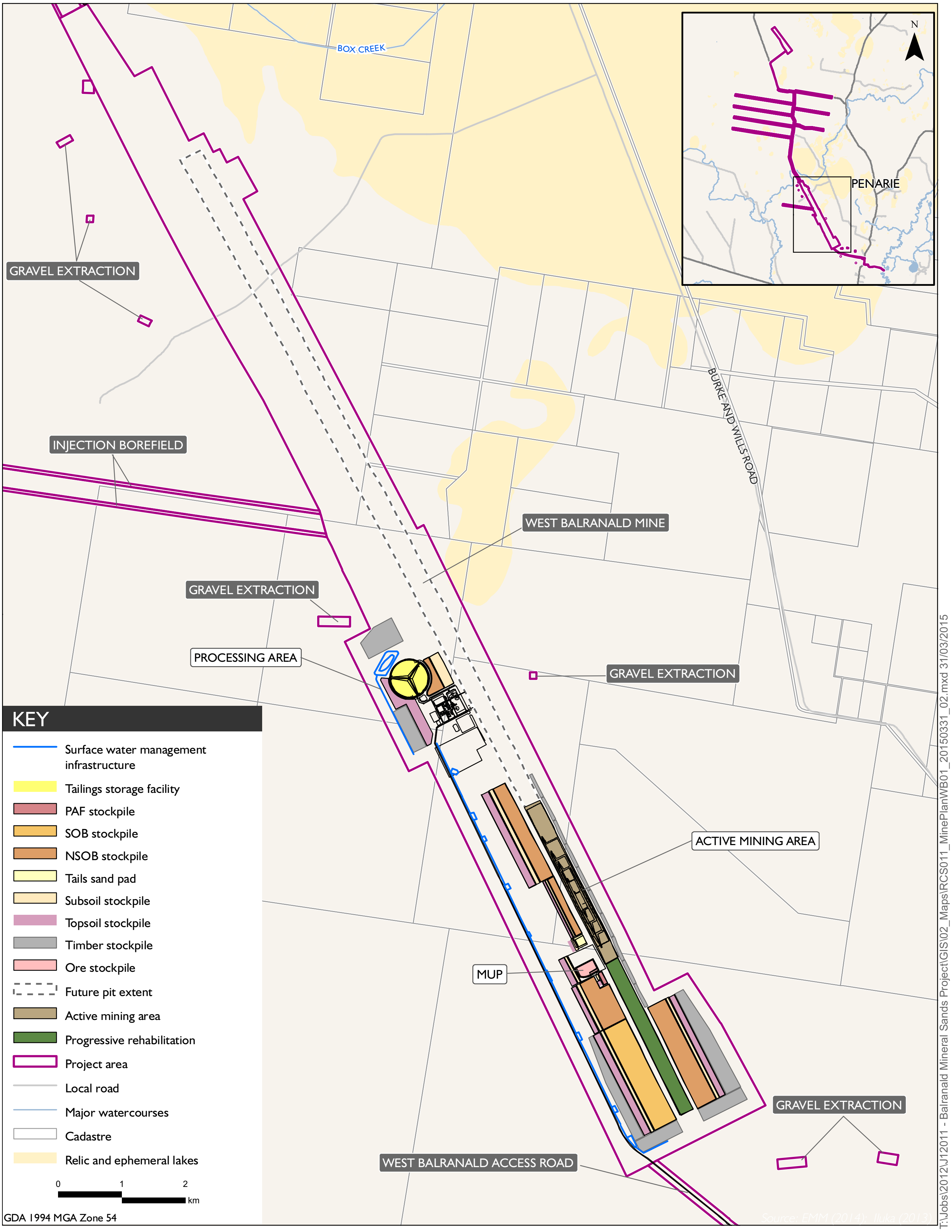
Domain	Activity	Year beginning 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1a	West Balranald Final Void															
1b	WB mine path backfilled															
1c	NSOB Stockpiles															
1d	Residual mine area															
2a	Nepean mine path															
2b	Nepean residual mine area															
3a	TSF															
3b	Other infrastructure															
4	Nepean Infrastructure															
5, 6 and 7	Access and Borefield															

Progressive backfilling and stockpiling

Infrastructure removal, final bulk earthworks, reshaping, grading, top soiling (where appropriate)

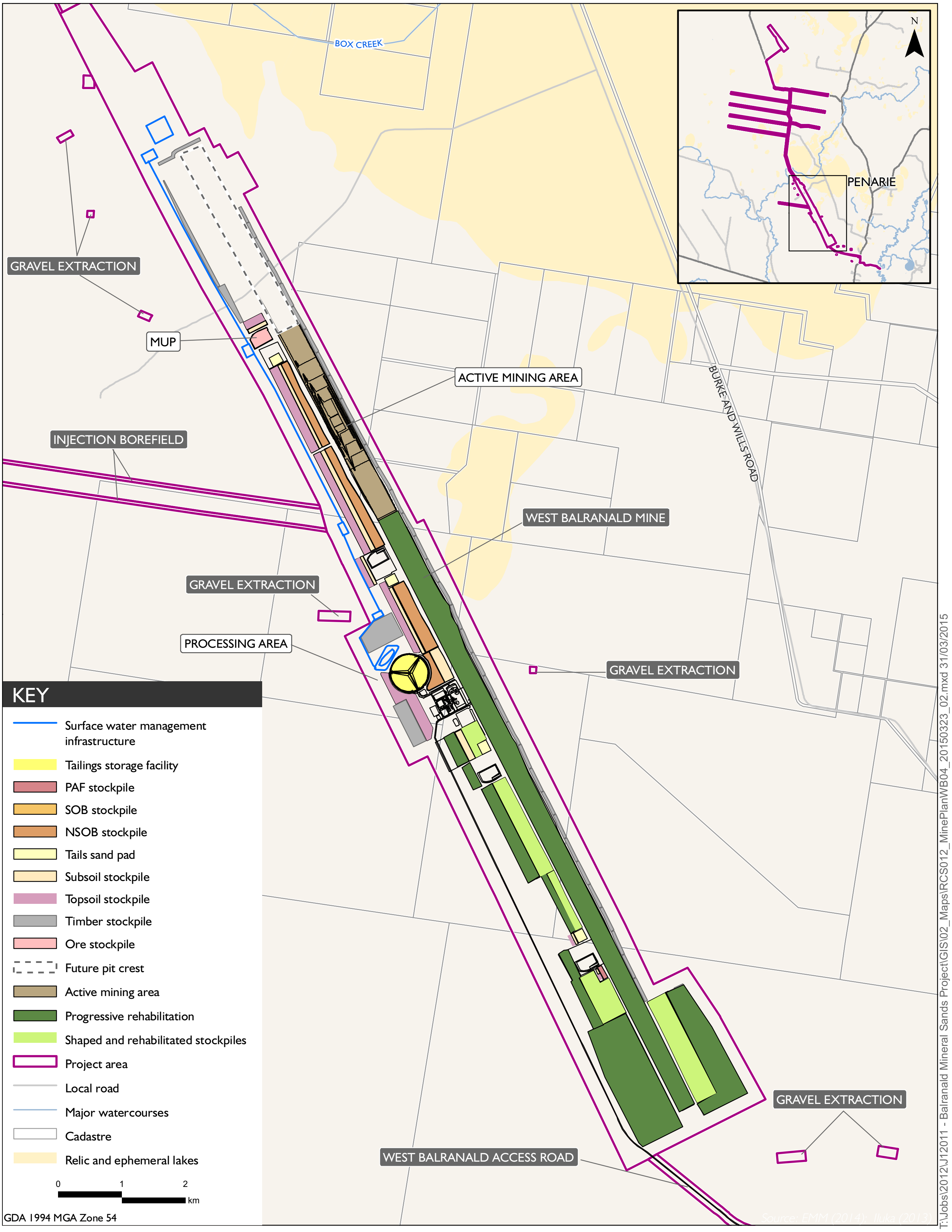
vegetation establishment

rehabilitation management and monitoring (min 2 years)



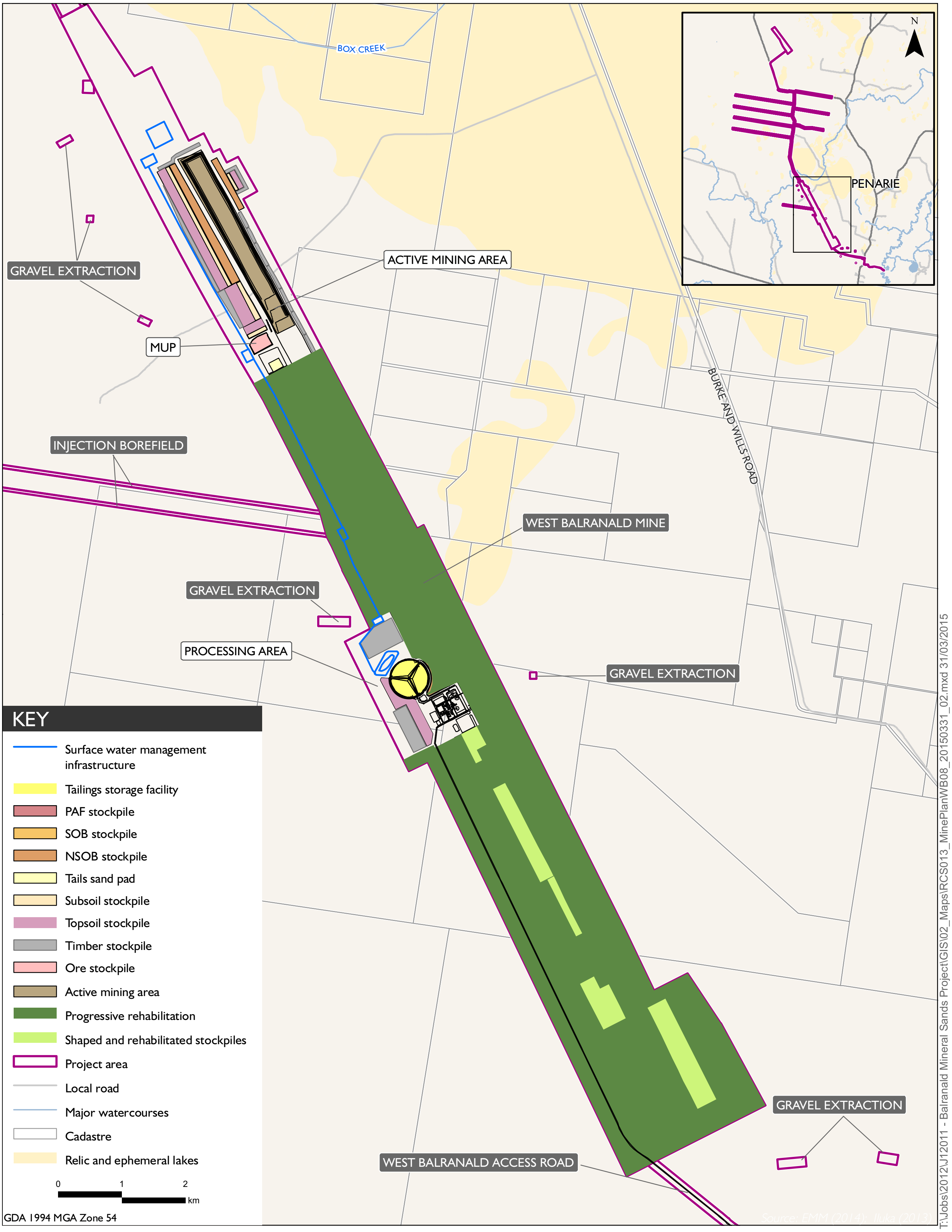
Planned rehabilittion for West Balranald Mine - Year 1

Balranald Mineral Sands Project
Rehabilitation and Closure Strategy
Figure 4.1



Planned rehabilitation for West Balranald Mine - Year 4

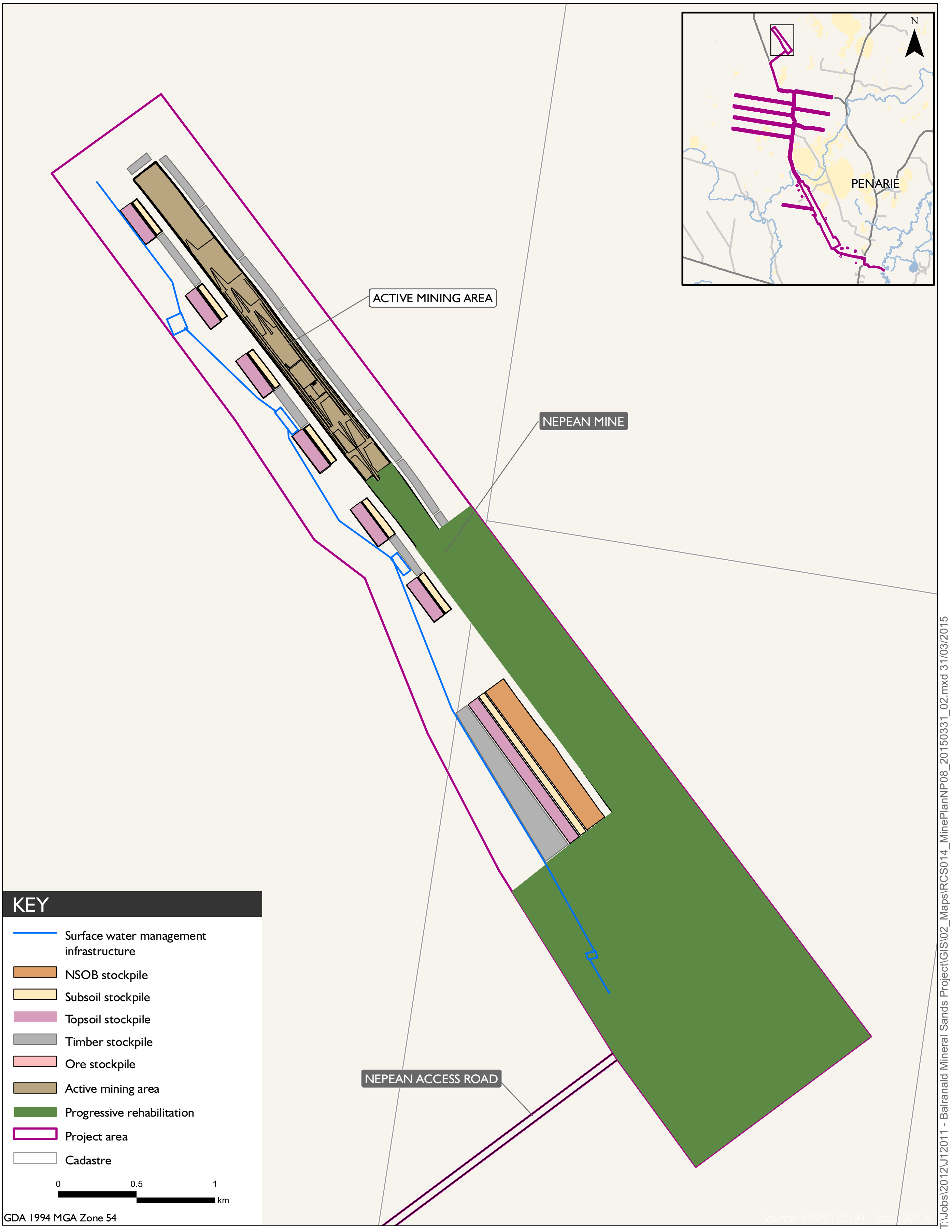
Balranald Mineral Sands Project
Rehabilitation and Closure Strategy
Figure 4.2



EMM
ILUKA

Planned rehabilitation for West Balranald Mine - Year 8

Balranald Mineral Sands Project
Rehabilitation and Closure Strategy
Figure 4.3



EMM
ILUKA

Planned rehabilitation for Nepean Mine - Year 8

Balranald Mineral Sands Project
Rehabilitation and Closure Strategy
Figure 4.4

4.3 Rehabilitation resources

4.3.1 Professional advice and services

Numerous qualified professionals have contributed to the development of this *Rehabilitation and Closure Strategy*. This professional support will continue throughout the mining and rehabilitation process. Other professionals will be resourced as required.

4.3.2 Staff

Dedicated Iluka environmental and rehabilitation staff will ensure specific management requirements arising from this report are adhered to. Roles may include:

- operations staff - Rehabilitation Advisor, Environmental Specialist & Advisor, Environmental Technician, Rehabilitation Officer;
- consulting rehabilitation professionals;
- Iluka Closure Manager; and
- operational staff.

Earth moving operations will be performed by machinery operators with experience and skill in the operation of the relevant machinery (scrapers, loaders, excavators etc). Mine Supervisors will ensure these operators comply with the requirements of the Rehabilitation and Closure Plan.

The Mine Manager will be responsible for achieving the rehabilitation criteria.

5 Performance indicators and completion/relinquishment criteria

5.1 Rehabilitation criteria and reporting

Rehabilitation criteria will be used as the basis for assessing when rehabilitation of the Balranald Project is complete.

Interim rehabilitation criteria have been developed with the current knowledge of rehabilitation practices and success in similar project environments. They have been based largely on Iluka and other companies experience elsewhere in Australia. They consist of a set of objectives; rehabilitation criteria and evidence that criteria have been met.

Whether rehabilitation criteria have been met depends on the trending of measurements over time compared to pre-mining or analogue conditions.

The rehabilitation criteria will be subject to periodic formal review in consultation with relevant stakeholders. Amendments to the rehabilitation criteria will be subject to regulatory approval.

The rehabilitation criteria need to demonstrate that the rehabilitation objective has been achieved. Consequently, interim rehabilitation criteria are presented in Table 5.1 that address the following outcomes:

- restoration of a safe and stable landform;
- reinstate topsoil and subsoil profile and function and ensure that landforms are compatible with surrounding topography;
- the post mining ecosystem and landscape function is resilient, self sustaining and indicating that the pre-mining ecosystem and landscape function will ultimately be achieved. Due to the semi-arid environment, development of vegetation may take many years. Consequently, the proposed rehabilitation criteria, when considered in conjunction with criteria for top soil and sub soil and landform, are intended to indicate a trend where the revegetation will ultimately reach a level that is compatible with the surrounding environment; and
- the restored landform permits land uses of grazing and/or conservation with no adverse impacts on native fauna.

Reporting on rehabilitation activities, monitoring and progress towards achieving agreed rehabilitation criteria will occur via an Annual Environmental Management Report (AEMR).

Table 5.1 Interim rehabilitation criteria for the Balranald Project

Objective	Rehabilitation criteria	Evidence
Public safety		
Ensure that land is physically safe for people to access	(C1) Mine related hazards have been removed from the landscape	Audit/inspection by regulatory authorities and landholders
Landform stability		
Ensure that landforms are compatible with surrounding topography	(C3) Landform shape and slopes are compatible with surrounding topography. (C4) No slope > 10 % variance from agreed landform design (C5) Drainage channels/main flow pathways re-established and pre mining catchment flows are restored (C6) Erosion rates comparable with pre-mining landscape as top soil and sub soil and vegetation re-establishes	Post closure survey of landform shape and slope Survey channel profiles (pre and post mining) Comparison of surface erosion features with surrounding geomorphologic features, as measured by Landscape Function Analysis techniques (refer later)
Ecosystem reestablishment		
Pre existing top soil and sub soil profile and function are reinstated	(C7) Post mining top soil and sub soil profile and function are established in reference to original conditions (C8) Rainfall infiltration and top soil and sub soil moisture comparable to analogue sites (C9) Salt migration into 'clean' top soils is restricted (C10) Post mining surface soil function is re-established and is comparable with analogue sites	Placement details and thickness of overburden infill/backfill, top soil and/or sub soil, tailings, capillary break (if required) and clean soil horizons Sample overburden and top soil and sub soil to assess top soil and sub soil moisture and salt levels Surface soil function as measured by Landscape Function Analysis techniques or similar(refer later)
The post mining ecosystem and landscape function is resilient, self sustaining and indicating that the pre-mining ecosystem and landscape function will ultimately be achieved (Habitat reestablishment)	(C11) Placement of leaf litter and logs comparable to analogue sites	Post rehabilitation inspection
The post mining ecosystem and landscape function is resilient, self sustaining and indicating that the pre-mining ecosystem and landscape function will ultimately be achieved.	(C12) Within rehabilitation areas in secondary domains, projected foliage cover of rehabilitated overstorey species reaches an agreed percentage~ compared to analogue sites occurring within a representative Landscape-Vegetation Unit	Annual Vegetation Monitoring Report
No net adverse impacts from operations on native fauna in lease area and adjacent areas	(C13) Vegetation strata identified at analogue sites occur within the rehabilitation area. (C14) Fauna recovery at closure (at control sites) to be consistent with baseline data and indicating positive trends (as per the Biodiverstiy Management Plan or MOP - not proposing to have a Fauna Management Plan)	Annual Monitoring Report Post rehabilitation inspection

Throughout the life of the Balranald Project, these rehabilitation criteria will be refined based on the results of ongoing rehabilitation monitoring and as such may be amended as future research advances.

Further detail on specific rehabilitation criteria will be provided in the MOP.

5.2 Rehabilitation monitoring and research

5.2.1 Rehabilitation monitoring

Regular monitoring of the rehabilitated areas will be required during the initial vegetation establishment period and beyond to demonstrate whether the objectives of the closure and rehabilitation strategy (as amended for the MOP) are being achieved and whether a sustainable and stable landform has been provided. Monitoring will be conducted periodically by suitably skilled and qualified persons at locations which will be representative of the range of conditions on the rehabilitating areas. Regular reviews of monitoring data will be undertaken to assess trends and monitoring program effectiveness.

In addition to the rehabilitated areas, reference/analogue sites will be established and monitored to allow a comparison of the development and success of the rehabilitation against a target control site. Reference sites will indicate the condition of surrounding undisturbed areas for (primarily) chenopod shrubland rehabilitation and nearby land currently utilised for rural production.

Rehabilitation methods will be improved as additional knowledge develops from monitoring data collected through these programs.

The following provides an overview of monitoring proposed for the different issue areas.

i Landform and soils

a. Landform survey

Prior to disturbance and after restoration of the landform, the disturbed areas will be surveyed using LiDAR or alternative methods, and a map produced showing detailed contour intervals. Monitoring points will also be established to enable long term assessment of land stability or settling, particularly for the backfilled areas of the mine paths.

b. Landform function analysis

Landscape Function Analysis (LFA) is a proven technique that has been used in the semiarid rangelands for many years for monitoring landscape damage and recovery (Ludwig et al 1997). Iluka will assess the suitability of LFA to monitor rehabilitation monitoring at Balranald.

LFA may be used as a tool to assess the long term sustainability of the rehabilitated landforms. The assessment consists of two steps:

- **Landscape stratification:** a continuous data set is collected along transects oriented down the slope (the dominant direction of resource mobility), with identification and measurement of zones where landscape resources are either shedding (source) or accumulating (sink).

- **Soil surface condition classification:** landscape zones are assessed by ten soil surface features (Table 5.2) as per criteria outlined in Tongway and Hindley (1995).

Table 5.2 soil surface conditions assessed using LFA

Indicator	Interpretation
Soil cover	Assesses vulnerability to rain splash erosion.
Basal cover of perennial plants	Assesses contribution of below-ground organs to nutrient cycling processes.
Litter cover, origin and degree of decomposition	Assesses the availability of surface organic matter for decomposition and nutrient cycling.
Cryptogam cover	An indicator of surface stability, resistance to erosion and nutrient availability.
Crust brokenness	Assesses loose crusted material available for wind ablation or water erosion.
Erosion features	Assesses the nature and severity of current soil erosion features.
Deposited materials	Recognises mobile soil deposits.
Microtopography	Assesses surface roughness for water infiltration and flow disruption, seed lodgement.
Surface resistance to erosion	Assesses likelihood of soil detachment and mobilisation by mechanical disturbance.
Slake test	Assesses soil stability/depressiveness when wet.

The assessment will allow the derivation of indices for soil stability, soil infiltration capacity and nutrient cycling. Monitoring of these indices facilitates the observation of trends that may indicate whether the landform function is sustainable (accumulating resources) or likely to fail (losing resources). Other rehabilitation monitoring tools will be considered as identified.

c. Soil profile assessment

In the first year of rehabilitation, preliminary soil pits may be excavated to allow early confirmation of the soil profile and identification of any limiting factors such as compaction. Early identification of such factors will allow remedial activities such as ripping to be performed in a timely manner.

The final post-mining assessment of the rehabilitated soil profile will be performed by a suitably experienced soil scientist. This assessment will not be performed until several years after establishment of the native vegetation. This timing is so that plant root distribution through the profile may be assessed.

Assessment of the post-mining soil profile will utilise similar methods to the pre-mining soil survey. Pits or auger holes will be excavated until the tailings, overburden backfill, or natural ground, is encountered. The soil profile will be recorded, with all soil horizons described and their location within the profile measured. Similar physical and chemical parameters assessed in the pre-mining survey will be reassessed within each soil horizon.

The results of the soils assessment will be presented to the regulatory authorities in a final Post-Mining Soils Assessment Report.

ii Vegetation and flora

Rehabilitated vegetation will be monitored annually in the first three years following rehabilitation, subject to review observed vegetation growth rates. Subsequent monitoring is likely to be decreased to lower intervals. These intervals will be determined in consultation with rehabilitation specialists. An Annual Vegetation Monitoring Report will be provided to DRE, in years when monitoring is required.

Control sites will be established to allow comparison of rehabilitation with undisturbed sites under the same seasonal conditions.

The number and location of vegetation monitoring plots for rehabilitated and control sites will be determined in consultation with rehabilitation specialists.

The following techniques will be used:

- **1 Hectare Quadrats:** The quadrat surveys will be carried out using the standard. The survey method will be used to enable an assessment of the composition and cover of flora species within the rehabilitated vegetation. 100 m x 100 m quadrats will be installed at representative sites. Within the quadrat, percentage foliage cover, life stage (ie dormant, flowering, seedling), life form (ie tree, shrub, grass), and the overall vegetation association will be recorded;

- **Jessup Transects:** Jessup transects will be used to record the density of perennial species. Transects will be installed along the middle axis of the 100 m x 100 m quadrat. All perennial species that occur within two metres either side of a 100 m transect will be counted, with established and juvenile plants counted separately; and

- **Photographic Monitoring Points (Photopoints):** Photograph frames will be aligned along the Jessup transects.

5.2.2 Research and continual improvement

Knowledge of appropriate rehabilitation practices required to achieve the rehabilitation objectives is continually growing. Iluka will consult with various experts in the compilation of a detailed research and development plan to investigate key aspects of the rehabilitation process. The following items are an example of issues that have been identified for further investigation as part of the process of continual improvement in rehabilitation standards:

- **review of best practices in arid zone rehabilitation.** A vast pool of knowledge is available from similar projects across Australia that are undertaking arid zone rehabilitation. Iluka will benchmark its current rehabilitation standards against industry best practice;

- **flora propagation strategies.** Further laboratory testing and field trials will be required to maximise the number of species for which effective recruitment strategies are known;

- **strategies for land stabilisation.** Two specific strategies have been identified that will require further research and trialling:

  - the use of cryptogam spores as an additive to water for soil stabilisation; and

  - the use of native species for early stabilisation of rehabilitated land and stockpiles. Trials for those areas where woody native vegetation is proposed to be established (as opposed to chenopod vegetation) will be undertaken in this regard.

- **innovation and refinement of mechanical processes.** A diverse range of machinery is relied on to complete the mining and rehabilitation processes. Iluka will continue to trial new machinery, or new methods of operating existing machinery to improve rehabilitation outcomes. An example of such innovation is the use of tractor driven carry-graders for top soil replacement.

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Appendix A

Preliminary Environmental risk assessment - rehabilitation and closure

A.1.1 Domain-specific approach

A risk assessment relating to the rehabilitation and closure aspects of the project has been undertaken in accordance with the ESG3 Guidelines which state:

> A risk assessment is to be undertaken in accordance with standard risk assessment practices outlined in AS/NZS ISO 31000:2009 Risk Management - Principles & Guidelines. The risk assessment is expected to identify a range of issues or risks that require specific measures to be documented and implemented to mitigate those risks.

A risk based approach has been used to develop the expected environmental outcomes, rehabilitation criteria and environmental monitoring requirements for each domain in the plan. Each domain has been assessed using the risk based approach as follows:

1. Complete a qualitative risk assessment to:

   a) identify unmitigated potential risks of the proposed operations on the environmental values;

   b) identify rehabilitation strategies to ensure the risks to acceptable and/or manageable levels; and

   c) assess the residual risk, assuming the rehabilitation strategies and associated control measures have been implemented;

2. For each identified completion strategy:

   a) determine the control measures/steps to be implemented to achieve the environmental outcomes;

   d) determine the measurable rehabilitation criteria to demonstrate performance against these outcomes;

   e) determine the most appropriate final landform and land use; and

   f) determine the environmental monitoring requirements of the proposed measurable rehabilitation criteria.

Note that rehabilitation criteria are based on either industry standards or guidelines or have been set based on baseline data or mine-specific technical studies where standards and guidelines are not available or not relevant.

It is expected that a more comprehensive risk assessment will be prepared for the MOP once all environmental information has been subjected to agency and other stakeholder scrutiny and the conditions relating to project approval are known.

A.1.2 Qualitative risk assessment methodology

Qualitative risk assessment criteria were developed using the AS/NZS ISO 31000:2009 method. The AS/NZS ISO 31000:2009 method identifies risk profiles through combining the 'likelihood' of a hazard or impact occurring with the 'consequences' of a hazard or impact occurring.

The potential impacts were assessed in terms of their effects on three categories including:

- the natural environment;
- the social environment; and/or
- the economic environment.

Table A.1 presents qualitative measures of likelihood (ie probability) in accordance with AS/NZS ISO 31000:2009.

Table A.1 Qualitative measure of likelihood

Probability Rank	Likelihood	Description
A	Almost certain	Will occur, or is of a continuous nature, or the likelihood is unknown.
B	Likely	Will probably occur during mine lifetime.
C	Possible	Could occur in most mines.
D	Unlikely	Could occur in some mines, but is not expected to occur.
E	Rare	Has almost never occurred in similar mines but conceivably could.

Table A.2 below presents qualitative measures of maximum reasonable consequence.

Table A.2 Qualitative measures of maximum reasonable consequence

Consequence Rank	Consequence	Description
1	Insignificant	Possible impacts but without noticeable consequence.
2	Minor	Very local consequence with no significant long-term changes; may be simply rehabilitated or alleviated at some cost without outside assistance; not of significant concern to wider community.
3	Moderate	Significant local changes, but can be rehabilitated or alleviated with difficulty at significant cost and with outside assistance.
4	Major	Substantial and significant changes; will attract significant public concern; only partially able to be rehabilitated or alleviated. May be doubtful that can be successfully rehabilitated; major costs involved. Changes will be substantial if cumulative effects are considered.
5	Catastrophic	Extreme permanent changes to social or natural environment (not able to be practically or significantly rehabilitated or alleviated); deaths or widespread health and economic effects on public; major public outrage or the consequences are unknown.

The qualitative risk analysis uses descriptive scales to determine the likelihood of each identified hazard and its consequences. This provides an estimate of the likely rate of occurrence of hazardous events and their severity, from which a measure of the risk may be obtained. A risk rating is determined by combining the likelihood of the potentially hazardous event and the magnitude of its consequences. The process of combining the likelihood and consequence gives appropriate weight to the range between small consequence events (which are relatively frequent) and events of major consequence (which are very infrequent).

The risk-ranking matrix adopted for the plan is presented in Table A.3.

Table A.3 Risk ranking matrix

			Likelihood of consequence				
			E	**D**	**C**	**B**	**A**
			Rare	**Unlikely**	**Possible**	**Likely**	**Almost certain**
Severity of consequence	**5**	**Insignificant**	Low	Low	Low	Moderate	High
	4	**Minor**	Low	Low	Moderate	High	High
	3	**Moderate**	Moderate	Moderate	High	High	Extreme
	2	**Major**	High	High	Extreme	Extreme	Extreme
	1	**Catastrophic**	High	Extreme	Extreme	Extreme	Extreme

A.1.3 Structure of domain-specific risk assessment and completion strategies

A discussion of rehabilitation strategies, environmental outcomes and rehabilitation criteria for each domain are presented in the main body of the report and include:

- an overview of current status of the domain including existing environmental values;
- rehabilitation strategies to reduce inherent risk to acceptable residual risks;
- for each identified rehabilitation strategy for each domain, a detailed description of the rehabilitation process and controls, the desired environmental outcomes and associated measurable rehabilitation criteria;
- the final landform and land use; and
- environmental monitoring requirements.

A.1.4 Environmental values and risk to rehabilitation

i Climate

Drought is a common occurrence locally and regionally. Drought may impact on the ability to establish vegetation or conduct an economic agricultural business after mining is finished.

ii Topography

The land on which the Balranald Project will be is comprised gently sloping to level plains (typical slope of <1 to 4%) prior to mining. It is the general intent to replicate this landform for areas that have not undergone major disturbances, such as:

- the process plant area and associated ponds and constructed drainage channels;
- the office, laydown and storage/handling areas; and
- the mine access tracks (where no longer to be used).

Highly disturbed areas of the Balranald Project will include the final void and overburden stockpiles. These domains cannot feasibly be returned to their pre-mining topography. These domains will be re-contoured to create a stable landform or, in the case of the West Balranald pit, retained intact with appropriate exclusion measures.

iii Land use

Existing land uses comprise grazing on unimproved native pasture or intact shrubland. After rehabilitation, the majority of the Balranald Project are proposed to have a predominant final land use of light grazing on unimproved pasture, or native vegetation for conservation where appropriate. Implications for rehabilitation are that the vegetation that is established will have to be palatable and will have to be established at a density suitable for grazing.

iv Flora

Species selected to revegetate the rehabilitation areas, where practicable, will be:

- local to the area;
- aggressive colonisers suitable to a range of soil conditions;
- able to provide good cover and contribute to the landscape function;
- suitable for grazing/pastoral uses (as per overall rehabilitation compliance criterion); and
- available in the quantities required for the project rehabilitation or present in the local area sufficient to result in natural colonisation by wind-blown seed.

The aim is to establish a chenopod shrubland dominated by low bluebush and saltbush suitable for grazing.

v Fauna

Post rehabilitation, there is a possibility that excessive grazing pressure may cause an over-abundance of certain species.

vi Surface water

Water course disruption which can be associated with rehabilitation can include diversion of watercourses and drainage lines leading to an associated flood risk or water quality issues.

vii Hydrogeology

The prevailing salinity in groundwater in proximity to the West Balranald deposit is between 25,000 and 44,000 mg/L. This is highly saline and is commonly in excess of seawater salinity (ie approx 35,000 mg/L). Groundwater in proximity to the Nepean deposit is typically between 15,000 and 33,000 mg/L.

There is unlikely to be an impact on groundwater as a result of rehabilitation. The final void depth at West Balranald will be 52 m while it is planned to back fill the void at Nepean.

Iluka has identified that the final elevation of the West Balranald pit void (at the northern end of the deposit) will be 52 m AHD based on backfilling. The pre mining measured water level in the Shepparton Formation at the void is ~ 48.5 m AHD, and the potentiometric surface of the Loxton-Parilla Sands is ~ 49 m AHD. Backfilling will provide a fill cover of at least 3 m above the pre-mining potentiometric surface and 3.5 m above the pre-mining water table elevation. The pre mining potentiometric surfaces are also likely to be conservative (ie higher) compared to the expected post mining elevations due to the sediment pile stratigraphy being replaced with more homogeneous backfill, with potentially larger porosity.

The modelled groundwater level drawdown at the mine void is between 1.2 m lower than the pre-mining water level after 100 years of recovery (ie post mining). Therefore the depth to water at the final West Balranald void will more likely be 4.7 m below ground level 100 years after mining. Full recovery to pre-mining water level is expected approximately 110 years after mining.

Given the planned final backfill level is approximately 13 m below the initial and surrounding ground surface elevation of approximately 65 m AHD, any rainfall runoff is likely to collect within the remaining depression. This is likely to lead to increased recharge to the water table below the remaining depression and, therefore, slight mounding of the water table at this point. Given the void will overlie an area of reduced groundwater levels this enhanced recharge will assist with the overall predicted timeframe for recovery of groundwater levels in the area.

The maximum volume of water predicated to accumulate in the West Balranald final void is 34 ML (WRM 2015). The final void is predicted to behave in a similar hydrologic manner to the nearby dry lakes and surface depressions. The small volume of runoff expected to collect in the void will either evaporate or will infiltrate through the floor of the void into the Loxton-Parilla Sands. WRM note that between a 1 in 50 and 1 in 100 rainfall event (with ongoing rainfall) the final void would take approximately 5.5 weeks to completely dry out. Under average rainfall conditions the final void would take approximately 2 weeks to dry out.

Although the daily evaporation exceeds the adopted infiltration rate the height of capillary rise in unconsolidated units occurs at depths of less than 0.75 m (most conservative measurement for unconsolidated sediments) (Fetter 1994). Therefore there is enough cover to avoid the creation of an artificial salina, ie the accumulation of salts. The maximum EC of water in the final void is not expected to exceed the existing average EC conditions for the Loxton-Parilla Sands (56 mS/cm).

viii Soils

Soil Resources Assessment (EMM 2015) presents an assessment of soil conditions in the Balranald Project and their suitability for rehabilitation uses. This report presents a summary of the soil suitable for stripping and reuse and recommended stripping depths. In terms of overall soil quality, the following is a summary:

- Hypercalcic Calcarosols are the dominant soil type at both the West Balranald and Nepean mine areas. Red Kandosol is the second most extensive soil type in the Nepean mine area, with Brown Sodosol being the second most common in the West Balranald mine area. Red Dermosol and Grey Vertosol are the least extensive soil types found across the mine areas;
- most soils have very shallow top soils with very low organic matter levels;
- significant levels of carbonates are present, notably in the Calcarosols;
- most soils are moderately to strongly alkaline at depth;
- sodicity and salinity levels are high to extreme in most of the clayey soils (eg Sodosols and Dermosols) but lower in the sandy/loamy soils (eg Kandosols); and
- most soils are poorly drained and highly infertile.

The assessment of the land suitability classification (LSC) for the project and each soil type was done and found that both project areas have been identified as predominantly land suitability class 6 ie *Low capability land: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation.* Assessed land suitability outcomes generally reflect the current and historical uses of the land, being primarily used for low productivity grazing on mainly chenopod (saltbush and bluebush) pasture or uncleared.

In terms of Biophysical Strategic Agricultural Land (BSAL), an assessment has been done in accordance with the OEH (2012) guidelines and it has been found that none of the project area is BSAL.

ix Geochemistry (including acid mine drainage)

The Geochemistry Assessment report by Earth Systems (2015) provides an assessment of the existing geochemical characteristics of the overburden and, ore-body and likely characteristics of the process stream materials. As noted in that report, the environmental impact of each type of material, and the resultant water quality (and therefore implications for rehabilitation and final closure), will be strongly driven by several factors, including:

- the quality of the material placed in the pit (and associated handling and capping where necessary);
- the amount of time material is permitted to react with the atmosphere, notably poorer quality material;
- the rate at which groundwater inundates the pit, thereby limiting further oxidation;
- the rate of groundwater inflow; and
- the rate of outflow from the pit void over time.

The Geochemistry Assessment report by Earth Systems (2015) also presents an assessment of the acid mine drainage risks associated with each of the overburden and ore body types and the proposed means to handle and mitigate these risks in terms of mine rehabilitation. In all cases, where there is the potential for acid mine drainage, placement in the pit and capping with NSOB has been found to be likely to have minimal geochemical impact. Organic overburden (OOB) may continue to acidify following placement into the pit.

A.2 Domain risk assessment

Domains listed below have been derived as described in this report. Each of these domains (called Primary domains), where relevant, have been broken into secondary domains depending on the final land use intent. The risk assessment presented in Table A.4 has been modified from the MOP Guidelines.

Table A.4 Risk assessment

Rehabilitation /closure Issue	DOMAIN OF RELEVANCE	Land preparation, vegetation and top soil stripping	All construction activities incl. earthmoving	Mine Development and Mining, surface and underground	Use/maintenance of roads, tracks, equipment	Waste Rock emplacement management	Mineral processing facilities and infrastructure	Ore/product stockpiling and handling	Tailings impoundment and management	Water management including stormwater event contingencies	Hazardous materials and fuel, handling/spill management	Rubbish Disposal	Rehabilitation activities	Rehabilitated land and remaining features
Erosion/sediment minimisation	1 TO 7	L	L	L	L	L	L	L	L	M	VL	N	L	L
Surface water pollution	1,2,3,4	L	L	L	VL	L	L	L	VL	L	VL	VL	L	VL
Groundwater pollution	1,2,3,	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	N	N
Contaminated or polluted land	1,2,3,4,7	VL	VL	VL	VL	VL	VL	VL	L	VL	VL	N	N	N
Threatened flora protection	1 TO 7	VL	VL	N	N	N	N	N	N	N	N	N	N	N
Weed control and management	1 TO 7	L	VL	VL	VL	VL	N	N	N	VL	N	N	L	M
Aboriginal Heritage	1 TO 7	VL	VL	N	N	N	N	N	N	N	N	N	N	N
Bushfire	1 TO 7	VL	VL	N	N	N	N	N	N	N	N	N	VL	N
Mine subsidence	1,2	N	N	N	N	N	N	N	N	N	N	N	L	L
Hydrocarbon contamination	1,2,3,4,7	VL	VL	VL	VL	VL	VL	VL	N	N	N	VL	N	N
Public safety	1,2	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL

Notes: Risk Categories: N= negligible or not relevant; VL= very low; L= low; M= Moderate; H = high; E- Extreme. (note that the Low category previously presented in the risk Ranking Matrix has been divided into negligible, very low and low in the above table, given that many issues are of limited relevance to the project.

Appendix B

Sub soil and overburden geochemistry

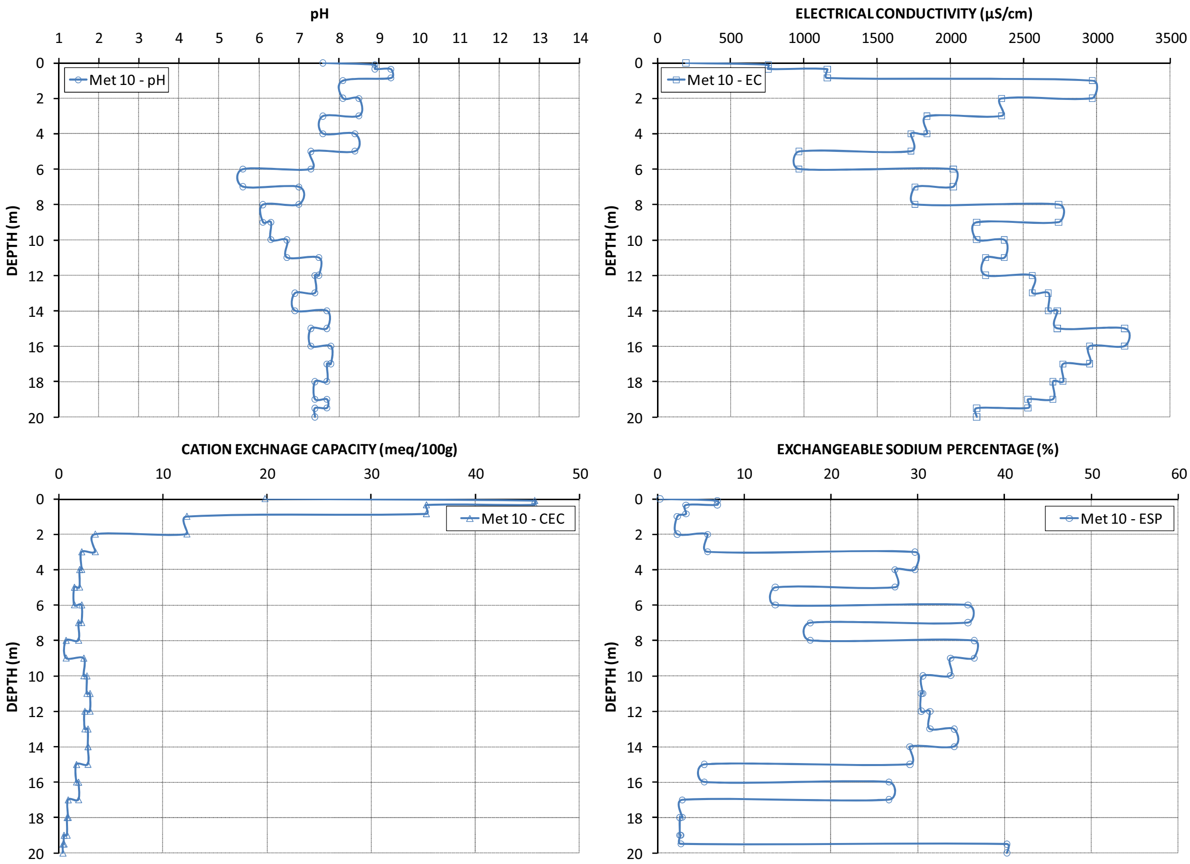


Figure B.1 Met10: sub soil and overburden geochemistry

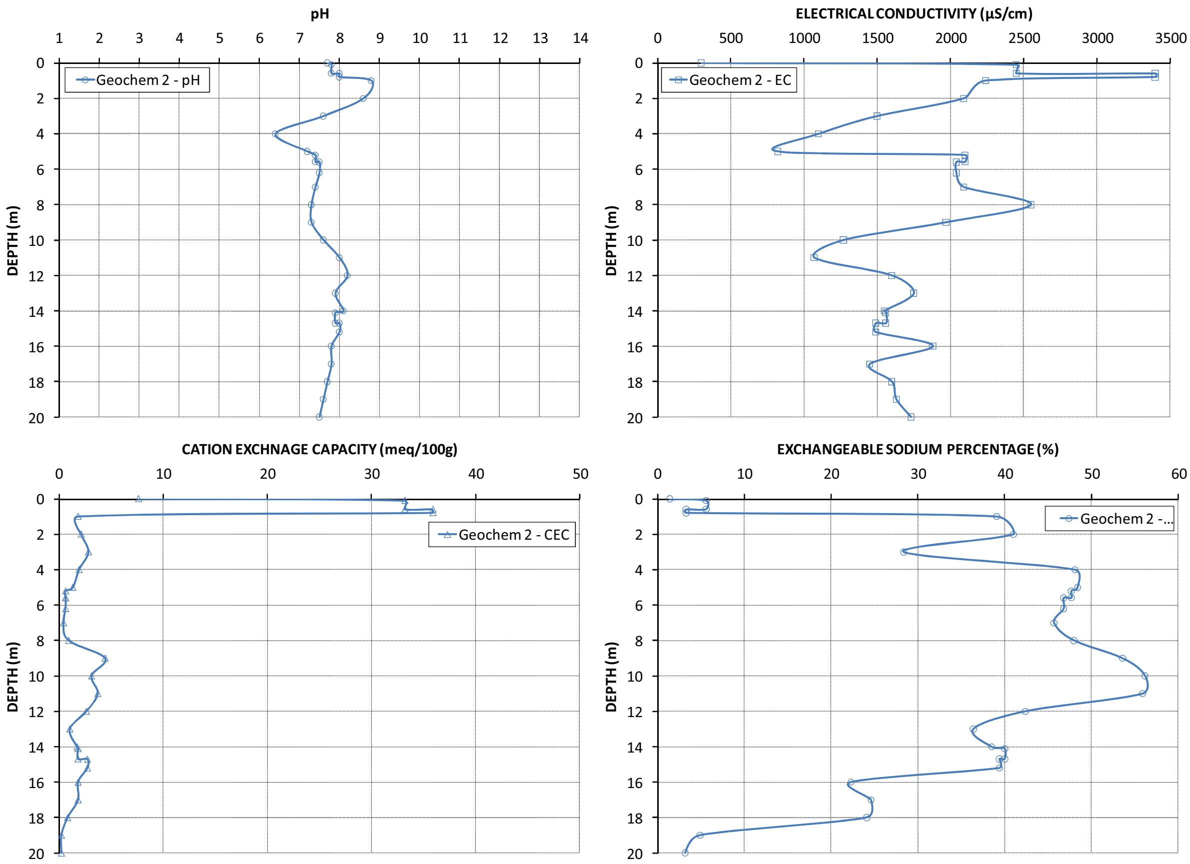


Figure B.2 Geochem 2: Met10: sub soil and overburden geochemistry

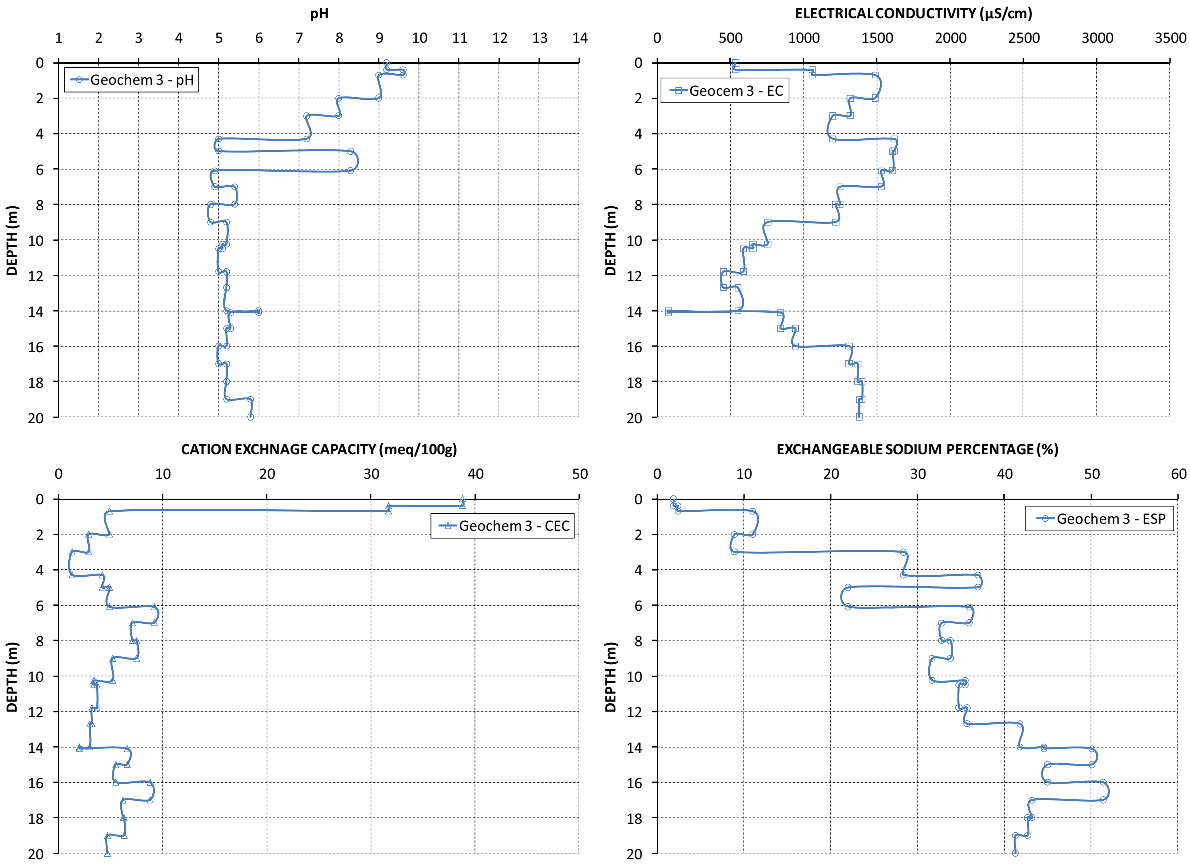
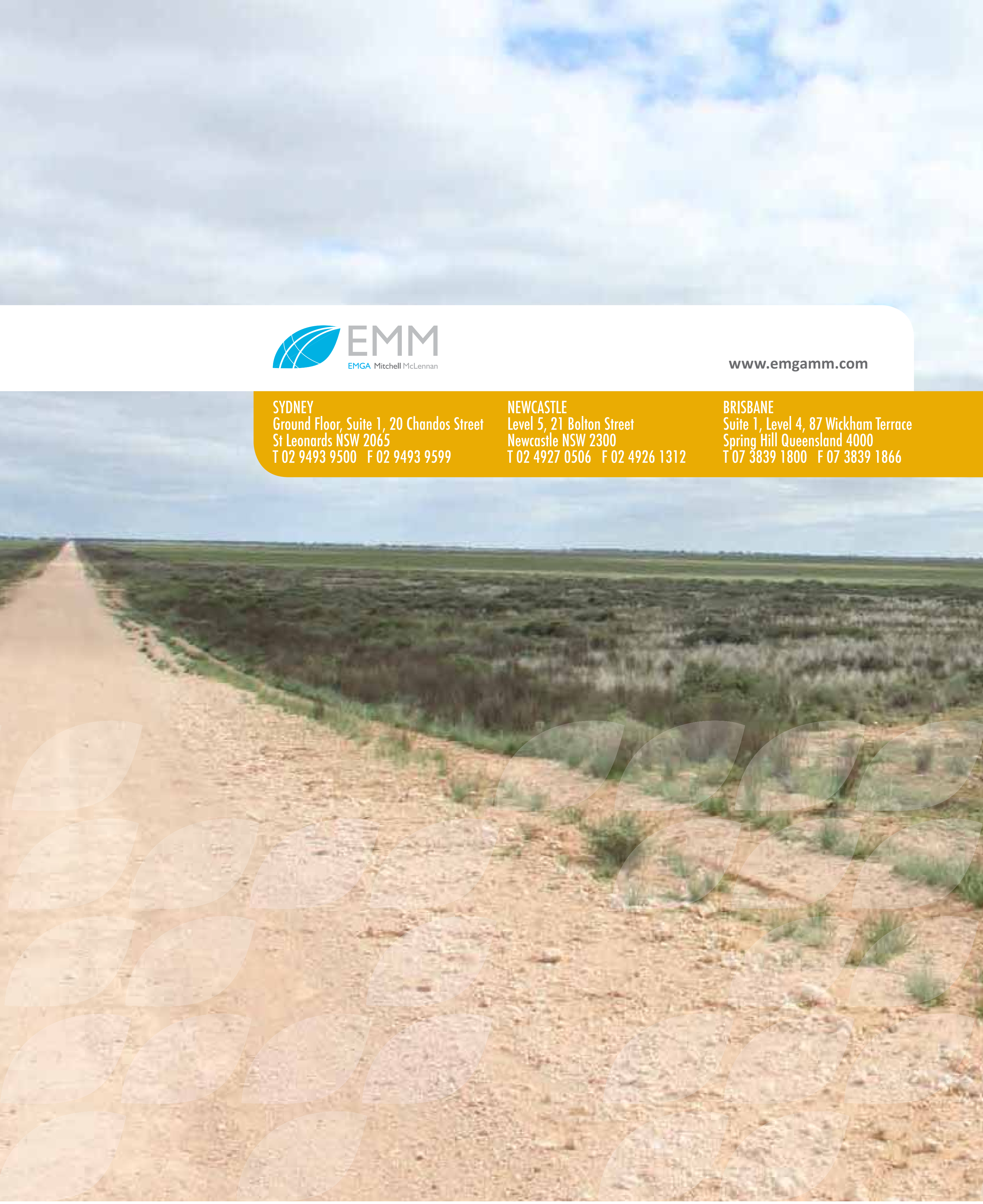


Figure B.3 Geochem 3: sub soil and overburden geochemistry



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