TRONOX

Cooljarloo Mine including Cooljarloo West: Mine Closure Plan

Rev 0.1

November 2015

Tenements M268SA, M701314, M70/1333 (pending), Mineral Field 70

Tronox Management Pty Ltd on behalf of Tronox Western Australia and Yalgoo Minerals

PO Box 31, Dandaragan WA 6507

Cooljarloo Mine (including Cooljarloo West) Mine Closure Plan

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CHECKLIST WITH CORPORATE ENDORSEMENT

Q No	Mine Closure Plan (MCP) checklist	Y/N/NA	Page No.	Comments	Changes from previous version (Y/N)	Page No.	Summary
1	Has the Checklist been endorsed by a senior representative within the tenement holder/operating company? (See bottom of checklist.)	Y	vii		Y		
Public Availability							
2	Are you aware that from 2015 all MCPs will be made publicly available?	Y					
3	Is there any information in this MCP that should not be publicly available?	N					
4	If "Yes" to Q3, has confidential information been submitted in a separate document/section?	N/A					
Cover Page, Table of Contents							
5	Does the MCP cover page include: • Project Title • Company Name • Contact Details (including telephone numbers and email addresses) • Document ID and version number • Date of submission (needs to match the date of this checklist)	Y	Cover		Y	Cover	Change in key contact
Scope and Purpose							
6	State why the MCP is submitted (e.g. as part of a Mining Proposal, a reviewed MCP or to fulfil other legal requirements)	Y	1		Y	1	As part of EP Act 1986 PIV assessment Cooljarloo West Project (EPA Assessment 1974).
Project Overview							
7	Does the project summary include: • Land ownership details (include any land management agency responsible for the land / reserve and the purpose for which the land / reserve [including surrounding land] is being managed) • Location of the project; • Comprehensive site plan(s); • Background information on the history and status of the project.	Y	1-16		Y	1-16	Included tenements and activities relating to the Cooljarloo West project (M70/1314 and MLA70/1333). Updated status of the Cooljarloo Project.
Legal Obligations and Commitments							
8	Does the MCP include a consolidated summary or register of closure obligations and commitments?	Y	19-21		Y	19-21	Added Permit to Take for *A gracilis*
Stakeholder Engagement							
9	Have all stakeholders involved in closure been identified?	Y	22-23		Y	22-23	Minor changes to format and wording
10	Does the MCP include a summary or register of historic stakeholder engagement with details on who has been consulted and the outcomes?	Y	24		Y	24	Updated to include recent consultation for Cooljarloo and associated with Cooljarloo West

Q No	Mine Closure Plan (MCP) checklist	Y/N/NA	Page No.	Comments	Changes from previous version (Y/N)	Page No.	Summary
11	Does the MCP include a stakeholder consultation strategy to be implemented in the future?	Y	25		N		
Post-mining land use(s) and Closure Objectives							
12	Does the MCP include agreed post-mining land use(s), closure objectives and conceptual landform design diagram?	Y	26		N		
13	Does the MCP identify all potential (or pre-existing) environmental legacies, which may restrict the post mining land use (including contaminated sites)?	Y	77-78		N		
14	Has any soil or groundwater contamination that occurred, or is suspected to have occurred, during the operation of the mine, been reported to DER as required under the Contaminated Sites Act 2003?	Y	90-92		N		
Development of Completion Criteria							
15	Does the MCP include an appropriate set of specific completion criteria and closure performance indicators?	Y	29-41		N		
Collection and Analysis of Closure Data							
16	Does the MCP include baseline data (including pre-mining studies and environmental data)?	Y	42-73		Y		Included reference information for Cooljarloo west Project area
17	Has materials characterisation been carried out consistent with applicable standards and guidelines (e.g. GARD Guide)?	Y	43-53	Ongoing	Y		
18	Does the MCP identify applicable closure learnings from benchmarking against other comparable mine sites?	Y	N/A		N		
19	Does the MCP identify all key issues impacting mine closure objectives and outcomes (including potential contamination impacts)?	Y	74-80		N		
20	Does the MCP include information relevant to mine closure for each domain or feature?	Y	84-89		Y		*Domain extended to include Cooljarloo west*
Identification and Management of Closure Issues							
21	Does the MCP include a gap analysis/risk assessment to determine if further information is required in relation to closure of each domain or feature?	Y	74-80, 84-89		N		
22	Does the MCP include the process, methodology, and has the rationale been provided to justify identification and management of the issues?	Y	74-80		N		
Closure Implementation							
23	Does the MCP include a summary of closure implementation strategies and activities for the proposed operations or for the whole site?	Y	84-89		Y		Updated to include Cooljarloo West Project and align with contemporary mine plan

Q No	Mine Closure Plan (MCP) checklist	Y/N/NA	Page No.	Comments	Changes from previous version (Y/N)	Page No.	Summary
24	Does the MCP include a closure work program for each domain or feature?	Y	86-96		Y		Additional items (infrastructure) included for Landfill Domain.
25	Does the MCP contain site layout plans to clearly show each type of disturbance as defined in Schedule 1 of the MRF Regulations?	N/A		MRF regulations do not apply to the State Agreement Mining Lease.			
26	Does the MCP contain a schedule of research and trial activities?	Y	App 3		Y	App 3	Updated the status of various items
27	Does the MCP contain a schedule of progressive rehabilitation activities?	Y	93-96		Y	93-96	Updated to include Cooljarloo West and align with mine plan as at end 2014
28	Does the MCP include details of how unexpected closure and care and maintenance will be handled?	Y	79-80		N		
29	Does the MCP contain a schedule of decommissioning activities?	Y	83		N		
30	Does the MCP contain a schedule of closure performance monitoring and maintenance activities?	Y	99-100		N		
Closure Monitoring and Maintenance							
31	Does the MCP contain a framework, including methodology, quality control and remedial strategy for closure performance monitoring including post-closure monitoring and maintenance?	Y	99-100		N		
Financial Provisioning for Closure							
32	Does the MCP include costing methodology, assumptions and financial provision to resource closure implementation and monitoring?	Y	103-104		N		
33	Does the MCP include a process for regular review of the financial provision?	Y	103-104		N		
Management of Information and Data							
34	Does the MCP contain a description of management strategies including systems and processes for the retention of mine records?	Y	102		N		

Corporate Endorsement:

I hereby certify that to the best of my knowledge, the information within this Mine Closure Plan and checklist is true and correct and addresses all the requirements of the Guidelines for the Preparation of a Mine Closure Plan approved by the Director General of the Department of Mines and Petroleum.

Name: Russell Austin **Signed**: _____

Position: General Manager Tronox Australia **Date**: 01/12/2015

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Figures

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1 SCOPE AND PURPOSE

1.1 Purpose of this document

The purpose of this document, the Cooljarloo Mine including Cooljarloo West Closure Plan (MCP), is to define the management framework and key steps required to enable the Cooljarloo Mineral Sands Mine Site (Cooljarloo and Cooljarloo West) to be closed, the land rehabilitated and mining lease relinquished.

This version of the MCP specifically supports the environmental assessment and approval process for the proposed Cooljarloo West Titanium Minerals Project (Cooljarloo West). Cooljarloo West is an extension of the existing Cooljarloo mining operations to mine mineral reserves located in tenements west of the existing mining activities at Cooljarloo (refer to Section 2.2). It is being assessed in accordance with Part IV of the Environmental Protection Act 1986 at a Public Environmental Review (EPA assessment 1978).

The Environmental Scoping Document for the assessment required a Mine Closure Plan to be included with the PER. As the Proposal will be approved as a Revised Proposal, amalgamating the various conditions for the existing operations with any conditions required for the Cooljarloo West project, this MCP addresses both the existing and proposed mining activities.

This MCP updates and expands the mine closure plan already in place for the existing Cooljarloo Mine (Tronox 2013) to address the Cooljarloo West area and proposed activities.

1.2 Scope of this document

This MCP covers the Cooljarloo operations contained within tenement M268SA granted pursuant to the *Mineral Sands (Cooljarloo) Mining and Processing State Agreement Act 1988* (SAA) and the proposed Cooljarloo West extension contained within M268SA and the following Mining Act 1978 tenements M70/1314, M70 1333 (pending grant).

This MCP may only be approved on approval of the Cooljarloo West project by relevant authorities, in accordance with the Environmental Protection Act 1988, Mining Act 1978, and Mineral Sands (Cooljarloo) Mining and Mineral Processing State Agreement Act 1988. Until such time as this occurs the existing Cooljarloo Mine Closure Plan (Tronox 2013 or approved revision) remains in force. The next review of the existing MCP is due in 2017.

This Plan covers the time period from its approval until the Mining Leases are relinquished. The MCP therefore focuses on the actions required to take the site from its current condition, to the condition required to enable tenement relinquishment.

Within this document unless otherwise stated "Cooljarloo" refers to both the existing Cooljarloo Mine and Cooljarloo West. Where it is necessary to refer to each area individually the "existing Cooljarloo Mine" and "Cooljarloo West" are used.

2 PROJECT SUMMARY

2.1 Project Location

The Cooljarloo Mineral Sands Mine is located approximately 170 km north of Perth, 12 km north of Cataby in Western Australia, Figure 1. The site is located to the west of the Brand Highway within the shire of Dandaragan.

Tronox has processing operations at Muchea and Kwinana, where further downstream processing of the Heavy Mineral Concentrate (HMC) is undertaken. Material storage and transport facilities are located at Henderson and Bunbury Port.

2.2 Land Tenure

The locations covered by the MCP are shown in Figure 2. These comprise:

The existing Cooljarloo Mine operates within SAA Mining Lease M268SA. The lease is approximately 9,744 ha, comprising of the Tronox owned Mullering Farm (1,035 ha), two freehold lots (45 ha and 13 ha) owned by local stakeholders and the remainder being Unallocated Crown Land (UCL) (8,651 ha).

The Cooljarloo West mining area which is principally located within Mine Act 1978 lease M70/1314 and M70/1333 (pending grant). Both are exclusively unallocated Crown land. Cooljarloo West also overlaps with M268SA.

Unallocated Crown Land is vested in the Department of Regional Development and Lands (DRDL) with the environmental aspects of land management being the responsibility of the Department of Parks and Wildlife.

The tenements are operated by Tronox Management Pty Ltd on behalf of equal share partners Tronox Western Australia Pty Ltd and Yalgoo Minerals Pty Ltd. All companies are wholly owned subsidiaries of Tronox Limited. The Cooljarloo Operations reside at the Cooljarloo Mine, Brandy Highway, Cataby WA 6507.

2.3 Mining Operations Overview

Mining at Cooljarloo is undertaken using dry mining methods (Figure 3) to access the upper to mid ore-bodies and dredge mining (Figure 4) to access lower grade ore deeper in the profile. The following sections describe key mining, rehabilitation and process waste disposal aspects at Cooljarloo.

2.3.1 Mining Operations

A description of both mining operations is provided in Table 1. In this table some of the processes are similar and therefore grouped, however both mines are discrete units and have no overlapping processing aspects. The mines do at times overlap in disturbance footprint and share some common supporting services such as power, water supply, and tailings facilities.

Figure 1: Location Map

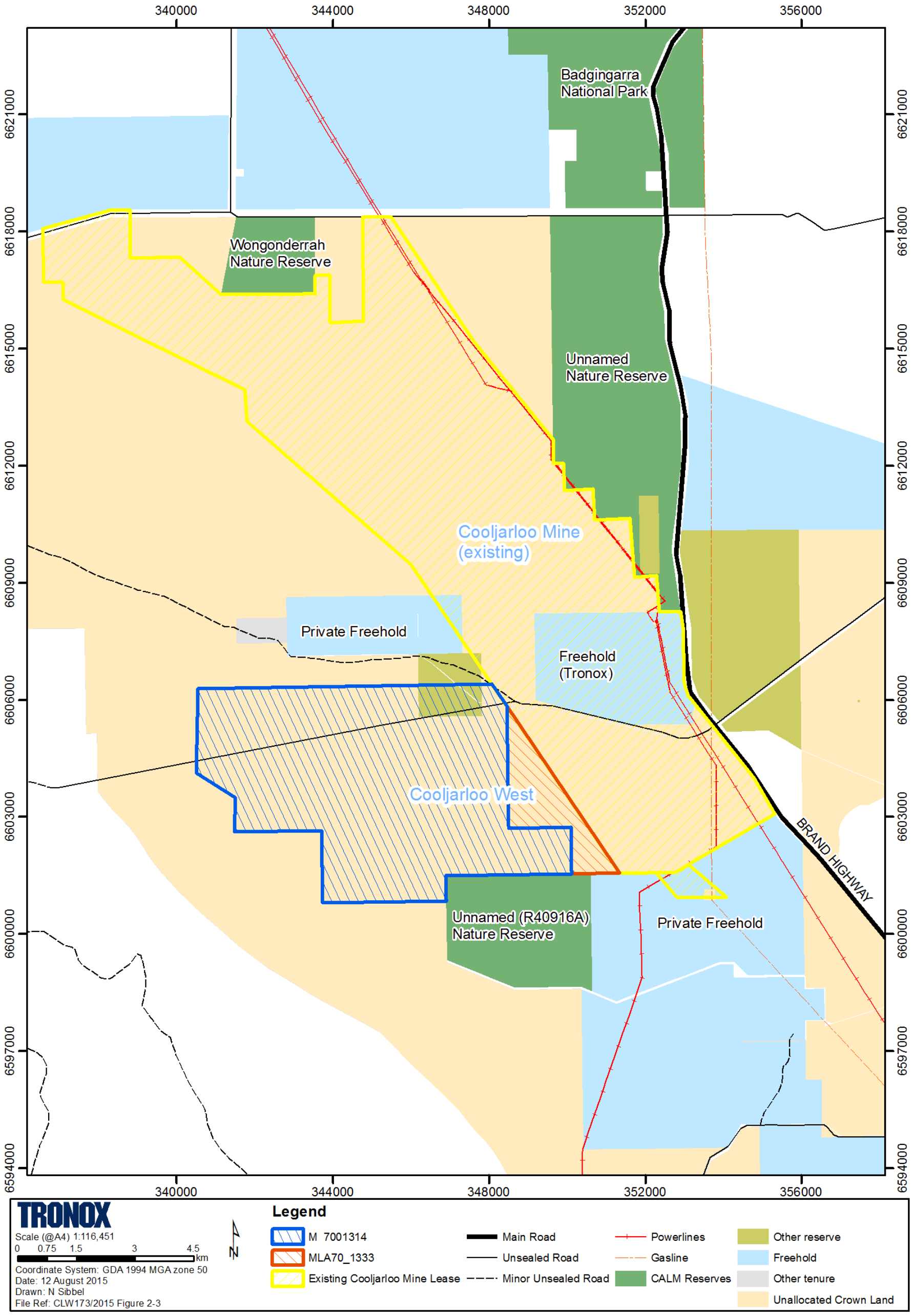
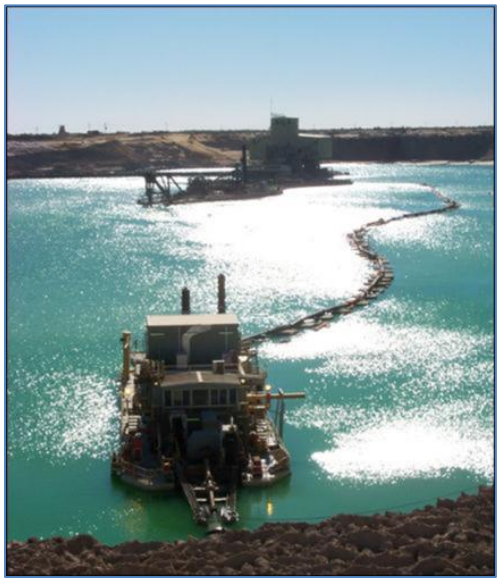


Figure 2: Land Tenure

Table 1: Mining Process

<table>
<tr><th>Dry Mining</th><th>Dredge mining</th></tr>
<tr><td> 
Figure 3: Dry Mining</td><td> 
Figure 4: Dredge Mining</td></tr>
<tr><td colspan="2">The site is prepared by harvesting, clearing, stripping topsoil and removing the upper overburden using excavator and truck.</td></tr>
<tr><td>Dewatering pumps are used to evacuate water from the active mining pit in areas below the water table. This water is generally utilised in the process or stored in water holding dams for later use.

Bulldozers push material into an in-pit hopper to screen the ore and remove oversize.

Water is then injected to create a slurry that is pumped to the trommel to remove the oversize.</td><td>Dual dredges are operated capable of mining to 25 m below the water surface. Ore is dredged then pumped via a floating pipeline to the wet concentrator situated behind the dredge in the pond.

Process water used at the concentrator is obtained from the dredge pond, nearby abstraction bores and decant water from the tailing dams. Water overflow from the various processes are recycled to the pond.

The ore slurry is screened through a trommel to remove oversize.</td></tr>
<tr><td colspan="2">The slurry ore is passed through a series of hydro-cyclones to separate the fine slimes fraction.</td></tr>
<tr><td colspan="2">The remaining ore is passed over the gravity spiral circuits which upgrade the ore to a heavy mineral concentrate (HMC).</td></tr>
<tr><td>Sand tailing rejects are deposited in nearby tailings storage facilities. Slimes tailings rejects are deposited in external solar drying cells.</td><td>Sand tailings rejects are deposited in the dredge pond or nearby tailings storage facility. Slimes tailings rejects are deposited in external solar drying cells.</td></tr>
<tr><td colspan="2">HMC is pumped to a land-based stockpile where it is allowed to drain and is then transported by road for further processing at Chandala.</td></tr>
<tr><td colspan="2">Final landform is created by backfilling and or shaping prior to rehabilitation with topsoil, seed and organic mulch.</td></tr>
<tr><td colspan="2">Rehabilitation transforms the new landform into land suitable for the post mining land use. Similar rehabilitation processes are employed at both mines as described in this document.</td></tr>
</table>

2.3.2 Transport Channel

At times there are spatial disconnects between areas of dredge mining. Connecting channels are constructed between such areas to enable mining and mineral processing equipment to be transported and continue mining.

This approach has been previously used at the existing Cooljarloo mine as shown in Figure 5 and will be used in the future for Cooljarloo West and other areas of mining within M268SA.

Figure 5 Photos showing mining equipment moving through a transfer channel from the existing Cooljarloo Mine.
Note these are similar in depth (approximately 20-30m) to the deepest sections of the channel planned for the Cooljarloo West project where approximately 80% of the channel is 10-14m deep.

Such channels are temporary structures that would be filled with water only for the duration of the transport of the mine plant. To prevent additional clearing requirements, they are retained and not rehabilitated until no longer required.

The locations of channels will be determined by the mining sequence

All channels will be backfilled and rehabilitated when they are no longer required.

2.3.3 Rehabilitation

Planning for the rehabilitation process commences well in advance of ground disturbance. Pre-disturbance vegetation surveys and data collected from reference sites in undisturbed native vegetation are used to characterise the vegetation and develop targets for native vegetation rehabilitation.

In UCL areas, native vegetation communities are simplified from around 27 into four key Rehabilitation Vegetation Groups (RVG's). The RVG's include a range of woodland and heath communities developed to broadly represent the species composition of the reference vegetation communities. Each RVG is associated with a set of soil characteristics defined from baseline reference sites. A planning matrix is used to match each RVG with a suitable soil profile and source of topsoil/mulch. Native seed mixes are tailored to suit each RVG,

with a keystone species model applied to manage the relative abundance of the key vegetation components recorded in native systems.

Tronox progressively backfills and rehabilitates disturbed areas as they become available. Plans are developed ahead of mining for landforming and rehabilitation as an integrated part of the mine planning process. Critical resources including topsoil, mulch, native seed and soil profile materials are identified, characterised and selectively managed according to site specific rehabilitation plans.

The final landforms are integrated with pre-existing surrounding landforms and the continuity of existing drainage lines from east to west is maintained. Rehabilitated soil profiles comprise various classes of overburden and/or tailings material appropriate for the final land-use. All soil profiles are designed to maximise infiltration and minimise the risk of overland flow. To minimise erosion risks, dispersive materials are identified during the mining process and buried at depth or treated with gypsum.

Rehabilitation plans are developed encompassing details of landform construction, topsoil/mulch placement and native seed application with approval and sign-off by the relevant line managers. Each plan aims to optimise the collection, storage and use of available resources based on pre-mining survey.

Landform development (backfilling and shaping) is conducted year round with maximum slope angles of 1:12 and the installation of infiltration banks where the potential for overland flow exists. Topsoil and mulch is targeted for application between March and May. In native vegetation areas topsoil is collected and spread in two cuts with the first (upper) cut comprising approximately 50 mm and the second cut approximately 200 mm. In agricultural areas a single cut of at least 100 mm of topsoil is collected and spread in rehabilitation areas.

Native vegetation rehabilitation areas receive a minimum of 10% fresh topsoil or direct returned. Ripping is predominantly conducted after second cut topsoil has been placed to minimise compaction. After placing of first cut topsoil, a stabilising cover crop is seeded, followed by native seed placement and stabilisation with mulch. Fresh harvested mulch is conserved during clearing operations on-mine path and is at times supplemented with composted organic mulch sources from external sources as required.

Each phase of rehabilitation establishment is recorded in Rehabilitation Operations Sign-off files developed for each rehabilitation area. This recording process captures all relevant data required to assess the successful completion of areas against the rehabilitation objective and completion criteria. Figure 6 shows a Woodland RVG at three years of age.

Figure 6: Woodland Rehabilitation (Year 3)

2.3.4 Waste Facility

Within Mullering Farm, Tronox operates a licenced Class lll waste disposal facility. This facility receives waste products from processing facilities at Chandala and Kwinana. The Cooljarloo site generally receives up to 500 000 wet tonnes of process waste each year.

The major constituents of the process waste are outlined below in Table 2.

The Cooljarloo waste facility has been designed, constructed and operated to minimise pollution. General requirements include;

- Establishing a liner for each pit with a permeability of less that 10^{-9} m/s;
- Pit capping with a low permeability layer;
- At least 2 m of overburden placed prior to rehabilitation;
- >100 m from Mullering Brook; and
- >3 m separation from the base of the pit to the water table.

Figure 7 shows the construction of the current waste cell during 2005.

Table 2: Indicative Process Waste Constituents

Waste	Source	Characteristic	Indicative Proportion
Filter cake (SRE)	Chandala SR Plant	Predominantly iron-oxide and calcium sulfate with some heavy metals.	~3%
Filter cake (IO/NAE)	Chandala SR Plant	Predominantly iron-oxide and calcium sulfate with some heavy metals. Benign material useful as a soil conditioner.	~23%
Pugged waste	Chandala SR Plant	Pugged Waste (iron oxide and char) or liquor pond solids or slurry (iron oxide).	~9%
Waste fines	Chandala SR Plant	Partly combusted coal from the SR kiln.	<1%
Pre-screen tailings	Chandala Dry Mill	Clay and oversize waste sand.	~9%
White tailings and screen 1 and 2 oversize	Chandala Dry Mill	Benign waste sand.	~13%
Coarse rejects	Chandala Dry Mill	Coarse sand containing up to 0.5% monazite, a low-level radioactive material.	~13%
Filter cake	Kwinana	Metal hydroxides.	~30%

Figure 7: Construction of Waste Cell (2005)

2.4 Future Operations

2.4.1 Process Waste Disposal

Process waste disposal will continue within Mullering Farm and is likely to operate beyond the life of the Cooljarloo Mine assuming an alternative feedstock supplies the Chandala and Kwinana Processing Plants. Figure 8 shows the process waste tipping face. Figure 9 shows the current waste pit and planned extension which will maintain capacity for the current operations until around 2017. Further extensions will be developed within Mullering Farm as required. The approval of design, construction and operation of the waste facilities are regulated by the Department of environmental Regulation in accordance with Part V of the EP Act 1986.

2.4.2 Mine Plan

Mining at Cooljarloo is expected to extend through to at least 2035 within ore bodies located in the central and northern areas of the Lease. The Dredge mine is expected to mine broadly in a northerly direction from its current location through GR6, 27000E, 20500 and 27300 ore-bodies as shown Figure 10. Depending on market conditions dredging of the Cooljarloo West orebodies (Woolka North and South, Harrier and Kestrel) may occur either following exhaustion of these orebodies, or following completion of the southern extent of the 27000E orebody.

The Dry mine is currently mining within the 20500 orebody. Other areas of potential mining include the northern extremity of the 12000 orebody as shown in Figure 10. It is expected that the Dry mining will relocate to prospects outside of the mining lease within the next few years.

In future mining activities, approximately 4400 ha is expected to be disturbed within the mine leases. This will bring the total disturbance footprint to approximately 7800 ha by end of mine life. The contribution of the Cooljarloo West Project to this is approximately 2000 ha. A breakdown of disturbance by tenement is provided in Table 3.

Table 3: Breakdown of existing and planned Disturbance by Tenement as at end 2014

Tenement	Disturbance			Rehabilitation
	Cooljarloo West	Cooljarloo	Total	
M268SA (existing)	-	3488	3488	1961
(planned)	*244*	*2334*	*2578*	*4105*
M70/1314 (planned)	*1624*	-	*1624*	*1624*
MLA70/1333 (planned)	*110*	-	*110*	*110*
Total	*1978*		*7800*	*7800*

Note: "Existing Disturbance within M268SA" includes only those areas where topsoil has been removed. Historically clearing has not always been recorded and is estimated to be 3755 ha (including areas of farmland). Future Disturbance generally refers to areas of clearing, which include both areas of disturbance (i.e. topsoil removal) and clearing (where it is undertaken without topsoil disturbance).

Figure 8: Process Waste Disposal

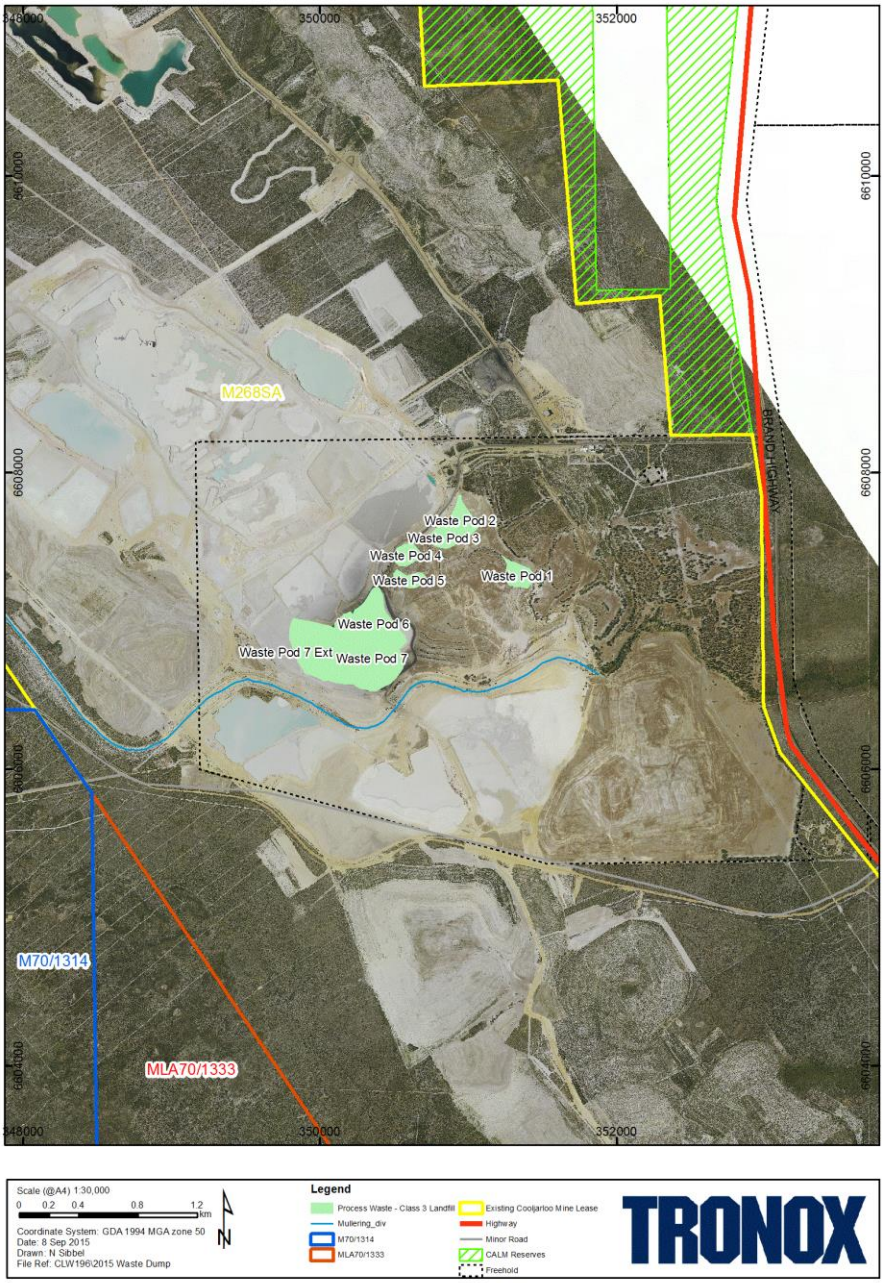


Figure 9: Process Waste Pits

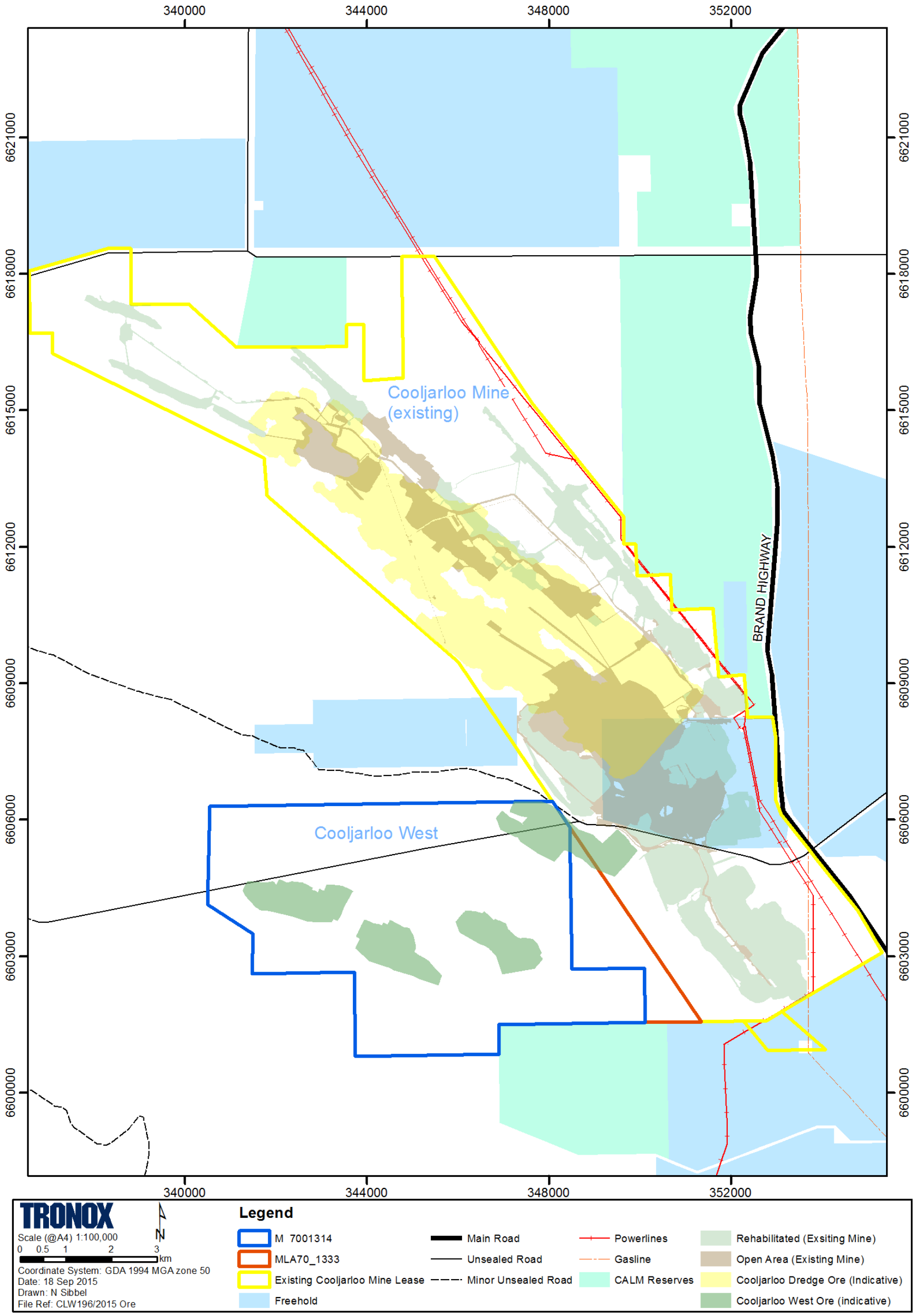


Figure 10: Orebodies

2.5 Rehabilitation Status

2.5.1 Approach to Rehabilitation

Tronox commenced progressive rehabilitation of native vegetation at Cooljarloo in 1993 with the establishment of rehabilitation trials on Mullering Farm. Since this time rehabilitation practices have evolved as new information became available and industry leading practice standards developed. Management of rehabilitation at Cooljarloo has been overseen by the Mineral Sands Agreement Rehabilitation Coordinating Committee (MSARCC), made up of representatives of key regulatory agencies relevant to the Cooljarloo operations. This group reviews site rehabilitation practices and outcomes on an annual basis.

The rehabilitation processes have been refined over time and completion criteria developed for areas of Unallocated Crown Land (UCL) in consultation with MSARCC. Tronox maintains detailed procedures and systems for the management of rehabilitation/closure planning, works management and monitoring. These systems are summarised in the Site Environmental Management Programme (Tronox 2013).

To ensure continuous improvement and to support the development of rehabilitation completion criteria, Tronox has developed a Rehabilitation Improvement Plan (WEC et. al. 2010). The Plan aims to identify and address information/knowledge gaps relating to rehabilitation outcomes/completion criteria and thereby drive continual improvement. This broad framework is shown in Figure 11 below. The items within the Improvement Plan have been incorporated into the Investigation Plan (Section 9.2.8).

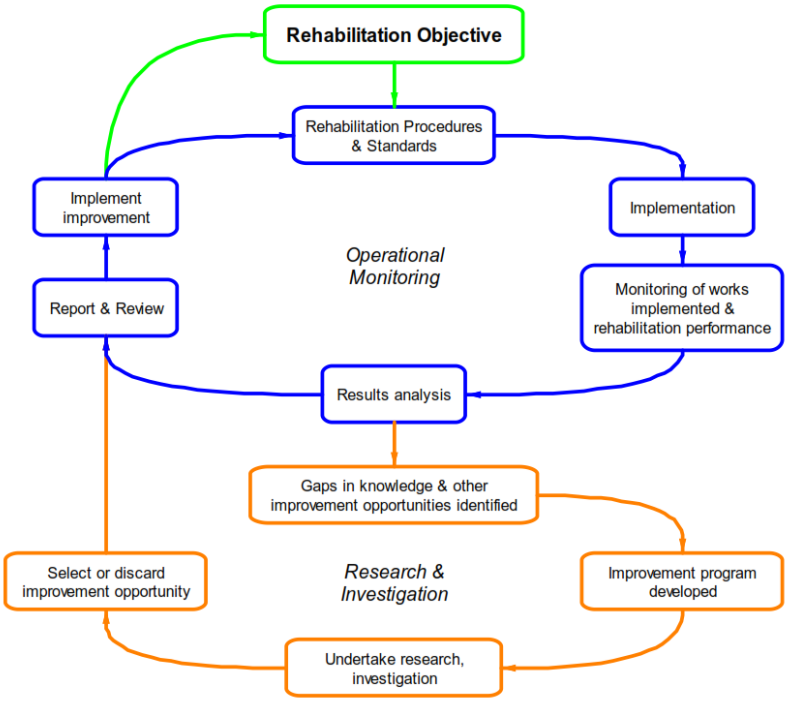


Figure 11: Cooljarloo Mine Rehabilitation Continual Improvement Process

2.5.2 Rehabilitation Areas

The total cumulative disturbed footprint at Cooljarloo at the end of 2014 calendar year was 3445 ha. Of this, 1527 ha was currently open and 1918 ha had been rehabilitated.

2.5.3 Rehabilitation Performance

Rehabilitation monitoring covers aspects of vegetation establishment (foliage cover and species richness), soil profile parameters (bulk density, texture, soil strength), fauna return (abundance, composition) and surface stability (condition assessments). Targeted investigations are also carried out to verify other functional characteristics such as drought resilience and successional trends.

Tronox reports rehabilitation monitoring results in its Annual Environmental Report which is provided to MSARCC for review and comment. By way of a brief summary, rehabilitation monitoring to date is showing that historically:

- Species richness is commonly within the range recorded within the reference plots;
- Shannon-Weiner Diversity index (reflects total number of species and their relative abundance) is generally comparable to that of corresponding reference site (Nichols et. al. 2010);
- Species composition of each Rehabilitation Vegetation Group is developing towards its associated reference baseline more so than reference plots of other RVG's (Nichols et. al 2010);
- Understorey density is variable with around half of the areas within the range of the baseline (except for dry heath areas which are generally lower than the baseline);
- Tree densities and foliage cover are generally within the range of the baseline;
- Few areas required intervention to address erosion issues and those that do tend to be early workings with an allocated remedial provision; and
- Fauna has been shown to be re-colonising rehabilitation areas with abundance and species richness increasing with age of rehabilitation.

Tronox maintains a Rehabilitation Improvement Plan designed to promote Continuous Improvement in rehabilitation. Pertinent aspects of this plan are provided in Section 9.2.8.

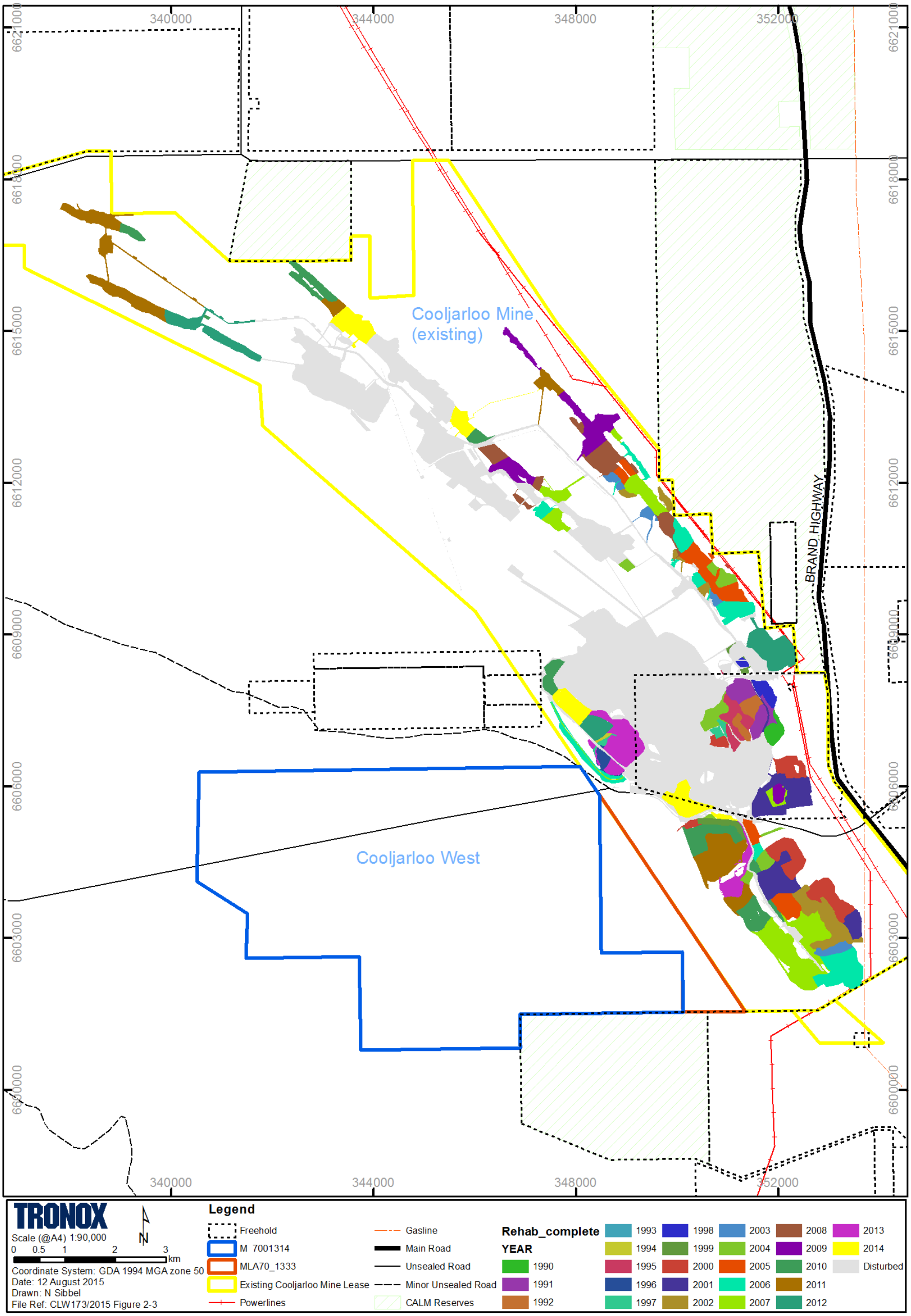


Figure 12: Rehabilitation Status (EOY 2014)

3 CLOSURE PLANNING PROCESS

A generic overview of mine closure planning is shown in Figure 13. Tronox closure planning is consistent with this process.

The Cooljarloo Mine Closure Plan is typically reviewed annually to ensure the key components remain relevant by:

- Incorporating relevant new baseline and/or closure data to support the planned activities and completion criteria;
- Ensuring that legal obligations and stakeholder commitments are relevant and up-to-date;
- Assessing the risks related to achieving the agreed post-mining land use and identifying relevant mitigation measures;
- Identifying the data/knowledge gaps and the activities required to fill them; and
- Updating the task listing and related plans to progress the site from its current state through to closure and decommissioning, including detailed costing.

Significant changes to the Mine Closure Plan will be reported to MSARCC and resubmitted to the DMP if the changes are considered to be substantial.

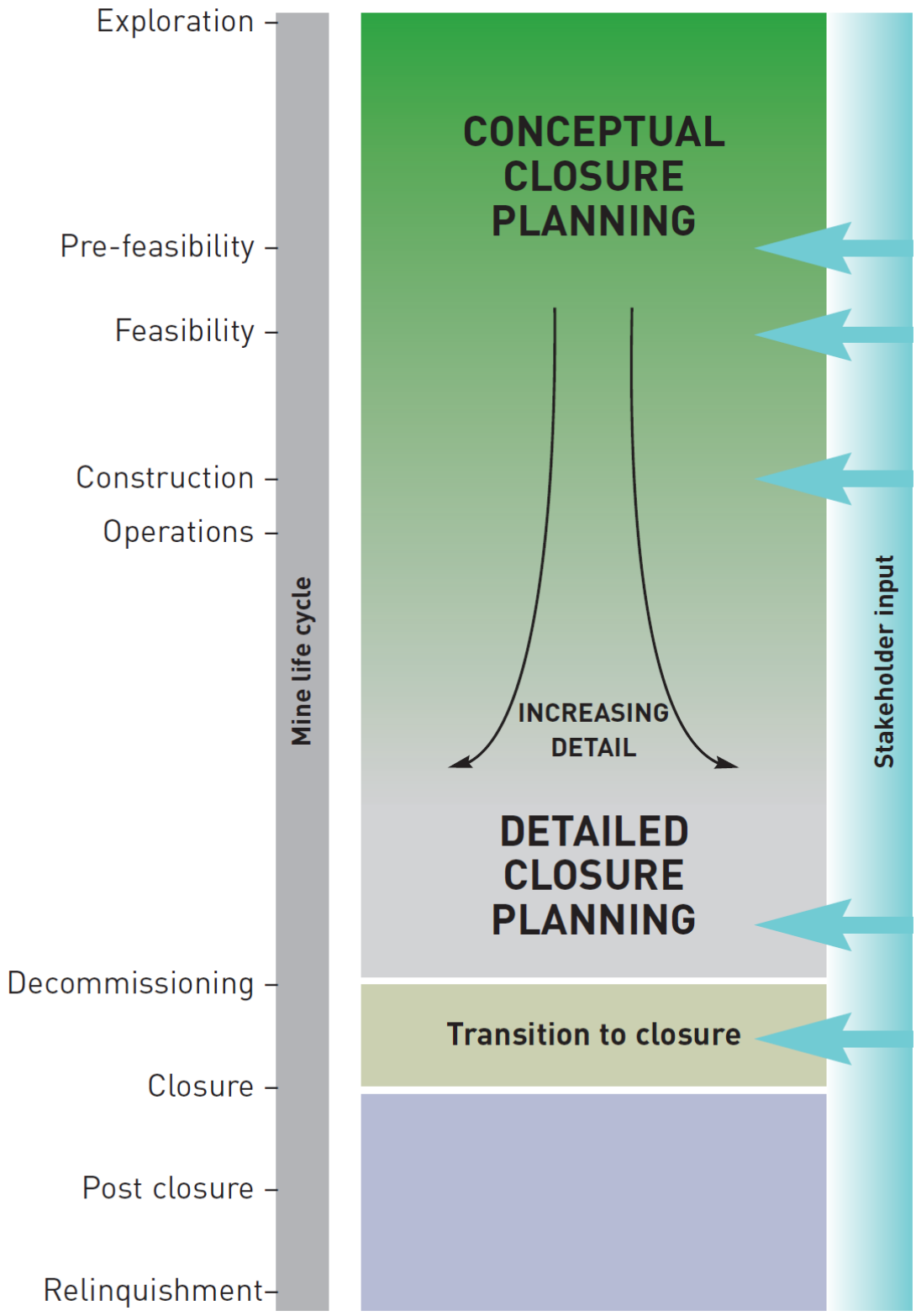


Figure 13: Mine Closure Plan Model (ICMM, 2006)

4 CLOSURE OBLIGATIONS AND COMMITMENTS

Mine sites have general legal obligations that relate to both the operational and closure phases. The sources of general legal obligations that may have application to the closure phase of Cooljarloo are presented in Table 4.

Table 4: Legislation Relevant to the Closure of Cooljarloo

Legislation	Relevance
Aboriginal Heritage Act 1972 (WA)	Provides protection for Aboriginal Heritage sites.
Agriculture and Related Resources Protection Act 1976 (WA)	Identifies weeds, control policies and other agriculture-related protection issues.
Bush Fires Act 1954 (WA)	Makes provision for minimising the dangers resulting from bush fires and for the prevention, control and extinguishment of bush fires.
Conservation and Land Management Act 1984 (WA)	Describes provisions for the use, protection and management of certain public lands and waters.
Contaminated Sites Act 2003 (WA)	Provides for the identification, recording, management and remediation of contaminated sites. A contaminated site is defined as 'in relation to land, water or a site, having a substance present in or on that land, water or site at above background concentrations that presents, or has the potential to present, a risk of harm to human health, the environment or any environmental value.' The *Contaminated Sites Act* is the primary legislation for the management of contamination associated with mining activity.
Environmental Protection Act 1986 (WA)	Provides for protection of the environment generally and specifically defines processes for environmental impact assessment and environmental approvals. Part V of this Act provides for DEC to regulate environmental pollution issues associated with operational activities.
Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)	Defines matters of National Environmental Significance (NES) that must be protected. Lists of plant and animal species and ecological communities that are considered matters of NES are maintained and legally protected.
Mines Safety and Inspection Act 1994 (WA)	Provides a framework for the promotion and improvement of health and safety of persons at mines.
Radiation Safety Act 1975 (WA)	This Act relates to the storage, use and disposal of radioactive substances (including tailings and by-products) and establishes the Radiological Council. Cooljarloo is registered with the Radiological Council and managed in accordance with the requirements of legislation and relevant Codes of Practice.
Rights in Water and Irrigation Act 1914 (WA)	Defines a number of rights and requirements, including the conditions associated with the extraction of groundwater – Licence to Take Water.
Soil and Land Conservation Act 1945 (WA)	Provides for the conservation of soil and land resources and mitigation of the effects of erosion, salinity and flooding. Relevant to the design of post-mining landforms and drainage systems.
Wildlife Conservation Act 1950 (WA)	Identifies lists of Conservation significant flora and fauna that must not be taken or disturbed without written authorisation from the Minister for Environment.

4.1 Site Specific Obligations

In addition, the site has specific obligations arising from approvals, licences, permits and agreements, some of which relate to mine closure and rehabilitation. These are reviewed briefly below. The obligations arising from these documents relating to closure of Cooljarloo are collated in the Closure Obligations Register (Appendix A).

4.1.1 SAA Approvals

The mining and processing operations at Cooljarloo are conducted under the Cooljarloo State Agreement Act (SAA). The Department of State Development (DSD) is the lead agency and primary regulatory authority responsible for the Cooljarloo site under the SAA. In relation to closure of the site, it is expected that DSD will take advice from the Department of Minerals and Petroleum (DMP) who generally oversee the closure of mining operations under the *Mining Act* 1978. Authorities providing advice to the DMP include the EPA, DoW, DEC, Department of Agriculture and Food Western Australia (DAFWA), Radiological Council, Main Roads of Western Australia (MRWA) and the Shire of Dandaragan.

Cooljarloo was initially approved via proposal under the SAA in 1988. In addition to proposals, the SAA requires annual and triennial reports to provide information relevant to protection and management of the environment. By agreement with key stakeholders these reports are integrated with the reporting requirements under the EP Act and Mining Act.

4.1.2 EP Act Approvals

Cooljarloo has been approved by the Minister for the Environment under the following three separate Ministerial Statements:

- Cooljarloo Mineral Sands Project (Excluding the Proposed Dry Processing Plant at Muchea), Ministerial Statement 37 (MS37) (approved 1988);
- Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27,000 and 28,000, Ministerial Statement 557 (MS557) (approved 2000); and
- Cooljarloo Mine Falcon Extension Ministerial Statement 790 (MS790) (approved 2009).

Each of these approvals identifies legal conditions of approval in the Ministerial Statement. Conditions relevant to these are detailed in Appendix A.

It is likely that conditions relating to mine closure and decommissioning will be applied to the Cooljarloo West Proposal should it be approved.

4.1.3 DEC Licence

As at the time of this report, Cooljarloo operates under the DEC Licence No. 5319/1988/12 (DEC File No. 2010/003370) which covered the following activities:

- Category 64: Class ll or lll Putrescible Landfill; and
- Category 08: Mineral Sands Mining or Processing.

The licence requires the provision of annual and triennial reports and prescribes specific conditions relating to management of waste, hydrocarbon and water quality.

4.1.4 Groundwater Licences

Groundwater extraction, monitoring and reporting is carried out in accordance with the conditions of groundwater licences:

- GWL101017(9);
- GWL 159548 (4);
- GWL 157540 (4); and
- GWL104551 (9).

These licences require the provision of annual and triennial aquifer reviews and the provision of data relating to volumes abstracted and flow meter calibration. They require compliance with a Groundwater Operating Strategy which sets out the specific measures required for groundwater abstraction and management of impacts arising from mining on groundwater value more generally.

4.1.5 Permits to Take Declared Rare

Permits issued under the *Wildlife Conservation Act* 1950 to take Threatened species relevant to Cooljarloo include:

- 91/99;
- 38/2002; and
- 206-1415.

Permit 38/2002 has associated general conditions relating to the translocation of Threatened species. Permit 206-1415 has conditions relating to the taking on *Andersonia gracilis* and dieback hygiene.

4.1.6 Yued Native Title Agreements

Two Native Title agreements are held between the Yued People and Tronox relating each to the Falcon extension (reached in 2006) and Cooljarloo West (reached in 2014) extension areas. These agreements include commitments for the protection of heritage, provision training/education, business opportunities, and the formation of a facilitation committee and the development of a cultural awareness programme for Tronox staff.

4.1.7 Billinue Obligations

An agreement was reach in 1987 between the Billinue Aboriginal Community and Tronox prior to mining on the Cooljarloo Lease. The Agreement involved nine commitments which focus on employment opportunities, land access and the rehabilitation of Mullering Brook. In addition Tronox committed to purchasing native seed from the Billinue's Cataby Seed enterprise to underwrite its viability.

5 STAKEHOLDER ENGAGEMENT

Stakeholders are generally defined as those people who have an interest in a particular decision, either as individuals or representatives of a group. This includes people who influence a decision, or can influence it, as well as those affected by it.

Broadly speaking Tronox stakeholders can be placed into five categories:

- Local communities;
- Government Organisations;
- Non-Government Organisations;
- Employees/Owners; and
- Local Landholders and Indigenous Groups.

Some stakeholders request minimal to no interaction at varying times while other groups seek to be regularly informed and actively participate in decision making.

Tronox's objectives for stakeholder consultation leading up to and during mine closure are to:

- Confirm closure objectives and completion criteria with key stakeholders;
- Be transparent in closure processes and objectives in relation to affected stakeholders;
- Create awareness of and be responsive to key stakeholder views and concerns;
- Mitigate social impacts associated with mine closure; and
- Conform to regulatory expectations for stakeholder engagement.

The following sections of this MCP outline the key stakeholders for mine closure at Cooljarloo and provide details of relevant past and planned consultation.

5.1 Key Stakeholders

The key stakeholders identified for Cooljarloo include:

- MSARCC committee which includes representation from DMP, EPA, DER, Parks and Wildlife, Department of Water (DoW), Department of State Development (DSD) and Department of Agriculture and Food (DAFWA);
- Department of Health, Main Roads WA, and Department of Indigenous Affairs (DIA);
- Shire of Dandaragan;
- Commonwealth Department of Sustainability Environment, Water, Population and Communities (SEWPaC);
- Local landholders and neighbours;

- Yued Native Title Party on behalf of the Yued People and South West Aboriginal Land and Sea Council (SWALSC); and
- Public and community including wildflower and native seed pickers (Cataby Seeds), apiarists.
- Special interest groups such as Wildflower Society of Western Australia and Conservation Council of Western Australia.

On-going consultation with MSARCC (annually) and the wider community has provided the opportunities for stakeholders to have input and influence a range of proposals and activities at Cooljarloo including;

- Various mining proposals including the Cooljarloo Environmental Review and Management Programme (1987), 27200 and 28000 Public Environmental Review (1999), and Falcon Extension Environmental Protection Statement (2008);
- Falcon Native Title Agreement and Cooljarloo Billinue Community Commitments (1987);
- Various Management Plans and related procedures relating to rehabilitation and mine closure (1987-2012);
- End land-use objectives and completion criteria for native ecosystems at Cooljarloo (2003, 2008-2012); and
- Long term research and development plans for rehabilitation improvement (2010-2012);

Recent consultation has focused on the development of completion criteria for mine closure. A summary of recent stakeholder consultation relevant to mine closure is provided in Table 5 below.

Table 5: Recent Consultation Relevant to Mine Closure

Description	Participants	Timing	Outcome or Status
Review and Approval of Rev 0 of Mine Closure Plan	All MSARCC members. OEPA and DSD carry regulatory authority for plan approval	2013-2014	Rev 0 of Mine Closure Plan approved Feedback to be incorporated in new revision of MCP (this document)
Annual MSARCC meeting and site inspection	All MSARCC members	2013 2014	Feedback on rehabilitation performance, improvement plansincoiratred into site plans and activities.
Review and approval of Site Environmental Management Programme	OEPA, DSD	2013-2014	EMP approved according to relevant Ministerial Conditions and provision of the State Agreement
Cooljarloo West Approvals			
Referral of the project, scoping of environmental studies and commencement of formal Part IV approvals processes	EPA, OEPA, Parks and Wildlife, DMP, DOW DAA, Department of the Environment	2013 to date	Cooljarloo West is being assessed as a Public Environmental Review in accordance with Part IV of the EP Act 1986. Proposal to be approved as a revised proposal amalgamating existing and new conditions into one consolidated statement. Environmental Scoping Document released in 2013 requiring MCP (this document) to be developed and submitted with the PER.
Site visit to Cooljarloo Mine and discussion of future mine plans, and rehabilitation outcomes	WA Wildflower Society	2014	Understanding of the proposed Cooljarloo West extension and outcomes being achieved in rehabilitation at the existing Cooljarloo Mine.
Negotiated native title Future Act agreement for the Cooljarloo West Project	Yued People as represented by the South west aboriginal Land and Sea Council	2013-2014	Agreement finalised

5.2 Stakeholder Consultation Plan

Tronox plans to continue to consult throughout the rehabilitation and closure phases of the Project. If Tronox proposes any significant change to mining plans, post-mining land use, landform design or completion criteria, further consultation will be carried out with the appropriate stakeholders.

Based on existing consultation and issues, a Stakeholder Consultation Plan capturing planned future consultation activities is presented below in Table 6.

Table 6: Stakeholder Consultation Schedule

Sector	Organisation	Task	Operations	Mine Closes	Yr 1	Yr 2	Yr 5	Yr 10
State Government	DMP/DSD	Review and update completion criteria as required	Every 3-5 years					
		Annual/Triennial Environmental Report submission and review	Annually					
		Review of MCP for Cooljarloo	Every 3 years					
		Obtain written confirmation that completion criteria have been met						
	OEPA	Consult in relation to Ministerial Statement compliance	Annually					
		Annual/Triennial Environmental Report submission and review	Annually					
		Review of MCP for Cooljarloo	Every 3-5 years					
	DEC	Consult with regard to research plans and potential changes to operations or criteria	As required					
		Annual/Triennial Environmental Report submission and review	Annually					
		Management of Contaminated Sites	As required					
		Consult in future reviews of this MCP	As required					
		Termination of licence at appropriate time						
	DoW	Annual/Triennial Environmental Report submission and review	Annually					
		Consult regarding capping or removal of groundwater bores	As required					
	MSARCC	Consult with regard to changes to completion criteria, research plans and operational activities	Annually					
	Radiological Council	Submit annual report on surface radiation levels.	Annually					
		Obtain sign-off on management of rehabilitated sites						
	DIA	Consult regarding Aboriginal Heritage Sites	As required					
	MRWA	Consult regarding road intersection and usage	As required					
Local Gov	Shire	Liaise with Shire regarding site closure	As required					
Land Owners	Neighbours	Liaise with neighbours regarding ongoing mining and rehabilitation activities	As required					
	Traditional Owners	Participate in facilitation Committee meetings regarding implementation of Native Title Agreements and consultation on the project more generally	As determined by the agreement (generally quarterly)					
Broader Community	Suppliers	Notify suppliers once the schedule/duration for the project has been confirmed.	As required					

Sector	Organisation	Task	Operations	Mine Closes	Yr 1	Yr 2	Yr 5	Yr 10
	Supported Organisations and Groups	Maintain current liaison with the surrounding residents and keep community aware of all relevant aspects of the mining operation.	As required					

6 Post Mining land use and closure objectives

6.1 Post-mining land use

Post-mining land use(s) must be relevant to the context of the particular mine site and surrounding region. Tronox has considered the surrounding land uses, the nature and extent of changes to the natural environment caused by mineral sands mining, the cost and ability to restore the land to different land uses and the environmental implications of targeting different post-mining land uses.

Mineral sands mining has the ability to mine and backfill such that landforms are generally similar to pre-mining. This makes the return of the land to pre-mining land uses a more feasible option than for other types of mines where final voids, tailings dams and waste rock dumps often remain as landscape features after mining is completed.

6.1.1 Unallocated Crown Land

Cooljarloo is based on land that was either private property cleared for farming, or unallocated Crown Land (UCL) comprising native vegetation occasionally used for bee keeping or flower and seed picking. Tronox has determined, in consultation with key stakeholders (including MSARCC) that the UCL within the Mining Lease of ML268SA will be rehabilitated back to a state that is broadly representative of native vegetation communities. The intention is that, like the pre-mining native vegetation, the vegetation is able to support a range of potential activities. The same end land use is considered appropriate for areas of UCL within M70/1314 and MLA70/1333.

Rehabilitated native vegetation will need to be self-sustaining and able to be integrated into the management framework applied to the surrounding native vegetation without additional management.

6.1.2 Freehold Land

Tronox proposes to rehabilitate the freehold land to mixed agriculture land-use after mining. Private land holders often adopt a range of agricultural practices on their properties post-rehabilitation that may include grazing, cropping or more intensive forms of agricultural production. Such land use may require irrigation, agroforestry or other activities consistent with rural land use(s). Figure 14 shows the proposed post-mining land use(s) for Cooljarloo.

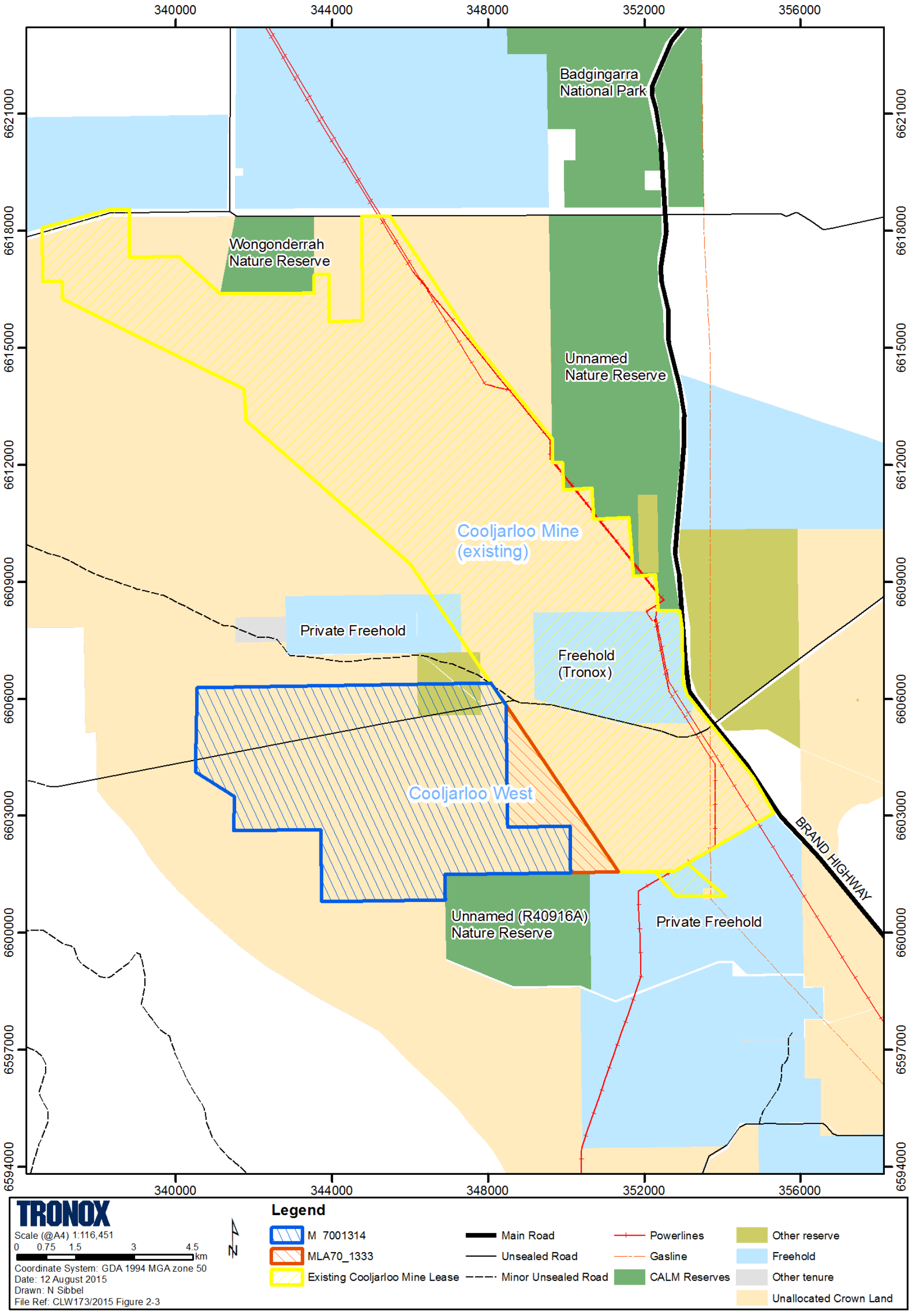


Figure 14: Proposed Landuse

6.2 Closure Objectives

Tronox's overarching closure objective is to establish safe and stable landforms capable of supporting sustainable native ecosystems similar to that which occurs in adjacent UCL areas and productive agricultural land on Mullering Farm, which:

- Fulfils designated land uses including conservation, protection of water quality and, where appropriate, provides for use by apiarists, native wildflower and seed pickers (UCL Native areas only);
- Can be achieved using mining industry current leading practice;
- Returns vegetation groups appropriate to the post mining land capabilities and are broadly representative of unmined reference sites (UCL Native areas only);
- Establishes soil profiles that have the capacity to provide sufficient plant available water to support mature plant communities in a similar manner to native reference sites (UCL Native areas only);
- Targets re-establishment of significant flora species such as *Andersonia gracilis* (DRF) (UCL Native areas only);
- Provides habitat for local endemic native fauna species with particular focus on species listed under the *Wildlife Conservation Act* 1950 (WA) and the *Environmental Protection and Biodiversity Conservation Act* 1999 (Cth), as of conservation significance (i.e. rare or threatened) (UCL Native areas only);
- Targets the return of productive mixed agriculture land on existing freehold land commensurate with the surrounding areas (Freehold Agriculture only);
- Is based on the findings of relevant research into the establishment of biodiversity, ecosystem function, and sustainability for native areas and agricultural productivity and sustainability for farm areas;
- Is aligned with Tronox's whole-of-lease management approach including initiatives such as support for regional feral animal control, Phytophthora dieback management, flora study and other offset activities;
- Takes into account the views of regulatory authorities, neighbours and all other relevant stakeholders;
- Results in no unacceptable off-site impacts; and
- Management requirements (e.g. maintenance of access tracks, fire control) are not greater than those of areas prior to mining, or where extra management actions may be required, a mechanism has been put in place for addressing these.

7 COMPLETION CRITERIA

The completion criteria included in this Plan outline the objectives for rehabilitation, detail the expected developmental milestones, relevant procedures and describe how attainment of the criteria will be assessed. The criteria have been developed in consultation with MSARCC, key stakeholders and technical specialists familiar with the Cooljarloo Site. The consultation process undertaken and the principles guiding the development and application of the criteria are documented in Nichols and Woodman (2011).

Section 7.1 details the criteria and Section 7.2 provides supporting information relating to their derivation. Criteria relating to agricultural (freehold) land have also been provided, based on concepts embodied in the criteria for native UCL. It is intended that the Mine Closure Plan become the mechanism for endorsement and regular review of the criteria listed in Section 7.1. The criteria will apply for future rehabilitation upon endorsement of this plan and are expected to be reviewed every 3 years.

Existing rehabilitation areas will be assessed against the criteria in this Plan and as a general principle will be required to meet these criteria. Where they do not meet the criteria, a risk assessment will be undertaken in consultation with MSARCC to determine if the area is likely to meet the Rehabilitation Objective or if intervention is required.

7.1 Completion Criteria for UCL and Agricultural Areas

The completion criteria for UCL and agricultural areas are shown below in Table 7. Definitions for the column headings in the table are as follows:

Objective: Rehabilitation objective as agreed with Tronox Stakeholders.

Completion Criteria: An agreed standard or level of performance which contributes to successful closure of a site.

Category: Identifies whether the criteria is a performance outcome or is an operational control; and if the criteria applies to Unallocated Crown Land (UCL) or Freehold Land.

Assessment Method: Describes how the criteria will be measured. Assessment methods are either:

- **Internal verification**: Signoff internally by management to verify that plans have been successfully implemented and outcomes are in line with agreed criteria.
- **Internal signoff**: Signoff internally by responsible personnel confirming that the required design criteria have been met.

Procedure: A standard Tronox Cooljarloo planning or operating procedure defining the steps required for the particular process to be successful.

The criteria are divided into four parts:

- Planning and Rehabilitation Works criteria to confirm that key planning and operational controls relevant to rehabilitation and closure have been carried out;

- Early Establishment Rehabilitation criteria to confirm that the appropriate conditions have been provided at the early stages of rehabilitation (establishment) and there are no early indications of failure;
- Maturing Rehabilitation criteria to confirm areas are developing appropriately and have reached or exceeded various developmental milestones; and
- Closure criteria to address land capability and final closure management.

Table 7: Completion Criteria

Planning and Rehabilitation Works Criteria				
Objective	**Criteria**	**Category**	**Assessment Method**	**Procedure**
1) Safe, stable landforms are constructed in keeping with the aesthetics of the surrounding undisturbed native areas.	1-1) Reconstructed landforms and drainage lines are tied into pre disturbed topography (i.e. step up or step down between rehabilitation and pre-existing landform is no steeper than 1:12 and drainage is maintained).	Outcomes (UCL and Freehold)	Internal Verification Internal Signoff	Rehabilitation Planning Procedure (C0058)
	1-2) Maximum height to length ratio of all reconstructed slopes are no steeper than 1:12.	Outcomes (UCL and Freehold)	Internal Verification Internal Signoff	Rehabilitation Planning Procedure (C0058)
	1-3) Upper soil profile to comprise Class 1 material. The minimum depth of Class 1 material on sloping (steeper than 1:100) areas is 1m and 0.3m on non-sloping/low lying areas.	Operational (UCL and Freehold)	Internal Verification Internal Signoff	Rehabilitation Planning Procedure (C0058) Characterisation of Materials used in Landforming (C0735)
	1-4) Lower soil profile comprises either Class 1 or Class 2 material. The combination of the upper profile and lower profile is >3m on all sloping (steeper than 1:100) native areas and >2m on all non-sloping areas.	Operational (UCL and Freehold)	Internal Verification Internal Signoff	Rehabilitation Planning Procedure (C0058) Characterisation of Materials used in Landforming Procedure (C0735)
	1-5) Rehabilitation areas are stabilised according to the agreed rehabilitation procedures to reduce the impacts of topsoil loss during vegetation establishment.	Operational (UCL and Freehold)	Internal Verification Internal Signoff	Rehabilitation Planning Procedure (C0058) Mulching Procedure (C0055)
	1-6) Potentially acid forming (PAF) soils are identified and managed in line with agreed standard operating procedures.	Operational (UCL and Freehold)	Internal Verification Internal Signoff	Identification of Acid Sulphate Soils (NO0372)
	1-7) Contaminated sites are identified and addressed in accordance with the *Contaminated Sites Act* 2003.	Operational/Outcome (UCL and Freehold)	Monitor and assess against agreed Management Plan	
	1-8) Implement mining planning processes to ensure landform reconstruction in accordance with these criteria is possible throughout the remaining mine life and to ensure mine voids are backfilled to above maximum winter water table (except as otherwise agreed with government).	Operational (UCL and Freehold)	Internal Verification Internal Signoff	
2) Vegetation groups are established that are similar to those in surrounding undisturbed areas	2-1) Topsoil required for rehabilitation is stripped in 2 separated cuts for use on native areas.	Operational (UCL)	Internal Verification Internal Signoff	Topsoil Placement (C0060)
	2-2) The minimum depth of 1st cut topsoil placed on standard rehabilitation is 50mm.	Operational (UCL)	Internal Verification Internal Signoff	Topsoil Placement (C0060)
	2-3) Native seed used in rehabilitation is of local provenance and includes representative keystone species recorded in baseline reference plots (see also 2.6 below).	Operational (UCL)	Internal Verification Internal Signoff	Seeding Procedure (C0059)
	2-4) 10% of all 1st cut topsoil used on rehabilitation areas is fresh cut.	Operational (UCL)	Internal Verification Internal Signoff	Topsoil Placement (C0060)
	2-5) Matching vegetation groups for mulch and topsoil with those targeted in rehabilitation is undertaken where possible.	Operational (UCL)	Internal Verification Internal Signoff	Mulching Procedure (C0055) Topsoil Placement (C0060)
	2-6) Keystone species are defined for each vegetation group, and targeted for return into rehabilitation via systematic management of propagule sources.	Operational (UCL)	Internal Verification Internal Signoff	Rehabilitation Planning Procedure (C0058) Seeding Procedure (C0059)
	2-7) Maintain a program targeting the establishment of recalcitrant species within rehabilitation.	Operational (UCL)	A recalcitrant species program is detailed and reported against annually to Stakeholders.	Seeding Procedure (C0059)
	2-8) A strategy for the establishment of relevant DRF and priority flora into rehabilitation is developed and implemented.	Operational (UCL)	Significant Species Rehabilitation Strategy developed and reported against annually to Stakeholders	Rehabilitation Planning Procedure (C0058)
3) Rehabilitation is designed to support fauna assemblages similar to those in the surrounding undisturbed areas	3-1) Upper soil profile is of sufficient depth (>300mm) and with properties (sandy <10% fines and non-hard setting) to provide habitat suitable for burrowing species.	Operational (UCL)	Internal Verification Internal Signoff	Rehabilitation Planning Procedure (C0058)
	3-2) Trees/shrub species (*Banksia attenuata, Banksia menziesii, Banksia telmatiaea, Banksia prionotes*) are included in native seed mixes at targeted densities to provide a feeding resource for Carnaby's Black-Cockatoo and other native bird species.	Operational (UCL)	Internal Verification Internal Signoff	Rehabilitation Planning Procedure (C0058) Seeding Procedure (C0059)
	3-3) Logs and wood material where available and not required as mulch for stabilisation of soils are distributed into rehabilitation to provide habitat for fauna.	Operational (UCL)	Internal Verification Internal Signoff	Mulching Procedure (C0055)
4) Rehabilitation is constructed to minimise	4-1) Hygiene control procedures are implemented to minimise the risk of spreading *Phytophthora* species.	Operational (UCL and Freehold)	Internal Verification Internal Signoff	Dieback Management Procedure (C0773)

Planning and Rehabilitation Works Criteria				
Objective	**Criteria**	**Category**	**Assessment Method**	**Procedure**
spread and reduce impact of Phytophthora species	4-2) Flora resistant to *Phytophthora* species are included in native seed mixes.	Operational (UCL)	Internal Verification Internal Signoff	Rehabilitation Planning Procedure (C0058)
	4-3) Soil profiles are reconstructed in accordance with criteria 1.3 and 1.4 to minimise surface ponding and overland flow thereby minimising risk of disease spread across the landscape.	Operational (UCL and Freehold)	Internal Verification Internal Signoff	Rehabilitation Planning Procedure (C0058)

Early Establishment Rehabilitation (<2 years)				
Objective	**Criteria**	**Category**	**Assessment Method**	**Procedure**
5) Vegetation groups established are similar to those in surrounding undisturbed areas	5-1) Monitoring of native plant abundance, tree abundance and species richness indicates the site is establishing appropriately to meet maturing rehabilitation stage criteria.	Operational (UCL)	Early Establishment Monitoring.	Rehabilitation Monitoring Procedure (C0069)
6) Soil profiles and landforms are stable	6-1) Soil surface is stabilised such that no areas greater than 0.25ha are bare and exposed to wind drift.	Outcomes (UCL and Freehold)	Early Establishment Monitoring.	Rehabilitation Monitoring Procedure (C0069)
	6-2) No channelised flow resulting in gullies greater than 30cm deep and 25cm wide are evident.	Outcomes (UCL and Freehold)	Early Establishment Monitoring.	Rehabilitation Monitoring Procedure (C0069)
7) Weeds are controlled and monitored	7-1) Population of weeds are monitored and controlled.	Operational (UCL and Freehold)	Early Establishment Monitoring.	Weed Control Procedure (C0062) Rehabilitation Monitoring Procedure (C0069)

Maturing Rehabilitation (2-10 years)				
Objective	**Criteria**	**Category**	**Assessment Method**	**Procedure**
8) Landforms are safe and stable	8-1) No channelised flow resulting in gullies greater than 30cm deep and 25cm wide are evident.	Outcomes (UCL and Freehold)	Rehabilitation Performance Monitoring	Rehabilitation Monitoring Procedure (C0069)
	8-2) No evidence of slumping.	Outcomes (UCL and Freehold)	Rehabilitation Performance Monitoring	Rehabilitation Monitoring Procedure (C0069)
9) Soil Profile have the capacity to provide sufficient plant available water to support mature plant communities.	9-1) Soil profiles are shown to have the capacity to provide sufficient Plant Available Water to support mature plant communities in a similar manner to native reference sites	Outcomes (UCL)	Investigation: Soil properties including key Plant Available Water indicators are assessed within established rehabilitation areas and reference sites.	Improvement Plan
	9.2) Plant communities are shown to be accessing the soil profile in a comparable manner to native reference sites.	Outcomes (UCL)	Investigation: Soil properties and root morphology are assessed within established rehabilitation areas and in reference sites	Improvement Plan
	9.3) Soil materials are managed as described in 1-3 and 1-4 to prevent issues relating to dispersive soils and hard setting clay layers in the upper soil profile.	Outcomes (UCL)	Internal Verification Internal Signoff	Characterisation of Materials used in Landforming (C0735)
10) *Areas containing potential or actual acid sulphate soils do not pose a threat to environmental values*	10-1) Areas containing potential or actual acid sulphate forming soils have been managed to ensure they do not result in uncontrolled acidification in surrounding soils and/or water.	Outcomes (UCL and Freehold)	Monitoring and investigation undertaken in accordance with the Management Plan developed in Criteria 1.6.	Identification of Acid Sulphate Soils (NO0372)
11) An adequate density of healthy growing trees is established in woodland areas and ongoing recruitment (or evidence thereof) is occurring	11-1) Tree densities are within the upper 75% of the range of values recorded for each corresponding baseline vegetation group.	Outcomes (UCL)	Rehabilitation Performance Monitoring	Rehabilitation Monitoring Procedure (C0069)
	11-2) Second generation tree seedlings are present in mature rehabilitation.	Outcomes (UCL)	Rehabilitation Performance Monitoring	Rehabilitation Monitoring Procedure (C0069)
12) An adequate understorey density, species richness and cover has developed	12-1) Species richness is ≥70% of the mean value recorded in all 20m x 20m reference plots of the same vegetation group.	Outcomes (UCL)	Rehabilitation Performance Monitoring.	Rehabilitation Monitoring Procedure (C0069)
	12-2) Density of native plants is ≥50% of the mean value of all quadrats recorded in reference sites of the same vegetation group.	Outcomes (UCL)	Rehabilitation Performance Monitoring.	Rehabilitation Monitoring Procedure (C0069)
	12-3) Total combined native plant percentage cover is ≥60% of the mean value of all quadrats recorded in reference sites of the same vegetation group.	Outcomes (UCL)	Rehabilitation Performance Monitoring.	Rehabilitation Monitoring Procedure (C0069)
	12-4) Significant Species strategy developed under criterion 2-8 has been implemented and targets contained within are achieved.	Outcomes (UCL)	Monitoring and assessment against the targets within the Significant Species strategy.	
13) Weeds, including Declared Weeds, have been	13-1) Declared Weeds are not present and total combined projected foliar cover of other weeds is not	Outcomes	Rehabilitation Performance	Rehabilitation Monitoring

Maturing Rehabilitation (2-10 years)				
Objective	**Criteria**	**Category**	**Assessment Method**	**Procedure**
controlled	significantly greater than that measured in reference plots.	(UCL)	Monitoring.	Procedure (C0069)
14) Native vegetation is sustainable and resilient to fire, and drought. Agricultural areas are	14-1) Rehabilitation will regenerate following burning.	Outcomes (UCL)	Investigation: conduct burning trials in typical rehabilitation deemed sufficiently developed to recover from fire and measure the response.	Improvement Plan
	14-2) Tree, understory and grass species are demonstrated to be resilient to drought, (total annual rainfall <50% of average, or more than 2 years of rainfall <75% of average).	Outcomes (UCL)	Investigation: vegetation resilience assessment based on quantitative monitoring data during periods of drought.	Improvement Plan
	14-3) Studies show soil nutrient resources are sufficient to support the targeted vegetation group, and there is no evidence of plant nutrient deficiencies. Nutrient cycling processes (e.g. litter breakdown) have developed in soil profiles.	Outcomes (UCL and Freehold)	Investigation: the nutrient status of soil profiles and plant nutrition at various ages after establishment is assessed	Improvement Plan
15) Fauna is colonising rehabilitation	15-1) Vertebrate fauna indices for key bio-indicator species or groups are trending towards those recorded in surrounding undisturbed areas.	Outcomes (UCL)	Fauna Monitoring	Rehabilitation Monitoring Procedure (C0069)
	15-2) Invertebrate fauna indices for key bio-indicator species or groups are trending towards those recorded in surrounding undisturbed areas.	Outcomes (UCL)	Investigation: selected groups such as ants and foliage invertebrates in typical rehabilitation of various ages to be undertaken	Improvement Plan
	15-3) Key fauna habitat characteristics are present in rehabilitation, including a developing soil profile, vegetation structure, a diversity of flowering species and a developing litter layer.	Outcomes (UCL)	Rehabilitation Performance Monitoring.	Rehabilitation Monitoring Procedure (C0069)

Closure Stage				
Objective	**Criteria**	**Category**	**Assessment Method**	**Procedure**
16) Rehabilitation is sustainable and the land capability is suitable for agreed end land use	16-1) Monitoring data and research outcomes relating to soil, flora, water and fauna, and site inspections indicate that the rehabilitation will be sustainable and fulfil the rehabilitation objectives.	Outcomes (UCL and Freehold)	Verification of company records and relevant monitoring and investigation projects.	Overall conclusion based on meeting the relevant criteria of Section 4
	16-2) Identified contaminated sites (as per criterion 1.7) has been managed in accordance with requirements of the *Contaminated Sites Act* 2003.	Outcomes (UCL and Freehold)	Verification in accordance with procedural requirements of the Act and supporting regulations.	
17) Infrastructure is decommissioned.	17-1) All infrastructure that does not serve a useful ongoing purpose has been removed unless its retention was agreed with relevant Government agencies.	Outcomes (UCL and Freehold)	Visual inspection and company records.	Will be developed as part of the Mine Closure Plan
18) Long-term management.	18-1) Long-term management operations will not be greater than those of areas prior to mining, or where extra management actions may be required, a mechanism has been put in place for addressing these	Outcomes (UCL and Freehold)	Verification of company records.	Identification of any ongoing management requirements during assessment of Section 4 Criteria and development of the Mine Closure Plan

7.2 Derivation of Completion Criteria

Given that this Mine Closure Plan is being used as the vehicle for EPA, DSD and DMP acceptance of the proposed completion criteria, this section has been included to explain the derivation of selected criteria in Table 7. The section elaborates where necessary on some of the principals used to develop the criteria and is taken from Nichols and Woodman (2011) with some amendments to incorporate relevant recent research and investigation. Reference to the criteria below is via the numbering system in the table (e.g. C1-1 is as presented in the table under Objective 1, Criteria 1).

7.2.1 Soils and Landform Criteria

7.2.1.1 Soil Profile

Detailed soil profile reconstruction plans are developed for each rehabilitation area to ensure appropriate resources are allocated to achieve the rehabilitation objectives.

Key considerations in soil profile reconstruction include:

- infiltration and water holding capacity;
- landform stability and the management of dispersive soils;
- access to plant available soil moisture and suitable plant rooting medium; and
- topsoil for plant establishment.

Available materials including those stripped prior to mining and sand tailing streams (sand and slimes fractions) are classified according to their properties. Soil texture and aggregate stability are the primary means of classifying materials. Table 8 shows the classification matrix applied at Cooljarloo which is based on the concepts proposed in Blandford (2004).

Table 8: Classification of materials used in soil profile reconstruction

Material	Texture / PSD[1]	Aggregate Stability[3]	ESP[2] %	Use in profile
Sands (Class 1)	<6% clay	4,5,6	<6	Upper or lower profile.
Loamy Sand – Clay (Class 2)	>6% clay	4,5,6	<6	Lower profile
Loamy Sand – Clay (Class 3)	>6% clay	1,2	>6	Buried at depth

1 Exchangeable Sodium Percentage

2 Particle Size Distribution

3 Aggregate stability classes

Likely Class 1 resources are identified prior to mining based on drill log data and sample analysis. This enables the development of detailed material movement schedules and landform plans. During mining and landforming, field tests are conducted to confirm soil texture and aggregate stability (as required). After placement into the rehabilitation profile,

soil samples are taken through representative horizons for laboratory testing and confirmation materials have been placed to plan. At this stage additional parameters are measured including bulk density, aggregate stability, soil chemistry, partial size distribution, soil moisture characteristics and soil strength.

All reconstructed soil profiles (with the exception of drainage lines, wetlands and other non-standard areas) are designed in two key layers:

- Upper profile; and
- Lower profile.

Soil profiles are designed such that the upper profile is constructed with sandy Class 1 material and topsoil to enable high rates of surface infiltration and reduce the risk of surface water runoff during intense rainfall events. Surface infiltration rates in profiles completed as per the design criteria (C1-3 and C1-4) have been shown to typically result in surface infiltration rates that fall within the range of baseline reference plots and capable of withstanding significant rain fall events without ponding (Blandford 2012). The design criteria (C1-3) prescribes the depth of Class 1 material required to avoid profile saturation during significant rainfall events thus reducing the risk of inundation and/or erosion. Unsaturated hydrologic modelling conducted by Soil Water Consultants in 2012 suggests that the profile design defined in C1-3 and C1-4 would withstand a 1:100 year 72 hour storm event without surface ponding. Furthermore, bulk density and permeability results assessed within rehabilitated profiles indicate that water movement through the profile is generally not impeded by compaction or hard setting clay lenses in profiles constructed according to the design criteria (Blandford 2012).

Criteria C9-1 to C9-3 acknowledge the need for the reconstructed soil profile to behave in a similar manner to reference sites with respect to Plant Available Water and root penetration through the soil profile. The criteria will be assessed via targeted investigations and are likely to be updated in future iterations of the completion criteria as monitoring and measurement techniques evolve.

7.2.1.2 Soil-Vegetation Associations

Soil profiles are constructed to support vegetation representative of the baseline communities (Section 8.1.4.3). Table 10 shows the target reconstructed soil profiles associated with each broad vegetation community. The key variable within each profile is the depth of sandy material (Class 1) over materials with higher clay content (Class 2) or water table. This depth is based on observations within baseline reference plots which were assessed in various surveys (Blandford 2001 and 2006) and more recently refined by unsaturated modelling work completed by Soil Water Consultants (SWC 2012).

The design criteria and material classification listed in C1-3 and C1-4 are intended to provide an adequate rooting zone in the upper soil profile for plant establishment without creating an impediment to rooting depth. Monitoring of rehabilitated profiles in the upper profile indicates that the soil strength and bulk densities are unlikely to impact rooting depth

(Blandford 2012). Furthermore, the Class 1 material was typically friable and unlikely to impede root penetration (Blandford 2012a).

Given the low clay content in natural Class 1 material and tails Class 1 (i.e. 1-3%), plant water demands for the intended vegetation communities are met via a zone of higher moisture retention (either Class 2 or water table) within the expected plant rooting zone. This is considered within the rehabilitation planning process to ensure the targeted Rehabilitation Vegetation Groups are associated with the appropriate soil moisture regime. To build upon the studies already conducted (Blandford 2012 and SWC 2012a) further work is proposed in the Investigation Plan (Section 9.2.8) to assess plant root penetration and access to soil moisture at depth via detailed root mapping in rehabilitation soil profiles.

7.2.1.3 Landform and Stabilisation

The reconstructed landform is designed to be sympathetic to the natural landscape such that the topography and drainage lines are tied into pre-existing features (C1-1). Slopes are designed flatter than 1:12 to reduce the risk of instability caused by water movement down slope, along subsurface impeding layers or surface flows in the event that 100% infiltration is not achieved (C1-2). Survey is used to control operations in the field and to verify that criteria have been met.

Criteria C6-2, C8-1 and C8-2 have been developed to identify landform instability characterised by channelised flow (gullies/rills) or slumping. Any channelised flow that has developed to form a gully is considered to be unstable and requiring attention. Any slumping beyond what could be expected in terms of normal land settling is also considered to be unstable. Transect monitoring is conducted in areas <12 months old and then again in maturing rehabilitation to assess these criteria.

Field trials and ongoing monitoring of rehabilitation areas at Cooljarloo have determined an appropriate method of stabilising topsoil against excessive loss due to wind erosion in rehabilitation areas. Mulching at a rate of between 40 – 70 m^3 per ha have been shown to effectively control topsoil loss in areas such that vegetation cover can be established. The operational requirements to stabilise rehabilitation areas has been included as C1-5. Transect monitoring is conducted in rehabilitation areas <12 months of age to assess if the areas shows signs of sheet erosion (C6-1) or loss of mulch/litter cover.

7.2.1.4 Acid Forming Soils

As outlined in criterion C1-6 the risk of disturbing Potentially Acid Sulfate Soils (PASS) during the mining process is assessed at various stages of resource definition through the sampling and analysis of representative drill samples. Where PASS are identified, a Management Plan for that specific area is developed. Options are weighed up against the potential economic cost of sterilising a part of the ore body and the risk/cost of managing the materials during the mining/rehabilitation process. Criterion C9-1 identifies that PASS which are mined must be managed according to procedure NO0372 (Identification of Acid Sulphate Soils) which

requires that any mined PASS areas be monitored, such that the success against targets in the site specific Management Plan can be demonstrated.

7.2.2 Vegetation Criteria

7.2.2.1 Keystone Species

Four vegetation groups are targeted for establishment at Cooljarloo based on groupings of similar plant communities in the baseline vegetation mapping (WEC 2012). Similarity is determined on the basis of floristic composition and landform/soil associations (WEC 2012).

This approach means that the 27 identified plant communities are combined into four RVG's that are intrinsically linked to relevant soil landscape/landform types. The species richness of each RVG exceeds that of any individual community, providing a broader range of species to establish in rehabilitation than would otherwise be available from any individual community. This approach effectively enables the species most suited to the specific conditions presented by each rehabilitated site to develop.

Criterion C2-6 relates to the establishment of RVG's through the use of keystone species identified in baseline reference plots. Work conducted during 2002 and 2012 by Woodman Environmental utilised the concept of keystone species to identify those species that were considered important functional components for each RVG. A keystone species may be a dominant component in terms of abundance, structure or foliage cover, or fulfil a specific function (e.g. habitat or foraging for fauna). Specifically they are species:

- recorded in greater than 25% of quadrats (frequency);
- contributing to the top 70% of cover (on average);
- structurally significant to the vegetation group; or
- providing habitat within the vegetation group.

Keystone species with tree form are determined using baseline reference plot data, where every tree species recorded in plots for each plant community is regarded as a keystone species (WEC 2012).

Understanding the keystone species enables native seed mixes to be developed ensuring the return of keystone species, providing a vegetation structure consistent with the original vegetation communities. Native Seed applied in rehabilitation is of local provenance (C2-3) and is supplemented by propagule resources in mulch and topsoil.

7.2.2.2 Topsoil and Mulch Management

Propagule sources including topsoil and mulch materials are managed systematically so that they are segregated and placed onto rehabilitation according to the planned Rehabilitation Vegetation Group (C2-5).

First cut topsoil contains propagules which become progressively less viable with age after stripping. A minimum of 10% fresh/direct return topsoil is committed to in C2-4. While

every effort is made to maximise the portion of direct return above 10%, volumetric topsoil stockpile balances limit this proportion without stripping off mine path. Furthermore, timing issues relating to when topsoil is disturbed and when rehabilitation areas are available means not all of this resource can be used as direct/fresh cut and has to be stored prior to use. These timing issues relate predominantly to the optimum window of opportunity for rehabilitation (~3 months) which conflicts with mining that operates continuously. Studies within the Investigation Plan look at optimising the use of available fresh topsoil reserves to assess whether this minimum proportion can be improved.

7.2.2.3 Species of Significance

Rehabilitation monitoring data is reviewed annually against baseline data to identify those desirable species that are not being re-established. These species include significant species, keystone species or iconic species as described in WEC 2012a.

In criterion C2-7 a commitment is made to maintain a recalcitrant species list and implement a strategy targeting return of these species. Corrective actions to improve recruitment, generally involves adjusting seed mix composition, seeding rates and seed treatments, however research targeting specific species is also undertaken.

Using a similar strategy as described above, relevant Threatened and Priority flora are targeted for return into rehabilitation areas. The strategy identifies all Threatened and Priority species recorded in baseline surveys and describes the management requirements for each species (C2-8). Further research and collaboration with specialists may be required for those species that are not currently being returned into rehabilitation via standard methods.

7.2.2.4 Native Plant Density (Abundance)

Native plant density referenced in criterion C11-2 is calculated using the average plants per quadrat from monitoring plots. Separate targets are applied to each Rehabilitation Vegetation Group to reflect the baseline reference plots. For each RVG, it is initially suggested that the minimum target density for native understorey plants be ≥50% of the mean value per quadrat recorded in reference sites of the same vegetation group. This value is at the higher end of what has been demonstrated to be achievable in historical rehabilitation areas and is within the range monitored in the baseline reference plots (except Dry Heath RVG which is slightly lower than the range).

This criterion takes into account variability over time in rehabilitation areas, with plant numbers increasing in the first few years as seeds germinate and establish, then decrease as competition occurs. Eventually a balance between the establishment of second generation plants, deaths, and reinvasion from the surrounding unmined areas occurs.

7.2.2.5 Tree Density

In Dry Woodland reference sites there is considerable natural variation in the density of tree species. Logically, it would seem appropriate for rehabilitation to be within the range recorded in the reference sites. However, it is not considered appropriate that the minimum

milestone for tree density be the lowest density recorded in any reference site. For this reason, it is initially recommended that in Dry Woodland rehabilitation, the target density for trees be within the upper 75% of the range recorded in reference sites (C10-1). No tree density targets are set for heath vegetation groups as trees do not form a significant component of these communities (Nichols et. al 2011).

7.2.2.6 Native Species Richness

Species richness is calculated for each plot by counting the total number of unique species in all 2 x 2 m quadrats within each plot. A milestone for species richness is essential in a floristically diverse ecosystem such as that at Cooljarloo. As with density, separate species richness targets are applied relevant to the associated reference sites.

It is initially suggested that the minimum species richness target for understorey be ≥70% of the mean value recorded in all 20 m x 20 m reference monitoring plots of the same vegetation group (C11-1) (Nichols et. al 2011). This value is at the higher end of what has been demonstrated to be achievable in historical rehabilitation areas and is within the range monitored in the baseline reference plots (except Dry Heath RVG which is slightly lower than the range).

As with density, this recognises that there is variability within reference sites. It also takes into account variation in richness over time, increasing in the first few years as seed germinate and establish, then decreasing as competition occurs, finally achieving a balance between establishment of second generation plants, deaths, and reinvasion from the surrounding unmined areas (Nichols et. al 2011).

7.2.2.7 Plant Cover

Plant cover is calculated as the total projective foliage cover of native plants within each quadrat. A measure of cover is important as it indicates protection from sun, wind and water erosion and is closely related to biomass development (Nichols et. al 2011). As with the other parameters above, this will serve as one of the indicators of ecosystem development. Initially a target value of ≥50% of the mean value per quadrat recorded in reference sites of the same Vegetation Group (C11-3) was recommended (Nichols et. al. 2011). This was later increased to ≥60% in 2013 to reflect what was broadly achievable in historical rehabilitation.

7.2.2.8 Dieback (Phytophthora cinnamomi)

Considerable effort has been made to prevent the spread of dieback through the mine lease at Cooljarloo. Strict hygiene controls (clean vehicles, machinery and equipment on entry and exit) are in place to reduce the risk of the pathogens entering the lease (C4-1). Existing infestations on the mining lease are quarantined and ongoing research is underway in conjunction with the Centre for *Phytophthora* Services and Management (CPSM) to determine cost effective means of containing/eradicating infestations.

Soil profiles are designed for 100% infiltration to minimise the risk of Pc being spread through surface water flow or water ponding (C4-3). Design criteria C1-3 and C1-4, meet the intent of this by dictating that the upper surface profile must be constructed with sandy material to a depth that will prevent saturation to the surface.

Dieback resistant plant species are included in native seed mixes to minimise the risk of rehabilitation failure if Pc infestation occurs (C4-2). A list of Pc tolerant species is maintained and updated as further research and information becomes available.

7.2.2.9 Weeds

Monitoring data and anecdotal evidence suggests that weeds are largely out-competed by native species as rehabilitation matures. Ongoing weed spraying is conducted for weeds in young rehabilitation to control any significant infestations (C7-1). At the mature rehabilitation stage the criteria requires that the projected foliar cover is not significantly greater than that of undisturbed vegetation and no declared weeds are present (C12-1).

7.2.2.10 Nutrient Cycling

Research projects investigating aspects of site nutrition will be undertaken to provide the information required in Objective 11, C11-1. These will focus on assessing the soil nutrient bank in rehabilitation of various ages and representative reference sites, development of biomass, litter breakdown and incorporation into the soil profile. The aim will be to determine whether the reconstructed soil profile and vegetation are likely to experience any deficiencies of key macro- or micro-nutrients, and if significant, what management needs to be undertaken to address the situation and prevent it occurring in future rehabilitation.

7.2.2.11 Resilience

Investigations will be conducted to determine the resilience of suitably developed rehabilitation to fire and drought (C13-1 and C13-2). It will be important to understand the long term response and recovery of rehabilitation to such aspects, to ensure sustainability can be demonstrated.

Resilience to drought will be assessed using health monitoring data from rehabilitation and reference sites during periods of drought and burning trials will be conducted in selected rehabilitation areas with targeted monitoring. Results of both investigations will be used to improve rehabilitation practices if necessary and all results will be reported to relevant Stakeholders.

7.2.3 Fauna Criteria

7.2.3.1 Habitats

Operational criteria, as described in Objective 3 require that 'Rehabilitation is designed to support fauna assemblages similar to those in the surrounding undisturbed areas.' The specific criteria in this instance focus on important actions that Tronox needs to carry out to establish habitat suitable for fauna recolonisation (C3-1 – C3-3). These include establishing

suitable soil profiles for burrowing fauna species, providing plant species suitable as a feeding resource for Carnaby's Cockatoo and returning woody material that will provide shelter for a range of fauna species. The criteria are assessed by survey control, rehabilitation records (e.g. seed lists) and documentation using signoff sheets.

7.2.3.2 Colonisation

Criteria, as described in Objective 14 require that 'Fauna is colonising rehabilitation.' This is assessed by criteria, which require that:

- indices for key indicator species and groups are trending towards those recorded in surrounding undisturbed areas;
- invertebrate groups are recolonising; and
- fauna habitat is establishing.

These are assessed through ongoing fauna monitoring and, where relevant, targeted studies of key faunal groups (e.g. invertebrate functional groups such as ants, foliage invertebrates and spiders).

The principles on which the faunal indicator species and groups are based, are described in Bamford Consulting Ecologists (2009). Their report concluded that development of fauna completion criteria can be guided using two complementary approaches, viz. fauna assemblage analysis and individual bio-indicator species monitoring. Together with assessment of fauna habitat development, and planned studies on key functional invertebrate groups, these will provide a good indication of the extent of fauna recolonisation.

8 CLOSURE DATA

The following sections provide a summary of the data available to plan and implement mine closure at Cooljarloo. Extensive and detailed baseline environmental information has previously been provided via a range of approval documents and management plans. Pertinent data, relevant to mine closure is summarised in Section 8.1 providing context for the sites environmental objectives, targets and associated procedures.

An assessment of gaps in knowledge relating to baseline data is provided in Section 8.2.

Data for the Cooljarloo West project has been incorporated into this MCP. Additional information is also provided in the Public Environmental Review document for the project.

8.1 Environmental Context

8.1.1 Climate

Cooljarloo is located in the Midwest region of the Southwest Land Division of WA, which is broadly defined as the area south of a line between Kalbarri in the northwest and Esperance in the southeast. The site experiences a dry Mediterranean type climate consisting of hot, dry summers and cool, wet winters.

Average annual rainfall is approximately 550 mm (25 year site average) with June and July typically the wettest months of the year. Overall the site is in rainfall deficit as at more than 2m per year, evaporation far exceeds annual rainfall. The dry summer months may be subject to infrequent but heavy, rainfall events. Temperatures range from a mean maximum of 34.9°C in January to a mean minimum of 9.0°C in July (5 year site average). Easterly winds are dominant in the morning throughout the year, particularly in summer. The afternoon wind pattern is variable with strong south-westerlies a feature during the summer months (Maunsell 1987).

Site specific climatic data has been collected at Cooljarloo since 1990, including various parameters relating to rainfall, evaporation, humidity, wind speed/direction and soil/air temperature. Figure 15 shows annual rainfall and the cumulative annual difference relative to the mean since 1990.

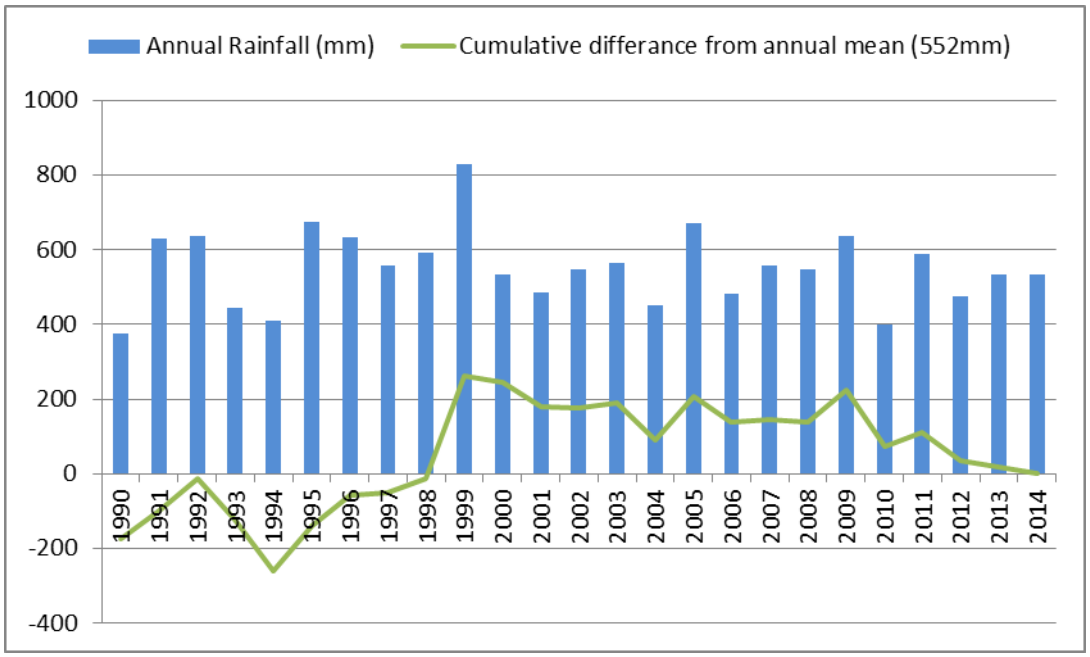


Figure 15: Annual Rainfall and cumulative annual rainfall difference relative to the mean – Cooljarloo Site Dataset

8.1.2 Geology

Cooljarloo is located within the Swan Coastal Plain, a major geomorphologic division of Western Australia, to the west of the Gingin Scarp. Extensive geological survey and interpretation has been conducted on site by Tronox Geologists and consulting professionals as a part resource development, aquifer characterisation and environmental baseline surveys (Figure 16).

The mineral sand deposits occur at the top of a series of sedimentary deposits, within a sequence of relatively recent (Quaternary) unconsolidated sands (Maunsell et. al. 1987). They generally originate from the adjacent Yilgarn Block, which has been eroded, transported by rivers and streams and deposited as beach sands along former coastlines (Maunsell et. al 1987).

The deposits now form successive north-south linear deposits well inland from the present coast. Upper level deposits that either outcrop or are covered by minimal amounts of non-mineralised material (overburden), occur in the northern half of the tenement. Mid-level deposits are covered with varying depths of overburden. The basement deposits occur below the mid-level deposits and are typically more weathered and of lower heavy mineral grade.

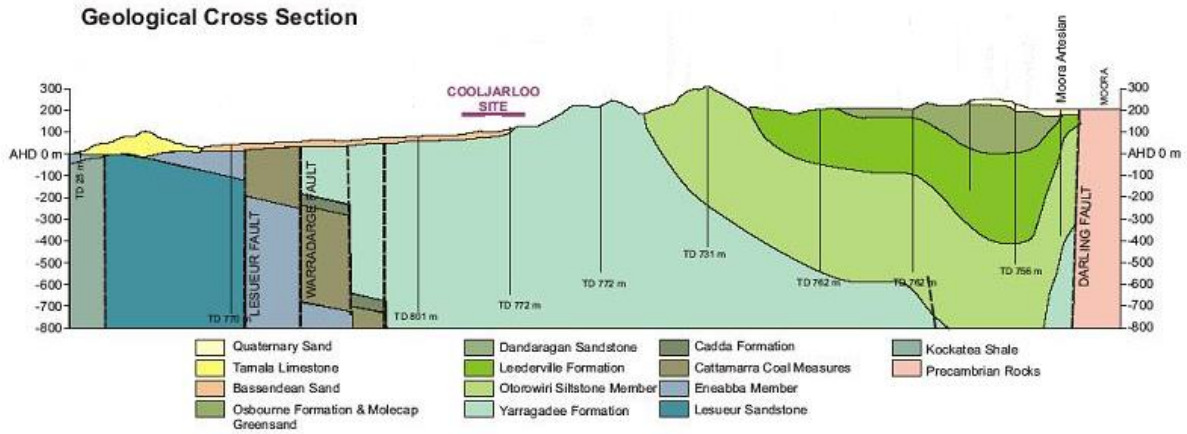


Figure 16: Regional Geological Cross Section (from Parsons Brinckerhoff, 2012)

8.1.3 Landforms

The site is bounded on the east by a distinctive terrain dominated by dissected remnant hills of the Ridge Hill Shelf where unconsolidated surficial deposits (colluvium) have built up and dominate slopes (Blandford 2011). Immediately to the west of the elevated terrain lies an extensive Bassendean sand complex comprising sand dunes, inter-dunal basins and sand plains with a gently undulating surface (Blandford 2004). The difference in elevation from the eastern ridge to the low-lying inter-dunal basins in the west is around 80 m.

Several surface drainage systems exist which appear to be older systems truncated by sand dunes and sheet sands that were deposited during the onset of aridity (Blandford 2004). Many of the contemporary drainage systems and wet areas have developed on materials with elevated clay and have impeded vertical infiltration (Blandford 2004). Two seasonal surface water channels exist which flow from the east to west (Mullering Brook and Mount Jetty Creek).

8.1.4 Soils

The Northern Sandplains are characterised by sandy surface soils, sometimes underlain by sandy material and sometimes by heavier soils and cemented materials (Blandford 2004). The Cooljarloo lease displays an accumulation of Tertiary ferricrete in the soil profiles of the eastern uplands (Blandford 2004). In areas where the debris was weathered and transported down slope, secondary cementation has often occurred in depositional areas of the Western Lowlands sometimes resulting in massive ferricrete (Blandford 2004).

Several significant soil investigations have been undertaken at Cooljarloo to map the soil landscapes and to collect baseline reference data. Most notably Blandford and Associates surveyed the Cooljarloo Site in 2001 excavating over 300 soil pits to characterise the soil profiles across site and Soil Water Consultants (SWC 2013) surveyed Cooljarloo West during 2013. The resulting soil map is provided in Figure 18. Further interpretation has been undertaken using available drilling data to assess soil texture to depth in the profile.

Broadly speaking, there are two vertically distinct horizons over much of the Cooljarloo Lease - the upper sandy profile and a deeper horizon with a higher clay content. Figure 17 shows a north-south cross section of the soil profile at Cooljarloo based on drilling data (fines content) and Figure 19 shows a plan view of the distribution of recharge (derived from the transmissivity and thickness of the clay rich intermediate superficial horizon (unit) as determined by Worley Parsons (2015). Further detail is provided below.

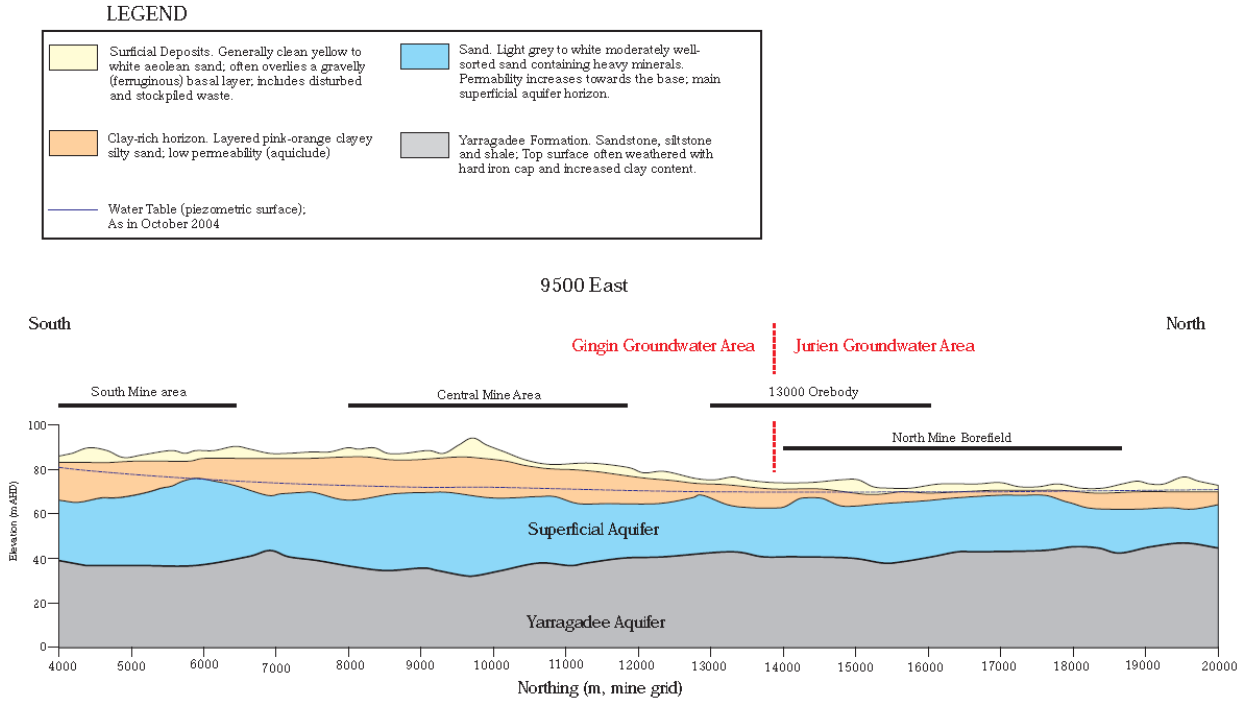


Figure 17: Cross Section Soil Profile

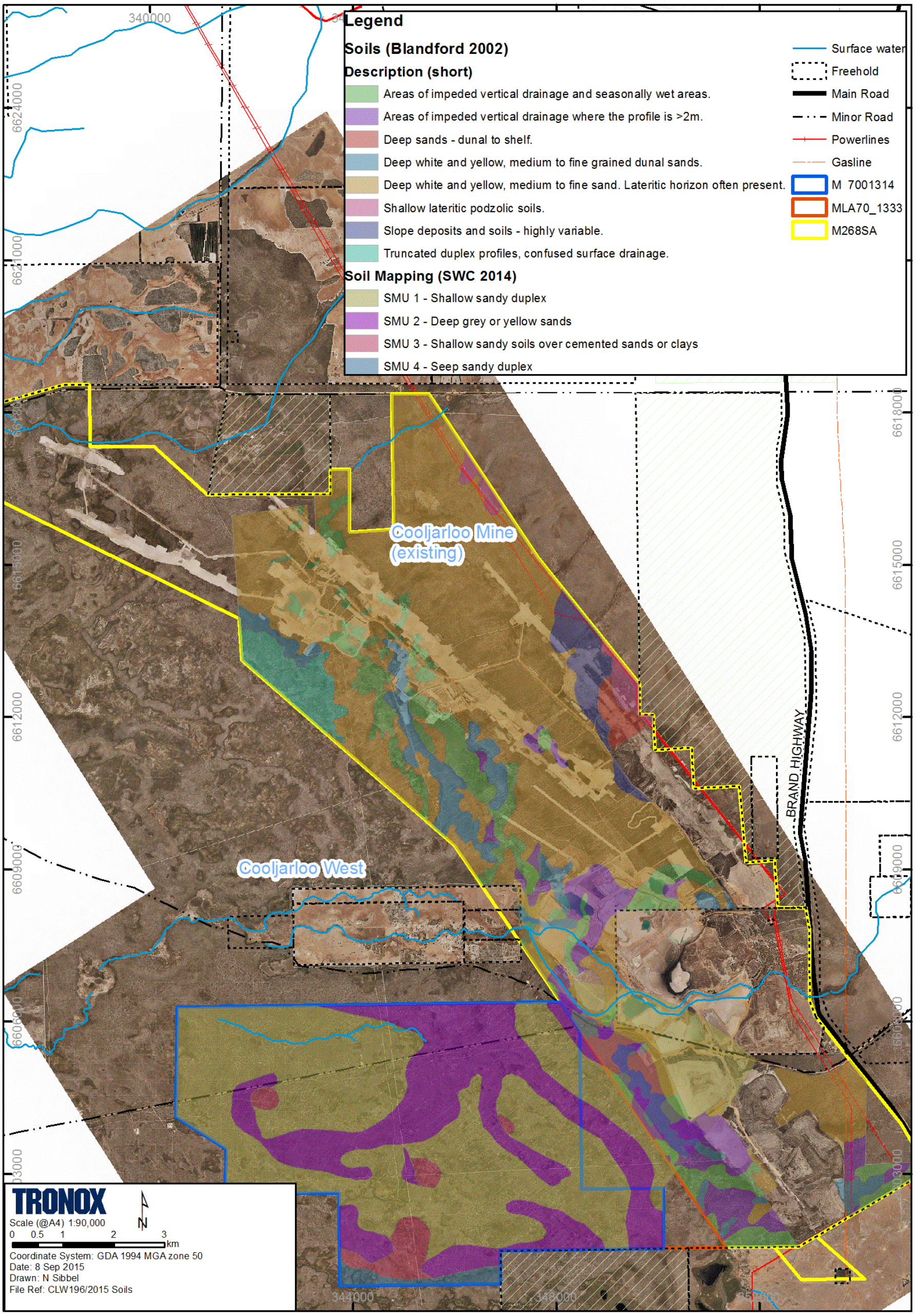


Figure 18: Cooljarloo Soil Map

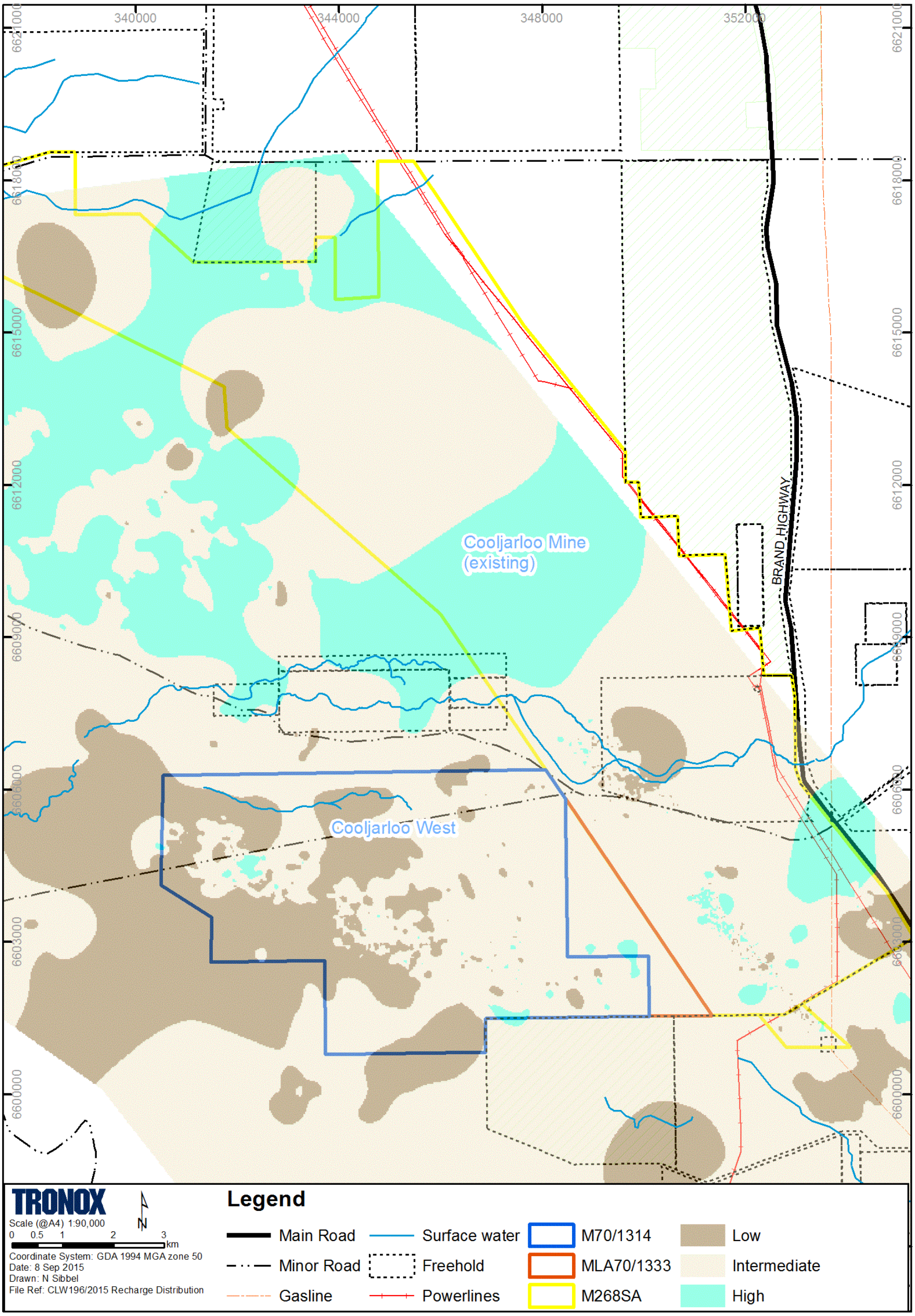


Figure 19: Distribution of recharge within the intermediate superficial formation (derived from fines distribution in and above the superficial aquifer)

8.1.4.1 Surface Sands

Surface sands are characterised by range of properties that influence the vertical movement of water and the retention of moisture in the profile (Blandford 2004). These properties include (from Blandford 2004):

- Particle size ranging from very fine to coarse grain size sands which strongly influences profile permeability and soil moisture retention;
- Degree of sorting which influences permeability, soil moisture retention and erodibility; and
- Presence of fabric development generally found in finer grained sand, indicative of pedologic processes which can indicate increased soil moisture retention capabilities.

These surface sands typically have a clay content of approximately 1%, silt content between 1-2% and fine sand content of 18-26% (Blandford 2004). *In situ* bulk densities in reference sites have been measured ranging from 1.14 - 1.78 t/m^3 (1.54 t/m^3 average) and soil strength average of 1.2 kg/cm^2 (Blandford 2012). The sand materials are generally non-sodic and nutrient deficient (Blandford 2004). Soil moisture retention in this sandy material is typically low with between 1- 4% plant available water. Surface infiltration rates are high, in excess of 1,000 mm/hr (Blandford 2004).

Figure 20 shows a typical surface sandy profile in a pit excavated to the north of the lease.

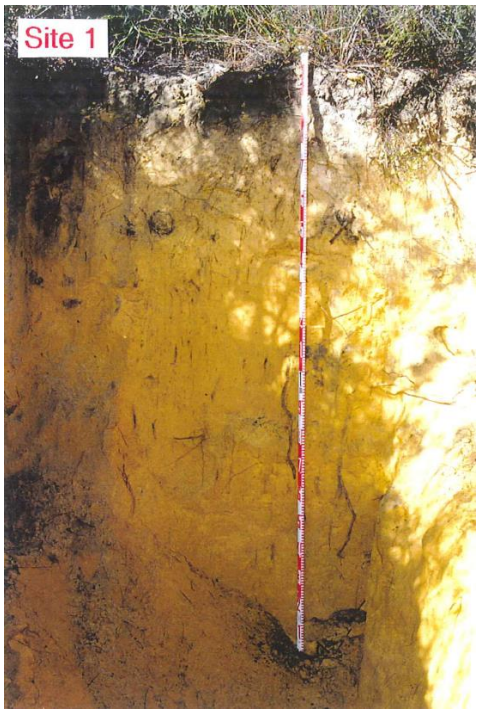


Figure 20: Sandy Upper Soil Profile

8.1.4.2 Deeper Clay zone

Underlying the sand sheet is a discontinuous layer of material with higher clay content than the overlying sands (Blandford 2004). This soil profile is often known as a "duplex soil". The layer varies in depth and thickness and contains sediments with variable clay content. In some areas this layer is absent and the upper sand layer continues to depth.

The clays at Cooljarloo are dominated by the kaolinite group however the smectite group have also been identified in the field in limited areas (Blandford 2004). Heavier clays exist in some areas close to the surface which have low permeabilities and impeded vertical drainage. These areas are typically associated with seasonally wet areas (Blandford 2004).

In places the clay horizon is associated with or overlain with ferricrette gravels of varying thicknesses (Blandford 2004). In some areas this gravel layer results in a zone of preferred lateral flowthrough due the high permeability of the materials. Where this gravel layer rests on the clay layer it can be associated with a zone of elevated soil moisture at depth (Blandford 2004).

This clay material can be sodic and dispersive in places. Its soil moisture retention varies greatly, closely linked to the proportions of clay and fine silt present (Blandford 2004). Figure 21 shows a typical clay profile overlain by the sandy upper layer.

Figure 21: Duplex Soil Profile

8.1.4.3 Soil Vegetation Associations

Woodman Environmental Consulting utilised the Blandford soils data to develop vegetation - soil associations for the purposes on rehabilitation planning in 2002 and later revised this in 2012. Table 9 below is based on the data taken from Woodman 2012. Further detail on the composition of each vegetation group is provided in Section 8.1.9

Table 9: Landform and Soil Characteristics of Rehabilitation Vegetation Groups

Rehabilitation Vegetation Group	Landform Characteristics	Soil Type and Characteristics
Dry Woodland	Dune mid and upper slopes and crests where water table does not approach within 2 m of the surface.	Upper profile: Sand from 1m to deep sands >3 m. Lower profile: Impeding layer not always present. Generally a gradation to a mottled clayey matrix at depth, sometimes with a laterite component.
Dry Heath	Lower slopes and undulating country that remain dry all year.	Upper profile: Sand from 0.5 to 1.5 m, generally <1 m with deeper sands near edges of Vegetation Group. Lower profile impeding layer: Generally a gradation to a mottled clayey matrix, however lateritic/clay layers are common.
Wet Heath	Lower slopes and in wet basins that may become waterlogged or inundated seasonally.	Upper profile: Sand from 0.3 to 1 m, generally around 0.5 m to sandy loams and clays Lower profile impeding layer: Not always present. Generally a lateritic/clay layer and siliceous pans may occur, however the water table often acts as a barrier to root development.
Wetland	Wet basins with frequent inundation.	Upper profile: Sand from 0.6 m to deep sands. Sandy loams and clays in some areas. Lower profile impeding layer: Not always present. Generally a clay layer and siliceous pans may occur where wetlands are perched above the water table. Wetlands that are not perched may have no impeding layer.

8.1.5 Potential Acid Sulphate Soils

Acid Sulphate Soils are naturally occurring sediments that contain iron sulfide minerals, predominantly as the mineral pyrite. These materials are typically found below the water table and are benign when undisturbed, but have the potential to cause environmental problems due to the release of sulphuric acid when exposed to oxygen (due to dewatering or during the excavation of soils and sediments) (DEC 2011 in Prep).

Pre-mining surveys have been undertaken as a part of standard exploration and resource drilling at Cooljarloo. An Acid Sulphate Soil (ASS) assessment was most recently submitted to the DMP/DEC in 2007 relating to the Dry Mine Falcon Extension in 2007. The findings of this investigation indicated the presence of potentially acid sulfate soils within the soil profile were typically restricted to depths of more than 2 metres below the proposed pit floor and would not be exposed disturbed in mining (Tiwest 2008).

For the existing Cooljarloo Mine, of the pre-mining soil data collected to date, less than 2% contain appreciable sulphides greater 0.03% (Chromium Reducible Sulfur). These samples

typically occur in isolated areas generally confined to the north and tend to be within a lithological unit represented by black/grey clays, which are generally located beneath the ore-body. The large majority of the black/grey clays encountered whilst mining to date are non-sulfidic and appear to consist of variably decomposed organics and peat (SWC 2012). Although Suspension Peroxide Oxidation Combined Acidity (SPOCAS) test work tends to suggest sulphides are present, with strong to extreme reactions following peroxide addition, the Chromium Reducible Sulphur results indicate in most cases the material is non-sulfidic with S_{cr} values <0.03% (SWC 2012).

An ASS survey of the Cooljarloo West project was undertaken by Soilwater Consultants (Soilwater 2013) in accordance with Tronox procedures and DER guidelines involving both desktop assessment and field survey. Based on the interpretation of the extensive geological dataset developed during resource drilling and experience identifying ASS material at the existing Cooljarloo Project and other sites, it was considered likely that PASS would occur predominantly at the boundary between the Guildford and Yoganup Formations and the boundary between the Yoganup and Yarragadee Formations.

From this, Soilwater developed a drilling program to sample for ASS. A total of 40 holes were drilled, with sampling undertaken between 12–72 m below ground level. All holes extended to a minimum of 2 m below the base of the proposed pit. Samples were collected at a 1 m intervals, with 1806 samples being collected.

The samples were screened for actual ASS and PASS using sampling for field pH (pHF) and pH following addition of hydrogen peroxide to oxidise any sulphides present (pHFOX). Actual ASS samples would show a pHF less than 4; PASS samples would have a pHF greater than 4 but a pHFOX less than 4 (DEC 2013). This testing determined that only two of the 1806 samples had a pHF less than 4, indicating that actual ASS are not common at Cooljarloo West.

PASS samples were associated with:

- basal 5 m of the Guildford Formation
- clayey sediments associated with a large lacustrine (ancient lake) system located along the southwestern margin of the North and South Woolka deposits
- within the Yoganup Formation where it overlies the Yarragadee Formation.

PASS samples were predominantly dark grey or black. Identification of PASS on the basis of colour is being used successfully at the existing Cooljarloo Mine.

Based on testing, PASS was determined to be extensive within the Kestrel deposit and along the southwestern boundary of the Woolka deposits, with areas of PASS also occurring in the central part of the Development Envelope (Figure 22).

Incubation testing confirmed that the PASS soils were relatively reactive and that soils would need to be managed fairly rapidly to prevent acidification, although samples did not always fully oxidise.

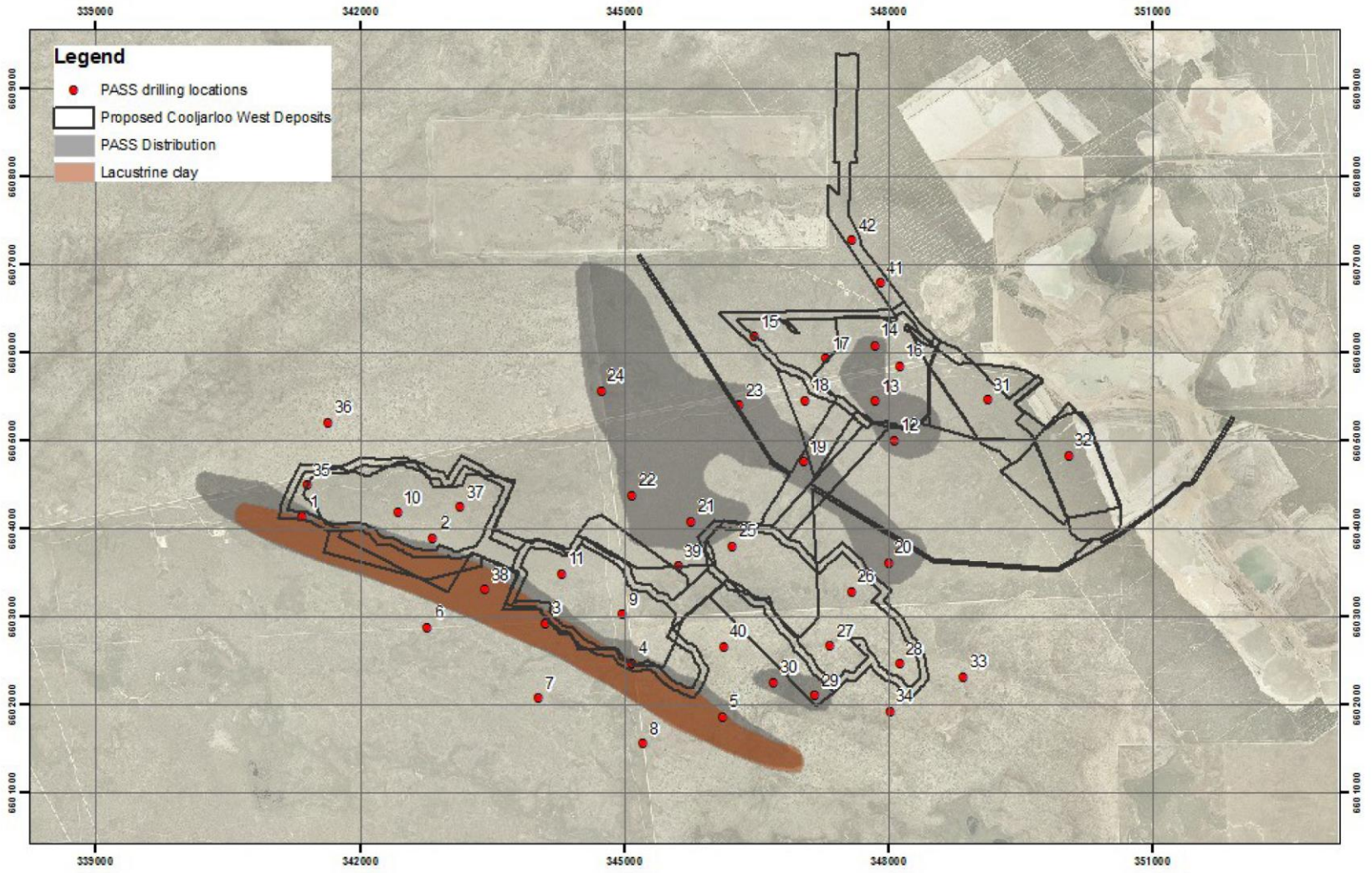


Figure 22: Location of PASS and sampling locations at Cooljarloo West (from SWC 2014)

8.1.6 Radiation

Mineral sands typically contain low level naturally occurring radioactive minerals including Monazite, a thorium bearing mineral (Tiwest 1989). Gamma radiation surveys were undertaken to characterise the baseline radiation levels at Cooljarloo (Terry 1989). Follow-up surveys were undertaken for ore-bodies in the Falcon Extension during 2007 (Calytrix 2007).

Baseline monitoring of radionuclides and absorbed dose rates were undertaken prior mining operations. The mean effective dose equivalent for radionuclides in air and absorbed dose rate in air, obtained for the baseline monitoring programme, was 0.27 mSv y^{-1} and 0.8 mSv y^{-1} respectively. This yielded a baseline background level of 0.83 mSv y^{-1} (Tiwest 1989). Baseline groundwater gross alpha activity was below the minimum detectable limits in most bores (Tiwest 1989).

8.1.7 Groundwater

An understanding of regional groundwater around Cooljarloo has been developed with a combination of regional investigation programmes by Government and site specific investigations completed by consulting specialists. A description of the key features as described in Parsons Brinkerhoff (PB 2012) and Worley Parsons (Worley 2013) is provided below.

There are two main regional aquifer systems in the vicinity of the project area: the Superficial Formations and the Yarragadee Formation.

The Superficial Formations are a series of Middle to Late Tertiary Formations composed of alternating layers of sands and clays, which form an unconfined to semi-confined anisotropic groundwater flow system (Kern 1989). This aquifer extends from ground surface to a depth ranging from 18-50 m (Parsons Brinckerhoff 2011) and receives recharge over a broad area (PB 2012). Groundwater in the superficial deposits flow westward from the Gingin Scarp to discharge along the coast.

The Yarragadee Formation is predominantly comprised of sandstone and forms both the thickest and most extensive aquifer system within the region (Parsons Brinckerhoff 2011). This aquifer is overlain in part by the Superficial Formations and is recharged via direct infiltration of rainfall through the Superficial Formations of direct rainfall recharge in locations of outcrop (west of the project area). Groundwater flow in the Yarragadee aquifer is in a westerly direction and the recharge zone is between the Gingin and Dandaragan Scarps (PB 2012) (Figure 15).

Further detail on the two distinct aquifers is provided below.

8.1.7.1 Superficial Aquifer

Description

The Cooljarloo mineral sands deposit is an undifferentiated formation contained within the Guildford Formation, a Quaternary sequence of Pleistocene age (Darragh and Kendrick,

1971). The economic deposits of heavy minerals are associated with reworked coarser coastal sands, and occur at depths of approximately 15 to 30 m below the surface and above the Yarragadee Formation. These sands form the main aquifer unit in the Superficial deposits at Cooljarloo (PB 2012).

The overburden composition is fundamentally different in the North Mine and South Mine areas. The superficial formation profile in the South Mine and Cooljarloo West area contains a significant thickness of clayey and silty, fine sand layers above the marine strand sands. These low permeability formations are either very thin or absent in the North Mine area. (PB 2012). The sequence is mantled by up to 6 m of aeolian Bassendean Sand which conformably overlies the Guildford Formation (PB 2012).

The clay-rich layer is thickest in the southern areas where the water table occurs within the clay-rich confining layer and accounts for the confined aquifer responses noted in some aquifer pump tests (PB 2012). There are also several areas where the clay layer is thin or absent. The water table is likely to be unconfined in these areas.

The Superficial aquifer is recharged primarily by direct infiltration of rainfall, supplemented by both seepage from runoff, and upward leakage from the Yarragadee Formation. Downward leakage from the Superficial deposits also occur in some locations. In cross sections generated from this work, Kern indicates an upward hydraulic gradient is present in the Yarragadee Formation in the vicinity of the Cooljarloo Mine site (PB 2012).

Recharge from direct precipitation has been estimated to be between 7.5% and 8% per annum over the coastal plain sands (PB 2012a), excluding upward flow from the Yarragadee Aquifer. This approximately corresponds to a recharge rate of 40 mm/yr.

Water Quality

Pre-mining baseline data indicates that the water quality within the Superficial aquifer ranges from around pH 3.4 (10 year average MSB03) in the north mine to maximum pH 5.9 (10 year average MSB09) in the south of the mining lease. Seasonal variations are evident in the Total Dissolved Solids (TDS) levels in the Superficial Aquifer and are inherently higher towards the northwest of the site (PB 2012). Baseline TDS levels range from a minimum of 514 mg/L (10 year average MSB05) in the south to 3,214 mg/L (10 year average MSB02) in the north. TDS levels increase further north in the Falcon Project area.

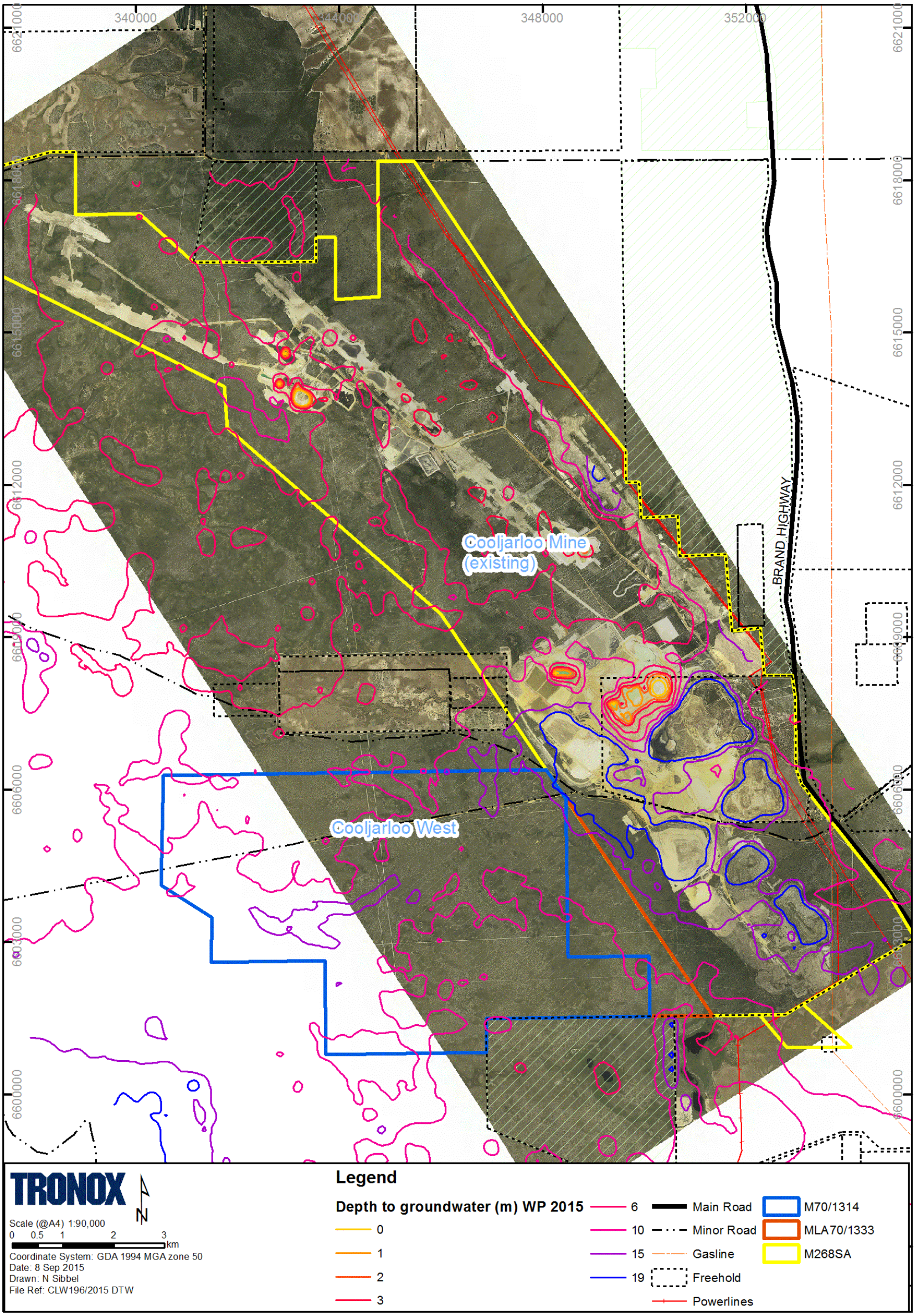
Water Levels

The seasonal variation in water levels observed in piezometers in the Superficial aquifer across Cooljarloo averages approximately 1.5 m, peaking in around October each year. Depth to groundwater ranges from >10 m in the south shallowing to the north to <3 m in some places as shown in Figure 23.

Hydrological drawdown modelling has been conducted to assess the likely drawdown associated with mining operations (PB 2012). Local temporary drawdown around mining voids is common due to dewatering within the mining pit or pond. Drawdown has the

potential to impact groundwater dependant vegetation and is managed in-line with established Groundwater Management Plans for specific areas.

Areas of groundwater dependant vegetation are generally confined to the northern areas of the lease where the depth to groundwater is relatively shallow. The degree to which vegetation is groundwater dependant decreases with depth to groundwater. For vegetation in areas where the water table is greater than 10 m from the surface the groundwater dependence is assumed to be negligible in terms of total plant water use (Froend & Zencich, 2002).



Note: Depth to water levels outside the mining leases are indicative only as the data available in these areas is limited.

Figure 23: Depth to Groundwater

8.1.7.2 Yarragadee Formation

The Yarragadee Formation occurs between 30 m and 50 m below the surface over much of the mining lease, but outcrops in places to the east. Testing, numerical modelling and water level monitoring indicates that the Yarragadee and Superficial aquifers are in hydraulic continuity for the majority of the site (PB 2012).

The Yarragadee Aquifer varies in composition from thin shale and coal units, to clean siltstones and thick coarse grained sandstones with primary porosity and permeability. Fracturing and faulting are present but not prevalent, and the aquifer in the eastern portion of the site appears to be uncharacteristically low yielding (PB 2012).

Water quality in the Yarragadee tends to be slightly acidic (pH 6.4-6.7) and TDS from 565-750 mg/l (Tiwest 1997). Water quality measured in the Yarragadee at Cooljarloo typically has a higher pH and lower TDS that in the superficial aquifer.

8.1.8 Surface Water

The Cooljarloo area is drained by watercourses originating on the Dandaragan Plateau and the Arrowsmith Region (WorleyParsons 2012). The occurrence of surface water at Cooljarloo is limited by the generally permeable surface sands and dry climate. Two ephemeral waterways pass through the Cooljarloo Lease including:

- Mullering Brook which bisects the lease draining a catchment in Gingin Scarp into a series of ephemeral lakes and swamps to the west of Mullering Farm (Tiwest 2008) (Figure 24); and
- Mount Jetty Creek which crosses the north east lease boundary and drains a catchment to the east of Wongonderrah Nature reserve forming a tributary to Nambung River (Tiwest 2008).

Lesser drainage lines carry intermittent flows from the Gingin Scarp onto the lease area where they dissipate in the sandy terrain.

All watercourses, including Mullering Brook in the Development Envelope and Minyulo Brook to the south, are seasonal streams, with highly variable flows, terminating in large swamps or lakes in the Bassendean dunes. Both brooks form part of the Minyulo suite, which is a group of wetlands that have local and regional significance as a result of stratigraphy and presence of endemic flora (Semeniuk Research Group 1994). Several permanent and seasonal lakes and swamps occur in interdunal depressions in the Bassendean Dunes, such as Emu Lakes to the south east of the Development Envelope (Kern 1989).

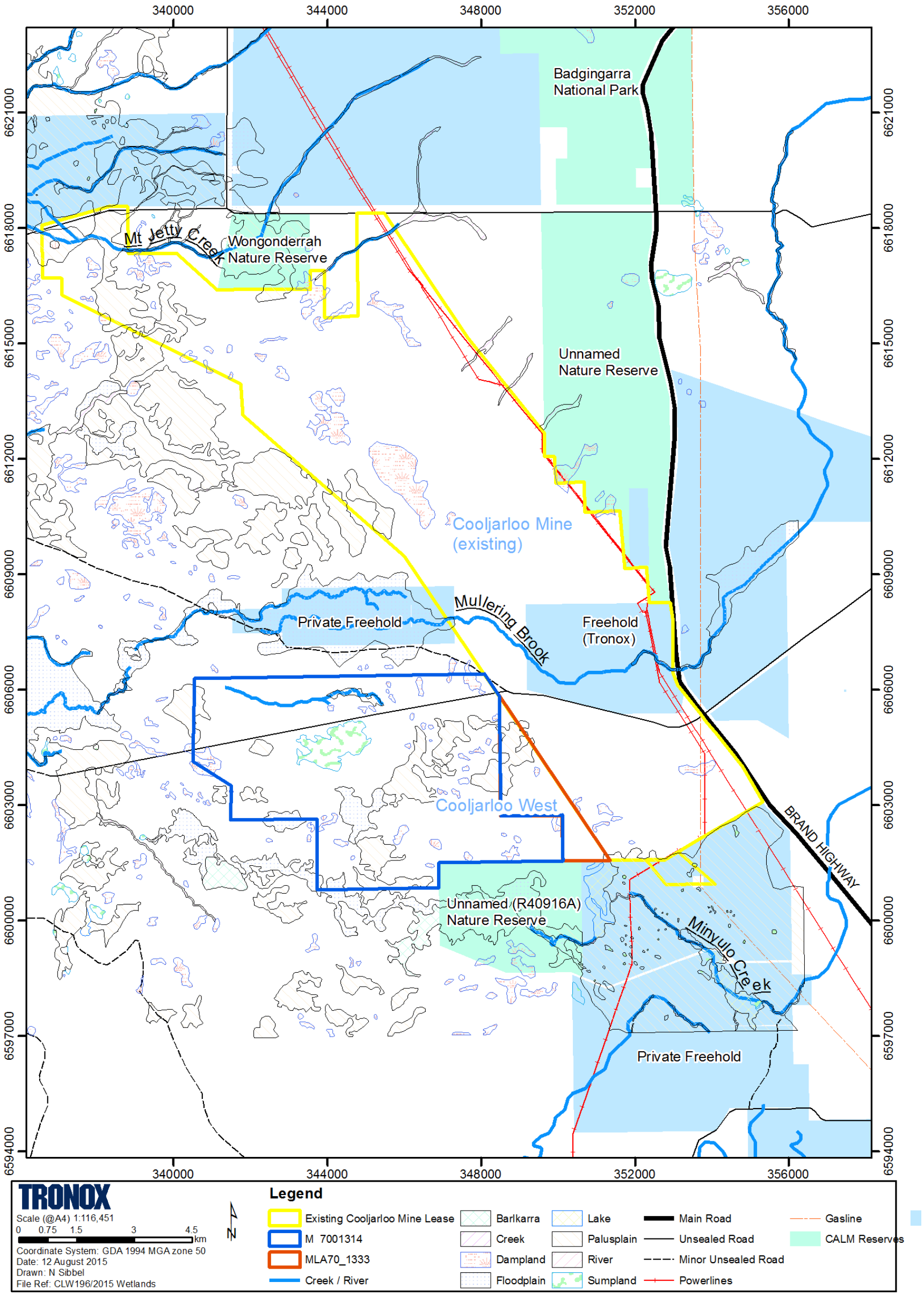


Figure 24: Surface Water Drainage

8.1.8.1 Mullering Brook

Mullering Brook streamflow and water quality has been measured since 1996 at the current two locations, one upstream and one downstream of the Cooljarloo operations (Figure 25). This data has been used to characterise various aspects of the watercourse as it enters and leaves the lease.

Flow is usually less than four months a year, typically during winter. Catchment flow modelling indicates a 10 year Average Reoccurrence Interval (ARI) is predicted to have a flow rate of up to 65 m^3/s (Golders 2003) in Mullering Brook. Flooding of the main Mullering Brook channel and across Cooljarloo Road has been recorded at flow rates of above 10 m^3/sec (Halpern Glick Maunsell 1996).

Water quality entering the lease has a Total Dissolved Solids (TDS) range of 200 to 6,600 mg/L and a Total Suspended Solids (TSS) range between <1 and 1,130 mg/L depending on the seasonal flow characteristics. Heavy metal concentrations are low and tend to be below detectable limits for most metals.

Figure 25: Mullering Brook Gauging Station

8.1.8.2 Mt Jetty Creek

Prior to mining the adjacent ore-bodies, flood modelling was conducted by Parsons Brinkerhoff to assess the characteristics of various flood events (PB 2006). Modelling results suggest that peak flow rates exceeding a 10 year ARI overtop the Mount Jetty Creek catchment and spill into the neighbouring catchment to the south (PB 2006).

Stream flow and water quality has been monitored since 2007 (prior to mining) at three locations. Stream flow was recorded in Mount Jetty Creek during 2007, 2009 and 2011 with no flow recorded in the intervening years. Water quality indicators appear to vary considerably between monitoring locations and sampling dates with no discernible spatial or temporal trends evident in the water quality to date.

8.1.9 Vegetation and Flora

The sandplains of south-west Western Australia support vegetation communities generally referred to as Kwongan. Kwongan typically includes heath and woodland elements (Ekomin 1987) and is known for high species diversity and a high degree of endemism. Kwongan vegetation is adapted to the nutritionally impoverished sandy soils and the growth form of plants is principally determined by the availability of soil moisture.

Quotations provided by OEPA and Parks and Wildlife describing the vegetation and flora of the region are:

> "The Southwest Australian Floristic Region (SWAFR) is species rich, with a Mediterranean climate and old, weathered, nutrient-deficient landscapes. This region has 7380 native vascular plants (species/subspecies): one third described since 1970, 49% endemic, and 2500 of conservation concern" (Hopper et al. 2004).
>
> "The [SWAFR] region now has more species of threatened plants (2500) than other Australian states and most countries of the world" (Hopper et al. 2004) and is characterised by its "species richness, high endemism and rapid turnover of species over short distances across the landscape" (p. 643) (Hopper et al. 2004).
>
> "Myers et al. (2000) recently listed "the Southwest Australian Floristic Region (SWAFR) ...among 25 global biodiversity hot spots-those regions on Earth richest in endemic species under threaf' (p. 625) the SWAFR is "the only region in Australia accorded this status" (p. 643) (Hopper et al. 2004)".
>
> Within the broader SWAFR region, the Cooljarloo area is significant as it sits at a juxtaposition of northern sand plain, lowland (seasonal damp land) and Banksia woodland systems. This mix of ecosystems presents the complex local ecology and results in significant flora diversity, including a number of priority and rare taxa within what is quite a small area (Kingsley Dixon 2014 pers. comm.).

Consistent with the native vegetation of the Northern Sandplains, UCL areas within the Mining Lease are considered to have a high biodiversity value (WEC, 2008 & WEC 2013). The area comprises a diverse range of upland and wetland communities and a very high rate of species turnover between sites.

Site surveys show there are up to 91 plant taxa per 80m^2 in some heath communities within baseline reference plots at Cooljarloo (WEC 2012). Both wetland and wet heath communities have been shown to be the most diverse communities which include a large number of species at the ends of their ranges, especially in the wetland areas. The drier heath and woodland communities tend to show a greater level of homogeneity between sites (WEC 2012).

Numerous flora and vegetation studies have been undertaken within the Cooljarloo Mining Lease and surrounding areas including:

- Vegetation community mapping (Ekomin 1987, Mattiske 1996, 1997, Landcare Services 1999, 2002; Woodman 2007, 2009, 2013 & 2014);
- Baseline reference plots for Rehabilitation Vegetation Types (Woodman 1999, 2002; 2012); and

- On-going routine Conservation Significant Species searches such as those undertaken prior to clearing for mining and exploration, rehabilitation and other vegetation monitoring as well targeted and opportunistic study.

The following sections provide details relating to this work.

8.1.9.1 Vegetation Mapping

Original baseline vegetation mapping of Cooljarloo, was a composite of structural mapping conducted by Mattiske Consulting (1996 and 1997), habitat mapping conducted by Landcare Services in 2002 and floristic community type mapping conducted by Woodman Environmental Consulting during 2009.

Woodman (2014) further refined vegetation mapping within the Cooljarloo area by classifying vegetation within the Cooljarloo area within a vegetation Study Area of approximately 34 424 ha, with dimensions of approximately 26 km from east to west (between Brand Highway and Nambung National Park/Wanagarren Nature Reserve) and 24 km from north to south (between Wongonderrah Road and the Lancelin Defence Training Area). This investigation involved sampling 235 quadrats over seven trips. Results from this survey were combined with quadrat data from previous vegetation surveys within the local area (totalling 370 quadrats) which were analysed. Results from the analysis described the baseline Vegetation Types (VTs) within the Cooljarloo area and local surrounds providing an accurate depiction of the distribution of VTs throughout the local area. The report produced from this survey also mapped the distribution of conservation significant flora throughout the Study Area.

This work has provided extensive flora species listing, detailed spatial vegetation maps and has provided data for the derivation of vegetation – soil associations. Collated vegetation maps from the various studies are provided in Appendix B. There are 18 different vegetation types mapped in the study area.

There are no known Threatened or Priority Ecological Communities within the Cooljarloo Mining Lease (Nichols & Woodman, 2011), Woodman 2014.

8.1.9.2 Rehabilitation Vegetation Reference Plots

For the purposes of managing rehabilitation, the complex array of vegetation communities have been grouped into four Rehabilitation Vegetation Groups (RVG). The RVGs have been developed at Cooljarloo to broadly represent the baseline vegetation communities recorded within the Mining Lease. Rehabilitation Vegetation Groups are described below in Table 10 with the associated soil profiles discussed in Section 5.1.4.

Table 10: Rehabilitation Vegetation Groups

Rehabilitation Vegetation Group	Vegetation Community (Woodman 2014)	Floristic Community Type (WEC 2009)	Vegetation Community Type (Landcare Services 2002)	Vegetation Community Type (Mattiske 1996, 1997)
Woodlands Dominant Species: *Banksia attenuatta, Melaleuca clavifolia, Hibbertia hypericoides*	6, 17, 18	9a; 9b; 10	BWT; BW; BWp; SH/BWT Complex; DSWp; 1b; 1f; SH/BW Mosiac	1a; 1c; 1a.1; 1a.2; 1d; 1e; 1g
Dry Heaths Dominant Species: *Banksia*	7	11	DSLH; SLH; DSFH; LAT; 3a	3d; 3g; 3b; 2b; 3c; 2a

dallanneyi, Allocasuarina microstachya, Calytrix flavescens.				
Wet Heaths Dominant Species: *Regelia ciliate, Banksia telmatiaea, Acacia lasiocarpa var. lasiocarpa*	1, 3, 5, 14	2; 3; 4; 5; 6	SH; 3f	3e; 3h; 3k
Wetlands Dominant Species: *Melaleuca brevifolia, Melaleuca viminea subsp, Viminea, Kunzea micrantha subsp. petiolata*	2, 4, 9a, 9b, 10, 11, 12, W	1, 7; 8	SMT; DrW	3j; 3i; 4a; 4b; 4c

There are 44 rehabilitation baseline reference plots established in native UCL areas to collected data relating to a range of vegetation indices. Data from these plots are used to compare rehabilitation performance for each of the RVG established. It is expected that these plots will be monitored approximately every 5 years to ensure the baseline reference plots remain current in terms of spatial coverage and temporal variance.

8.1.9.3 Conservation Significant Flora

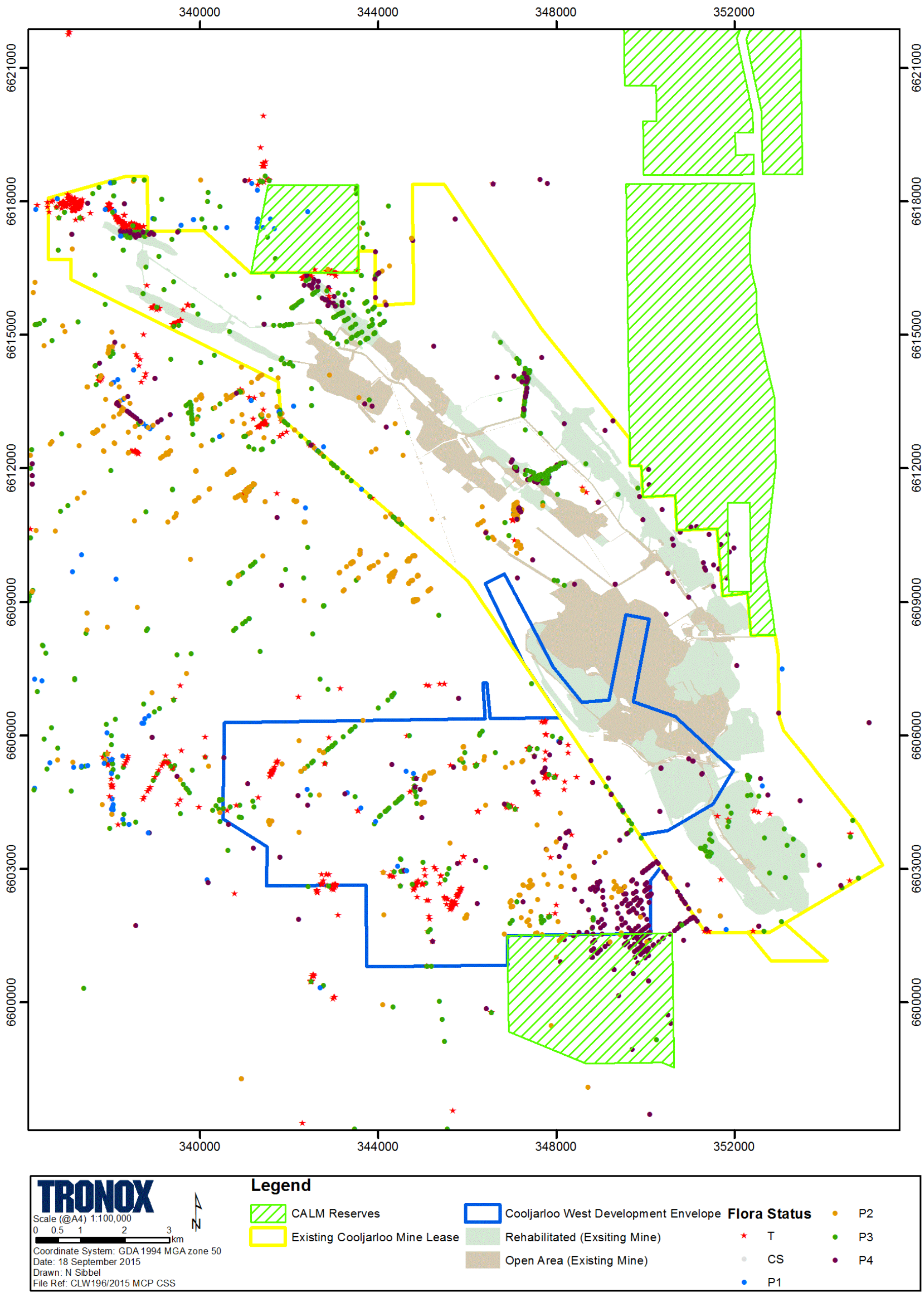
Species listed as Threatened (T) under the *Wildlife Conservation Act* 1950 (also known as Declared Rare Flora (DRF)) are legally protected. Species that are poorly known are identified as Priority Flora (PF) and are also identified under the same Act.

Two species listed as Threatened are known to occur on the lease. These are *Andersonia gracilis* and *Anigozanthos viridis ssp. terraspectans*. Both of these species have been successfully established in rehabilitated areas at Cooljarloo.

Two additional threatened species have been recorded within the Cooljarloo West area; *Macarthuria keigheryi* and *Paracaleana dixonii*.

All four species are listed under the *Environmental Protection and Biodiversity Conservation Act 1999*.

Over 30 species listed as Priority Flora (PF) by the Department of Environment and Conservation (DEC) have been recorded within Cooljarloo Mine area (combined tenements). Tronox maintains a list of conservation significant flora recorded on site (Table 11) and GIS records of known locations locally and broadly. This is a consolidated listing of records from a variety of internal and third party sources (the Iluka-Tronox Conservation Significant Species Dataset). Locations of conservation significant flora recorded in and around the Cooljarloo mine area shown in Figure 21.



Priority C relates to species that have been recently delisted.

Figure 26: Conservation Significant Flora

Table 11: Conservation Significant Species Recorded at Cooljarloo

Species	Priority	Species	Priority
Anigozanthos viridis subsp. terraspectans	T	*Byblis gigantea*	
Andersonia gracilis	T	*Conospermum scaposum*	
Macarthuria keigheryi	T	*Desmocladus biformis*	
Paracaleana dixonii	T	*Guichenotia alba*	P3
Calectasia palustris	P1	*Hakea longiflora*	P3
Chordifex reseminans	P1	*Hensmania stoniella*	P3
Grevillea thelemanniana subsp. Cooljarloo (B.J. Keighery 28 B)	P1	*Hypocalymma serrulatum*	P3
Malleostemon sp. Cooljarloo (B. Backhouse s.n. 16/11/88)	P1	*Jacksonia carduacea*	P3
Schoenus pennisetis	P1	*Lepidobolus densus ms*	P3
Anigozanthos humilis subsp. Badgingarra (S.D. Hopper 7114)	P2	*Meionectes tenuifolia*	P3
Arnocrinum gracillimum Keighery Fl.Australia 45:466,Fig.77 (1987)	P2	*Onychosepalum nodatum*	P3
Hypocalymma sp. Cataby (G.J. Keighery 5151)	P2	*Platysace ramosissima*	P3
Isopogon panduratus subsp. palustris	P2	*Schoenus griffinianus*	P3
Lepyrodia curvescens B.G.Briggs & L.A.S.Johnson	P2	*Verticordia amphigia*	P3
Onychosepalum microcarpum	P2	*Boronia tenuis*	P4
Stenanthemum sublineare	P2	*Chordifex chaunocoleus*	P4
Stylidium aceratum	P2	*Conostephium magnum*	P4
Stylidium hymenocraspedum	P2	*Eucalyptus macrocarpa* subsp. *elachantha*	P4
Allocasuarina grevilleoides	P3	*Grevillea saccata*	P4
Angianthus micropodioides	P3	*Hibbertia helianthemoides* (Turcz.) F.Muell	P4
Baeckea sp. Moora (R. Bone 1993/1)	P3	*Thysanotus glaucus*	P4
Baeckea sp. Perth Region (R.J. Cranfield 444)	P3	*Verticordia lindleyi* subsp. *lindleyi*	P4
Banksia dallanneyi subsp. pollosta	P3		

8.1.9.4 Weeds

Baseline weed populations are routinely assessed as a part of the standard rehabilitation baseline reference plots. Results from this monitoring indicate cover throughout native vegetation on UCL is low. Targeted weed surveys of the mining areas (on UCL) by Woodman Environmental Consulting concluded that weed cover through native areas is minimal with greater cover present adjacent to roads and tracks (WEC 2014). Distribution of weed and weed risk mapping is provided as Figure 27.

Agricultural activities within the region over the past thirty years have contributed to the large number of introduced species on and around Mullering Farm. The majority of introduced species are seasonal and can be controlled using herbicides. There are around 40 introduced species recorded on Mullering Farm. Two (common) species declared under the *Agriculture and Related Resources Protection Act* 1976 (WA) are present including *Echium plantagineum* (Paterson's curse) and *Emex australis* (Double gee).

8.1.10 Dieback

Extensive dieback surveys have been conducted at Cooljarloo since the commencement of mining including Hart, Simpsons and Associates (1998-1999); Woodman Environmental (2004) and most recently Glevan consulting (2008, 2010). A number of *Phytophthora* species have been recorded at the Cooljarloo Mine mostly in the area surrounding Mullering Farm. Of these species *Phytophthora cinnamomi* (Pc) is considered to pose the greatest risk to native vegetation communities. Many local species are susceptible to Pc and as such, the disease threatens the biodiversity values of the area. Tronox undertakes soil sampling, water baiting and regular interpretation/mapping across the lease. Figure 28 shows the recoveries of Pc recorded on site.

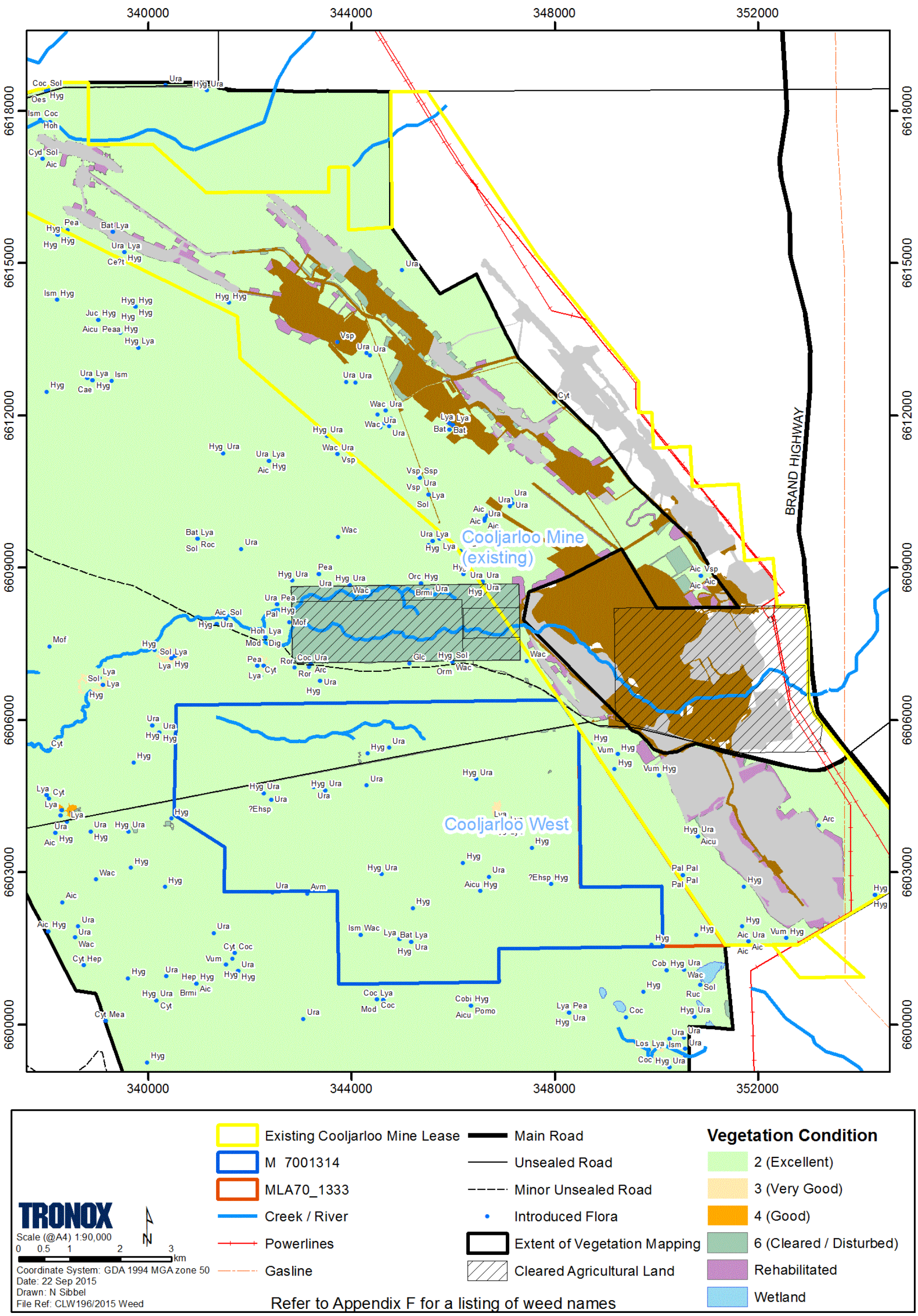


Figure 27 Weed distribution and weed risk mapping

Figure 28: *Phytophthora cinnamomi* Dieback Recoveries

8.1.11 Fauna

Fauna studies at Cooljarloo began with preliminary surveys in 1986, followed by intensive studies from 1989 to 1992 and monitoring studies annually thereafter (Bamford 2004). Standard annual monitoring of baseline reference plots include pitfall trapping, bird census and invertebrate searches.

These studies have focused on native vegetation at Cooljarloo and have identified 10 frog species, 43 reptile species, 132 bird species and 21 mammal species. Species listed as protected under State and/or Commonwealth Acts include:

- *Morelia spilota* (Carpet Python);
- *Haliaeetus leucogaster* (White-bellied Sea-Eagle);
- *Merops ornatus* (Rainbow Bee-eater);
- *Actitis hypoleucos* (Common Sandpiper); and
- *Calyptorhynchus latirostris* (Carnaby`s Black-Cockatoo).

Common introduced species have also been recorded in these surveys including (but not limited to):

- *Oryctolagus cuniculus* (Rabbits);
- *Vulpes vulpes* (Red Fox);
- *Felis catus* (Cats); and
- *Mus musculus* (House Mouse).

Aquatic biology baseline studies were conducted in Mullering Brook by Streamtec 1990 and 1991 (Streamtec 1992). The vertebrate fauna collected within the mining lease and adjacent areas included:

- *Galaxias occidentalis* (Native Minnow);
- *Chelodina oblonga* (Long Necked Tortoise); and
- *Neobatrachus pelobatoides; Psuedophryne guentheri; Helioporus sp* (Tadpoles).

None of the aquatic species above are listed under State and/or Commonwealth Acts.

8.1.12 Land Use

Prior to mining there were two distinct areas within Cooljarloo Mining Lease:

- Cleared freehold title used for agricultural purposes; and
- Unallocated Crown Land comprising native vegetation.

The native UCL areas within ML268SA were used for the following purposes on an *ad hoc* basis;

- Beekeeping, Wildflower harvesting;
- Recreation (off road vehicles and bushwalkers); and
- Camping grounds.

Native vegetation at Cooljarloo includes species of plants, plant communities and fauna that supports the activities identified in the list above.

Several sites of cultural significance to the Yued Aboriginal community are also present within the mining areas (section 8.1.13).

The agricultural land was cleared during the early 1970's and has been predominantly used for cattle and sheep grazing until mining commenced in 1988. In surrounding areas there is occasional cropping or intensive agriculture consistent with the sandy surface soils (such as lupins, olives).

Approximately 13 ha of freehold land was ceded to the Billinue Aboriginal Community in 1994. This land is currently used to facilitate the seed picking/processing business and dwellings for the community. There is one other third party stakeholder owned parcel of land of 45 ha which is located on the western boundary and has been used at times for agricultural grazing (Figure 29).

8.1.13 Heritage

8.1.13.1 Aboriginal Heritage

Detailed ethnographic surveys of the Mining Lease were completed in 1987 as part of the original project approvals for Cooljarloo and as a part of the Falcon approval. Mullering Brook is registered as an ethnographic site and an archaeological site has been surveyed on Mullering Farm (Figure 29).

Surveys of the Falcon area were completed in 2009 and Cooljarloo West in 2012. No sites in addition to the existing registered sites were noted.

8.1.13.2 European Heritage

No European heritage sites relevant to the closure of Cooljarloo are known.

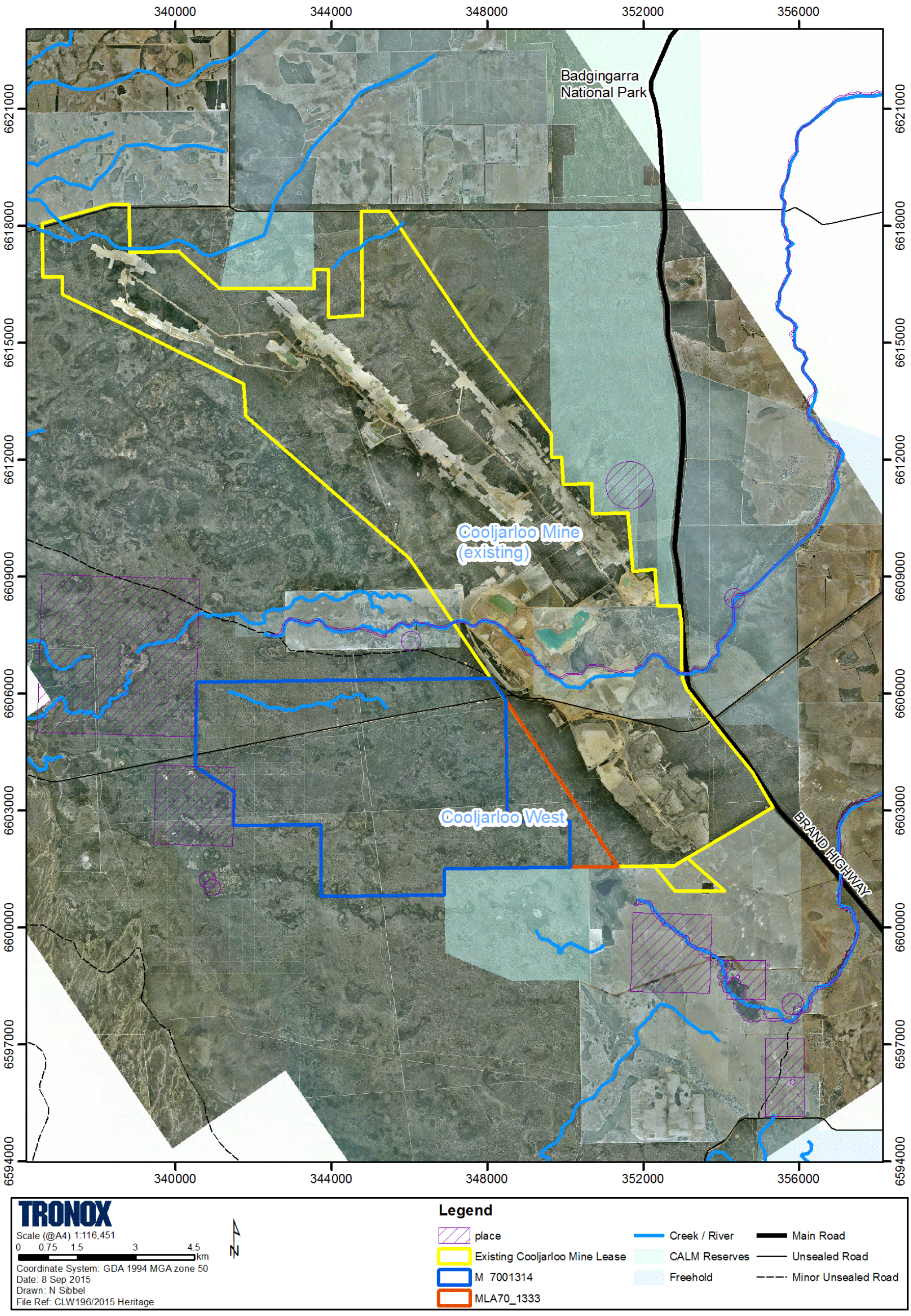


Figure 29: Heritage Sites

8.2 Assessment of Knowledge Gaps

This section aims to assess the completeness of the environmental baseline data summarised in Section 8.1 and to identify the areas where further information and/or data is required to support the mine closure process. Table 12 provides a summary of the identified knowledge gaps. A series of investigation activities are proposed to address the gaps highlighted below (see the Investigation Plan presented in Section 9.2.8).

Table 12: Assessment of Knowledge Gaps

Environmental Aspect	Available Baseline Data	Assessment
Climate	Comprehensive climatic data is collected on site and analysed in the context of various environmental Aspects (i.e. dust management, rehabilitation performance and vegetation health).	Adequate data exists.
Geology/Landforms	Detailed geological and hydrogeological records have been collected from exploration/resource drilling and soil landscape surveys.	Adequate data exists.
	A Digital Terrain Model is updated every 12 to 36 months for the purposes of mine and rehabilitation planning.	Greater resolution may be required for some modelling aspects relating to Mullering Brook (i.e. see surface water).
Potential Acid Sulphate Soils	Pre-mining screening is conducted to identify acid sulphate soils within the mine path and drawdown cone.	Some infill drilling sampling is required in identified risk areas (northern part of Cooljarloo and Cooljarloo West).
Radiation	Pre-mining baseline survey available for the current mine plan.	Pre-mining baseline is required for the Cooljarloo West Area.
Groundwater	Comprehensive network of monitoring bores are established and monitored prior to and after mining.	Adequate data exists for the existing Cooljarloo operations; Existing monitoring bores at Cooljarloo may need to be supplemented for monitoring of drawdown effects particularly in relation to Reserve 40916.
Surface water	Comprehensive flow and quality monitoring conducted for Mullering Brook and Mount Jetty Creek.	Updated flood modelling of Mullering Brook is required to progress detailed rehabilitation plans prior to closure.
Vegetation and Flora	Comprehensive vegetation community mapping has been conducted on all UCL areas excepting the very eastern portion of the mine area. In the eastern portion structure vegetation mapping has been completed.	Existing mapping provides a suitable basis for rehabilitation planning.
	Baseline rehabilitation reference sites have been monitored to represent the key Rehabilitation Vegetation Groups.	Adequate baseline understanding of vegetation communities. Baseline reference site may be monitored during 2016 (existing and potentially new sites) in response to community mapping recently completed, mine plan, rehabilitation outcomes and environmental change.

Environmental Aspect	Available Baseline Data	Assessment
	A complete site flora species listing is available with detailed information relating to the attributes of species return in rehabilitation and seed collection.	Ongoing studies will build on this dataset and drive continual improvement relating to species propagation in rehabilitation and more effective seed collection programmes.
	Comprehensive surveys to identify Conservation Significant Species have been conducted on site.	Further investigation into the regional significance of some significant species may assist in the management of these species. Ongoing surveys are conducted as required.
	Weed data is collected in baseline surveys and ongoing monitoring in reference sites.	Adequate data exists.
Dieback	Comprehensive dieback surveys have been undertaken to characterise baseline status. Known infestations are monitored to assess containment and management programmes.	Further research is underway with the aim of developing a means of containment and eradication.
Fauna	Comprehensive baseline fauna data has been collected prior to and during mining operations.	Adequate data exists.
Land use and Heritage	Heritage surveys conducted and prior land use information available.	Adequate data exists.

9 IDENTIFICATION AND MANAGEMENT OF CLOSURE RISKS

9.1 Process for identifying and managing closure issues (risks)

Tronox routinely conduct assessments of the Cooljarloo Operations Environmental Aspects to assist in the development of management responses for identified risks. Tronox uses a standard risk assessment framework that is consistent with the requirements of AS/NZS4360 – Risk management. The full site Aspects register is included as Appendix C.

Tronox personnel and consultants have considerable experience with mine site rehabilitation in general and specifically the Cooljarloo site. Using their knowledge and experience, key risks have been identified relevant to closure as proposed in the Guidelines. From this the key risks associated with achieving successful closure outcomes have been summarised below:

- Understanding ecological processes and rehabilitation requirements;
- Maintaining operational control over mining and rehabilitation processes;
- Seasonal conditions or significant events (e.g. flood, fire, drought);
- Availability of rehabilitation resources including topsoil, native seed and mulch;
- Managing hostile materials during the landforming process;
- Managing contaminated sites;
- Understanding and acting on changes in community/regulator/legal expectations; and
- Managing unplanned closure due to sustained adverse market conditions and outlook.

The management of these risks are considered in relation to Cooljarloo in the sections below. Tronox has implemented procedures designed to control these risks that form part of the certified Environmental Management System. Where appropriate, these procedures are mentioned.

9.2 Management of Closure Issues

9.2.1 Understanding of Ecology Processes

Characterisation and understanding pre-mine conditions is critical to enable the development of effective rehabilitation plans and completion criteria. Gaps in knowledge, if significant, can result in failure to meet the agreed rehabilitation objective.

As a part of the various approvals processes and subsequent research and development programmes, Tronox has developed a robust understanding of the ecological processes within the areas it is operating. Much of this work is summarised in Section 5.

To ensure the currency of this information Tronox engages in the following activities:

- Ongoing baseline monitoring of such aspects as vegetation, fauna, groundwater and surface water to track changes relating to natural processes and mine related aspects;
- Pre-mining soil surveys and drilling to identify hostile materials and rehabilitation resources (subsoil material);
- Targeted investigations and research to better understand ecological processes including soil-water-vegetation-fauna relationships within baseline areas and rehabilitation;
- Benchmarking and exchange of data/research with industry peers and government regulators to maintain currency of knowledge;
- Applying completion criteria which describe key rehabilitation standards and performance indicators based on current research and leading practice for the Cooljarloo Site; and
- Maintaining a comprehensive Investigation Plan to identify and address gaps in knowledge (Section 9.2.8).

Given the extensive and detailed characterisation work that has been completed for Cooljarloo and the control measures identified above, the residual risks are not expected to be significant.

9.2.2 Management of Mining and Rehabilitation Processes

There are key requirements during the mining and rehabilitation process which must be addressed in a timely and controlled manner to achieve successful outcomes. Loss of operational control can result in deviations from plan and can adversely impact the quality of rehabilitation. The most significant potential issue is associated with landform and soil profile reconstruction, including the identification and management materials such as dispersive clays. Failure to adhere to established procedures and standards can result in deterioration and failure of the final landform.

Tronox maintains the following controls to manage this risk:

- An integrated mine and rehabilitation planning processes to identify and schedule material movement in advance (C0058);
- Work standards and procedures to describe the characterisation and placement of rehabilitation resources including topsoil and subsoil material (C0735 and C0061);
- Training programmes targeted at operators and technical specialists to communicate work standards and procedures (NO0264);
- Works supervisor programmes and quality control checks to ensure standards and procedures are implemented (C0431 and C0057); and
- Ongoing monitoring and investigation programmes to confirm rehabilitation is developing appropriately (C0919).

With the implementation of the control measures listed above, the residual risks to site closure associated with loss of operational control are expected to be manageable.

9.2.3 Seasonal Events/Conditions

Rehabilitation outcomes can be significantly impacted by seasonal events and conditions in much the same way that farmers have variable success in different years. Seasonal conditions that can impact rehabilitation success directly or indirectly include:

- Drought;
- Significant rainfall and storm events;
- Fire;
- High wind conditions; and
- Pest/grazing animal attack.

A sound understanding of the baseline soil-hydrological-vegetation associations assist in the development of controls to minimise the risks associated with adverse seasonal conditions and extreme events. Key controls include:

- Establishment of vegetation communities comprising the range of species broadly representative of the baseline communities. Incorporating this biodiversity ensures inclusion of a range of drought tolerant and fire responsive species (C0735);
- Soil profiles and landforms designed to withstand large rainfall events (1:100 year 72 hr. event) such that overland flow and erosion risks are minimised (C0735);
- Topsoil stabilisation using organic mulch and cover crops in areas at high risk of wind erosion (C0058);
- Native animal and feral animal control programmes to minimise grazing and physical damage (C0027);
- Site hygiene controls to minimise the spread of pathogens including dieback and weed species (C0773);
- Maintenance of firebreaks and other fire control measures to minimise the risk of fire too early in the life of rehabilitation areas (C0028); and
- Research programs to investigate rehabilitation resilience to various adverse conditions.

With the implementation of the control measures above and the ongoing research to guide further improvements the residual risks to site closure associated with extreme events and conditions are expected to be minimised. Further research and improvement activities relating to this risk are outlined in Section 9.2.8.

9.2.4 Availability of Rehabilitation Resources

The quality of rehabilitation is dependent upon having suitable rehabilitation resources available including topsoil, subsoil materials and mulch. In worst case scenarios some mine sites may have insufficient topsoil or subsoil material to complete rehabilitation due to inadequate planning or operational control in the past.

The controls Tronox has in place to avoid such scenarios include:

- Planning and operational control procedures to ensure topsoil and mulch are salvaged prior to mining (C0058);
- Material balances relating to topsoil resources and area open to confirm there is adequate topsoil available for the remainder of mine life (C0058);
- Integrated mine and rehabilitation planning processes to salvage and maximise the use of direct return topsoil (C0058) and mulch resources; and
- The treatment and use of sand/slimes tailing streams such that they can be used in landform reconstruction and in doing so provide adequate material for soil profile reconstruction (C0058).

Based on the material reconciliations undertaken in 2012, there are adequate resources to complete all areas according to the commitments in this plan.

With implementation of the control measures above, the residual risks to site closure associated with poor management of rehabilitation materials are expected to be low. Further research has been identified in Section 9.2.8 to maximise the utilisation of direct topsoil return and to find alternatives to fresh harvested mulch.

9.2.5 Hostile Materials

Potentially Acid Sulfate Soils (PASS) may be encountered during mining that can cause issues if not appropriately managed. In particular, if they are not recognised and managed, they can compromise the quality of groundwater/soil and impact rehabilitation outcomes. While no significant issues relating to hostile soil materials have been encountered to date the following controls are in place to minimise the risk of issues arising in the future.

Tronox operations control these risks by:

- Sampling for Acid Sulphate Soils during the drilling programme prior to mining (NO0372);
- Maintaining a conceptual model to assess if the materials to be mined are likely to contain sufficient levels of sulphides to impact the environment if disturbed (NO0372);
- Developing site specific management plans to deal with identified areas of risk (NO0372);
- Implementing a hierarchy of controls by avoiding exposing the materials where necessary or otherwise treating and capping materials to mitigate the risk (NO0372); and

- Monitoring groundwater and pit material to assess the effectiveness of the above listed controls.

With the implementation of the control measures above, the residual risks to site closure associated with hostile materials are expected to be minimised. Further improvement activities are identified in Section 9.2.8.

9.2.6 Site Contamination

The risk of site contamination in mineral sands mining is limited as no reagents are used during processing. The risk arises largely from the storage and use of hydrocarbons and the disposal of process waste on site. Western Australia has a strong legal basis for the management of contamination via the *Contaminated Sites Act* 2000. Management of this risk at Cooljarloo includes:

- Ongoing compliance with the *Contaminated Sites Act*, EP Act Licence and Dangerous Goods licence conditions to limit the potential for hydrocarbon contamination;
- Maintenance of oil-water separators at wash-down facilities and monitoring of waste water discharged (C0784);
- Secondary containment bunding for bulk hydrocarbon storage tanks (C0784);
- Regular workplace inspections to check hydrocarbons and waste material are being managed appropriately (C0784 and NO0025);
- Class lll landfill areas are lined and capped to restrict infiltration and leaching of waste constituents into the surrounding groundwater (C0777);
- Regular monitoring of waste material disposed of in the Class lll landfill and water monitoring in surrounding bores (C0777); and
- Emergency response training to respond to hydrocarbon and hazardous material spills.

With the implementation of the control measures above, the residual risks to site closure associated with site contamination are expected to be manageable.

9.2.7 Changes in Community/Regulator/Legal Expectations

Foreseeable risks associated with evolving stakeholder expectations include changes to legislation that cannot be complied with, delays to tenement relinquishment or delays in approval for new projects though lack of consultation and stakeholder engagement.

To manage the risks associated with stakeholder expectations, Tronox has developed a stakeholder engagement schedule for decommissioning and closure of Cooljarloo. The schedule provides engagement actions to be carried out in accordance with other closure activities. It aims to inform all key stakeholders in advance of closure and provide them with the opportunity to communicate concerns or requests relating to closure. Stakeholder engagement also affords the opportunity for Tronox to have input into changing community and regulator expectations. To manage this risk Tronox has and will continue to:

- Engage the MSARCC committee and other stakeholders on matters of rehabilitation completion criteria, performance and research/development;
- Maintain close relationship with the local community including the Shire Dandaragan, South West Aboriginal Land and Sea Council (SWALSC) and local Yued group;
- Benchmarking with industry peers and relevant organisations; and
- Reporting progress via annual reports and community open days.

With implementation of the control measures above, the residual risks to site closure associated with changing expectations are considered to be manageable.

9.2.8 Data Gaps, Investigations and Research

Tronox has invested in research, investigations and trials since the initial planning phase for operations in the 1980's. This investment has continued and resulted in reliable, well documented mining and rehabilitation processes. The key research and investigation projects that Tronox has conducted or sponsored are listed in Appendix D.

Knowledge and information gaps relating to rehabilitation and mine closure are captured and managed using the Tronox EMS continuous improvement process as it applies to rehabilitation. A Rehabilitation Improvement Plan was developed in 2010 in consultation with government and community stakeholders. It is intended that the Mine Closure Plan becomes the mechanism for updating this plan and communicating it to stakeholders on an ongoing basis.

Appendix E shows the investigations documented in the Improvement Plan (WEC 2010) plus those items identified during the development of this MCP. The table identifies those investigations that are in progress and those planned for the coming three year period. Those items in the Improvement Plan (WEC 2010) that have been completed are summarised in the AER.

9.2.9 Unplanned Closure

Occasionally mines may be forced into unplanned closure, usually due to significant changes in economic settings such as a sudden, sustained, large drop in commodity prices, increases in cost of production or other pressures that make continuing operations, in any foreseeable future, unviable.

Tronox has considered and forecast the costs associated with unplanned closure. There are several key strategy elements and control measures that address these risks:

- Progressive rehabilitation reduces the amount of open area and rehabilitation liability at any one time (C0058);
- Closure planning/provisioning contributes to ensuring that the financial aspects of funding for closure and rehabilitation are addressed whilst the mine is operating (C0058);
- Closure provisions are managed according to international accounting standards for check with accountants; and

- Care and maintenance programmes are planned in the event of a sudden cessation of operations to ensure that key aspects of the site are managed whilst detailed plans are made regarding resuming mining or closing the site.

With implementation of the control measures above, the residual risks to site closure associated with unplanned events are expected to be manageable.

10 CLOSURE IMPLEMENTATION

This section focuses on the scenario of a planned closure for the Cooljarloo site.

10.1 Closure Implementation Strategy

Key elements of the closure strategy include:

- Defined post-mining land use, objectives and completion criteria;
- Progressive rehabilitation to optimise use of available resources and to reduce liability; and
- Identification of key closure issues and associated controls to minimise risk.

An integrated mine and rehabilitation planning process is established to plan and document all stages of rehabilitation and closure. General closure processes are detailed in Section 10.3 and domain specific tasks are provided in Section 10.4.

10.2 Roles and Responsibilities

The responsibility for effective mine closure rests with the General Manager (GM) – Tronox Australia Operations. Reporting to the GM are a group of Managers responsible for Operations, Commercial, Engineering, Safety, Health, and Environment and Human Resources. Departments reporting to each Manager have delegated responsibilities for various aspects of mine closure. These responsibilities flow through to Positions Descriptions and Key Performance Indicators.

10.3 Closure processes

This section documents the key activities routinely undertaken to progress toward mine closure.

10.3.1 Landforming and Soil Profile Reconstruction

Progressive landforming is undertaken with the objective of establishing safe and stable landforms capable of supporting the intended final land-use. The rehabilitation completion criteria and associated procedures outline how landforming and soil profile reconstruction is undertaken to achieve this objective as well as key outcomes to be achieved from this. Rehabilitation Plans are developed prior to backfill to match planned soil profiles with the appropriate Vegetation Group as described in Section 7.2.1.

The following key steps are pertinent to landforming and soil profile reconstruction:

- Materials available for backfill and soil profile reconstruction are characterised prior to mining and plans are developed in-line with the completion criteria and related procedures;
- Mining voids are backfilled to above the water table with a combination of overburden and/or sand tailings as appropriate to maintain groundwater flow across site;
- Above the water table some areas are utilised for slimes drying cells that are later incorporated in the soil profile and capped with sandy Class 1 material;

- Soil profiles are reconstructed according to the requirements for the targeted Rehabilitation Vegetation Group;
- Final batters are contoured to a slope flatter than 1:12 and infiltration embankments are constructed where required to minimise the risk of overland and erosion problems;
- Soil samples are taken to verify appropriate material classification and placement; and
- The final landform is surveyed and the depth of different subsoil materials is recorded to verify the completion criteria have been met.

Upon the completion of these steps the area is formally signed off by the Mining Department to confirm it meets the landform design criteria and topsoil placement/revegetation activities can commence.

10.3.2 Topsoil Placement and Revegetation Process.

The objective of the native revegetation process is to restore the land surface to a productive, self-sustaining and resilient Rehabilitation Vegetation Group consistent with the agreed post-mining land use on UCL areas. Freehold farm areas are seeded with stabilising species suitable for grazing or cropping.

The following key steps area undertaken during revegetation:

- Second cut topsoil resources (lower 200 mm) are placed (where appropriate) to provide a rooting medium for establishing rehabilitation;
- Ripping is undertaken to mitigate compaction of the Class 1 subsoil and second cut topsoil;
- First cut topsoil is placed to a depth of approximately 50 mm to provide a source of propagules appropriate to the final Rehabilitation Vegetation Group;
- First cut topsoil is scarified with an oaten cover crop and fertilized to stabilise the area during establishment;
- Native seed is spread to supplement propagules in the first cut topsoil;
- Mulch is spread to supplement the organic matter in the topsoil and assist to stabilise the site; and
- Tube stock or direct seeding may later occur to target the re-establishment of recalcitrant species.

Upon completion of this step the area is signed off by the Rehabilitation Officer as complete and the area is no longer considered a part of the operational area open. On-going monitoring is then undertaken to assess if the area is developing to meet the mature rehabilitation completion criteria.

10.3.3 Decommissioning and Infrastructure Removal process

At mine closure it is expected that much of the equipment will be re-used at other prospective Tronox mine sites. Equipment such as concentrators, thickeners, conveyors,

grizzlies/screens, pumps/pipes, offices, workshops and sheds, are generally dismantled (as necessary) and relocated off the mining lease. Hence, the cost of relocation of these is accounted for as a mining cost.

Current closure plans cover all fixed infrastructure such as roads, bores and piezometers. However, some of these may remain after closure in agreement with the responsible authority and (post-mining) land owner if they are considered of ongoing value.

The following steps will be undertaken to decommission and remove infrastructure at mine closure:

- Clean and decontaminate equipment and prepare infrastructure for installation at a new mine site, or storage until it is required;
- Remove and dispose of footings, concrete and bitumen (unless retention is agreed with the land owner) into the mine void or licenced landfill;
- Re-use or recycle materials and equipment or dispose of waste materials at an appropriate disposal facility;
- Remove power lines, pipelines and other utility infrastructure or secure a letter of acceptance from the (post-mining) land owner;
- Complete post-removal radiation surveys and remove any materials exceeding required closure standards to approved areas onsite or an appropriate offsite facility; and
- Complete any contaminated sites investigations and comply with the requirements of the *Contaminated Sites Act* 2000.

Once the area is clear of infrastructure, redundant services, rubbish and waste, the remaining area open can be landformed and prepared for rehabilitation and closure.

10.4 Domain Specific Closure Tasks

To assist in planning for mine closure and consistent with the WA Guidelines (DMP/EPA 2015), the Cooljarloo site has been divided into domains. The spatial domain system enables the allocation of tasks to be defined for those areas that require common tasks to achieve the closure or rehabilitation objective.

For Cooljarloo two broad domains have been defined including:

- Mining and ancillary activities; and
- Class lll landfill.

In this context the Class lll waste pits have been separated from standard areas of disturbance due to the different requirements for the closure and rehabilitation of the Class lll waste facilities. Specific features are identified in sub-domains in Table 13 and Table 14. The spatial extent of each domain is shown below in Figure 30.

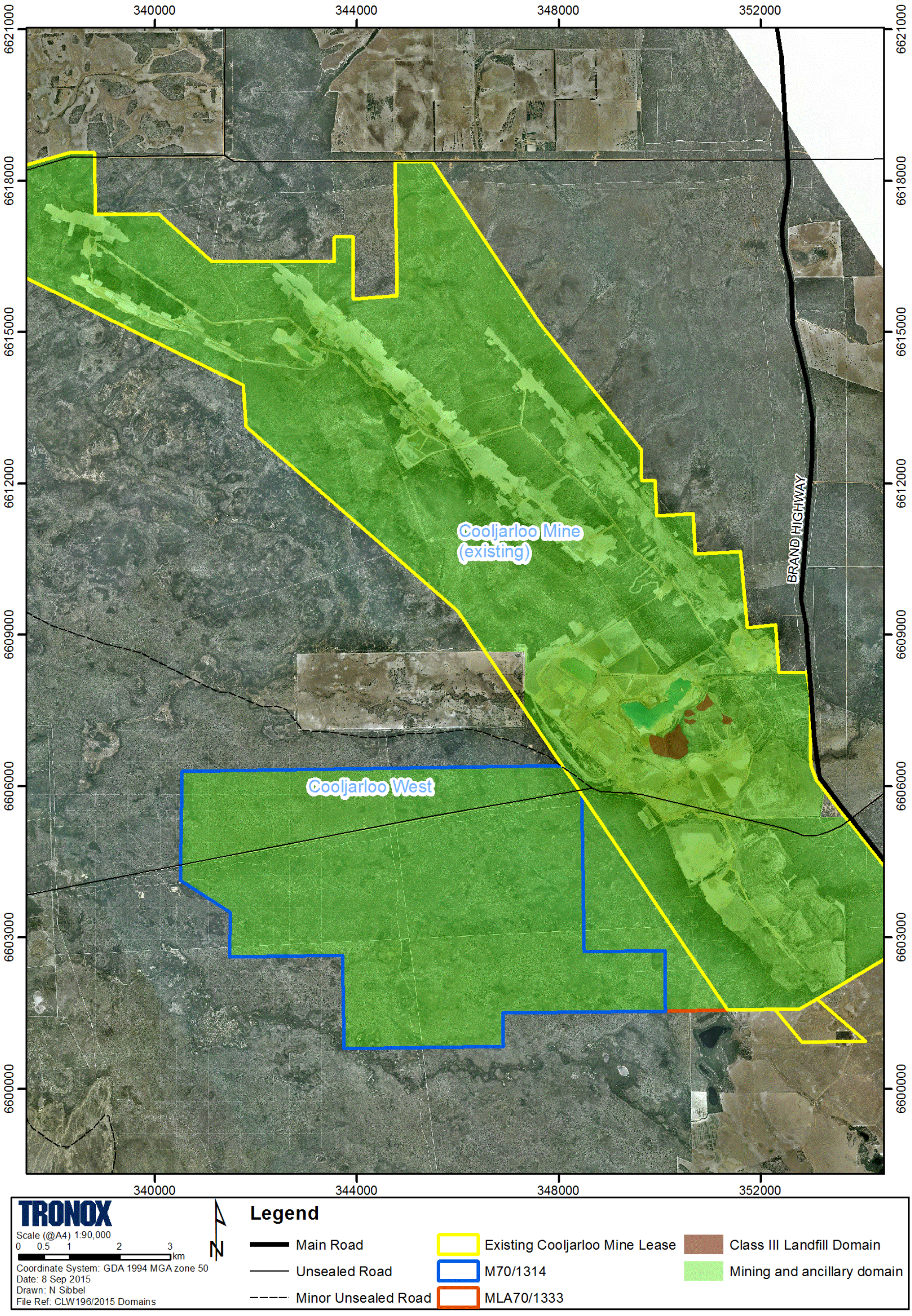


Figure 30: Domain Classification

10.4.1 Mining and Ancillary Activities Domain

This domain covers the majority of the area on the Cooljarloo Lease and is expected to comprise a total of approximately 7,800 ha by the end of mine life. It covers areas on freehold land as well as areas on UCL. Subdomains and associated actions and performance indicators are provided below in Table 13

Table 13: Mining and Ancillary– Closure Task List

Sub Domain	Item	Action	Verification	Record	Performance Indicators
Power line corridor	Power line corridor	Remove power lines and poles.	Site inspection and signoff	Rehabilitation Operations Register.	No power poles or lines visible
Roads	Haul roads and internal access roads	Remove signage. Remove road base and dispose into mining void. Place topsoil and rip. Mulch/native seed (UCL) or pasture seed (Farm).	Site inspection and signoff. Rehabilitation Monitoring.	Rehabilitation Operations Register. Rehabilitation monitoring reports.	Relevant Completion Criteria met (refer to Section 7.1).
	Access tracks	Place topsoil and rip. Mulch/native seed (UCL) or pasture seed (Farm).	Site inspection and signoff. Rehabilitation Monitoring.	Rehabilitation Operations Register. Rehabilitation monitoring reports.	Relevant Completion Criteria met (refer to Section 7.1).
	Cooljarloo and Woolka Roads	Remove cattle grids (unless otherwise agreed with Shire)	Site inspection and signoff	Rehabitliation operation register	Cattle grids removed and road reinstated
Laydown areas	Equipment and hardpads	Dispose of equipment as required. Remove signage. Remove road base and dispose into mining void. Place topsoil and rip. Mulch/native seed (UCL) or pasture seed (Farm).	Site inspection and signoff. Rehabilitation Monitoring.	Rehabilitation Operations Register. Rehabilitation monitoring reports.	Relevant Completion Criteria met (refer to Section 7.1).
Drill Lines	Drill holes	Drill holes capped.	Site inspection and signoff.	Rehabilitation Operations Register.	No open drill holes present.
	Cleared Lines	Survey pegs removed and regrowth assessed.	Site inspection and signoff. Rehabilitation Monitoring.	Rehabilitation Operations Register.	No survey pegs present. Relevant Completion Criteria met (refer to Section 7.1).

Sub Domain	Item	Action	Verification	Record	Performance Indicators
Mullering Brook	Brook alignment and landform	Complete earthworks to plan including the construction of two lakes as requested by Traditional Owners.	Survey data Site inspection and signoff. Inspection with Traditional Owners.	Rehabilitation Operations Register.	Completed in-line with Plan. Stream flow maintained and no significant contamination of water. Lakes consistent with Traditional Owner expectations.
	Bed and banks	Revegetate in native areas.	Rehabilitation Monitoring.	Rehabilitation monitoring reports.	Relevant Completion Criteria met (refer to Section 7.1).
Dredge Pond	Dredge	Decommission dredge and relocate to new mining location.	Site Inspection.	Rehabilitation Operations Register.	Equipment removed.
	Concentrator	Decommission concentrator and relocate to new mining location or scrap.	Site Inspection.	Rehabilitation Operations Register.	Equipment removed.
	Ancillary infrastructure and services	Decommission as required.	Site Inspection.	Rehabilitation Operations Register.	Equipment removed.
	Voids	Backfill to above water table. Place subsoil materials. Place topsoil and rip. Mulch/native seed (UCL) or pasture seed (Farm).	Survey data. Site inspection and signoff. Rehabilitation Monitoring.	Rehabilitation Operations Register. Rehabilitation monitoring reports.	Relevant Completion Criteria met (refer to Section 7.1).
Dry mine	Dozer trap and Trommel.	Decommission equipment and relocate to a new mining location.	Site Inspection.	Rehabilitation Operations Register.	Equipment removed.
	Ancillary infrastructure and services	Decommission and relocate to a new mining location.	Site Inspection.	Rehabilitation Operations Register.	Equipment removed.
	Concentrator	Decommission concentrator and relocate to new mining location or scrap.	Site Inspection.	Rehabilitation Operations Register.	Equipment removed.
		Remove all footings and concrete structures and bury in mining pit.	Site Inspection.	Rehabilitation Operations Register.	All footings and concrete structures removed or buried at least 1 m below ground or disposed of in onsite Class 1 Landfill

Sub Domain	Item	Action	Verification	Record	Performance Indicators
	Mine voids and dams.	Backfill to above water table Place subsoil materials. Place topsoil and rip. Mulch/native seed (UCL) or pasture seed (Farm).	Site inspection and signoff. Rehabilitation Monitoring.	Rehabilitation Operations Register. Rehabilitation monitoring reports.	Relevant Completion Criteria met (refer to Section 7.1).
	Slimes cells	Dry slimes and incorporate into subsoil material. Cap slimes, place subsoil materials. Place topsoil and rip. Mulch/native seed (UCL) or pasture seed (Farm).	Site inspection and signoff. Rehabilitation Monitoring.	Rehabilitation Operations Register. Rehabilitation monitoring reports.	Relevant Completion Criteria met (refer to Section 7.1).
Building and workshops	Buildings/work shops	Remove and re-use, recycle or dispose	Site Inspection.	Rehabilitation Operations Register	All buildings removed.
	Footings	Remove all footings and concrete structures	Site Inspection.	Rehabilitation Operations Register.	All footings and concrete structures removed or buried at least 1 m below ground or disposed of in onsite Class 1 Landfill.
	Chemical storage, hydrocarbon bund and wash facilities (i.e. areas of potential contamination)	Decommission and remove all equipment and products Sample area for potential contamination	Site Inspection. Lab analysis.	Rehabilitation Operations Register and contaminated Sites reports.	All equipment removed and contamination issues addressed in line with statutory requirements.
	All areas	Place subsoil materials. Place topsoil and rip. Mulch/native seed (UCL) or pasture seed (Farm).	Site inspection and signoff. Rehabilitation Monitoring.	Rehabilitation Operations Register. Rehabilitation monitoring reports.	Relevant Completion Criteria met (refer to Section 7.1).
HMC stockpiles	Stockpile	Remove all excess mineral.	Radiation monitoring.	Radiation Reports.	Radiation level below statutory levels.
Monitoring Bores	Collars	Collars removed to 30cm below surface and capped for all bores no longer required.	Site inspection.	Rehabilitation Operations Register.	Bore collar removed and hole capped.
All areas	Rehabilitation	Radiation monitoring to be undertaken.	Radiation monitoring.	Radiation report.	Within statutory requirements.

10.4.2 Class III Waste Domain

This domain is within Mullering Farm covering a current area of 46ha and is likely to continue to be used post mine closure. Subdomains and associated actions and performance indicators are provided below in Table 14.

Table 14: Class III Waste Domain

Sub Domain	Item	Action	Verification	Record	Performance Indicators
Waste containment	Waste Pit	All process waste to be contained within the designated waste pit.	Site inspection during backfill.	Rehabilitation Operations Files. Incident reports.	No waste dumped outside designated waste pit.
	Waste pit capping	Waste is capped according to regulatory requirements at the time of construction.	Site inspection post capping.	Rehabilitation Operations Files.	Cap established according to agreed design criteria.
		Profile above the cap at least 2 m with a >1 m sandy profile upper horizon.	Site inspection.	Rehabilitation Operations Files.	Cap established according to agreed design
	Final Landform	Infiltration embankments constructed. Place subsoil materials. Place topsoil and rip. Pasture seed (Farm).	Site inspection. Rehabilitation Monitoring.	Rehabilitations Operations Register.	Relevant Completion Criteria met (refer to Section 7.1).
Roads	Haul roads and internal access roads	Remove signage. Remove road base and dispose into mining void. Place topsoil and rip. Pasture seed (Farm).	Site inspection and signoff. Rehabilitation Monitoring.	Rehabilitation Operations Register. Rehabilitation monitoring reports.	Relevant Completion Criteria met (refer to Section 7.1).
Monitoring Bores	Collars	Collar removed to 30 cm below surface and capped for all bores no longer required.	Site inspection.	Rehabilitation Operations Register.	Relevant Completion Criteria met (refer to Section 7.1).
Supporting Infrastructure	Chemical storage, hydrocarbon bund and wash facilities (i.e. areas of potential contamination)	Decommission and remove all equipment and products Sample area for potential contamination	Site Inspection. Lab analysis.	Rehabilitation Operations Register and contaminated Sites reports.	All equipment removed and contamination issues addressed in line with statutory requirements.
	Buildings/work shops	Remove and re-use, recycle or dispose	Site Inspection.	Rehabilitation Operations Register	All buildings removed.
	Footings	Remove all footings and concrete structures	Site Inspection.	Rehabilitation Operations	All footings and concrete structures removed or buried at least 1 m below

Sub Domain	Item	Action	Verification	Record	Performance Indicators
				Register.	ground or disposed of in onsite Class 1 Landfill.
	Power line corridor and substation	Remove power lines and poles. Remove all Tronox equipment from substation unless otherwise agreed.	Site inspection and signoff	Rehabilitation Operations Register.	No power poles or lines visible
All areas	Rehabilitation	Radiation monitoring to be undertaken.	Radiation monitoring.	Radiation report.	Within statutory requirements.

This domain will be rehabilitated in accordance with DEC requirements under the *Contaminated Sites Act* 2000. An overview of the process for contaminated sites management under the Act is provided in the next section.

10.5 Contaminated Sites

Western Australia has a comprehensive legal framework for the identification and management of contaminated sites under the *Contaminated Sites Act* 2000. The legislation, in summary, provides for the:

- Definition and identification of contaminated sites;
- Investigation of contamination;
- Publicly available reporting of contaminated sites;
- A classification system for contaminated sites with a hierarchical basis for action based on risk;
- Registration of contamination on the title of the land; and
- Ownership and liability for contamination.

The Contaminated Sites Act is administered by the Contaminated Sites Branch of the DEC. DEC has produced and operates under an extensive set of guidelines and standards for managing contaminated sites under the Contaminated Sites Act. In these documents, DEC recommends that contaminated sites should be investigated and managed in a staged manner as illustrated in Figure 31 (DEC, 2010).

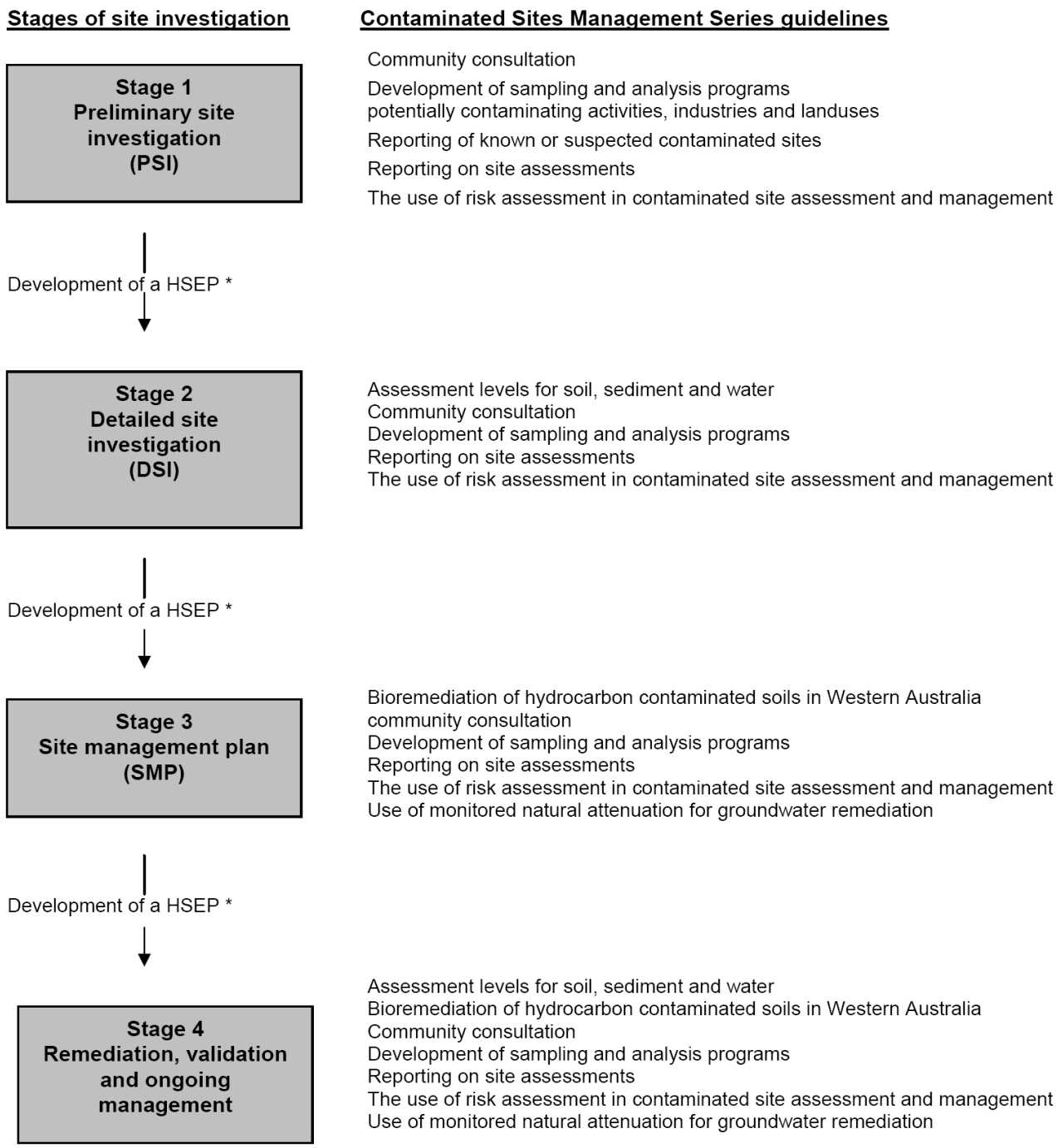


Figure 31: Staged Approach to Site Investigations (source: DEC, 2010)

* Health, Safety and Environment Plan. Refer to *Guidance Note Occupational Safety and Health Management and Contaminated Sites Work* (Commission for Occupational Safety and Health, 2005).

Tronox will manage any contaminated sites at Cooljarloo in accordance with the requirements of the Contaminated Sites Act, which is independent of this MCP and Mining Act responsibilities. Tronox recently updated DEC regarding contaminated sites with the summary information replicated below (Table 15).

Table 15: Suspected Contaminated Sites – Investigation Required

Name/Location	Known or suspected Contamination	Contaminants
Cooljarloo Mine – Unallocated Crown Land Lot 3906 12051 Brand Highway – Mining Tenement AM70/268	Pond 4 Bioremediation	Hydrocarbons (diesel fuel)
	Bioremediation Area (open)	Hydrocarbons
Cooljarloo Mine - Mullering Farm Melbourne Location 3906 – title 1600-362	Fuel Storage Area (fuel farm)	Hydrocarbons, solvents, glycol (coolant)
	Central Workshop and Parking Area	Hydrocarbons, solvents, glycol (coolant)
	Process waste Pits 1-5	Class III Landfill Metals (As, Pb), dissolved solids, soluble salts, trace hydrocarbons, low level radiation
	Process Waste Pits 6-7	Class III Landfill Metals (As, Pb), dissolved solids, soluble salts, trace hydrocarbons, low level radiation
	Bioremediation Area 2003-6	Hydrocarbons
	Bioremediation Area 2006	Hydrocarbons
	Dams 1-3	Hydrocarbons (grease)

10.6 Environmental Controls During Closure Implementation

Following the cessation of mining, a number of activities will continue that will require active management of environmental aspects. The rehabilitation programme will still require some significant earthmoving activities, decommissioning works will require specialist teams to disconnect, modularise and remove equipment. There will continue to be requirements for water and power. The closure works will not be on the scale of the mining operations in terms of amount of machinery or personnel used.

Tronox has developed and implemented an EMS to identify and manage environmental aspects at Cooljarloo. The EMS will continue to be applied during the closure phase to ensure management of continuing activities. The EMS includes a systematic means of:

- Identifying activities that may cause environmental impacts;
- Assessing and managing risks;
- Recording obligations relating to Cooljarloo;
- Reporting, investigating and applying corrective actions to environmental and safety incidents;
- Recording and responding to community complaints; and
- Continuously improving.

Adequate resources will be provided during closure to fulfil the requirement of this Plan.

10.7 Rehabilitation Schedule

The schedule of activities relating to mine closure and rehabilitation proposed for the Cooljarloo site is maintained via an integrated mine and rehabilitation planning process. Plans are continually updated and modified in response to such as influences as changing information (such as additional geological information), technology and standards, statutory requirements and economic (product prices and operating costs).

In this context, the mine plan is maintained to efficiently access and process ore and backfill and rehabilitate consistent with completion criteria and relevant procedures. The time between mining and rehabilitation is minimised to utilise resources such as topsoil and mulch as soon as possible, minimising storage times and associated deterioration of contained propagules.

The life of mine plan for Cooljarloo, incorporating Cooljarloo West, has two alternative sequences; mining of Cooljarloo West commencing in 2019 or mining of Cooljarloo West commencing in 2028. The resultant disturbance and rehabilitation schedule for both alternatives is shown in Figure 32 and as a plan in Figure 33 and Figure 34. The life of mine landform plan for the existing Cooljarloo Mine is provided in Figure 35. The plan for Cooljarloo West will be included in future iterations of this MCP.

Broadly speaking the rehabilitation schedule is based on a 5 year cycle from time of initial disturbance through to final rehabilitation works. This includes:

- One year clearing, stripping, mining;
- Three years for slimes deposition and slime drying; and
- One year for landforming and rehabilitation.

Variations to this cycle exist as not all mine areas require slimes cells, so the turn-around time is shorter. Conversely, some areas are required for infrastructure or are used for other purposes (i.e. waste pits), therefore the turn-around time is longer. The Freehold land is preferentially used for various activities that will extend the close out time of these areas.

The key features of the mine plan and rehabilitation schedule are:

- Dredge mining continuing to approximately 2036 with final rehabilitation work expected by 2041;
- The final dredge pond at the end of mine life will be around 20 ha and will be backfilled using stockpiled material from Mullering Farm or nearby overburden dumps;
- Dry mining will continue at Cooljarloo until approximately the end of 2015;
- Forecast rate of rehabilitation will continue at an average of around 100 ha/yr;
- Total disturbed area over the life of mine is approximately 7800 ha; and
- Current open area of approximately 1,572 ha.

The life of mine rehabilitation and disturbance chart is shown below in Figure 32.

The scenario used for this plan is based on a particular set of assumptions relating to mineability, revenue and cost factors that may or may not reflect current market conditions. As such, the plan is indicative and includes ore may or may not be economic to mine.

In this particular iteration, the plan that reasonably matched the area of clearing likely to be required to maximise the value obtained from the identified mineral resources within the Cooljarloo and Cooljarloo West tenement (M2687SA, M70/1314, MLA70/1333) was selected. This ensures that planning considered the potential full extent of operations and aligned with the proposed extent of clearing for the combined project within the Cooljarloo West Public Environmental Review.

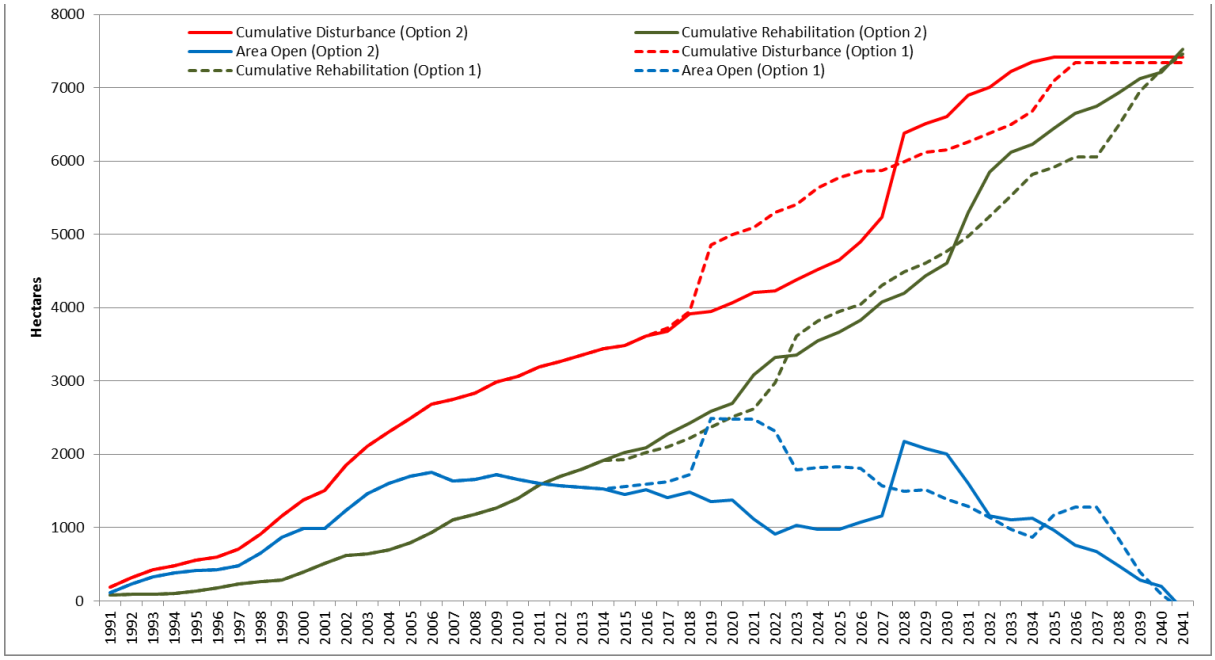


Figure 32: LOM Rehabilitation and Disturbance Schedule, Cooljarloo including Cooljarloo West

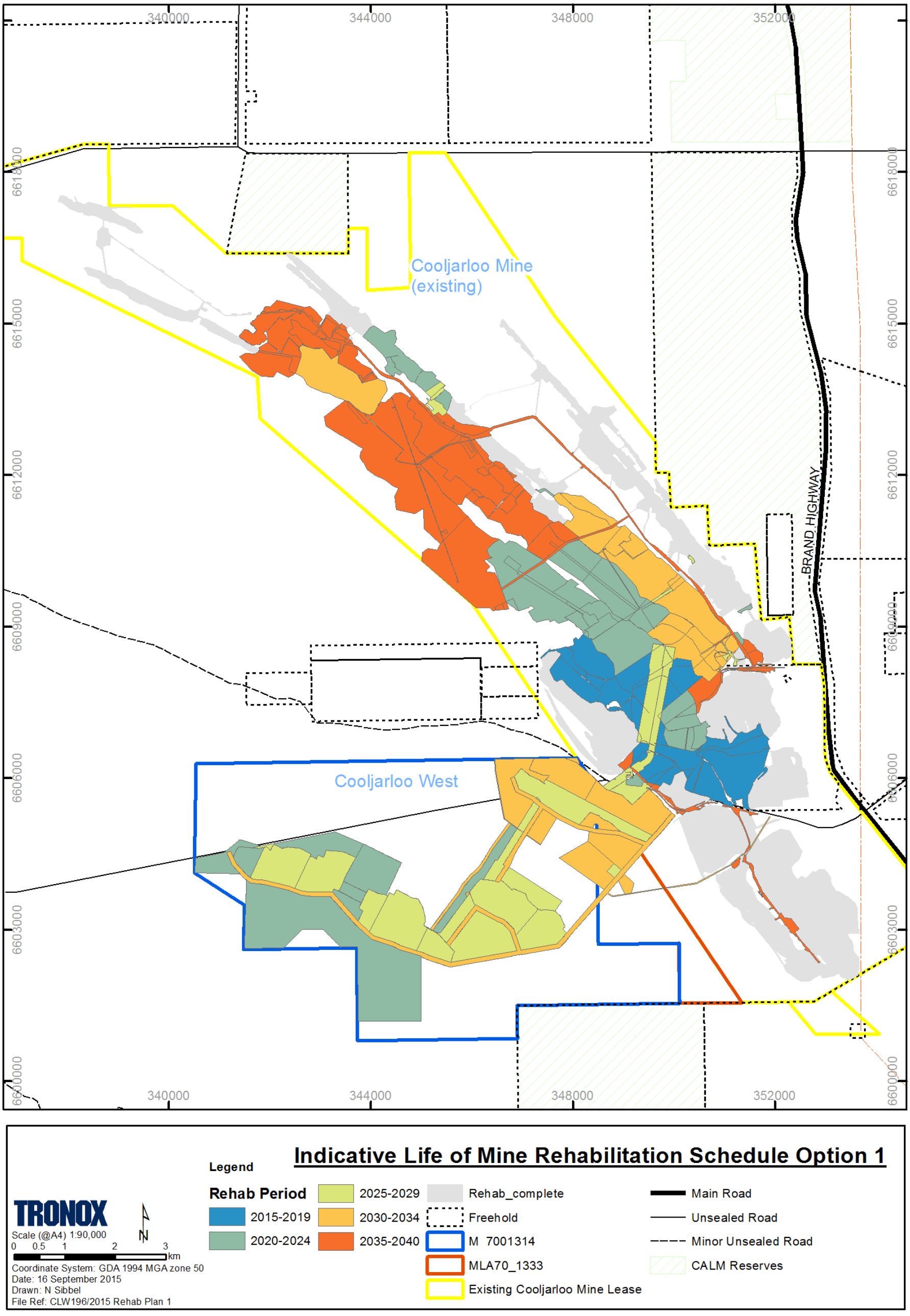


Figure 33: Life of Mine Rehabilitation Plan Option 1 (Cooljarloo West commencing in 2019)

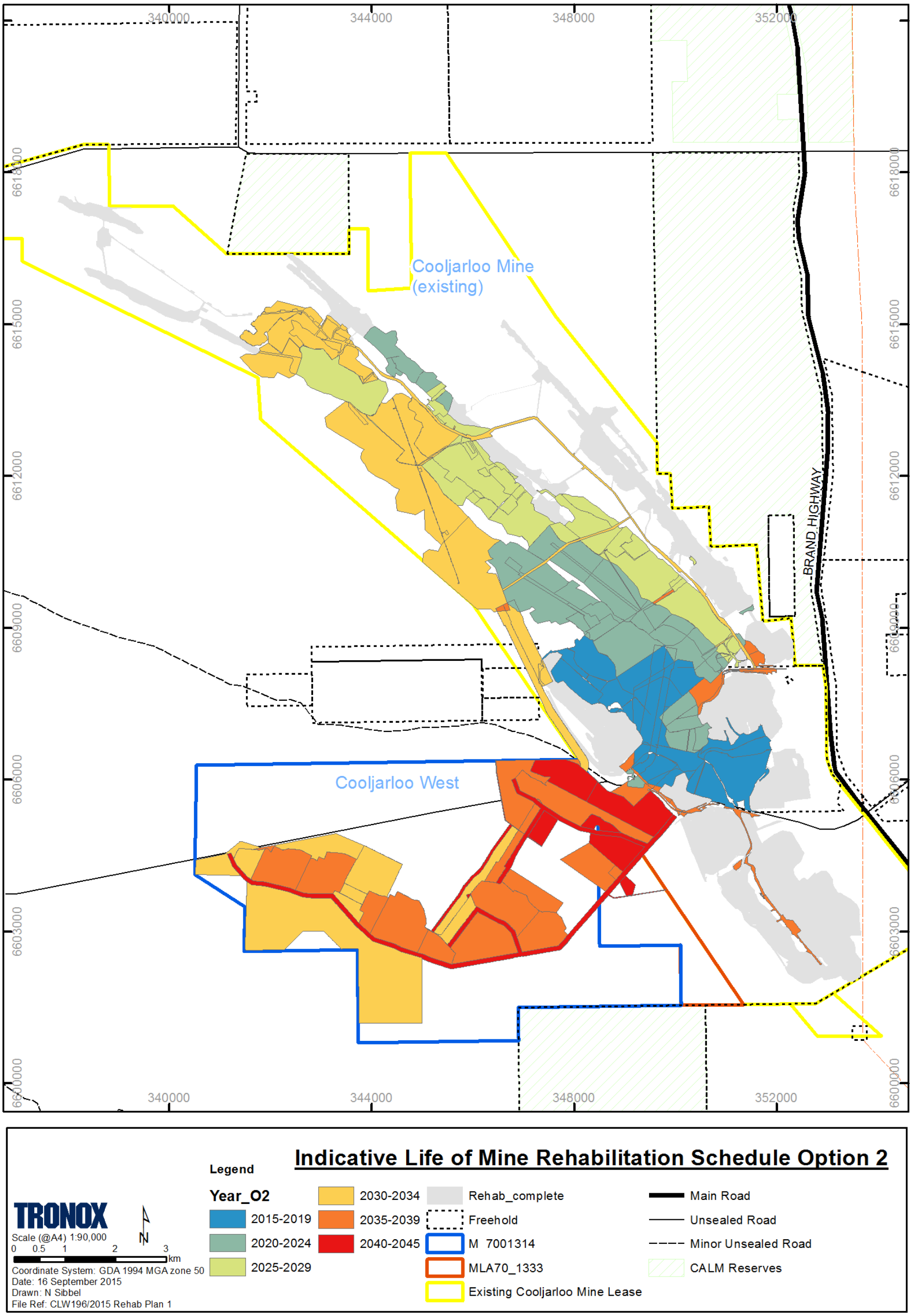


Figure 34 Life of Mine Rehabilitation Plan Option 2 (Cooljarloo West commencing in 2028)

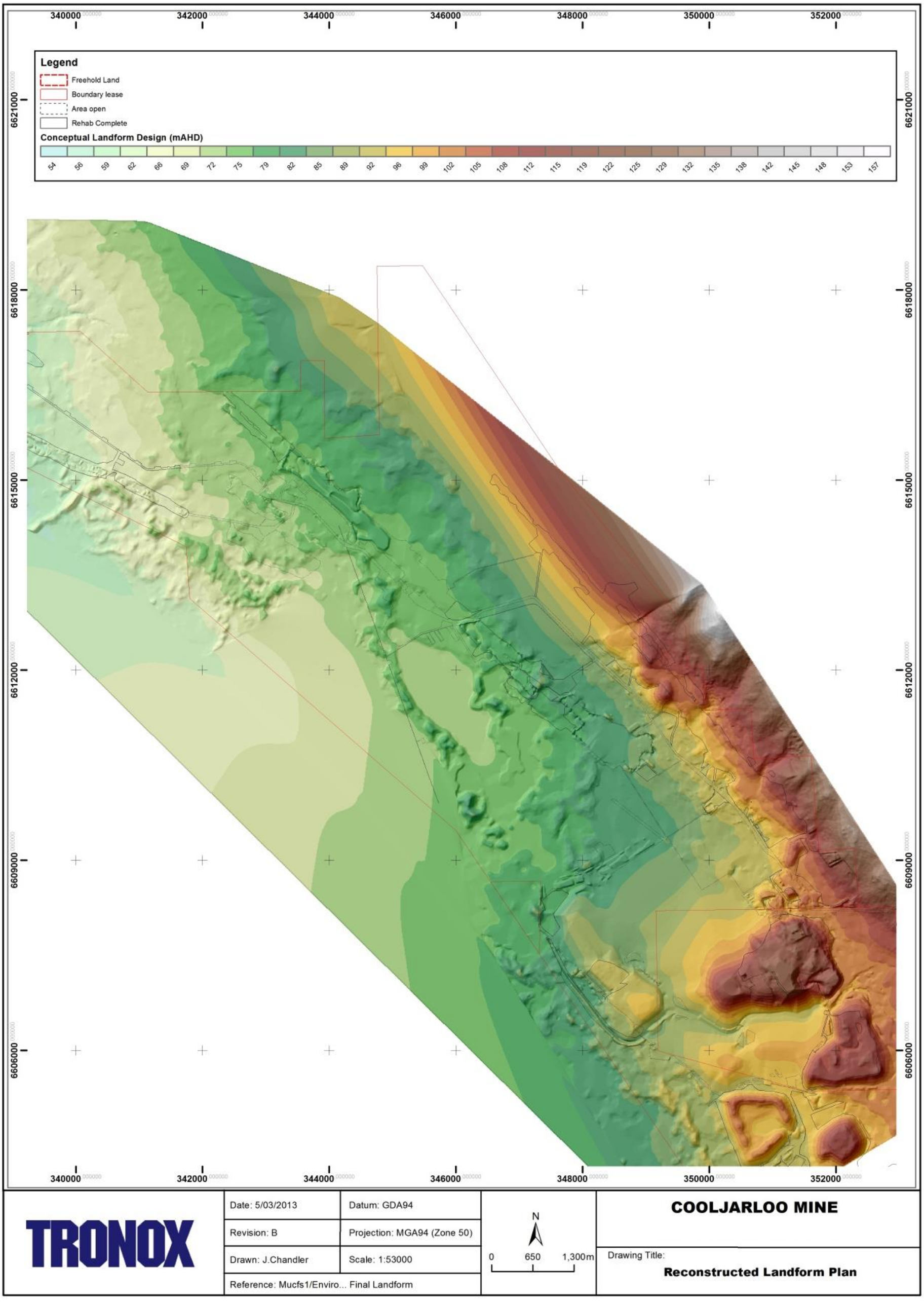


Figure 35: Reconstructed Landform Plan

10.8 Tenement Relinquishment

A key step in the finalisation of mine closure is the relinquishment of tenements. At this point the tenement holder effectively relinquishes any rights associated with being the holder of the tenement. Tenement relinquishment therefore, is only likely to happen when the estimated value of any opportunity associated with the tenement is not commercially viable under any foreseeable set of circumstances. Prior to tenement relinquishment, it is suggested that:

- Land will have been thoroughly assessed for any residual commercial value;
- Land will have been rehabilitated according to the agreed post mining landuse and rehabilitation objectives; and
- Monitoring data and relevant information will have been provided to the State to confirm the performance of the land in relation to agreed completion criteria.

Responsibility for any ongoing liability or risks will have been established and agreed. Monitoring is expected to continue until Tronox and the State agree that monitoring can either be rationalised or ceased.

11 CLOSURE MONITORING AND MAINTENANCE

This section outlines the approach to monitoring relevant to this MCP. Note that operational monitoring in accordance with existing requirements will continue until no longer required. Any monitoring associated with contaminated sites will be subject to the *Contaminated Sites Act* 2000 and is not presented here.

11.1 Monitoring standards and frequency

The Site monitoring requirements are outlined in the Cooljarloo EMP and updated as required via the EMS to respond to new or emerging risks. It is assumed that the current monitoring programme will continue, as may be amended from time to time in consultation with key regulators, until closure obligations have been met.

Monitoring of rehabilitation is undertaken to demonstrate the rehabilitation objectives have been met. Areas of rehabilitation are monitored at ages 1, 3, 5, 7 and 10 years and thereafter every three years or as required. Parameters monitored, as listed in Table 16, specifically relate to the Completion Criteria (refer to Table 7).

Monitoring requirements for of surface water, groundwater, dust and radiation are outlined in the Cooljarloo Environmental Management Programme.

Table 16: Post-mining Rehabilitation Monitoring Programme

Phase	What is being Monitored?	Method
Rehabilitation Works	Soil type characterised by texture, aggregate stability, soil strength and bulk density.	Field and laboratory testing prior to topsoil placement.
	Soil depth of each soil type in the upper profile.	Survey pickup of soil horizons or excavated soil pits prior to topsoil placement.
	Landform gradient.	Survey of final landform contours.
	Topsoil depth and volume.	Topsoil volumes surveys and quality control checks (depth).
	Topsoil type in terms of the vegetation community from which it was sourced.	Vegetation mapping and records of topsoil stripped.
Early Establishment	Species richness and plant abundance.	Condition monitoring conducted in transects measuring species richness within 1 x 1 m quadrats.
	Soil stability.	Condition monitoring conducted in transects identifying measuring surface erosion features on contour (slumping, rilling and surface movement).
Mature Rehabilitation	Species richness.	Total native perennial plant species within a 20 x 20 m plot.
	Tree density.	Total number of trees within a 20 x 20 m plot.
	Foliage cover.	Average foliage cover for all native species measured in 2 x 2 m quadrats.
	Weed cover.	Average foliage cover for all weed species measured in 2 x 2 m quadrats.
	Soil stability.	Condition monitoring conducted in transects identifying surface erosion features on contour (including slumping, rilling and surface movement).
	Soil characteristics including, PSD, bulk density, soil strength, chemistry, soil moisture retention, nutrients status.	Targeted monitoring within established rehabilitation adjacent vegetation monitoring plots.
	Topsoil hydrophobicity.	Targeted monitoring within established rehabilitation adjacent vegetation monitoring plots.
	Fauna recolonisation with regards to biodiversity and abundance.	Pitfall trapping and bird census conducted on established rehabilitation areas.

11.2 Maintenance and Intervention

Maintenance activities that may be undertaken include during operations and in some instances after closure include:

- repairing fences and controlling grazing animals to reduce pressure on rehabilitation areas;
- maintaining roads, tracks, signage, communications facilities, power and water supplies necessary to complete mine closure and rehabilitation works;
- replanting unsuccessful revegetation areas (a range of interventions are possible, from additional tube stock, to clearing and re-seeding);
- controlling weeds in rehabilitation areas;
- implementing fire and dieback controls in liaison with Parks and Wildlife; and
- maintaining farm management practices until completion criteria are signed off and the land is in stable agricultural production.

Resources are made available for these activities in the operating budget and closure estimates as required. Remedial works are provided for in a separate provision for areas that do not meet the rehabilitation objective. The following description relating to the process of identifying and planning remedial works is taken from Nichols and Woodman (2011).

"Failure to meet particular criteria will prompt an internal investigation into the likely causes and, where necessary, a risk assessment will be carried out to determine the likelihood and consequences of any resulting environmental impacts. A joint decision on whether to implement remedial action(s) will be made by the company and MSARCC.

The investigation will seek to determine:

- The cause of the non-conformance;
- The extent or magnitude of the failure;
- Likelihood of escalation of the consequences either through the situation getting worse (e.g. an erosion gully getting bigger) or the mode of failure appearing elsewhere (e.g. gullies appearing in other areas of rehabilitation); and
- If and what remedial works are required.

In all instances it is important to identify the reason or cause of the non-conformance to determine implications for the long term overall performance of the rehabilitation, both in terms of that area as well as wider rehabilitation across site. It is also important to be able to distinguish between non-conformances that are the result of a once off anomaly or failure to adhere to the appropriate design or works standards, and those that represent a failure of the rehabilitation standards / criteria themselves.

Both require addressing, however, the potential repercussions and thereby response required for the latter are more significant. Instances of non-conformance together with

details of the investigation and associated responses will be recorded in the Signoff Sheets for the relevant areas and reported via annual reporting.

Where non-conformances to criteria are material to the long-term performance of the rehabilitation against the objective (i.e. they may inhibit signoff) and are the result of either significant divergence from rehabilitation works/design standards or the failure of the criteria themselves, and affect a significant area (tens of hectares), remedial plans will be communicated to MSARCC participants prior to implementation.

The nature and scale of remedial actions will take into account both what is required to rectify the issue as well as the likely repercussions of undertaking the remedial works themselves. In some instances the damage done in attempting to rectify relatively minor non-conformances can be greater than taking no action. Conversely, failure to act can result in the escalation of issues."

11.3 Management of Information and Data

Tronox operates a document control system that provides a mechanism to update controlled documents (predominantly procedures) via a hierarchy of stakeholder and owner approval and access. Electronic records are kept in a centralised system with site wide access via the Corporate intranet.

Environment specific records are managed using the Company EMS, which incorporates a number of procedures for the appropriate storage of information relevant to planning, obligations, rehabilitation and closure.

Site specific information relating to works pertaining to rehabilitation is recorded in the Rehabilitation Operations Register. Information collected can be used to demonstrate performance against key planning and rehabilitation works completion criteria and in doing so will assist in the final signoff and relinquishment of rehabilitation areas.

Annual Environmental Reports are provided to key regulators which provide a good reference point for activities and data relevant to the Cooljarloo site. Tronox is required to make particular environmental management plans publicly available in compliance with Ministerial conditions.

12 FINANCIAL PROVISIONING

Financial provisioning is a key accounting process undertaken to recognise current liability and provide adequate financial resources for mine closure. Tronox prepares annual closure cost estimates in accordance with the International Financial Reporting Standards (IFRS). Closure cost estimates are used to establish provisions for mine closure, rehabilitation activities and residual liabilities. This section of the MCP summarises Tronox's mine closure costing methodology, assumptions and financial processes used in cost estimation and management of provisioning.

12.1 Scope of the Closure Provision

The closure provision is established on the basis of estimates, which include the closure and rehabilitation costs to be incurred after mining operations have ceased. Ongoing progressive rehabilitation is accounted for under a separate provision as areas are disturbed. A separate remedial provision is also maintained for rehabilitation areas formally identified as requiring additional work to meet the rehabilitation objectives.

12.2 Cost Estimation

The mine closure cost provision in Tronox's books is based on the 2014 management cost review and is fully provided for in accordance with Australian Accounting Standards.

The balance of the provision represents the present value of the future estimated mine closure cost which is reviewed by management each year. The mine closure cost provision is increased each month as the discount is unwound with the time period to mine closure decreasing, thus ensuring the mine closure costs are fully provided for at the end of mine life.

Given the progressive nature of rehabilitation, a considerable amount of data is available upon which the cost assumptions for individual closure tasks can be based. Each year, the assumptions relating to the costs of key closure tasks are reviewed and revised if required. Contingencies are included in cost estimates and vary according to the degree of uncertainty associated with each task.

The is further supported by an external consultant review which is conducted every five years with the next external review to be completed in November 2015.

12.3 Key Assumptions

Key assumptions relevant to closure cost estimation and provisioning at Cooljarloo are listed below:

- Disturbed areas will be progressively rehabilitated over the life of mine with a minimum area of around 1,250 ha required for active working and operations (i.e. infrastructure and voids).
- At the end of mining it is expected that a 20 ha dredge void will be backfilled using previously constructed overburden dumps on Mullering Farm or other equivalent areas.

- In total, mining and ancillary activities will have disturbed up to a total of 7800 ha by the time mining is complete in 2036 and final rehabilitation of all disturbed areas is expected by 2041.
- At closure it is expected that sufficient slime drying cells will be constructed to allow for the storage and drying of any slime produced in the last years of production (~100 ha).
- Landforming and rehabilitation requirements will be aligned with agreed completion criteria for UCL and farm areas.
- Limited re-work of historic rehabilitation areas (due to unforeseen failure) is assumed.
- A separate provision is maintained for areas that are identified as required remedial rehabilitation work (i.e. areas that do not meet the rehabilitation objective).
- No value is assumed for the sale of assets including processing facilities and infrastructure (e.g. processing infrastructure, pumps, buildings, sheds and pipes etc.).
- Costs associated with relocating processing facilities are covered by mining prospects outside the scope of this plan (i.e. further prospects off lease).
- No value is assumed for land owned by Tronox on Mullering Farm.
- Waste disposal activities will continue on Freehold land beyond the expected life of mine (linked to the life of Chandala and Kwinana operations).
- Ongoing monitoring cost allowances are based on anticipated requirements including (but not limited to):
    - radiation survey and report;
    - water monitoring; and
    - pasture and native vegetation monitoring.

It is assumed that the responsibility for management of UCL will revert to Parks and Wildlife (or equivalent) at a point where the responsible agency agrees that rehabilitation objective has been met and suitable administrative arrangements are in place.

13 CONCLUSION

Cooljarloo has been mined since 1989 and progressive rehabilitation of disturbed areas has been undertaken since 1991. The current status (as at end of 2014) of the site is as follows:

- 3,445 ha of area has been disturbed in mining to date;
- 1,918 ha has been rehabilitated (rehabilitation to revegetation stage);
- 1,527 ha is currently open;
- A life of mine plan exists and includes plans for ongoing progressive rehabilitation;
- Site rehabilitation is reviewed by the Mineral Sands Agreement Rehabilitation Coordinating Committee (MSARCC);
- Completion criteria for native vegetation on Unallocated Crown Land (UCL) and Freehold have been prepared in consultation with key stakeholders; and
- A Rehabilitation Improvement Plan is maintained to facilitate continuous improvement of rehabilitation.

This MCP covers the Cooljarloo operations and disturbance footprint contained within the tenement ML268SA as defined under the *Mineral Sands (Cooljarloo) Mining and Processing State Agreement Act* 1988 (SAA) and M70/1314 and M70/1333 as granted under the *Mining Act 1978*.

The MCP has been structured and prepared to meet the requirements of the Environmental Protection Authority (EPA) and DMP's Western Australian Guidelines for Preparing Mine Closure Plans (the Closure Guidelines).

The purpose of preparing this plan is to support the assessment and approvals of the Revised Cooljarloo Mine, specifically, the inclusion of the activities associated with the Cooljarloo West Project. This document (Rev 1) revises Rev 0 to incorporate the proposed activities at Cooljarloo West as well and incorporates changes in the existing Cooljarloo Mine as appropriate.

Tronox's overarching closure objective is to rehabilitate Cooljarloo to a condition where agreed post-mining land use activities can resume, and ultimately the Company is able to relinquish the mining lease.

The post-mining land use proposed for the majority of the site is native vegetation, with the utility afforded by vegetation similar to the surrounding undisturbed native vegetation. The freehold land will be rehabilitated to mixed agriculture.

This MCP identifies the required closure actions and processes to enable Cooljarloo to be closed and the post-mining land uses to be re-established. The closure actions are considered by Tronox to be practicable and all identified risks are considered manageable.

Tronox has planned and financially provided for the closure activities outlined in this MCP to be carried out in a staged manner in the event of a planned closure. In the event of an unplanned closure, a period of care and maintenance would begin. During the care and

maintenance period Tronox would plan for resumption of mining or for managed site closure.

14 GLOSSARY

Acronym/Item	Definition
Agreement Act	*Mineral Sands (Cooljarloo) Mining and Processing Agreement Act, 1988*
AER	Annual Environmental Review. Report on annual environmental management activities and outcomes provided in response to all environmental reporting requirements for Cooljarloo Operations.
ANZECC	Australia and New Zealand Environment and Conservation Council
ASS	Acid Sulphate Soils
Aggregate Stability	Soil aggregates are groups of soil particles that bind to each other more strongly than to adjacent particles. Aggregate stability refers to the ability of soil aggregates to resist disintegration and has a standard test procedure and classification system. Class I materials are the least stable, and Class VI are the most stable. Aggregate stability is critical for infiltration, root growth, and resistance to water and wind erosion.
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency.
Cooljarloo	Cooljarloo Mineral Sands Mine Site.
Existing Cooljarloo Mine	Pre-existing mining activities within tenement M268sa
Cooljarloo West	Proposed mining activities within tenements M268SA, M70/1314 and M70/1333, the subject of EPA assessment 1974.
Completion Criteria	Standards against which closure activities can be measured to determine whether or not specific closure objectives have been met to achieve completion
DAFWA	Department of Agriculture and Food
DEC	Department of Environment and Conservation – now Department of Parks and Wildlife
Declared weed	Weed that is subject to control or eradication policy under the *Agriculture and Related Resources Protection Act 1976*
Dieback	Phytophthora – An introduced microscopic soil-borne fungus, which has an adverse impact on the health of native plants.
Direct return topsoil	Topsoil stripped and placed into rehabilitation without stockpiling
Disturbed	Area where vegetation has been cleared and/or topsoil (surface cover) removed

Acronym/Item	Definition
DIA	Department of Indigenous Affairs.
DMP	Department of Mines and Petroleum.
DoW	Department of Water.
DRF	Declared Rare Flora
DRDL	Department of Regional Development and Lands
DSD	Department of State Development
Duplex soil	Soil type with a layer of sand over a deeper and distinct layer of clay.
EMP	Environmental Management Programme
EMS	Environmental Management System
Endemism	The state of being unique to a defined geographic location (eg. SW of Western Australia
ERMP	Environmental Review and Management Programme
EPBC Act	*Environmental Protection Biodiversity Conservation Act 1999* (Cth)
EPA	Environmental Protection Authority.
EP Act	*Environmental Protection Act* 1986.
ESP	Exchangeable Sodium Percentage - the degree of saturation of the soil exchange complex with sodium. It may be calculated by the formula: $ESP = \frac{\text{Exchangeable sodium (me/100 g soil)}}{\text{Cation exchange capacity (me/100 g soil)}} x100$
Fresh cut topsoil	Topsoil that has been stockpiled for less than nine months and not through winter.
GDE	Groundwater Dependant Ecosystem
GW	Groundwater
Heavy Minerals	Minerals characterised by high specific gravity (SG above 2.9). Heavy minerals in this report include ilmenite, leucoxene, rutile, zircon, monazite and xenotime
Heavy Mineral Concentrate (HMC)	A mixture of heavy minerals that has been extracted from mineral sands ore by means of wet gravity separation. Ilmenite and zircon typically constitute that majority of the HMC, respectively. HMC is a feedstock for the dry mineral separation process. (Note:

Acronym/Item	Definition
	synthetic rutile, does not constitute part of the HMC)
HSE	Health, Safety and Environment
International Organization for Standardization (ISO)	The world's largest developer and publisher of International Standards
Life of Mine (LOM)	Expected duration of mining and processing operations
MRWA	Main Roads Western Australia.
MSARCC	Mineral Sands Agreement Rehabilitation Coordinating Committee – coordinating body to consider rehabilitation of Cooljarloo operations.
MCP	Mine Closure Plan (Cooljarloo)
MS	Ministerial Statement
MSDS	Material Safety Data Sheet
NAE	Neutralised Acid Effluent
NGERS	The *National Greenhouse and Energy Reporting Act 2007* is a federal legislation that was introduced by the Federal Government in 2007 to provide data and accounting in relation to greenhouse gas emissions and energy consumption and production
Obligations Register	A register of legally binding conditions and commitments relevant to rehabilitation and closure at a given mine site
OEPA	Office of Environmental Protection Authority
Parks and Wildlife	Department of Parks and Wildlife
Project	The total integrated mining operations in which a number of sites contribute to the overall operation to supply ore, processing facilities and disposal of waste products
Provenance	Plants whose native origin is close to where they are going to be planted (e.g. in the same local area) and the individuals all have a similar genetic make-up. In Tronox Cooljarloo's specific case, this means that while seed is preferentially sourced from the immediate locality (i.e. notionally the region bounded by the Moore River to the South and Wongonderrah Road to the North), it can be from anywhere on the northern Swan Coastal Plain providing it is of a species that is known from the Cooljarloo tenement area (i.e. has been recorded in surveys of the area). In practice seed is picked outside the immediate locality of the mine site only in times of short supply locally. At no times will Tronox intentionally introduce non-local species into native rehabilitation

Acronym/Item	Definition
	(with the exception of stabilising cover crops).
PASS	Potentially Acid Sulfate Soils – soils that have potential to acidify due to changes in soil conditions exposing soil to oxygen.
Pc	*Phytophthora cinnamomi*
Priority Ecological Community (PEC)	Plant communities on a list maintained by Parks and Wildlife that may be rare or threatened but for which there are insufficient survey data to accurately determine status, or are regarded as rare but are not currently threatened.
Priority Flora (PF)	Species on a list of taxa maintained by Parks and Wildlife that may be rare or threatened but for which there are insufficient survey data to accurately determine their status, or are regarded as rare but are not currently threatened.
PSD	Particle size distribution - a particle size distribution analysis is a measurement designed to determine and report information about the size and range of a set of particles representative of a material.
Rehabilitation Area	The planning process relies on the Mining Lease being broken down into logical units to manage rehabilitation. As mining progresses, areas are identified where rehabilitation can commence. A contiguous area that is revegetated in a single season is usually referred to as a "rehabilitation area".
Rehabilitation Vegetation Groups	Rehabilitation Vegetation Groups that simplify and broadly represent baseline vegetation communities recorded within the Mining Lease. Four RVGs have been developed for Cooljarloo: dry heath, wet heath, wetland and woodland.
Rehabilitation	The return of disturbed land to a stable, productive and/or self-sustaining condition, consistent with the post-mining land use
Revegetation	Establishment of self-sustaining vegetation cover after earthworks have been completed, consistent with the post-mining land use
SHEHR	Safety, Health, Environment and Human Resources
SHE Systems	Safety, Health and Environment Systems
Stakeholder	A person, group or organisation who have an interest in a particular decision, either as individuals or representative of a group, with the potential to influence or be affected by the process of, or outcome of, mine closure
S_{CR}	Chromium Reducible Sulfur – a soil assay method for the determination of reduced inorganic sulphur (sulphides + sulphur).
SEWPaC	Federal Department of Sustainability, Environment, Water,

Acronym/Item	Definition
	Population and Communities.
Slimes	Reject clay slurry from the mineral separation process conducted in the concentrator. The material is characteristically made up of undifferentiated clay particles.
SPOCAS	Suspension Peroxide Oxidation Combined Acidity - is a self-contained acid base accounting test. It provides a measurement of the maximum oxidisable sulphur, Titratable Actual Acidity (TAA) and Titratable Peroxide Acidity (TPA) present in the soil sample (Department of Environment 2004).
Superficial Aquifer	The mineral sands deposits occur within the Guildford Formation of Pleistocene age which in turn forms the major aquifer unit in the superficial formations on the site.
Superficial deposits	Overlying the Yarragadee Formation is a series of Middle to Late Tertiary Formations collectively termed the Superficial deposits.
SWALSC	South West Aboriginal Land and Sea Council
TDS	Total Dissolved Solids - a measure of the combined content of all inorganic and organic substances contained in a liquid in: molecular, ionized or micro-granular suspended form.
Threatened (T)	Threatened species as identified under the *Wildlife Conservation Act* 1950 (WA) or *Environmental Protection and Biodiversity Conservation Act* 1999 (Cth)
Threatened Fauna	Threatened fauna species as identified under the *Wildlife Conservation Act 1950 (WA)* or *Environmental Protection and Biodiversity Conservation Act 1999 (Cth)*
Threatened Ecological Community (TEC)	Threatened Ecological Communities as defined under the *Wildlife Conservation Act* 1950 (WA). The DEC maintains a list of communities which are threatened with extinction.
Tubestock	Seedlings of (usually native) species of plants grown in a nursery and transplanted into rehabilitation areas.
UCL	Unallocated Crown Land – land held by the Crown and jointly managed by the Department of Regional Development and Lands and the DEC.
WA Mine Closure Guidelines	Western Australian *Guidelines for Preparing Mine Closure Plans* released by DMP and EPA (WA) in June 2011.
Weed	A plant, often a self-sown exotic species, growing where it is not wanted
WWTP	Waste Water Treatment Plant

Acronym/Item	Definition
Yarragadee Aquifer	Deeper, confined and semi-confined aquifer system underlying the Cooljarloo site. The Yarragadee is a regional scale feature.

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APPENDIX A: CLOSURE RELATED OBLIGATIONS

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Mineral Sands (Cooljarloo) Mining and Processing Agreement Act 1988 (MSMPAA)	MSMPAA	Mining Lease 4	The Joint Venturers shall at all times permit the State and third parties with the consent of the State (with or without stock, vehicles and rolling stock) to have access to and to pass over the Mining Lease (by separate route, road or railway) so long as that access and passage does not unduly prejudice or interfere with the operations of the Joint Venturers under this Agreement PROVIDED THAT the provisions of this subclause shall not apply to privately owned land in the Mining Lease.
Mineral Sands (Cooljarloo) Mining and Processing Agreement Act 1988	MSMPAA	Protection and Management of the Environment 12 (1)	The Joint Venturers shall in respect of the matters relating to the environment which are referred to in the approved project or which are the subject of approved proposals, carry out a continual programme of investigation, research and monitoring to ascertain the effectiveness of the measures they are taking both generally and pursuant to the approved project or such approved proposals as the case may be for protection and management of the environment.
Mineral Sands (Cooljarloo) Mining and Processing Agreement Act 1988	MSMPAA	Protection and Management of the Environment 12 (2)	The Joint Venturers shall during the currency of this Agreement submit to the Minister — a) not later than 31 December 1989 and 31 December in each year thereafter (except those years in which a comprehensive report is required to be submitted pursuant to paragraph (b) of this subclause) a brief report concerning investigations and research carried out pursuant to subclause (1) and the implementation by the Joint Venturers of the elements of the approved project and approved proposals relating to the protection and management of the environment in the year ending 31 October immediately preceding the due date for the brief report; and (b) not later than 31 December 1991 and 31 December in each third year thereafter, a comprehensive report on the result of such investigations and research and the implementation by the Joint Venturers of the elements of the approved project and approved proposals relating to the protection and management of the environment during the three year period ending 31 October immediately preceding the due date for the detailed report together with a mining plan setting forth the proposed mining operations of the Joint Venturers during the three year period commencing 1 November immediately preceding such due date and the programme proposed to be undertaken by the Joint Venturers during that period in regard to investigation and research under subclause (1) and the implementation by the Joint Venturers of the elements of the approved project and approved proposals relating to the protection and management of the environment.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Mineral Sands (Cooljarloo) Mining and Processing Agreement Act 1988	MSMPAA	Protection and Management of the Environment 26 (a)	On the cessation or determination of this Agreement — except as otherwise agreed by the Minister the rights of the Joint Venturers to in or under this Agreement shall thereupon cease and determine but without prejudice to the liability of either of the parties hereto in respect of any antecedent breach or default under this Agreement or in respect of any indemnity given under this Agreement.
Mineral Sands (Cooljarloo) Mining and Processing Agreement Act 1988	MSMPAA	Protection and Management of the Environment 26 (b)	On the cessation or determination of this Agreement — the Joint Venturers shall forthwith pay to the State all moneys which may then have become payable or accrued due and if a surrender has been required by the State under Clause 10(4) but has not been effected the Joint Venturers shall forthwith complete such surrender.
Mineral Sands (Cooljarloo) Mining and Processing Agreement Act 1988	MSMPAA	Protection and Management of the Environment 26 (c)	On the cessation or determination of this Agreement — the Joint Venturers may request that the Mining Lease, subject to subclause (4) of Clause 10, continue in force for its unexpired term as if it were a mining lease under and subject to the Mining Act whereupon the Minister for Mines shall issue the appropriate mining lease or mining leases as the case may require in the stead thereof (and the Jurien Mining Lease if then existing) under the Mining Act for the balance of the term of the Mining Lease but without the benefit of any of the provisions of this Agreement.
Mineral Sands (Cooljarloo) Mining and Processing Agreement Act 1988	MSMPAA	Protection and Management of the Environment 26 (d)	On the cessation or determination of this Agreement — save as aforesaid and as otherwise provided in this Agreement neither of the parties shall have any claim against the other of them with respect to any matter or thing in or arising out of this Agreement.
Aboriginal Heritage Act 1978	General	Part IV	Heritage sites are not to be altered, excavated, damaged, concealed or any portion of the site removed in anyway, unless granted via Section 16 or 18 under the *Aboriginal Heritage Act 1978.*
Agriculture and Related Resources Protection Act 1976	General	Part V, Division IV (47)	The occupier of any private land shall control declared plants and declared animals on and in relation to that land.
Contaminated Sites Act 2003 *Contaminated Sites Regulations 2006.*	General	Part I, Section 11 Part II (6)	The proponent or individuals are to report known or suspected areas of contaminated sites.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Contaminated Sites Act 2003.	General	Part III, (23)	Sites classified as Contaminated - Remediation Required as described under the *Contaminated Sites Act 2003* are to be remediated.
Environmental Protection (Controlled Waste) Regulations 2004	General	44	Disposal of asbestos is to be separated, wrapped and labelled and disposed in accordance with Part III,(6)(44).
Environmental Protection (Controlled Waste) Regulations 2004	General		The proponent is to treat all products listed in schedule 1 of the Environmental Protection (Controlled Waste) Regulations 2004 as a controlled waste.
Environmental Protection Act 1986	General	Part V, (49)	Proponent shall not cause pollution or an unreasonable emission of noise, odour or electromagnetic radiation.
Environmental Protection Act 1986	General	Part V, (51)	The proponent shall not clear native vegetation without the relevant approval (e.g. clearing permit) in place.
Health Act 1911	General	Part IV (2) (87)	The proponent shall ensure (stagnant) pools, ponds, open ditches, and drains do not become offensive to the public or allow these areas to become prejudicial to human health.
Health Act 1911 *Environmental Protection (Controlled Waste) Regulations 2004*	General	Part IV (3) (95) Part III	Removal of sewerage systems is to be conducted in accordance with Local Government Law and by a licensed contractor in accordance with the *Environmental Protection (Controlled Waste) Regulations 2004*.
Mines Safety and Inspection Regulations 1995	General	Part III, (2) (3.11)	Notification of suspension of mining operations must be in writing and include the requirements specified in Section 3.14 of the regulations.
Mines Safety and Inspection Regulations 1995	General	Part III, (2) (3.16)	At notification of abandonment the proponent is required to notify the department how the following has been achieved: • Secure the site against inadvertent public access. • Prevent and mitigate mine subsidence. • Plant and equipment removed or secured and left in a safe condition. • Hazardous substances removed or properly disposed.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Mines Safety and Inspection Regulations 1995	General	Part XVI, (2) (16.35)	The proponent shall submit a plan with the notification which shows: a. the specific locations in which radioactive waste has been buried; and b. the absorbed dose rates in air one metre above the final surface.
Mines Safety and Inspection Regulations 1995	General	Part XVI, (2) (16.35)	After the mine is abandoned, rehabilitation sites are to be inspected and monitored at such intervals and in such a way as is approved by the State mining engineer.
Mines Safety and Inspection Regulations 1995	General	Part XIII, (13.8)	The principal employer at, and the manager of, a mine must ensure that geotechnical aspects are adequately considered in relation to the design, operation and abandonment of quarry operations.
Mining Act 1978	General	Part IV (84AA)	A mine closure plan is required to be approved by the Department and reviewed every 3 years, or as specified by the Department.
Mining Act 1978.	General	Part III (1) (20) (3a)	Make safe all holes, pits, trenches and other disturbances on the surface of the land which are likely to endanger the safety of any person or animal.
Mining Act 1978.	General	Part III (1) (20) (3b)	Take all necessary steps to prevent fire and damage to trees or other property.
Mining Regulations 1981	General	Part V, (6) (97)	Avoid activity that obstructs any public thoroughfare or undermines any road, railway, dam or building in such manner as to endanger the public safety.
Mining Regulations 1981	General	Part V, (6) (98)	The proponent shall not allow detritus, dirt, sludge, refuse, garbage, mine water or pollutant from the tenement to become an inconvenience to the holder of any other mining tenement or to the public, or in any way injure or obstruct any road or thoroughfare or any land used for agricultural purposes.
Soil and Land Conservation Act 1945	General	Part V (32)	The proponent shall take adequate precautions to prevent or control soil erosion, salinity or flooding; or the destruction, cutting down or injuring of any tree, shrub, grass or any other plant on land where land degradation is occurring or likely to occur.
Wildlife Conservation Act 1950	General	(16 and 23F)	A person may not take for any purpose protected fauna or flora without a licence, or rare and endangered flora without the written consent of the Minister.
Water and Rivers Commission Licence to Take Water 2007	GWL104551(7)	Terms, Conditions and Restrictions (7)	Monitoring reports are to be submitted to the Water and Rivers Commission for assessment by the 31st of March each year.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number: L5319/1988/11)	L5319/1988/11	General Conditions: Annual Reporting Requirements (G2a)	The licensee shall prepare each year, an Annual Environmental Report containing the monitoring data and other collected data required by any condition of this licence. This report shall cover the previous 12 month period from 1 January to 31 December. The report shall be forwarded to the Director no later than 1 April each year.
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number: L5319/1988/11)	L5319/1988/11	General Conditions: Annual Reporting Requirements (G2b)	The licensee shall ensure that the Annual Environmental Report contains the following information, where appropriate, for the relevant reporting period: i. a summary table of any licence exceedence and significant environmental incidents; ii. a summary of the characteristics, volume and effects of discharges from the premises to the environment; iii. an assessment of the reported information against previous monitoring results, licence limits or other appropriate measures (e.g. standards or guidelines); iv. a table showing quantities of raw materials used and the quality and quantity of wastes produced; and v. a summary of issues raised during any DEC inspections and the manner in which these issues have been, or will be, addressed.
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number: L5319/1988/11)	L5319/1988/11	General Conditions: Annual Reporting Requirements (G2c)	The licensee shall by 1 April in each year, provide to the CEO an Annual Audit Compliance Report in the form in Attachment 2 to this licence, signed and certified in the manner required by Section C of the form, indicating the extent to which the licensee has complied with the conditions of this licence, and any previous licence issued under Part V of the Act for the Premises, during the period beginning 1 January the previous year and ending on 31 December in that year.
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number: L5319/1988/11)	L5319/1988/11	Solid Waste Disposal Conditions S(1a)	The licensee shall dispose of all wastes accepted at the premises only at the approved class Ill landfill, excepting inert waste which may be either disposed of at the approved class Ill landfill or be co-disposed with overburden, slimes and/or sand tailings within the boundaries of the premises.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number: L5319/1988/11)	L5319/1988/11	Solid Waste Disposal Conditions S(1b)	The licensee shall ensure the wastes referred to in part (a) of this condition are limited to the following: i. tailings from Chandala Dry Separation Plant; ii. fine and coarse coal waste from Chandala Synthetic Rutile Plant; (iii) filter cake from Chandala Synthetic Rutile Plant; iii. pugged waste and liquor pond solids/slurry from Chandala Synthetic Rutile Plant; iv. filter cake from Kwinana Pigment Plant; v. material from clean-up, maintenance, decommissioning and/or construction activities at the Cooljarloo mine site, the Chandala Dry Separation and Synthetic Rutile Plants, the Kwinana Pigment Plant or other Tronox sites (e.g. Port or Storage facilities at Sunbury and Henderson); and vi. other inert waste.
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number: L5319/1988/11)	L5319/1988/11	Solid Waste Disposal Conditions S(1c)	The waste referred to in condition S1(b) (vi) shall be solid material only, it shall not include liquids or any container containing liquids, excepting liquid or other potential contaminant that has inadvertently come in contact with the solid material.
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number: L5319/1988/11)	L5319/1988/11	Solid Waste Disposal Conditions S(1d)	The licensee shall report the amount, types, and locations of wastes accepted for disposal at the premises, including wastes covered under Condition S1(a) in the Annual Environmental Report required by condition G2(a).
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number: L5319/1988/11)	L5319/1988/11	Analysis of Waste (S2)	The licensee shall analyse the waste described in conditions S1(b), with the exception of wastes described in condition S1(b)(vi) and S1(b)(vii), every 6 months to determine its waste classification pursuant to the "Landfill Waste Classification and Waste Definitions 1996 (as amended)" and include this information in the Annual Environmental Report required by condition G2(a).
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number:	L5319/1988/11	Burial of Tyres (4b)	The licensee shall keep an annual tyre inventory detailing the number and types of tyres stored, buried and disposed of by other means on the premises, including a map detailing the locations in which the tyres were buried, and include this information in the Annual Environmental Report required by condition G2(a).

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
L5319/1988/11)			
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number: L5319/1988/11)	L5319/1988/11	1.4.4 Rehabilitation Dust Control (Cooljarloo Dust Management Plan Attachment 3)	The progressive rehabilitation of open areas limits the potential for general dust. The effective control of dust in rehabilitation works is essential to prevent the loss of topsoil through wind erosion and sand creep. This is particularly important in areas close to the Brand Highway where dust could potentially create a traffic hazard and in disturbed areas adjacent to rehabilitation or undisturbed vegetation where sand creep could bury vegetation.
Western Australia Department of Environment and Conservation *Environmental Protection Act 1986* Licence 5319 (Licence Number: L5319/1988/11)	L5319/1988/11	1.4.4 Rehabilitation Dust Control (Cooljarloo Dust Management Plan Attachment 3)	To minimise generation of dust from disturbed areas and rehabilitation : • A combination of mulch, cover crops of oats and/or chemical stabilising agents is used to prevent wind erosion from exposed surfaces; • An annual stabilisation plan is developed and implemented by the Environmental Coordinator - Rehabilitation. This addresses the stabilisation of rehabilitation areas, topsoil stockpiles and other areas with the use of stabilising agents such as mulch, oats cover crops, chemical stabilisers and hydro-mulch to assist in keeping levels of dust and erosion low; • Traffic is restricted to established roads and tracks.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Proposal Implementation 1-1	The proponent shall implement the proposal as assessed by the Environmental Protection Authority and described in schedule 1 of this statement subject to the conditions and procedures of this statement.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Proponent Nomination and Contact Details 2-2	The proponent shall notify the Chief Executive Officer (CEO) of the Department of Environment and Conservation of any change of the name and address of the proponent for the serving of notices or other correspondence within 30 days of such change.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Compliance Reporting 4-1	The proponent shall submit to the CEO of the Department of Environment and Conservation environmental compliance reports annually reporting on the previous twelve-month period, unless required by the CEO of the Department of Environment and Conservation to report more frequently.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Compliance Reporting 4-2	The environmental compliance reports shall address each element of an audit program approved by the CEO of the Department of Environment and Conservation and shall be prepared and submitted in a format acceptable to the CEO of the Department of Environment and Conservation.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Compliance Reporting 4-3	The environmental compliance reports shall: 1. be endorsed by signature of the proponent's chief executive officer or a person, approved in writing by the CEO of the Department of Environment and Conservation, delegated to sign on behalf of the proponent's chief executive officer; 2. state whether the proponent has complied with each condition and procedure contained in this statement; 3. provide verifiable evidence of compliance with each condition and procedure contained in this statement; 4. state whether the proponent has complied with each key action contained in any environmental management plan or program required by this statement; 5. provide verifiable evidence of conformance with each key action contained in any environmental management plan or program required by this statement; 6. identify all non-compliances and non-conformances and describe the corrective and preventative actions taken in relation to each noncompliance or non-conformance; 7. review the effectiveness of all corrective and preventative actions taken; and 8. describe the state of implementation of the proposal.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Compliance Reporting 4-4	The proponent shall make the environmental compliance reports required by condition 4-1 publicly available in a manner approved by the CEO of the Department of Environment and Conservation.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Flora and Vegetation 6-3	The proponent shall monitor the health and abundance of native vegetation (including Declared Rare Flora and Priority flora species) outside the areas to be cleared to ensure that there is no decline in the health or abundance of such vegetation through the implementation of the proposal. This monitoring is to be carried out to the satisfaction of the CEO of the Department of Environment and Conservation.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Flora and Vegetation 6-4	The proponent shall submit the results of monitoring required by condition 6-3 to the CEO of the Department of Environment and Conservation annually.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Flora and Vegetation 6-5	In the event that monitoring required by condition 6-3 indicates a decline in the health or abundance of native vegetation outside the areas to be cleared, the proponent shall report such findings to the CEO within 21 days of the decline being identified, and shall state the actions the proponent shall take remediate the decline.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Flora and Vegetation 6-6	The proponent shall make the monitoring reports required by condition 6-4 publicly available in a manner approved by the CEO of the Department of Environment and Conservation.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Groundwater Drawdown 7-1	At all times, the proponent shall ensure that groundwater drawdown in the proposal area and in the vicinity of the proposal area does not exceed the absolute minimum magnitude and absolute minimum rate trigger levels defined in schedule 2 - Table 3.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Groundwater Drawdown 7-2	At all times, the proponent shall ensure that the limit of groundwater drawdown in the proposal area and in the vicinity of the proposal area does not approach the potentially acid-forming substrate to the extent that acidic waters are generated and/or released.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Groundwater Drawdown 7-4	The proponent shall monitor groundwater from bores indicated in Figure 4 (attached) to facilitate determination of whether the requirements of conditions 7-1, 7-2 and 7-3 are being met. This monitoring is to be carried out to the satisfaction of the CEO of the Department of Environment and Conservation.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Groundwater Drawdown 7-5	The proponent shall submit annually the results of the monitoring of groundwater required by condition 7-4 to the CEO of the Department of Environment and Conservation.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Groundwater Drawdown 7-6	The proponent shall provide proposed management measures to the CEO of the Department of Environment and Conservation in the event that the requirements of conditions 7-1, 7-2 and/or 7-3 are not met or are not likely to be met.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Closure and Rehabilitation 8-1	Prior to commencement of productive mining, the proponent shall conduct surveys of the proposal area to collect baseline information on the following: 1. Pre-mining soil profiles; 2. Groundwater levels; 3. Surface water flows; 4. Vegetation complexes; and 5. Landscape and landforms.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Closure and Rehabilitation 8-2	Within 12 months following cessation of productive mining, the proponent shall, subject to the requirements of the Wildlife Conservation Act 1950, translocate the Declared Rare Flora plants referred to in condition 6-1 from their temporary locations back into their original areas.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Closure and Rehabilitation 8-3	As mining progresses, the proponent shall commence rehabilitation of the mined area in accordance with the following: 1. Re-establishment of vegetation in the rehabilitation area to be comparable with that of the pre-mining vegetation such that the following criteria are met within three years following the cessation of productive mining: a. Species diversity is not less than 70 percent of the known original species diversity; b. Declared Rare Flora and Priority flora are re-established with not less than 50 percent success after three years and 65 percent success after five years; and c. Weed coverage not to exceed the recorded baseline weed cover levels or species within the proposal area, with the baseline to be established by the proponent prior to the commencement of clearing. 2. A schedule of rate of rehabilitation acceptable to the CEO of the Department of Environment and Conservation.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Closure and Rehabilitation 8-4	In liaison with the Department of Environment and Conservation, the proponent shall monitor progressively the performance of rehabilitation against the criteria in condition 8-3 based on annual monitoring in spring.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Closure and Rehabilitation 8-5	The proponent shall submit annually a report of the rehabilitation performance monitoring required by condition 8-4 to the CEO of the Department of Environment and Conservation and shall address in the report the following: 1. Progress towards meeting the criteria required by condition 8-3 and milestone criteria; and 2. Contingency management measures in the event that criteria are unlikely to be met.
Cooljarloo Mine - Falcon Extension EP Act Part IV Approval Conditions (2009)	MS 790	Closure and Rehabilitation 8-6	The proponent shall report the findings of the Nichols-Woodman review of rehabilitation practices and standards to the CEO of the Department of Environment and Conservation. If findings indicate that rehabilitation criteria defined in condition 8-3 can be improved, then the new criteria defined in the findings shall be used.
Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27 200 and 28 000 EP Act Part IV Approval Conditions (2000)	MS 557	Proponent Commitments 2-1	The proponent shall implement the consolidated environmental management commitments documented in schedule 2 of this statement.
Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27 200 and 28 000 EP Act Part IV Approval Conditions (2000)	MS 557	Proponent Commitments 2-2	The proponent shall implement subsequent environmental management commitments which the proponent makes as part of the fulfilment of conditions and procedures in this statement.
Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27 200 and 28 000 EP Act Part IV Approval Conditions (2000)	MS 557	Proponent 3-3	The proponent shall notify the Department of Environmental Protection of any change of proponent contact name and address within 30 days of such change.

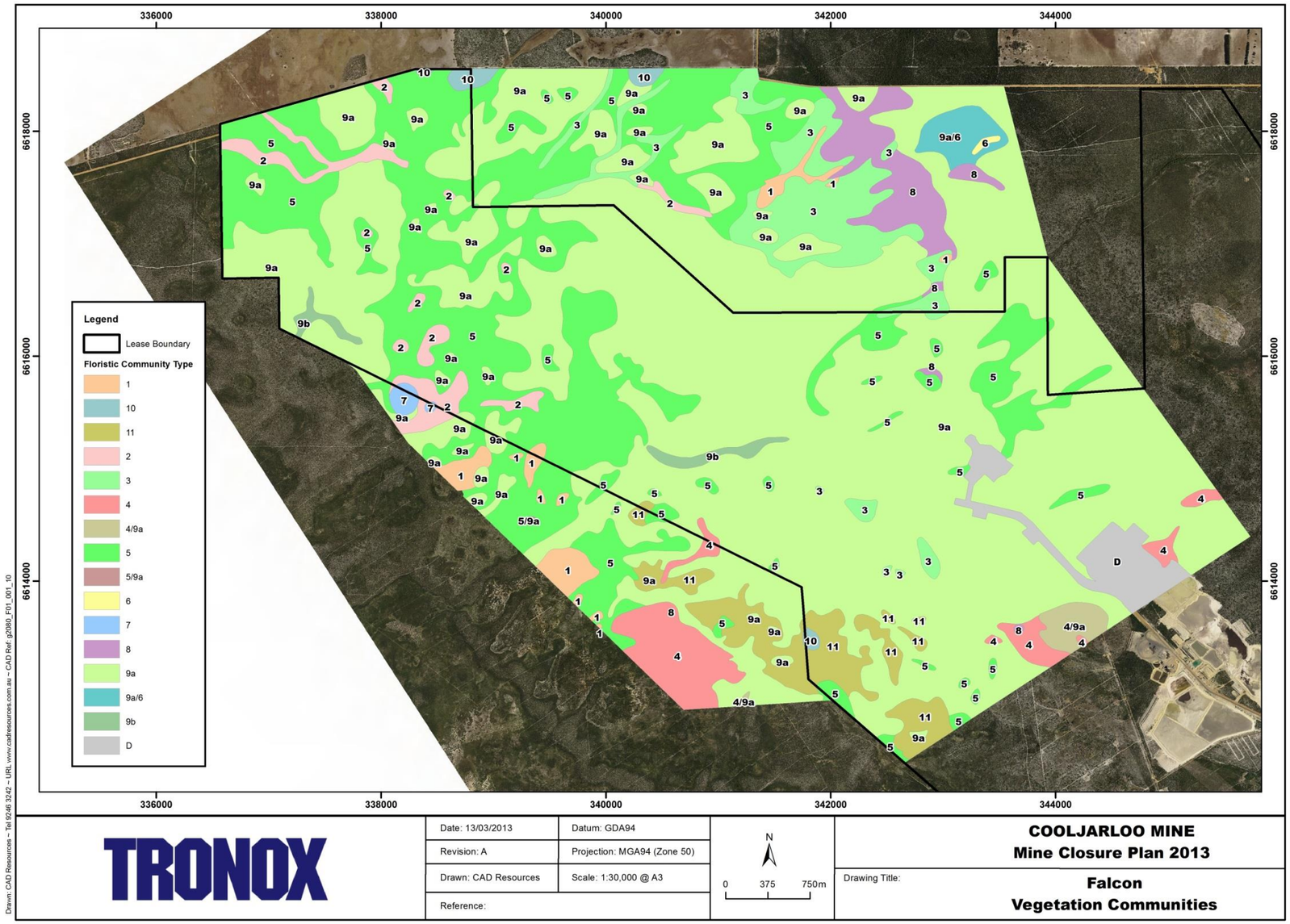
Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27 200 and 28 000 EP Act Part IV Approval Conditions (2000)	MS 557	Compliance Auditing 5-1	The proponent shall submit periodic Compliance Reports, in accordance with an audit program prepared in consultation between the proponent and the Department of Environmental Protection.
Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27 200 and 28 000 EP Act Part IV Approval Conditions (2000)	MS 557	Compliance Auditing 5-2	Unless otherwise specified, the Chief Executive Officer of the Department of Environmental Protection is responsible for assessing compliance with the conditions, procedures and commitments contained in this statement and for issuing formal, written advice that the requirements have been met.
Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27 200 and 28 000 EP Act Part IV Approval Conditions (2000)	MS 557	Compliance Auditing 5-3	Where compliance with any condition, procedure or commitment is in dispute, the matter will be determined by the Minister for the Environment.
Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27 200 and 28 000 EP Act Part IV Approval Conditions (2000)	MS 557	Integrated Mining and Rehabilitation Plan 9-1	To ensure that rehabilitation is optimised, prior to ground-disturbing activities, the proponent shall develop an Integrated Mining and Rehabilitation Plan, to the requirements of the Environmental Protection Authority (including any requirement of the Environmental Protection Authority for independent expert advice) on advice of the Department of Environmental Protection, the Department of Minerals and Energy, and the Department of Conservation and Land Management. This Plan shall address: 1. baseline vegetation survey; 2. optimal clearing techniques; 3. a mining strategy integrating the mining and rehabilitation schedules, including a reconciliation of voids, tailings and overburden; promptly re-establishing the soil profile; and systematically reducing the area of land awaiting rehabilitation; 4. achievement of "best practice" rehabilitation; 5. comparison with industry benchmarking study, should such data be available; 6. reporting of clearing and rehabilitation rates; 7. weed management; 8. dieback management;

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
			9. propagation strategy, including seed collection, maximising the direct return of topsoil, direct seeding, planting of seedlings, smoke treatment and translocation; 10. development of specific rehabilitation performance criteria; 11. a monitoring programme to determine rehabilitation success; 12. contingency plans in the event that rehabilitation is not likely to meet, or does not meet performance criteria; 13. decommissioning of the mining areas and final voids, and removal of any mine infrastructure; and 14. allocation of resources (equipment, appropriately trained and experienced personnel and independent expert advice). Components 1 to 9 of this Plan shall be prepared prior to ground-disturbing activities. The remaining components shall be prepared within 12 months following commencement of ground-disturbing activities.
Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27 200 and 28 000 EP Act Part IV Approval Conditions (2000)	MS 557	Integrated Mining and Rehabilitation Plan 9-2	The proponent shall implement the Integrated Mining and Rehabilitation Plan required by condition 9-1 to achieve the rehabilitation performance criteria referred to in condition 9-1 (10) to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection.
Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27 200 and 28 000 EP Act Part IV Approval Conditions (2000)	MS 557	Integrated Mining and Rehabilitation Plan 9-3	The proponent shall make the Integrated Mining and Rehabilitation Plan, required by condition 9-1, publicly available to the requirements of the Environmental Protection Authority.
Cooljarloo Mineral Sands Project, Mining of Titanium Minerals, Orebodies 27 200 and 28 000 EP Act Part IV Approval Conditions (2000)	MS 557	Proponent's Environmental Management Commitments 1	Apply the existing Cooljarloo Environmental Management Programme (EMP) to the mining of the 27 200 and 28 000 orebodies as defined in the EMP and Cooljarloo Environmental Procedures Manual.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Cooljarloo Mineral Sands Project EP Act Part IV Approval Conditions (1988)	MS 37	Condition 1	The proponent shall adhere to the proposal (excluding the dry processing plant at Muchea) as assessed by the Environmental Protection Authority and shall fulfil the commitments made in the Environmental Review and Management Programme with the exception of those commitments relating to the proposed dry processing plant (copy of commitments attached).
Cooljarloo Mineral Sands Project EP Act Part IV Approval Conditions (1988)	MS 37	Condition 8	The proponent shall submit brief annual and comprehensive triennial reports to the Department of Mines (and hence to the Environmental Protection Authority) discussing various aspects of the Environmental Management Programme and monitoring of the project, including rehabilitation programmes and other aspects detailed in the Environmental Management Programme. The Environmental Protection Authority will advise the Department of Mines as to the acceptability of these reports and the programme performance.
Cooljarloo Mineral Sands Project EP Act Part IV Approval Conditions (1988)	MS 37	Environmental Management Commitments 1	TiO_2 Corporation NL is committed to achieve a very high standard of mine-site rehabilitation and in particular to: • carry out detailed soil profile analyses, and flora and vegetation studies in front of the mine path to provide site specific information for rehabilitation planning; • supplement rehabilitation measures by seeding and planting using local indigenous species; • consult closely with Government agencies and especially the Rehabilitation Section of the Department of Mines; • establish long-term monitoring studies to assess revegetation and recolonisation by fauna; and • encourage independent research programmes into rehabilitation methods.
Cooljarloo Mineral Sands Project EP Act Part IV Approval Conditions (1988)	MS 37	Environmental Management Commitments 6	As monazite is radioactive, strict adherence to all Western Australian regulations and the Commonwealth Code of Practice relating to radiation protection will be adopted as described in Section 7.4. This will include specifically: • a comprehensive radiation level monitoring programme at the mine site and environs and of monazite transport units; • comprehensive dust suppression measures; and • specific precautions in the handling, storage and transport of monazite product.

Obligation Source Reference	Instrument Requirement ID No	Requirement Summary	Requirement
Cooljarloo Mineral Sands Project EP Act Part IV Approval Conditions (1988)	MS 37	Environmental Management Commitments 7	Tio_2 Corporation NL is committed to a high level of environmental management and monitoring as an integral part of the Cooljarloo project. It intends to conduct its operations with the highest level of corporate social responsibility and is firmly committed to the principle that mining should involve a transient impact on the environment.
Cooljarloo Mineral Sands Project EP Act Part IV Approval Conditions (1988)	MS 37	Environmental Management Commitments 13	The Company will routinely monitor industrial waters for dieback infection and will develop a contingency plan in association with the Department of Conservation and Land Management to prevent the spread of dieback if there is an infection and to return the waters to a dieback free condition in line with their recommended solution.
Cooljarloo Mineral Sands Project EP Act Part IV Approval Conditions (1988)	MS 37	Environmental Management Commitments 14	Ti02 Corporation NL will install an access road at Cooljarloo along which all vehicles entering the tenement on lawful business will be required to travel. This will have a dieback control facility through which all vehicles will be required to pass. Earthmoving equipment entering or re-entering the site will be subject to stringent cleaning for dieback control. Ti02 cannot be responsible for non-company vehicles entering the tenement areas from other directions. But, in liaison with the Government, Ti02 will discuss the possibility of closing off all other tracks which enter the tenement area.
Cooljarloo Mineral Sands Project EP Act Part IV Approval Conditions (1988)	MS 37	Environmental Management Commitments 15	A disease free nursery, using local sources of seed, will be established near Cooljarloo to provide plants for rehabilitation.
Cooljarloo Mineral Sands Project EP Act Part IV Approval Conditions (1988)	MS 37	Environmental Management Commitments 17	Ti02 Corporation NL recognises the operations areas which are subject to regulation under the *Radiation Safety Act*, and will abide by the requirements of the Act or any amendments made to that Act.
Cooljarloo Mineral Sands Project EP Act Part IV Approval Conditions (1988)	MS 37	Environmental Management Commitments 19	Wastes containing radioactive residues will be disposed of to standards approved by the appropriate authority.

APPENDIX B: VEGETATION MAPS



Drawn: CAD Resources ~ Tel 9246 3242 ~ URL www.cadresources.com.au ~ CAD Ref: g2080_F01_001_10

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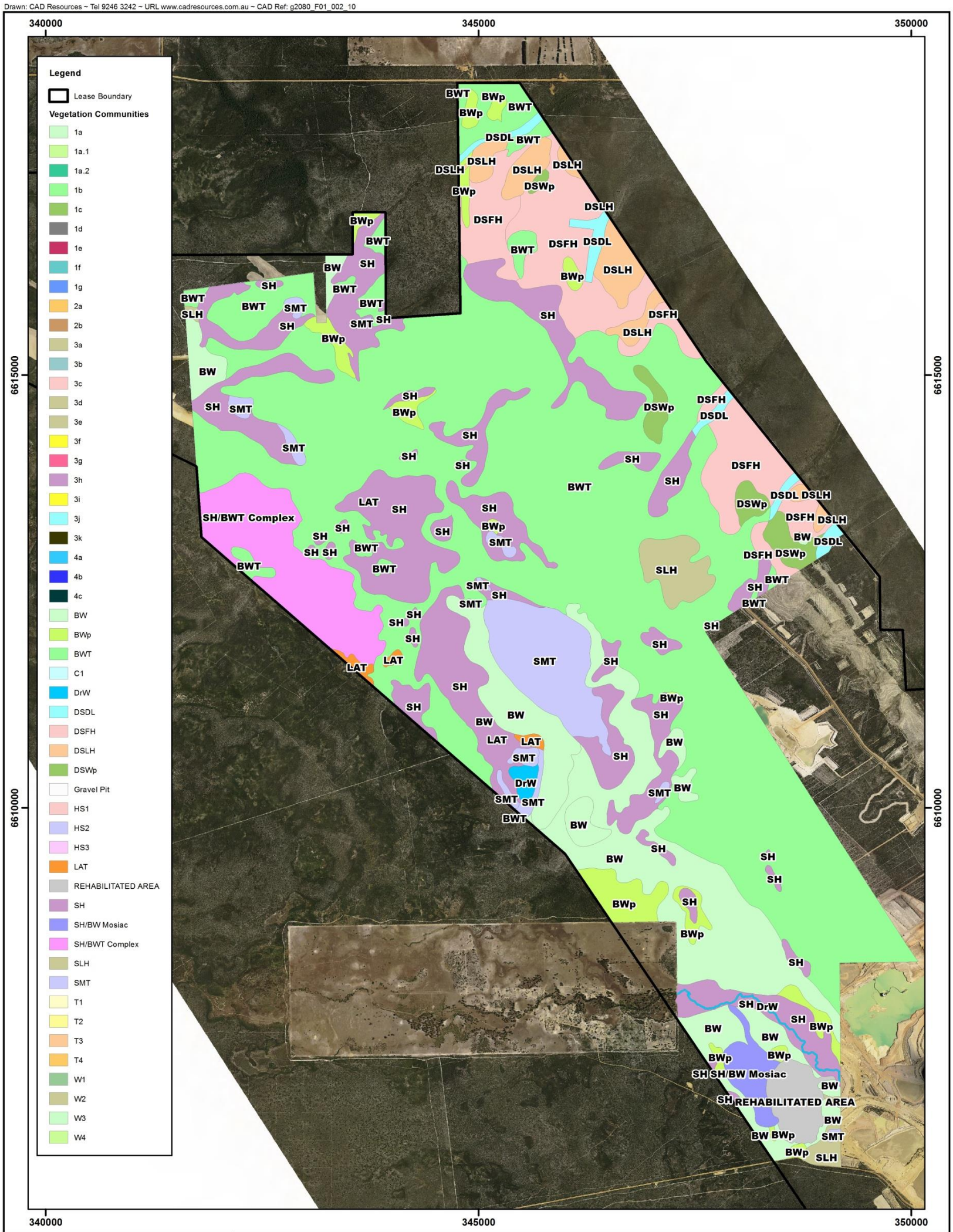
	Revision: A	Projection: MGA94 (Zone 50)	
	Drawn: CAD Resources	Scale: 1:30,000 @ A3	Drawing Title: Falcon Vegetation Communities
	Reference:	N 0 375 750m	

Drawn: CAD Resources ~ Tel 9246 3242 ~ URL www.cadresources.com.au ~ CAD Ref: g2080_F01_002_10



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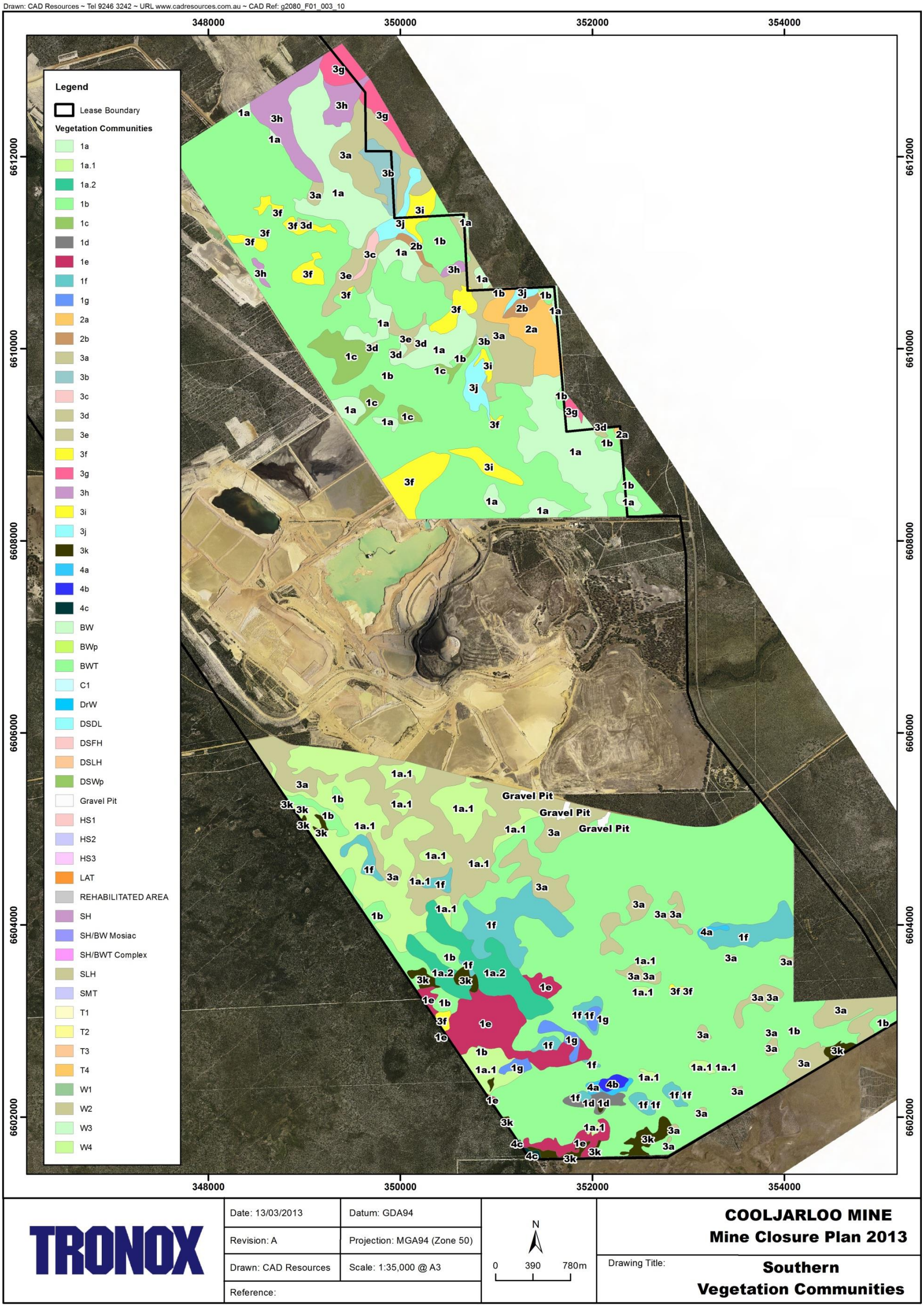
Drawn: CAD Resources ~ Tel 9246 3242 ~ URL www.cadresources.com.au ~ CAD Ref: g2080_F01_003_10



TRONOX	Date: 13/03/2013	Datum: GDA94	N 0 390 780m	COOLJARLOO MINE Mine Closure Plan 2013
	Revision: A	Projection: MGA94 (Zone 50)		Drawing Title: Southern Vegetation Communities
	Drawn: CAD Resources	Scale: 1:35,000 @ A3		
	Reference:			

Vegetation Key Tables

Floristic Community Types

Key	Vegetation Type
1	Heath dominated by *Banksia telmatiaea* and/or *Melaleuca viminea subsp. viminea* on grey or brown sandy clay in drainage lines and basins
2	Heath dominated by a mix of species including *Melaleuca brevifolia*, *M. rhaphiophylla* and *M. lateriflora subsp. acutifolia* interspersed with stands of *Viminaria juncea* on grey or brown sandy clay on lowerslopes, flats and basins
3	Heath dominated by *Banksia telmatiaea* and *Regelia ciliata* on grey sand over clay on lowerslopes and flats
4	Scrub of *Viminaria juncea* over Heath of *Banksia telmatiaea* and *Regelia ciliata* on grey or brown sand in wet basins
5	Species rich Heath dominated by *Banksia telmatiaea* and various other species including *Beaufortia squarrosa, Kingia australis* and *Regelia ciliata* on brown or grey sand on lowerslopes, flats and depressions
6	Heath dominated by *Pericalymma spongiocaule* with emergent *Banksia littoralis* on grey sandy clay in swales
7	Heath dominated by *Melaleuca rhaphiophylla* and *M. viminea subsp. viminea* on grey-black clay in basins
8	Low Forest to Open Low Woodland dominated by *Banksia littoralis, Melaleuca preissiana* or *M. rhaphiophylla* with Thickets of *Acacia saligna* on grey sandy clay or occasionally ironstone on lowerslopes and basins
9a	Low Woodland of *Banksia attenuata, B. menziesii* and *Eucalyptus todtiana* with occasional *Banksia ilicifolia* over Heath on grey or white sand on mid to upperslopes
9b	Low Woodland of *Banksia ilicifolia* and *Eucalyptus todtiana* over Low Heath on grey sand in swales
10	Low Forest to Low Woodland of *Banksia prionotes* and *Eucalyptus todtiana* over Low Heath on brown or yellow sand on mid to upperslopes
11	Low Heath dominated by *Calothamnus sanguineus, Hakea incrassata, H. lissocarpha* and *Hibbertia spp.* on grey or brown sandy clay with lateritic gravel on midslopes and swales

Vegetation Communities

Southern Areas:

Key	Vegetation Type
1a1	Open woodland of *Banksia attenuata, Banskia menziesii* over mixed Proteaceous and Myrtaceous shrubs in upper slope areas on yellow-brown sand.
1a2	Woodland of *Banksia prionotes, Eucalyptus todtiana* over mixed Proteaceous and Myrtaceous shrubs in upper slope areas on yellow sand.
1b	Woodland of *Eucalyptus todtiana, Banskia menziesii, Banksia attenuata* over mixed Proteaceous and Myrtaceous shrubs on lower slope areas on grey sand.
1d	Woodland of *Eucalyptus decipiens, Eucalyptus todtiana, Banskia* spp. And *Nuytsia floribunda* over *Conostephium minus, Eremaea pauciflora* and *Calytrix leschenaultii* on lower slopes on grey sand.
1e	Woodland of *Banksia attenuata, Banksia menziessii* and *Nuytsia floribunda* over *Banksia incana, Beaufortia squarrosa* and *Adenanthos cygnorum* on lower slopes on grey-brown sand.
1f	Woodland of *Melaleuca preissiana, Banksia attenuata, Banksia menziesii* and *Eucalyptus todtiana* over *Adenanthos cygnorum, Eremaea pauciflora* and *Calytrix fraseri* over *Dasypogon obliquifolius*, on mid to lower slopes on grey-brown sand.
1g	Woodland of *Melaleuca preissiana, Nuytsia floribunda* and *Banksia attenuata* over *Banksia incana* and *Adenanthos cygnorum, Beaufortia spp*. And *Melaleuca scabra* in depressions on yellow-brown sand.
3a	Heath of occasional *Nuytsia floribunda, Banksia prionotes* and *Eucalyptus todtiana* over *Beautfortia elegens*, *Petrophile macrostachya* and *Allocasuarinia* spp.on grey sand.
3f	Low heath dominated by *Calytrix aurea, Calytrix fraseri, Banksia incana* and *Beaufortia squarrosa* on yellow sandy-loam.
3k	Low heath dominated by *Banksia incana*, with occasional emergent *Nuytsia floribunda* and *Eucalyptus todtiana*, on brown sandy-loam.
4a	Woodland of *Melaleuca preissiana* and *Melaleuca rhaphiophylla* over *Calothamnus quadrifidus, Jacksonia stembergiana, Xanthorrhoea preissii* and *Chamelaucium uncinatum* on brown sandy-loam.
4b	Woodland of *Eucalyptus rudis, Banksia prionotes* and *Banksia grandis* over *Acacia saligna, Jacksonia stembergiana, Xanthorrhoea preissii* and *Macrozamia riedlei* over annual herbs and grasses on dark brown loam.
4c	Open Low woodland of *Melaleuca rhaphiophylla* over *Regelia cilata, Hakea varia* and *Banksia incana* over *Dryandra nivea ssp.nivea, Lepidosperma tenue* and *Anarthria laevis* on dark brown loam.

Key	Vegetation Type
BW	*Banksia attenuata, B. menziessii* Woodlands with *Eucalyptus todtiana* on low lying level sites
BWT	*Banksia attenuata, B. menziessii* Woodlands on low dunes
BWp	*Banksia prionotes* and mixed Banksia woodlands on low lying to low rises of yellow sands
DrW	Drainage Line Woodland - Mullering Brook
SH	Sand Heaths Ephemeral Wetlands
SH/BW mosaic	*Sand Heath/Banksia Woodland Mosaic*
SLH	*Sand over laterite heaths*
SMT	*Swamp Melaleuca Thicket*
DrW	Drainage Line Woodland – Mullering Brook (not recognised by Mattiske)
LAT	Laterite outcrops and low rises within Sand Heaths
DSFH	Dandaragan Scarps Footslope Heaths (Mattiske 3c)
DSBWp	Dandaragan Scarp Banksia prionotes woodlands on yellow sand (not mapped by Mattiske)
DSSLH	Dandaragan Scarp sand over Laterite Heath (Mattiske 2a, 2b)
DSDL	Dandaragan Scarp Drainage Lines (not mapped by Mattiske)
MT	Melaleuca Thicket
SH/BW Mos	Sand Heath / Banksia Woodland Mosaic

Northern-Central Areas

Key	Vegetation Type
SH/BWT Com	Sand Heath / Banksia Woodland with *Ecualyptus todtiana* Mosaic
1a	Open Woodland of *Banksia prionote, Banskia menziesii, Banksia attenuata* and *Nuytsia floribunda* over mixed Proteaceous and Myrtaceous shrubs in upper slope areas on grey sand.
1b	Woodland of *Eucalyptus todtiana, Banskia menziesii* and *Banksia attenuata* over mixed Proteaceous and Myrtaceous shrubs on lower slopes of grey sand.

Key	Vegetation Type
1c	Woodland of *Banksia prionotes, Banksia ilicifolia* and *Banksia attenuata* over mixed Myrtaceous and Proteaceous shrubs on lower slopes on grey sand.
2a	Heath of *Xanthorrhoea preissii* over mixed Proteaceous shrubs and mixed sedges, with occasional emergent *Eucalyptus todtiana,* on grey sand over lateritic gravel.
2b	Heath of *Allocasuarina microstachya* and mixed Proteaceous and Myrtaceous shrubs over *Ecdeiocolea monostachya*, with occasional emergent *Xanthorrhoea preissii*, on lateritic gravel.
3a	Heath of occasional *Nuytsia floribunda*, *Banksia prionotes* and *Eucalyptus todtiana* over *Beaufortia elegans, Petrophile macrostachya* and *Allocasuarina* spp. On grey sand.
3b	Heath of *Xanthorrhoea preissii* and occasional *Nuytsia floribunda* over *Melaleuca scabra* and mixed Myrtaceous species over sedges on grey sand.
3c	Heath of stunted *Banksia attenuata* over *Banksia candolleana, Daviesia incrassata* and *Allocasuarina humilis*, with emergent *Nuytsia floribunda*, over *Dasypogon obliquifolius* and mixed low shrubs on brown sandy-loam.
3d	Heath of *Pericalymma ellipticum, Beaufortia elegans* and *Eremaea pauciflora* over *Dasypogon obliquifolius* on grey sand.
3e	Low heath dominated by *Verticordia densiflora, Scholtzia involucrata, Calothamnus quadrifidus* and *Conospermum stoechadis* over sedges on yellow sandy-loam.
3f	Low heath dominated by *Calytrix aurea, Calytrix drummondii, Hakea conchifolia, Banksia sphaerocarpa* ssp. *sphaerocarpa* and *Beafortia squarrosa* on yellow sandy-loam.
3g	Heath of *Xanthorrhoea preissii* over mixed Proteaceous shrubs in yellow sandy-loam.
3h	Heath of stunted *Melalecua rhaphiophylla, Melaleuca scabra, Banksia sphaerocarpa* ssp*. sphearocarpa* and *Kunzea recurva* with emergent *Xanthorrhoea preissii* on black clay-loam in winter-wet depression.
3i	Occasional *Melaleuca preissiana* over Shrubland of *Viminaria juncea*, *Hypocalymma angustifolium, Xanthorrhoea preissii* and mixed Myrtaceous shrubs over *Lepidosperma squamtum* on grey clay-loam.
3j	Dense Shrubland of *Melaleuca viminea* and *Kunzea recurva* over annual species on grey clay-loam in winter wet depressions.

APPENDIX C: ASPECTS REGISTER

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Air Emissions	Process waste pits generating dust emissions from open pits and adjacent roads.	Impacts to biodiversity and visual amenity.	Moderate	Likely	High	Capping to reduce dust; Water carts to suppress dust on haul roads; Cover crop and slimes stabilisation where appropriate.	Insignificant	Likely	Low
Air Emissions	Heavy vehicle wash-down (near Sth Mine concentrate stockpile) and surrounding wash-down facility generating airborne visible dust.	Impacts to biodiversity and visual amenity.	Moderate	Likely	High	Routine clean out of sump and surrounding area (disposed of within the landfill). Road sweeping.	Insignificant	Likely	Low
Air Emissions	Heavy machinery movement around site resulting dust emissions (OB movement, Topsoil stripping/placement etc.).	Impacts to biodiversity and visual amenity.	Moderate	Likely	High	Water carts to suppress dust on haul roads; Cover crop and slimes stabilisation where appropriate.	Insignificant	Likely	Low
Air Emissions	Light vehicle movement around site resulting in dust emissions on unsealed roads.	Impacts to biodiversity and visual amenity.	Moderate	Likely	High	Water carts to suppress dust on haul roads; Cover crop and slimes stabilisation where appropriate.	Insignificant	Likely	Low
Biodiversity	Movement of machinery around site resulting in the transfer of weed propagules.	Impacts to biodiversity.	Moderate	Likely	High	Hygiene controls/inspections; Monitoring; Regular eradication (spraying) programs.	Minor	Unlikely	Low
Biodiversity	Drill holes not appropriately capped resulting in capture and death of fauna.	Impacts to biodiversity.	Moderate	Likely	High	Drill hole capping.	Minor	Unlikely	Low
Biodiversity	Funding to biodiversity projects inadequate resulting in failure of local programs.	Impacts to biodiversity.	Moderate	Likely	High	Funding to Western shield.	Minor	Unlikely	Low
Biodiversity	Feral animal or excessive native breeding on site resulting in damage to the environment/rehabilitation.	Impacts to biodiversity.	Moderate	Likely	High	Feral animal trapping; Baiting; Routine culling were appropriate.	Minor	Unlikely	Low

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Biodiversity	Spread of Pc Dieback via root to root contact or surface water movement within infestation areas.	Impacts to biodiversity.	Major	Likely	High	Drainage Control and Containment Buffers; Pc surveys/monitoring; Research into eradication methods.	Moderate	Moderate	Medium
Biodiversity	Rake and blade clearing resulting in transfer of Pc Dieback.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Biodiversity	Heavy machinery movement around site resulting in transfer of Pc Dieback.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Biodiversity	Mobilisation and demobilisation of high risk heavy machinery to and from site resulting in transfer of Pc Dieback.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Biodiversity	Carry grader topsoil stripping/placement resulting in transfer of Pc Dieback.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Biodiversity	Road construction, maintenance and other miscellaneous civil works resulting in a transfer of Pc Dieback.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Biodiversity	Movement of topsoil resulting in transfer of Pc Dieback.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Biodiversity	Movement of vehicles off main roads resulting in transfer of Pc Dieback.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Biodiversity	Staff light vehicles in admin car park transferring Pc Dieback to from site.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Biodiversity	Movement of overburden around site resulting in transfer of Pc Dieback.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Biodiversity	Road drainage not appropriately managed resulting in transfer of Dieback.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Biodiversity	Road construction blocking drainage ways resulting in water ponding/shadowing increasing risk of Dieback infestation.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Biodiversity	Heavy Vehicle inspection inadequate resulting in transfer of Pc Dieback onto site.	Impacts to biodiversity.	Major	Likely	High	Hygiene controls/inspections; Quarantine of infested areas; Pc surveys/monitoring.	Moderate	Moderate	Medium
Energy	Excavation, hauling and dumping poorly planned resulting in excessive diesel use.	Emission contributing to greenhouse gas generation.	Minor	Likely	Medium	EEO systems including the Capital Review, PCR process and Business Improvement identification sessions; annual Maine Planning	Insignificant	Likely	Low

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
						processes.			
Energy	Inefficient electric pumps or motors using excessive energy to move material (slimes, tails, slurry, water).	Emission contributing to greenhouse gas generation.	Minor	Likely	Medium	EEO systems including the Capital Review, PCR process and Business Improvement identification sessions.	Insignificant	Unlikely	Low
Energy	Inefficient diesel pumps or motors using excessive energy to move material (slimes, tails, slurry, water).	Emission contributing to greenhouse gas generation.	Minor	Likely	Medium	EEO systems including the Capital Review, PCR process and Business Improvement identification sessions.	Insignificant	Unlikely	Low
Energy	Planning pump locations incorrectly resulting in inefficient transfer of materials around site.	Emission contributing to greenhouse gas generation.	Minor	Likely	Medium	EEO systems including the Capital Review, PCR process and Business Improvement identification sessions.	Insignificant	Likely	Low
Fire	Storage of dangerous good not conducted as per standard resulting in fire.	Impacts to biodiversity.	Major	Likely	High	Fire Breaks; Controlled burns as agreed with DEC; Fire Tender; ERT, Prestart checks, Vehicle maintenance; Fire extinguishers in vehicles; Harvest Ban notifications; Management of dangerous good conducted as per regulations.	Moderate	Unlikely	Medium
Fire	Vegetation harvesting resulting in fire due to build-up of material adjacent moving parts.	Impacts to biodiversity.	Major	Likely	High	Fire Breaks; Controlled burns as agreed with DEC; Fire Tender; ERT, Prestart checks, Vehicle maintenance; Fire extinguishers in vehicles; Harvest Ban notifications; Water carts present.	Moderate	Unlikely	Medium
Fire	Drilling in UCL resulting in fire due to build-up of material adjacent moving parts.	Impacts to biodiversity.	Major	Likely	High	Fire Breaks; Controlled burns as agreed with DEC; Fire Tender; ERT, Prestart	Moderate	Unlikely	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
						checks, Vehicle maintenance; Fire extinguishers in vehicles; Harvest Ban notifications; Water carts present.			
Fire	Light vehicle movement in UCL resulting in fire.	Impacts to biodiversity.	Major	Likely	High	Fire Breaks; Controlled burns as agreed with DEC; Fire Tender; ERT, Prestart checks, Vehicle maintenance; Fire extinguishers in vehicles; Harvest Ban notifications.	Moderate	Unlikely	Medium
Fire	Hot work resulting in fire due to stray embers.	Impacts to biodiversity.	Major	Likely	High	Fire Breaks; Controlled burns as agreed with DEC; Fire Tender; ERT, Prestart checks, Vehicle maintenance; Fire extinguishers in vehicles; Harvest Ban notifications; Hot works supervision procedures.	Moderate	Unlikely	Medium
Fire	Machinery/or plant starting bushfire; Bushfire leading to loss of biodiversity.	Impacts to biodiversity.	Major	Likely	High	Fire Breaks; Controlled burns as agreed with DEC; Fire Tender; ERT, Prestart checks, Vehicle maintenance; Fire extinguishers in vehicles; Harvest Ban notifications.	Moderate	Unlikely	Medium
Fire	Power lines pole-top sparks resulting in fire.	Impacts to biodiversity.	Major	Likely	High	Fire Breaks; Controlled burns as agreed with DEC; Fire Tender; ERT, Prestart checks, Vehicle maintenance; Fire extinguishers in vehicles; Harvest Ban notifications.	Moderate	Unlikely	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Housekeeping	General housekeeping poor resulting in impacts to visual amenity and/or environment.	Visual amenity.	Moderate	Likely	High	Training and awareness; Work place SEIMS inspections.	Minor	Unlikely	Low
Hydrocarbons	Central Fuel Facility and bunding failure resulting in spillage to land.	Soil and water contamination.	Major	Moderate	High	Bunds designed to relevant standard (including jetting); Regular inspections.	Minor	Unlikely	Low
Hydrocarbons	Drilling Rig hydraulic failure resulting in spills to land/water.	Soil and water contamination.	Minor	Likely	Medium	Regular maintenance checks; Prestart checks (vehicles); Regular Inspections; Training and awareness; Spill kits (land and water).	Minor	Unlikely	Low
Hydrocarbons	Fuel transfer from north or south fuel farms resulting in spills to land.	Soil and water contamination.	Major	Unlikely	Medium	Regular maintenance checks; Prestart checks (vehicles); Regular Inspections; Training and awareness; Spill kits (land and water).	Minor	Unlikely	Low
Hydrocarbons	Pumps and motors (tails/water/slimes) leaking hydrocarbons to land/water.	Soil and water contamination.	Moderate	Likely	High	Regular maintenance checks; Regular Inspections; Training and awareness; Spill kits (land and water).	Minor	Unlikely	Low
Hydrocarbons	Oily / water separator failure resulting in contaminated water discharge to land/water (Piacentini).	Soil and water contamination.	Moderate	Likely	High	Regular maintenance checks; Regular Inspections; Training and awareness; Spill kits (land and water).	Minor	Unlikely	Low
Hydrocarbons	Service area/motor wash-down using inappropriate degreasers (e.g. not quick break) resulting in discharge to hydrocarbons to land/water.	Soil and water contamination.	Minor	Likely	Medium	Training and Awareness; Product approval required.	Minor	Unlikely	Low
Hydrocarbons	Oily / water separator failure resulting in discharge to land/water (Washday and HMC stockpile).	Soil and water contamination.	Moderate	Likely	High	Regular maintenance checks; Regular Inspections; Training and	Minor	Unlikely	Low

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
						awareness; Spill kits (land and water).			
Hydrocarbons	Hydraulic Power Packs (trommel, scrubber, belt feeder, winches) failure resulting in spillage to Pond 1 (3000L in Coolj1, others much lower quantities).	Soil and water contamination.	Major	Moderate	High	Regular maintenance checks; Regular Inspections; Training and awareness; Spill kits (land and water).	Moderate	Moderate	Medium
Hydrocarbons	Hydrocarbon field storage tank (1000L) failure resulting in discharge to land/water.	Soil and water contamination.	Moderate	Likely	High	Regular maintenance checks; Prestart checks (vehicles); Regular Inspections; Training and awareness; Spill kits (land and water).	Moderate	Unlikely	Medium
Hydrocarbons	Servicing of diesel engines in the field resulting in spills to land/water.	Soil and water contamination.	Moderate	Likely	High	Regular maintenance checks; Prestart checks (vehicles); Regular Inspections; Training and awareness; Spill kits (land and water).	Minor	Moderate	Medium
Hydrocarbons	Dredge excavator gearbox failure resulting in spillage to Pond 1.	Soil and water contamination.	Major	Moderate	High	Regular maintenance; Prestart checks (vehicles); Regular Inspections; Training and awareness; Spill kits (land and water).	Moderate	Moderate	Medium
Hydrocarbons	Heavy machinery hydraulic failure resulting in spillage to land/water.	Soil and water contamination.	Major	Likely	High	Regular maintenance checks; Prestart checks (vehicles); Regular Inspections; Training and awareness; Spill kits (land and water).	Minor	Moderate	Medium
Hydrocarbons	Pelican dredge hydraulic failure resulting in spillage to Pond 1.	Soil and water contamination.	Moderate	Likely	High	Regular maintenance checks; Regular Inspections; Training and awareness; Spill kits (land and water).	Moderate	Moderate	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Hydrocarbons	Hydrocarbon storage facility (stores) bunding failure resulting in spill to land.	Soil and water contamination.	Moderate	Moderate	Medium	Bunds designed to relevant standard (including jetting); Regular inspections.	Moderate	Unlikely	Medium
Hydrocarbons	Hydrocarbon disposal area inappropriately used resulting in hydrocarbon waste going to wrong refuse site.	Soil and water contamination.	Moderate	Likely	High	Regular maintenance checks; Regular Inspections; Training and awareness; Spill kits (land and water).	Moderate	Moderate	Medium
Hydrocarbons	Service truck leaking/spilling hydrocarbons to land/water.	Soil and water contamination.	Moderate	Likely	High	Regular maintenance checks; Regular Inspections; Training and awareness; Spill kits (land and water).	Moderate	Moderate	Medium
Hydrocarbons	Transformers leaking hydraulic fluid to land/water.	Soil and water contamination.	Moderate	Moderate	Medium	Regular maintenance checks; Regular Inspections; Training and awareness; Spill kits (land and water).	Moderate	Unlikely	Medium
Hydrocarbons	Bulk oil transfer via tanker to Cooljarloo 1 excavator gearbox resulting in spillage to land/water.	Soil and water contamination.	Moderate	Moderate	Medium	Regular maintenance checks; Regular Inspections; Training and awareness; Spill kits (land and water).	Moderate	Unlikely	Medium
Hydrocarbons	North Mine Fuel Facility and bunding failure resulting in spillage to land.	Soil and water contamination.	Moderate	Likely	High	Bunds designed to relevant standard (including jetting); Regular inspections.	Moderate	Moderate	Medium
Hydrocarbons	Bioremediation areas not adequately decommissioned resulting in land contamination.	Soil and water contamination.	Moderate	Likely	High	Sampling and monitoring; Investigate contamination as per contaminated sites Regs.	Moderate	Moderate	Medium
Hydrocarbons	Fuel facilities not adequately decommissioned resulting in land contamination.	Soil and water contamination.	Moderate	Likely	High	Sampling and monitoring; Investigate contamination as per contaminated sites Regs.	Moderate	Moderate	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Hydrocarbons	Dangerous/hazardous goods stored incorrectly resulting in fire/explosion.	Soil and water contamination.	Minor	Likely	Medium	Regular Inspections; Training and awareness; Spill kits (land and water).	Moderate	Moderate	Medium
Process Waste	Heavy Vehicle Wash-down (process waste) design/management inadequate resulting in runoff into sensitive areas.	Soil and water contamination.	Moderate	Likely	High	Drainage design; Inspections.	Minor	Unlikely	Low
Process Waste	Process waste pit design/management inadequate resulting in leaching of constitutes into groundwater.	Soil and water contamination.	Major	Likely	High	Agreed DEC design standards applied; Verification of design standards; Groundwater monitoring.	Minor	Likely	Medium
Process Waste	Process waste pit landform design/management inadequate resulting in runoff into Mullering Brook.	Soil and water contamination.	Moderate	Likely	High	Road design and maintenance; Road side clean-up; Progressive capping.	Minor	Moderate	Medium
Rehabilitation	Topsoil ripping is not conducted to plan/standard impacting rehab outcomes (soil compaction/strength).	Rehabilitation outcomes.	Moderate	Likely	High	Rehabilitation Plan; Works Scheduling; Supervision.	Minor	Unlikely	Low
Rehabilitation	Topsoil placement not conducted to plan (e.g. veg type, 1st or 2nd cut) resulting in impacts to rehab outcomes.	Rehabilitation outcomes.	Moderate	Likely	High	Rehabilitation Plan; Survey control, Supervision; Operator competency.	Minor	Unlikely	Low
Rehabilitation	Topsoil placement conducted during wet conditions resulting in compaction to topsoil and upper soil profile.	Rehabilitation outcomes.	Moderate	Likely	High	Ripping second cut; Placement during dry season.	Minor	Unlikely	Low
Rehabilitation	Topsoil inventory inadequately maintained resulting in loss of information relating to source material.	Rehabilitation outcomes.	Moderate	Likely	High	Clearing and stripping application process; Survey; Supervision; Regular inspections.	Minor	Unlikely	Low
Rehabilitation	Rehabilitation monitoring procedure inadequate resulting in the inability to identify rehab success and remedial works.	Rehabilitation outcomes.	Moderate	Likely	High	Completion criteria and agreed SOPs review by consultants and MSARCC stakeholders.	Minor	Unlikely	Low

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Rehabilitation	Rehabilitation monitoring/signoffs recording inadequate resulting in loss of information.	Rehabilitation outcomes.	Moderate	Likely	High	Established procedures and systems in place and reviewed as part of the Improvement Plan.	Minor	Unlikely	Low
Rehabilitation	Topsoil placement conducted at an inappropriate time of year resulting in poor plant establishment.	Rehabilitation outcomes.	Moderate	Likely	High	Timing of rehabilitation season specified; Knowledge gaps addressed in the 5 Year Improvement Plan.	Minor	Unlikely	Low
Rehabilitation	Native seed cleaning/processing inadequate leading to unknown seed purity (% of seed in product supplied).	Rehabilitation outcomes.	Moderate	Likely	High	Terms and conditions established in scope of works; Seed Lab testing.	Minor	Unlikely	Low
Rehabilitation	Native seed inappropriately stored impacting seed viability.	Rehabilitation outcomes.	Moderate	Likely	High	Refrigerated Storage available.	Minor	Unlikely	Low
Rehabilitation	Native seed mixed/placed at inappropriate rates.	Rehabilitation outcomes.	Moderate	Likely	High	Supervision; Operator training; Regular inspection; Contract for Seed supply.	Minor	Unlikely	Low
Rehabilitation	Native seed inappropriately spread resulting poor coverage (patchy or not at appropriate rates).	Rehabilitation outcomes.	Moderate	Likely	High	Supervision; Operator training; Regular inspection.	Minor	Unlikely	Low
Rehabilitation	Native seed not treated prior to placement resulting in poor germination.	Rehabilitation outcomes.	Moderate	Likely	High	Supervision; Operator training; Regular inspection.	Minor	Unlikely	Low
Rehabilitation	First cut topsoil stripped incorrectly resulting in loss/dilution of resource for rehabilitation.	Rehabilitation outcomes.	Moderate	Likely	High	Carry Graders used; Clearing and stripping application process; Survey; Supervision; Regular inspections	Minor	Moderate	Medium
Rehabilitation	Clearing/stripping areas beyond the extent required for operations resulting in unnecessary disturbance.	Rehabilitation outcomes.	Moderate	Likely	High	Clearing and stripping application process; Survey; Supervision; Regular inspections.	Moderate	Moderate	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Rehabilitation	Clearing drill lines, pipe corridors and stockpile areas excessively (i.e. disturbance of topsoil) resulting in poor regrowth.	Rehabilitation outcomes.	Moderate	Likely	High	Clearing and stripping application process; Survey; Supervision; Regular inspections.	Moderate	Moderate	Medium
Rehabilitation	Clearing/stripping within areas of potential significant threatened species resulting in unintentional impacts to population.	Rehabilitation outcomes.	Major	Likely	High	Clearing and stripping application process; Survey; Supervision; Regular inspections; Spatial datasets maintained.	Major	Unlikely	Medium
Rehabilitation	Clearing prior to harvesting resulting in loss of mulch resources for rehabilitation.	Rehabilitation outcomes.	Moderate	Likely	High	Clearing and stripping application process; Survey; Supervision; Regular inspections.	Moderate	Unlikely	Medium
Rehabilitation	Design criteria for rehabilitation areas is inadequate resulting in landform failure (i.e. assumptions relating to max slope, class 1 thickness etc.).	Rehabilitation outcomes.	Major	Likely	High	Design criteria established; Research and development (5 year Improvement Plan).	Moderate	Moderate	Medium
Rehabilitation	Design Criteria for Class 3 landfill capping is inadequate resulting in landform failure.	Rehabilitation outcomes.	Major	Likely	High	Design criteria established; Research and development (5 year Improvement Plan).	Moderate	Moderate	Medium
Rehabilitation	Provision funding for rehabilitation works inadequate impacting outcomes.	Rehabilitation outcomes.	Major	Likely	High	Mine Closure Plan; Annual Rehabilitation Completion Report and Provision Review; Annual area open reconciliation.	Moderate	Unlikely	Medium
Rehabilitation	Provision funding for mine closure inadequate resulting in an inability to meet closure obligations.	Rehabilitation outcomes.	Major	Likely	High	Mine Closure Plan; Annual Rehabilitation Completion Report and Provision Review; Annual area open reconciliation.	Moderate	Unlikely	Medium
Rehabilitation	Provision funding of remedial works is inadequate impacting rehab and closure outcomes.	Rehabilitation outcomes.	Major	Likely	High	Revise plans for Dam 123; Develop intervention criteria for historical areas.	Moderate	Unlikely	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Rehabilitation	Overburden placement in reconstructed profiles impedes lateral ground water flow resulting in interruption of hydrological regimes.	Impacts to Groundwater Dependant Ecosystems.	Major	Likely	High	Integrated mine and rehabilitation planning (5 year plan); Tracking progress against Plan.	Moderate	Moderate	Medium
Rehabilitation	Slimes not adequately dewatered and dried resulting in delays to landform completion.	Rehabilitation outcomes.	Moderate	Likely	High	Integrated mine and rehabilitation planning (5 year plan); Tracking progress against Plan.	Moderate	Unlikely	Medium
Rehabilitation	Overburden removal incorrectly characterised resulting in class 2/3 material in the upper soil profile.	Rehabilitation outcomes.	Major	Likely	High	Integrated mine and rehabilitation planning (5 year plan); Field supervision; Soil profile verification monitoring.	Moderate	Moderate	Medium
Rehabilitation	Overburden removal and placement not adequately planned resulting in loss of resource (i.e. Class 1).	Rehabilitation outcomes.	Moderate	Likely	High	Integrated mine and rehabilitation planning (5 year plan);	Minor	Moderate	Medium
Rehabilitation	Overburden removal incorrectly characterised resulting in incorrect placement of material (i.e. Class 1, 2, 3 material).	Rehabilitation outcomes.	Major	Likely	High	Integrated mine and rehabilitation planning (5 year plan); Field supervision; Soil profile verification monitoring.	Moderate	Moderate	Medium
Rehabilitation	Native seed resources inadequate to meet demand (delivery from suppliers or poor season) impacting outcomes.	Rehabilitation outcomes.	Moderate	Likely	High	Use of several contractors; Further gaps addressed in the Rehab Improvement Plan.	Moderate	Moderate	Medium
Rehabilitation	Mulch harvesting resources exhausted resulting in impacts to rehabilitation quality.	Rehabilitation outcomes.	Major	Likely	High	Mulch Harvesting Strategy developed; Mulch Harvesting Plan endorsed; Access to composted mulch form external sources.	Moderate	Moderate	Medium
Rehabilitation	Mulch placement not conducted to standard resulting in inadequate cover and poor topsoil stabilisation.	Rehabilitation outcomes.	Moderate	Likely	High	Supervision; Operator training; Regular inspection.	Minor	Moderate	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Rehabilitation	Cover crop establishment inadequate to stabilities topsoil.	Rehabilitation outcomes.	Moderate	Likely	High	Supervision; Operator training; Regular inspection.	Minor	Moderate	Medium
Rehabilitation	Topsoil placement not conducted on contour resulting in the development of preferential flow paths.	Rehabilitation outcomes.	Moderate	Likely	High	Supervision; Operator training; Regular inspection.	Moderate	Unlikely	Medium
Rehabilitation	Stripping conducted without adequate characterisation of materials (veg type) resulting in impacts to rehab quality.	Rehabilitation outcomes.	Moderate	Likely	High	Supervision; Operator training; Regular inspection.	Minor	Moderate	Medium
Rehabilitation	Stripping/placement of topsoil during wet conditions resulting in loss of soil structure (soil compaction/strength).	Rehabilitation outcomes.	Moderate	Likely	High	Supervision; Operator training; Regular inspection.	Minor	Moderate	Medium
Rehabilitation	Stripping without consideration to direct return or fresh cut placement resulting in loss of resource.	Rehabilitation outcomes.	Moderate	Likely	High	Integrated mine and rehabilitation planning (5 year plan); Field supervision; Soil profile verification monitoring.	Minor	Moderate	Medium
Rehabilitation	Native seed incorrectly identified resulting in inappropriate species within the seed mix.	Rehabilitation outcomes.	Moderate	Likely	High	Terms and conditions established in scope of works.	Minor	Moderate	Medium
Rehabilitation	Vegetation Harvesting off mine path impacting ecological values.	Rehabilitation outcomes.	Major	Moderate	High	Research and Investigation addressed in the 5 Year Improvement Plan and associated Mulch Harvesting Strategy.	Moderate	Unlikely	Medium
Rehabilitation	Tailing transfer (sand & slimes) inappropriately placed resulting in reconstructed landforms that do not adhere to design criteria.	Rehabilitation outcomes.	Major	Likely	High	Supervision; Operator training; Regular inspection.	Moderate	Moderate	Medium
Rehabilitation	Acid Sulphate Soils inadequately identified and characterised resulting in exposure of sulfidic material and impacts to rehab outcomes.	Rehabilitation outcomes.	Major	Moderate	High	Premining screening; Pit inspections; Conceptual model relating to ASS risks.	Moderate	Unlikely	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Rehabilitation	Acid Sulphate Soils inadequately manage resulting in exposure of sulfidic material and impacts to rehab outcomes.	Rehabilitation outcomes.	Major	Moderate	High	Premining screening; Pit inspections; Conceptual model relating to ASS risks.	Moderate	Unlikely	Medium
Rehabilitation	First cut topsoil stockpiled resulting in a loss of propagule viability.	Rehabilitation outcomes.	Major	Likely	High	Supervision; Operator training; Regular inspection.	Moderate	Moderate	Medium
Stakeholder	Community engagement inadequate resulting in failure to maintain favourable community relations.	Community relations.	Moderate	Moderate	Medium	Support Regional collaborative biodiversity projects: – Western Shield fox baiting (DEC) – CPSM Pc research (Murdoch Uni) – Nightstalk Programs (Perth Zoo) – MERIWA Pc research (MERIWA) – Investigate support for Kings Park	Minor	Unlikely	Low
Waste	Clinical waste inappropriately disposed of resulting in impacts to the environment.	Soil and water contamination.	Minor	Unlikely	Low	Training; Supervision.	Minor	Unlikely	Low
Waste	Municipal litter from light vehicles and building impacting land and water.	Soil and water contamination.	Minor	Unlikely	Low	Periodic disposal; Training; SEIMS inspections; Environmental Inspections.	Minor	Unlikely	Low
Waste	Mechanical waste inappropriately disposed of resulting in impacts to land/water.	Soil and water contamination.	Minor	Likely	Medium	Periodic disposal, Training; SEIMS inspections, Environmental Inspections; Ruggies Recycling, Waste Management Strategy, Consolidation of Ruggies yard	Minor	Unlikely	Low

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Waste	Radiation waste inappropriately disposed of resulting in impacts to land/water.	Soil and water contamination.	Minor	Unlikely	Low	Radiation monitoring prior to removing any production based scrap off site	Minor	Unlikely	Low
Waste	Municipal waste disposed of inappropriately resulting in little accumulation.	Soil and water contamination.	Minor	Likely	Medium	Periodic disposal; Training; SEIMS inspections; Environmental Inspections.	Minor	Unlikely	Low
Waste	Used heavy vehicle batteries stored incorrectly.	Soil and water contamination.	Minor	Likely	Medium	Periodic disposal; Training; SEIMS inspections; Environmental Inspections.	Minor	Unlikely	Low
Waste	Effluent waste inappropriately managed resulting in pollution to land/water.	Soil and water contamination.	Major	Unlikely	Medium	Waste treatment facilities; Maintenance servicing; Monitoring.	Minor	Unlikely	Low
Water	Bore water transfer resulting in loss of water from process due to seal or pipe failure.	Loss of water resource.	Moderate	Moderate	Medium	Regular inspection; Maintenance schedules (MSTs).	Insignificant	Likely	Low
Water	Abstraction from bores resulting in exposure of sulfidic material and release of contaminants.	Soil and water contamination.	Major	Unlikely	Medium	Premining screening; Conceptual model relating to ASS risks; Water monitoring; In-pit inspection.	Moderate	Unlikely	Medium
Water	Water demand/supply inadequately forecast resulting in breach of licence or under supply of resource.	Loss of water resource.	Major	Likely	High	Water balance to forecast water demand and supply; Monitoring abstraction and use.	Moderate	Moderate	Medium
Water	Dewatering of mine voids or process water dams resulting in exposure of sulphidic material and release of contaminants to groundwater.	Soil and water contamination.	Major	Unlikely	Medium	Pre-mining screening; Conceptual model relating to ASS risks; Water monitoring; In-pit inspection.	Moderate	Unlikely	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Water	Dewatering of mine voids or process water dams resulting in groundwater drawdown and impacts to vegetation.	Impacts to biodiversity.	Major	Likely	High	Drawdown modelling and associated risk assessments; Regulator endorsement of plans; Hydraulic placement of tails and infiltration Dams; Backfill as soon as possible; Monitoring water level and veg health.	Moderate	Moderate	Medium
Water	General plant/pumps leaking resulting in loss of water resources.	Loss of water resource.	Moderate	Moderate	Medium	Regular inspection; Maintenance schedules (MSTs).	Insignificant	Likely	Low
Water	Process Water Dams inadequately managed resulting in overtopping and impacts vegetation.	Impacts to biodiversity.	Major	Likely	High	Design criteria for TSF's and dams; TSF's built to design; Regular inspection.	Moderate	Unlikely	Medium
Water	Process Water Dams inadequately planned/constructed resulting in seepage through wall/based impacting vegetation.	Impacts to biodiversity.	Major	Likely	High	Design criteria for TSF's and dams; TSF's built to design; Regular inspection.	Minor	Moderate	Medium
Water	Process Water Dams inadequately planned/constructed resulting in wall failure and impacts to vegetation.	Impacts to biodiversity.	Major	Likely	High	Design criteria for TSF's and dams; TSF's built to design; Regular inspection.	Moderate	Unlikely	Medium
Water	Pumping from Process Water Dams below water table resulting in drawdown and impacts to vegetation.	Impacts to biodiversity.	Major	Likely	High	Drawdown modelling and associated risk assessments; Hydraulic placement of tails and infiltration Dams; Backfill as soon as possible. Monitoring water level and veg health.	Moderate	Moderate	Medium
Water	Tailing transfer (slimes) resulting in discharge to environment due to seal failure.	Impacts to biodiversity.	Major	Likely	High	Cleared pipeline corridors established.	Minor	Moderate	Medium
Water	Mullering brook design inadequate resulting in bank failure or excessive mobilisation of sediment.	Impacts to biodiversity.	Major	Likely	High	Design criteria; Monitoring of stream flow and sedimentation; Erosion control matting.	Moderate	Unlikely	Medium

Standard	Aspect	Impact	Consequence	Likelihood	Risk	Controls	Consequence	Likelihood	Risk
Water	Mullering brook design inadequate resulting in disruption to baseline flow regime.	Impacts to biodiversity.	Major	Likely	High	Design criteria; Monitoring of stream flow and sedimentation; Erosion control matting.	Moderate	Unlikely	Medium

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APPENDIX D: OUTCOMES OF KEY RESEARCH AND INVESTIGATION

Investigation	Outcomes	Referenced by	Timing
Impacts of rehabilitation activities on topsoil bulk density.	Topsoil bulk density was measured at various stages of rehabilitation works, including pre-stripping, topsoil stockpiling and respreading. The soil bulk density of the topsoil sampled did not vary markedly between treatments and more significantly the bulk density of topsoil measured in pre-mining areas was not significantly different than topsoil that has been stockpiled and respread.	Ecos Consulting	1998
Effects of fertiliser rates and soil profile reconstruction on plant establishment in rehabilitation.	A range of soil profile types and treatments of fertiliser were trailed. Superphosphate was shown to suppress the growth and diversity of some perennial native plants. Soil profiles with a higher clay content provided higher soil moisture retention than the sandier profiles. Ponding and water logging were however more common in the profiles with higher clay content. This trial informed the development for early landform design criteria.	Western Botanical	1998
Effects of soil profile reconstruction on rooting patterns in native species.	Soil trenches were excavated in trial plots to determine the effects of different soil profiles on the rooting pattern of native plants. This trial suggested that rehabilitation established with clay close to the surface (i.e. under topsoil) inhibited root penetration. This trial informed the development for early landform design criteria by ensuring clays were buried at depth to provide an adequate rooting zone.	Ecos Consulting	1999
Proposed native seed mixes for rehabilitated areas at Cooljarloo.	An assessment of baseline soil and vegetation data was undertaken to develop targeted rehabilitation soil profile and vegetation associations. Species lists were developed for each association to enable the targeted return of a range of vegetation communities.	Ecos Consulting	1999
Survey and review of significant species.	Several surveys for significant species and desktop reviews were undertaken to locate and assess the significance of various plant species. This information has provided spatial data relating to significant species within the region and lead to targeted research of some species.	Western Botanical	1999 - ongoing
Response of vegetation to drawdown events	Vegetation condition assessments and soil profile sampling was conducted in areas of vegetation that had been recently drought stressed. This work contributed to a better understanding to the types of vegetation and the associated soil profiles that were susceptibility to drought stress.	Western Botanical/Blandford and Associates.	2000 - 2007
Effect of smoke treatment, mulch and cover crops on rehabilitation establishment.	Key vegetation indices where monitored in a trial comprising of plots established with various treatments of mulch, oaten cover crops and smoke treated seed. Species richness was shown to be greatest in plots that had been smoke treated. This trial resulted in a program to treat native seed and several other procedural adjustments relating to cover crops.	Western Botanical	2001 - 2006
Success of DRF translocation (*Andersonia gracilis*) into rehabilitation.	*Andersonia gracilis* was translocated via the movement of fresh topsoil to a rehabilitation area. Plants were successfully re-established in the rehabilitation areas and the population was recorded up to 5 years after translocation. This trial lead to a subsequent successful translocation of this species in the north mine.	Western Botanical	2001 - 2006

Investigation	Outcomes	Referenced by	Timing
Design criteria and risk assessment for the Process Waste Class lll Landfill at Cooljarloo.	A study was undertaken to assess the long term environmental risks associated with solid waste management on Mullering Farm. This study provided the basis for early waste pit design and risk measurement measures.	PPK Environment and Infrastructure	2001
Investigation into the soils and soil landscapes of the Cooljarloo Mine Site.	Soil pits were dug throughout the Cooljarloo lease to map the landform/soil associations and to provide data upon which landform design criteria could be refined.	D. C Blandford and Associates	2001
Proposed reconstructed soil profiles for rehabilitation areas (Class 3 Landfill).	Design criteria and guidance provided for the reconstruction of rehabilitated soil landforms on the Process waste pits.	D. C Blandford and Associates	2001
Derivation of Keystone flora species for rehabilitated vegetation communities.	This project identified keystone species within baselines communities and developed the concept of targeted rehabilitation vegetation communities. This study provided the basis for targeting native seed mixes which broadly represented the baseline communities. Native seed mixes were reviewed with consideration to the information provided in this study.	Woodman Environmental Consulting	2002, 2012
Proposed rehabilitation vegetation and soil associations.	A review of previous vegetation mapping and soil profile data was undertaken which resulted in the formation of five broad associations to be targeted in the rehabilitation of native areas. This work provided the basis for soil-vegetation associations in rehabilitation areas and contributed to the development of completion criteria.	Woodman Environmental Consulting Environmental Consulting	2002
Vegetation habitat mapping North mine	A delineation of major habitats was undertaken within the Cooljarloo north mine area. Two lands systems, five landscape types and 12 habitats types were identified. Species lists associated with different Vegetation Groups were develop to assist in the development of targeted rehabilitation vegetation groups.	Western Botanical	2002
Identification and management of recalcitrant species.	A review of historical monitoring data was undertaken to assess rehabilitation performance, identify recalcitrant species and establish recalcitrant species lists.	Western Botanical	2003
Proposed remedial design options for Dams 123.	An investigation was undertaken into an area of historical rehabilitation that required remedial works (i.e. failed landform stability criteria). This involved field work to test material stability which lead to a better understanding of how dispersible clays behave within reconstructed soil profiles.	D. C Blandford and Associates	2003
Success of fauna re-colonisation in rehabilitation over time.	Long term fauna monitoring was conducted in native reference plots, rehabilitation of various ages and areas that had been mulch harvested. This monitoring is ongoing and provides extensive baseline species listings for site and provides data relating to the establishment of rehabilitation and mulch harvested areas.	Bamford Consulting Ecologists	2004 - ongoing
Soil and landform reconstruction options for rehabilitated areas.	A review of soil landform monitoring studies was undertaken. It provided recommendations for differentiating soil types based on texture and other chemical characteristics (i.e. dispensability and sodicity). Options for placement within the soil profile were proposed to mitigate the risk of soil dispersion and ponding/profile saturation.	D. C Blandford and Associates	2004
Effects of various soil stabilisation techniques (chemical versus mulch).	Various chemical soil stabilisers were trailed between 2005 and 2010. No chemical stabilisers were shown to be as effective as organic mulch to stabilise topsoil and produce adequate revegetation outcomes. These trials lead to investigations into composted organic mulch from external suppliers.	Tronox	2005 - 2010

Investigation	Outcomes	Referenced by	Timing
Success of fauna translocation in rehabilitated areas at Cooljarloo.	A collection of reptiles were translocated from in front of mine path into rehabilitation areas during 2006. A number were recaptured in 2007 indicating translocation was successful for at least a portion of the animals.	Bamford Consulting Ecologists	2006 - 2007
Design criteria and rehabilitation options for Mullering Brook.	Design criteria were developed for the UCL portion of Mullering Brook Diversion. The design criteria included specifications for bed and bank construction as well as material management. Follow-up work was conducted by the consultant to oversee the construction of the diversion.	D. C Blandford and Associates	2006
Relative effectiveness of Carry Graders and Scrapers to place topsoil.	Informal trials were conducted to assess the effectiveness of Scrapers versus Carry graders to place topsoil. Carry Graders resulted in less wheel rutting compared to scrapers. This lead to a change in machinery used at the site to minimise compaction.	Tronox	2006
Impacts of Kangaroo grazing on rehabilitation areas.	A trial plot was established to exclude Kangaroos from a portion of newly established rehabilitation. Kangaroo grazing was shown to have a significant impact on the rehabilitation establishment at this site. Herbaceous plants and sedges appear to be the most vulnerable to grazing.	Tronox	2007 - ongoing
Impacts of mulch harvesting on Floristic Community Types in uCL areas.	Quadrats where monitored in areas that had been harvested and in adjacent areas to assess the floristic compositional similarity and development of foliage cover in sites covering a range of ages after harvesting. The floristic composition of each plant community in harvested areas was shown to retain a high level of similarity with the adjacent non-harvested areas. Very few flora species recorded in non-harvested quadrats were not recorded in the harvested quadrats however some species warranted further investigation to determine if they were recalcitrant. This project lead to the development of a broad scale mulch harvesting trial submitted to the OEPA and DEC for approval.	Woodman Environmental Consulting	2010
Review of rehabilitation systems and outcomes at Cooljarloo.	A thorough review of rehabilitation systems was undertaken against current leading practice. Recommendations were made for the development of various system improvements which lead to the development of the Rehabilitation Improvement Plan and Draft Completion Criteria (2011).	Woodman Environmental Consulting and Owen Nichols.	2008
Pc containment and eradication in native areas.	A Management and Research Plan were developed for a *Phytophthora cinnamomi* (Pc) Dieback infestation identified in the north mine. Containment measures were implemented and monitoring transects were established to monitored the effectiveness of the containment measures. To date Pc Dieback has remained within the containment zone	Murdoch University	2009 - ongoing
Susceptibility to Pc and sensitivity to phosphate in native Australian plants – Why are they linked?	A MERIWA collaboration commenced in 2007/8 and is due to be completed in 2013. The study aims to increase the knowledge base relating to the mode of phosphate action by using metabolomic, transcriptomic and genetic approaches.	UWA/Murdoch (MERIWA)	2008 - ongoing
Development of completion criteria for fauna indices at Cooljarloo	A discussion paper was written relating to the development of completion criteria for fauna re-establishment in native rehabilitation. This paper recommends using a combination of fauna assemblage analysis and specific bio-indicators to track the development of rehabilitation sites.	Bamford Consulting Ecologists	2009

Investigation	Outcomes	Referenced by	Timing
Review of rehabilitation performance with respect to key structural units in target vegetation community	A review of historical Rehabilitation data was undertaken against baseline information with a focus on the proportion of different life forms (i.e. trees, shrubs etc.). This study showed all life form categories were represented in the baseline were recorded in rehabilitation however herbs and sedges were in a proportional lower abundance that perennial shrubs in rehab areas.	Woodman Environmental Consulting and Owen Nichols.	2010
Success of infill seeding to improve under-performing rehabilitation areas.	Various infill seeding and planting trials were conducted between 2006 and 2012. Mixed results to date however direct seedling approaches, translocation and transplantation of certain recalcitrant species has been shown to be successful.	Tronox	2010, 2012 - ongoing
Impacts of ground water drawdown and burning on woodland and heath vegetation communities.	Areas of drought stressed vegetation were burnt to determine if fire promoted faster recovery in stressed vegetation. Results for will trial will come available as the trial matures.	Woodman Environmental Consulting	2010 - ongoing
Impacts of soil compaction of plant establishment in rehabilitated areas.	Soil compaction (bulk density) in upper soil profile was measured in established woodland rehabilitation sites and was shown to be within the range measured in the baseline reference sites. Furthermore soil strength and field observations indicated that soil compaction was not recorded at levels that that would impede root penetration. This supported current rehabilitation procedures for material classification and compaction mitigation techniques (i.e. ripping).	D. C Blandford and Associates	2012
Impacts of hydrophobicity on plant establishment in rehabilitation areas.	Hydrophobicity testing was conducted at sites throughout the north and south mines. Around 20% of established rehabilitations sites monitored showed some form of non-wetting behaviour associated with the topsoil. Hydrophobicity appeared to be more a function of soil structure and organic mats than waxy coatings on sand grains. The spatial extent of non-wetting topsoil within sites was patchy which meant it did not present a continuous impedance to water penetration. Further studies were recommended into the function of soil biota and non-wetting topsoil behaviour.	D. C Blandford and Associates	2012
Success of reconstructed soil profiles to retain moisture and contain high rainfall events without ponding.	Unsaturated hydrologic modelling conducted by Soil Water Group in 2012 suggests that the profile design defined in C1-3 and C1-4 would withstand a 1:100 year 72 hour storm event without surface ponding due to saturation. Furthermore modelling indicated soil moisture availability was adequate for sandy profiles with access to a zone of higher soil moisture retention within 3m meters of the surface. This broadly supported the existing soil - vegetation planning procedures in place and resulted in the development of clearer guidelines and working procedures for material management.	Soil Water Consultants	2012
Review of plant species targeted for return in rehabilitation to achieve sustainable vegetation groups representative of baseline communities.	This work involved reviewing the site species list (i.e. surveyed on site) to characterise various plant attributes including Pc susceptibility, fertiliser sensitive's, drought and fire tolerance. This work is the precursor to further analysis of rehabilitation species compositional data to assess successional trends and resilience to various factors affecting sustainability. It has also lead to a review of the site seeding list to optimise seeding rates and timing of sowing of certain species to address some recalcitrant species.	Western Botanical	2012 - ongoing

Investigation	Outcomes	Referenced by	Timing
Identification and characterisation of soil biota in established rehabilitation and reference sites at Cooljarloo.	Topsoil was sampled in rehabilitation areas 7-8 years old (both direct return and stockpiled topsoil) and in adjacent control sites. Biotrophic associations, including Ectomycorrhizal (ECM), ericoid (Erm), Arbuscular mycorrhizal (AM), dark septate endophyte (DSE) and nodulation by rhizobia (Nod), were all found in association with the roots of one or more host species that were sampled within undisturbed vegetation, and within all the rehabilitated sites regardless of soil treatment. Further controlled bioassay trials are planned to support this research.	Murdoch University	2012
Identify limiting factors affecting plant growth and establishment arising from the physical, chemical and hydrological characteristics within the observed profiles by comparing the soil profile and plant rooting characteristics within established rehabilitation areas and corresponding baseline reference plots.	The surficial soils were investigated through the excavation and examination of deep trenches (up to 8m depth) in 13 *in-situ* soil profiles and 13 reconstructed soil profiles (undisturbed and rehabilitated areas respectively). A broad range of chemical, physical and hydrological properties were assessed including but not limited to bulk density, soil strength, partial size distribution, sodicity, water retention characteristics and root length density. The study found that: • The hydrological requirements of the Dry Woodland vegetation type established on reconstructed deep native yellow sands (i.e. overburden) have the capacity to support the targeted vegetation type and contained no physical or chemical limitations to root penetration. • Tails sand provides a PAW content that is at the lower end of the range recorded in the grey baseline sands. While no physical or chemical impedances were observed in the tails sand profile, the rooting depth was shallower where there was no access to a zone of higher fines/soil moisture. These profiles are suited to vegetation communities that tolerate drought and periods of seasonally low PAW during the dry months. • Landform design criteria require dispersive overburden (clay > 10%) at a depth greater than 3 m. However, this investigation demonstrated that such material can be placed closer to the surface providing it is capped with at least 40 cm to prevent the profile drying out and landform criteria be amended to reflect this.	Soil water Consultants	2014
Investigation (by Woodman Environmental Consulting) to develop a recalcitrant species list. This lists those species considered desirable to return into rehabilitation but were underrepresented in the existing monitoring dataset. Western Botanical in 2013, then investigated return methods for the identified recalcitrant species, including 'quick win' method for a number of species and investigation designs for more difficult species.	Recalcitrant species listing updated listing those species not recorded or recorded in very low number within rehabilitation. The findings in terms of the methods to address recalcitrant species include: • The report reinforces the existing understanding that the most economical way to return geosporous species is through the spreading of viable topsoil. However, further investigation of the relative contribution of plants from topsoil at different ages is proposed. • Several species identified as recalcitrant could easily be included in the standard native seed mix. These 'easy win' recalcitrant species will be targeted for collection and included in the native seed mix. Some additional seed treatments were also recommended. • Field trials are underway to assess the viability of returning various recalcitrant species by means of tubestock, or transplantation. Further investigations will be undertaken in a prioritised manner such that those considered most important to return will be addressed first.	Woodman Western Botanical	2013 2014

Investigation	Outcomes	Referenced by	Timing
Improve the understanding of successional trends in rehabilitation vegetation communities by comparing the relative abundance and frequency of key family groups over time within established rehabilitation to the baseline reference dataset.	In this analysis three separate targeted vegetation communities were investigated including Dry Woodland, Dry Heath and Wet Heath communities. • of the 40 families recorded in the baseline reference dataset, 39 have been recorded within rehabilitation performance monitoring plots, and an additional 22 families have been recorded in rehabilitation • taxa from families in reference plots are represented in rehabilitation areas at relatively similar frequencies • families that were represented in rehabilitation at significantly lower frequencies than in the baseline included *Restionaceae*, *Haemodoraceae* and *Dasypogonaceae*. These are generally herbs, rushes and sedges, a large proportion of which are resprouters and are more likely returned with topsoil. Many are considered recalcitrant and are currently targeted through the use of fresh-cut topsoil. • Several families are recorded in rehabilitation at slightly higher frequencies than in the reference plots including *Poaceae*, *Araliaceae*, *Asteraceae* and *Campanulaceae*. • *Myrtaceae* and *Fabaceae* taxa count declines with increasing age of rehabilitation. Both families include species that can be collected and distributed as part of the native seed mix. • The families *Cyperaceae* and *Dilleniaceae* were found to have significantly fewer taxa in the rehabilitation than the reference plots, while several other families have more taxa recorded in rehabilitation than in the reference plots. • Families dominated by species commonly returned with topsoil appear to have lower taxa counts in the rehabilitation than those families that can be seeded. This can be linked to stockpiling topsoil prior to spreading. • The lower counts and frequency in older rehabilitation is attributed to resource competition and the use of improved rehabilitation techniques in the younger rehabilitation (i.e. use of more fresh topsoil on recent sites).	Woodman	2013
The influence of Phytophthora species as damping-off pathogens in native and rehabilitated Kwongan Heath and Banksia Woodland Vegetation Communities	This comprised three elements: 1. A glasshouse experiment aimed to identify if Phytophthora spp. (*P. arenaria, P. cinnamomi* etc.) that occur in kwongan ecosystems are damping-off pathogens. This involved monitoring the effect of six Phytophthora spp. on seed germination and seedling survival of 21 important native plant species. It was shown for the first time Phytophthora spp. are damping-off pathogens of kwongan plant species. *P. cinnamomi* was a prolific damping-off pathogen, significantly reducing the germination and survival of seven plant species, including *Banksia spp.*, *Melaleuca spp.*, *Xanthorrhoea preissii* and others. The potentially native P. *arenaria* had a similar host range to *P. cinnamomi* and significantly reduced the germination and survival of four plant species. *P. rosacearum* and *P. aff. rosacearum* significantly reduced the germination and survival of a single plant species 2. A Phytophthora survey was conducted across 6 natural and 6 rehabilitated sites in heath and woodland communities to understand the distribution and abundance of Phytophthora species. Soil and root samples were baited to determine if the soil contained Phytophthora species. *P. arenaria* was isolated twice from natural kwongan heath and rehabilitated woodland, while *P. constricta* was isolated from natural kwongan heath. Results indicate *Phytophthora spp*. occur in both rehabilitated and natural vegetation communities, however, they are not abundant. Further work on the abundance and distribution of Phytophthora is being completed using the more accurate Next Generation Sequencing of detection. 3. Investigated if Pythium and Phytophthora species present in the topsoil of natural and rehabilitated vegetation reduces the germination, establishment and fitness of important plant species. Soil was collected from the same	Christopher Shaw Murdoch University	2014

Investigation	Outcomes	Referenced by	Timing
	sites as experiment two. Seeds of 10 plant species were sown into untreated soil and soil treated with a fungicide to suppress the damping-off pathogens Pytophthora and Pythium. Only two plant species experienced significantly reduced germination or survival in soils untreated with the fungicide. The survival of *Gompholobium tomentosum* and *Hakea trifurcata* seedlings were significantly reduced in natural heath and rehabilitated woodland soils, respectively. *Pythium irregulare, Py. mamillatum* and *Py. vanterpoolii* were isolated from dead or dying seedlings indicating these were likely responsible for the damping-off experienced by *G. tomentosum* and *H. trifurcata.*		

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APPENDIX E: INVESTIGATION PLAN

Aspect	Proposed Action / Investigation	Start Date	Deliverable
Propagule Management	Determine the most cost effective means of increasing plant abundance in areas that are underperforming by undertaking field trials using: a) Leggett Spears; b) Infill Planting; and c) Hand broadcast.	Complete	Procedures for addressing low plant density rehabilitation sites
Soil Stabilisation	Conduct field trials to determine whether Terolas is a viable alternative to mulch; measure impacts on stabilization success and plant establishment (abundance and diversity) and the appropriate application methodology (rates, equipment etc.)	Complete	Determination of the suitability of Terolas for use in rehabilitation, and application procedures
Harvesting Impacts	Study the recovery of ecological communities subject to mulch harvesting. Consider: a) flora communities and species; and b) fauna	Commenced	Harvesting procedures/practices that result in no significant loss in ecological value
Fauna Grazing	Conduct field trials to determine whether exclusion of kangaroos and emus improve overall plant density and abundance of particular species.	Commenced	Understanding of the relative impact of grazing on rehabilitation outcomes.
Fauna Grazing	Investigate cost effective methods of reducing numbers of kangaroos in/grazing rehabilitation.	Complete	Viable methods for reducing grazing pressures
Weed Management	Monitor change in density of weeds within rehabilitation and baseline vegetation community's esp. in response to disturbance events (e.g. fire) and native plant abundance. Determine appropriate performance targets for weed abundance or projected foliar cover.	Complete	Understanding of weed abundance in rehabilitation relative to baseline. Performance targets for weed abundance or projected foliar cover.
Fauna Habitat	Identify key faunal species and groups from an ecosystem function and biodiversity conservation perspective; determine their habitat requirements, and investigate ways to promote recolonisation (particularly burrowing reptiles and mammals) by improving the suitability of rehabilitation as habitat. Develop success indicators and completion criteria for fauna and their habitat as and if appropriate. Focus on vertebrates and key invertebrate groups. Consider: a) Phenology studies comparing duration and intensity of nectar availability across a standard year b) Correlation between abundance of litter, vegetation abundance, composition and physical structure (incl. cover) and utilization by key faunal groups (reptiles, birds and mammals)	Commenced	Improved criteria addressing delivery of appropriate habitat in rehabilitation and success measures/indicators
Data Collection	Revise data collection procedures regarding recording of foliage cover data and implement for rehabilitation and baseline monitoring. Focus on standardising the approach to measurement, recording, collating and analysing data.	Complete	Plant cover criteria and an assessment of current performance against these
Knowledge Exchange	Pursue greater engagement across mineral sands and other relevant industries regarding exchange of rehabilitation knowledge	Commenced	Industry collaboration
Soil Moisture Availability	Measure soil compaction in rehabilitation areas, relate to plant abundance, soil moisture and climatic conditions (infiltration and availability). Collect comparative information for undisturbed reference sites.	Complete	Improved understanding of soil compaction and its effects on rehabilitation performance.
Soil Moisture Availability	Determine the role of topsoil hydrophobicity on infiltration and soil moisture content. Investigate the hydrophobic characteristics of topsoil in rehab and reference sites. Measure the extent across site and determine the factors contributing to their occurrence.	Complete	Quantified extent of water repellence across the site and variability seen across insitu, stockpiled and placed topsoil.

Aspect	Proposed Action / Investigation	Start Date	Deliverable
Soil Moisture Availability	Optimise utilization of natural Class One materials (overburden) in all areas by defining available resources and incorporate in to the mine planning process.	Complete	Improved characteristics of materials used for soil profile construction.
Propagule Management	Apply the recalcitrant species identification procedure to identify and address species requiring increased density and/or distribution in rehabilitation.	Complete	Improved density and diversity of plants at establishment.
Propagule Management	Apply the recalcitrant species procedure to identify and address other significant species requiring increased density and/or distribution in rehabilitation.	Complete	Improved density and diversity of plants including significant species at establishment
Propagule Management	Optimise use of fresh topsoil by considering justifications for increasing %, and methods of decreasing costs (separation of organic and mineral content).	Complete	Optimised fresh topsoil and additional planning tools to facilitate implementation of findings
Propagule Management	Review annual vegetation monitoring data and germinability/viability testing against seed mixes and adjust rates as necessary to achieve internal establishment targets.	Complete	Understanding of the rate of establishment (average, variability) for all seeded species
Soil Biota	Investigate soil biota types and distribution in rehabilitation versus undisturbed sites to determine whether there is a correlation between biota activity and rehabilitation performance.	Complete	Improved understanding of the relationship between soil biota and rehabilitation performance and thereby ability to identify improvement opportunities (i.e. improved topsoil handling)
Nutrient Status	Measure key macro and micronutrients and organic matter in representative rehabilitated soil profiles and unmined reference sites.	Complete	Comparison between rehabilitation sites and baseline and understanding of potential deficiencies.
Soil Stabilisation	Continue to identify, investigate and trial other alternative stabilizing agents such as – organic materials, native grasses, mulch farming etc.	Complete	Alternative agents identified, assessed, trialled and implemented thereby reducing the reliance on mulch (harvested or otherwise).
Successional Trends	Establish representative long term monitoring data required to understand successional dynamics (survival, mortality and recruitment) in vegetation communities within representative areas of undisturbed vegetation and rehabilitation, and linkage to environmental conditions (rainfall etc.) through analysis of a) monitoring data from rehabilitation baseline plots (as per procedure C0019); and b) existing and future rehabilitation performance monitoring data.	Commenced	Demonstration that recruitment and survival within rehabilitation communities is appropriate
Rehabilitation Success	Improve collection of information regarding establishment and survival of trees and plants in general, and relate this meteorological information, site treatment and other relevant parameters as per revised monitoring procedure.	Complete	Improved / focused performance data regarding tree and other plants establishment
Soil Moisture availability	Model the plant available water content range for a range of standard reconstructed soil profiles and determine the carrying capacity for each profile in relation to the key vegetation communities targeted in rehabilitation.	Commenced	Understand the carrying capacity of established soil profiles with regards to soil moisture.

Aspect	Proposed Action / Investigation	Start Date	Deliverable
Seeding Success	Undertake studies to determine and improve the relative contribution of each source of propagules (e.g. topsoil, mulch and seed) to rehabilitation. In doing so investigate the: a) difference in viable propagules in stockpiled topsoil (numbers, species and viability) of different ages and veg types; b) relative proportion of species introduced to rehab through different mulch types; and c) relative proportion of species introduced in native seed mixes.	Commenced	Improved understanding of each propagule source
Seeding Success	Develop and implement a programme to improve the effectiveness and efficiency of seed collection to improve volumes and range of species.	Complete	Revised picking strategy
Timing of Rehabilitation	Investigate how the timing of rehabilitation operations (including seeding and mulching) affects the germination of specific groups of plants. Also investigate if the site preparation methods (including seeding methods e.g. drill vs broadcast) affect germination and establishment.	Commenced	Revised rehab works procedures
Soil Stabilisation	Identify alternative species to use as stabilizing crops in rehabilitation areas.	Complete	Improved species selection for cover crops with lower competition thereby improved plant abundance and vigour
Pc Management	Incorporate consideration of P.c. resistance into procedures for developing picking targets by adding a "P.c. resistance" field to site species database and sourcing available information for listed species to highlight knowledge gaps	Complete	Revised site species database incorporating available knowledge regarding P.c. resistance Priority species for further investigation
Pc Management	Investigate viable and saleable means of containing and eradicating Pc investigation in native areas.	Commenced	Trial results to determine if containment and eradication methods are viable
Pc Management	Develop and implement programme to investigate status for unknowns for high priority species (i.e. keystones)	Commenced	Improved knowledge of P.c. resistance
Fire Resilience	Analyse community composition (species and relative abundance) within rehabilitation relative to baseline. Determine the different fire recovery strategies for species and then investigate the respective fire readiness of rehabilitation areas (e.g. rootstock development for re-sprouters, seed soil store etc.).	Commenced	Assessment of the resilience of rehabilitation to fire
Soil Condition	Relate root penetration to soil (topsoil and subsoil) characteristics by measuring size (depth, width and overall volume) of root bolus and relating these to soil characteristics such as PSD, soil strength, aggregate stability, hard setting and density in both rehab and reference sites. Consider rehabilitation of differing ages as well as soil types.	Complete	Understanding of plant response to different soil conditions specific to root penetration to key soil parameters
Soil Condition	Investigate management options including ameliorative treatments, classification/segregation, storage, handling and selective placement.	Scoped	Management measures for minimizing impacts of soil water repellence in topsoil
Soil Condition	The viability of tails-slimes Co-deposition will be investigated and a determination of the associated risk/opportunities for rehabilitation will be made.	Scoped	Assessment relating to the viability of Co-deposition.
Nutrient Status	For poorly performing sites/species, measure plant nutritional status to determine if deficiencies are present (symptoms, leaf tissue analysis) and trial application of fertiliser to determine if this yields a performance improvement.	Commenced	Linkage between existing poor performance and soil resource availability. Revised fertiliser regime
Vegetation Mapping	Extend the FCT mapping across southern areas of Cooljarloo to assist in further refining the Site GDE mapping and provision of data to manage harvesting activities.	Complete	Revised Vegetation Map for Cooljarloo.

Aspect	Proposed Action / Investigation	Start Date	Deliverable
Acid Sulphate Soils	Conduct infill sampling within risk areas to collect additional information relating to Acid Sulfate Risks	Commenced	Updated Site risk assessment and amended management if necessary.
Nutrient Status	Determine if the incorporation of organic matter with topsoil (mulch/hay) improves plant abundance and survival.	Commenced	Improved understanding of the role of organic matter in plant abundance and survival
Soil Condition	Monitor how soil compaction in rehabilitation areas and reference sites change over time, relate to plant abundance and soil moisture (infiltration and availability).	Complete	Improved understanding of soil compaction and its effects on rehabilitation performance over time
Propagule Management	Optimise seed storage and quality assurance procedures to increase viability of native seed spread.	Commenced	Revised seed storage procedures
Nutrient Status	Measure the key macro and micronutrients and organic matter in rehabilitation and unmined reference sites over time	Complete	Understanding of the change in nutrient availability over time and how this can relate to vegetation performance
Climatic Conditions	Determine the links between rainfall (frequency, intensity, effective wetting etc.) and tree survival in rehabilitation.	Commenced	Improved understanding of the role of rainfall in tree survival
Drought Resilience	Investigate response of rehabilitation to drought (to the extent this can be done with available data and additional weather monitoring data).	Commenced	Improved understanding of the drought resilience of rehabilitation
Geology and Landform	A Digital Terrain Model with great resolution to assist in the interpretation of baseline drainage features	Complete	Higher resolution DTM model
Surface water	Undertake flood modelling on the existing Mullering Brook Diversion and the proposed Final Landform design for Mullering Brook to more fully understand closure risks.	Complete	Flood modelling upon which design risks can be assessed.
Vegetation Reference site (RVGs)	Review of the distribution of reference sites upon the completion of the previously mentioned FCT mapping to ensure the location of sites is adequate to represent the key vegetation communities present.	Complete	Revised baseline data for rehabilitation Vegetation Groups.
Significant species	Comprehensive surveys to identify Conservation Significant Species have been conducted on site. Further investigation into the regional significance some significant species may assist ongoing management.	Commenced	Better understanding of the Significance of certain flora species.
Propagule Management	Infill plant seedlings with developed root stock to determine if this overcomes moisture availability issues	Commenced	Appropriate method for infill planting poor performing sites.
Soil Condition	Trial the effectiveness of incorporating slimes fines into sand tails to improve the soil moisture holding capacity of the upper profile.	Scoped	Improved characteristics of materials used for soil profile construction.
Propagule Management	Investigate the cost/benefits of dry strip, stockpile and storage of topsoil	Scoped	Understanding of the relationship between topsoil moisture, handling techniques and viability/abundance of contained propagules
Successional Trends	Undertake targeted investigations on the effects of initial rehabilitation treatments on final outcomes as driven by identified successional processes. Consider (as appropriate) linkages between soil profiles, topsoil treatments and seed mixes and long term community composition. This information will help determine sustainability of vegetation through collation of data on recruitment and survival of species.	Scoped	Identification of causes when poor performance in succession occurs (e.g. unexpected/undesirable trends). Defined performance targets and understanding of performance against these

Aspect	Proposed Action / Investigation	Start Date	Deliverable
Managing Pc	Determine whether a process of tailoring of seed mixes with set percentages of resistant species in each structural grouping can or should be implemented. Analyse rehabilitation monitoring data to determine the proportion of resistant species actually establishing within rehabilitation communities and how this corresponds to baseline communities &/or establishment targets (if developed).	Scoped	Understanding of status of P.c. resistance within rehabilitation and undisturbed vegetation communities. Revised target seed lists
Successional Trends	Subject representative plots of mature (7-20yrs) rehabilitation to fire and measure their response, focusing on key nutrients/carbon, vegetation recruitment and fauna indicators; relate to un-mined baseline data.	Scoped	Assessment of the resilience of rehabilitation to fire

APPENDIX F: LISTING OF INTRODUCED FLORA ABBREVIATIONS

Record Count	Species	Abbrev.
3	?Ehrharta sp.	?Ehsp
1	?Isolepis prolifera	?Isp
1	?Lysimachia sp.	?Lysp
1	?Taraxacum sp.	?Tasp
30	Aira caryophyllea	Aic
30	Aira cupaniana	Aicu
12	Arctotheca calendula	Arc
3	Avellinia michelii	Avm
1	Avena ?barbata	Av?b
7	Bartsia trixago	Bat
17	Briza maxima	Brma
22	Briza minor	Brmi
1	Bromus diandrus	Brd
5	Carpobrotus edulis	Cae
2	Centaurea melitensis	Cem
2	Centaurium ?tenuiflorum	Ce?t
3	Cerastium glomeratum	Ceg
3	Conyza bonariensis	Cob
1	Conyza sp.	Csp.
6	Cotula bipinnata	Cobi
11	Cotula coronopifolia	Coc
1	Crassula glomerata	Crg
5	Crassula natans var. minus	Crnm
1	Cynodon dactylon	Cyd
17	Cyperus tenellus	Cyt
2	Dischisma arenarium	Dia
2	Dittrichia graveolens	Dig
1	Echium plantagineum	Ecp
1	Ehrharta ?brevifolia	Eh?b
2	Ehrharta calycina	Ehc
6	Ehrharta longiflora	Ehl
4	Galium murale	Gam
4	Gladiolus caryophyllaceus	Glc
1	Hainardia cylindrica	Hac
10	Heliophila pusilla	Hep
2	Hordeum ?leporinum	Ho?l
4	Hordeum hystrix	Hoh
169	Hypochaeris glabra	Hyg
22	Isolepis marginata	Ism
1	Juncus bufonius	Jub
1	Juncus capitatus	Juc
6	Lolium rigidum	Lor
4	Lotus angustissimus	Loa
3	Lotus subbiflorus	Los
55	Lysimachia arvensis	Lya
1	Medicago polymorpha	Mep
1	Melilotus indicus	Mei
1	Mercurialis annua	Mea
10	Monopsis debilis	Mod
2	Moraea flaccida	Mof
1	Oenothera stricta	Oes
1	Ornithopus compressus	Orc
1	Ornithopus pinnatus	Orp
4	Ornithopus sativus	Ors
1	Orobanche minor	Orm
2	Oxalis sp.	Osp
13	Parentucellia latifolia	Pal
4	Parentucellia viscosa	Pav
1	Pelargonium capitatum	Pec
7	Pentameris airoides	Pea
1	Pentameris airoides subsp. airoides	Peaa
3	Polycarpon tetraphyllum	Pot
2	Polypogon maritimus	Pom
6	Polypogon monspeliensis	Pomo
2	Romulea rosea	Ror
1	Romulea rosea var. australis	Rora
1	Rostraria cristata	Roc
1	Rumex ?crispus	Ru?c
1	Rumex crispus	Ruc
2	Silene gallica	Sig
3	Silene gallica var. gallica	Sigg
4	Solanum nigrum	Son
23	Sonchus oleraceus	Sol
1	Sonchus sp.	Ssp
1	Spergularia marina	Spm
2	Taraxacum officinale	Tao
5	Trifolium arvense var. arvense	Traa
1	Trifolium campestre var. campestre	Trcc
2	Trifolium dubium	Trd
2	Trifolium glomeratum	Trg
1	Trifolium sp.	Tsp
1	Urospermum picroides	Urpi
106	Ursinia anthemoides	Ura
1	Vellereophyton dealbatum	Ved
4	Vulpia ?myuros	Vu?m
5	Vulpia bromoides	Vub
16	Vulpia myuros	Vum
16	Vulpia sp.	Vsp
34	Wahlenbergia capensis	Wac