ILUKA

Mineral Sands By-product Disposal

Crown Allotments 91, 94, 95, 96

Parish of Telangatuk

Environmental Management Plan

Revision: 4

Date: 6 July 2017

Document control

Revision	Details of review or changes	Prepared by	Date created	Document reference
0	Issued to revegetation consultant	C Burns M Little	17/04/2017	
1	Table 23 updated plus other minor edits	C Burns	19/04/2017	
2	Numerous minor edits	C Burns MLittle	21/04/2017	
3	Incorpration of AECOM comments	C Burns M Little	3/07/2017	
4	Minor edits to finalise	C Burns	6/072017	
Revision 1				
[Add as necc.]				

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1 Introduction

1.1 Background

Iluka Resources Limited (Iluka) disposes of heavy mineral processing by-products generated by its mineral separation plant (MSP), located near Hamilton in the Southern Grampians Shire, to a mining void at its Douglas Mine. The void at the Douglas Mine, known as Pit 23, is located in the municipality of the Horsham Rural City in the Kanagulk area, as shown in Figure 1 and Figure 2.

Under the Horsham Planning Scheme the subject land is in the Farming Zone and under the provisions of that zone a permit is required for use and development for Industry (Refuse Disposal). The conditions in Planning Permit 15-105, (the Permit), issued by the Horsham Rural City Council as the Responsible Authority, includes the following:

Environmental Management Plan

16 Within 90 days of the commencement of this permit coming into operation an ***Environmental Management Plan (EMP)*** to the satisfaction of the Responsible Authority must be submitted for its approval. Three copies of the EMP and an electronic version must be provided.

17 The EMP must be accompanied by written endorsement from an environmental auditor appointed under the *Environment Protection Act 1970.*

18 When approved the EMP will be endorsed to form part of this permit, and is to be placed on the permit holder's website.

19 The EMP must identify potential environmental impacts of the proposed use and development as derived from a risk analysis, and set out monitoring programs and control measures to prevent any adverse impact on the environment, applicable for the duration of the planning permit.

20 The annual performance report must be reviewed by an independent suitably qualified person with expertise in risk management plans in the context of mines and quarries, and appointed under the *Environment Protection Act 1970* pursuant to Condition 11.

21 The permit holder must amend the EMP to address any relevant issues, or changes or recommendations of the independent environmental reviewer to the satisfaction of the responsible authority. Amended EMPs are to be placed on the Permit Holder's website from the time of endorsement by the Responsible Authority.

22 No changes are to be made to the approved use and development or operational practices that may affect environmental quality under the scope of the EMP, unless these have been approved within a revised EMP and monitoring program by the responsible authority.

23 To address the above, the EMP must contain but is not limited to the following components:

(a) A risk analysis and response plan;

(b) A Groundwater Monitoring and Management Plan

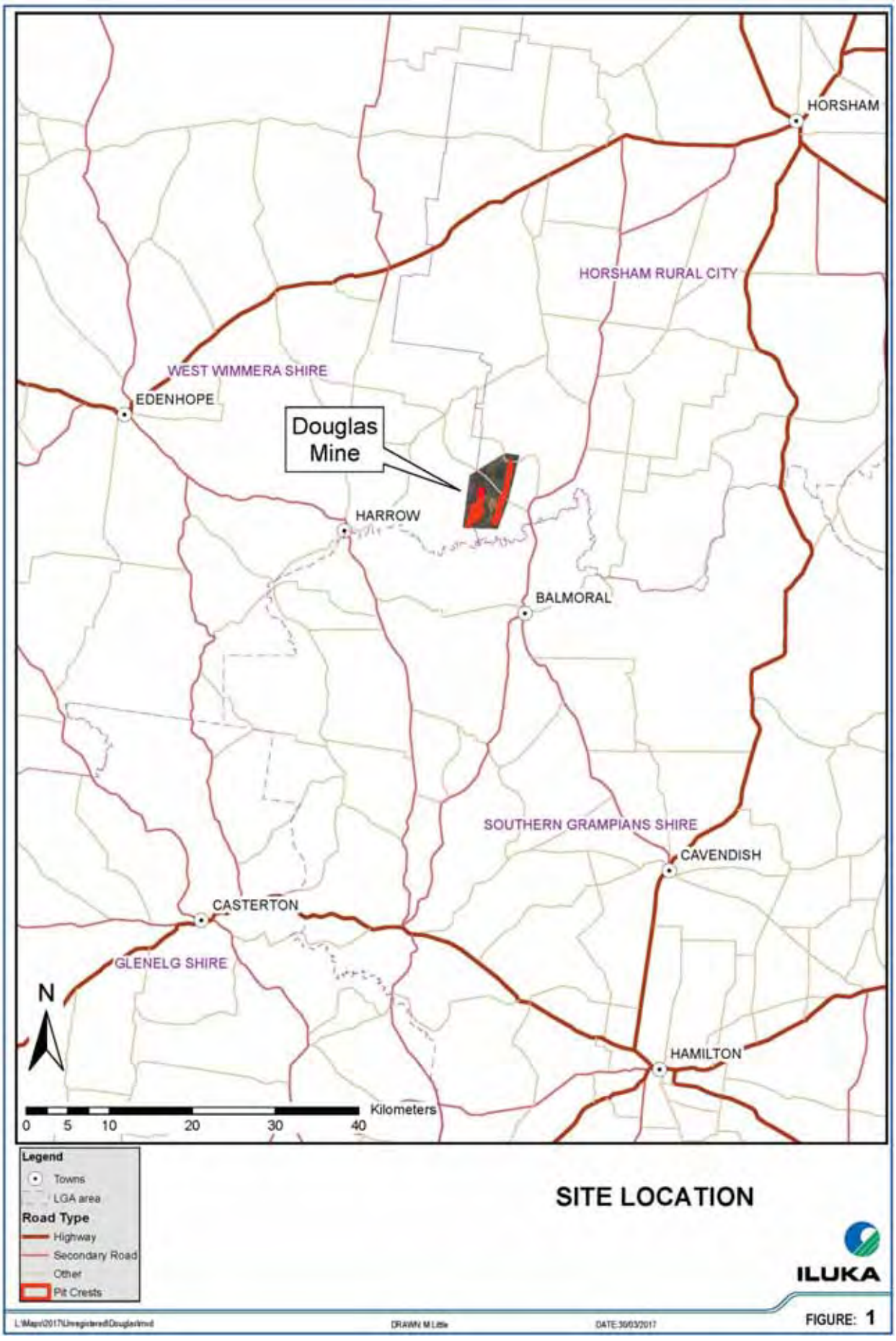
(c) A Surface Water Monitoring and Management Plan

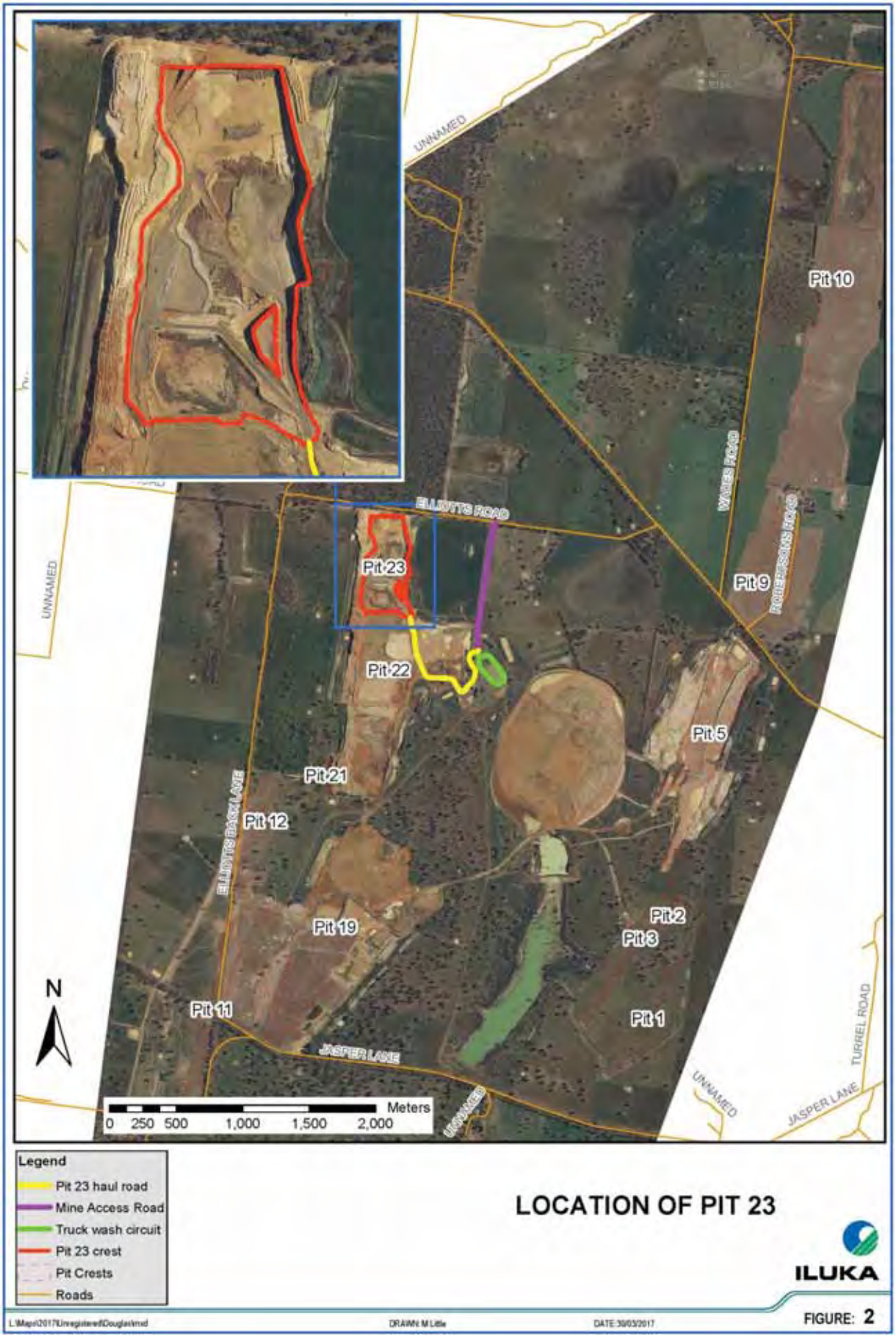
(d) An Air Quality / Dust Control Plan

(e) A due diligence program to ensure continual review, improvement and monitoring of operational practices, ;

(f) Reporting arrangements.

(g) Process for decisions on the need for and (as appropriate) requirements for ongoing monitoring and management programming for the above matters.


HORSHAM
HORSHAM RURAL CITY
WEST WIMMERA SHIRE
EDENHOPE
Douglas Mine
HARROW
BALMORAL
SOUTHERN GRAMPIANS SHIRE
CAVENDISH
CASTERTON
GLENELG SHIRE
HAMILTON
N
0 5 10 20 30 40
Kilometers
Legend
Towns
LGA area
Road Type
Highway
Secondary Road
Other
Pit Crests
SITE LOCATION
ILUKA
DRAWN M Little
DATE:30/03/2017
FIGURE: 1


UNNAMED
Pit 10
WARES ROAD
ROBERTSONS ROAD
ELLIOTTS ROAD
Pit 23
Pit 9
UNNAMED
Pit 22
Pit 5
Pit 21
ELLIOTTS BACK LANE
Pit 12
Pit 19
Pit 2
Pit 3
N
Pit 11
Pit 1
JASPER LANE
TURREL ROAD
UNNAMED
JASPER LANE
UNNAMED
Meters
0 250 500 1,000 1,500 2,000
Legend
Pit 23 haul road
Mine Access Road
Truck wash circuit
Pit 23 crest
Pit Crests
Roads
LOCATION OF PIT 23
ILUKA
L:\Maps\2017\Unregistered\Douglas\mxd
DRAWN: M Little
DATE:30/03/2017
FIGURE: 2

1.2 Purpose

This Environmental Management Plan (EMP) provides the framework for disposal operations on, and rehabilitation of, the subject land. This EMP:

- describes the operational, environmental and legal context for the permitted development and use;
- describes the operational methods to be used;
- identifies key environmental issues that, if not managed, could compromise environmental performance; and
- defines the monitoring program to be used for assessing the environmental performance.

This EMP has been designed to address:

- the conditions of the Permit;
- Iluka's environmental management commitments as detailed in the planning permit application and further information provided in support of that application; and
- Iluka's Environmental, Health and Safety Management System (EHSMS) and standards.

This EMP is one of a number of management plans required by permit conditions, which together form the overall framework for the environmental management of the permitted development and use.

These management plans will be implemented within the framework provided by Iluka's Environment, Health and Safety Management System (EHSMS). Iluka's EHSMS defines the requirements, processes and tools to assist with achieving the company's sustainability objectives. The EHSMS consists of policies, standards, procedures, guidelines and plans.

All Standards and Procedures provide auditable criteria, against which compliance can be measured. All EHS Standards and Group Level Procedures are mandatory documents applying to all Iluka sites.

In particular, the EHSMS sets out how risk assessments and incident investigations are used to identify potential and actual hazards and risks, and the controls required to mitigate those risks.

EHS Standard 1 – Risk and Hazard Management has been developed with the objective that environment, workforce and community risks associated with Iluka operations are assessed and managed, controls are implemented, communicated and monitored for their suitability and effectiveness, and planned and unplanned changes are managed effectively.

The required management plans include:

- Environmental Management Plan (this plan), which includes:
    - a Groundwater Monitoring and Management Plan (GWMMP);
    - a Surface Water Monitoring and Management Plan (SWMMP);
    - an Air Quality/Dust Control Plan (AQDCP); and
    - descriptions of the management of other environmental aspects; and
- an Incoming Waste Monitoring Plan (IWMP); and
- a Rehabilitation and Vegetation Management Plan (R&VMP).

In addition to these management plans the some of the activities are subject to the *Radiation Act 2005* under Iluka's Radiation Management Licence that requires compliance with an approved Radiation Management Plan that includes a Radioactive Waste Management Plan.

The hierarchy and periods of application of the various plans are shown in Figure 3.

<table>
<tr><th>Phase</th><th colspan="2">Disposal</th><th>Rehabilitation and closure</th><th>Post-closure monitoring</th></tr>
<tr><td rowspan="2">Regulator & regulatory instrument</td><td colspan="3">HRCC – Planning Permit (PP)</td><td></td></tr>
<tr><td colspan="4">DHHS – Radiation Management Licence (RML)</td></tr>
<tr><td rowspan="3">Relevant Management Plan (relevant regulatory instrument)</td><td colspan="3">Environmental Management Plan (PP)</td><td></td></tr>
<tr><td colspan="2">Incoming Waste Monitoring Plan (PP)</td><td>Rehabilitation Plan (PP)</td><td></td></tr>
<tr><td colspan="4">Radiation Management Plan/Radioactive Waste Management Plan (RML)</td></tr>
</table>

Figure 3: Regulatory instruments and management plans

1.3 Scope

This EMP applies to:

- Pit 23 and the immediate surrounding area;
- the existing mine access road;
- the existing haul-road to Pit 23;
- a truck washing facility (and access road); and
- mine offices, ablution facilities and car park.

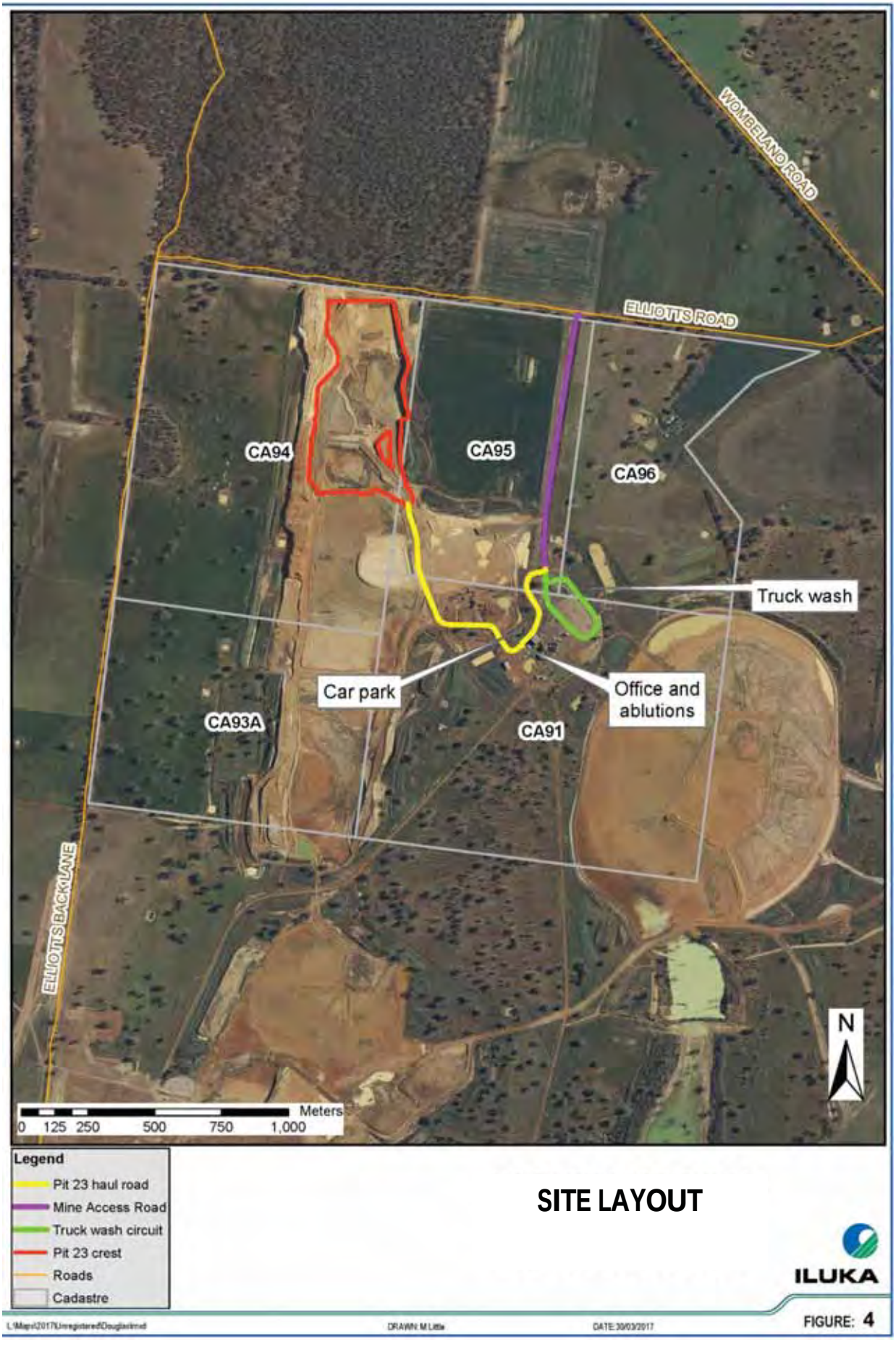
As shown in Figure 4, these features and facilities are located within parts of four Crown Allotments (CA) in the Parish of Telangatuk. Pit 23 is located predominantly on CA94. The mine access road, haul road, truck wash, offices, ablution facilities and car park are located on CA91, CA95 and CA96.

An area encompassing Pit 23 was excised from the Mining Licence in April 2017 to enable current and future by-product disposal and pit rehabilitation to be regulated under the Permit which was issued in accordance with the *Planning and Environment Act 1970*.

Rehabilitation of the remainder of the Douglas Mine is being undertaken in accordance with a rehabilitation plan approved under the *Mineral Resource (Sustainable Development) Act 1990* (MRSDA) and is therefore outside the scope of this plan.

1.4 Objective

The objective of this EMP is to ensure that potential environmental impacts from the disposal and site rehabilitation are appropriately identified and mitigated to minimise adverse impacts on the environment such that impacts are limited to acceptable levels as defined in the planning permit application.


WOMBELANO ROAD
ELLIOTTS ROAD
CA94
CA95
CA96
Truck wash
Car park
Office and ablutions
CA93A
CA91
ELLIOTTS BACK LANE
N
Meters
0 125 250 500 750 1,000
Legend
Pit 23 haul road
Mine Access Road
Truck wash circuit
Pit 23 crest
Roads
Cadastre
SITE LAYOUT
ILUKA
DRAWN: M Little
DATE: 30/03/2017
FIGURE: 4

2 Project description

2.1 Background

2.1.1 Land tenure

Crown Allotments 91, 94, 95 and 96 are owned by Basin Mineral Properties Pty Ltd (BMP), a wholly-owned subsidiary of Iluka. The land is located within the Farming Zone of the Horsham Planning Scheme.

The land to the east, south and west of the subject land is privately owned while land to the north is Crown Land.

2.1.2 Land use

Prior to the commencement of mining, the subject land was used for agriculture. Agriculture remains the predominant land use surrounding the subject land, typically comprising sheep, pasture, and grain/legume crop production.

The Crown Land to the north is in the Public Conservation and Resource Zone.

2.1.3 Douglas Mine history

Mineral sand mining at the Douglas Mine commenced in 2004 and was completed in 2012. Mining of Pit 23 occurred between 2010 and 2012, with deposition of on-site Wet Concentrator Plant tailings occurring between late 2011 and early 2012. Since processing concluded in early 2012, the main activities at the Douglas Mine have been the deposition of MSP by-products into Pit 23 and rehabilitation of other parts of the mine.

All mining, processing, and disposal activities have been conducted under Mining Licence 5367 granted under the MRSDA and in accordance with the Work Plan approved under that act (the Douglas Mine Work Plan). The Douglas Mine Work Plan includes an Environment Management Plan, which includes plans for the monitoring and management of the full range of environmental aspects, and a Rehabilitation Plan. Implementation of these plans to date has seen the successful operation and partial rehabilitation of the Douglas Mine site without unplanned or unexpected adverse impacts on the environment.

The cessation of mineral sands mining by Iluka in Victoria meant that the disposal operations could no longer be regulated under the MRSDA thereby requiring planning approval to be obtained. In April 2017:

- approval was obtained to vary the Douglas Mine Work Plan such that:
    - the prescribed end use of the area of Pit 23 and its surrounds was changed to Industry (Refuse Disposal) under conditions detailed in the Permit; and
    - rehabilitation of the area of Pit 23 and surrounds was removed because no such rehabilitation is required to make the land suitable for the now prescribed end use;
- the area of Pit 23 and surrounds was surrendered from the mining license; and
- the Permit commenced.

2.2 Disposal operations

The material to be disposed of to Pit 23 is limited to:

- by-products of the processing of heavy mineral concentrate (HMC) at the Hamilton MSP;
- used dust filter bags from the Hamilton MSP; and

- concrete and steel from plant and infrastructure, that contains or is contaminated with naturally occurring radioactive material (NORM).

2.2.1 MSP by-product types and quantities

The majority of Hamilton MSP by-products include:

- lighter mineral particles (sand and clay) of spadeable consistency;
- heavier mineral particles as dry sand; and
- gypsum, currently in the form of filter-cake.

The total quantity of Hamilton MSP by-products to be disposed of each year ranges between 50,000 and 120,000 tonnes and the Hamilton MSP has a further operational life of approximately 20 years,

2.2.2 Other materials

The dust filter bags from the Hamilton MSP are nylon that has become impregnated with NORM.

The concrete and steel to be disposed of will be from sources specified in the Permit and will be contaminated with NORM such that reuse, recycle or disposal elsewhere is impractical.

2.2.3 Acceptance for disposal

Acceptance criteria for the materials disposed of have been developed and are detailed in the IWMP.

2.2.4 Disposal method

MSP by-products and other materials to be disposed are transported to the subject land in accordance with the *Code of Practice for Safe Transport of Radioactive Material, 2008* published by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). For MSP by-products this requires sealed trailers. Vehicles carrying materials for disposal must only enter the site via the mine access road and, once on-site, must pass through the existing office area and onto a haul road to the Pit 23 entrance ramp. The vehicles drive directly into the pit to deposit their loads.

After depositing their loads, trucks exit Pit 23 and proceed to the truck wash facility to remove any residual materials. The operation of the truck wash is described in more detail in section 10.3 of this document.

The disposal of materials to Pit 23 will be limited by the first of either:

- the completion of the rehabilitation of the Hamilton MSP site; or
- space available in Pit 23 becoming equal to that required to install a 5 metre cover over the disposed of materials and to reinstate the pre-mining surface landform.

Following completion of the disposal of materials from off-site locations the level of activity at the site will reduce significantly and the office, ablution facilities and parking area at the locations shown in Figure 4 will no longer be required. From this point in time the office functions will be performed at house known as “Chadwick’s” that is located on Wombelano Road. This will enable the land occupied by the office, ablution facilities and associated parking area to be decommissioned as described in Sections 9.5.3 and 9.5.4 of the R&VMP.

Some support infrastructure (mine access road, haul road and truck wash) will be required for the duration of disposal operations and the post-operational rehabilitation period. Consequently, decommissioning of this infrastructure and rehabilitation of the land will occur towards the end of the rehabilitation phase, as described in the R&VMP.

2.2.5 Hours of operation

Works associated with the use and development will only occur between the following hours

- Truck/trailer deliveries 24 hours a day, 7 days a week.
- Earthworks 7am-6pm, 7 days a week, excluding emergency works.

Works outside these hours can only occur with written consent of the Responsible Authority.

3 Environmental context

3.1 Climate

The climate of the region is characterised by cool, wet winters and long, dry summers. Typical seasonal characteristics include irregular rainfall during warm to hot summers and relatively reliable, moderate rainfall during cool winters. The average annual rainfall is 550mm. Most rainfall occurs in winter and spring.

In summer, the mean daily maximum temperature is 26°C and the mean daily minimum temperature is 13°C. In winter, the mean daily maximum temperature is 13.4 °C and the mean daily minimum is 4.6°C.

Annual pan evaporation is estimated to be 1410mm, which is approximately 2.5 times the average annual rainfall.

3.2 Landform

The pre-mining landform of the subject land was very gently undulating to flat, typically ranging between 210mAHD and 190mAHD. The pre-mining topography of the Pit 23 area was very gently undulating, with elevations ranging between 204mAHD and 199mAHD. The pre-mining landform contours overlaid on the current Pit 23 footprint are shown in Figure 5.

3.3 Soils

As shown in Figure 6, pre-mining soil surveys showed that the soils of the Pit 23 area comprise sand and sandy loam. The sandy loams have generally low salinity at the surface and are neutral to slightly alkaline at depth. During the development of Pit 23, topsoil, subsoil and overburden were sequentially removed and stockpiled. These materials are available for backfilling and rehabilitation.

3.4 Radiation

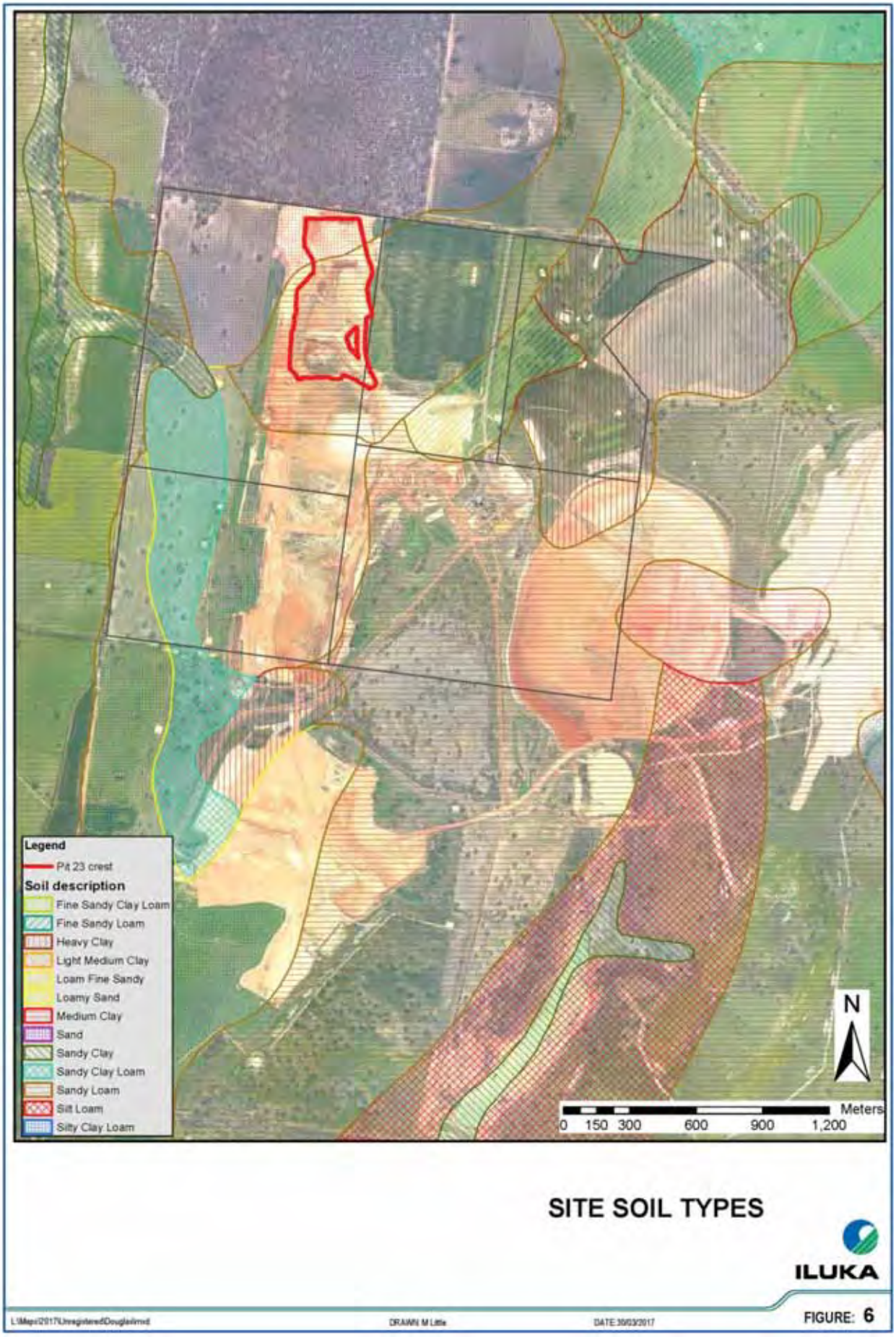
All ore-bodies of heavy minerals contain the natural radioactive elements uranium and thorium together with their decay products, i.e. NORM. Table 1 contains the results of measurements of the background (or pre-mining) radiation levels for the Douglas Mine

Table 1: Average background radiation levels for the Douglas Mine site

Surface gamma dose rate (µSv/h)	Radionuclide activity concentration of soil (Bq/g)		Radionuclide activity concentration in groundwater (Bq/L)		Gross alpha activity concentration of airborne dust (mBq/m^3)	Radon activity concentration in air (Bq/m^3)	Thoron activity concentration in air (Bq/m^3)
	Uranium	Thorium	Ra-226	Ra-228		Rn-222	Rn-220
0.14	0.012	0.072	0.18	0.29	0.010	< DL*	< DL*

*Less than the detectable limit


196
197
198
199
201
200
198
199
203
204
202
197
196
195
194
N
Meters
0 20 40 80 120 160
Legend
Pre-mining surface contours (1m)
Pit 23 crest
PIT 23 PRE-MINING
SURFACE CONTOURS
ILUKA
L:\Mapol2017\Unregistered\Douglas\mxd
DRAWN: M.Little
DATE:30/03/2017
FIGURE: 5


Legend
Pit 23 crest
Soil description
Fine Sandy Clay Loam
Fine Sandy Loam
Heavy Clay
Light Medium Clay
Loam Fine Sandy
Loamy Sand
Medium Clay
Sand
Sandy Clay
Sandy Clay Loam
Sandy Loam
Silt Loam
Silty Clay Loam
N
0 150 300 600 900 1,200
Meters
SITE SOIL TYPES
ILUKA
DRAWN: M Little
FIGURE: 6

3.5 Groundwater

The principal hydro-stratigraphic units in the vicinity of the Douglas Mine include the Shepparton Formation, the Loxton-Parilla Sands, the Basal Clay and the Basement. The water table generally lies within the lower parts of Loxton-Parilla Sands and represents the unconfined water table aquifer throughout most of the area.

Regionally, the groundwater flows to the north, north-east and north-west and is controlled by the saline lakes of the Douglas Depression to the north-west which act as groundwater discharge sites, including Tea Tree Lake, White Lake, Centre Lake and North Lake. McGlashin Swamp, located to the south of White Lake, is also likely to be receiving some groundwater discharge.

Groundwater quality within the Douglas mine area ranges from brackish to very saline (electrical conductivity (EC) ranging from 3,000µS/cm to 51,000µS/cm) and slightly acidic (pH ranging from 5.0 to 7.6). There is significant natural temporal a special variability in salinity. The quality of the groundwater that may be impacted by seepage from Pit 23 is discussed in more detail in Sections 7.4 and 7.5.

A detailed description of the groundwater monitoring and management during the disposal and rehabilitation phases can be found in Section 7 of this document.

3.6 Surface water

The Pit 23 footprint straddles what was a gentle north-south trending ridge which formed a surface water catchment divide. From the top of the ridge, surface water runoff would have predominately flowed to the west and east as overland flow, as no defined flow paths existed. It can be seen from Figure 7 that a number of surface water bodies occur as groundwater expressions to the north, north-west and north-east of Pit 23.

During the disposal operations into Pit 23 no surface water flow will occur from the pit, as the pit floor level will be well below the surrounding topography until the final landform surface is created during the rehabilitation phase. Water that has the potential to impact on surface water quality includes:

- run-off from the outer batters of the overburden stockpiles on the western and eastern sides of Pit 23, topsoil and subsoil stockpiles and relatively small volumes that may overflow from the truck wash facilities.; and
- groundwater to which seepage from Pit 23 has been added that then discharges at the surface.

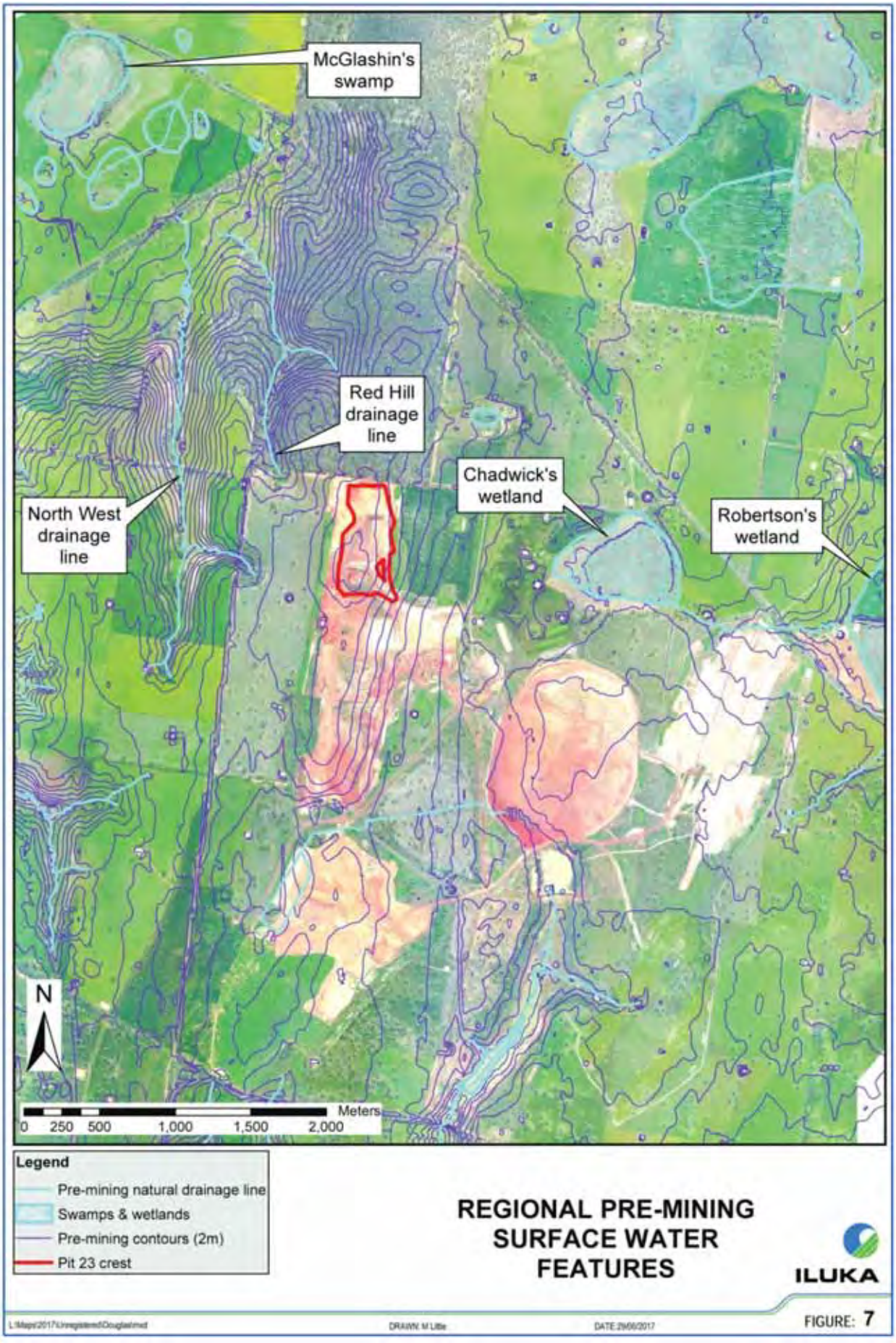
A detailed description of the surface water monitoring and management during disposal and rehabilitation phases can be found in Section 8 of this document.

3.7 Native vegetation

Prior to mining, the subject land was already cleared for agriculture. No further clearing of native vegetation is required or envisaged.

Remnant native vegetation in the Douglas Mine area includes the Little Young's State Forest that occurs to the north of the Douglas mine and the Red Hill Reserve immediately to the north of Pit 23.

These stands of remnant vegetation to the north of the Douglas Mine provide benchmark vegetation assemblages ("Ecological Vegetation Classes" (EVCs)) to guide the revegetation objectives for Pit 23. These objectives and the activities associated with revegetation during the rehabilitation phase are described in the R&VMP.


McGlashin's swamp
Red Hill drainage line
Chadwick's wetland
Robertson's wetland
North West drainage line
N
Meters
0 250 500 1,000 1,500 2,000
Legend
Pre-mining natural drainage line
Swamps & wetlands
Pre-mining contours (2m)
Pit 23 crest
REGIONAL PRE-MINING SURFACE WATER FEATURES
ILUKA
DRAWN: M Ulbe
FIGURE: 7

4 Environmental management objectives

Table 2 presents the environmental management objectives for this EMP.

Table 2: Environmental management objectives

Aspect	Objectives
Air quality (non-radiological)	Off-site air quality is not adversely affected by the development and use
Noise	Noise emissions from the development and use comply with limits determined in accordance with EPA publication 1411, Noise from Industry in Regional Victoria, October 2011 (NIRV)
Weeds and feral species	Populations of weeds and feral species are actively managed to minimise spread and reduce numbers
Native vegetation	No adverse impact to native vegetation communities
Geotechnical stability	The development and use does not pose an unacceptable risk to the public, site personnel or contractors and the creation of stable final lanforms is assured.
Site safety and security	The development and use does not pose an unacceptable risk to the public, native fauna and domestic livestock
Radiation	Radiation doses arising from the development and use are below the prescribed limits
Surface water	Surface water runoff during by disposal and rehabilitation operations or groundwater discharge to surface waters do not adversely affect users of the resource (including extractors and the environment) or existing local land uses.
Groundwater	Impacts on groundwater resulting from the development and use does not adversely affect users of the resource (including extractors and the environment), or existing local land uses by changes in groundwater quality or accessability.
Disposal	Material disposed of into pit 23 is limited to non-liquid material that contain or are contaminated with naturally occurring radioactive material (NORM), with the source sites being limited to those specified in the Permit.

5 Roles and responsibilities

Table 3 sets out the roles and responsibilities for the implementation of this plan

Table 3: Roles and responsibilities

Position	Role
Rehabilitation Superintendent - Douglas	Oversight of activities at the Douglas Mine
Environment Superintendent – Murray Basin	Oversight of environmental management and compliance for the Douglas Mine
Principal Environmental Specialist and Radiation Safety Officer – Murray Basin	Specialist environmental and radiation technical support.
Environmental Advisor – Murray Basin	Planning, coordination and reporting on environmental aspects of Douglas Mine activities
Environment Technician – Murray Basin	Environmental monitoring
Senior Health and Safety Specialist	Occupational health and safety and emergency response
Hamilton Operation Manager	Overall responsibility for operations at the Hamilton Mineral Separation Plant
Production Superintendent - Hamilton	Metallurgical control of Hamilton mineral separation plant, including sampling and analysis of by-products
Transport Co-ordinator – Murray Basin	Direction and co-ordination of transport of materials, including by-products, throughout the Murray Basin

6 Risk analysis and response plan

The risk analysis and response plan was prepared by AECOM Australia Pty Ltd (AECOM) and a copy of AECOM's report (the RARP Report) is contained in Appendix A

It can be seen from the RARP Report that:

- the AECOM personal responsible for the risk assessment are suitably qualified as required by the Permit;
- the methodology applied is considered best practice as required by the permit;
- a Risk Register was developed identifying 26 events for risk assessment (A copy of the Risk Register is appended to the RARP Report);
- a semi-quantitative approach was used to assess the risks of identified events with the following results:
    - the risk of all events were assessed as being less than "Minor"
    - the risk of three events were assessed as being between "Negligible" and "Minor" while for 23 of the events the risk was assessed as "Negligible";
    - the events for which the risk was assessed as being between "Negligible" and "Minor" were:
        - drought;
        - bushfire; and
        - stormwater containment failure;
- the requirement of the Permit to identify "material risks" to ensure that appropriate trigger levels and management responses are in place was made difficult by the lack of a definition of the term "material risks", however, extra mitigation measures were developed for the top two risks (drought and bushfire);
- in response to the requirement of the Permit to identify "acute risks" to ensure that adequate contingency planning is in place, only one risk, that to stormwater containment was identified as an acute risk and for this risk the mitigation measures in the EMP were considered to be adequate;
- AECOM recommend that the Risk Register be reviewed annually at the time of the EMP and rehabilitation performance review which is in accordance with Iluka's Risk and Hazard Management Standard so such reviews will be conducted; and
- Iluka's Emergency Response Plan for the Douglas Mine site and Iluka's Incident Reporting & Investigation Standard were reviewed and found to be adequate.

7 Groundwater Monitoring and Management Plan

7.1 Background

Condition 24 of the Permit specifies the requirements of a GWMMP as follows:

> Groundwater Monitoring and Management Plan
>
> (a) A *Groundwater Monitoring and Management Plan (GWMMP)* (component of the *EMP*) must be prepared to the satisfaction of the responsible authority.
>
> (b) The GWMMP must be generally in accordance with the plan in Appendix A to the *Supplementary Response to Amended Notice* provided to the EPA and the Responsible Authority, but modified or added to so as to include:
>
> i the applicable recommendations contained in section 6.2 of the report prepared by Environmental Earth Sciences titled *Independent Desktop Review For The Continuation Of Mineral By-Products Disposal Into Pit 23 At Iluka's Douglas Mine Site, Northwest Victoria No. 215071v2* dated April 2016 (**the EES April 2016 review**);
>
> ii a discrete description of measures for groundwater protection and monitoring included in any approval in force under the *Radiation Act 2005*;
>
> iii A plan showing the proposed location and spatial distribution of groundwater bores (including new drilled bores and replacement borehole locations) which must include as a minimum those recommended in the EES April 2016 review - Figure 6 on Page 32.
>
> (c) confirmation that all new and replacement bores are installed and tested under the supervision of a qualified, experienced hydrogeologist;
>
> (d) details of the frequency of monitoring of groundwater bores for groundwater levels
>
> (e) details of the frequency of sampling of groundwater bores for and the analytes to be tested and reported on;
>
> (f) appropriate trigger criteria and associated management responses for analytes of concern;
>
> (g) groundwater level and criteria for analytes of concern that will trigger the recalibration of the groundwater model and re-forecasting of predicted groundwater behaviour and transport of analytes of concern;
>
> (h) the means by which site specific distribution coefficients will be determined, if such determination is required, to improve model predictions;
>
> (i) quality assurance controls and reporting;
>
> (j) criteria that will trigger points when it is appropriate to review and amend the GWMP requirements.

This Groundwater Monitoring and Management Plan (GWMMP) has been prepared to satisfy this permit condition.

7.1.1 Purpose

This GWMMP provides the framework for the monitoring and management of groundwater potentially impacted by the disposal operations and the rehabilitation of the subject land. This GWMMP:

- describes the background conditions relating to groundwater including:
    - the hydrogeological setting;
    - groundwater water levels and flow paths;
    - groundwater chemistry; and
    - sensitive receptors;
- identifies the standards to be applied;
- assesses the risks to groundwater;
- details the processes by which impacts on groundwater will be detected and managed including:
    - identifying the number and location of groundwater monitoring points;
    - specifying the frequency of groundwater sampling and measurements;
    - specifying the field parameters and laboratory analytical suites to which the groundwater samples will be subjected including quality assurance;
    - the use of hydrogeological and solute transport modelling; and
    - setting of appropriate trigger points and actions;
- specifies of the reporting of the groundwater monitoring data.

As required by the Permit, this GWMMP has been prepared such that it is in general accordance with the plan in Appendix A to the *Supplementary Response to Amended Notice* provided to the Victorian Environment Protection Authority (EPA) and the Responsible Authority. In addition the preparation of this plan has had regard to:

- the information pertaining to groundwater as described in the section 4.4 of Attachment A to the Permit application;
- further information subsequently supplied within Appendix C of the document "*Response to Notice to Supply Further Information – Hydrogeological and groundwater related matters*", submitted to the Responsible Authority and EPA;
- *the State Environment Protection Policy (Groundwaters of Victoria*) (the Groundwater SEPP);
- conditions of the Permit; and
- relevant policies, standards and procedures that comprise Iluka's Environmental, Health and Safety Management System (EHSMS).

7.1.2 Objective

The objective of this GWMMP is to ensure that changes to groundwater resulting from the permitted development and use do not adversely affect users of the resource (including extractors and the environment), or existing local land uses.

7.2 Description of background conditions

7.2.1 Conceptual hydrogeological model

CDM Smith Australia Pty Ltd (CDM Smith) developed a conceptual hydrogeological model of the Douglas Mine site and surrounding area and reported the results in *Douglas Mine Site Hydrogeological Modelling, 6 November 2014*, (CDM Smith Nov 2014), a report that was submitted in support of the planning permit application. The conceptual model is illustrated in Figure 8

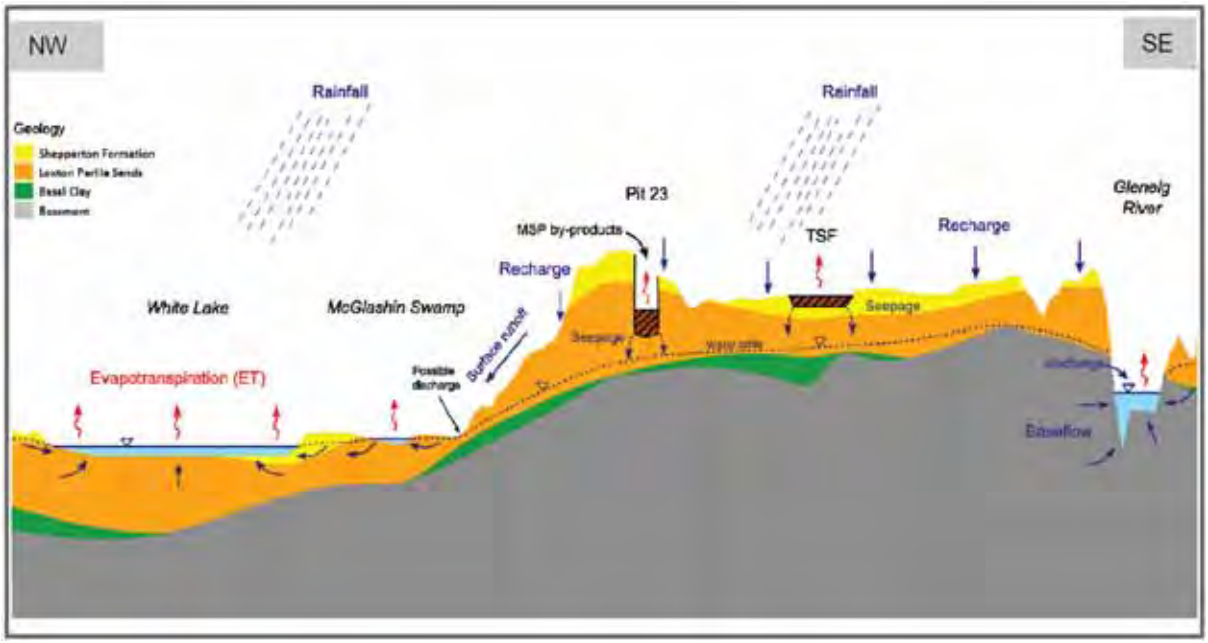


Figure 8: Illustration of conceptual hydrogeological model

The conceptual model is summarised as follows:

- a total of four hydrostratigraphic units (HSUs) are identified, which include the Shepparton Formation (SFM), Loxton-Parilla Sands (LPS), Basal Clay and Basement. (each of which is described below) The water table generally lies within the basal level of the LPS, which forms the uppermost saturated unit. Where the Basement is high the water table locally occurs within the Basement;
- the water table is a subdued reflection of surface topography, which also mirrors the surface of the Basement. Groundwater from the Douglas mine site flows to the north, north-west and east, away from an elongated mound in the water table located over a ridge in the Basement;
- groundwater receives rainfall-derived recharge. The water table shows fluctuations in response to seasonal variations in rainfall, including a steady decline in groundwater levels during a period of low rainfall from 2005 to 2010. The response of the water table to seasonal variations in recharge becomes less pronounced with an increase in depth to groundwater, i.e. the thickness of the unsaturated zone;
- seepage from the Fresh Water Dam (FWD) resulted in a gentle and steady rise in groundwater levels at a number of locations within the mine site. The disposal of tailings into the pits and the Tailings Storage Facility (TSF) during mining and processing at Douglas provided temporary sources of recharge that locally elevated the water table beneath these features. Groundwater levels in the vicinity Pits 22 and 23 show mounding of up to 4 metres. There is the potential for recharge to remain enhanced over the pits and the TSF following the disposal of tailings and until they are backfilled and rehabilitated;

- groundwater that currently flows beneath Pit 23 discharges to surface via a series of saline water lakes in the Douglas Depression, located to the north-west of the mine site. Areas to the south of Pit 23 have groundwater which discharges to the Glenelg River and along existing drainage lines/creeks. Evapotranspiration by vegetation, particularly within the riparian zone, is also interpreted as a groundwater discharge mechanism; and
- nearby potential sensitive receptors include stock and domestic bores and groundwater supported surface water bodies (and associated ecosystems). McGlashin Swamp is a brackish swamp that is interpreted to be a through flow water body, receiving some baseflow as well as surface runoff. White Lake and Tea Tree Lake are saline/hypersaline closed lakes receiving primarily groundwater discharge.

The identified HSUs are described below:

Shepparton Formation
The SFM drapes over much of the region, with thicknesses generally ranging from two to seven meters with a median thickness of 4.5 m. The formation comprises clay and sandy clay. Surficial Quaternary sands and alluvium sediments are also locally present within the vicinity of the mine site. These are sometimes unnamed in geological maps; in other places they are called the Lowan Sands or Coonambidgal Formation. For the purpose of conceptualisation these sediments are collectively referred to as the SFM. The water table is generally located several metres below the SFM; however, this unit is delineated as the uppermost HSU due to its potential influence on recharge to the underlying water table.

Loxton-Parilla Sands
The LPS underlies the SFM and comprises sand and gravel with minor clay and silt. The unit is laterally continuous and outcrops in places where the overlying SFM is absent. The thickness generally ranges from five to 25 m at the mine site and a thickness of up to 55 m has been encountered in the area surrounding the mine site. The ore mined was located toward the base of the LPS. The water table typically lies along the basal level of this unit and it represents the uppermost saturated zone across much of the mine site.

The LPS represents an unconfined aquifer and receives rainfall-derived recharge. The available borehole logs indicate the presence of clay lenses and gravel layers that are discontinuous, suggesting local scale heterogeneities. On a regional scale, the unit is expected to behave as a granular, porous medium with groundwater flowing via inter-granular pore spaces.

Basal Clay
In many of the available borehole logs, a pervasive clay layer was identified below the LPS. The observations in a number of pits also support the occurrence of plastic clay below the zone of mineralisation. The logging descriptions and geological reports indicate that this clay layer could belong to several geological units including the Geera Clay, Ettrick Formation, Duddo Limestone, weathered bedrock or pervasive clay within the LPS. For the purpose of hydrogeological conceptualisation, all of these clay units are collectively referred to as the Basal Clay.

In some borehole logs, a thin layer of gravel was identified between the clay layer and the underlying Palaeozoic basement. This gravel layer may belong to the Renmark Group although the Renmark Group is not delineated as an HSU due to its insubstantial thickness and infrequent occurrence at the mine site and in surrounding area.

The Basal Clay is generally less than 10 m thick and is interpreted as an aquitard. It is laterally discontinuous and, where present, locally confines the underlying Palaeozoic basement.

Basement
The Palaeozoic basement, referred to as the Basement, is comprised of biotitic rich granite and schist. This HSU forms the effective hydraulic base of the regional groundwater flow system and represents the lowermost HSU considered at the site. The Basement is interpreted to be a fractured rock aquifer, with groundwater flowing via network of interconnected fractures. At the

mine site the water table locally intersects the upper part of the Basement, particularly where it is elevated. In these areas the Basement is interpreted to be unconfined and receives rainfall-derived recharge. Where the Basement is overlain by the Basal Clay and the water table occurs above the Basement, it is interpreted to be confined.

7.2.2 Groundwater levels and flow paths

CDM Smith used the results of groundwater level measurements to construct groundwater contours as at the end of mining at the site, i.e. in 2012, (CDM Smith 2014) and, in further information provided to the Responsible Authority in a letter report titled *Douglas Mine Site Hydrogeological Modelling – Flow Path from Pit 23 to Glenelg River, 20 October 2015* (CDM Smith, Oct 2015) included the plan shown in Figure 9, which shows the interpreted groundwater contours and indicated flow directions from Pit 23 at the completion of mining.

Conclusions drawn by CDM Smith included the following:

- groundwater levels are elevated along Pit 19 and groundwater flows to the east and west from this location;
- the highest groundwater levels occur at Pit 22, a consequence of seepage from past tailings disposal;
- groundwater gradients show that flow will occur from Pit 23 to the north and north-west;
- a long elongated mound exists to the north of the TSF, corresponding to the basement ridge, which partially divides the groundwater flow;
- to the east of the elongated mound, groundwater will flow to the east and north-east; and
- to the west of the mound, groundwater will flow to the north-west, towards the drainage lines and the Douglas Depression lakes.

In late 2015/early 2016 the groundwater levels at all available bores were measured and the results obtained used to construct groundwater contours. Jacobs Australia Pty Ltd (Jacobs) assessed the results and included the plans shown in Figure 10 in *Disposal of by-products at the Douglas Mine Site – Groundwater Geochemistry Baseline Review, 25 February 2016* (Jacobs Feb 2016), a report provided as further information in support of the planning permit application.

Jacobs concluded that:

> "Groundwater level measurements and the resulting interpreted contours are consistent with previous interpretations and the projected groundwater flow patterns remain as evaluated from previous studies. The conceptual understanding of the groundwater flow pattern has not changed from the previous assessment made by CDM-Smith." (Jacobs 2016, Section 6 page 66)

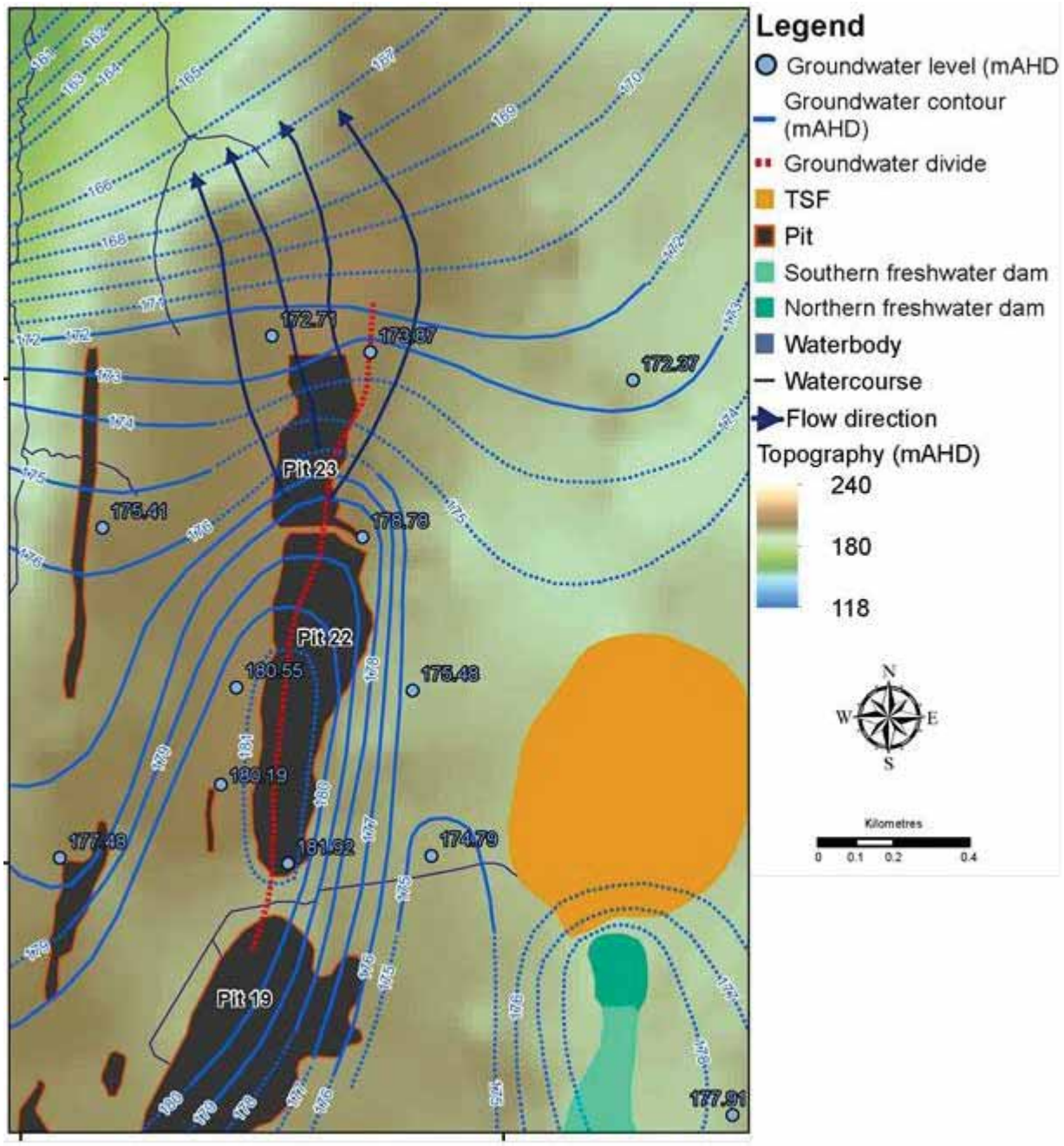


Figure 9: Groundwater contours and flow paths at the completion of mining

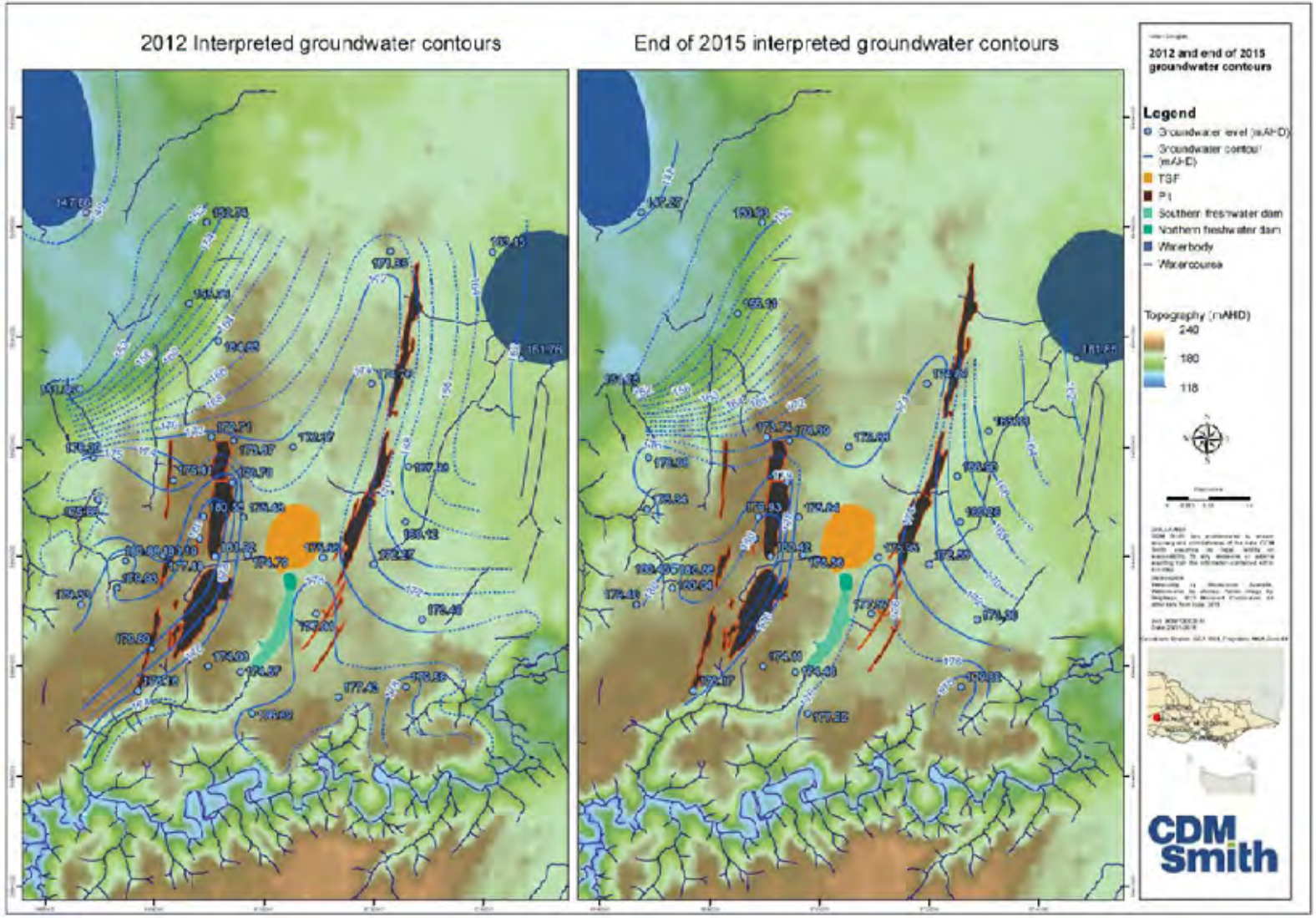


Figure 10: Groundwater contours at completion of mining and end of 2015

7.2.3 Groundwater chemistry

The groundwater chemistry at the site was the subject of a detailed examination by Jacobs with results of that examination being provided in Jacobs Feb 2016.

The data examined by Jacobs included the results of detailed analysis of groundwater samples collected between 7 December 2015 and 12 January 2016. Conclusions drawn by Jacobs in regard to groundwater quality include:

- the groundwater sampling round of late 2015 and early 2016 is considered to be a comprehensive set of samples that provides sufficient data to enable the baseline chemistry for the area to be determined;
- groundwater samples demonstrate the background chemistry across the area; and
- groundwater chemistry in the vicinity of Pit 23 is not markedly different from groundwater across the rest of the area sampled. In other words:
    - the evidence provided by total soluble salts concentrations shows that groundwater chemistry at the sampled bores near Pit 23 has not been altered by mining activities (including MSP by-product disposal);
    - the evidence provided by the major ion concentrations and ionic ratios is that the groundwater chemistry at the sampled bores near Pit 23 has not been affected by mining activities (including MSP by-product disposal); and
    - the evidence provided by radionuclide activity concentrations is that there is there is no marked difference from the activity concentrations found in the nearby area.

Groundwater chemistry along the potential flow path from Pit 23 has been characterised and the results provide a baseline for future assessment. Table 3 summarises the groundwater quality results obtained from the samples collected including both the full data set, representing the groundwater in the Douglas mine area and the data on the groundwater in the predicted flow path from Pit 23, representing the groundwater with the highest potential to be impacted. To provide context, the groundwater quality objectives specified the Groundwater SEPP, by reference to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000,* (the Water Quality Guidelines) for the protection of the beneficial use of stock watering are also included in Table 3.

The following observations can be made of the data in Table 3:

- while the salinity of the groundwater at the mine site, as measured by total soluble salts, ranges from fresh to brackish, the groundwater in the predicted flow path from Pit 23 is brackish ranging in total soluble salts concentration from 8,020 to 13,649 mg/L therefore being in Segment C or D as defined in the Groundwater SEPP;
- the vast majority of the dissolved ions in the groundwater are the stable ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-} and HCO_3^{-}) with those ions, on average, constituting 96.1% of the dissolved ions in the groundwater at the mine site and 95.4% in the groundwater in the predicted flow path from Pit 23;
- the dominant salt pair in all groundwater tested is Na-Cl being, on average, 79.0% of all ions in the groundwater at the mine site and 82.7% in the groundwater in the predicted flow path from Pit 23;

Table 3: Baseline groundwater chemistry

		Douglas Mine Site			In Predicted Flowpath			GW SEPP
		Av.	Max.	Min.	Av.	Max.	Min.	
General								
pH	Units	6.76	7.54	5.44	6.81	7.54	5.90	-
Electrical Conductivity	µS/cm	7163	11900	14675	12635	19700	6360	-
Total Soluble Salts	mg/L	7056	14461	354	8020	13649	3548	10000
Alkalinity								
Bicarbonate Alkalinity as $CaCO_3$	mg/L	209	528	16	284	528	30	-
Carbonate Alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1	<1	<1	-
Hydroxide Alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1	<1	<1	-
Major Ions								
Calcium	mg/L	236	664	2	176	306	92	1000
Magnesium	mg/L	239	598	7	249	381	110	-
Sodium	mg/L	1894	4360	104	2350	4360	1030	-
Potassium	mg/L	21	82	1	48	82	13	-
Sulfate	mg/L	660	1430	35	553	876	301	1000
Chloride	mg/L	3730	7790	139	4280	7100	1700	-
Fluoride	mg/L	0.28	0.40	0.65	0.38	0.5	0.3	2
Metals and Metalloids								
Aluminium	mg/L	2.63	22.30	0.01	1.15	2.81	0.33	5
Arsenic	mg/L	0.067	0.564	0.001	0.138	0.513	0.012	0.5
Barium	mg/L	0.029	0.111	0.003	0.048	0.105	0.026	-
Beryllium	mg/L	0.004	0.100	<0.001	<0.001	<0.001	<0.001	-
Boron	mg/L	0.15	0.60	0.94	0.62	1.50	0.15	5
Cadmium	mg/L	0.0003	0.0060	<0.0001	<0.0002	0.0002	<0.0002	0.01
Cobalt	mg/L	0.009	0.044	<0.001	0.007	0.016	0.001	1
Chromium	mg/L	0.013	0.098	<0.001	0.005	0.008	0.002	1
Copper	mg/L	0.006	0.047	<0.001	0.0035	0.007	0.002	0.4
Iron	mg/L	7.91	53.60	0.12	2.40	4.7	0.85	-
Manganese	mg/L	0.601	3.470	0.004	0.47	1.6	0.004	-
Mercury	mg/L	0.00007	0.00050	<0.0001	0.0016	0.0005	<0.0001	0.002
Molybdenum	mg/L	0.0046	0.103	<0.001	0.0016	0.003	<0.001	0.15
Nickel	mg/L	0.015	0.091	<0.001	0.0049	0.008	<0.001	1
Lead	mg/L	0.017	0.309	<0.001	0.0055	0.002	<0.001	1
Selenium	mg/L	0.009	0.04	<0.01	0.0063	0.01	<0.01	0.02
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Thorium	mg/L	0.0056	0.058	<0.001	0.0025	0.003	<0.001	-
Uranium	mg/L	0.003	0.027	<0.001	0.0019	0.004	<0.001	0.2
Vanadium	mg/L	0.030	0.24	<0.01	<0.01	<0.01	<0.01	-
Zinc	mg/L	0.055	0.52	<0.005	0.0254	0.050	<0.005	20
Anions								
Ammonium as N	mg/L	0.435	7.15	<0.01	1.123	4.40	<0.01	-
Ammonia as N	mg/L	0.442	7.17	<0.01	1.124	4.40	<0.01	-
Total Ammonia as N	mg/L	0.877	14.32	<0.01	2.247	8.40	<0.01	
Nitrite as N	mg/L	0.013	0.190	<0.01	0.051	0.19	<0.01	98.7
Nitrate as N	mg/L	1.736	9.13	<0.01	2.40	5.82	0.15	1722
Reactive Phosphorous as P		0.11	1.92	<0.01	0.485	1.92	<0.01	-
Total Phosphorous	mg/L	0.16	2.22	<0.01	0.59	2.22	0.03	-
Radionuclides								
Radium-226	Bq/L	0.107	0.95	<0.05	0.05	0.10	<0.05	5
Radium-228	Bq/L	0.18	0.90	<0.08	0.15	0.48	<0.08	2
Uranium-238	Bq/L	0.02	0.25	<0.025	<0.025	<0.025	<0.025	0.2

- Average concentrations of the water quality indicators specified in the Groundwater SEPP for stock watering in the groundwater at the mine site are below the Groundwater SEPP objectives, however, maximum concentrations of those indicators exceed those objectives in the cases of:
    - TDS, as indicated by total soluble salts;
    - sulphate;
    - aluminium;
    - arsenic;
    - lead;
    - selenium;
    - uranium;
    - uranium-238;
- Average concentrations of the water quality indicators specified in the Groundwater SEPP for stock watering in the groundwater in the predicted flow path from Pit 23 are below the SEPP objectives, however, maximum concentrations of those indicators exceed those objectives in the cases of:
    - TDS, as indicated by total soluble salts; and
    - arsenic.

7.3 Groundwater users and sensitive receptors

There are 168 registered bores located within 14 km of the centre of the Douglas Mine site, however not all of these bores are used for water supply. The locations of the bores are shown in Figure 11 and categorised as follows:

- 11 stock and domestic bores. (A stock and domestic bore is permitted to be used free of charge provided the person owns or occupies the land. Stock and domestic uses include:
    - household purposes (e.g. laundry, bathroom);
    - watering of animals kept as pets;
    - watering of cattle or other stock; and
    - irrigation of a kitchen garden (does not include dairies, piggeries, feed lots, poultry or any other intensive or commercial use).

      The salinity of the groundwater would suggest that few, if any, of these bores are used for domestic water supply;
- 28 stock bores;
- 61 investigation and observation bores;
- 4 non groundwater bores; and
- 64 bores where the use is not known.

The closest bores, excluding observation and non-groundwater bores, to Pit 23 are Bore 94970, located approximately 1 km to the north-east of Pit 23, and several bores between 1 and 2.5 km to the east of Pits 9 and 10. None of these bores are located in the predicted groundwater flow path from Pit 23.

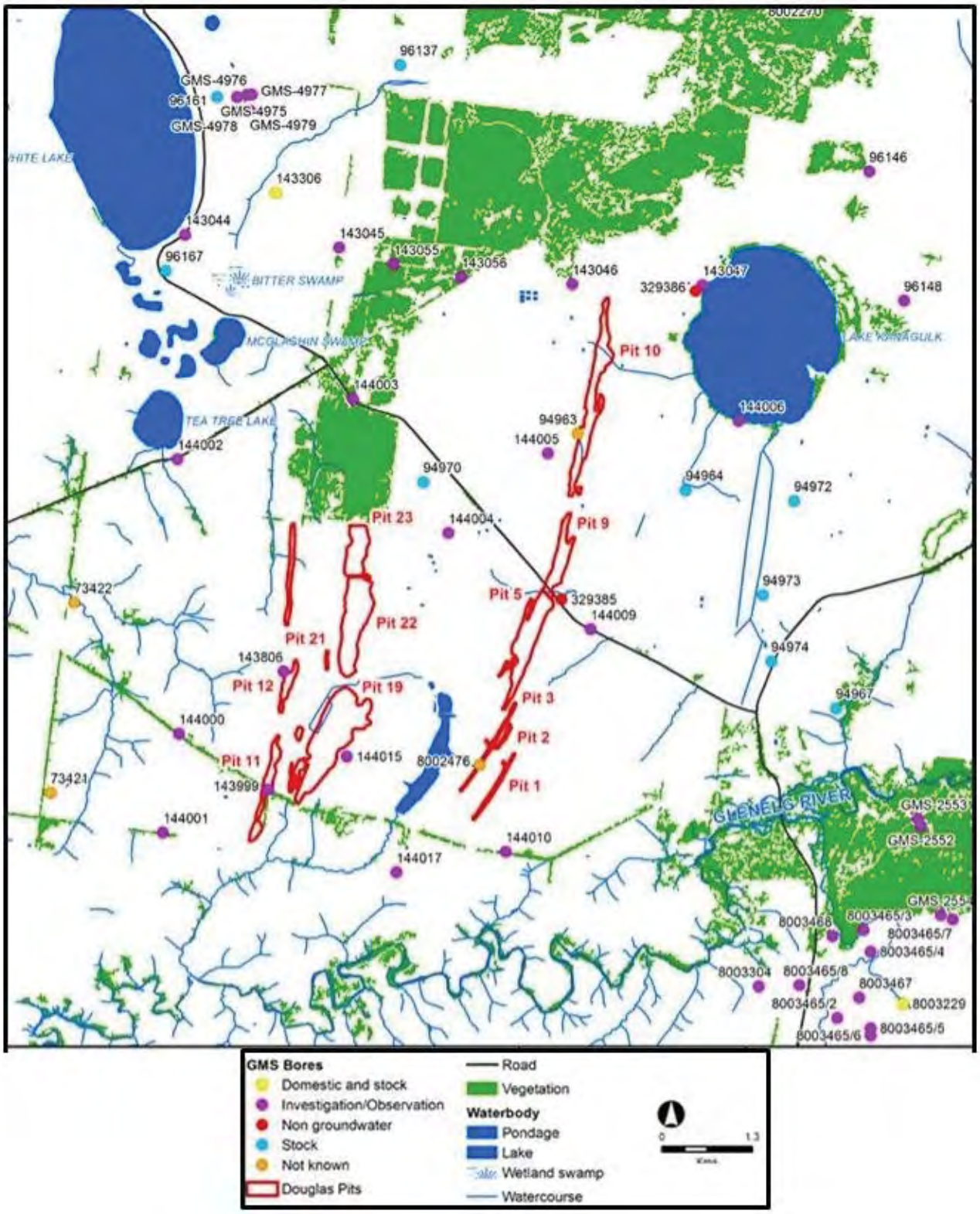


Figure 11: Registered bore locations

CDM Smith (CDM Smith Nov 2014) utilised the *National Atlas of Groundwater Dependent Ecosystems (NAoDGES)* and previous studies to determine that:

- the majority of groundwater dependent ecosystems (GDE's) identified in and around the mine site are within the riparian zone of the Glenelg River to the south-east, south and south-west of the mine site, and thus outside the flow path from Pit 23;
- springs located to the west of the mine site provide base flow to a number of creeks that support native flora and fauna; and
- surface water bodies to the north-west of the mine site, including Tea Tree Lake, McGlashin Swamp, Bitter Swamp and White Lake, shown in Figure 7, are connected to and supported by groundwater and therefore ecosystems associated with these features are groundwater dependant ecosystems (GDE's).

In addition to those GDEs shown in NAoDGES, there is the potential the potential for groundwater discharge to a surface drainage line located to north-west of Pit 23 (the North-West Drainage Line) (CDM Smith Nov 2014). Any ecosystem associated with this drainage line may therefore be groundwater dependent and thus included as a potential receptor.

7.4 Standards

The Groundwater SEPP divides groundwater in Victoria into "segments" according to salinity, as measured by the concentration of total dissolved solids (TDS). The segments as, defined in the Groundwater SEPP, are shown in Table 4.

Table 4: Groundwater segments as defined in the Groundwater SEPP

Segment	A1	A2	B	C	D
TDS range (mg/L)	0-500	501-1000	1001-3500	3501-13000	>13000

The results of the analysis of groundwater samples collected in late 2015/early 2016 have been used to construct the plan in Figure 12 that shows the salinity of groundwater in and around the Douglas mine site.

It can be seen from Figure 12 that:

- the groundwater immediately below Pit 23 and within a distance of approximately 400 m falls in to Segment C;
- there are zones containing groundwater that falls within Segments A2 and B to south-west of Pit 23 but in all other directions the groundwater falls in either Segment C or Segment D

The groundwater potentially impacted can be considered to fall within Segment C.

The Groundwater SEPP also defines the beneficial uses that must be protected for each segment and for Segment C those beneficial uses are:

- maintenance of ecosystems;
- stock watering;
- industrial water use;
- primary contact recreation (e.g. bathing, swimming); and
- buildings and structures.

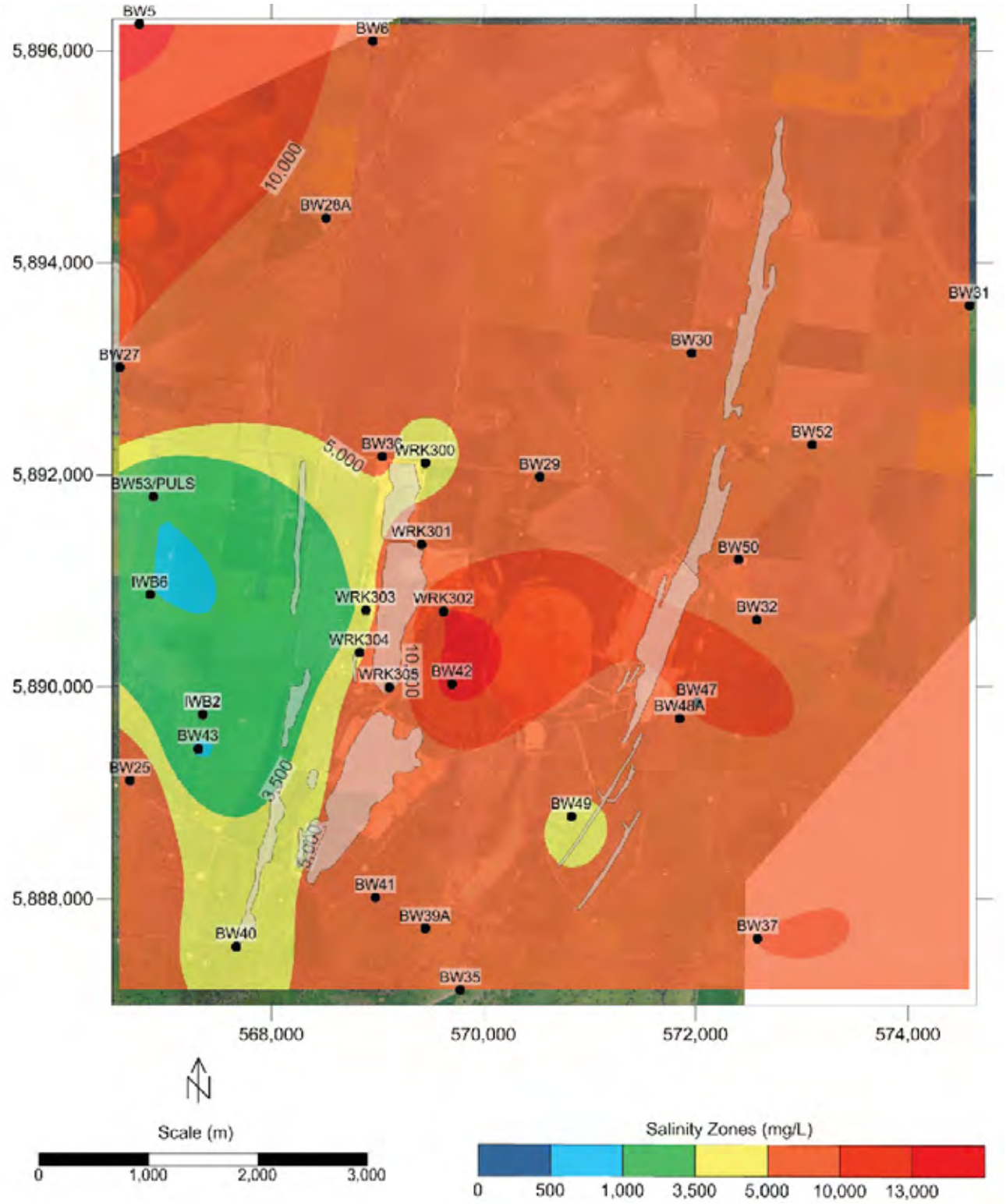


Figure 12: Groundwater salinity at the end of 2015

The Groundwater SEPP specifies water quality indicators and objectives for each indicator that need to be met in order to protect the specified beneficial uses.

No indicators or objectives identified or set for industrial water use or buildings and structures.

As noted by the Victorian Civil and Administrative Tribunal (VCAT), at paragraph 153 of [2017] VCAT 107, the limited exposure pathways for people to conduct recreational activities means that the risk to impact on the beneficial use of primary contact recreation is very limited and at paragraph 152, the only substantive groundwater beneficial uses in the region are the interaction of surface water ecosystems and stock water use.

While groundwater/surface water interactions have been identified the potential for impacts are considered in the Surface Water Monitoring and Management Plan detailed in Section 8 of this document.

The indicators and objectives relevant to this GWMMP are those for the protection of stock watering, which are shown in Table 5.

Table 5: Groundwater SEPP indicators and objectives

Indicator		Objective
General		
Total Dissolved Solids	mg/L	10000[a]
Anions		
Aluminium	mg/L	5
Arsenic	mg/L	0.5
Boron	mg/L	5
Calcium	mg/L	1000
Cadmium	mg/L	0.01
Chromium	mg/L	1
Cobalt	mg/L	1
Copper	mg/L	0.4
Lead	mg/L	0.1
Mercury	mg/L	0.002
Molybdenum	mg/L	0.15
Nickel	mg/L	1
Selenium	mg/L	0.02
Uranium	mg/L	0.2
Zinc	mg/L	20
Cations		
Fluoride	mg/L	2
Nitrate-N	mg/L	1722[b]
Nitrite-N	mg/L	98.7[c]
Sulphate	mg/L	1000
Radionuclides		
Radium 226	Bq/L	5
Radium 228	Bq/L	2
Uranium 238	Bq/L	0.2

a. The Water Guidelines recommended concentration for no production loss from sheep
b. Equivalent to nitrate concentration of 400 mg/L
c. Equivalent to a nitrite concentration of 30 mg/L

In addition to the requirement to protect the beneficial uses of the groundwater by maintaining the quality specified, access to groundwater in terms of volume available and the pumping requirement as result of depth, needs to be maintained

7.5 Impact assessments

Groundwater impact assessments completed in support of the applications for a planning permit and works approval have included:

- Development, calibration and use of a hydrogeological model to enable prediction of groundwater levels and flow paths in the future (CDM Smith Nov 2014);
- Use of the hydrogeological model to investigate seepage from tailings disposal locations detailed in *Douglas Mine – Particle Tracking of Seepage Water, CDM Smith 18 February 2016* (CDM Smith Feb 2015)
- A review of baseline groundwater chemistry; (Jacobs Feb 2016);
- Development and use of an in-pit dissolution model to provide a prediction of the quality of leachate from Pit 23 detailed in Appendix F to *Response to Notice to Supply Further Information Hydrogeological and Groundwater Related Matters, 25 February 2016* (Iluka Feb 2016);
- Solute transport modelling detailed in Appendix D to *Proposed Disposal of By-products to Pit 23 at the Douglas Mine Site – Groundwater Risk Assessment, Jacobs December 2014* (Jacobs Dec 2014)
- Solute transport modelling detailed in Appendix G to Iluka Feb 2016 (Jacobs 24 Feb 2016)

The results of this work are summarised below.

7.5.1 Hydrogeological modelling

CDM Smith, in CDM Smith Nov 2014, describe the development and calibration of a numerical model of the Douglas mine site and surrounds and the use of that model to predict changes in groundwater levels under two scenarios, one in which disposal to Pit 23 is discontinued and rehabilitation works are completed, the other in which disposal to Pit 23 continues for a further 20 years after which rehabilitation works are completed. By comparison of the predictions under the two scenarios the impact of continuing disposal has been determined.

The results of this work are as follows:

- it is predicted that groundwater levels under Pit 23 will be up 1.3 m higher due to the enhanced recharge rate over the 20 year additional disposal period;
- the difference in groundwater levels is predicted to become negligible within a period of 48 years after the completion of disposal;
- the predicted changes in groundwater levels are not predicted to result in any change in the groundwater flow paths from Pit 23, i.e. the flow paths will remain to the north-west toward McGlashin Swamp with the possibility of groundwater discharge in that swamp and the North-West Drainage Line;
- groundwater flow paths would not be affected by a greater than predicted mounding under Pit 23 with a the sensitivity analysis showing that, with a doubling of expected recharge rates, mounding would be increased to 1.5 metres and a change in flow paths would require an increase in mounding of 3 metres. The robustness of the flow path predictions was confirmed by further work completed by CDM Smith the results of which were contained in a letter report of 20 October 2015 (CDM Smith Oct. 2015), which was provided to the Responsible Authority in Appendix D to the further information provided on 19 November 2015; CDM Smith concluded from this work that:

  > "The information currently available, including consideration of alternative hydrogeological conditions, and detailed hydrogeological modelling undertaken to date indicate that the potential for seepage water from Pit 23 to flow to the Glenelg River (or any other locations other than those already identified) is negligible." (CDM Smith 2015, page 3)

- the predicted minimum travel time for a water particle from Pit 23 to the nearest discharge point, the North-West Drainage Line, will be reduced from 215 to 190 years as a result of the higher groundwater level at Pit 23.; and
- consideration of the potential impact of uncertainty in the inputs to the model shows that while there is considerable uncertainty in predicted water particle travel times, no such uncertainty exists in predicted changes in water levels or groundwater flow paths from Pit 23.

CDM Smith, in CDM Smith Feb 2015, identified monitoring bores BW36 and WRK300 and McGlashin Swamp as locations in the predicted groundwater flow path from Pit 23 and give best case predictions of the year in which water particles from Pit 23 will reach those locations as 2080, 22195 and 2160 respectively. More conservative cases were also considered with the predicted years in which water particles from Pit 23 will reach these locations being 2020, 2035 and 2140 respectively.

7.5.2 Baseline groundwater chemistry

As discussed previously, the review of baseline water chemistry (Jacobs Feb 2016) resulted in the conclusions that the quality of groundwater at monitoring bores located on the vicinity of Pit 23 has not been affected by past activities, including MSP by-product disposal. This is as predicted by the hydrogeological model, i.e. no impact predicted or observed.

7.5.3 In-pit dissolution modelling

The purpose of the in-pit dissolution modelling, detailed in Iluka Feb 2016, was to provide input to the solute transport modelling and the results obtained are shown in Table 6.

Table 6: Predicted quality of leachate from Pit 23

TDS in leachate when above background	13300 mg/L
Average activity concentration in first 100 years	
Thorium 232	2 Bq/L
Radium-228	97 Bq/L
Uranium-238	15.5 Bq/L
Radium-226	55 Bq/L

It should be noted that:

- These results do not indicate:
  - the resultant groundwater quality as this must be assessed on the basis of the results of solute transport modelling; or
  - the risk of exposure to radiation as there is no exposure pathway from the water at the base of Pit 23; and
- While these results are best available estimates, the model has not been subject to calibration as there is no monitoring data directly indicating leachate quality; and
- sensitivity analysis shows the results to be conservative (over-estimates);

7.5.4 Solute transport modelling

Analytical modelling was undertaken by Jacobs (Jacobs Dec 2014) to assess the likely contaminant concentrations that might occur in groundwater plumes as they migrate away from Pit 23. Groundwater flow rates, aquifer properties and the potential plume dimensions at Pit 23 were obtained from the hydrogeological model discussed in 6.5.1 above and solute transport modelling was used to evaluate the impacts of dilution and dispersion on contaminant concentrations as they migrate away from Pit 23. The effects of retardation and degradation were not included in the analysis.

The results predict that significant decreases in concentrations will occur within 500 m of Pit 23

due to dilution as the leachate as it mixes with water in the aquifer. It is predicted that at steady state conditions (after more than 1000 years) a contaminant originating from Pit 23 would have a concentration at the nearest point of groundwater discharge (the North-West Drainage Line) equal to approximately 0.018 times its concentration at Pit 23.

Jacobs concluded that plume development and migration towards McGlashin Swamp is highly unlikely to lead to unwanted water quality outcomes in the future.

Additional solute transport modelling was also conducted by Jacobs (Jacobs 24 Feb 2016). This modelling was based on the prediction of leachate quality obtained from the dissolution modelling discussed above and included the effects of dilution, dispersion, retardation (absorption) and radioactive decay.

The results obtained predict:

- that, of the radionuclides considered (Ra-226, Ra-228, U-238 and Th-232):
    - Only U-238 and Ra-226 will migrate away from the pit and that such migration is restricted to a distance of 10 m, with the activity concentrations at locations beyond 0.1 m from Pit 23 being below the Groundwater SEPP objectives (U-238 0.2 Bq/L, Ra-226 5 Bq/L); and
    - only U-238 will reach White Lake. This will occur after more than 500,000 years and the activity concentration of U-238 at that time will be less than 0.001 Bq/L;
- increases in TDS concentration of up to 1500 mg/L in a region up to 1 km from the Pit 23 resulting in minimal impact on the potential beneficial use of the groundwater; and
- no impact on the TDS concentration in water discharging to White Lake.

It is noted that, while the model provides best available estimates, it has not been subject to calibration due to non-availability of monitoring data that shows actual impact of seepage from Pit 23 on groundwater quality.

7.5.5 Groundwater risk assessment

Jacobs completed a detailed groundwater risk assessment and reported the results of that assessment in Jacobs Dec 2014. The assessment was based on:

- the results of the hydrogeological modelling completed by CDM Smith;
- the results of laboratory leach testing on MSP by-products; and
- the initial solute transport modelling.

The risk assessment utilised relevant components of the risk assessment framework documented in Victorian EPA's *Guidelines for Risk Assessment of Wastewater Discharges to Waterways, 2009* and identified the key potential impacts as changes to groundwater levels and groundwater quality that have the potential to impact on groundwater users and groundwater dependent ecosystems.

Jacobs concluded that:

> "Overall the consequence of the potential impacts is considered to be low because the environmental impacts are described as:
>
> - negligible to minor, short-term stress on groundwater environment with rapid recovery;
> - no change in aquifer yield or quality;
> - groundwater beneficial uses remain protected;
> - impacts within the range of natural variability; and
> - inter-connected systems, including adjacent and overlying aquifers, hydraulically connected surface water systems and groundwater dependent ecosystems are unaffected

> Overall the likelihood of the potential impacts is considered to be unlikely in consideration of the modelling results and the groundwater sampling and testing undertaken to date.
>
> Overall the risk of the proposed continued disposal of MSP by-products in Pit 23 at Douglas Mine is low." (Jacobs Dec 14)

All of the reports on impact and risk assessment discussed above were subject to review by an independent expert, commissioned jointly by the Responsible Authority and the EPA, and assessment by the EPA. The EPA published its findings in *Decision on proposed waste by-product disposal at Douglas Mine Pit 23* (EPA Publication 1626) including the following:

> "EPA has not found any evidence to show that a condition of pollution or environmental hazard has arisen or is likely to arise from Iluka's proposal." (EPA Publication 1626, Page 1); and
>
> "The independent desktop reviewer concluded that there is low to no likelihood of an environmental hazard occurring in groundwater due to the waste by-product in Pit 23" (EPA Publication 1626, Page 3); and
>
> while acknowledging a predicted increase in groundwater salinity;
>
> "this increase in salinity is unlikely to affect the beneficial uses of groundwater as the salinity would still remain within the limits of Segment C. As such, this is not considered pollution." (EPA Publication 1626, Page 3)

It is evident from the results of the impact assessments and the risk assessment described above that there is little or no risk to the groundwater, providing the predictions obtained from the hydrogeological modelling are confirmed by monitoring.

7.6 Groundwater monitoring

While no significant adverse impacts on groundwater availability or quality are predicted or expected, this prediction must be confirmed by monitoring. The predictions are based on the following:

- the groundwater contours that define the flow path(s) from Pit 23;
- predicted changes in groundwater levels that are most highly dependent on:
    - the assumed recharge rate in the area of the pit; and
    - the assumed values for hydraulic conductivity and porosity of the LPS; and
- predictions of the dissolution and transport of potential contaminants, which are highly sensitive to:
    - leachability of potential contaminants; and
    - assumed partition coefficients.

The uncertainties that exists in the predictions are due to either a lack of data or the fact that model calibration against actual results is not possible because no detectable impact has occurred to date.

The monitoring program below is aimed at reducing or eliminating uncertainty in the model predictions while enabling assessment of impacts, if any occur. On-going development and improvement in the models will enable accurate prediction of future impacts thus enabling appropriate actions to be taken should any such actions be required.

7.6.1 Monitoring bore network

The monitoring bore network at the Douglas Mine site consists of over 50 individual monitoring bores, all of which have been sampled at some point in time. The majority of bores are screened across the LPS, however, some are screened across both the LPS and basement lithology.

During the December 2015-January 2016 groundwater sampling round, samples were able to be

obtained from 36 of these monitoring bores. The locations of many of these bores are such that the water quality at those locations is not required in order to monitor potential impacts of the development and use.

A comprehensive audit and assessment of the monitoring bore network was completed in October 2015. The adequacy of the network for the monitoring of potential impacts of disposal and confirmation of model predictions was considered by CDM Smith and Jacobs Australia with the following results and recommendations:

- the existing network is adequate and the bores that should be monitored include BW36, WRK300, and WRK301 to provide early detection of changes in groundwater levels and BW29, BW45, WRK302 and WRK303 to verify the predicted groundwater level changes (CDM Smith Nov 2014);
- two additional bores are required in the predicted flow path from Pit 23, one close to the Pit and one approximately 120 metres from the pit. Monthly monitoring of groundwater levels and sample collection, and analysis of a full suite of analytes annually (Jacobs Dec 2014); and
- the review of the groundwater chemistry baseline (Jacobs Feb 2016) identified the following:
    - Bores at which the water quality represents background – BW53, IWB2 and IWB6
    - Bores located on the predicted flow path from Pit 23 – WRK300, BW36, BW28A, BW5

In addition, Environmental Earth Sciences completed an independent desktop review of groundwater matters and recommended that “additional groundwater monitoring bores are required down, cross and up gradient of Pit 23” (the EES April 2016 review, page 39).

Environmental Earth Sciences also recommended additional monitoring points on the surface at locations of suspected groundwater discharge. These recommendations have been accepted and implemented as part of the Surface Water Monitoring and Management Plan detailed in Section 8.

It is noted that the Permit Condition 24 requires that the groundwater monitoring network include additional bores recommended by Environmental Earth Sciences as illustrated in Figure 6 of the EES April 2016 review, page 32. Examination of the figure referred to and its context in the report shows the following:

- the base plan, including the locations of existing and proposed bores and proposed stream monitoring locations, was obtained from a report by Sinclair Knight Merz (SKM) *Bondi West Hydrogeological Investigation, 19th March 2004*;
- the stated purpose of Figure 6 in the EES April 2016 review is “to show the approximate locations of springs in the vicinity of Pit 23” (the EES April 2016 review, page 31);
- there is no recommendation in the EES April 2016 review for the additional monitoring bores proposed by SKM to be included in the monitoring network.

It is therefore apparent that there is no need for additional bores as illustrated in Figure 6 of the EES April 2016 review.

The groundwater monitoring bore network and works, based on the above recommendations, is shown in Table 7 and Figure 13.

7.6.2 Monitoring bore network audits

Regular bore inspections will be conducted. Features that will be reviewed as part of such monitoring network audits include, but are not limited to:

- surface condition and surroundings, captured by notes at monthly and quarterly inspections and photographs if the condition of the bore has changed significantly;
- inspection of surface casing and monument condition to minimise surface water ingress;

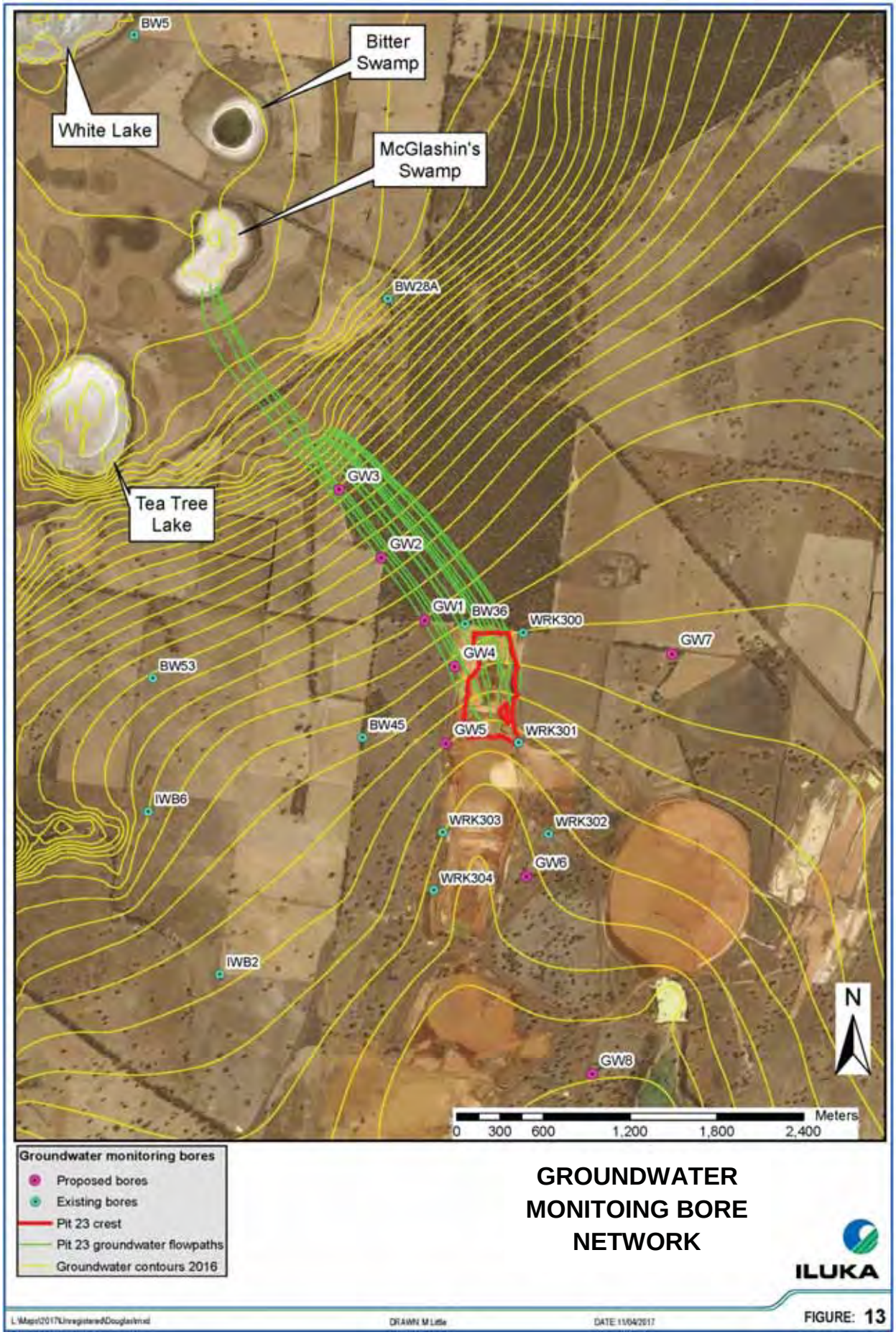
- status of bore cap;
- field quality measurements; and
- any further comments or actions that should be considered.

Monitoring network audits will be completed monthly or six monthly to coincide with level measurements and reported on an annual basis. Audits coinciding with level measurements will be conducted by field technicians responsible for level measurements and/or sampling. Additional audits may be conducted by Iluka personnel. Any required work identified will be managed and supervised by a qualified hydrogeologist.

Audit results will be compiled within two weeks of audits with recommended corrective actions addressed prior to the due date of the next audit. A summary of audit results and corrective actions will be complied and reported annually.

Table 7: Pit 23 monitoring bore network

Well ID	Location, distance from		Location	Comment	Status/required works as per 2015 monitoring well audit	Monitoring requirement		
	Pit centroid	Pit crest	Bearing			Water level	Water quality	
	(m)	(m)	Degrees				Field	Laboratory
WRK300	430	102	30	In predicted flow path	OK	Monthly	Monthly	6 monthly
WRK301	440	65	155	Up-gradient of Pit 23	OK	Monthly	Monthly	6 monthly
WRK302	1100	729	160	Up-gradient of Pit 23	OK	Monthly	Monthly	6 monthly
WRK303	1080	692	200	Up-gradient from Pit 23	OK	Monthly	Monthly	6 monthly
WRK304	1103	1459	196	Up-gradient from Pit 23	OK	Monthly	Monthly	6 monthly
GW1	570	270	280	In predicted flow path	To be constructed	Monthly	Monthly	6 monthly
GW2	490	160	320	In predicted flow path	To be constructed	Monthly	Monthly	6 monthly
GW3	290	139	230	In predicted flow path	To be constructed	Monthly	Monthly	6 monthly
GW4	1170	830	310	In predicted flow path	To be constructed	Monthly	Monthly	6 monthly
GW5	520	138	217	Up-gradient of Pit 23	To be constructed	Monthly	Monthly	6 monthly
GW6	1334	989	169	Up-gradient of Pit 23	To be constructed	Monthly	Monthly	6 monthly
GW7	1312	1172	79	Cross-gradient (east) of Pit 23	To be constructed (replace BW29)	Monthly	Monthly	6 monthly
GW8	2754	2414	166	Up-gradient of Pit 23	To be constructed	Monthly	Monthly	6 monthly
BW5	5150	4780	330	In predicted flow path	OK	6 monthly	6 monthly	6 monthly
BW28A	2780	2406	345	In predicted flow path	Upgrade surface monument	6 monthly	6 monthly	6 monthly
BW36	470	104	340	In predicted flow path	Upgrade surface monument	Monthly	Monthly	6 monthly
BW45	1150	857	240	Cross-gradient (west) of Pit 23	Redrill or replacement required	Monthly	Monthly	6 monthly
BW53	2350	2190	270	Representative of background	OK	6 monthly	6 monthly	6 monthly
IWB2	2546	2346	229	Representative of background	OK	6 monthly	6 monthly	6 monthly
IWB6	2466	2316	256	Representative of background	OK	6 monthly	6 monthly	6 monthly


BW5
Bitter Swamp
White Lake
McGlashin's Swamp
BW28A
GW3
Tea Tree Lake
GW2
GW1
BW36
WRK300
GW7
GW4
BW53
BW45
GW5
WRK301
IWB6
WRK303
WRK302
GW6
WRK304
IWB2
GW8
N
0 300 600 1,200 1,800 2,400 Meters
Groundwater monitoring bores
Proposed bores
Existing bores
Pit 23 crest
Pit 23 groundwater flowpaths
Groundwater contours 2016
GROUNDWATER MONITOING BORE NETWORK
ILUKA
DRAWN: M Little
DATE: 11/04/2017
FIGURE: 13

7.6.3 Monitoring bore installation

As shown in Table 7, this plan include the installation of a number of new bores. Furthermore new bore installation may also be required in the future in order to replace ageing infrastructure or reduce groundwater data gaps.

The installation of all new monitoring bores will be supervised and managed by a qualified hydrogeologist. The drilling and bore construction methods used will be as detailed in the *Minimum Construction Guidelines for Water Bores in Australia*, with a discreet screen interval of no greater than 3 m used. All new bores will require a license from GWMWater. Data collected during installation will include but not be limited to:

- borehole diameter and depth;
- annular fill and well construction materials used;
- lithological descriptions and screened aquifer information; and
- bore development technique and duration, including permeability assessment via slug-testing conducted post-development.

Furthermore, composite samples of aquifer material (adjacent to the screened section of the bore) will be collected, and, if considered necessary in order to validate or enhance the model, submitted for laboratory determination of partition (distribution) coefficients (Kd) and other sorption properties of radionuclides and potential contaminant ions.

All new monitoring bores will be located away from areas prone to surface water inundation and where active works are being conducted. Furthermore, monitoring bores will each be equipped with:

- vented well caps;
- robust and lockable, painted steel monuments;
- concrete plinths, with a beveled water-shedding surface; and
- 2 m high, painted steel marker posts.

7.6.4 Monitoring bore decommissioning

Blocked, collapsed, or bores otherwise excluded from the groundwater monitoring network, will be decommissioned to reinstate the aquifers' hydraulic isolation that existed prior to drilling and construction.

Decommissioning of bores will require a license from GWMWater and the decommissioning procedure will be as detailed in the *Minimum Construction Guidelines for Water Bores in Australia*, with a 5% bentonite-cement grout and inert sand used for sealing and backfill respectively.

7.6.5 Groundwater level monitoring

A calibrated groundwater level measuring tape with probe affixed to the end is slowly lowered into the bore. An audible sound from the probe indicates the presence of water (buzzer, whistle or plop). Once the presence of the water surface has been confirmed, the tape is gently raised and lowered to substantiate the exact level of the water surface.

The tape is held at this point and the value that aligns with the marked reference point at the top of the bore casing is read and recorded.

7.6.6 Groundwater sampling

Groundwater samples will be collected using methods in accordance with the following EPA guidelines:

- EPA Publication 669: *Groundwater sampling guidelines, 7th edition, March 2000*
- EPA Publication 441: *A guide to the sampling and analysis of waters, wastewaters, soils*

and wastes, 7th edition, April 2000

7.6.7 Groundwater quality analysis

7.6.7.1 Field parameters

The following field parameters will be measured using a calibrated water quality meter (with calibration records to be kept and reported):

- pH
- Electrical conductivity (EC);
- Oxidation reduction potential (ORP);
- Dissolved oxygen (DO)
- Temperature.

7.6.7.2 Laboratory analysis

Groundwater samples will be supplied under chain of custody documentation to a NATA accredited analytical laboratory for analysis as detailed in Table 8. With the exception noted below, the analytical suite is that recommended by Environmental Earth Science in the EES April 2016 review plus a number of additional water quality indicators specified in the Groundwater SEPP. The exception is gross alpha and gross beta activity concentrations which have been replaced by activity concentrations of the radionuclides of interest.

It is clear from the Water Quality Guidelines (Section 9.2.8.3) that trigger levels are set for gross alpha and beta activity concentrations to provide a screening technique that provides an indication the presence of specific radionuclides, such as radium-226 and radium-228, to determine if the activity concentrations of such radionuclides should be determined. It is also noted that:

- analyses for gross alpha and beta provide an “order of magnitude estimate” an lack the precision of activity concentration determinations for specific radionuclides; and
- radium-226 and radium-228 are the specific radionuclides of interest in this case as they are decay progeny of uranium-238 and thorium-232 and the human body metabolises radium in much the same way as calcium, resulting in accumulation in bones.

In this case the activity concentrations of radium-226 and radium-228 will be determined therefore gross alpha and beta activity concentrations are not required.

7.6.8 Quality control and quality assurance

Quality assurance/quality control (QA/QC) measures are activities undertaken to demonstrate the accuracy and precision of the groundwater monitoring program. Quality Control (QC) consists of the steps that will be taken to determine the validity of specific sampling and analytical procedures. Quality Assurance (QA) broadly refers to the plan for maintaining quality in all aspects of the GWMMP. The reliability of and confidence in the data collected as part of this GWMMP will be determined by implementing the following quality controls:

- Routine and regular equipment maintenance, checks and calibrations;
- Internal data validation;
- External data validation;

All QA/QC results will be considered to enable assessment of the overall adequacy and reliability of each parameter to meet the monitoring program objectives.

The following sub-sections outline the QA/QC plan associated with groundwater monitoring.

Table 8: Groundwater laboratory analyte suite

	Units	Limit of Reporting	Method Reference*
General			
pH	Units	0.01	APHA 4500 H^+B
Electrical Conductivity	µS/cm	1	APHA 2510 B
Total Dissolved Solids	mg/L	10	Calculated
Alkalinity			
Bicarbonate Alkalinity as CaCO3	mg/L	1	APHA 2320 B
Carbonate Alkalinity as CaCO3	mg/L	1	
Hydroxide Alkalinity as CaCO3	mg/L	1	
Total Alkalinity	mg/L	1	
Major Ions			
Calcium	mg/L	1	APHA 3120 and 3125
Magnesium	mg/L	1	
Sodium	mg/L	1	
Potassium	mg/L	1	
Sulphate	mg/L	1	APHA 4500-SO_4
Chloride	mg/L	1	APHA 4500-Cl^- G
Fluoride	mg/L	0.1	APHA 4500-F C
Total anions	meq/L	0.01	Calculated
Total cations	meq/L	0.01	
Charge Balance Error	%	0.01	
Metals and Metalloids			
Aluminium	mg/L	0.01	APHA 3125
Arsenic	mg/L	0.001	
Barium	mg/L	0.001	
Boron	mg/L	0.05	
Cadmium	mg/L	0.0001	
Cobalt	mg/L	0.001	
Chromium	mg/L	0.001	
Copper	mg/L	0.001	
Iron	mg/L	0.05	
Manganese	mg/L	0.001	
Mercury	mg/L	0.0001	APHA 4500 3112 Hg B
Molybdenum	mg/L	0.001	APHA 3125
Nickel	mg/L	0.001	
Lead	mg/L	0.001	
Silver	mg/L	0.001	
Thorium	mg/L	0.001	
Uranium	mg/L	0.001	
Zinc	mg/L	0.005	
Anions			
Nitrite as N	mg/L	0.01	APHA 4500 NO_2 B
Nitrate as N	mg/L	0.01	APHA 4500 NO_3 F
Total ammonia as N	mg/L	0.01	APHA 4500-NH_3 G
Reactive phosphorous	mg/L	0.01	APHA 4500-P H
Radionuclides			
Radium-226	Bq/L	0.05	-
Radium-228	Bq/L	0.08	-
Uranium-238	Bq/L	<0.025	-

* Laboratory method indicative only. May be modified upon selection of external laboratory

7.6.8.1 Equipment maintenance, checks and calibrations

Field meters used to measure water levels, pH, EC, ORP etc. at all monitoring bores will be calibrated on each day of use prior to measurements being made.

The calibrations will be carried out using standards and buffers that reflect the likely range of measurement.

The requirement for recalibration during a monitoring event will be assessed based on any observed measurement drift, measurement error, equipment malfunction, or discrepancy with previously collected field data. At a minimum, each sensor will be calibrated according to the guidance provided by the instrument manufacturer. When not in use, equipment will be stored and maintained according to the manufacturer's guidance.

All calibrations will be recorded in an electronic calibration log, either within the database described in Section 7.8 or accessible from that database, that will include the instrument serial number and the measured parameter before and after calibration. This log will allow detection of possible instrument issues over time, and serve as a reference to increase data confidence should future validation be required.

All equipment will be cleaned routinely as part of calibration, and maintained according to the manufacturer's specifications or more frequently as required.

7.6.8.2 Internal data validation

Internal data validation measures will be performed and will include the following:

a) *field blanks*: at a minimum, one field blank will be collected per batch of groundwater samples analysed.
b) *field duplicates*: at a minimum, one duplicate sample will be collected and analysed for selected parameters per batch of groundwater samples or per 20 samples. In addition, a minimum of two duplicate samples will be collected and analysed by a different external laboratory.
c) *spike samples*: will be used for investigative purposes, as required. The concentration of the standard used and amount of standard addition will be determined based on the parameter and/or test method in question;
d) *duplicate level measurements*: at a minimum one level measurement will be duplicated for every 5 measurements made; and
e) *duplicate field parameter measurements*: at a minimum one set of field parameter measurements will be duplicated for every 5 sets of measurements made.

7.6.8.3 External data validation

External checks will be performed by non-Iluka personnel such as an external monitoring contractor and/or analytical laboratory. Iluka will select one or more laboratories that are accredited by the Australian National Association of Testing Authorities (NATA). As such, each laboratory selected operates according to the guidelines set out in ISO/IEC 17025 - "General requirements for the competence of calibration and testing laboratories". Iluka will review the external laboratory QA/QC program as part of the laboratory procurement process.

External laboratories will provide a QA/QC report with each batch of samples given. To avoid data entry errors, the laboratory will provide all data and reports electronically.

Inter- and intra-laboratory testing may be conducted, if required.

7.7 Groundwater protection under the *Radiation Act 2005*

The Radiation Management Plan and Radioactive Waste Management Plan, required by the Radiation Management Licence issued under the *Radiation Act 2005,* both include assessments of background radiation levels in groundwater and doses from radiation exposure pathways including

groundwater. It is concluded from these assessments that there is no significant exposure pathway through the groundwater. As a consequence there are no measures for protection of groundwater included in the RMP or RWMP, other than monitoring of groundwater for radionuclides which is also included in this GWMMP.

7.8 Data Management

All groundwater monitoring data collected, including calibration and quality control and assurance data, will be stored and/or managed using Monitor Pro 5 (MP5). All MP5 data will sit within the Murray Basin server located at: Iluka Resources, Level 23 140 St Georges Terrace, Perth WA. MP5 will be configured to automatically compare imported data to pre-defined filters and export automatically-generated report for review by Iluka personnel.

7.9 Management response

While no adverse impact on groundwater is expected, this expectation is based on the results of predictions from the hydrogeological and solute transport models. The current model predictions can be seen as best available estimates, however, they need to be confirmed by monitoring results and, if such confirmation is not obtained, the models need to reviewed and recalibrated so as to provide predictions of improved accuracy.

In the event that monitoring results, or improved model predictions show that adverse impacts that have or will affect the prescribed beneficial uses of the groundwater then management actions are required to remediate or prevent such impacts.

The following describes how the monitoring results will be used to determine if management actions are required and the management actions that may be necessary.

7.9.1 Groundwater levels

At monthly intervals, groundwater level measurements will be made at bores WRK300 – WRK304 inclusive, GW1 to GW7 inclusive, GW9, BW36 and BW45, the groundwater levels at which are required to define the groundwater contours in the vicinity of Pit 23. The data obtained will be:

- Used, by Iluka personnel, to construct groundwater contours in the area of Pit 23 and surrounds and the indicated flow paths from Pit 23 determined; and
- compared with the groundwater levels and flow paths predicted by the hydrogeological model .

If the results obtained show that groundwater flow from Pit 23 is in any direction other than that expected or the variance of the actual water levels from those predicted is such that a change in groundwater flow path could occur then the hydrogeological model will be re-assessed and, if necessary, re-calibrated using the newly available data and re-run.

If the predictions from the revised model include a flow from Pit 23 to a sensitive receptor other than those already identified then a detailed impact assessment will be completed including the development of an action plan to prevent any unacceptable impacts. The action plan developed will be proposed as an amendment to this GWMMP and, once approved by the Responsible Authority, implemented.

The results of groundwater level measurements that will be made at six-monthly intervals will be used in the same way as described above although the assessment will cover a larger area.

7.9.2 Groundwater quality

In CDM Smith Nov 2014 it was noted that groundwater quality varies with both location and time due to natural variation. It is therefore important that changes in groundwater quality that are observed are attributable to seepage from Pit 23 and not the result of natural variation. While detection of changes in concentrations of potential contaminants is extremely difficult due to the small changes that can be expected, the character of leachate from Pit 23 is distinctly different to that of the groundwater. As discussed previously the groundwater is dominated by the Na-Cl ion

pair while the results of laboratory leach tests on MSP by-products (Iluka Feb 2016) show that leachate will be dominated by the Ca-SO_4 ion pair.

Table 9 shows the ratios of chloride:sulphate and sodium:calcium in the groundwater in the vicinity of Pit 23 (average of all results from bores located with 2 km of Pit 23) and the leachate.

Table 9 - Ionic ratios in groundwater and Pit 23 leachate

	Groundwater within 2 Km of Pit 23			Leachate	
				Laboratory	Model
	Average	Maximum	Minimum		
Chloride/Sulphate	5.21	6.80	3.33	0.008	0.015
Sodium/Calcium	10.15	18.04	5.29	0.017	0.050

The reason for the difference between the laboratory leachate and the modelled leachate is that the latter makes allowance for the limited solubility of gypsum. In either case the ratios are distinctly different to those in the groundwater.

At six monthly intervals, samples will be collected from all bores listed in Table 7 and the samples subjected detailed analysis including the analytical suite detailed in Table 8. This will enable:

- Calculation of the chloride:sulphate and sodium:calcium ratios at each of the bore locations; and
- Comparison of ratios with those obtained in the previous sampling round with a reduction in either of the ratios by 10% being taken as an indication that seepage from Pit 23 has reached the bore location.

To avoid the influence of sampling and analytical errors an indication that seepage from Pit 23 has reached a particular bore location the bore sampling and analysis of the sample will be repeated within one month of the collection of the first sample.

If there is no confirmed indication that seepage from Pit 23 has reached the bore location no action will be required or taken.

If the indication of the arrival of seepage from Pit 23 is confirmed, the following will occur.

- the timing of seepage from Pit 23 reaching the bore location will be compared with that predicted by the hydrogeological model and if there is variance of more than 10% the model will be recalibrated and the impact assessment re-examined;
- the full suite of analysis will be compared with trigger values, defined as follows:
    - Precautionary trigger value, set at 85% of the Groundwater SEPP objective or 85% of the background value, as defined below, whichever is the greater; and
    - Upper trigger value, set at the Groundwater SEPP objective or the background value, as defined below, whichever is the greater.
- If the average of the two results is greater than the precautionary trigger value, the following will occur:
    - Investigations to determine the cause of the indicated impact;
    - Increasing monitoring frequency in order to assess trends and understand processes occurring;
    - Possible analytical and/or numerical modelling to help determine cause of impact.
- If the average of the two results is greater than the upper trigger value an exception report as described as described in Section 12 of this document will be prepared and submitted. The exception report will include a plan for remediation/prevention that may include any or all of the following;
    - further investigation of the cause, if not adequately understood;
    - detailed impact assessment based on recalibrated models;
    - development and implementation of strategies to prevent future unacceptable results or to mitigate any impacts, potentially including groundwater abstraction immediately adjacent and down-gradient of Pit 23; and

- reducing or ceasing the disposal to Pit 23 until observations are stabilised and/or at acceptable levels.

The Groundwater SEPP specifies groundwater quality objectives but also states that these objectives will not apply if the background values are greater than the objectives in which case the background values will be the objective.

Background levels are best defined by the results of multiple sampling and analysis that reflect natural variation. Given the mean and standard deviation of the multiple results, an observed result can be compared with the confidence interval around the mean value to determine if the result is from the same population, i.e. likely to be the result of natural variation. In order to utilise this method a reasonable number of results are required to provide estimates of the mean and standard deviation. In this case it is considered that a minimum of five results are required and the background value is defined as the average value plus two standard deviations. The relevant bores for which sufficient data on relevant indicators is available is limited to BW5, BW29, BW36, BW53, IWB2, IWB6 and WRK300-303 inclusive, for TDS, radium-226 and radium-228.

Table 10 summarises the relevant data.

Table 10: Background groundwater quality

	BW5	BW29	BW36	BW53	IWB2	IWB6	WRK300	WRK301	WRK302	WRK303
Total Dissolved Solids* (mg/L)										
Results	33	20	19	45	48	46	7	7	7	7
Average	16946	9848	9545	948	3814	1114	4268	7153	14954	4740
Standard Deviation	3426	3154	2612	241	468	128	259	170	256	730
Background	23797	16156	14768	1430	4751	1370	4786	7494	15466	6201
Precautionary Trigger	20227	13733	12553	1216	4038	1164	4068	6370	13146	5271
Upper Trigger	23797	16156	14768	1430	4751	1370	4786	7494	15466	6201
Radium-226 (Bq/L)										
Results	12	7	13	12	13	14	6	6	6	6
Average	0.028	1.1	0.27	0.012	0.023	0.019	0.051	0.081	0.10	0.034
Standard Deviation	0.028	0.91	0.149	0.009	0.005	0.013	0.024	0.044	0.050	0.008
Background	0.084	2.9	0.57	0.029	0.034	0.046	0.099	0.168	0.20	0.049
Precautionary Trigger	0.071	2.5	0.48	0.025	0.029	0.039	0.084	0.143	0.17	0.041
Upper Trigger	0.084	2.9	0.57	0.029	0.034	0.046	0.099	0.168	0.20	0.049
Radium-228 (Bq/L)										
Results	12	7	13	12	12	13	6	6	6	6
Average	0.10	0.66	0.64	0.10	0.10	0.15	0.11	0.14	0.71	0.06
Standard Deviation	0.048	0.60	0.39	0.048	0.088	0.12	0.045	0.086	0.131	0.028
Background	0.19	1.9	1.4	0.19	0.28	0.39	0.20	0.31	0.97	0.12
Precautionary Trigger	0.16	1.6	1.2	0.16	0.24	0.33	0.17	0.26	0.82	0.099
Upper Trigger	0.19	1.9	1.4	0.19	0.28	0.39	0.20	0.31	0.97	0.12

* Total Dissolved Solids = Electrical Conductivity x 0.715 *(See Jacobs Feb 2016)

As the monitoring program proceeds additional data will be obtained that will enable the application of this method to more bores and more quality indicators, however, in the interim background values will be based on the results of the analysis of samples collected in late 2015/early 2016 with the precautionary and upper trigger levels in circumstances where the background value is greater than Groundwater SEPP objective being 1.25 and 1.5 times the background value, respectively.

Table 11 shows the trigger levels determined for each bore.

It will be noted that the vast majority of the trigger levels are derived from the Groundwater SEPP objectives rather than measurements of the background quality. These trigger levels will be reviewed as additional backgrounds data becomes available.

Table: 11 Groundwater quality trigger levels

	BW5	BW28A	BW36	BW45	BW53	IWB 2&6	GW 1-6 & 9	GW7	WRK 300	WRK 301	WRK 302	WRK 303&304
Totals Dissolved Solids (mg/L)												
Precautionary trigger	20227	8500	12553	8500	8500	8500	8500	13733	8500	13146	8500	8500
Upper trigger	23797	10000	14768	10000	10000	10000	10000	16156	10000	15466	10000	10000
Aluminium (mg/L)												
Precautionary trigger	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Upper trigger	5	5	5	5	5	5	5	5	5	5	5	5
Arsenic (mg/L)												
Precautionary trigger	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Upper trigger	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Boron (mg/L)												
Precautionary trigger	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Upper trigger	5	5	5	5	5	5	5	5	5	5	5	5
Calcium (mg/L)												
Precautionary trigger	850	850	850	850	850	850	850	850	850	850	850	850
Upper trigger	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Cadmium (mg/L)												
Precautionary trigger	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085
Upper trigger	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Chromium (mg/L)												
Precautionary trigger	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Upper trigger	1	1	1	1	1	1	1	1	1	1	1	1
Cobalt (mg/L)												
Precautionary trigger	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Upper trigger	1	1	1	1	1	1	1	1	1	1	1	1
Copper (mg/L)												
Precautionary trigger	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
Upper trigger	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Lead (mg/L)												
Precautionary trigger	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085
Upper trigger	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Mercury (mg/L)												
Precautionary trigger	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017
Upper trigger	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Molybdenum (mg/L)												
Precautionary trigger	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Upper trigger	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Nickel (mg/L)												
Precautionary trigger	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Upper trigger	1	1	1	1	1	1	1	1	1	1	1	1
Selenium (mg/L)												
Precautionary trigger	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
Upper trigger	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Uranium (mg/L)												
Precautionary trigger	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Upper trigger	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Zinc (mg/L)												
Precautionary trigger	17	17	17	17	17	17	17	17	17	17	17	17
Upper trigger	20	20	20	20	20	20	20	20	20	20	20	20
Fluoride (mg/L)												
Precautionary trigger	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Upper trigger	2	2	2	2	2	2	2	2	2	2	2	2
Nitrate-N (mg/L)												
Precautionary trigger	1464	1464	1464	1464	1464	1464	1464	1464	1464	1464	1464	1464
Upper trigger	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722
Nitrite-N (mg/L)												
Precautionary trigger	84	84	84	84	84	84	84	84	84	84	84	84
Upper trigger	99	99	99	99	99	99	99	99	99	99	99	99
Sulphate (mg/L)												
Precautionary trigger	850	850	850	850	850	850	850	850	850	850	1788	850
Upper trigger	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	2145	1000
Radium 226 (Bq/L)												
Precautionary trigger	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Upper trigger	5	5	5	5	5	5	5	5	5	5	5	5
Radium 228 (Bq/L)												
Precautionary trigger	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Upper trigger	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Uranium 238 (Bq/L)												
Precautionary trigger	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Upper trigger	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Triggers derived from Groundwater SEPP

Triggers derived from recent analyses

Triggers derived from mean and standard deviation of historical data

7.10 Groundwater modelling

As discussed above, the use of hydrogeological and solute transport modelling will be an essential management tool utilised by this GWMMP. While models as they currently exist are capable of predicting changes in groundwater levels, groundwater flow paths and the fate of potential contaminants, thus enabling impact prediction, the collection of monitoring data will enable, at the least, validation of the models. If such validation is not provided then monitoring data will be able to be used to review and recalibrate the models thus providing models capable of predicting long term impacts with confidence.

As stated previously triggers for review of the hydrogeological model and recalibration of the model will include the following:

- results of groundwater level measurements indicating that groundwater flow paths from Pit 23 will be anything other than currently predicted; and
- detection of seepage from Pit 23 at a bore location where the observed arrival time shows a travel time of less than 90% of that predicted.

Review and recalibration of the model will also be considered when and if:

- slug tests performed provide better estimates of model parameters;
- monitoring data is obtained that provides direct evidence of a contaminant reaching a bore location is obtained thus enabling calibration of the solute transport model; and
- measurements of partition coefficients on any samples collected during new bore installation provided better estimates for use in solute transport model.

In addition, within two years of the commencement of the development and use, a suitably qualified expert will be commissioned to:

- conduct an audit of the modelling against the *Australian Groundwater Modelling Guidelines*;
- review all available data and, if considered necessary, complete a review and recalibration of the models;
- recommend the frequency of subsequent reviews

Whenever models are recalibrated the recalibrated model will be used to generate the data required for a detailed impact assessment. The results of such assessments will be used to determine if modifications to this plan are required to protect the beneficial uses of the groundwater.

7.11 Management, triggers, actions and contingency plans.

The management of groundwater, action triggers, management actions and contingency plans are summarised in Section A of Appendix B.

7.12 Reporting

Reporting on groundwater matters will be in accordance with Section 12 of this document and will include both exception and routine reporting.

7.13 Audit regime

Review and auditing will be as described in Section 13 of this document.

7.14 Plan review and amendment

Review and amendment if this plan will be as described in Section 14 of this document.

8 Surface water monitoring and management

8.1 Background

The Permit specifies the requirements of a SWMMP as follows:

Surface Water Monitoring and Management Plan

25 A *Surface Water Monitoring and Management Plan (SWMMP)* (component of the *EMP*) must be prepared to the satisfaction of the responsible authority.

26 The SWMMP must be prepared generally in accordance with the application and associated material addressing surface water management provided to the EPA and the Responsible Authority in response to the EPA's *section 22 notice* dated 11 February 2016, but modified or added to so as to include:

(a) Additional surface water monitoring points recommended by Environmental Earth Sciences in its report 'independent Desktop Review For The Continuation Of Mineral By-Products Disposal Into Pit 23 At Iluka's Douglas Mine Site, Northwest Victoria' No. 215071v2 dated April 2016 and submitted to the EPA;

(b) Agreement of the location and number of surface water monitoring points;

(c) Additional surface water monitoring points (at least during periods of flow) are to include the Northern Drainage Line and McGlashin Swamp, and locations shown on the EES independent review report, Figure 6, Page 32 and analytical suites to include full ionic balances;

(d) Monitoring of run off during periods of flow in the drainage lines as identified in the previous point;

(e) A survey for the occurrence of springs in the vicinity of the Northern Drainage Line

(f) Sampling of any identified springs;

(g) Collected samplnorth-eastes analysed for the range of analytes advised by the Environment Protection Authority Victoria;

(h) Details of the hydrological conditions of surface water sampling regime, noting that this should be cognisant of hydrological conditions and the availability of water in the surface water bodies to be sampled;

(i) Field parameters which are to be recorded and measured using a calibrated water quality meter (with calibration records to be kept and reported):

i pH;

ii Oxidation reduction potential (ORP);

iii Electrical conductivity (EC);

iv Dissolved oxygen (DO); and

v Temperature;

(j) The suite of analytes and analysis to be undertaken on the surface water samples by a NATA accredited laboratory;

(k) Appropriate trigger criteria, actions and contingency planning and associated management responses;

(l) Quality Assurance controls and reporting.

27 The permit holder must submit an annual performance statement (within the wider EMP annual report).

28 The permit holder must amend the SWMMP to address any identified issues, or changes or recommendations of the independent environmental auditor to the satisfaction of the responsible authority.

This SWMMP has been prepared to satisfy this permit condition.

It should be noted that the drainage line referred to in the Permit and other early documents as the "Northern Drainage Line" is referred to as the "North-West Drainage Line" in this plan. The drainage line has been renamed to better reflect its location relative to Pit 23 and to avoid confusion with the Red Hill Drainage Line which is to the north of Pit 23.

8.1.1 Purpose

This SWMMP provides the detailed management framework for the monitoring and management of surface water associated with disposal operations on, and the rehabilitation of the subject land. This SWMMP:

- describes the background conditions relating to surface water;
- identifies the standards to applied;
- describes the proposed mitigation measures aimed at the prevention of any uncontrolled discharge of runoff from disturbed areas;
- identifies the number and location of surface water monitoring points;
- identifies the frequency or hydrological conditions of surface water sampling;
- identifies the field parameters and laboratory analytical suites to which the surface water samples will be subjected;
- sets appropriate trigger points and actions;
- details the applicable Quality Assurance controls; and
- provides for the reporting of the surface water monitoring data.

As required by the Permit, this SWMMP has been prepared such that it is in general accordance with the information pertaining to surface water as described in the section 4.5 of Attachment A to the Permit application and further information subsequently supplied within Appendix C of the document "*Response to Notice to Supply Further Information – Non-hydrogeological and groundwater related matters*", submitted to the EPA and the Responsible Authority. In addition the preparation of this plan has had regard to:

- the *State Environment Protection Policy (Waters of Victoria)* (the WoV SEPP);
- conditions of the Permit; and
- relevant policies, standards and procedures that comprise Iluka's Environmental, Health and Safety Management System (EHSMS).

8.1.2 Objective

The objective of this SWMMP is to ensure that surface water runoff during disposal and rehabilitation operations or groundwater discharge to surface waters do not adversely affect users of the resource (including extractors and the environment) or existing local land uses.

8.2 Description of background conditions

8.2.1 Topography of Pit 23 surrounds, pre-mining

Pit 23 at the Douglas mine site is positioned on the remnants of a NNW-SSE trending curvilinear coastal ridge. The topography of the area surrounding Pit 23 is relatively flat with gentle relief; elevation varies from 180 – 190 m Australian Height Datum (AHD) in the lower swale areas to 200 – 210 m AHD at the crest of the ridge.

The hill-slopes draining from Pit 23 have very gentle inclinations of 1 – 2%, extending over the distances of 500 to 700 m from the edge of the overburden and soil stockpiles, with no hill-slope or channel erosion evident over these distances.

8.2.2 Surface water flow paths, pre mining

Drainage follows the natural downward direction of hill-slopes, sloping gently in all directions. As can be seen in Figure 7, surface flows from the western flank of the pre-mining Pit 23 surface flows west to collect into either the North-West Drainage Line or the Red Hill Drainage Line both of which ultimately report to McGlashin swamp within the White Lake catchment. Surface flows from the eastern flank of the pre-mining Pit 23 surface drain east to Chadwick's wetland and thence to Robertson's wetland within the Lake Kanagulk catchment.

Drainage from the hill-slopes collects in the low gradient waterway depressions. The depressions are broad and shallow with no defined beds or banks connecting to the downstream waterways. Flow in these waterway depressions only occurs during heavy rainfall events. During such events the potential for erosion along the low gradient hill-slopes and waterway depressions is low because runoff would be shallow and spread across the width of the depression.

Observations made by site personnel during the heavy rainfalls in late 2010 and 2011 confirm that runoff is conveyed through these waterway depressions as broad shallow flows. Following the events in 2010 and 2011, no visual signs of erosion were noted in these areas.

The current surface water flow paths are unchanged except for the isolation of the area of Pit23 and surrounds as described in Section 8.5.1.

8.2.3 Surface water quality

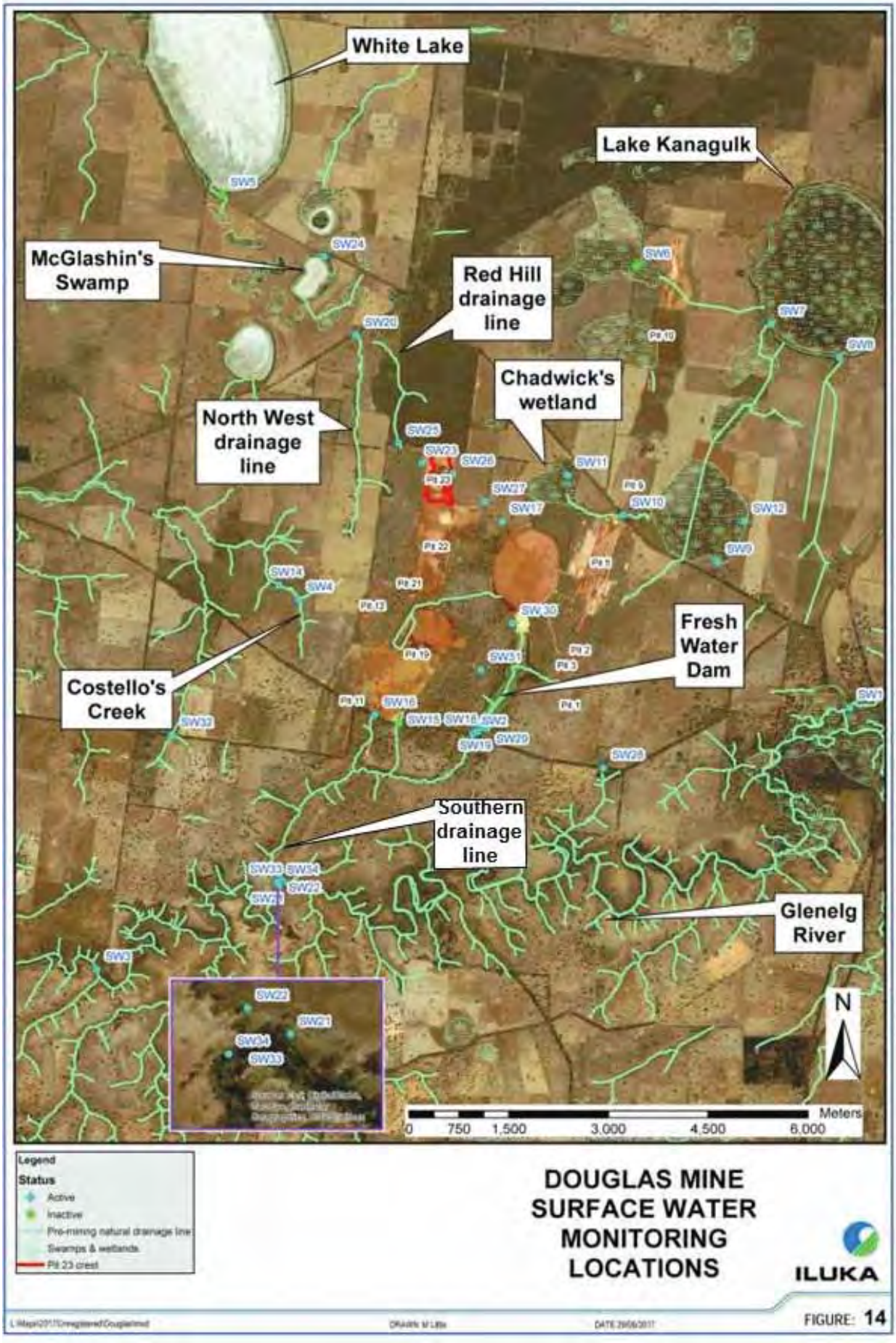
Surface water monitoring has been undertaken at various locations in and around the Douglas mine site since 2003, subject to availability of water to sample. Monitoring locations include:

- dams that form part of the site stormwater management system (FWD and Penny's Dam);
- drainage lines and swamps located immediately downstream of the active mining areas; and
- regional swamps, wetlands, drainage lines and watercourses more distant from the mine area.

The monitoring locations used during the operational life of the Douglas mine are shown on Figure 14.

Water samples obtained from these monitoring locations were subjected to field measurements and laboratory analysis for the following parameters in accordance with the Douglas Mine Work Plan, which is approved under the MRSDA.

- Electrical Conductivity;
- pH;
- Total Nitrogen;
- Total Phosphorus;
- Total Suspended Solids; and
- Turbidity


White Lake
Lake Kanagulk
McGlashin's Swamp
Red Hill drainage line
Chadwick's wetland
North West drainage line
Fresh Water Dam
Costello's Creek
Southern drainage line
Glenelg River
SW5
SW24
SW6
SW7
SW8
SW20
Pit 10
SW25
SW23
SW26
SW11
Pit 23
SW27
Pit 9
SW10
SW17
SW12
Pit 22
SW9
Pit 8
SW14
SW4
Pit 21
Pit 13
SW30
Pit 20
SW31
Pit 2
Pit 3
Pit 11
SW16
Pit 1
SW1
SW32
SW15
SW18
SW2
SW19
SW29
SW28
SW33
SW34
SW22
SW21
SW3
N
0
750
1,500
3,000
4,500
6,000
Meters
Legend
Status
Active
Inactive
Pre-mining natural drainage line
Swamps & wetlands
Pit 23 crest
DOUGLAS MINE
SURFACE WATER
MONITORING
LOCATIONS
ILUKA
FIGURE: 14

Two monitoring sites, namely Penny's Dam (SW17) and FWD (SW19) are part of the mine site stormwater management system, as described in Section 8.5.1 of this document. This system of drains, sumps, pumps, pipes and dams intercepts and stores runoff to prevent environmental impact due to off-site discharge from the operational mine areas. Water quality in these two dams, which are designated as being "Within System", can at times have significantly elevated concentrations or levels of turbidity without adverse impact off-site.

White Lake (SW05) is a groundwater-fed salt lake located in the Douglas Depression north-west of the mine site, with the electrical conductivity results of samples from the lake more representative of the regional groundwater aquifer than local surface water.

Based on the results of monitoring to date of electrical conductivity and turbidity, the surface water monitoring locations, excluding those that are "within system" and White Lake, can be divided into the following groups.

Group A – Receiving groundwater discharge

Group A includes the surface water monitoring locations where the water quality can be expected to be influenced by surface expression of groundwater. The two monitoring locations in Costello's Creek (SW04, SW14) are included in this group.

Group B - Glenelg River

Group B includes the surface water monitoring locations where water quality reflects that in or from the Glenelg River, which has a groundwater base flow component. Naturally the upstream and downstream Glenelg River monitoring locations (SW01, SW03) are included in this group. The monitoring location at the Jasper's Lane table drain below FWD (SW02) is also included in this group, as this location is used to monitor the quality of any discharge from FWD, which received pumped inflow from the Rocklands Reservoir and Strathlynn bore field during mining operations. The inclusion of SW02 in this group is only relevant for the purpose of considering historical water quality data as the addition of water from off-site sources has not occurred since October 2010.

Group C - Wetlands in an agricultural setting

Group C includes the surface water monitoring locations where the water quality reflects that of natural wetlands in an agricultural setting. The swamp west, north-west of Pit 10 (SW06), Chadwick's wetland (SW11) and the west-north-west side of Robertson's wetland (SW12) are included in this group.

Group D – Possibly impacted by mining or agricultural activities

Group D includes the surface water monitoring locations at which water quality, based on the results of measurements of turbidity and total suspended solids concentration, may have been impacted by mining or agricultural activities within the monitoring period., The south side of Robertson's wetland (SW09), the drainage line south of Lake Kanagulk (SW08), Wombelano Road drainage line (SW10) and Jaspers Lane drainage line (SW15) are included in this group.

Table 12 shows summaries of the monitoring data at each of the locations in each of the groups.

To provide context the water quality objectives of the WoV SEPP are also included in Table 12.

Table 12: Surface water monitoring data

Parameter	Within System		Group A		Group B			Group C			Group D				WoV SEPP
	SW17	SW19	SW04	SW14	SW01	SW02	SW03	SW06	SW11	SW12	SW08	SW09	SW10	SW15	
Electrical Conductivity µS/cm															
Number of Samples	117	125	12	18	65	27	58	7	18	18	23	13	33	4	
Mean	2646	2300	6733	5705	5743	5098	5140	271	263	499	295	448	313	237	
Standard Deviation	1382	939	2100	537	1290	1600	1420	74	130	242	65	215	101	58	
75th Percentile	2900	2950	8175	6023	7650	6900	6325	340	323	575	350	600	385	293	1500
50th Percentile	2100	2200	6550	5650	5300	3200	5400	290	230	485	300	380	280	234	
25th Percentile	1400	1700	5700	5350	2800	970	3450	200	148	323	240	295	248	184	
pH units															
Number of Samples	117	125	12	18	65	27	58	7	18	18	23	13	32	4	
Mean	7.9	7.6	8.3	7.8	7.1	6.8	7.2	7.0	7.1	7.3	7.4	7.1	7.4	7.1	
Standard Deviation	0.50	0.55	0.44	0.14	0.33	0.27	0.48	0.35	0.41	0.28	0.3	0.26	0.49	0.36	
75th Percentile	8.2	7.9	8.6	7.8	7.4	7	7.5	7.2	7.3	7.5	7.5	7.3	7.6	7.4	8.3
50th Percentile	7.9	7.5	8.3	7.8	7.2	6.8	7.3	6.9	7.1	7.3	7.3	7.2	7.3	7.1	
25th Percentile	7.5	7.2	8.1	7.7	6.9	6.5	7	6.9	6.9	7.1	7.2	6.9	7.1	6.7	6.5
Total Nitrogen mg/L															
Number of Samples	117	125	12	18	65	27	58	7	17	17	23	13	32	4	
Mean	1.6	1.4	3.4	0.7	1.1	1.8	1.3	3.5	3.1	4	4.6	5	3.7	5.3	
Standard Deviation	0.86	0.64	3.6	0.34	0.2	1	3.6	1.1	1.2	1.3	2.7	2.1	1.8	2.1	
75th Percentile	2.0	1.8	4.4	1	1.3	2.7	1.1	4.1	4.3	5.1	5.7	6.3	4.3	7.4	0.9
50th Percentile	1.3	1.20	1.9	0.6	1	1.3	0.89	3.5	2.8	3.5	4.8	5.1	3.2	5.3	
25th Percentile	0.97	0.90	1.2	0.48	0.88	1.1	0.7	2.7	2	3.1	1.9	3.3	2.2	3.3	
Total Phosphorous mg/L															
Number of Samples	117	125	12	18	65	27	58	7	17	17	23	13	32	4	
Mean	0.075	0.038	0.048	0.05	0.047	0.082	0.031	0.12	0.17	0.19	0.67	0.18	0.27	0.27	
Standard Deviation	0.11	0.050	0.050	0.075	0.033	0.091	0.024	0.067	0.104	0.112	0.964	0.136	0.219	0.1	
75th Percentile	0.071	0.041	0.083	0.043	0.040	0.099	0.03	0.17	0.22	0.27	0.65	0.32	0.32	0.33	0.04
50th Percentile	0.032	0.021	0.028	0.03	0.023	0.05	0.02	0.11	0.16	0.14	0.31	0.14	0.21	0.32	
25th Percentile	0.015	0.013	0.014	0.019	0.019	0.035	0.01	0.077	0.087	0.09	0.22	0.085	0.1	0.17	
Turbidity NTU															
Number of Samples	117	119	10	18	59	25	52	6	15	15	21	10	28	4	
Mean	183	23	18	13	4.5	48	7.8	82	75	73	529	218	750	953	
Standard Deviation	828	44	12	5.3	1.8	6	8.2	85	72	64	285	131	669	939	
75th Percentile	79	21	27	17	4.6	61	10	128	92	94	725	336	1167	1910	10
50th Percentile	24	8.2	14	13	3.1	24	4	51	57	62	452	210	416	605	
25th Percentile	13	4.9	9.1	9.2	2.2	14	2.5	32	20	18	304	80	291	345	
Total Suspended Solids mg/L															
Number of Samples	117	125	12	18	65	27	58	7	17	18	23	13	32	4	
Mean	42	11	17	19	5.8	34	6.3	34	29	32	87	116	214	258	
Standard Deviation	82	16	18	19	1	19	6.6	45	25	31	53	93	466	318	
75th Percentile	37	12	27	26	6	41	7	50	34	50	110	220	163	585	
50th Percentile	16	8.0	11	10	4	29	3	17	22	18	66	94	78	130	
25th Percentile	8.0	4.0	5.3	7.5	2	10	2	6	12	10	44	36	52	58	

WoV SEPP – Objectives for rivers and streams, lowlands of Wimmera and Glenelg catchments, Table A1, State Environment Protection Policy (Waters of Victoria)

SW04 – Creek in Costello property
SW14 – Creek in Costello property downstream of SW04
SW01 – Glenelg River at Fulham, upstream of Douglas mine
SW02 – Jaspers Lane table drain
SW03 – Glenelg River downstream of Douglas mine
SW06 – Swamp west of north end of Pit 10
SW11 – Chadwick's wetland
SW12 – Robertson's wetland, west side
SW08 – Roberson's wetland, south side
SW09 – Drainage line, south side of Lake Kanagulk
SW10 – Drainage line Wombelano Road, north end of Pit 5
SW15 – Jaspers Road drainage line, south-east end of Pit 19
SW17 – Penny's Dam
SW19 – Fresh Water Dam

The following observations can be made of the data in Table 12:

- Within system (best represented by SW17 as at SW19 the quality has been influenced by water added)
    - electrical conductivity greater than the WoV SEPP objective but less than at locations where water quality is affected by groundwater discharge (Groups A and B);
    - total nitrogen and total phosphorous concentrations greater than the WoV SEPP objectives but similar to that in other surface waters in the area; and
    - turbidity significant higher than the WoV objective and greater than at locations where water quality is not thought to be affected by run-off from disturbed areas (Groups A, B & C);
- Group A
    - elevated electrical conductivity as would be expected if the source of the water is groundwater;
    - relatively low total nitrogen and total phosphorous concentrations but higher than the WoV SEPP objective; and
    - relatively low turbidity but higher than the WoV SEPP objective;
- Group B
    - elevated electrical conductivity as expected due to the groundwater discharge to Glenelg River, particularly during periods of low flow in the river;
    - relatively low total nitrogen and total phosphorous concentrations but higher than the SEPP objective; and
    - relatively low turbidity only slightly higher than the WoV SEPP objective;
- Group C
    - relatively low electrical conductivity reflecting surface runoff and well below the SEPP objective;
    - relatively low total phosphorous concentrations but higher than the WoV SEPP objective;
    - relatively high total nitrogen concentration; and
    - greater turbidity than the WoV SEPP objective; and
- Group D
    - relatively low electrical conductivity reflecting surface runoff and well below the WoV SEPP objective;
    - relatively high total nitrogen and total phosphorous concentrations probably from runoff from areas to which fertiliser has been applied, significantly higher than the WoV SEPP objective; and
    - Very high turbidity reflecting runoff from areas disturbed by agricultural and/or mining activities.

The above observations are not unexpected and are in line with the known influences on water quality for each group.

The data contained in Table 12 can be said to represent background water quality for each group.

In addition, samples of water from SW04, SW14 (Costello's Creek) and the North-West Drainage Line (SW20), all of which may include groundwater discharge, have been collected and subjected to detailed analysis. The results obtained are shown in Table 13.

To provide context the water quality objectives of the WoV SEPP are also included in Table 13.

Table 13: Quality of surface water at locations of groundwater discharge

	Units	SW04	SW14		SW20	WoV SEPP Objective
		2/11/16	2/11/16	19/01/17	2/11/16	
General						
pH	Units	7.96	7.77	7.98	8.00	6.5-8.3*
Electrical Conductivity	µS/cm	9270	5600	9360	3550	1500*
Total Dissolved Solids	mg/L	6020	3640	6080	2310	-
Alkalinity						
Bicarbonate Alkalinity as CaCO3	mg/L	156	191	294	170	-
Carbonate Alkalinity as CaCO3	mg/L	<1	<1	<1	<1	-
Hydroxide Alkalinity as CaCO3	mg/L	<1	<1	<1	<1	-
Total Alkalinity	mg/L	156	191	294	170	-
Major Ions						
Calcium	mg/L	79	38	45	53	-
Magnesium	mg/L	121	80	138	64	-
Sodium	mg/L	1670	933	1740	607	-
Potassium	mg/L	8	7	18	5	-
Sulphate	mg/L	415	258	380	124	-
Chloride	mg/L	2920	1450	3330	976	-
Fluoride	mg/L	0.3	0.3	0.4	0.2	-
Total anions	meq/L	94.1	50.1	108	33.5	-
Total cations	meq/L	86.7	49.2	89.7	34.4	-
Charge Balance Error	%	4.08	0.85	9.1	1.37	-
Metals and Metalloids						
Aluminium	mg/L	0.72	0.46	0.21	0.94	0.08
Arsenic	mg/L	0.002	0.001	0.002	0.004	0.042
Barium	mg/L	0.112	0.068	0.06	0.052	-
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	0.0004
Chromium	mg/L	0.002	0.122	<0.001	<0.001	0.006
Copper	mg/L	0.002	<0.001	<0.001	<0.001	0.0018
Iron	mg/L	0.98	1.35	0.83	2.50	-
Manganese	mg/L	0.016	0.156	0.043	0.082	2.5
Mercury	mg/L	0.0002	0.0001	<0.0001	0.0002	0.0019
Nickel	mg/L	0.061	<0.001	0.002	0.004	0.013
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	0.056
Silver	mg/L	0.001	<0.001	0.004	<0.001	0.0001
Thorium	mg/L	0.001	<0.001	<0.001	0.003	-
Uranium	mg/L	0.001	<0.001	<0.001	<0.001	0.2
Zinc	mg/L	<0.005	<0.005	0.008	0.016	0.015
Anions						
Nitrite as N	mg/L	<0.01	<0.01	<0.01	<0.01	-
Nitrate as N	mg/L	<0.01	0.01	<0.01	<0.01	0.82
Ammonia as N	mg/L	0.09	<0.01	0.10	<0.01	1.18
Ammonium as N	mg/L	0.08	<0.01	0.10	<0.01	-
Reactive Phosphorous	mg/L	0.07	<0.01	<0.01	<0.01	-
Total Phosphorous	mg/L	0.14	0.05	1.8	0.09	-
Radionuclides						
Radium-226	Bq/L	<0.05	<0.05	<0.05	<0.05	5
Radium-228	Bq/L	<0.08	<0.08	<0.08	<0.08	2

* 75th Percentile

It can be seen from table 13 that in these surface waters:

- salinity, as indicated by electrical conductivity, is elevated and well above the WoV SEPP objective;
- concentrations of metals and metalloids are generally well below the WoV SEPP objectives with the exceptions of aluminium, copper and silver;
- concentrations of nitrate and ammonia are well below the WoV SEPP objectives;
- the vast majority of the dissolved ions in the groundwater are the stable ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-} and HCO_3^{-}) with those ions, on average, constituting 99.9% of the dissolved ions; and
- the dominant salt pair is Na-Cl being, on average, 82.8% of all dissolved ions.

It is important to note that the quality of surface waters described above represents the background with no impact from the disposal of materials to Pit 23.

8.3 Standards

The WoV SEPP:

- places the waters from which run-off from the Douglas mine site could enter in the “Murray and Western Plains” segment;
- specifies the beneficial uses protected;
- specifies water quality objectives to be met to protect the defined beneficial uses in various segments; and
- provides specific objectives and other objectives by reference to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Table 14 shows the quality indicators and objectives specified in WoV SEPP for waters in lowlands of the Glenelg, Hopkins and Wimmera catchments in a highly modified aquatic system, excluding those for organic compounds that are not considered relevant in this case.

It should be noted WoV SEPP states that:

> “The environmental quality objectives for some surface waters may not be attained due to natural variation. In these cases, the background level becomes the environmental quality objective.” (WoV SEPP Part V)

In other words, if the background concentration or level exceeds the objective then the objective is the background concentration or level.

Table 14: WoV SEPP water quality indicators and objectives

Specific			
pH	=>6.5	units	25th percentile
	=<8.3	units	75th percentile
Oxygen	=>85	%Sat	25th percentile
	=<110	%Sat	maximum
Turbidity	=<10	NTU	75th percentile
Conductivity	=<1500	µS/cm	75th percentile
Total phosphorus	=<40	µg/L	75th percentile
Total nitrogen	=<900	µg/L	75th percentile
Metals and Metalloids			
Aluminium pH <6.5	80	µg/L	maximum
Arsenic (III)	94	µg/L	maximum
Arsenic (V)	42	µg/L	maximum
Boron	680	µg/L	maximum
Cadmium	0.4	µg/L	maximum
Chromium (VI)	6	µg/L	maximum
Copper	1.8	µg/L	maximum
Lead	5.6	µg/L	maximum
Manganese	2500	µg/L	maximum
Mercury (inorganic)	1.9	µg/L	maximum
Nickel	13	µg/L	maximum
Selenium (Total)	18	µg/L	maximum
Silver	0.1	µg/L	maximum
Zinc	15	µg/L	maximum
Non-metallic Inorganics			
Ammonia	1430	µg/L	maximum
Chlorine	6	µg/L	maximum
Cyanide	11	µg/L	maximum
Nitrate	3400	µg/L	maximum
Hydrogen Sulphide	1.5	µg/L	maximum
Radionuclides			
Radium-226	5	Bq/L	maximum
Radium-228	2	Bq/L	maximum
Uranium-238	0.2	Bq/L	maximum

8.4 Impact Assessment

8.4.1 Run-off from disturbed areas

Potential impacts of surface water were identified in the Permit application and found to be related to the potential for runoff from disturbed areas that are devoid of vegetation. During disposal the areas in question include:

- the areas surrounding Pit 23 on which overburden is stockpiled;
- roads; and
- the office area and car parking areas.

In addition an unplanned overflow from the truck wash facility would result in potentially contaminated run-off directed to the surface water management facilities.

It was also acknowledged that between pit backfilling and establishment of vegetation on the area the pit area itself could be a source of contaminated run-off.

The surface water management facilities, described in Section 8.5 of this document, have proved to be adequate up to this point in time as they have been successful in preventing any discharge of surface water from the area surrounding Pit 23 despite periods of high rainfall (in excess of rainfall with a recurrence interval exceeding 1:100 years and rainfall events of an intensity exceeding that of events with a recurrence interval of 1:100 years).

While discharge from the FWD has occurred, it should be noted that:

- the disturbed area associated with Pit 23 from which run-off can occur, i.e. the area of the outer batters of the overburden stockpiles adjacent to Pit 23 and the space between them and the catch drains totals 13.7 ha;
- recent modelling by Water Technology, undertaken as part of the whole Douglas Mine surface water management system assessment, showed the contribution of the paddock to the west of the mine access road (run-off from which was reporting to the surface water management system, specifically Penny's Dam) contributed between 8 and 12% of the inflow to the FWD in 10yr to 100yr ARI events from an area of 41.2 ha being a volume of 2ML in a 10yr ARI event and 10 ML in 100 yr ARI even;
- The contribution of run-off from the disturbed areas adjacent to Pit 23 would be 0.67 to 3.3 ML representing 2.7% to 4% of the in-flow to FWD. Such quantities can be considered to be negligible.

It is therefore predicted that, during disposal and pit backfilling, run-off from disturbed areas associated with Pit 23 will have negligible impact on the likelihood of a discharge from the FWD.

While the adequacy of the existing surface water management facilities during disposal and pit backfilling is known to be sufficient, the requirements of those facilities will increase dramatically when run-off from the currently open pit area can occur. To ensure the adequacy of the facilities during the critical period this plan includes measures to evaluate the adequacy of the facilities and, if required, upgrade those facilities, prior to reaching the critical period. This approach will ensure that contaminated run-off from disturbed areas will not result in impacts on surface waters for the life of the development and use and beyond.

Examination of Figures 7 and 15 show that, in the unlikely event of a discharge from the surface water management facilities, run-off from disturbed areas associated with the development and use would flow to:

- The paddock immediately to the east of the disturbed area and on to Chadwick's wetland via Penny's Dam; and
- a drainage line running to the north from a point on Elliotts Road some 500 metres to west of the north-western corner of Pit 23 (the Red Hill Drainage Line).

At the present time run-off from the paddock between Pit 23 and the mine access road flows to the drain on the western side of the mine access road and then along that drain to where it joins the stormwater drain carrying run-off from disturbed areas to Penny's Dam. In the absence of a failure of the surface water management facilities run-off from the paddock can be expected to be of the same quality as run-off from agricultural land in the region and suitable for discharge to the environment. For this reason the current arrangement is to be altered by the installation of a culvert through which run-off from the paddock will flow under the mine access road and on to Chadwick's wetland separately from the run-off from disturbed areas.

On the western side of Pit 23 run-off from the outer batters of the northern overburden stockpiles flows to the north-west dam from which water is pumped to a drain running the western side of the southern overburden stockpiles. The pump has proved to be of sufficient capacity to prevent overflow form the north-west dam so the potential for such an overflow is the result of the possibility of a pump failure. If such a failure occurred and resulted in an overflow from the dam, water would flow across the paddock to the north-west to a culvert passing under Elliotts Road to the Red Hill Drainage Line.

The catchment of the Red Hill Drainage Line includes an unsealed section of Elliotts Road and the drainage line itself is not well vegetated. As a result, the quality of water in the drainage line during rainfall events could be expected to be similar to that which could overflow from the north-west dam thus limiting any adverse impact of such an overflow. While this supports a reasonable expectation of little or no adverse impact, this will be able to be tested using the results of the monitoring program detailed in Section 8.6.

8.4.2 Truck wash facility overflow

Water for the truck wash facility is contained in storage tanks at the facility and any overflow form these tanks will flow to Penny's Dam thus entering the surface water management facilities.

Water can only be added to the storage tanks by:

- incident rainfall on the collection pan of the truck wash; and
- the gravity fed pipeline that runs from a tank located adjacent to the Wet Concentrator Plant.

The area of the collection pan is approximately 50 m^2 so if a run-off coefficient 5 times that of the disturbed area to the east of Pit 23, which has an area of 6 ha the contribution the overflow from the storage tank would be:

100 x (50 x 5) ÷ (6 x 104 + 50 x 5) = 25000 ÷ 600250 = 0.42%

0.42% represents a negligible volume.

If the valve on the pipeline were to be left open, water would flow at a rate of between 1 and 1.2 litres per second and could result in an overflow at the same rate. The overflow could therefore be 0.086 to 0.184 ML per day, a negligible amount.

It should also be noted that source of the water suppled to the storage tanks is the FWD an overflow from the storage tanks resulting from inflow from the pipeline would not result in an increased in the volume of water within the surface water management facilities.

It is clearly apparent that the potential impact of the truck wash facility on the surface water is negligible.

8.4.3 Groundwater discharge

As noted in the groundwater impact assessment, groundwater discharges to the surface at a number of locations and therefore gives rise to potential for contamination of surface waters. While the potential for adverse impacts on surface water has been assessed as extremely low, this assessment is based on modelling with which some uncertainty is associated.

CDM Smith, CDM Smith Nov 2014, found that discharge of groundwater:

- containing seepage from Pit 23 is expected, at some time in the future, at:
    - the North-West Drainage Line;
    - McGlashin Swamp; and
    - White Lake; and
- is also expected at the following where groundwater discharging is not expected to contain seepage from Pit 23:
    - a creek/drainage line to the south-west of Pit 23 on Costello's property (Costello's Creek which is a tributary to the Glenelg River); and
    - the Glenelg River and a number of its tributaries.

In addition, the possibility of other drainage lines to the north-west of Pit 23 that may receive groundwater containing seepage from Pit 23 has been raised and may be identified in the survey described in Section 8.6.2.

While no adverse impact is expected, it is considered prudent to monitor potentially impacted surface waters and surface waters containing groundwater without seepage from Pit 23 to validate the modelling. Such monitoring will enable detection of seepage from Pit 23 and enable validation of model predictions or provide data that can be used to recalibrate and hence improve the models.

8.5 Surface water management

8.5.1 Containment of contaminated run-off

The surface water management facilities consist of:

- earthen bunds and drain to direct runoff from undisturbed areas around disturbed areas;
- earthen bunds and channels to intercept runoff from disturbed area and direct it to collection ponds;
- a network of pumps, pipes and channels that deliver collected runoff from disturbed areas to FWD, as shown in Figure 15;
- a portable pump set to provide backup for installed pumps; and
- the FWD, which is of sufficient capacity to contain all runoff from disturbed areas and can be discharged from, by a managed water release, if water quality is appropriate

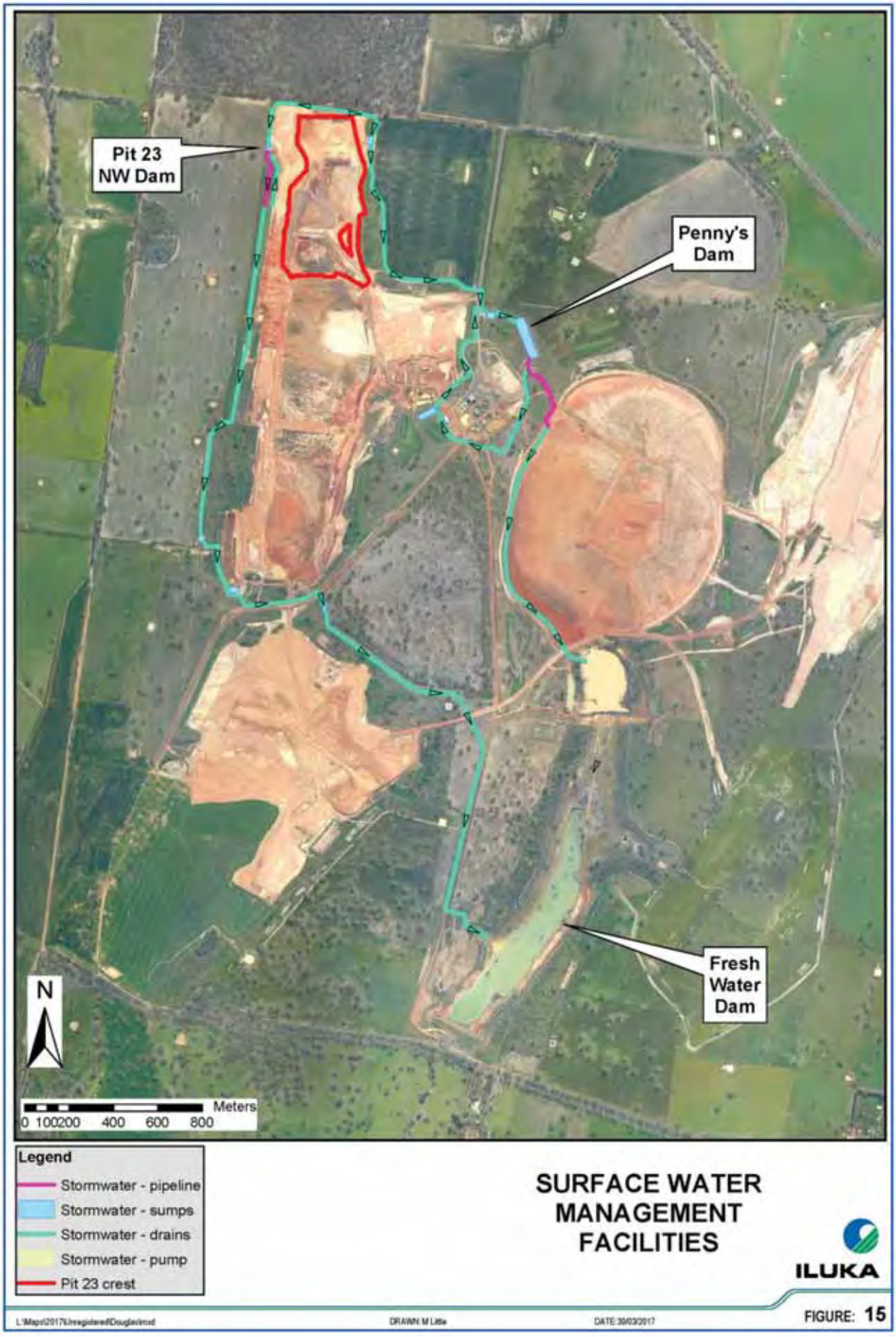
It should be noted that:

- until pit backfilling and soil placement is completed the disturbed areas do not include the area of Pit 23 itself as no water entering the pit by incident rainfall will be able to leave the pit other than by evaporation or seepage; and
- a managed water release is neither a licenced or emergency discharge as provided for by the *Environment Protection Act 1970* as the water in the FWD is not considered to be waste. Nevertheless, the requirements of a managed water release are such beneficial uses prescribed in the WoV SEPP are protected in accordance with the objectives of that SEPP.

. The surface water management system includes:

- Management of the water inventory by:
  - regular inspection, at least weekly, of collection and storage facilities to enable estimation of the capacity of the system to contain runoff and movement of water to maximise that capacity;
  - regular inspection, at least weekly of installed pumps to test readiness to run and replacement with portable pump, if necessary;
  - monitoring of daily rainfall forecasts from the Bureau of Meteorology rainfall forecast website with results triggering management actions as follows:

    If rainfall forecasts are for a daily rainfall greater than 10mm, a four day rainfall of greater than 25 mm or an eight day rainfall of greater than 50 mm, the following management actions are taken:
    - visual inspection and documentation of water level in the FWD;
    - visual inspection of surface water drainage lines and drainage bunds;
    - confirmation that pumps and pipelines required are in place; and
    - shifting of water within the system to ensure the distribution of available storage volume is optimised; and
- Targeted monitoring of the surface water management facilities when runoff from disturbed areas is occurring, including:
  - monitoring of rainfall recorded at the site daily with detection of intense rainfall events;
  - the inspection and documentation of the water level in FWD;
    - daily if the FWD is holding in excess of 80% of its capacity; and
    - weekly if the FWD is holding in excess of 50% of its capacity;
  - twice daily visual inspection of surface water drainage lines and drainage bunds;
  - twice daily visual inspections of all ponds; and
  - shifting of water within the system to ensure the distribution of available storage volume is optimised.


Pit 23
NW Dam
Penny's
Dam
Fresh
Water
Dam
N
Meters
0 100200 400 600 800
Legend
Stormwater - pipeline
Stormwater - sumps
Stormwater - drains
Stormwater - pump
Pit 23 crest
SURFACE WATER
MANAGEMENT
FACILITIES
ILUKA
DRAWN M Little
FIGURE: 15

8.5.2 Adequacy assessment and upgrade

Prior to the commencement of the post disposal pit backfilling or any significant proposed changes to the facilities, water balance modelling of the surface water management facilities will be performed by an expert in the field with the general scope being to:

- assess the adequacy of the existing facilities and management system; and
- make recommendations as to modifications required to make the facilities and system adequate when run-off from the pit area is possible.

The methodology used will be developed by the expert but is expected to include the following:

- provision of detailed information on the dimensions of each component of the facilities to the expert;
- inspection of the facilities by the expert;
- mathematical simulation of the system in wet years of average recurrence intervals (ARI) ranging from one to 100 years and during intense rainfall events with ARI's in the same range. The simulations would identify any point in the system at which water would be discharged such as points of insufficient storage and insufficient transport capacity;
- Design of modifications to the system to provide the required capacities (this may include enlargement of storage, pumps and channels); and
- Further mathematical simulations to demonstrate the adequacy of the upgraded facility.

Following each such water balance modelling event a detailed report will be provided to the Responsible Authority together with a plan for the any works required to upgrade the facilities. Any works required will be incorporated into this plan to the satisfaction of the Responsible Authority in consultation with relevant government agencies.

8.6 Surface water monitoring

The continued monitoring and evaluation of potential impacts on surface water receptors, resulting from continued disposal of material into Pit 23, will be achieved through Surface Water Monitoring Events (SWME) conducted on a quarterly basis plus additional monitoring when discharge of run-off from disturbed areas to locations outside of the surface water management facilities occur. The results of routine (quarterly) monitoring will add to the understanding of the background water quality while the incident driven monitoring will enable assessment of any impacts.

The following sections detail the surface water monitoring network, and the sampling and analysis activities.

8.6.1 Surface water monitoring locations

8.6.1.1 On-site monitoring locations

The locations of on-site (i.e part of the site stormwater management facilities) surface water monitoring points are listed below and shown on Figure 16

- Freshwater Dam (SW19)
- Penny's Dam (SW17)
- the Pit 23 north-west dam (SW23).
- The Pit 23 eastern storm water drain (SW26)

Water at these monitoring locations can be expected to include surface water runoff from the disturbed areas of the subject land.

8.6.1.2 Off-site monitoring locations

The locations of off-site surface water monitoring points are listed below and shown on Figure 16:

- locations at which water quality represents that from areas undisturbed by disposal and rehabilitation activities on the subject land unless a failure of the surface water management facility occurs:
    - a culvert under the mine access road carrying run-off from the paddock between the Pit 23 area and the mine access road (SW27);
    - Chadwicks wetland (SW11);
    - Red Hill Drainage Line (SW25); and
    - run-off from revegetated Pit 23 area (SW23 & SW26); and
- locations at which water quality represents that resulting from run-off from undisturbed areas plus actual or potential expression of groundwater at the surface:
    - Costello's Creek (SW14). SW14 is considered to be the appropriate monitoring point on Costello's Creek as observations at that location and at SW4 show an obvious expression of groundwater at SW14 while at SW4 water is only present after a significant rainfall event;
    - White Lake (SW5);
    - the northern end of McGlashin Swamp (SW24);
    - the North-West Drainage Line at the Harrow-Kanagulk Road (SW20);
    - the Southern Drainage Line , a tributary of the Glenelg River (SW22);and
    - any other springs identified in the survey described in Section 8.6.2.

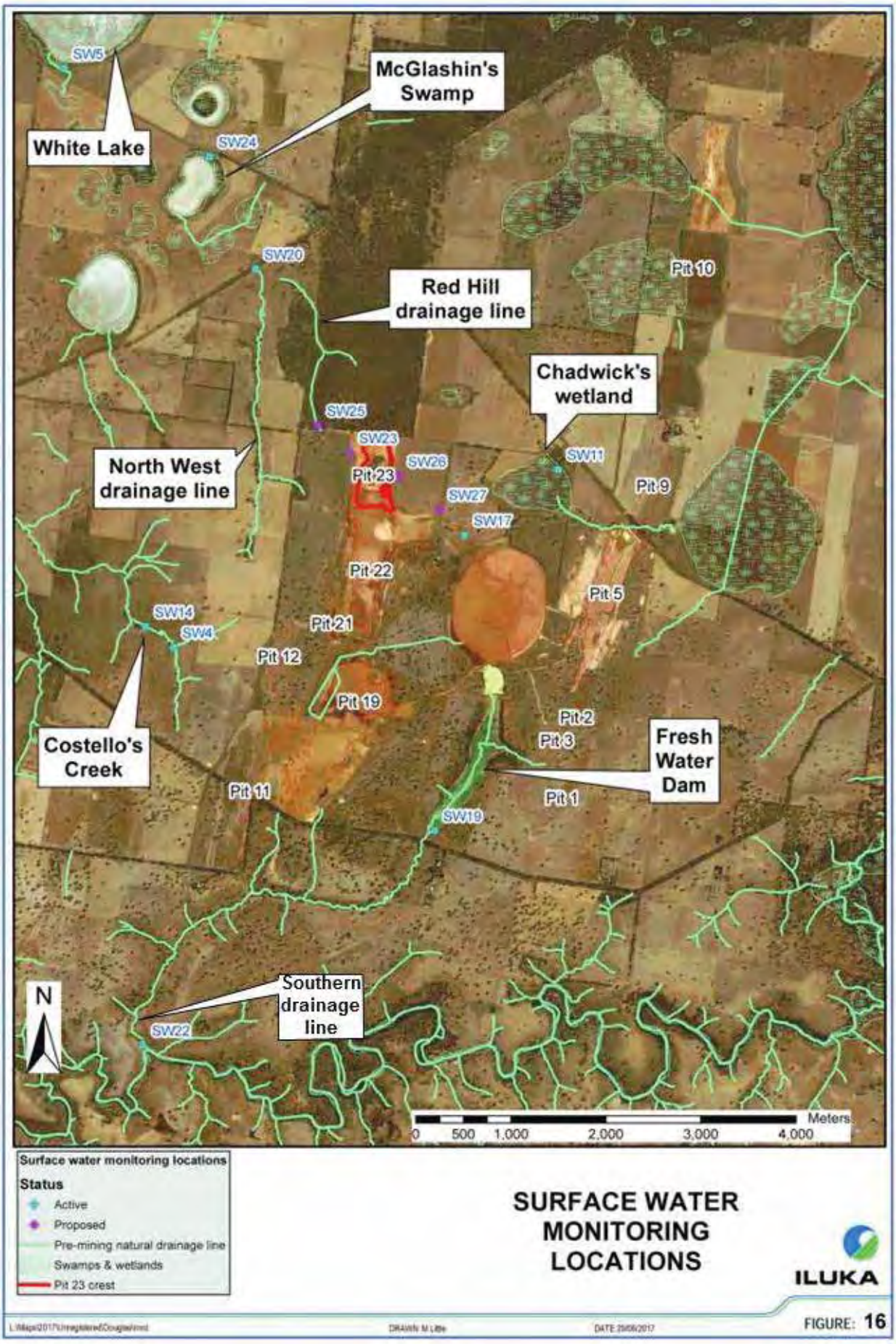
8.6.1.3 Post revegetation monitoring locations

Following the backfilling of the pit, soil placement and establishment of vegetation on the Pit 23 area and surrounds, the quality of run-off from the area will improve to such an extent that it will become suitable for discharge to the environment, i.e. meet the objectives of the WoV SEPP.

When vegetation is established the Pit 23 north-west dam will still be in place and SW23 will be an appropriate location for the monitoring of run-off from the western side of the revegetated area. In addition a monitoring location (SW26) will be established for the sampling of run-off from the eastern side of the revegetated area.

8.6.2 Survey for springs

A foot-based survey will be undertaken along the North-West Drainage Line between Elliotts Back Lane and the Harrow-Kanagulk Road to identify the presence of any springs. The relevant landholder(s) will be invited to be involved in the survey. The survey will be undertaken during the first winter period following commencement of the permitted use.


SW5
McGlashin's Swamp
White Lake
SW24
SW20
Red Hill drainage line
Pit 10
Chadwick's wetland
SW25
SW23
SW26
SW11
North West drainage line
Pit 23
Pit 9
SW27
SW17
Pit 22
Pit 5
SW14
SW4
Pit 21
Pit 12
Pit 19
Pit 2
Pit 3
Costello's Creek
Fresh Water Dam
Pit 11
Pit 1
SW19
Southern drainage line
SW22
N
0 500 1,000 2,000 3,000 4,000
Meters
Surface water monitoring locations
Status
Active
Proposed
Pre-mining natural drainage line
Swamps & wetlands
Pit 23 crest
SURFACE WATER MONITORING LOCATIONS
ILUKA
FIGURE: 16

8.6.3 Surface water sampling

8.6.3.1 Sampling methodology

Surface water samples will be collected using methods in accordance with the EPA Publication 441: *A guide to the sampling and analysis of waters, wastewaters, soils and wastes, 7th edition, April 2000*.

8.6.3.2 Recording of hydrologic conditions

The hydrologic conditions present at the surface water monitoring location at the time of sampling shall be recorded, including:

- for drainage lines – flowing/pooled/dry; and
- for sumps/dams/lakes/swamps – estimate of % water volume held (to nearest 25%)

8.6.3.3 Field parameters

During each SWME the following field parameters, which are to be measured using a calibrated water quality meter, with measurement results recorded and reported along with calibration records:

- Electrical conductivity (EC);
- pH;
- turbidity;
- Oxidation reduction potential (ORP);
- Dissolved oxygen (DO); and
- Temperature.

8.6.4 Laboratory analysis of surface water samples

Surface water samples will be supplied under chain of custody documentation to a NATA accredited analytical laboratory for analysis. The analyte suites for various monitoring locations are described below:

8.6.4.1 Laboratory analysis, all sites

Surface water samples from all monitoring sites will be subject to laboratory analysis for:

- pH;
- Total Suspended Solids (TSS);
- Total Dissolved Solids (TDS);
- Electrical Conductivity (EC);
- Total Nitrogen (Total N); and
- Total Phosphorus (Total P).

8.6.4.2 Laboratory analysis, sites of potential groundwater expression

In addition to the analysis listed in Section 8.6.4.1 above, surface water samples from sites where water quality may be affected by groundwater, i.e. SW5, SW14, SW20, SW24 and any springs identified during the survey undertaken along that drainage line (Section 8.6.2), will be subjected to laboratory analysis for the following:

- major cations: calcium (Ca), magnesium (Mg), potassium (K), sodium (Na);
- major anions: sulphate (SO_4), carbonate (CO_3), bicarbonate (HCO_3), hydroxyl (OH), chloride (Cl) and fluoride (F);

- nutrients: nitrate (NO_3), nitrite (NO_2), total ammonia (NH_4+NH_3), reactive phosphorus (PO_4 as P) and total phosphorous (P);
- metals and metalloids: aluminium (Al), arsenic (As), barium (Ba), boron (B),cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), selenium (Se), silver (Ag), uranium (U), thorium (Th) and zinc (Zn); and
- radioactive isotopes (Ra-226, Ra-228 and U-238)

The purpose of these analyses is to detect any impact on groundwater quality of seepage from Pit 23. While no such impact is expected, such expectations are, to some extent, based on the results of hydrogeological and solute transport modelling and the Groundwater Monitoring and Management Plan includes the recalibration of the models using the results of on-going monitoring. The results of this detailed analysis of surface water impacted by groundwater discharge will provide input for such model recalibration if, contrary to expectations, impacts are detected.

8.6.5 Data Management

All surface water monitoring data collected during disposal to Pit 23, including calibration and quality control and assurance data, will be stored and/or managed using Monitor Pro 5 (MP5; EHS Data, 2015). All MP5 data will sit within the Murray Basin server located at: Iluka Resources, Level 23 140 St Georges Terrace, Perth WA. MP5 will be configured to automatically compare imported data to pre-defined filters and export automatically-generated reports for consideration by Iluka staff.

8.6.6 Quality control and quality assurance

Quality control and quality assurance measures will be the same as the described in Section 6.6.8 of this document.

8.6.7 Summary of surface water monitoring

The surface water monitoring program is summarised in Table 15.

Table 15: Surface water monitoring program

Surface water monitoring location	Frequency	Hydrologic conditions	Field parameters	Laboratory analysis
On-site locations				
SW17 – Penny's Dam SW19 – Fresh Water Dam SW23 – Pit 23 NW dam SW26 – Pit 23 eastern stormwater drain	• Quarterly • During or following and off-site discharge event	• Estimate of % water volume held (to nearest 25%)	• Electrical conductivity • pH • turbidity • Oxidation reduction potential • Dissolved oxygen • Temperature	• pH • Total Suspended Solids • Total Dissolved Solids • Electrical Conductivity • Total Nitrogen • Total Phosphorus
Off-site locations				
SW27 – Culvert under the mine access road SW11 – Chadwick's wetland SW25 – Red Hill Drainage Line SW26 – Eastern run-off from revegetated Pit 23 SW23 – Western run-off from revegetated Pit 23	• Quarterly (excluding SW26 & SW23) • During or following and off-site discharge event	• Flowing/pooled/ dry	• Electrical conductivity • pH • turbidity • Oxidation reduction potential • Dissolved oxygen • Temperature	• pH • Total Suspended Solids • Total Dissolved Solids • Electrical Conductivity • Total Nitrogen • Total Phosphorus
SW14 – Costello's Creek SW5 – White Lake SW24 – McGlashin Swamp SW20 – North-West Drainage Line SW 22 – Southern Drainage Line	• Quarterly • During or following and off-site discharge event (creek and drainage lines only)	• Swamps - Estimate of % water volume held (to nearest 25%) • Springs and drainage lines - flowing/ pooled/dry	• Electrical conductivity • pH • turbidity • Oxidation reduction potential • Dissolved oxygen • Temperature	• pH • Total Suspended Solids • Total Dissolved Solids • Electrical Conductivity • Total Nitrogen • Total Phosphorus o major cations: calcium, magnesium, potassium, sodium; o major anions: sulphate, carbonate, bicarbonate, Hydroxyl, chloride, fluoride; o nutrients: nitrate, nitrite, total ammonia, reactive phosphorus, total phosphorous; o metals and metalloids: aluminium, arsenic, barium, cadmium, chromium, copper, iron, manganese, mercury, nickel, lead, silver, uranium, thorium and zinc (Zn); and • radium-226, radium 228 and uranium-238

8.7 Management response

While no adverse impacts on surface waters are expected, this expectation will be confirmed or otherwise by the results obtained from the monitoring program described in Section 8.6 of this document.

The following describes how the monitoring results will be used to determine if additional management actions are required and the management actions that may be necessary.

8.7.1 Surface waters potentially impacted by run-off from disturbed areas

The management actions described in Section 8.5.1, which include monitoring, maintenance of the functionality of the system and the movement of water within the system to maximise available capacity, represent appropriate management responses, however, additional responses are required if, despite the management effort, a discharge of run-off from the disturbed area of Pit 23 and surrounds does occur.

If such a discharge did occur the management response required includes two aspects:

- quantification of the impact of the discharge; and, if that impact is found to be unacceptable;
- determination of what upgrades to the management facilities are required to prevent a recurrence and implementation of such upgrades.

It was noted in Section 8.4.1 that, if a discharge of run-off from the disturbed area of Pit 23 and surrounds did occur, the surface water bodies potentially affected are Chadwick's wetland and the Red Hill drainage line (the receiving waters). The quality of water in these water bodies needs to comply with the objectives of the WoV SEPP, which are shown in Table 14, except if the background water quality is inferior to those objectives.

The quality of the water in Chadwick's wetland may be affected by run-off from disturbed areas outside of the subject land and therefore measurements of the quality of the water in Chadwick's wetland will not reflect impacts of run-off from disturbed areas in the subject land. For this reason the receiving waters monitoring point will be the culvert under the mine access road carrying the run-off from the paddock between the Pit 23 area and that road (SW27).

The need for management action will determined as follows:

- identification of run-off from the disturbed area of Pit 23 and surrounds to either the paddock to the east of Pit 23 or an overflow from the Pit 23 north-west dam by inspection. If no such run-off is detected no action is required;
- If such run-off has occurred the following actions will be taken:
    - field measurements as listed in Section 8.6.3.3 and collection of samples of:
        - the run-off from the disturbed area, i.e. at the point of overflow from the water management facilities to the east of Pit 23 or the Pit 23 north-west dam; and
        - the water flowing through the culvert under the mine access road (SW27) and/or the Red Hill Drainage Line (SW25)
    - comparison of the results obtained for electrical conductivity, pH and turbidity on the water discharging from the eastern side of Pit 23 or the Pit 23 north-west dam with trigger levels, defined below. If the results are below the trigger levels then no further action is required;
    - comparison of the results obtained for electrical conductivity, pH and turbidity in receiving waters (SW27 and/or SW25) with trigger levels, as defined below. If the results are below the trigger levels then no further action is required;

- given that electrical conductivity, pH or turbidity in both the discharging and receiving waters are above the trigger levels, as defined below, the field measurements will be repeated to provide confirmation. If such confirmation is obtained, an exception report, which will include full details of the impact assessment and a plan for remediation and prevention of recurrence as required, as described in Section 12 will be produced and submitted.

The exception report will include:

- details of the observation including results of field measurements and descriptions of the circumstances;
- identified of the causes of the event;
- a description of immediate actions taken; and
- if appropriate, a plan of action aimed at preventing on-going exceedances of trigger levels complete with a schedule for implementation.

Actions required will be determined on a case by case basis but may include:

- review of the method of operation of the surface water management facilities;
- design and assessment by hydraulic modelling of possible upgrades to management facilities; and
- upgrading of surface water management facilities by measures such as increasing storage capacity, installation of additional bunds and drains and increasing pumping capacity.

The trigger levels are defined as the greater of the 75th percentile value of the background based on the measured means and standard deviations and the assumption of normal distribution, and a level based on the WoV SEPP objective.

The relevant WoV SEPP objectives are set as 75th percentile values or in the case of the lower pH value the 25th percentile. The trigger levels based on the WoV SEPP are set at the 75th or 25th percentile values and are therefore equal to the WoV SEPP objectives.

The trigger levels determined from the WoV SEPP objectives are shown in Table 16.

Table 16: Trigger levels based on WoV SEPP objectives

Indicator	Unit	Trigger Value
Electrical Conductivity	uS/cm	1500
pH Upper	Units	8.3
pH Lower	Units	6.3
Turbidity	NTU	10

Background data on the receiving waters is not currently available but will be collected over time. In the interim, the data available for analogous sites will be used.

The following drainage lines have been selected as analogue sites:

- running into Lake Kanagulk at a point approximately 6270 metres to the north-east of Pit 23 (SW8); and
- running into Robertson's swamp at a point approximately 2780 to the east-south-east of Pit 23 (SW10)

The locations of these sites are shown in Figure 14 and both are drainage lines in which the water quality has been unaffected by run-off from areas disturbed by mining. Measurements of field parameters have been made routinely, when water has been present, from August 2003 to June 2016 and Table 17 summarises the results obtained

Table 17: Background at analogue sites

	Electrical Conductivity	pH	Turbidity
	µS/cm	Units	NTU
Number of measurements	51	51	44
Average	306	7.40	505
Standard Deviation	95	0.41	307
Maximum	550	8.9	1399
Minimum	128	6.6	79
75th percentile	370	7.6	712
25th percentile	241	7.2	298

Trigger levels derived from background data from analogue sites are defined as the 75th or 25th percentile based on the means and standard deviations of the data and the assumption of a normal distribution. Table 18 shows the trigger levels derived from the background data at the analogue sites.

Table 18: Trigger levels derived from background at analogue sites

	Electrical Conductivity	pH		Turbidity
		Upper	Lower	
	uS/cm	Units	Units	mg/L
Mean	306	7.40	7.40	505
Standard Deviation	95	0.41	0.41	307
Trigger levels	370	7.6	7.2	712

Trigger levels for the discharge from the eastern side of the Pit 23 area will be those determined for the flow through the culvert under the mine access road while for discharge from the Pit 23 north-west dam (SW23) the trigger levels will be those determined for the Red Hill Drainage Line (SW25).

Table 19 shows the trigger levels.

Table 19: Surface water trigger levels – run-off from disturbed areas

		Eastern Run-off	Culvert under MAR	Pit 23 NW Dam	Red Hill DL
		SW26	SW27	SW23	SW25
Electrical conductivity	uS/cm	1500	1500	1500	1500
pH upper	units	8.3	8.3	8.3	8.3
pH lower	units	6.3	6.3	6.3	6.3
Turbidity	NTU	712	712	712	712

Based on WoV SEPP objectives

Based in background data at analogue sites

8.7.2 Surface water potentially impacted by groundwater

Section 7.4.2 identifies SW14 (Costello's Creek), SW05 (White Lake), SW24 (McGlashin Swamp) and SW20 (the North-West Drainage Line) as locations at which water quality may be influenced by groundwater discharge.

The first matter to consider in determining appropriate management responses is the question of whether the development and use is the source of any observed impact. The mechanism by which impact from Pit 23 may occur is by seepage from the pit discharging to the creek or drainage line. Detection of changes in concentrations of potential contaminants is extremely difficult due to the magnitudes of the changes that can be expected compared with that due to natural variation. The

character of leachate from Pit 23, however, is distinctly different from that of background surface waters. As noted previously, the surface waters are dominated by the Na-Cl ion pair. The results of laboratory leach tests on MSP by-products (Iluka Feb 2016) show that leachate is dominated by the Ca-SO_4 ion pair.

Table 20 shows the ratios of chloride to sulphate and sodium to calcium in the surface waters and the leachate

Table 20: Ionic ratios in surface waters and Pit 23 leachate

	Surface Waters			Laboratory	Model
	Average	Maximum	Minimum		
Chloride/Sulphate	7.32	8.76	5.62	0.008	0.015
Sodium/Calcium	23.95	38.67	11.45	0.017	0.050

The reason for the difference between the laboratory leachate and the modelled leachate is that the latter makes allowance for the limited solubility of gypsum. In either case the ratios are distinctly different to those in the surface waters.

In each quarter, when water is present, samples will be collected from each monitoring location and the samples subjected to detailed analysis. This will enable:

- calculation of the chloride:sulphate and sodium:calcium ratios;
- comparison of ratios with those obtained in the previous sampling round with a reduction in either ratio by 10% being taken as an indication that the water sampled contains seepage from Pit 23.

To avoid the influence of sampling and analytical errors confirmation of an indication of the presence of seepage from Pit 23 will be obtained by repeating the sampling and analysis.

If there is no confirmed indication of the presence of seepage from Pit 23 then no action will be required or taken.

If the indication of the presence of seepage from Pit 23 is confirmed then the following actions will occur:

- the timing of seepage from Pit 23 reaching the monitoring location will be compared with that predicted by the hydrogeological model and if there is variance of more than 10% the model will be recalibrated and the impact assessment re-examined;
- the full suite of analysis will be compared with trigger values, defined as follows:
    - Precautionary trigger value, set at 85% of the WoV SEPP objective or 85% of the background value, as defined below, whichever is the greater; and
    - Upper trigger value, set at the WoV SEPP objective or the background value, as defined below, whichever is the greater.
- if the average of the two results is greater than the precautionary trigger value, the following will occur:
    - Investigations to determine the cause of the indicated impact;
    - Increasing monitoring frequency in order to assess trends and understand processes occurring;
    - Possible analytical and/or numerical modelling to help determine cause of impact.
- if the average of the two results is greater than the upper trigger value an exception report, as described as described in Section 12 of this document, will be prepared and submitted. The exception report will include a plan for remediation/prevention that may include any or all of the following;
    - further investigation of the cause, if not adequately understood;
    - detailed impact assessment based on recalibrated models;

- development and implementation of strategies to prevent future unacceptable results or to mitigate any impacts, potentially including groundwater abstraction immediately adjacent and down-gradient of Pit 23; and
- reducing or ceasing the disposal of materials to Pit 23 until observations are stabilised and/or at acceptable levels if:
  - a change in the Na:Ca or Cl:SO4 ratios is detected;
  - the change is found to due to seepage from Pit 23; and
  - the elevated result is assessed to be resulting in an unacceptable impact

The WoV SEPP specifies water quality objectives but also states that these objectives will not apply if the background values are greater than the objectives in which case the background values will be the objective.

Background levels are best defined by the results of multiple sampling and analysis that reflect natural variation. Given the mean and standard deviation of the multiple results an observed result can be compared with the confidence interval around the mean value to determine if the result is from the same population, i.e. likely to be the result of natural variation. In order to utilise this method a reasonable number of results are required to provide estimates of the mean and standard deviation. In this case sufficient data is only available on pH, electrical conductivity, turbidity, total phosphorous and total nitrogen for Costello's Creek monitoring location (SW14). For these indicators, at this monitoring location, the background level is the 75th percentile value based on the mean and standard deviation of the past monitoring results and the assumption of normal distribution.

As the monitoring program proceeds additional data will be obtained thus enabling the application of this method to each of the monitoring locations. In the interim, background values will be based on the results of the analysis of samples currently available with the precautionary and upper trigger levels in circumstances where the background value is greater than WoV SEPP objective being 1.25 and 1.5 times the background value, respectively.

Table 21 shows the trigger levels determined using the method described above for each monitoring locations.

8.7.3 Post revegetation

Once the area of Pit 23 and surrounds has been revegetated the field measurements detailed in Section 8.6.3.3 and the laboratory analyses detailed in Section 8.6.4.1 will be performed on samples of water flowing to the east and the west. Samples will be collected whenever run-off occurs and sampling will continue until five consecutive sets of results collected over a period of at least one year show the quality of the water to be compliant with the specific WoV SEPP objectives listed in Table 14 or the established background levels in the receiving waters.

The surface water management facilities collecting and directing run-off to the Fresh Water Dam will remain in place until the quality of the run-off is shown to be satisfactory.

8.8 Management, triggers, actions and contingency plans.

The management of surface water, action triggers, management actions and contingency plans are summarised Section B of Appendix B.

8.9 Reporting

Reporting on surface water matters will be in accordance with Section 12 of this document and will include both exception and routine reporting.

Table 21: Surface water trigger levels – locations influenced by groundwater

Water Quality Indicator	Trigger	Costello's Creek	Pit 23 NW Drainage Line
		SW14	SW20
pH upper (units)	Precautionary Trigger	7.5	7.5
	Upper Trigger	8.8	8.8
pH lower (units)	Precautionary Trigger	7.1	7.1
	Upper Trigger	6.1	6.1
Electrical Conductivity µS/cm	Precautionary Trigger	5157	4438
	Upper Trigger	6067	5325
Turbidity (NTU)	Precautionary Trigger	14	14
	Upper Trigger	17	16
Aluminium (mg/L)	Precautionary Trigger	0.42	1.62
	Upper Trigger	0.50	1.41
Arsenic (mg/L)	Precautionary Trigger	0.080	0.080
	Upper Trigger	0.094	0.094
Boron (mg/L)	Precautionary Trigger	0.58	0.58
	Upper Trigger	0.68	0.68
Cadmium (mg/L)	Precautionary Trigger	0.0003	0.0003
	Upper Trigger	0.0004	0.0004
Chromium (mg/L)	Precautionary Trigger	0.077	0.005
	Upper Trigger	0.092	0.006
Copper (mg/L)	Precautionary Trigger	0.0015	0.0015
	Upper Trigger	0.0018	0.0018
Lead (mg/L)	Precautionary Trigger	0.0048	0.0048
	Upper Trigger	0.0056	0.0056
Manganese (mg/L)	Precautionary Trigger	2.1	2.1
	Upper Trigger	2.5	2.5
Mercury (mg/L)	Precautionary Trigger	0.0016	0.0016
	Upper Trigger	0.0019	0.0019
Nickel (mg/L)	Precautionary Trigger	0.011	0.011
	Upper Trigger	0.013	0.013
Selenium (mg/L)	Precautionary Trigger	0.015	0.015
	Upper Trigger	0.018	0.018
Silver (mg/L)	Precautionary Trigger	0.0028	0.0013
	Upper Trigger	0.0034	0.0020
Zinc (mg/L)	Precautionary Trigger	0.013	0.020
	Upper Trigger	0.015	0.024
Total Phosphorous (mg/L)	Precautionary Trigger	0.09	0.12
	Upper Trigger	0.10	0.14
Total Nitrogen (mg/L)	Precautionary Trigger	0.79	2.4
	Upper Trigger	0.93	2.9
Ammonia (mg/L)	Precautionary Trigger	1.37	1.37
	Upper Trigger	1.62	1.62
Nitrate (mg/L)	Precautionary Trigger	2.9	2.9
	Upper Trigger	3.4	3.4
Radium-226 (Bq/L)	Precautionary Trigger	4.25	4.25
	Upper Trigger	5	5
Radium-228 (Bq/L)	Precautionary Trigger	1.7	1.7
	Upper Trigger	2.0	2.0
Uranium-238 (Bq/L)	Precautionary Trigger	0.17	0.17
	Upper Trigger	0.20	0.20

Trigger derived from WoV SEPP objective

Trigger derived from results of recent analysis

Trigger derived from mean and standard deviation of historic data

It will be noted that the majority of the trigger levels are derived from the WoV SEPP objectives rather than measurements of the background quality. These trigger levels will be reviewed as additional backgrounds data becomes available.

8.10 Audit regime

Auditing will be as described in Section 13 of this document.

8.11 Plan review and amendment

Review and amendment of this plan will be as described in Section 14 of this document

9 Air quality management

9.1 Background

The Permit specifies the following requirements in regard to air quality/dust control

Air quality / dust

29. The ***Air Quality / Dust Control Plan (AQMP)*** within the EMP must address and ensure compliance with the following requirements:

    a) Dust emissions to air must be managed to ensure that beneficial uses of the air environment are protected, and all emissions are reduced as far as is practicable by the application of best practice procedures and arrangements.

    b) The permit holder must ensure dust does not emanate from the Subject Land so as to exceed the Assessment Criteria for mining and extractive industries specified in Table 2, Clause 3.3 of the *SEPP (Air Quality Management) Protocol for Environmental Management: Mining and Extractive Industries* or any subsequent replacement document.

The following is the Air Quality/Dust Control Plan (AQDCP) required by the permit.

9.1.1 Purpose

This AQDCP provides the management framework to ensure that beneficial uses of the air environment are protected, and dust emissions are reduced as far as is practicable by the application of best practice procedures and arrangements.

This AQDCP has been designed to address or be consistent with:

- the disposal operations as currently approved under Radiation Management Licence 300042022 issued to Iluka by the Department of Health and Human Services (DHHS);
- the requirements of the Permit; and
- the relevant policies, standards and procedures that comprise Iluka's Environmental, Health and Safety Management System (EHSMS).

9.1.2 Objective

The objective of this plan is to ensure that off-site air quality is not adversely affected by the development and use.

9.2 Standards

EPA Publication 1191, *Protocol for Environmental Management – Mining and Extractive Industries* (the Mining PEM) is an incorporated document of the *State Environment Protection Policy (Air Quality Management)* (SEPP AQM). It supports the interpretation of SEPP AQM, and sets out the statutory requirements for the management of emissions to the air environment arising from activities undertaken in the operation of mining and extractives sites.

Table 22 below shows the assessment criteria for the range of air quality indicators specified in Table 2 of the Mining PEM.

Table 22: Air quality objectives and assessment criteria

Indicator	Units	PEM: Mining & Extractive Industries	
		Assessment Criteria	Averaging Period
Particles as PM_{10}	$\mu g/m^3$	60	1 day
Particles as $PM_{2.5}$	$\mu g/m^3$	36	1 day
Respirable crystalline silica as $PM_{2.5}$	$\mu g/m^3$	3	1 year
Arsenic (total inorganic)	$\mu g/m^3$	0.003	1 year
Hydrogen cyanide	$\mu g/m^3$	340	1 hour
		9	1 year
Nitrogen dioxide	ppm	0.14	1 hour
Carbon monoxide	ppm	29	1 hour
Polyaromatic hydrocarbons	ng/m^3	0.3	1 year
Asbestos	$\mu g/m^3$	0.2	1 year
	$fibres/m^3$	0.05	1 year
Radionuclides	-	ALARA	1 year

The following comments can be made in regard to the objectives and assessment criteria shown in Table 21:

- emissions of carbon monoxide, sulfur dioxide, nitrogen dioxide, photochemical oxidants and polyaromatic hydrocarbons are related to products of combustion of fuel and, in this case, the quantity of fuel consumed is small and would be insufficient to produce detectible changes in the concentrations of these indicators;

- the concentration of arsenic in the MSP by-products is of the order of 52 ppm and if this was the concentration of arsenic in the PM_{10}, a very conservative assumption, and the concentration of PM_{10} was continuously at the specified limit of 60 $\mu g/m^3$ then the concentration of arsenic in the air would be of the order of 0.003 $\mu g/m^3$. The PM_{10} limit is a 24 hour average and the annual average would be significantly lower resulting in an even lower annual arsenic concentration, which would be significantly less than the annual average limit on arsenic concentration;

- no hydrogen cyanide will be used or produced;

- there is no potential for emissions of asbestos;

- dust emissions from mining contain PM_{10} and $PM_{2.5}$ particulates in a ratio between 13 and 28. A PM_{10} concentration at the 60 $\mu g/m^3$ would therefore indicate a $PM_{2.5}$ concentration less than 5 $\mu g/m^3$, i.e. significantly less than the objective/assessment criteria of 36 $\mu g/m^3$;

- the maximum $PM_{2.5}$ concentration, 24 hour average, will be 5 $\mu g/m^3$ or less so the annual average is expected to be of the order of 1-2 $\mu g/m^3$. The proportion of the $PM_{2.5}$ material that is crystalline silica will be 30% or less so the annual average concentration of crystalline silica in the $PM_{2.5}$ can be expected to be 0.6 $\mu g/m^3$ or less, i.e. well below the assessment criteria 3 $\mu g/m^3$; and

- the use of measures to keep exposure to radionuclides As Low as Reasonably Achievable (ALARA) is a requirement of Iluka's Radiation Management License issued under the *Radiation Act 2005* and compliance with this requirement can be expected.

It is evident from the above that, in this case:

- the only possibly relevant assessment criteria are PM_{10}, $PM_{2.5}$, crystalline silica as $PM_{2.5}$ and arsenic; and
- demonstration of compliance with the PM_{10} assessment criteria will provide demonstration of compliance with the assessment criteria for $PM_{2.5}$, crystalline silica as $PM_{2.5}$ and arsenic.

It is therefore proposed that the standard that needs to be met for the protection of air quality at sensitive receptors, i.e. an occupied residence, is a 24 hour average concentration of PM_{10} of 60µg/m^3 or less.

9.3 Management

Measures aimed at minimisation of dust emissions include:

- clearly marked roads to ensure vehicle movements are confined to areas where dust control can be applied;
- gravel sheeting of all unsealed roads;
- where practical, application via water truck of water and, if required, biodegradable crust forming chemicals to:
  - unsealed roads;
  - deposited materials within the pit;
  - stockpiles; and
  - other exposed areas;
- a prohibition on stockpiling of materials for disposal outside of the pit;
- covering of disposed of materials in areas that not are subject to active deposition and, if required, the treatment of the cover material with crust forming chemicals;
- limiting any dust creating works (i.e. earthmoving activities) on high dust-risk (dry windy) days;
- strictly enforced speed limits on all vehicles;
- tarpaulins and sealed tailgates on all trucks/trailers carrying materials for disposal; and
- site inductions for all drivers and equipment operators to ensure awareness of the importance of dust minimisation and the means by which it can be achieved.

These measures collectively represent best practice procedures for dust control.

9.4 Impact Assessment

The impact on air quality can be expected to be the similar if not the less than that which has occurred since mining at the Douglas site was completed. The 24 hour average concentrations of PM_{10} in the air have been measured on numerous occasions since mining was completed at:

- a residence not in Iluka ownership (private residence); and
- a residence owned by Iluka (Iluka house).

The results of these measurements, excluding those where an impact form farming or mining activities unrelated to disposal are shown in Table 23.

Table 23: PM_{10} concentration monitoring results since completion of mining

	Iluka House	Private Residence
Distance from Pit 23 (m)	2000	4750
Bearing from Pit 23 centroid	86.7º	99.6º
Number of Measurements	232	240
PM_{10} Concentration (µg/m^3)		
Average	8.3	11.1
Maximum	42.8	50.0
Minimum	0.04	0.39

The data in Table 23 shows:

- no exceedances of the 60 µg/m^3 objective have been detected; and
- the average PM_{10} concentration at the private residence is greater than that at the Iluka house even though the Iluka house is closer to Pit 23.

While dust generated from the delivery and disposal of materials in the future will be identical to that of the post-mining period to date, the PM_{10} concentrations at these receptors may reduce as disturbed areas on the remainder of the Douglas site are revegetated.

Based on past performance it is safe to predict that compliance with the recommended limits will be achieved.

9.5 Monitoring

Air quality monitoring will be aimed at:

- confirming the prediction of compliance with the recommended limit; and
- triggering action to reduce impacts on air quality, if such action is required.

To achieve the first purpose the concentration of PM_{10} in the air at sensitive receptors will be measured. The measurement locations are shown in Figure 17. Measurements will be made:

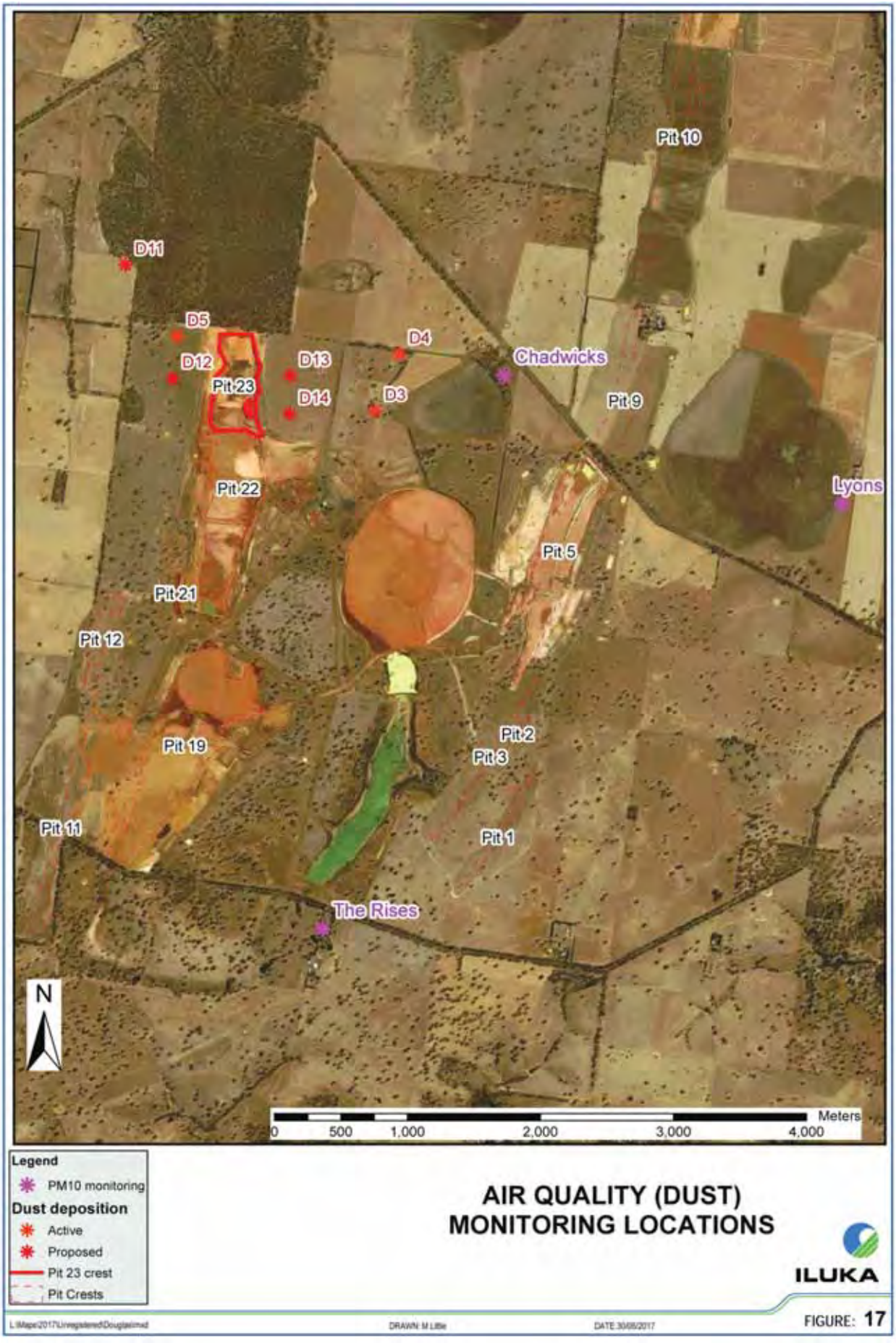
- in accordance with AS\NZS 3580.9.6:2003 (R2014) -*Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM_{10} high volume sampler with size-selective inlet - Gravimetric method* with weighing of collected particulates being performed at a NATA registered laboratory; and
- on a six day cycle, ensuring that variations with the days of the week can be detected.

Monitoring of PM_{10} concentrations will be continued until consistent compliance of the development and use has been demonstrated.

While the Mining PEM does not specify dust deposition rates to be complied with, it does state:

> "Deposited dust is an indicator of the effectiveness of site management practices and the potential for offsite nuisance. Deposited dust should be monitored at the site boundary for most operations. Monitoring is conducted with dust deposition gauges that should be located both upwind and downwind of the site to reflect the impact of the mining or quarry operations during the most predominant wind directions. Results of monitoring should not exceed 4g/m^2/month (no more than 2g/m^2/month above background) as a monthly average. If dust levels exceed this value then site management practices should be reviewed and dust controls implemented to reduce dust levels to within these guidelines." (Mining PEM, Section 4, page 12)

To implement this recommendation, dust deposition rates will be measured at locations shown in Figure 17 with the measurements being made in accordance with AS/NZS 3580.10.1: 2003, *Methods for sampling and analysis of ambient air Determination of particulate matter - Deposited matter - Gravimetric method.* Processing and weighing of collected material will be performed in a NATA registered laboratory. Measurements will be made monthly.


Pit 10
D11
D5
D4
D12
D13
Chadwicks
Pit 23
D14
D3
Pit 9
Pit 22
Lyons
Pit 5
Pit 21
Pit 12
Pit 19
Pit 2
Pit 3
Pit 11
Pit 1
The Rises
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Meters
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1,000
2,000
3,000
4,000
Legend
PM10 monitoring
Dust deposition
Active
Proposed
Pit 23 crest
Pit Crests
AIR QUALITY (DUST)
MONITORING LOCATIONS
ILUKA
DRAWN: M Little
FIGURE: 17

Neither PM_{10} nor dust deposition monitoring enables a real time assessment of the effectiveness of the management measures in place due to the time required to make the measurements and the laboratory processing and weighing required. To provide real time assessment site inspections will be made with the need for such an inspection being triggered by the daily forecasts of wind speed, temperature and rainfall. Such forecasts, by the Bureau of Meteorology, will be examined on a daily basis and, if criteria set by the Environmental Superintendent or Environmental Specialist are met. on-site supervisory personnel will make morning and afternoon observations from Elliotts Road to determine if there is any visible dust leaving the site. The observations made will be recorded and reported to operating personnel.

9.6 Management Response

The primary line of management response will be in reaction to observations of visible dust generated from the disposal of rehabilitation. Actions that may be taken if levels of visible dust are excessive include:

- increasing dust suppression by watering;
- enforcement or reduction of speed limits;
- restriction of earthmoving activities in Pit 23; and
- suspension of dust generating activities.

Additional management responses will be triggered by monitoring results if a “dust event” occurs with a dust event being defined as follows:

- A downwind dust deposition rate greater than 4 g/m^2/month and exceeding the upwind dust deposition rate by more than 2 g/m^2/month
- PM_{10} concentrations as follows:

  Precautionary and upper trigger levels being set at 50 $\mu g/m^3$ and 60 $\mu g/m^3$ respectively.

  If a monitoring result above either trigger level is obtained the first matter to be determined is whether the elevated PM_{10} concentration is due to the activities associated with the development and use. This determination will be based on the measured PM_{10} concentrations at the Chadwick’s and Lyon’s residences. Possible results and the consequent interpretation as to the association with the development and use of the elevated PM_{10} concentrations are shown in Table 24.

Table 24: Determination of association with elevated PM_{10} concentrations

Location	Measured Concentration		Associated
Chadwick's	>Trigger Level	>Lyon's	Yes
Chadwick's	>Trigger Level	<Lyon's	No
Lyon's	>Trigger Level	>Chadwick's	No
Lyon's	>Trigger Level	<Chadwick's	Yes

If it is determined that the elevated PM_{10} concentration is not associated with the development and use then a dust event has not occurred.

If it is determined that the elevated PM_{10} concentration is associated with the development and use and the measured concentration is between the precautionary and upper trigger then a dust event has not occurred.

If it is determined that the elevated PM_{10} concentration is associated with the development and use and the measured concentration is at or above upper trigger level then a serious dust event has occurred.

If a dust event occurs:

- On-site personnel will:
    - Implement additional or improved dust control measures that may include:
        - increasing dust suppression by watering;
        - enforcement of speed limits;
        - application of crust forming chemical;
        - management measures on overburden and soil stockpiles such as watering and application of crust forming chemicals; and
        - restriction of earthmoving activities in Pit 23;and
    - complete a review of the operation following a standard checklist prepared by an Iluka senior environmental advisor and submission of the results to such an advisor. The items on the checklist will include the information required to assess each of the following for the day of elevated PM_{10} concentration:
        - the level of activity associated with the development and use (loads, equipment operating hours etc.);
        - un-associated activities being conducted (other rehabilitation works, farm related etc.);
        - the weather conditions on the day of elevated PM_{10} concentration (wind speed, wind direction, rainfall, temperature etc.);
        - the extent to which required practices were, or were not, being implemented (dust suppression watering, speed limits, road condition, chemical dust suppression; and
        - The appropriateness of the corrective actions taken.
- the Environmental Superintendent or Environmental Specialist will review the checklist completed by the onsite personnel and instigate additional action if considered necessary.

If a serious dust event occurs, in addition to the actions described above:

- the Environmental Superintendent or Environmental Specialist will complete an on-site inspection to assess current practice and determine additional actions that should be taken;
- an exception report, as described in Section 12 of this document will be prepared and submitted to the Responsible Authority; and
- if the results of PM_{10} concentration measurements made in the following two weeks show concentrations above the upper trigger level, disposal operations will be suspended until PM_{10} concentration below the precautionary trigger level is obtained.

9.7 Management, triggers, actions and contingency plans.

The management of air quality, action triggers, management actions and contingency plans are summarised in Section C of Appendix B.

9.8 Reporting

Reporting on air quality matters will be in accordance with Section 12 of this document and will include both exception and routine reporting.

9.9 Audit regime

Auditing will be as described in Section 13 of this document.

9.10 Plan review and amendment

Review and amendment of this plan will be as described in Section 14 of this document

10 Management of other environmental aspects

10.1 Noise

10.1.1 Assessment of risk

The major impact on the acoustic environment will be the noise generated by:

- trucks delivering materials for disposal to the mining void and travelling back to Elliotts Road; and
- earthmoving machinery operating within Pit 23.

Consideration of noise emissions from a combination of a truck/trailer and front end loader operating within Pit 23 showed that noise emissions would be below the recommended limit during the Night period, and would be unlikely to be noticeable during the Evening and Day periods.

No noise complaints were received during the mining operations when more plant and equipment was operating.

The risk of adverse impact on the acoustic environment is assessed as being low.

10.1.2 Standards

The Permit includes the following condition:

Noise

10 The permit holder must comply with noise limits determined in accordance with the EPA *Guideline Publication 1411, Noise from Industry in Regional Victoria* (NIRV: EPA Publication 1411, 2011), or any subsequent replacement document.

The EPA Publication 1411 – Noise from Industry in Regional Victoria (the NIRV) provides a method for determining recommended maximum noise levels at sensitive receptors, and use of this method determines the Zone Levels to be as shown in Table 25.

Table 25: Maximum noise levels at sensitive receptors

Period	Times/days	Recommended maximum noise level, dB(A)
Day	07:00 -18:00 Monday-Friday 07:00 – 13:00 Saturday	46
Evening	18:00 - 22:00 Monday-Friday 13:00 - 22:00 Saturdays 07:00 – 22:00 Sundays and public holidays	41
Night	22:00 – 07:00 all days	36

The relevant noise sensitive areas are occupied residences.

It is noted that the NIRV provides for variations to these noise limits in certain circumstances including “final site rehabilitation”, which is defined as “any activity related to site closure occurring at the final surface level after normal operations have ceased. It does not include backfilling of a pit” (NIRV Table 4). The allowed variation is for the recommended maximum noise level to be increased by 10 dB up to a maximum of 68 dB(A) with the following conditions applying:

- the allowance should be approved for a limited period of exposure for each noise sensitive area with the start and finish dates specified by the operator being communicated to affected neighbours;
- where the project continues over a significant number of years, an allowance for multiple, well separated periods may be given;
- an allowance period is counted as the total period from start to finish , in which noiser works are programmed; and
- weather conditions that increase noise at sensitive areas to make it above the recommended levels (propagation conditions “favourable to noise propagation”) should be assumed for noise modelling and works programming, regardless of the actual conditions when the works occur.

Pit backfilling and placement/profiling of topsoil and subsoil are activities that fit the description of final site rehabilitation therefore the noise limit at sensitive receptors during the “Day” as defined in Table 25 are expected to increase to 56 dB(A) during such activity.

10.1.3 Management

Noise mitigation measures that will be applied include the following:

- strictly enforced on-site speed limits on all vehicles;
- the fitting and maintenance of approved mufflers on all equipment;
- limitation of in-pit earthmoving to “Day” except in emergency situations; and
- site inductions for all drivers and equipment operators to ensure awareness of the importance of noise minimisation and the means by which it can be achieved.

10.1.4 Monitoring

Routine monitoring to confirm compliance with recommended noise limits is not required or proposed. In the unlikely event of complaints regarding noise levels are received, measurements of noise levels will be made.

10.1.5 Management, triggers, actions and contingency plans

The management of noise, action triggers, management actions and contingency plans detailed above have been collated into Section D of Appendix B.

10.2 Weeds

10.2.1 Assessment of risk

The presence of weed species during the operational phase has the potential to have a significant impact on revegetation and regeneration outcomes of rehabilitated areas due to contamination of topsoil with seed and other weed material.

10.2.2 Standards

Declared noxious weeds in Victoria are plants that have been proclaimed under the *Catchment and Land Protection Act 1994* (the CaLP Act). These plants cause environmental or economic harm or have the potential to cause such harm. They can also present risks to human health. The CaLP Act defines four categories of noxious weeds:

- **State Prohibited Weeds**. Species that either do not occur in Victoria but pose a significant threat if they invade or species that are present and pose a serious threat that can reasonably be expected to be eradicated. They are to be eradicated from Victoria if possible or excluded from the State. The Victorian Government is responsible for their

eradication, but under Section 70(1) of the CaLP Act, it may direct land owners to prevent their growth and spread.

- **Regionally Prohibited Weeds**. Usually species that are not widespread in a region but are capable of spreading further. It is reasonable to expect that they can be eradicated from a region and they must be managed with that goal. Land owners, including public authorities responsible for Crown Land management, must take all reasonable steps to eradicate regionally prohibited weeds on their land but not on roadsides adjoining their property.
- **Regionally Controlled Weeds**. Usually widespread and require continual control measures. Land owners have the responsibility to take all reasonable steps to prevent the growth and spread of regionally controlled weeds on their land.
- **Restricted Weeds.** This category includes plants that pose an unacceptable risk of spreading in this State and are a serious threat to another State or Territory of Australia. Trade in these weeds and their propagules, either as plants, seeds or contaminants in other materials is prohibited.

The *Wimmera Invasive Plant and Animal Management Strategy 2010-2015* (Wimmera CMA, 2010) outlines the principles and logic that government agencies, industry and the community can use to take a strategic and coordinated approach to regional management of invasive plants and animals (IPA). The strategy aims to coordinate and prioritise efforts between government, industry and the community to make a tangible and measurable difference to management of IPA on a whole-of-catchment scale in line with the stated vision "*to prevent new highly invasive plants or animals becoming established and to protect high-value assets to a standard that allows normal functions and processes to continue*".(Wimmera CMA 2010 Section 2, page 9)

The strategy establishes priorities to maximise the public benefit from public funding at a regional scale, while understanding that community work on local priorities are a valid and important contribution to regional pest control. The strategy replaces the *Wimmera Rabbit Action Plan 2000–2005* and *Wimmera Weed Action Plan 2000–2005*.

The strategy has the following objectives:

1. No new high risk pest incursions into the region.
2. High risk new and emerging IPA species eradicated from the region.
3. Containment of invasive species with limited distribution and potential to spread further within the region.
4. High-value assets protected from invasive pests (to the extent that their natural functioning is not impaired),
5. Establishment of pest management targets and monitoring and reporting on progress towards those targets.

The strategy divides IPA management actions into either a species-based approach or an asset-based protection approach, with the highest priority activities being those listed under the species-based approach.

Appendix 4 of the strategy lists the pest plants of concern in the Wimmera region, and categorises them with regard to the type of action required, being:

- Prevent and Eradicate
- Contain (and eradicate where practical); and
- Asset Protection

It is also recognised that other vegetation species not listed as invasive weeds can adversely affect the success of revegetation efforts, and are also considered in the following monitoring and management activities.

10.2.3 Management

Weeds will be managed by the following means:

- washing equipment prior to entry or exit through the Douglas Mine boom-gate access;
- herbicide spraying or scalping of weeds from operational areas, and from topsoil stockpiles;
- spot spraying of identified weed infestations within revegetated areas;
- hand pulling of weeds, when appropriate; and
- where gravel, crushed rock or other material is required to be imported to site, care will be taken to ensure that the material is free from noxious weed seed.

The need for herbicide spraying, scalping of weeds, spot spraying and hand pulling of weeds will be determined on the basis of the results of quarterly site inspections and observations made by on-site and environmental personnel.

To limit any potential of spray drift and impact to native plants through the root zones, Glyphosate formulations will be used as the standard approach for weed control by herbicide in the operational areas. In the event that Glyphosate formulations are found to be ineffective the advice of ecological/revegetation experts as to the best herbicide for a given weed species and the use of that herbicide will be subject to a risk assessment prior to its use.

10.2.4 Monitoring

Monitoring for weeds will include:

- quarterly site inspections to identify potential weed infestations, provide the scope for weed control programs, and to assess the success of such programs; and
- vehicle hygiene inspections as described in the following section.

10.2.5 Management, triggers, actions and contingency plans

The management of weeds, action triggers, management actions and contingency plans are summarised in Section E of Appendix B.

10.3 Vehicle hygiene

10.3.1 Assessment of risk

Light vehicles, vehicles delivering materials for disposal and earthmoving equipment that have operated within Pit 23 and subsequently exit the site have the potential to transfer mud, soil, residual NORM or weed plant material and/or seeds onto the public road system or other sites. This risk is increased during wet conditions.

10.3.2 Standards

The Permit includes the following condition:

Vehicle-wash

12 All vehicles, earth-moving equipment and other machinery must be cleaned of soil and plant material before leaving the designated Pit 23 site, to prevent the spread of weeds and pathogens, and to ensure vehicles leaving the site do not deposit mud or other materials on roadways, to the satisfaction of the responsible authority. Accumulated waste and debris from the clean-down process must be periodically removed from sediment traps associated with the clean-down facilities and disposed of within Pit 23, or otherwise in a manner to the satisfaction of the responsible authority.

13 The permit holder must ensure that all public roads within 200 metres of the intersection of the mine access road with Elliotts Road are maintained free of debris, mud, clay or other deposits, from the Subject Land, to the satisfaction of the responsible authority.

10.3.3 Management

Plant, vehicles and machinery will be washed down prior to leaving site, either through the truck wash or at the workshop wash-down bay.

Road-going trucks and light vehicles will pass through the truck wash which is automatically activated and consists of:

- a series of three water tanks;
- a pump delivering water from the tanks to the wash bay; and
- a wash-bay fitted with spray nozzles and a collection pan.

Water and solids collected on the collection pan are returned to the tanks. When required, sediment collected in the tanks is removed, subjected to analysis for hydrocarbon contamination, treated to remove hydrocarbons (where required), and then transported by truck to Pit 23 for disposal.

In the event that the truck wash facility is non-operational alternative vehicle cleaning methods will be applied, including:

- brushing down in the pit;
- hose-down in the workshop wash down bay; and
- portable tank and pump for hose-down in the pit.

Items that cannot fit through the truck wash such as some earthmoving machinery will be washed down at the workshop wash-down bay. The wash-down bay has a concrete surface that drains into a sump and triple interceptor. When required, sediment collected in the triple interceptor is removed, subjected to analysis for hydrocarbon contamination, treated to remove hydrocarbons (where required), and then transported by truck to Pit 23 for disposal. Hydrocarbons collected in the triple interceptor are collected and disposed of by a licenced waste contractor.

Any debris, mud, clay or other material from the site deposited on any public road surface within 200 metres of the intersection of the mine access road with Elliotts Road will be recovered and disposed of on the site.

10.3.4 Monitoring

Monitoring associated with ensuring vehicle hygiene includes:

- weekly confirmation of truck wash operational performance;
- inspection each working day of the mine access road and public roads within 200 metres of the mine access road utilised by vehicles departing the site for mud and debris arising from the site operations; and
- vehicle hygiene inspections of:
    - earthmoving machinery, drill rigs, and other plant and equipment prior to entry or exit through the Douglas Mine boom-gate access; and
    - light vehicles and equipment prior to entry or exit through the Douglas Mine boom-gate access if previously used within known areas of weed infestation.

10.3.5 Management, triggers, actions and contingency plans

The management of vehicle hygiene, action triggers, management actions and contingency plans are summarised in Section F of Appendix B.

10.4 Feral animals

10.4.1 Assessment of risk

Prohibited pest animals are animals that did not occur naturally in the wild in Australia before European settlement and today pose, or have the potential to pose, a serious threat to primary production, Crown Land, the environment or community health in Victoria. Established pest animals in the region include rabbits, foxes, and feral cats.

The presence of rabbits, foxes and cats has been monitored through recordings of visual sightings since mining operations at the Douglas Mine site commenced in 2005. Irregular cat sightings have meant that implementation of control programs has not been warranted. Rabbit control programs are undertaken on an as-needs basis. Fox baiting programs have generally been undertaken annually during the mining and rehabilitation phases of the mine.

The potential risk posed by feral animals due to the disposal operations is therefore relatively minor; however, control of populations is important to ensure the continued good relationships with neighbouring landholders.

10.4.2 Standards

Pest animals are those that have been declared as prohibited, controlled or established under the *Catchment and Land Protection Act 1994*.

Rabbits are declared as a threatening process under the *Flora and Fauna Guarantee Act 1988* and designated as priority species for eradication and control in the Wimmera.

The *Wimmera Invasive Plant and Animal Management Strategy 2010-2015* (Wimmera CMA, 2010) identifies rabbits, foxes and feral cats as the invasive animals of concern in the Wimmera region.

The strategy outlines that rabbit densities need to be kept low to minimise erosion of landscapes and regeneration of slow growing native woodlands such as Bulokes, and defines rabbit densities as:

> **High** if spotlight counts exceed six per km, and/or warren counts >3 active entrances per ha, and/or faecal pellet counts >15 per quadrat (0.25 m^2).
>
> **Moderate** if spotlight counts range between three and six per km, and/or warren counts in 1–3 active entrances per ha, and/or faecal pellet counts 10–15 per quadrat (0.25 m^2).
>
> **Low** if spotlight counts <3 per km, and/or warren counts <1 active entrance per ha, and/or faecal pellet counts <10 per quadrat (0.25 m^2).

The strategy does not provide equivalent acceptable thresholds for density of foxes or feral cats; however a reduction in density should be the aim of any control programs in the target area.

10.4.3 Management

A feral animal control strategy will be implemented to minimise detrimental impacts on operational areas, adjacent farmland and remnant native vegetation by feral animals. Feral animals will be controlled by the following means:

- ripping of identified burrows or dens;
- baiting for rabbits, foxes and cats; and
- trapping of cats if deemed necessary.

10.4.4 Monitoring

Monitoring for feral animal species will include:

- recording of feral animal sightings or evidence of activity via the Loss Control Card reporting system; and
- 6 monthly spotlight surveys.

The monitoring results will be used to develop the requirement and scope for feral animal control programs, and assess the success of such programs.

10.4.5 Management, triggers, actions and contingency plans

The management of feral animals, action triggers, management actions and contingency plans are summarised in Section G of Appendix B.

10.5 Geotechnical stability

10.5.1 Assessment of risk

As a former mine site that is still subject to rehabilitation earthworks and active disposal operations, Pit 23 and the associated infrastructure areas are subject to the following potential geotechnical risks:

- erosion and/or tunnelling of the pit crest and wall due to surface water runoff from adjacent stockpiles;
- slumping or failure of 10-15m high Pit 23 walls; and
- differential settlement of the rehabilitated pit surface jeopardising the ability to meet final landform closure criteria.

10.5.2 Management

Current mitigation measures include:

- regular inspections of pit walls and tip heads by site personnel;
- annual inspections of pit walls and tip heads by a geotechnical engineer;
- bunds along the Pit 23 crest to divert surface water runoff from adjacent stockpiles away from the pit crest; and
- bunding of signed exclusion zones to prevent unauthorised access to the toes of the pit walls.

These measures are considered adequate for current disposal activity, however, geotechnical risks will be the subject of a detailed investigation within six months of the commencement of the development and use. This investigation will include:

- cone penetration testing;
- pit slope stability assessment including modelling to determine:
    - factors of safety for current pit walls;
    - potential point of failure and zero disturbance line; and
    - identification of remedial measures required, if any;
- assessments of the performance of previously filled pits;

- assessment of long-term settlement of pit backfill materials based on consolidation analyses; and
- determination of backfill methodology required to meet closure objectives including methods for the disposal steel and concrete such that void space into which sand etc. can flow is not created.

10.5.3 Monitoring

Monitoring associated with geotechnical stability includes:

- Inspection of active tip-heads prior to accessing;
- documented monthly inspection of Pit 23 walls, tip-heads, haul roads and hard stand areas by site personnel; and
- documented inspection of Pit 23 by the Iluka geotechnical engineer either:
    - annually; or
    - as required.
- the adequacy of this monitoring regime will be assessed as part of the geotechnical investigation described above and may be modified as a result of that assessment.

10.5.4 Management, triggers, actions and contingency plans

The management of geotechnical aspects, action triggers, management actions and contingency plans detailed above have been collated into Section H of Appendix B.

10.6 Site safety and security

10.6.1 Assessment of risk

As a former mine site that is still subject to rehabilitation earthworks and active disposal operations Pit 23 and the associated infrastructure areas pose the following potential risks to public health and safety:

- interaction with heavy earthmoving equipment and trucks;
- fall from the crest of 10-15m high Pit 23 walls;
- slips/trips/falls associated with rough and/or slippery ground surfaces; and
- exposure to radiation from disposed materials.

10.6.2 Management

The measures implemented to ensure site security and public safety during mining operations will remain in place throughout the disposal and rehabilitation phases. Risk to public health and safety are primarily managed through restriction of access into the site. Management actions to minimise or prevent radiation exposure to members of the public are in accordance with the requirements of Radiation Management Licence 300042022, as issued by DHHS to Iluka.

Warning signs indicate that access is restricted to authorised personnel with visitors being required to:

- use approved access routes;
- report to the site administrative office; and
- be accompanied by a designated Iluka representative when on-site.

The main access gate consists of a boom-gate operated by a swipe-card issued to inducted employees and contractors, or which can be opened by site staff in response to a visitor request

over the access gate intercom. After hours or on non-working days the security boom-gate is supplemented by a closed and padlocked mesh farm gate.

All alternative farm gate entry points into the site are padlocked. A chain mesh security fence constructed along the outer toe of the overburden stockpiles at the northern end of Pit 23 prevents unauthorised access to the pit crest.

10.6.3 Monitoring

Monitoring associated with ensuring public health and safety includes:

- confirmation on each working day that the security boom-gate is operating satisfactorily;
- monthly inspection of the Pit 23 security fence; and
- monthly download and inspection of security camera footage from Pit 23 and other areas.

10.6.4 Management, triggers, actions and contingency plans

The management of site security and safety, action triggers, management actions and contingency are summarised in Section H of Appendix B.

10.7 Radiation

Under Section 22 of *the Radiation Act 2005*, it is an offence to knowingly, recklessly or negligently cause another person to receive a radiation dose that is greater than the prescribed dose limit. Requirements of Radiation Management Licence 300042022 issued to Iluka include management actions to ensure doses are below the prescribed limit.

It is a requirement of Iluka's Radiation Management Licence that works are conducted in accordance with a Radiation Management Plan and a Radioactive Waste Management Plan and that the Department of Health and Human Services are satisfied that implementation of these plans will result in compliance with the prescribed dose limit.

Under these circumstances detailing of the management measures and monitoring program in this plan is unnecessary.

11 Stakeholder Engagement

In accordance with the requirements of the Permit:

- contact details will be provided of a person or people for the receipt and actioning of complaints and other comments relating to activity on the site;
- a register of complaints and other comments will be maintained; and
- EMP and Rehabilitation performance reports, which will be provided to the Responsible Authority and published on Iluka's website, will include a "complaints statement" summarising the complaints register and actions taken in response to complaints.

12 Reporting

The reporting requirements for this EMP include:

- exception reporting, which is the reporting of non-compliance with standards/limits; and
- routine reporting.

12.1 Exception reporting

For the following environmental aspects there are specific standards that must be met.

- noise – limits recommended in NIRV;
- air quality – 24 hour average PM_{10} concentration at sensitive receptors of 60µg/m^3 ;
- groundwater – objectives set in the Groundwater SEPP; and
- surface water – objectives set in the WoV SEPP.

The approved Radiation Management Plan details the requirements for radiation-related exception reporting to DHHS.

Within one (1) week of receiving a monitoring result indicating non-compliance with a noise or air quality limit, or a confirmed observation of an indicator concentration in groundwater or surface water above an upper trigger level a report will be provided to the Responsible Authority. Such reports will include:

- details of the observation including magnitude and the identified causes;
- a description of immediate actions taken; and
- if appropriate, a plan of action aimed at preventing on-going exceedances of limits or upper trigger levels complete with a schedule for implementation.

Should no response from the Responsible Authority be received within four (4) weeks the actions taken and proposed will be deemed appropriate and sufficient, and it will be taken that no additional actions are required.

12.2 Routine reporting

A review of performance will be completed and an EMP and Rehabilitation Performance Report prepared annually, or less frequently as may be agreed with the Responsible Authority.

Each EMP and Rehabilitation Performance Report will include, at least:

- for the period from the previous EMP and Rehabilitation Performance Report:
    - the total tonnage of materials disposed of;
    - the average and maximum number of deliveries of materials for disposal per day; and
    - the results of all measurements of:
        - noise levels made in response to a complaint regarding noise;
        - PM_{10} concentrations in air at sensitive receptors;
        - environmental radiation monitoring results in accordance with the approved Radiation Management Plan, which will generally include:
            - radon concentration in air;
            - gross alpha activity concentration of airborne dust; and
            - radionuclide concentrations in groundwater and surface water;

        - the results of all measurements of groundwater level and quality;
        - the results of and actions taken in response to monitoring bore audits;
    - discussion of any implications of the results of groundwater level monitoring on groundwater flow paths form Pit 23; and
    - descriptions of any model review and recalibration completed and the results of subsequent model re-runs;
- the maximum elevation of the upper surface of materials disposed of at the end of the reporting period;
- a detailed discussion of all non-compliant events including progress toward resolution;
- a summary of comments and complaints received and resulting actions;
- plans for the next reporting period; and
- discussion on other matters considered relevant by the Responsible Authority or Iluka.

Deficiencies identified in an EMP and Rehabilitation Performance Report that can be addressed without amendment of this plan will be addressed as soon as practicable.

EMP and Rehabilitation Performance Reports will be subject to review by an independent auditor as described in Section 13.2 below.

13 External auditing

The following functions will be performed by experts:

- as required by Condition 17 of the Permit this plan must receive the endorsement of an environmental auditor appointed under the *Environment Protection Act 1970* (EPA Accredited Auditor);
- as required by Condition 20, EMP and Rehabilitation Performance Reports must be reviewed by and independent, suitably qualified person with expertise in risk management plans in the context of mines and quarries who is an EPA Accredited Auditor;
- a suitably qualified expert is required to:
    - complete an audit of modelling work; and
    - if considered necessary, complete a review of model calibration and use. (modelling review)

13.1 Plan endorsement

While the Permit requires the endorsement of an EPA Accredited Auditor the function of plan endorsement is not an audit function. The requirement for an EPA accredited auditor is one means by which a reputable and reliable person can be selected to complete the task. EPA accredited auditors are of three types; contaminated land, industrial facilities and natural resources. In this case an industrial facilities or contaminated land auditor are considered appropriate.

The selected auditor will be commissioned to review the EMP to form a view as whether:

- the EMP fully meets the requirements of the Permit; and
- implementation of the EMP can be reasonably expected to result in the achievement of the objectives of the EMP.

If the selected auditor reaches affirmative views then the auditor will provide formal endorsement of the plan.

It is highly unlikely that an EPA accredited auditor with qualifications and experience in the considerable range of disciplines required will be able to be identified. It is therefore expected that the selected auditor will utilise the services of other experts to assist in the review of the plan.

It is noted that there is no requirement for the selected auditor to be independent of Iluka or to be to the satisfaction of the Responsible Authority.

A report by the selected auditor, including endorsement of the EMP, will be provided to the Responsible Authority with the plan submitted.

13.2 Performance review

The performance review function is, in part, an audit function in that the selected auditor will be required to audit EMP and Rehabilitation Performance Report to confirm its completeness and accuracy in terms of compliance of the implementation of the plan and compliance with established standards and limits.

In addition to these audit functions the selected auditor will be invited to recommend amendments to the EMP to ensure future compliance.

There are a number of requirements of the expert in this case, including:

- EPA auditor accreditation;
- independence (from Iluka);
- suitable qualifications;

- expertise in risk management plans in the context of mines and quarries; and
- to the satisfaction of the Responsible Authority.

It is extremely unlikely that an expert meeting all of these requirements exists, however, an expert may choose to direct the work of others.

A scope of works will be prepared and a number of EPA accredited auditors asked to submit proposals for the completion of performance reviews. Iluka will select the best candidate and provide the Responsible Authority with details of the candidate and their proposal for completion of works. The Responsible Authority may indicate its agreement with the candidate selected or request that details of an alternative be provided.

A copy of the selected auditor's report will be provided to the Responsible Authority with each EMP and Rehabilitation performance review report.

Any deficiencies identified or recommendations made by the auditor will be dealt with in accordance with Conditions 44 and 45 of the Permit, which require:

- Copies of the EMP and Rehabilitation Performance Report and the auditor's report to be provided to the Responsible Authority with 28 days of receipt of the auditor's report
- A description of steps to be taken, including timeframes, to address any non-compliance and recommendations identified in the EMP and Rehabilitation Performance Report and the auditor's report be provided to the Responsible Authority within 28 days of submission of the EMP and Rehabilitation Performance Report to the Responsible Authority;
- The Responsible Authority to determine whether amendment to the EMP or R&VMP is required and the timeframe and conditions under which such amendment is to occur.

13.3 Groundwater Modelling review

Groundwater modelling reviews requires particular qualifications, experience and expertise rather than EPA auditor accreditation. An expert in the field of hydrogeological/solute transport will be selected, by Iluka, on relevant criteria.

A copy of the modelling expert's report will be provided to the Responsible Authority.

14 Review and Amendment

This plan will be reviewed within two years of the commencement of the development and use but may be reviewed at any time. Such reviews may identify the need for amendments to the EMP as described below.

This plan may be amended with the consent of the Responsible Authority. Such amendments may be proposed by:

- Iluka to take account of:
  - knowledge gained from the results of the monitoring program;
  - advances in knowledge and technology pertaining to disposal;
  - changes in applicable legislation or standards; and
  - changes in Iluka's EHS standards; or
- the expert completing a review of an EMP and Rehabilitation Performance Report.

In the case of an amendment proposed by Iluka a request for an amendment will be provided to the Responsible Authority, which will include:

- the purpose and objectives of the amendment;
- a detailed description of the amendment proposed;
- a detailed assessment of the potential impact of the proposed amendment; and
- an assessment of risk associated with the proposed amendment.

In the case of an amendment recommended by the expert completing a review of the EMP and Rehabilitation Performance Report, Iluka will either:

- request an amendment as recommended by the expert; or
- request an amendment that achieves the objectives of that recommended by the expert but by alternative means.

In the case of the latter the requested amendment must be accompanied by an endorsement by the expert.

Once approved by the Responsible Authority, amendments will be incorporated into the EMP and the amended plan made available to the public via the Iluka website.

15 Acronyms

AHD	Australian Height Datum
ALARA	As Low As Reasonably Achievable
AQDCP	Air Quality/Dust Control Plan
ARI	Average Recurrence Interval
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
Bq	Becquerel
CA	Crown Allotments
CaLP Act	*Catchment and Land Protection Act 1994*
CDM Smith	CDM Smith Australia Pty Ltd
DHHS	Department of Health and Human Services
DO	Dissolved oxygen
EC	Electrical conductivity
EHSMS	Iluka's Environmental, Health and Safety Management System
EMP	Environmental Management Plan
EPA	Victorian Environment Protection Auuthority
EVC	Ecological Vegetation Classes
FWD	Freshwater Dam
g	gram
GDE	Groundwater dependent ecosystem
Groundwater SEPP	State Environment Protection Policy (Groundwaters of Victoria)
GWMMP	Groundwater Monitoring and Management Plan
h	hour
ha	Hectare
HMC	Heavy mineral concentrate
Iluka	Iluka Resources Limited
IPA	Invasive plants and animals
IWMP	Incoming Waste Monitoring Plan
Jacobs	Jacobs Australia Pty Ltd
Kd	Partition (distribution) Coefficient
LPS	Loxton-Parilla Sands
m	metre
m^2	square metre
m^3	cubic metre
mg	milligram
µg	microgram
µSv	micro Sievert
MP5	Monitor Pro 5
MRSDA	Mineral Resources (Sustainable Development) Act 1990
MSP	Mineral Separation Plant
NATA	National Association of Testing Authorities, Australia
NAoDGES	National Atlas of Groundwater Dependent Ecosystems

NIRV	EPA publication 1411, Noise from Industry in Regional Victoria, October 2011
NORM	Naturally Occurring Radioactive Material
ORP	Oxidation/Reduction Potential
PM10	Particulate matter with a diameter of less than 10 micrometres
PM2.5	Particulate matter with a diameter of less than 2.5 micrometres
PP	Planning Permit
ppm	parts per million
PEM	Protocol for Environmental Management
QC	Quality Control
QA	Quality Assurance
R&VMP	Rehabilitation and Vegetation Management Plan
RML	Radiation Management Licence
SEPP(AQM)	State Environment Protection Policy (Air Quality Management)
SFM	Shepparton Formation
SWME	Surface water monitoring event
SWMMP	Surface Water Monitoring and Management Plan
the Permit	Planning Permit No. 15-105
TSF	Tailings Storage Facility
TSS	Total suspended solids
TDS	Total dissolved solids
VCAT	Victorian Civil and Administrative Tribunal
Water Quality Guidelines	Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000
WoV SEPP	State Environment Protection Policy (Waters of Victoria)

APPENDIX A

Risk Analysis and Response Plan

Iluka Resources Ltd.
06-Jul-2017

Risk Analysis and Response Plan

Iluka Mineral Sands By-product Disposal Project

Risk Analysis and Response Plan

Iluka Mineral Sands By-product Disposal Project

Client: Iluka Resources Ltd.

ABN: 34 008 675 018

Prepared by

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Quality Information

Document Risk Analysis and Response Plan

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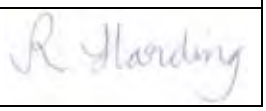
Date 06-Jul-2017

Prepared by Victoria Conlon

Reviewed by Rachel Harding

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	19-Jun-2017	DRAFT	Suanna Harvey	
1	04-Jul-2017	FINAL	Rachel Harding Associate Director	

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1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was commissioned by Iluka Resources Limited (Iluka) to review the EMP[1] for their Mineral Sands By-product Disposal Project at the Douglas Mine, near Horsham.

The EMP and associated Auditor endorsement is a requirement under the Horsham Rural City Council Planning Permit. Conditions 25 and 26 of the planning permit require Iluka to prepare a Risk Analysis and Response Plan (RARP) for inclusion in the EMP.

- **Condition 25**: The risk analysis is to be prepared by a suitable qualified person to accord with best practice processes to identify and quantify uncertainties and estimate their impact on outcomes.
- **Condition 26:** The risk analysis is to include, at least:
    a. A risk register that identifies environmental risks, assigns and prioritises key design, operational and rehabilitation risks over the life of the use and development;
    b. Trigger levels and associated management responses for material identified environmental risks; and
    c. Contingency planning arrangements for any acute risks that could lead to an environmental hazard or pollution event.

The EMP describes the environmental management of the site throughout the operational and rehabilitation phases of the project. The details of the rehabilitation of the mine are provided in the Rehabilitation and Vegetation Management Plan[2]. As the operation is based on filling existing excavations, there is little design other than the provision of facilitating infrastructure on the site and therefore any risks associated with this can be incorporated into the operational risks.

The objective of this report is to respond to the requirements of these conditions:

Condition 25 - This report, section 1.1 and specifically Section 5.1

Condition 26a) – Section 6.2 and Appendix A

Condition 26b) – Section 7.2

Condition 26c) – Section 7.3

1.1 Condition 25

Condition 25 requires that the risk analysis is to be prepared by a suitable qualified person to accord with best practice processes.

The suitably qualified persons responsible for the Risk Assessment and this report were:

- Rachel Harding - Associate Director Environment (workshop facilitator and report reviewer)
- Victoria Conlon - Principal Environmental Scientist (workshop scribe and report author)
- Suanna Harvey - Technical Director Environment and EPA Accredited Environmental Auditor (review of methodology, risk register and risk workshop process).

These staff have been responsible for a number of risk assessments and risk assessment projects.

The methodology used is in line with the Australian Standard AS/NZS ISO 31000:2009 Risk Management Process and based on Risk Assessment methodology described in work reported in Bowden, A.R., Lane, M.R. and Martin, J.H., 2001, Triple Bottom Line Risk Management – Enhancing Profit, Environmental Performance and Community Benefit, Wiley and Sons, New York, 314 pp.

[1] Mineral Sands By-product Disposal Environment Management Plan 21 April 2017, Revision 2
[2] Mineral Sands By-product Disposal Rehabilitation and Vegetation Plan 21 April 2017 Revision 2

The methodology used as described in **Section 5.0** is considered best practice and has been used in the following projects. The risk assessment methodology has been accepted by the Environment Effects Statement (EES) panels and EPAs, where involved.

- Stawell Gold Mine, Big Hill Enhanced Development Project EES.
- Port of Melbourne Corporation, Channel Deepening EES.
- Independence Group (NL), Stockman Base Metals EES.
- Zerogen, Australia, Clean coal power project risk assessment.
- Rio Tinto, Australia, Management of project risk in relation to a major brownfields mine expansion.
- GLNG Santos, Queensland, Australia, CSG to liquids risk assessment.
- Geraldton Port Authority, Australia, Enhancement of port project risk assessment.
- Goulburn Valley Water, Port of Hastings Development Authority, Australia, Enterprise-wide risk assessment and management.
- Rio Tinto (formerly CRA) US, Indonesia, Australia, New Zealand, Assessment of corporate-wide risk issues for development of insurance strategy.
- Assessment of mine closure risk - BHP Billiton, Suriname.

2.0 Project Description

Iluka disposes of heavy mineral processing by-products generated by its Mineral Separation Plant (MSP), located near Hamilton in Southern Grampians Shire, to a mining void (Pit 23) at its Douglas Mine. The EMP and therefore the RARP applies to:

- Pit 23 and the immediate surrounding area.
- The existing mine access road
- The existing haul-road to Pit 23
- A truck washing facility (and access road)
- Mine offices, ablution facilities and car-park.

The site location is shown in **Figure 1**.

Figure 1 Location of Pit 23 and associated Infrastructure, from Iluka EMP Rev 2

Rehabilitation of the remainder of the Douglas Mine is being undertaken in accordance with a rehabilitation plan approved under the *Mineral Resources (Sustainable Development) Act (MRSDA) 1990* and is therefore outside the scope of the EMP and the RARP.

Pit 23 and the associated access roads, offices and car-park are located within parts of four Crown Allotments (CAs 91, 94, 95 and 96) in the Parish of Telangatuk. These allotments are owned by Basin Mineral Properties Pty Ltd. (BMP) which is a wholly owned subsidiary of Iluka. The land is located within the Farming Zone of the Horsham Planning Scheme. Land to the east, south and west is privately owned and land to the north is Crown Land (Public Conservation and Resource Zone).

Iluka began mining mineral sand in 2004 and completed mining in 2012. Since 2012, the main activities at the Douglas Mine have been the deposition of by products from their Mineral Separation Plant (MSP) in Hamilton into Pit 23 and site rehabilitation. The material which is to be disposed into Pit 23, in accordance with the planning permit, is limited to:

- By-products of the processing of heavy mineral concentrate (HMC) at the Hamilton MSP
- Used dust filter bags from the Hamilton MSP
- Concrete and steel from plant and infrastructure that contains or is contaminated with naturally occurring radioactive material (NORM).

The Hamilton MSP by-products include:

- Lighter mineral particles (sand and clay) of spadeable consistency
- Heavier mineral particles as dry sand
- Gypsum, in the form of filter cake.

The total quantity of Hamilton MSP by-products to be disposed of each year ranges between 50,000 and 120,000 tonnes and the Hamilton MSP has a further operational life of approximately 20 years.

The disposal of Hamilton MSP by-products to Pit 23 and associated activities has been ongoing for a number of years under the mining licence Work Plan, approved under the MRDSA. The cessation of mining in Victoria has resulted in the need for a separate approval for the disposal activities, being the planning permit that was issued. Therefore, the past experience with the operational activities that were the subject of the risk assessment were taken into account when assessing the risks.

3.0 Environmental Context

Pit 23 and the Douglas Mine are located approximately 85 kilometres north of Hamilton, approximately 15 – 20 kilometres west of the Grampians National Park. The climate in this area is characterised by cool, wet winters and long dry summers. Average rainfall is 550 mm and average pan evaporation is 1410 mm.

The pre-mining landform of the subject site was gently undulating to flat, typically ranging from 210 m AHD to 190 m AHD. During mining the topsoil, subsoil and overburden were sequentially removed and stockpiled for rehabilitation. Prior to mining at the site, the land was already cleared for agriculture and no further clearance of vegetation is required or envisaged.

The Glenelg River, located approximately three kilometres south of the site is the main surface water feature in the vicinity of the mine site. Surface water will not flow from the area of Pit 23 during operations as the base of the pit is below the ground level.

Based on the conceptual site model (CSM) produced by CDM Smith,

Groundwater recharge via rainfall occurs over the entire Douglas Mine Site. Groundwater flow over the Douglas Mine Site is controlled by the surface and basement rock topography. This results in groundwater flowing to the north, northwest and east from an elongated mound in the water table located over a ridge in the Palaezoic Basement rock. In the vicinity of Pit 23, the groundwater flows to the northwest and north towards McGlashin Swamp, Bitter Swamp, Douglas Depression, Tea Tree Lake, White Lake, Centre Lake and North Lake.

In terms of beneficial use, the groundwater which could be impacted by Pit 23 falls into Segment C or Segment D, therefore the beneficial uses which need to be protected are maintenance of ecosystems, stockwatering, industrial water use, primary contact recreation and buildings and structures.

Once disposal into Pit 23 is complete, the land will be rehabilitated in accordance with the Rehabilitation and Vegetation Management Plan (21 April 2017). The total area to be rehabilitated is estimated to be 58.1 hectare and the proposed end uses are biodiversity conservation for the land currently occupied by Pit 23 plus a buffer zone outside of the pit crest and agriculture for the remainder of the land.

4.0 Environmental Management and Rehabilitation Objectives

Section 4 of the EMP and Section 5.2 of the Rehabilitation and Vegetation Management Plan (RVMP) outline the environmental management and rehabilitation objectives which are to be achieved by the implementation of the EMP and RVMP.

Table 1 Environmental Management and Rehabilitation Objectives

Plan	Aspect of the Environment	Objectives
EMP	Air quality	Off-site air quality is not adversely affected by the development and use
EMP	Noise	Noise emissions from the development and use comply with limits determined in accordance with EPA publication 1411, Noise from Industry in Regional Victoria, October 2011 (NIRV)
EMP	Weeds and feral species	Populations of weeds and feral species are actively managed to minimise spread and reduce numbers
EMP	Native vegetation	No adverse impact to native vegetation communities
EMP	Geotechnical stability	The development and use does not pose an unacceptable risk to the public, site personnel or contractors and the creation of stable final landforms is assured
EMP	Site safety and security	The development and use does not pose an unacceptable risk to the public, native fauna and domestic livestock
EMP	Radiation	Radiation doses arising from the development and use are below the prescribed limits
EMP	Surface water	Surface water runoff during by-product disposal and rehabilitation operations or groundwater discharge to surface waters do not adversely affect users of the resource (including extractors and the environment) or existing local land uses
EMP	Groundwater	Groundwater quality resulting from the development and use does not adversely affect users of the resource (including extractors and the environment), or existing local land uses
EMP	Disposal	Material disposed of into pit 23 is limited to non-liquid material that contain or are contaminated with naturally occurring radioactive material (NORM), with the source sites being limited to those specified in the Permit
RVMP	Landform design and stability	The restored landform is structurally stable, resists erosion (comparable to surrounding landscape) and is visually compatible with the surrounding landscape
RVMP	Surface water flow-paths	Surface water flows from rehabilitated areas are returned to their pre-mining catchments
RVMP	Restoration of soil profiles and productivity	Soil profiles are equivalent to pre-mining, and soil characteristics do not pose an unacceptable risk to human health, the environment or existing local land uses
RVMP	Revegetation	Native vegetation communities of appropriate and agreed composition are established and are self-sustaining
RVMP	Agricultural production	Agricultural productivity is comparable to pre-operational levels and can be maintained though standard agricultural practices
RVMP	Radiation	To ensure that radiation doses arising from the rehabilitation operations, and the final rehabilitated site, are below the prescribed limits

These environmental and rehabilitation objectives formed the basis of the risk register, which was reviewed and revised at the workshop.

5.0 Methodology

5.1 Best Practice

The approach to risk assessment used in this report is consistent with AS/NZS ISO 31000:2009 Risk Management Process and involves the following steps: establishment of the context of the risk assessment, risk identification; risk analysis and risk evaluation.

Once risks have been evaluated then treatment or mitigation can be defined and the process repeated.

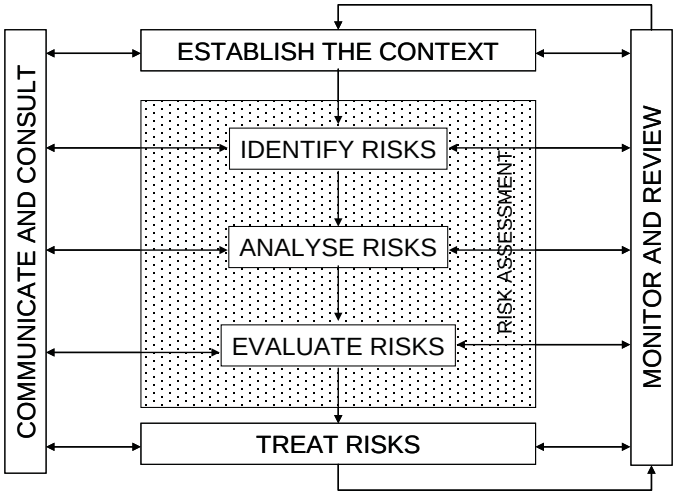


Figure 2 AS/NZS ISO 31000:2009 Risk Management Process

5.2 Definition of Risk

In AS/NZS ISO 31000:2009 Risk Management Principles and Guidelines, risk is defined as "the effect of uncertainty on objectives". In the broader Project context this definition refers to the ability of the Project to achieve the defined evaluation objectives, for example those identified in **Table 1**.

More specifically, and more relevant to this report, risk can also be defined as the condition resulting from the prospect of an event occurring and the magnitude of its consequences. Therefore, risk is an intrinsic combination of:

- The likelihood of an event occurring and its associated consequences (this incorporates consideration of the frequency of the event and the likelihood of the consequences occurring each time the event occurs); and
- The magnitude of potential consequences of the event.

In quantitative terms, "risk" is defined by a risk "level", which is:

- Risk level = Likelihood x Consequence

The risk level is therefore a numerical value that describes the level of risk posed by an event.

Both likelihood and consequence can be measured in several ways using different techniques, depending on the aims of the risk assessment and the nature of the risk issue. The selected methodology for assessing likelihoods and consequences is described in the sections below.

5.3 Estimating likelihoods and consequences

A risk event is an event which may or may not occur during the lifetime of a project i.e. its likelihood is less than 100%. If a risk event were to occur, or when a known impact occurs, there would be an impact which also has a specific likelihood of occurrence. This two-step process of describing likelihoods of occurrence of risk events and known events and the subsequent likelihood of impact occurrence are described in this report using event trees.

These two likelihoods are combined to give a total likelihood for the event. These "two-step" event trees were conducted for each identified risk event and known impact for the Mineral Sands By-product Disposal project.

5.3.1 Estimating likelihoods for risk events

For more common risk events (i.e. those with a likelihood above around 1 in 10 (10%) the chance of occurrence over the life of the project, the event likelihood can usually be estimated to the nearest few percent (e.g. 5% (0.05), 20% (0.2), 70% (0.7) etc.) based on a given subject matter expert's experience or knowledge of similar types of events, and documented information in the industry and literature.

On the other hand, for more novel, untested activities and events with likelihoods below around a 1% chance over the life of the project, an individual expert's experience becomes increasingly less direct as the likelihoods become lower. In these cases, project likelihoods are estimated more conceptually and expressed in order of magnitude terms (for example a 1 in 100 or a 1 in 1,000 chance).

To assist in ensuring consistency of approach to making this type of conceptual level estimate for events with lower likelihoods, a likelihood guide will be supplied to assist workshop participants in estimating likelihoods. As the name suggests, a likelihood guide serves as a guide only, however the application of a single guide across all of the different disciplines and event types ensures greater consistency of likelihood estimates across the risk assessment. The likelihood guide to be used in the workshop is shown in **Table 2** below.

Table 2 Guide to Quantification of Likelihood

Qualitative Description	Order of Magnitude Frequency over a Given Time Period	Basis
Certain	1 (or 0.999, 99.9%)	Certain, or as near to as makes no difference
Almost certain	0.2-0.9 (20 – 90%)	One or more incidents of a similar nature has occurred here
Highly probable	0.1 (10%)	A previous incident of a similar nature has occurred here
Possible	0.01 (1%)	Could have occurred already without intervention
Unlikely	0.001 (0.1%)	Recorded recently else where
Very unlikely	1×10^{-4} (0.01%)	It has happened else where
Highly improbable	1×10^{-5} (0.001%)	Published information exists, but in a slightly different context
Almost impossible	1×10^{-6} (0.0001%)	No published information on a similar case

Source: Bowden, A.R., Lane, M.R. and Martin, J.H., 2001, *Triple Bottom Line Risk Management – Enhancing Profit, Environmental Performance and Community Benefit,* Wiley and Sons, New York, 314 pp.

5.3.2 Describing consequences

The consequences table used in this risk assessment was initially developed for the Port Phillip Channel Deepening Project. The development of the consequences table was conducted in consultation with subject matter specialists in all areas for this project. The consequence table has subsequently been modified and used in the whole-of-project Environment Effect Statements (EESs) for the Stockman Base Metals Project and the Big Hill Enhanced Development Project.

The consequences table will be used to achieve a practical level of consistency when estimating consequence levels across different disciplines and different asset categories (i.e. Social, Environmental, Economic etc.). The consequences table incorporates qualitative descriptions for different consequence types and levels, and normalises them into a consistent set of semi quantitative measures.

The consequence table has a qualitative consequence level (Negligible, Minor, Moderate, Major, and Extreme) as shown in the top row of **Table 3**.

Table 3 Portion of Consequence Table

Allocated Impact Level	Negligible	Minor	Moderate	Major	Extreme
Generic qualitative description of impact level	Minimal, if any impact for some communities. Potentially some impact for a small number (<10) of individuals.	Low level impact for some communities, or high impact for a small number (<10) of individuals.	High level of impact for some communities, or moderate impact for communities area-wide.	High level of impact for communities area-wide.	High level of impact State-wide.
Allocated quantitative impact level	0.1 0.3	1 3	10 30	100 300	1000 Plus

A generic qualitative description for each of the consequence levels is shown in the middle row and a quantitative value is indicated along the bottom row (0.1, 0.3, 1, 3, 10, 30 etc.). The quantitative values show that each subsequent consequence level represents a half order of magnitude increase in the scale of the consequence, which is a critical factor in ensuring that the levels could be applied consistently across all disciplines and which allows for uncertainty in the accuracy of the allocation of consequences.

The five asset categories of impact in the consequence table are:

- Environment (13 asset sub-categories)
- Social (6 asset sub-categories)
- Public Health and Safety (4 asset sub-categories)
- Economic (3 asset sub-categories)
- Property and Infrastructure (1 asset sub-category)

The purpose of the consequences table is to enable diverse and complex consequence types to be evaluated using a normalised (to the extent practicable) scale. Consideration was given to providing descriptions within each consequence level (i.e. Negligible, Minor, Moderate, Major, Extreme) for each of the five asset categories (and the twenty-seven asset sub-categories) despite the fundamental differences in the nature of the consequences.

For the purposes of this risk assessment, the consequence categories of economic and property and infrastructure were available but were generally not applicable to the project as the economic consequences of the project are not considered relevant to the assessment of risks of an already approved operation and the location of the site means that impacts to property and infrastructure were highly unlikely.

5.3.3 Advantages of a semi quantitative approach

The outputs of a semi quantitative analysis are typically relative risk rankings and are not absolute values such as would be produced by quantitative analysis (Risk management – Guidelines on risk management techniques, HB 89-2012). It is acknowledged that the fact that numeric values are used may make the approach appear quantitative; however this is not the intention. The semi quantitative approach is considered acceptable for this risk assessment where the absolute quantification of differing risks and their absolute comparison is not generally possible. The use of half order of magnitude multipliers for the quantification of consequences (0.1, 1, 0.3, 3, etc.) and eight qualitative descriptors for the likelihood has allowed for greater differentiation between risk events in terms of assigning a risk level.

The use of the semi qualitative approach allows the graphical representation of risk events in the form of risk profiles and makes their prioritisation easy to visualize. This approach allows risks to be more easily compared against each other and, if required, in relation to applied targets.

6.0 Identification of Risks

6.1 Risk Workshop

The identification of risks was conducted in a workshop environment. The workshop was conducted at AECOM offices on 1 June 2017.

The objective of the workshop was to identify the potential risks posed by the project as described and to assess their likelihoods of occurrence and consequence magnitude if they were to occur. The outputs from the workshop were entered into a risk register and were used as input data to a spread sheet risk model. The workshop was attended by AECOM subject matter specialists as well as by representatives of Iluka.

Attendee	Organisation	Role
Colin Burns	Iluka	Project Manager
Andrew Patterson	Iluka	Rehabilitation Superintendent - Douglas
Marcus Little	Iluka	Principal Environmental Specialist & Radiation Safety Officer – Murray Basin
Nick Travers	Iluka	Environmental Superintendent – Murray Basin
Harry Grynberg	AECOM	Environmental Auditor (EMP)
Suanna Harvey	AECOM	Peer Review (RARP)
Rachel Harding	AECOM	Project Manager and Risk Workshop Facilitator
Victoria Conlon	AECOM	RARP Author and Risk Workshop Documentation
Bryan Chadwick	AECOM	Subject Matter Specialist (Groundwater)

6.2 Risk Register

Prior to the workshop, the AECOM EMP review team developed a preliminary list of risk events which could occur as a result of the Project. The preliminary list was provided to the specialist team and to Iluka for review and input prior to the workshop.

This preliminary list was then reviewed at the workshop and amended by input from the specialists present and Iluka.

The final list of risk events numbered 26 and is shown in **Appendix A**. The risk register contains the name of the event, the description of the event and its impact, the timing/phase at which the risk was likely to occur (operations/rehabilitation).

For the purpose of the risk assessment the operational phase of works was assumed to be 20 years and the rehabilitation phase was assumed to begin at the cessation of disposal of material into the mine and to continue for 20 years (10 years to achieve completion criteria and 10 years to complete monitoring).

A review of the risk register and the inputs was conducted by sending the inputs table to Iluka and the other subject matter specialists for review after the workshop. Detailed notes were taken of the discussions which occurred during the course of the workshop and any subsequent review meetings and emails. In addition, technical reports, as far as possible, were consulted for consistency with the findings of the risk report.

6.3 Risk Events

In the workshop environment, each of the subject matter specialists was asked to provide an estimate of the likelihood of occurrence of all of the events for which the person was the recognised expert, using the process described in **Section 5.3**.

The likelihood of occurrence for each of these 26 events was estimated for the operational phase of the Project and the rehabilitation phase.

The relevant subject matter specialists were asked to utilise their expert knowledge and assign best estimate consequences under each of the asset categories for each of the known events and risk events, for which they were the subject matter specialist. The relative comparability of impacts in the consequences table allows for additive consequences to be assigned under each asset category without unduly overestimating the overall consequence level.

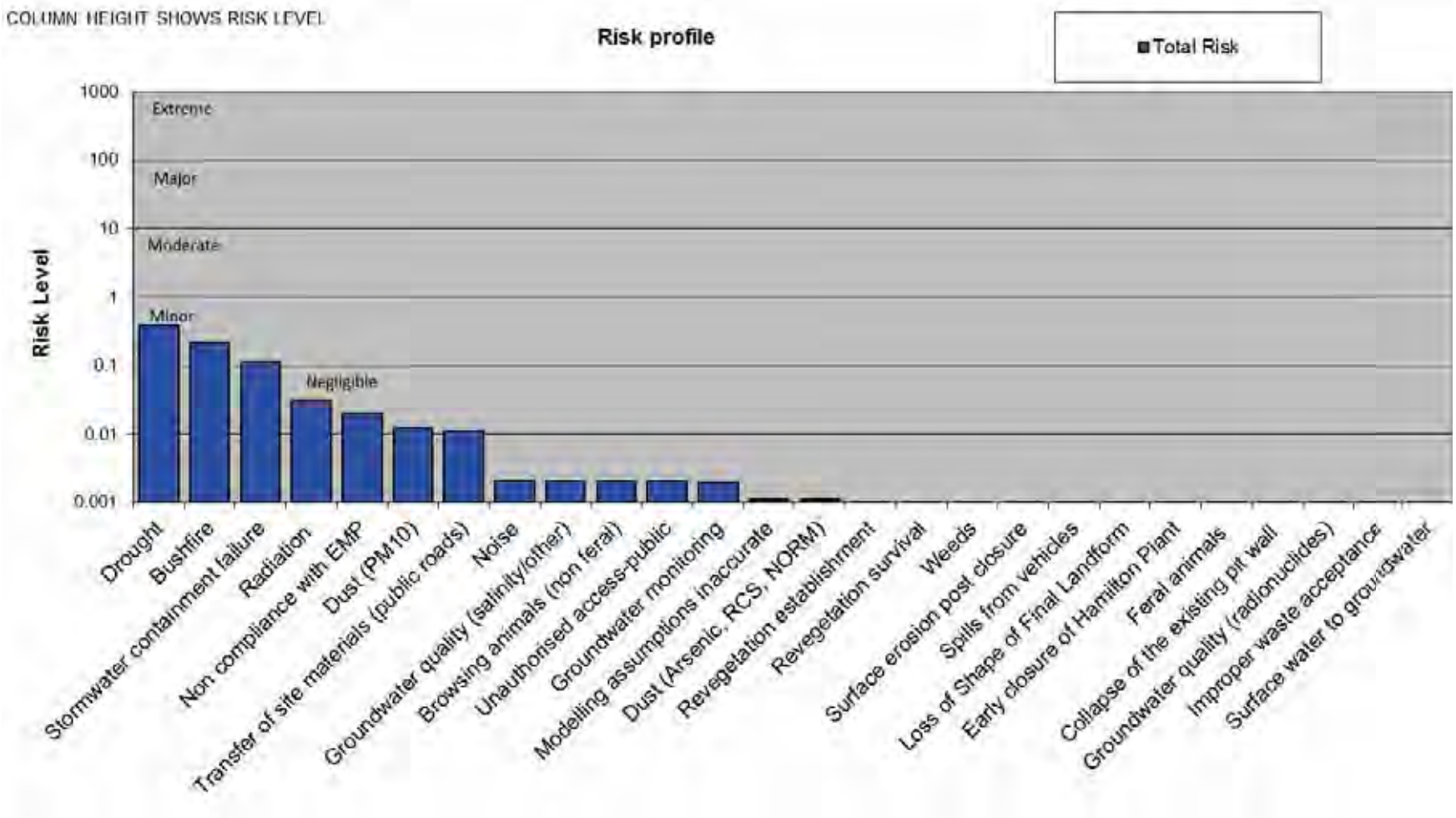
The likelihoods and consequences estimated for the Project assume that the core environmental management measures will be in place and functioning adequately and that the Project is designed, constructed and operated within the planning permit requirements. The risk is, therefore, the mitigated or residual risk.

7.0 Evaluation of risks and impacts

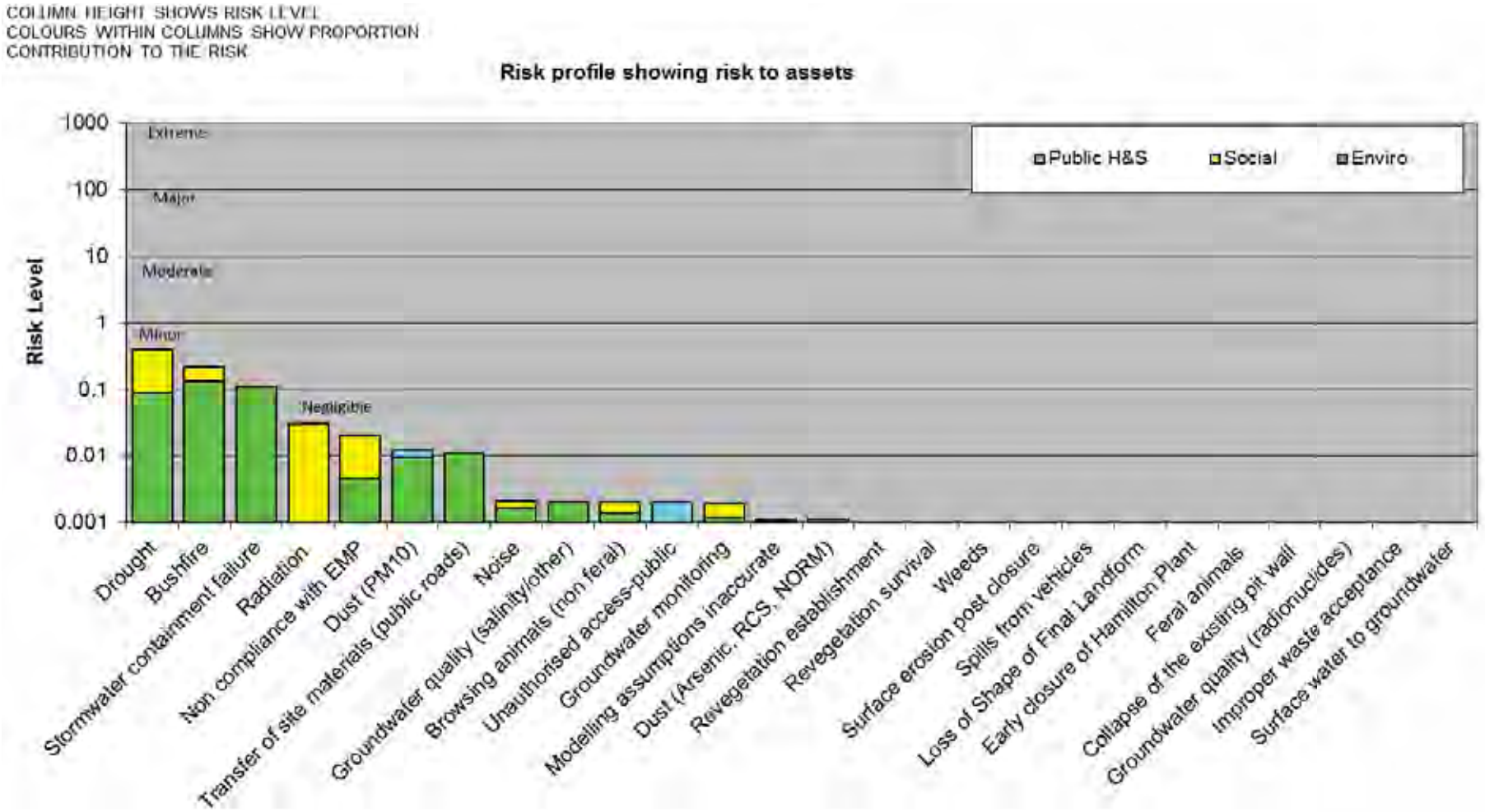
7.1 Risk Events

The inputs from the workshop were input into a risk model to produce the following profiles:

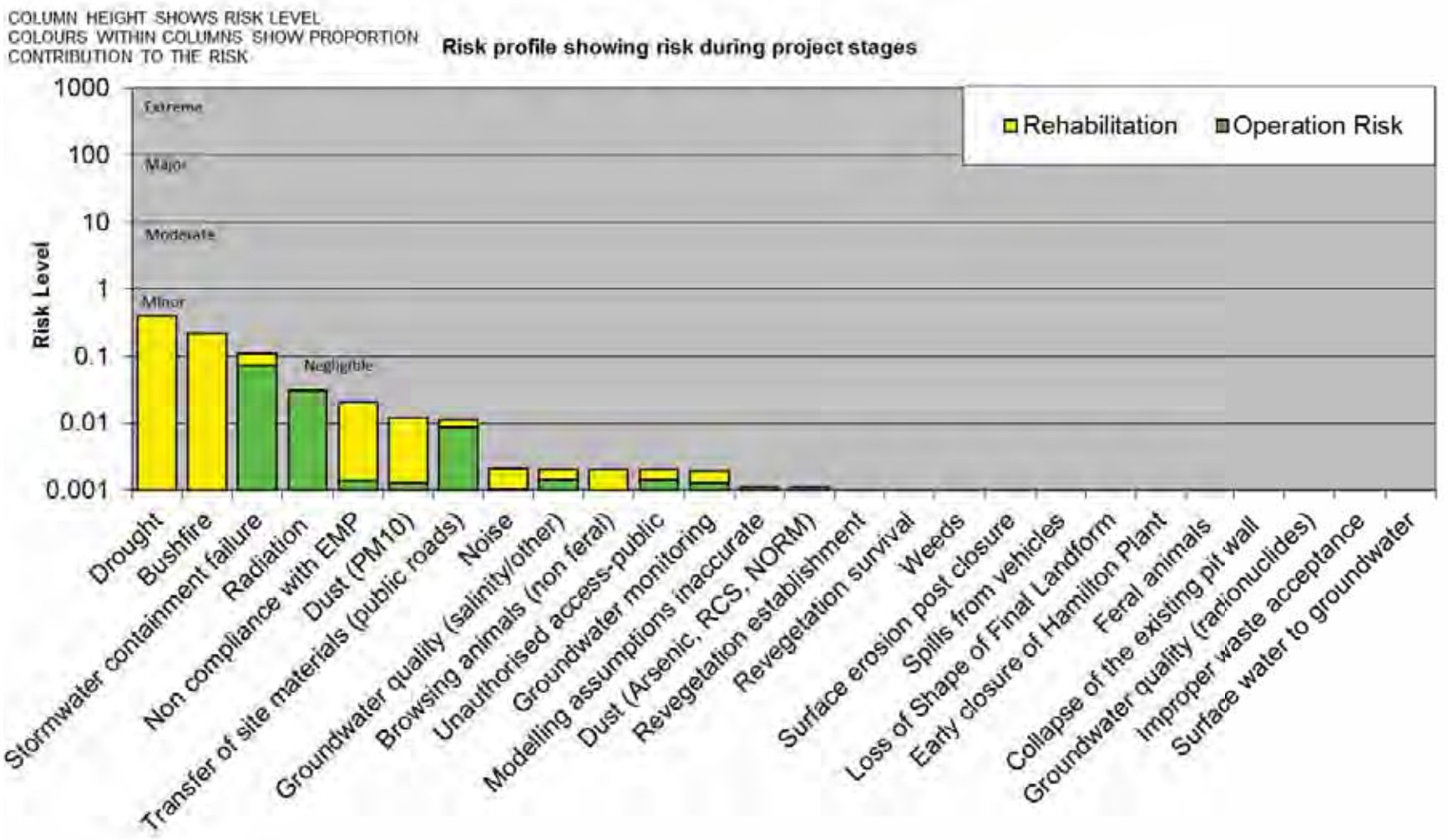
- Total risk - this profile shows the prioritised list of risk events.
- Total risk (assets) - this profile shows which asset(s) (environment, social and public health and safety) would be affected if the risk were to eventuate.
- Timing - this profile shows the phase of the project in which the risk is likely to occur (operation or rehabilitation).



Profile 1 Total Risk



Profile 2 Total Risk (Assets)



Profile 3 Total Risk (Timing)

The profiles provide a visual representation of the risk level for the total project and allow Iluka and project stakeholders such as Horsham Rural City Council to readily compare the level of mitigated/residual risk across the project as a whole. The profiles also allow Iluka to evaluate the acceptability of risks from the company's perspective, prioritise the implementation of further core environmental management measures or mitigation measures and to ensure that existing core management and mitigation measures are performing to the standards described in the Project's Environmental Management Plan.

7.2 Material Risks

One of the requirements of the planning permit (Condition 26b) is to identify "*material*" risks to ensure that trigger levels and an associated management response is in place to deal with these risks.

The definition of "*material*" in terms of risk is not well defined. There are no specific industry guidelines on appropriate risk targets for overall project risk levels. In relation to environmental risks with which this report is mostly concerned, the concept of "As low as reasonably practicable (ALARP)" are often applied (AS/NZS 4360:2004). The ALARP approach to risk management involves the application of two questions in relation to risks: "*can something be done*" and "*is it worth doing something*"? The answers to these questions may involve the making of value judgements which will, inevitably, vary depending on the perspective of those making the judgements

Materiality will, therefore, vary with perspective and what is considered material in the eyes of an organisation may be difference to what is considered material by an external stakeholder.

To allow some consistency and acceptability of a material threshold, a discussion was held in the workshop around what level of risk Iluka would consider material, bearing in mind the stated objectives of the EMP which are "*to ensure that potential environmental impacts from the disposal and site rehabilitation are appropriately identified and mitigated to minimise adverse impacts on the environment such that impacts are limited to acceptable levels as defined in the planning permit application*".

Of the 26 identified risks, three were assessed as minor, with the remaining 23 assessed as negligible. However, it was agreed that the top two risks (Drought and Bushfire) merited the addition of an extra management response/contingency into the EMP.

Drought and bushfire are external events and their likelihood cannot be controlled by Iluka. It was estimated that the likelihood of drought occurring during the rehabilitation phase was 100% and that the likelihood of revegetation being impacted by this drought was 10%.

The likelihood of bushfire occurring in the 20 year rehabilitation phase was estimated as being 5% and that the likelihood of revegetation being impacted by this bushfire was 100%.

In both cases, the events would have to occur in the in the first 5 years of planting to have the estimated impact. After this period, the vegetation would be sufficiently robust to withstand the impact of bushfire and drought

Although the likelihood of occurrence of these events cannot be controlled by Iluka, the likelihood of impact and the consequences will be reduced by implementation of the mitigation measures described in the Rehabilitation and Vegetation Management Plan (R&VMP) in relation to the revegetation (increasing soil moisture, monitoring of revegetation, replacement planting and a bushfire management plan). In the workshop it was agreed that a further mitigation measure of ensuring a sufficient seed bank supply would be included in the R&VMP to further ensure that native species can be replaced in the event of bushfire and/or drought.

Quantitative and qualitative trigger levels are in place for all of the risk events and these are detailed in **Appendix A**. In the event of these trigger levels being exceeded, the core environmental management measures will reviewed and, if necessary, further management responses or contingencies will be put in place to reduce the risk back to below trigger levels.

7.3 Acute risks

One of the requirements of the planning permit (Condition 26c) is to identify "*acute*" risks to ensure that contingency planning is in place to deal with these risks.

AS/NZS ISO 31000:2009 does not contain a definition of an acute risk. For the purposes of this risk assessment the definition of acute is a risk which could happen quickly and the effects could last for a short period of time. The timing aspect of risk occurrence has been taken into account by the division of risks into operation and rehabilitation phases. Two of the "material" risks discussed above (Drought and Bushfire) will occur in the rehabilitation phase and are therefore are not acute in the sense that they are not likely to occur in the next 20 years. Once revegetation begins these risks could occur quickly (acute likelihood) but the mitigation measures described above and in **Appendix A** will mitigate the consequences (as control of occurrence is outside of Iluka's control).

The third highest risk (Stormwater Containment) may be acute in likelihood and consequence (however the consequences are low) and is mitigated by the measures identified in **Appendix A** (appropriate design of surface water management facilities, monitoring, upgrade of facilities (if required). If it does occur, a contingency measure (deployment of backup pump) has been specified.

The remainder of the risks discussed in the workshop were not considered to be acute as they either have triggers in place (groundwater, dust, surface water, radiation) or there are no immediate receptors for noise and dust.

The risk register should be reviewed annually at the time of the annual EMP review and in conjunction with the Iluka incident review so that any new or emerging risks identified through incident reporting are added to the register.

8.0 Roles and Responsibilities

The following roles and responsibilities have been defined by Iluka.

Position	Role
Rehabilitation Superintendent - Douglas	Oversight of activities at the Douglas Mine
Environment Superintendent – Murray Basin	Oversight of environmental management and compliance for the Douglas Mine
Principal Environmental Specialist and Radiation Safety Officer – Murray Basin	Specialist environmental and radiation technical support.
Environmental Advisor – Murray Basin	Planning, coordination and reporting on environmental aspects of Douglas Mine activities
Environment Technician – Murray Basin	Environmental monitoring
Senior Health and Safety Specialist	Occupational health and safety and emergency response
Hamilton Operation Manager	Overall responsibility for operations at the Hamilton Mineral Separation Plant
Production Superintendent - Hamilton	Metallurgical control of Hamilton mineral separation plant, including sampling and analysis of by-products
Transport Co-ordinator – Murray Basin	Direction and co-ordination of transport of materials, including by-products, throughout the Murray Basin

9.0 Emergency Response and Incident Reporting

9.1 Emergency Response

Iluka's Emergency Response Plan (ERP)[3] for the whole Douglas Mine was provided to AECOM as part of the EMP review. The scope of the emergency plan includes environmental damage including loss of containment that may impact on people, equipment or the environment. The ERP includes a list of the following reportable environmental events, which are also applicable to the Pit 23 Project:

- potential or actual off-site impact to waterway
- unplanned off-site discharge of poor quality surface water
- unplanned exposure to radioactive material
- unplanned off-site movement of radioactive material
- noise complaints
- spills/leaks of Dangerous Goods.

The plan provides contact details of the responsible authorities for each type of incident and the procedure to be followed in the event of an emergency. Specific action response plans are included for hazardous material spills and bushfire.

9.2 Incident Reporting &Investigation

Iluka's Environment, Health and Safety (EHS) Incident Reporting & Investigation Standard 12[4] was provided to AECOM. The objective of the standard is to ensure that environmental near misses and actual events are reported and appropriately investigated. This is achieved through the Loss Control Card system and associated Group Guideline – Hazard, Incident and Emergency Classification[5] which will see the incident reported to the relevant supervisor for review of the incident classification to determine what, if any, further investigation is required.

The Group Standard 01-Risk and Hazard Management[6] requires a risk register to be maintained and reviewed by relevant stakeholders and updated at least annually. This procedure will ensure that any new or emerging risks will be added to the environmental risk register and that actions (or mitigation measures) will be developed for any new or emerging risks.

[3] Douglas Emergency Response Plan, document number 729586, first issued 15/05/2012, revised 23/09/2016 and due for review 23/09/2017.
[4] EHS Standard 12: Incident Reporting and Investigation, Document Number 0016-890777318-51, dated 27/10/2016.
[5] EHS Group Guideline Hazard, Incident & Emergency Classification, Document Number 0016-890777318-60, dated 19/10/2016.
[6] EHS Standard 01: Risk and Hazard Management, Document Number, 0016-890777318-47, dated 27/10/2016.

Appendix A

Risk Register

ILUKA MSD RISK REGISTER

Risk Number	EMP/R&VMP ASPECT	Risk Event Name	Description of event/impact	Timing/Phase	Core environmental management measures (mitigation measures) Environmental Management Plan (EMP) & Rehabilitation and Vegetation Management Plan (R&VMP)	Trigger Levels	Management Action (Response)/Contingency Measures
1	Rehabilitation	Drought	Lack of recharge causes revegetation failure. Drought mainly an issue in the first 5 years after planting.	**Rehabilitation**	**R&VMP Section 7.4.2.1** Watering using water from Freshwater Dam or off-site if the soil moisture is considered too low to support plant survival. **R&VMP Section 11.2.1** Monitoring of native vegetation in each of the first 3 years, 5 years and 10 years after planting including assessment of seedling survival and density counts and replacement planting, if required to achieve completion criteria.	Below average rainfall resulting in revegetation failure.	Increase frequency of inspection to quarterly, implement additional watering and replanting. Additional mitigation measure resulting from the risk workshop - ensure a sufficient seed supply for plant replacement.
2	Rehabilitation	Bushfire	Bushfire removes revegetation cover. Bushfire mainly an issue in the first 5 years of planting.	**Rehabilitation**	**R&VMP Section 9.4.11** Prior to establishment of native vegetation across the Pit 23 footprint and buffer area, a Bushfire Risk Assessment of the proposed. revegetation area will be conducted in collaboration with representatives of the RA, the CFA and DELWP. **R&VMP Section 11.2.1** Monitoring of native vegetation in each of the first 3 years, 5 years and 10 years after planting including assessment of seedling survival and density counts and replacement planting, if required to achieve completion criteria.	Bushfire impacts vegetation at Pit 23.	Implement a replanting program to re-establish the proposed revegetation in accordance with the R&VMP. Additional mitigation measure resulting from the risk workshop - ensure a sufficient seed supply for plant replacement.
3	Surface Water	Stormwater containment failure	Northwest Dam (SW23) overflow occurs due to pump failure resulting in uncontrolled sediment-laden surface water flow across paddock to Red Hill Drainage Line	**Operation/ Rehabilitation**	**Refer to EMP Appendix B (Part B)**	**Refer to EMP Appendix B (Part B)**	**Refer to EMP Appendix B (Part B)**
4	Radiation	Radiation	Radiation doses above prescribed OHS limits (public exposure) resulting in public concern.	**Operation/ Rehabilitation**	**EMP Section 10.7** Radiation Management Licence/Plan/Waste Management Plan. **R&VMP Section 7.5** Radiation Management Licence/Radiation Management Plan/Radioactive Waste Management Plan.	As per Radiation Management Plan and Radioactive Waste Management Plan.	As per Radiation Management Plan and Radioactive Waste Management Plan.
5	Compliance	Non compliance with EMP	Monitoring for air/noise/groundwater/surface water not conducted in accordance with EMP and/or results not reported to Regulatory Authority.	**Operation/ Rehabilitation**	**EMP Section 12** Exception and routine reporting in place. **EMP Section 13** External Auditing in place. Implementation of recommendations from external audit.	Trigger levels for air/noise/groundwater/surface water. Identification of deficiencies through the annual review.	Modify management and mitigation procedures relating to the triggering event.
6	Air Quality	Dust (PM10)	Concentration of PM10 dust at sensitive receptors exceeds guidelines resulting in health impacts.	**Operation/ Rehabilitation**	**Refer to EMP Appendix B (Part C)**	**Refer to EMP Appendix B (Part C)**	**Refer to EMP Appendix B (Part C)**
7	Vehicle Hygiene	Transfer of site materials (public roads)	Transfer of mud, soil, debris and NORM onto public roads.	**Operation/ Rehabilitation**	**EMP Section 10.3** Truck wash or workshop wash-down bay. Any debris, mud, clay or other material deposited on any public road surface within 200 m of the intersection of the mine access road with Elliotts Road will be recovered and disposed of on-site. **R&VMP Section 9.4.7** Vehicle hygiene requirements as per EMP.	Visible mud, soil, debris on mine access road or Elliotts Road. Mechanical failure of wheel wash.	Use alternative means of washing vehicles such as truck wash, brushing in Pit, hose down in Workshop wash-down bay, hose down in Pit using potable tank/pump facility. Implement procedural control to prevent vehicles exiting site until they have been cleaned.
8	Noise	Noise	Noise at sensitive receptors above NIRV guidelines resulting in loss of amenity.	**Operation/ Rehabilitation**	**Refer to EMP Appendix B (Part D)**	**Refer to EMP Appendix B (Part D)**	**Refer to EMP Appendix B (Part D)**
9	Groundwater	Groundwater quality (salinity/other)	Change to groundwater quality impacting beneficial users (Segment C-stock mostly).	**Operation/ Rehabilitation**	**Refer to EMP Appendix B (Part A)**	**Refer to EMP Appendix B (Part A)**	**Refer to EMP Appendix B (Part A)**
10	Site Safety&Security	Unauthorised access-public	Unauthorised access results in an injury to the public.	**Operation/ Rehabilitation**	**EMP Section 10.6** Warning signs, security fencing, swipe card access, security camera. **R&VMP Section 11.1 (Table 7)** As per EMP Section 9.6.	Unauthorised public access.	Identify means of entry and install further prevention measures.
11	Rehabilitation	Browsing animals	Browsing animals remove revegetation.	**Rehabilitation**	**R&VMP Section 9.4.9** Installation of 100 mm galvanised steel pipe strainer posts with steel pipe stays, steel picket posts, four plain wires and rabbit netting. **R&VMP Section 11.2.2** Maintenance of fencing to control livestock and feral animals.	Browsing animals identified.	Identify means of entry and install prevention measures if practicable. Institute a control program that may including baiting. Other methods are available and may be used.

ILUKA MSD RISK REGISTER							
Risk Number	**EMP/R&VMP ASPECT**	**Risk Event Name**	**Description of event/impact**	**Timing/Phase**	**Core environmental management measures (mitigation measures) Environmental Management Plan (EMP) & Rehabilitation and Vegetation Management Plan (R&VMP)**	**Trigger Levels**	**Management Action (Response)/Contingency Measures**
12	Groundwater	Groundwater monitoring	Frequency of monitoring or well network not sufficient/not accessible.	**Operation/ Rehabilitation**	**EMP Section 7** Implementation of groundwater monitoring and management plan (GWMMP) until completion criteria reached. **EMP Section 13** External Auditing in place. Implementation of recommendations from external audit. Routine bore inspections monthly or six-monthly. New bores to be installed as needs. Decommission in accordance with guidelines. **R&VMP Section 11.1 (Table 7)** As per EMP Section 7.	Annual external review identifies deficiencies.	Modify management and mitigation procedures relating to the triggering event.
13	Groundwater	Modelling assumptions inaccurate	Modelling assumptions inaccurate leading to lack of groundwater flow/direction understanding.	**Operation/ Rehabilitation**	**Refer to EMP Appendix B (Part A)**	**Refer to EMP Appendix B (Part A)**	**Refer to EMP Appendix B (Part A)**
14	Air Quality	Dust (Arsenic, RCS, NORM)	Dust containing heavy metals resulting in health impacts.	**Operation**	**Refer to EMP Appendix B (Part C)**	**Refer to EMP Appendix B (Part C)**	**Refer to EMP Appendix B (Part C)**
15	Rehabilitation	Revegetation establishment	Inability of native vegetation to become established due to poor species choice, low soil moisture, weed infestation or lack of protective fencing resulting in slope erosion and dust generation.	**Rehabilitation**	**R&VMP Section 9.4 (Species choice)** Preparation of plan by ecological consulting organisation. Selection of species from appropriate EVCs. Use of seed from neighbouring forest areas. **R&VMP Section 9.4.5 (Low soil moisture)** Watering in the first summer after planting, if required. **R&VMP Section 9.4.7 (Weed Control)** Herbicide spraying 3 months prior to planting. Cleaning of vehicles. Spraying and scalping of weeds from topsoil stockpiles. **R&VMP Section 9.4.9 (Fencing)** Installation of 100 mm galvanised steel pipe strainer posts with steel pipe stays, steel picket posts, four plain wires and rabbit netting.	Vegetation establishment not in accordance with the requirements in the approved plan.	Review R&VMP and develop alternate revegetation program, increase inspection frequency.
16	Rehabilitation	Revegetation survival	Inability of native vegetation to remain established resulting in slope erosion and dust generation.	**Rehabilitation**	**R&VMP Section 9.4 (Species choice)** Preparation of plan by ecological consulting organisation. Selection of species from appropriate EVCs. Use of seed from neighbouring forest areas. **R&VMP Section 11.2 (Monitoring and maintenance)** Annual monitoring for the first 3 years, then at 5 and 10 years. Re-seeding, re-topsoiling of in-fill planting, if required.	Vegetation survival not to in accordance with the requirements in the approved plan.	Review R&VMP and develop alternate revegetation program, increase inspection frequency.
17	Weeds	Weeds	Weed infestation infecting topsoil during operations and inhibiting revegetation.	**Operation/ Rehabilitation**	**Refer to EMP Appendix B (Part E).** **R&VMP Section 9.4.7** Vehicle hygiene as per EMP. Site inspections to monitor for weed infestations. Herbicide spraying 3 months prior to planting.	**Refer to EMP Appendix B (Part E).**	**Refer to EMP Appendix B (Part E).**
18	Geotech Stability	Surface erosion post closure	Erosion of the final landform shape (or near final) once it is at design level and before topsoiling and a vegetation cover is established. Open surface of erodible soils resulting in increased turbidity to surface waters.	**Rehabilitation**	**R&VMP Section 7** Have conducted landform evolution modelling for up to 500 years post closure. **R&VMP Section 9.2** Earthmoving to be scheduled for moist periods to reduce wind erosion. Landform evolution modelling will be conducted on final surveyed contours with slope adjustment to be carried out if required. **R&VMP Section 10.2** Monitoring of erosion in Years 1, 2, 3, 5 and 10 after closure.	Erosion identified through inspections.	Investigate frequency of flood event which caused erosion and if required, increase frequency of inspection. Repair to produce an erosion resistant landform.
19	Site Safety&Security	Spills from vehicles	Vehicle accident on-site, leads to hydrocarbon spill and environmental impact to soil, groundwater or surface water.	**Operation/ Rehabilitation**	**EMP Section 9.3** Speed limits on vehicles (for management of dust/noise emissions). **Iluka Standard Practices** Development and implementation of a traffic management plan. Appropriate road design. Effective road maintenance. Inspection and maintenance of on-site vehicles.	Spill occurs leading to impact.	Current contingency measures (clean-up of spills and placement of impacted soil in pit or disposal elsewhere, in accordance with EPA guidelines) considered adequate.
20	Geotech Stability	Loss of shape of final landform	Differential settlement of the final landform such that the completion criteria of return of surface water flows to pre-mining catchments is not met.	**Rehabilitation**	**EMP Section 2.2.3** Acceptance only of sand and clay of spadable consistency. **EMP Section 10.5.2 and 10.5.3** Geotechnical expert advice on backfill placement to avoid differential settlement. **EMP Section 10.5.3 and R&VMP Section 7.1.3** Monitoring to detect settlement. **R&VMP Section 11.1.2** Earthworks to repair erosion.	Poor backfill methods resulting in variable and large post closure settlement.	Obtain expert geotechnical advice and implement recommendations.

ILUKA MSD RISK REGISTER							
Risk Number	**EMP/R&VMP ASPECT**	**Risk Event Name**	**Description of event/impact**	**Timing/Phase**	**Core environmental management measures (mitigation measures) Environmental Management Plan (EMP) & Rehabilitation and Vegetation Management Plan (R&VMP)**	**Trigger Levels**	**Management Action (Response)/Contingency Measures**
21	Rehabilitation	Early closure of Hamilton Plant	MSP closes prior to scheduled closure and insufficient overburden available to fill pit to required final landform height.	**Rehabilitation**	Not considered in the R&VMP.	Residual pit void at the end of disposal.	A reduced amount of by-product is not contemplated in the PP application or EMP. Iluka to complete a detailed study in the short-term to identify the source of additional fill material depending on the short-fall. Possible sources of material include the overburden and material from the tailings storage facility (TSF).
22	Feral Animals	Feral animals	Rabbit, cat and fox populations increase.	**Rehabilitation**	**R&VMP Section 11.2.2** Maintenance of fencing to control livestock and feral animals.	Failing revegetation activities due to seedling destruction. Increase in feral animal abundance.	Re-evaluate control program and assess efficacy of additional fencing.
23	Geotech Stability	Collapse of the existing pit wall	Environmental impact is loss of valuable subsoil stockpiles falling into pit and potential loss of bund walls. Disruption of surface water drainage systems	**Operation**	**EMP Section 10.5.2** Regular inspections of pit walls and tip heads by site personnel. Annual inspections by geotech engineer. Bunds along the Pit 23 crest to divert surface water runoff from adjacent stockpiles away from pit crest. Bunding of exclusion zones (OHS risk). Further geotechnical studies to be conducted.	Pit wall failure.	Modify management and mitigation procedures relating to the triggering event.
24	Groundwater	Groundwater quality (radionuclides)	Change to groundwater quality impacting beneficial users (Segment C-stock mostly).	**Operation/ Rehabilitation**	**Refer to EMP Appendix B (Part A)**	**Refer to EMP Appendix B (Part A)**	**Refer to EMP Appendix B (Part A)**
25	Acceptance for disposal	Improper waste acceptance	Improper (non-concrete/steel, non spadable, non NORM contaminated) waste acceptance and tracking resulting in non-compliance with permit conditions.	**Operation**	**EMP Section 2.2.3** IWMP followed. RWMP and RMP monitoring and mitigation measures.	Non compliances identified through the Incoming Waste Monitoring Plan (IWMP).	Modify management and mitigation procedures relating to the triggering event.
26	Surface Water	Surface water to groundwater	Impacted surface water runoff to FWD ultimately impacts groundwater and GDEs.	**Operation**	**Refer to EMP Appendix B (Part B)**	**Refer to EMP Appendix B (Part B)**	**Refer to EMP Appendix B (Part B)**

APPENDIX B

Management, Triggers, Actions and Contingency Plans

PART A - GROUNDWATER

Core environmental management	Trigger	Actions	Contingency Plans
Groundwater levels and flow direction • routine monitoring of levels at bores; and • audits of bore condition and repair/upgrade/replacement as required.	In the event that monitoring results, or improved model predictions show that adverse impacts that have or will affect the prescribed beneficial uses of the groundwater then management actions are required to remediate or prevent such impacts (section 7.9.1)	If the results obtained show that groundwater flow from Pit 23 is in any direction other than that expected or the variance of the actual water levels from those predicted is such that a change in groundwater flow path could occur: • re-examine the hydrogeological model and, if necessary, re-configure, re-calibrated and re-run the model; • if the predictions from the re-calibrated model include a flow from Pit 23 to a sensitive receptor other than those already identified, complete a detailed impact assessment; • if the impact assessment shows or predicts an unacceptable impact, develop an action plan to mitigate or prevent such impacts; and • incorporation of the action plan into the GWMMP, with approval from the Responsible Authority.	Implement action plan that may include, additional monitoring bores, groundwater interception and reduction, suspension or cessation of disposal to Pit 23
Groundwater quality • Routine monitoring of levels at bores; and • Audits of bore condition and repair/upgrade/replacement as required.	In the event that monitoring results, or improved model predictions show that adverse impacts that have or will affect the prescribed beneficial uses of the groundwater then management actions are required to remediate or prevent such impacts (section 7.9.2	If an indication of the arrival of seepage from Pit 23 is obtained the sampling and analysis indication will be confirmed by repeat sampling and analysis and if confirmed: • if the timing of seepage from Pit 23 reaching the bore location is at a variance by more than 10% from that predicted by the model recalibrate the model and use to re-assess predicted impacts; • compare the full suite of analysis, based on the average of the analyses on original and repeat samples, with precautionary and upper trigger; • if the average concentration/levels is greater than the precautionary trigger value: o complete an investigation to determine the cause of the indicated impact; o increase the monitoring frequency in order to assess trends and understand processes occurring; and o if appropriate, conduct analytical and/or numerical modelling to help determine cause of impact; and • if the average concentration/level is greater than the upper trigger value: o complete further investigations of the cause, if not adequately understood; o complete a detailed impact assessment; o if the impact assessment shows or predicts an unacceptable impact, develop an action plan to mitigate or prevent such impacts; o prepare and submit an exception report as described in the EMP Section 12, including any action plan that has been developed; and o incorporate the action plan into GWMMP, with approval of the Responsible Authority.	Implement action plan that may include, additional monitoring bores, groundwater interception and reduction, suspension or cessation of disposal to Pit 23

PART B - SURFACE WATER

Core environmental management	Trigger	Actions	Contingency Plans

Containment of surface water runoff through use of (Section 8.5.1):
• earthen bunds and drains to:
  o direct runoff from undisturbed areas around disturbed areas; and
  o intercept runoff from disturbed area and direct it to collection ponds;
• a network of pumps, pipes and channels to deliver collected runoff from disturbed areas to FWD;
• routine inspections and additional inspections triggered by forecast rainfall;
• movement of water to maximise available capacity;
• managed water releases from FWD;
• routine and event driven water quality monitoring (Section 8.6); and
• assessment by modelling of adequacy of management facilities prior to backfilling and upgrade as required.
	Identification of run-off from the disturbed area of Pit 23 and surrounds to either the paddock to the east of Pit 23 or an overflow from the Pit 23 north-west dam by inspection (Section 8.7.1).	If run-off from disturbed areas exiting the surface water management facilities is identified (Section 8.7.1):
		• make field water quality measurements (EC, pH and turbidity) and collect of samples of the run-off from the disturbed area and of receiving waters;
		• compare the results of the field measurements on the water discharging and that of receiving waters with trigger levels.(Section 8.7.1);
		• if EC. pH or turbidity in both the discharging and receiving waters are above (or in the case of pH below) the trigger levels, repeat field measurements to provide confirmation;
		• if confirmation is obtained:
		  o complete an investigation to determine the cause of the indicated impact;
		  o develop an action plan to prevent on-going exceedances of trigger levels; and
		  o prepare and submit an exception report as described in the EMP Section 12, including any action plan that has been developed; and
		• incorporate the action plan into SWMMP, with approval of the Responsible Authority/
			Implement Action plan that may include
			• review of operation of surface water management facilities;
			• design and assessment by hydraulic modelling of possible facilities upgrade; and
			• upgrade of management facilities.

PART B - SURFACE WATER

Core environmental management	Trigger	Actions	Contingency Plans
Groundwater discharge zones • routine water quality monitoring (Section 8.6.3); • detection of seepage from Pit 23 by change in ion ratios (Section 8.7.2); and • survey for springs (Section 8.6.2).	Monitoring results exceeds trigger levels	If additional springs are identified they will be added to monitoring regime If indication of the presence of seepage from Pit 23 to surface water is confirmed: • compare the timing of seepage from Pit 23 reaching the monitoring location with that predicted by the hydrogeological model and; o if there is variance of more than 10%. recalibrate the model and use to review impact assessment; and o if the impact assessment shows or predicts an unacceptable impact, develop an action plan to mitigate or prevent such impacts; • compare the full suite of analysis with precautionary and upper trigger levels; • if a measured concentration/level is greater than the precautionary trigger value: o investigate to determine the cause of the indicated impact; o increase monitoring frequency in order to assess trends and understand processes occurring; and o if appropriate, conduct analytical and/or numerical modelling to help determine cause of impact. • if the a measured concentration/level is greater than the upper trigger level: o complete further investigations of the cause, if not adequately understood; o complete a detailed impact assessment; o if the impact assessment shows or predicts an unacceptable impact, develop an action plan to mitigate or prevent such impacts; and o prepare and submit an exception report as described in the EMP Section 12, including any action plan that has been developed; and • incorporate any action plan into GWMMP, with approval of the Responsible Authority.	Implement action plan that may include, additional monitoring bores, groundwater interception and reduction, suspension or cessation of disposal to Pit 23

PART C – AIR QUALITY

Core environmental management	Trigger	Actions	Contingency Plans
Air quality – Dust minimisation (Section 9.3) : • vehicle movements confined to areas where dust control can be applied; • gravel sheeting of unsealed roads; • where practical, application of water and, if required, biodegradable crust forming chemicals to: o unsealed roads; o deposited materials; o stockpiles; and o other exposed areas; • a prohibition on stockpiling of materials for disposal outside of the pit; • covering of materials in areas that not are subject to active deposition and, if required, the treatment of the cover material with crust forming chemicals; • limiting any dust creating works (i.e. earthmoving activities) on high dust-risk (dry windy) days; • strictly enforced speed limits on all vehicles; • tarpaulins and sealed tailgates on all trucks/trailers carrying materials for disposal; • site inductions to ensure awareness of the importance of dust minimisation and the means by which it can be achieved; and • monitoring of visible dust, dust deposition rates and PM_{10} concentrations at sensitive receptors (Section 9.5).	• visible dust leaving site (Section 9.6); • dust deposition rate a downwind location greater than trigger level; and • PM_{10} concentration at sensitive receptor shown to be the result of dust from the site and greater than precautionary and upper trigger levels.	If visible dust leaving the site is observed any or all of the following: • increase dust suppression by watering; • enforcement or reduction of speed limits; • restriction of earthmoving activities in Pit 23; and • suspension of dust generating activities. If the dust deposition rate at a downwind location is greater than 4 g/m^2/month and more 2 g/m^2/month greater than at the upwind location or the PM_{10} concentration at sensitive receptor is greater than the precautionary trigger of 50µg/m^3 and the elevated concentration is the result of dust from the site" • on-site personnel will: o implement additional or improved dust control measures that may any or all of: ▪ increase dust suppression by watering; ▪ enforcement of speed limits; ▪ application of crust forming chemical; ▪ restriction of earthmoving activities in Pit 23; and ▪ management of the overburden and topsoil stockpiles to minimise dust emissions; and o complete a review of the operation following a standard checklist prepared by the Environmental Superintendent or Environmental Specialist and submit the results to the superintendent or specialist. The items on the checklist will include the information required to assess each of the following for the period in which the elevated result was obtained: ▪ the level of activity; ▪ un-associated activities being conducted; ▪ the weather conditions as determined from the BoM Kanagulk weather station; ▪ the extent to which required practices were, or were not, being implemented; and ▪ the appropriateness of the corrective actions taken; and • the Environmental Superintendent or Principal Environmental Specialist will review the checklist completed by the onsite personnel and instigate additional action if considered necessary. If the PM_{10} concentration at sensitive receptor is greater than the upper trigger of 50 µg/m^3 and the elevated concentration is the result of dust form the site the actions described above plus: • an on-site inspection by the Environmental Superintendent or Principal Environmental Specialist; • prepare and submit an exception report as described in the EMP Section 12, including any action plan that has been developed; and • incorporate any action plan into the AQDCP, with approval of the Responsible Authority. If the results of the PM_{10} concentration measurement made in the following two weeks are above the upper trigger level, suspend disposal operations until PM10 concentration is below the precautionary trigger level.	Implement action plan that may include, additional monitoring, enhanced watering, vegetation of exposed areas and additional restrictions on dust generating activities

PART D - NOISE

Core environmental management	Trigger	Actions	Contingency Plans
Noise mitigation (Section 10.1.3): • strictly enforced on-site speed limits on all vehicles; • the fitting and maintenance of approved mufflers on all equipment; • limitation of in-pit earthmoving to "Day" except in emergency situations; and • site inductions for all drivers and equipment operators to ensure awareness of the importance of noise minimisation and the means by which it can be achieved.	Complaint received regarding noise emissions from the use and development	If a noise complaint is received the following actions will be taken: • noise levels at the sensitive receptor will be measured and the results compared with those recommended in the NIRV, including allowances for final site rehabilitation as described in the NIRV; • If the noise levels exceed the applicable noise limits: o Investigate to determine the source of the noise; o cease identified noise emitting activities; o develop an action plan to prevent further exceedances of applicable limits' and o prepare and submit an exception report as described in the EMP Section 12, including any action plan that has been developed; and • incorporate any action plan into the EMP, with approval of the Responsible Authority	Implement Action plan that may include, additional monitoring, noise modelling to assess alternative mitigation measures, further restrictions on operating hours and modification of operations, e.g. speed limits, equipment used etc.

PART E - WEEDS

Core environmental management	Trigger	Actions	Contingency Plans
Weeds will be managed by the following means (Section 10.2): • washing equipment prior to entry or exit to or from the site; • quarterly inspections for weeds; • herbicide spraying or scalping of weeds from operational areas, and from topsoil stockpiles; • spot spraying of identified weed infestations within revegetated areas; • hand-pulling of weeds where appropriate; and • where gravel, crushed rock or other material is required to be imported to site, care will be taken to ensure that the material is free from noxious weed seed.	Weed infestations are identified	If a weed infestation is identified the following actions will be implemented: • herbicide spraying with Glyphosate formulations or scalping of weeds from operational areas, and from topsoil stockpiles; • spot spraying with Glyphosate formulations of identified weed infestations within revegetated areas; and • hand-pulling of weeds where appropriate.	In the event that Glyphosate formulations are found to be ineffective, the advice of ecological/revegetation experts as to the best alternative herbicide for a given weed species and the use of that herbicide will be subject to a risk assessment prior to its use

PART E –VEHICLE HYGIENE

Core environmental management	Trigger	Actions	Contingency Plans
Prevention of import of weeds to site and inadvertent export of NORM, mud and debris (Section 10.3) by: • washing of plant, vehicles and machinery prior to exiting the site in either the purpose built truck wash or at the workshop wash down bay; • requiring vehicles to be free of mud and plant material prior to entering the site; • weekly confirmation of truck wash operational performance; • inspection on each working day of mine access road and public road with 200 metres for mud and debris; • recovery of any mud or debris from the site from the public road within 200 metres of the site; and • inspection of all machinery, drill rigs and other plant and equipment prior to entry or exit to or from the site.	Identification of debris, mud, clay or other material from the site deposited on any public road surface within 200 metres of the intersection of the mine access road with Elliotts Road Machinery, vehicles, plant or equipment identified as contaminated with mud, soil, residual NORM or weed plant material and/or seeds.	• material from on-site deposited on the public road within 200 metres of the site will be recovered and disposed of on the site; • machinery, vehicles, plant or equipment with mud, soil or plant material will be denied access until cleaned off-site; and • machinery, vehicles, plant or equipment with mud, soil, residual NORM or plant material will be kept on site until cleaned.	In the event that truck wash facility is non-operational alternative cleaning methods will be applied, including: • brush down in the pit; • hose-down in the workshop wash down bay; and • portable tank and pump set for hose-down in the pit.

PART F – FERAL ANIMALS

Core environmental management	Trigger	Actions	Contingency Plans
Control of feral animal species (Section 10.4) by: • recording of feral animal sightings; • 6 monthly spotlight surveys; • ripping of identified burrows or dens; • baiting for rabbits, foxes and cats; and • trapping of cats if deemed necessary.	Identification of feral animal populations	The monitoring results will be used to develop the requirement and scope for feral animal control programs, and assess the success of such programs.	N/A

PART G – GEOTECHNICAL STABILITY

PART G – GEOTECHNICAL STABILITY

Core environmental management	Trigger	Actions	Contingency Plans
Control of pit wall stability and subsidence management (Section 10.4) by: • regular inspections of pit walls and tip heads by site personnel; • annual inspections of pit walls and tip heads by a geotechnical engineer; • bunds along the Pit 23 crest to divert surface water runoff from adjacent stockpiles away from the pit crest; • bunding of signed exclusion zones to prevent unauthorised access to the toes of the pit walls; and • completion of a detailed geotechnical investigation to prescribed methods to ensure pit wall stability and appropriate placement and compaction to prevent subsidence of backfilled pit	Observation of slumping of pit wall	Inspection of pit walls by geotechnical engineer that may lead to: • re-design of exclusion zones; and • immediate action to enhance pit wall stability. Implement recommendations arising from geotechnical study that may include: • reduction in pit wall slopes; • buttressing of pit walls; • controlled placement of material against pit walls; and • prescription of placement and compaction method for by-products, steel, concrete and backfill.	Detection and repair of subsidence that does occur is included in the R&VMP

PART H – SITE SAFETY AND SECURITY

PART H – SITE SAFETY AND SECURITY

Core environmental management	Trigger	Actions	Contingency Plans
Risk to public health and safety managed through restrictions on site access (Section 10.6), including: • warning signs indicating that access is restricted and that all visitors must: o use approved access routes; o report to the site administrative office ; and o be accompanied by a designated Iluka representative when on-site; • boom gate control at site entrance; • security fencing preventing unauthorised access to pit crest • locking of alternative farm gate access; • confirmation on each working day that the security boom-gate is operating satisfactorily; • monthly inspection of the Pit 23 security fence; and • monthly download and inspection of security camera footage from Pit 23 and other areas.	Monitoring identifies that a site security measure has failed	Failed site security measures repaired or reinstated.	N/A

ATTACHMENT B

Review of Environmental Management Plan and Auditor's Endorsement

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6 July 2017

Colin Burns
Iluka Resources Limited

Dear Colin

Endorsement Of the Iluka Mineral Sands By-product Disposal Project EMP

Iluka Resources Limited (Iluka) was issued a planning permit (15-105) by the Horsham Rural City Council for the development and use of land for the disposal of waste by-products associated with or sourced through mineral sands processing undertaken at the Hamilton Mineral Separation Plant (MSP), including waste by-products and contaminated materials resulting from the processing and transport operations as follows:

- By-products from the processing of heavy mineral concentrate at the Hamilton MSP;
- used dust filter bags from the Hamilton MSP; and
- Other chemically inert material contaminated with naturally occurring radioactive material; in accordance with the endorsed plans.

The land being:

- Vol: 10234, Fol: 134, Crown Allotment: 91, Elliotts Road, Kanagulk VIC 3401
- Vol: 10325, Fol: 229, Crown Allotment: 94, Elliotts Road, Kanagulk VIC 3401
- Vol: 10325, Fol: 230, Crown Allotment: 95, Elliotts Road, Kanagulk VIC 3401
- Vol: 10325, Fol: 231, Crown Allotment: 96, Elliotts Road, Kanagulk VIC 3401

The conditions of that permit include:

Clause 16: Within 90 days of the commencement of this permit coming into operation an Environmental Management Plan (EMP) to the satisfaction of the Responsible Authority must be submitted for its approval. Three copies of the EMP and an electronic version must be provided.

Clause 17: The EMP must be accompanied by written endorsement from an environmental auditor appointed under the Environment Protection Act 1970.

Iluka has defined the endorsement as an assessment of whether

- the EMP meets the requirements of the planning permit; and
- whether the EMP is reasonably expected to meet the EMP objectives.

The scope of the EMP is described in clauses 16-33 of the planning permit.

The scope of work comprised a review of the draft EMP to assess whether it meets the requirements of the planning permit and whether it is reasonably expected to meet the EMP objectives.

The scope excludes actions and activities addressed through the Radiation Management Plan, the Radioactive Waste Management Plan and the Rehabilitation and Vegetation Management Plan. We have assumed that these plans have been approved or will be approved by the Department of Human and Health Services and Horsham Rural City council respectively.

Dr Harry Grynberg an Environmental Auditor (Industrial Facilities) appointed pursuant to the Environment Protection Act 1970 led the review. Dr Grynberg is a Technical director –Environment at AECOM Australia Pty Ltd (AECOM).

The draft EMP was reviewed for the following matters:

- compliance with the key planning permit conditions (16-33), including:
  - technical and practical basis for proposed management measures;
  - scope and appropriateness of the risk assessment;
  - whether the risk assessment and proposed monitoring and risk mitigation measures are congruent;
- inclusion of other measures required in the EMP by the planning permit (e.g. reporting processes required by clause 42).

Comments arising from the review of Revision 2 dated 21 April 2017 were provided to Iluka for response and update of the EMP to Revision 4 dated 6 July 2017.

AECOM was asked to prepare the Risk Assessment and Response Plan (RARP) and was advised by Iluka that Horsham Rural City Council was comfortable with AECOM preparing the RARP as well as undertaking the review of the EMP.

On the basis of the review of the EMP that I have conducted I endorse the EMP (Revision 4 dated 6 July 2017) as:

- Complying with the relevant conditions of the permit (16-33) and including elements to address requirements outlined in conditions 42-45;
- Can reasonably be expected to meet the objectives outlined in it (Table 2 in Section 4);

subject to the following limitations:

Actions and activities addressed through the Radiation Management Plan, the Radioactive Waste Management Plan and the Rehabilitation and Vegetation Management Plan (RVMP) have not been reviewed other than the RVMP with respect to preparation of the RARP. We have assumed that these plans have been approved or will be approved by the Department of Human and Health Services and Horsham Rural City Council respectively.

I have assumed that the EMP will be implemented in full.

Dr Harry Grynberg (Technical Director – Environment) along with his support team from AECOM has prepared this endorsement in accordance with the usual care and thoroughness of the consulting profession for the use of Iluka and Horsham Rural City Council. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this endorsement. It is prepared in accordance with the scope of work and for the purpose outlined in the proposal dated 3rd April 2017.

It is acknowledged that the endorsement may be used by Iluka and Horsham Rural City Council in reaching conclusions about the site. The scope of work performed in connection with the audit may not be appropriate to satisfy the needs of any other person. Any other person's use of, or reliance on, the Report, or the findings, conclusions, recommendations or any other material presented to them, is at that person's sole risk.

The review and this endorsement were prepared between April 2017 and July 2017 and is based on the conditions encountered and information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred or may occur after this time.

The methodology adopted and sources of information used by Dr Harry Grynberg and the support team are outlined in an associated report. Dr. Harry Grynberg and the support team have made no independent verification of this information beyond the agreed scope of works and we assume no liability for any inaccuracies in or omissions to that information. No indications were found during our investigations that information used as basis for this endorsement as provided to Dr Harry Grynberg and the support team was false.

This endorsement should be read in full. No responsibility is accepted for use of any part of this endorsement in any other context or for any other purpose. This Report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Except as required by law, no third party may use or rely on this endorsement unless otherwise agreed by AECOM, in writing. Where such agreement is provided, AECOM will provide a letter of reliance to the agreed third party in the form required by AECOM.

To the extent permitted by law, AECOM expressly disclaims and excludes liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this endorsement. AECOM does not admit that any action, liability or claim may exist or be available to any third party.

AECOM does not represent that this Report is suitable for use by any third party. Except as specifically stated in this section, AECOM does not authorise the use of this Report by any third party.

Dr Harry Grynberg
Environmental Auditor (Industrial Facilities) appointed pursuant to the Environment Protection Act (1970)

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AECOM

EMP Review
Iluka Resources Limited
06-Jul-2017
Doc No. R001

Review of Mineral Sands By-product Disposal EMP

Review of Mineral Sands By-product Disposal EMP

Client: Iluka Resources Limited

ABN: 34008675018

Prepared by

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ABN 20 093 846 925

06-Jul-2017

Job No.: 60545236

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document Review of Mineral Sands By-product Disposal EMP

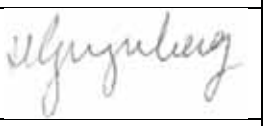
Ref 60545236

Date 06-Jul-2017

Prepared by Harry Grynberg

Reviewed by Rachel Harding

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
1	6 July 2017	FINAL	Harry Grynberg Technical Director	

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1.0 Introduction

Iluka Resources Limited (Iluka) owns and operates a mineral separation plant (MSP) at Hamilton, Victoria. By-products of the MSP are disposed of by placement in an a void left from open pit mining at the Douglas mine site, which is located at Kanagulk, in the municipality of the Horsham Rural City. Regulatory approval for the disposal operations include a planning permit issued by the Horsham Rural City Council (HRCC) and the conditions of that permit include:

- requirements for the preparation of an Environmental Management Plan (EMP); and
- endorsement of the EMP by an Environmental Auditor appointed under the Environment Protection Act 1970.

Iluka has defined the endorsement as an assessment of whether

- the EMP meets the requirements of the planning permit; and
- whether the EMP is reasonably expected to meet the EMP objectives.

The scope of the EMP is described in clauses 16-33 of the planning permit as noted in section 1.1.

The objectives of the EMP presented in Table 1.

Table 1 EMP Objectives (Table 2 EMP)

Aspect	Objectives
Air quality (non-radiological)	Off-site air quality is not adversely affected by the development and use
Noise	Noise emissions from the development and use comply with limits determined in accordance with EPA publication 1411, Noise from Industry in Regional Victoria, October 2011 (NIRV)
Weeds and feral species	Populations of weeds and feral species are actively managed to minimise spread and reduce numbers
Native vegetation	No adverse impact to native vegetation communities.
Geotechnical stability	The development and use does not pose an unacceptable risk to the public, site personnel or contractors and the creation of stable final landforms is assured.
Site safety and security	The development and use does not pose an unacceptable risk to the public, native fauna and domestic livestock.
Surface water	Surface water runoff during by-product disposal and rehabilitation operations or groundwater discharge to surface waters do not adversely affect users of the resource (including extractors and the environment) or existing local land uses.
Groundwater	Groundwater quality resulting from the development and use does not adversely affect users of the resource (including extractors and the environment), or existing local land uses by changes in groundwater quality or accessibility.
Disposal	Material disposed of into pit 23 is limited to non-liquid material that contain or are contaminated with naturally occurring radioactive material (NORM), with the source sites being limited to those specified in the Permit.

The scope of this assessment excludes actions and activities addressed through the Radiation Management Plan, the Radioactive Waste Management Plan and the Rehabilitation and Vegetation Management Plan. The scope of this assessment includes radiation impacts in relation to groundwater and surface water. We have assumed that these plans have been approved or will be approved by the Department of Human and Health Services and Horsham Rural City Council.

The activities conducted at the following locations are the subject of the EMP (see Figure 3):

- Pit 23 and the immediate surrounding area;
- the existing mine access road;
- the existing haul-road to Pit 23;
- a truck washing facility (and access road); and
- mine offices, ablution facilities and car park.

1.1 Planning Permit Requirements

The specific requirements of the planning permit (Permit No.15-105 Horsham Planning Scheme Horsham Rural City Council)) are:

Environmental Management Plan

16. Within 90 days of the commencement of this permit coming into operation an Environmental Management Plan (EMP) to the satisfaction of the Responsible Authority must be submitted for its approval. Three copies of the EMP and an electronic version must be provided.

17. The EMP must be accompanied by written endorsement from an environmental auditor appointed under the Environment Protection Act 1970.

18. When approved the EMP will be endorsed to form part of this permit, and is to be placed on the permit holder's website.

19. The EMP must identify potential environmental impacts of the proposed use and development as derived from a risk analysis, and set out monitoring programs and control measures to prevent any adverse impact on the environment, applicable for the duration of the planning permit.

20. The annual performance report must be reviewed by an independent suitably qualified person with expertise in risk management plans in the context of mines and quarries, and is an environmental auditor appointed under the Environment Protection Act 1970.

21. The permit holder must amend the EMP to address any relevant issues, or changes or recommendations of the independent environmental reviewer to the satisfaction of the responsible authority. Amended EMPs are to be placed on the Permit Holder's website from the time of endorsement by the Responsible Authority.

22. No changes are to be made to the approved use and development or operational practices that may affect environmental quality under the scope of the EMP, unless these have been approved within a revised EMP and monitoring program by the responsible authority.

23. To address the above, the EMP must contain but is not limited to the following components:

a. A risk analysis and response plan

b. A Groundwater Monitoring and Management Plan

c. A Surface Water Monitoring and Management Plan

d. An Air Quality / Dust Control Plan

e. A due diligence program to ensure continual review, improvement and monitoring of operational practices

f. Reporting arrangements

g. Process for decisions on the need for and (as appropriate) requirements for ongoing monitoring and management programming for the above matters.

Each component of the EMP set out above, must address, but is not limited to, the following matters:

Risk analysis and response plan

25. The risk analysis is to be prepared by a suitably qualified person, to accord with best practice processes to identify and quantify uncertainties, and estimate their impact on outcomes.

26. The risk analysis is to include, at least:

a. A risk register that identifies environmental risks, assigns and prioritises key design, operational and rehabilitation risks over the life of the use and development;

b. Trigger levels and associated management responses for material identified environmental risks; and

c. Contingency planning arrangements for any acute risks that could lead to an environmental hazard or pollution incident.

Groundwater Monitoring and Management Plan

27. A Groundwater Monitoring and Management Plan (GWMMP) (component of the EMP) must be prepared to the satisfaction of the responsible authority.

28. The GWMMP must be generally in accordance with the plan in Appendix A to the Supplementary Response to Amended Notice provided to the EPA and the Responsible Authority, but modified or added to so as to include:

a. The applicable recommendations contained in section 6.2 of the report prepared by Environmental Earth Sciences titled Independent Desktop Review For The Continuation Of Mineral By-Products Disposal Into Pit 23 At Iluka's Douglas Mine Site, Northwest Victoria No. 215071v2 dated April 2016 (the EES April 2016 review);

A discrete description of measures for groundwater protection and monitoring included in any approval in force under the Radiation Act 2005;

c. A plan showing the proposed location and spatial distribution of groundwater bores (including new drilled bores and replacement borehole locations) which must include as a minimum those recommended in the EES April 2016 review - Figure 6 on Page 32.

d. Confirmation that all new and replacement bores are installed and tested under the supervision of a qualified, experienced hydrogeologist;

e. Details of the frequency of monitoring of groundwater bores for groundwater levels

f. Details of the frequency of sampling of groundwater bores for and the analytes to be tested and reported on;

g. Appropriate trigger criteria and associated management responses for analytes of concern;

h. Groundwater level and criteria for analytes of concern that will trigger the recalibration of the groundwater model and re-forecasting of predicted groundwater behaviour and transport of analytes of concern;

i. The means by which site specific distribution coefficients will be determined, if such determination is required, to improve model predictions;

j. Quality assurance controls and reporting;

k. Criteria that will trigger points when it is appropriate to review and amend the GWMP requirements.

Surface Water Monitoring and Management Plan

29. A Surface Water Monitoring and Management Plan (SWMMP) (component of the EMP) must be prepared to the satisfaction of the responsible authority.

30. The SWMMP must be prepared generally in accordance with the application and associated material addressing surface water management provided to the EPA and the Responsible Authority in response to the EPA's section 22 notice dated 11February 2016, but modified or added to so as to include:

a. Additional surface water monitoring points recommended by Environmental Earth Sciences in its report 'independent Desktop Review For The Continuation Of Mineral By-Products Disposal Into Pit 23 At Iluka's Douglas Mine Site, Northwest Victoria' No. 215071v2 dated April 2016 and submitted to the EPA;

b. Agreement of the location and number of surface water monitoring points;

c. Additional surface water monitoring points (at least during periods of flow) are to include the Northern Drainage Line and McGlashin Swamp, and locations shown on the EES independent review report, Figure 6, Page 32 and analytical suites to include full ionic balances;

d. Monitoring of run off during periods of flow in the drainage lines as identified in the previous point;

e. A survey for the occurrence of springs in the vicinity of the Northern Drainage Line

f. Sampling of any identified springs;

g. Collected samples analysed for the range of analytes advised by the

Environment Protection Authority Victoria;

h. Details of the hydrological conditions of surface water sampling regime, noting that this should be cognisant of hydrological conditions and the availability of water in the surface water bodies to be sampled;

i. Field parameters which are to be recorded and measured using a calibrated water quality meter (with calibration records to be kept and reported):

i. pH;

ii. Oxidation reduction potential (ORP);

iii. Electrical conductivity (EC);

iv. Dissolved oxygen (DO); and

v. Temperature;

j. The suite of analytes and analysis to be undertaken on the surface water samples by a NATA accredited laboratory;

k. Appropriate trigger criteria, actions and contingency planning and associated management responses;

l. Quality Assurance controls and reporting.

31. The permit holder must submit an annual performance statement (within the wider EMP annual report).

32. The permit holder must amend the SWMMP to address any identified issues, or changes or recommendations of the independent environmental auditor to the satisfaction of the responsible authority.

Air quality / dust

33. The Air Quality / Dust Control Plan (AQMP) within the EMP must address and ensure compliance with the following requirements:

a. Dust emissions to air must be managed to ensure that beneficial uses of the air environment are protected, and all emissions are reduced as far as is practicable by the application of best practice procedures and arrangements.

b. The permit holder must ensure dust does not emanate from the Subject Land so as to exceed the Assessment Criteria for mining and extractive industries specified in Table 2, Clause 3.3 of the SEPP (Air Quality Management) Protocol for Environmental Management: Mining and Extractive Industries or any subsequent replacement document.

1.2 EPA Auditor

Dr. Harry Grynberg who led the review is an Environmental Auditor (Industrial Facilities) appointed by EPA in pursuant to the Environment Protection Act 1970. He was supported by specialists as outlined in Table 2.

Table 2 Support Team

Component	Staff Member (s)
Environmental Auditor	Dr Harry Grynberg
Overall EMP	Harry Grynberg
Sections 1, 2, 3, 4, 5,11, 12, 13 and 14	Harry Grynberg
6 Risk Analysis and Response	Suanna Harvey/Victoria Conlon
7 Groundwater	Bryan Chadwick
8 Surface water	Harry Grynberg
9 Air Quality	Harry Grynberg
10.1 Noise	Rachel Harding
10.2-10.4 Weeds, Vehicle Hygiene and Feral Animals	Christopher White
10.5 Geotechnical Stability	Gavan Hunter
10.6 Site Safety and security	Rachel Harding
10.7 Radiation	Harry Grynberg
Report	Harry Grynberg/Rachel Harding
Summary Endorsement Letter	Harry Grynberg

2.0 Proposed Activity

2.1 Description of proposed activities

2.1.1 Douglas Mine History

Mineral sand mining at the Douglas Mine commenced in 2004 and was completed in 2012. Since 2012, the main activities at the Douglas Mine have the deposition of MSP by-products into Pit 23 and rehabilitation of other parts of the mine.

2.1.2 Disposal operations

The material to be disposed of to Pit 23 is limited to:

- by-products of the processing of heavy mineral concentrate (HMC) at the Hamilton MSP;
- used dust filter bags from the Hamilton MSP; and
- concrete and steel from plant and infrastructure, that is contaminated with naturally occurring radioactive material (NORM).

2.1.3 MSP by-product types and quantities

The majority of Hamilton MSP by-products include:

- lighter mineral particles (sand and clay) of spadeable consistency;
- heavier mineral particles as dry sand; and
- gypsum, currently in the form of filter-cake.

The total quantity of Hamilton MSP by-products to be disposed of each year ranges between 50,000 and 120,000 tonnes and operations at the Hamilton MSP are expected to continue for approximately 20 years.

2.1.4 Other materials

The filter bags from the Hamilton MSP are nylon that has become impregnated with NORM.

The concrete and steel to be disposed of will be from sources specified in the Permit and will be contaminated with NORM such that reuse, recycle or disposal elsewhere is impractical.

2.1.5 Acceptance for disposal

Acceptance criteria for the materials disposed of have been developed and are detailed in the IWMP.

2.1.6 Disposal method

MSP by-products and other materials to be disposed are transported to the subject land in sealed trailers, which must only enter the site via the mine access road. Once on-site the truck/trailers pass through the existing office area and onto a haul road to the Pit 23 entrance ramp. The trucks drive directly into the pit to deposit their loads. After depositing their loads, trucks exit Pit 23 and proceed to the truck wash facility to remove any residual MSP by-products. The operation of the truck wash is described in more detail in section 10.3 of the EMP.

The disposal of MSP by-products at Pit 23 will be limited by the first of either:

- the completion of the rehabilitation of the Hamilton MSP site; or
- space available in Pit 23 becoming equal to that required to install a 5 metre cover over the disposed materials and to reinstate the pre-mining surface landform.

The support infrastructure (mine access road, office and ablutions, car park, haul road and truck wash) will be required for the duration of disposal operations and the post-operational rehabilitation period. Consequently, decommissioning of these infrastructure and rehabilitation of the land will occur towards the end of the rehabilitation phase, and is described in the R&VMP.

2.1.7 Hours of operation

Works associated with the use and development will only occur between the following hours

- Truck/trailer deliveries 24 hours a day, 7 days a week.
- Earthworks 7am-6pm, 7 days a week, excluding emergency works.

Works outside these hours can only occur with written consent of the Responsible Authority.

2.2 Site Location and layout

Figure 1 the location of pit 23 is shown in Figure 2 and the layout of activities in Figure 3

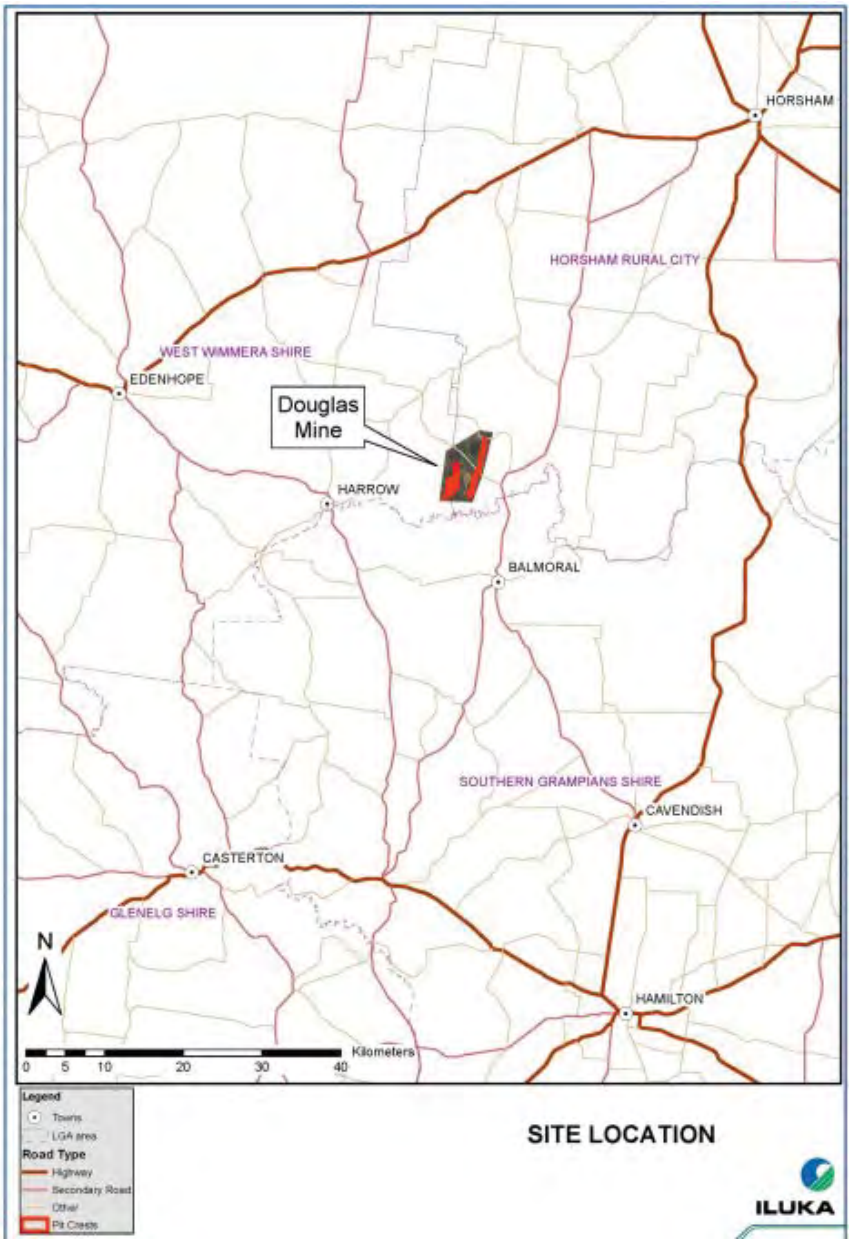

Figure 1 Site Location

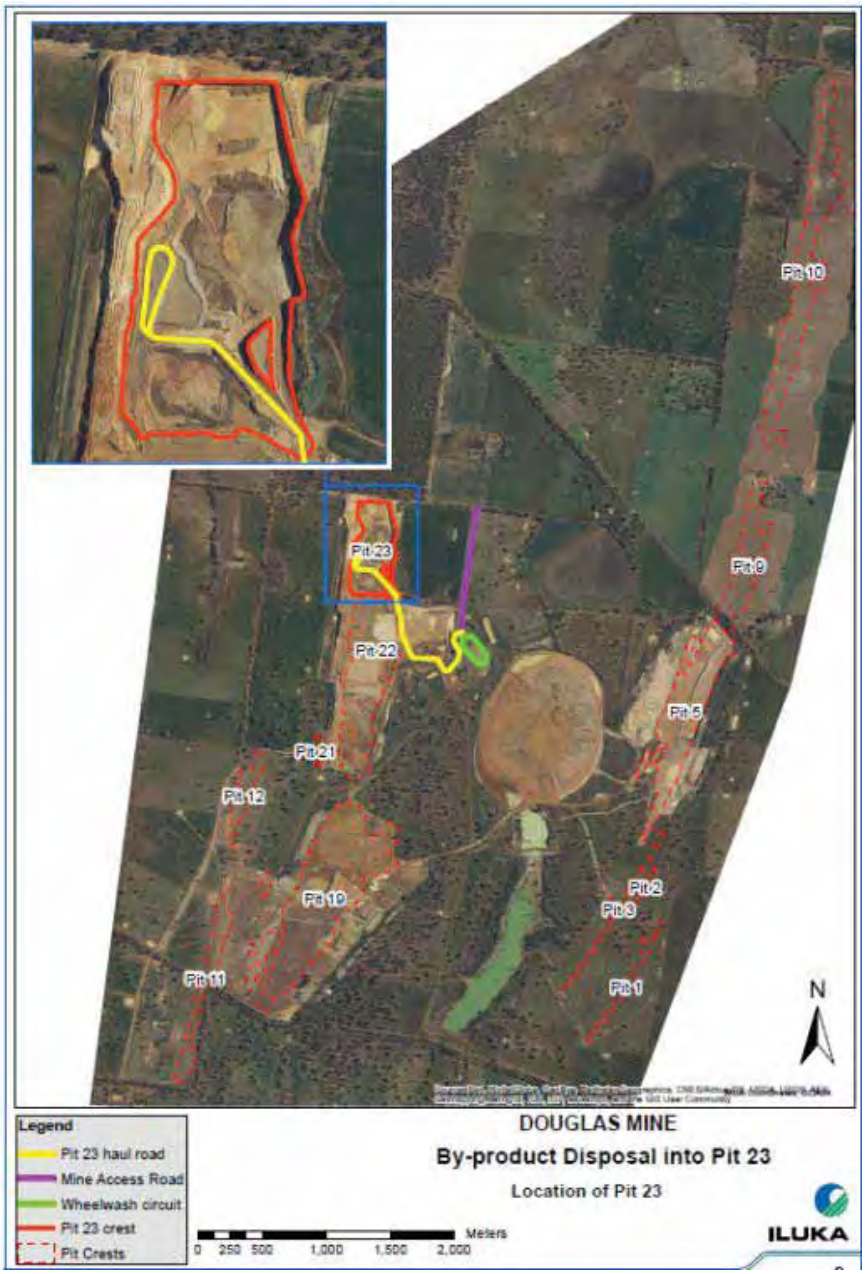

Figure 2 Location of Pit 23

Figure 3 Pit 23 and associated facilities

2.3 Land Description

2.3.1 Land tenure

Crown Allotments 91, 94, 95 and 96 are owned by Basin Mineral Properties Pty Ltd (BMP), a wholly-owned subsidiary of Iluka. The land is located within the Farming Zone of the Horsham Planning Scheme. The land to the east, south and west of the subject land is privately owned while land to the north is Crown Land.

2.3.2 Land use

Prior to the commencement of mining, the subject land was used for agriculture. Agriculture remains the predominant land use surrounding the subject land, typically comprising sheep, pasture, and grain/legume crop production. The Crown Land to the north is in the Public Conservation and Resource Zone.

3.0 Compliance with Planning Permit Requirements and EMP Objectives

AECOM was provided with the Environment Management Plan (EMP) Revision 2 dated 21 April 2017.

The assessment of the EMP (Revision 2) is summarised in Table 3 - Table 5. The comments were provided to Iluka. Iluka revised the EMP and the final version reviewed (Revision 4 dated 6 July 2017) and endorsed by AECOM (Section 4.0).

Table 3 Review against Planning Permit Requirements

Environmental aspect	Planning Permit Clause	Planning Permit Requirements	Environmental Management Objectives	Documentation reviewed	Assessment based on EMP Revision 2 dated 21 April 2017	Conclusions based on Version 4 dated 6 July 2017
	17	*Within 90 days of the commencement of this permit coming into operation an Environmental Management Plan (EMP) to the satisfaction of the Responsible Authority must be submitted for its approval. Three copies of the EMP and an electronic version must be provided*			This will be an outcome of this assessment and cannot be assessed	
	18	*The EMP must be accompanied by written endorsement from an environmental auditor appointed under the Environment Protection Act 1970.*		Prepared as output from this assessment		Endorsement provided
	19	*The EMP must identify potential environmental impacts of the proposed use and development as derived from a risk analysis, and set out monitoring programs and control measures to prevent any adverse impact on the environment, applicable for the duration of the planning permit*		EMP RA matrix (undated)		Comply
	20	*The annual performance report must be reviewed by an independent suitably qualified person with expertise in risk management plans in the context of mines and quarries, and is an environmental auditor appointed under the Environment Protection Act 1970*			Section 12.2 complies with the PP requirement. Compliance can only be assessed after year 1.	Comply
	21	*The permit holder must amend the EMP to address any relevant issues, or changes or recommendations of the independent environmental reviewer to the satisfaction of the responsible authority. Amended EMPs are to be placed on the Permit Holder's website from the time of endorsement by the Responsible Authority.*		EMP Section 14	Section 14 complies with the PP requirement. Compliance can only be assessed after changes have been made.	Comply
	22	*No changes are to be made to the approved use and development or operational practices that may affect environmental quality under the scope of the EMP, unless these have been approved within a revised EMP and monitoring program by the responsible authority.*		EMP section 14	Addressed in section 14	Comply
	23	*To address the above, the EMP must contain but is not limited to the following components:*				
		a. A risk analysis and response plan;		EMP section 6	see assessment under clause	Comply
		b. A Groundwater Monitoring and Management Plan		EMP Section 7	see assessment under clause	Comply
		c. A Surface Water Monitoring and Management Plan		EMP Section 8	see assessment under clause	Comply
		d. An Air Quality / Dust Control Plan		EMP Section 9	see assessment under clause	Comply
		e. A due diligence program to ensure continual review, improvement and monitoring of operational practices,;		EMP Sections 12,13,14		Comply
		f. Reporting arrangements.		EMP section 12.2	This is addressed	Comply
		g. Process for decisions on the need for and (as appropriate) requirements for ongoing monitoring and management programming for the above matters.		EMP Section 14	This is addressed	Comply
		Each component of the EMP set out above, must address, but is not limited to, the following matters:				
Risk Assessment	24	*The risk analysis is to be prepared by a suitably qualified person, to accord with best practice processes to identify and quantify uncertainties, and estimate their impact on outcomes*	Material disposed of into pit 23 is limited to non-liquid material that contains or are contaminated with naturally occurring radioactive material (NORM), with the source sites being limited to those specified in the Permit.	RARP AECOM dated 6 July 2017	see assessment under clauses 25, 26	Comply
Risk Assessment	25	*The risk analysis is to include, at least:*				

Environmental aspect	Planning Permit Clause	Planning Permit Requirements	Environmental Management Objectives	Documentation reviewed	Assessment based on EMP Revision 2 dated 21 April 2017	Conclusions based on Version 4 dated 6 July 2017
Risk Assessment	26	*a. A risk register that identifies environmental risks, assigns and prioritises key design, operational and rehabilitation risks over the life of the use and development;*		RARP AECOM dated 6 July 2017	Risk register included	Comply
Risk Assessment		*b. Trigger levels and associated management responses for material identified environmental risks; and*		RARP AECOM dated 6 July 2017	included	Comply
Risk Assessment		*c. Contingency planning arrangements for any acute risks that could lead to an environmental hazard or pollution incident*		RARP AECOM dated 6 July 2017		Comply
	27	*A Groundwater Monitoring and Management Plan (GWMMP) (component of the EMP) must be prepared to the satisfaction of the responsible authority.*		EMP section 6	The GWMMP is included in the EMP, council approval will be required	GWMMP is endorsed.
Groundwater	28	*The GWMMP must be generally in accordance with the plan in Appendix A to the Supplementary Response to Amended Notice provided to the EPA and the Responsible Authority, but modified or added to so as to include:*	Groundwater quality resulting from the development and use does not adversely affect users of the resource (including extractors and the environment), or existing local land uses	EMP Section 6 Appendix A to the Supplementary Response to Amended Notice provided to the EPA	This is addressed	Comply
Groundwater		*a. The applicable recommendations contained in section 6.2 of the report prepared by Environmental Earth Sciences titled Independent Desktop Review For The Continuation Of Mineral By-Products Disposal Into Pit 23 At Iluka's Douglas Mine Site, Northwest Victoria No. 215071v2 dated April 2016 (the EES April 2016 review);*		EES 2016, EMP Section 7	This is addressed	Comply
Groundwater		*A discrete description of measures for groundwater protection and monitoring included in any approval in force under the Radiation Act 2005;*		EMP Section 7.7	This is addressed	Comply
Groundwater		*c. A plan showing the proposed location and spatial distribution of groundwater bores (including new drilled bores and replacement borehole locations) which must include as a minimum those recommended in the EES April 2016 review - Figure 6 on Page 32.*		EMP section 7.6.2 Figure 13	This is addressed	Comply
Groundwater		*d. Confirmation that all new and replacement bores are installed and tested under the supervision of a qualified, experienced hydrogeologist;*		EMP section 7	This is addressed	Comply
Groundwater		*e. Details of the frequency of monitoring of groundwater bores for groundwater levels*		EMP Section 7 Table 7	This is addressed	Comply
Groundwater		*f. Details of the frequency of sampling of groundwater bores for and the analytes to be tested and reported on;*		EMP Section 7 Table 7	This is addressed	Comply
Groundwater		*g. Appropriate trigger criteria and associated management responses for analytes of concern;*		EMP Section 7 Table 11 section 7.9.1 and 7.9.2	This is addressed	Comply
Groundwater		*h. Groundwater level and criteria for analytes of concern that will trigger the recalibration of the groundwater model and re-forecasting of predicted groundwater behaviour and transport of analytes of concern;*		EMP Section 7 Table 11 section 7.9.1 and 7.9.2	This is addressed	Comply
Groundwater		*i. The means by which site specific distribution coefficients will be determined, if such determination is required, to improve model predictions;*		EMP Section 7 section 7.10	This is addressed	Comply
Groundwater		*j. Quality assurance controls and reporting;*		EMP Section 7 section 7.6.8 and 7.12	This is addressed	Comply
Groundwater		*k. Criteria that will trigger points when it is appropriate to review and amend the GWMP requirements*		EMP Section 7.14 and Section 14	This is addressed	Comply

Environmental aspect	Planning Permit Clause	Planning Permit Requirements	Environmental Management Objectives	Documentation reviewed	Assessment based on EMP Revision 2 dated 21 April 2017	Conclusions based on Version 4 dated 6 July 2017
Surface water	29	*A Surface Water Monitoring and Management Plan (SWMMP) (component of the EMP) must be prepared to the satisfaction of the responsible authority.*	Surface water runoff during by disposal and rehabilitation operations or groundwater discharge to surface waters do not adversely affect users of the resource (including extractors and the environment) or existing local land uses	EMP section 8 Dust deposition spreadsheet	A SWMMP has been prepared and included in the EMP. The assessment is included under Clause 30 items as follows. The Site wide SWMP is being updated by Iluka in response to recent issues with the capacity of the Fresh Water Dam capacity to retain all stormwater on site. Stormwater that falls into the pit 23 is retained in the pit. The sources of Stormwater from Pit 23 are external flows from the overburden piles surrounding the pit. These flows enter the site wide stormwater management system The stormwater flows from Pit 23 are small compared to the whole site . the SWMMP indicates in section 7.5.1 that the FWD has sufficient capacity and discharge could occur. Recent experience is that capacity may not be sufficient and unlicensed discharge has occurred. This should be addressed in the EMP through alignment with the site wide SWMMP.	SWMMP is endorsed
Surface water	30	*The SWMMP must be prepared generally in accordance with the application and associated material addressing surface water management provided to the EPA and the Responsible Authority in response to the EPA's section 22 notice dated 11February 2016, but modified or added to so as to include:*		EMP Section 8. The application and associated material addressing surface water management provided to the EPA and the Responsible Authority in response to the EPA's section 22 notice dated 11February 2016	This is addressed	Comply
Surface water		*a. Additional surface water monitoring points recommended by Environmental Earth Sciences in its report 'independent Desktop Review For The Continuation Of Mineral By-Products Disposal Into Pit 23 At Iluka's Douglas Mine Site, Northwest Victoria' No. 215071v2 dated April 2016 and submitted to the EPA;*		EES 2016; EMP section 8.6.1	The additional surface monitoring points have been identified and included in the proposed program.	Comply
Surface water		*b. Agreement of the location and number of surface water monitoring points;*		EMP section 8.6.1.	It is unclear as to who should agree. It has been assumed that agreement would be between Iluka and the Environmental Auditor.	The additional sampling points seem reasonably located
Surface water		*c. Additional surface water monitoring points (at least during periods of flow) are to include the Northern Drainage Line and McGlashin Swamp, and locations shown on the EES independent review report, Figure 6, Page 32 and analytical suites to include full ionic balances;*		EES 2016; EMP section 8.6.1	The additional surface monitoring points have been identified and included in the proposed program.	Comply
Surface water		*d. Monitoring of run off during periods of flow in the drainage lines as identified in the previous point;*		EES 2016; EMP section 8.6.3	This has been included in the EMP	Comply
Surface water		*e. A survey for the occurrence of springs in the vicinity of the Northern Drainage Line*		EMP section 8.6.2	This has been included in the EMP	Comply
Surface water		*f. Sampling of any identified springs;*		EMP section 8.6.4.2	This has been included in the EMP	Comply
Surface water		*g. Collected samples analysed for the range of analytes advised by the EPA*		EMP section 8.6.4	No specific requirements from EPA has been seen, however the EES (2016) review (on behalf of EPA) included some recommendations for analytes that have been included in the EMP.	Comply
Surface water		*h. Details of the hydrological conditions of surface water sampling regime, noting that this should be cognisant of hydrological conditions and the availability of water in the surface water bodies to be sampled;*		EMP Section 8.6.3.2	This has been included in the EMP	Comply
Surface water		*i. Field parameters which are to be recorded and measured using a calibrated water quality meter (with calibration records to be kept and reported):*		EMP section 8.6.3.3	This has been included in the EMP	Comply

Environmental aspect	Planning Permit Clause	Planning Permit Requirements	Environmental Management Objectives	Documentation reviewed	Assessment based on EMP Revision 2 dated 21 April 2017	Conclusions based on Version 4 dated 6 July 2017
Surface water		*i. pH;*				
Surface water		*ii. Oxidation reduction potential (ORP);*				
Surface water		*iii. Electrical conductivity (EC);*				
Surface water		*iv. Dissolved oxygen (DO); and*				
Surface water		*v. Temperature;*				
Surface water		*j. The suite of analytes and analysis to be undertaken on the surface water samples by a NATA accredited laboratory;*		EMP Section 8.6.3.1 and 8.6.4.1	These indicated that the samples with be taken in accordance with EPA guidelines and analysed in a NATA accredited laboratory.	Comply
Surface water		*k. Appropriate trigger criteria, actions and contingency planning and associated management responses;*		EMP section 8.7	The EMP includes appropriate trigger levels and actions in response to trigger level exceedances. This element should align with the site wide SWMMP. However contingency plans have not been outlined, beyond indicating what would be done e.g. "upgrading surface water management systems". Further thought should be given to identifying potential scenarios and responses.	Contingencies better defined. Scenarios and responses assessed as part of the RARP Comply
Surface water		*l. Quality Assurance controls and reporting.*		EMP section 8.6.5, 8.6.6 and 8.8	This has been included in the EMP	Comply
	31	*The permit holder must submit an annual performance statement (within the wider EMP annual report).*		EMP Section 8.8 and 12	This has been included in the EMP	Comply
	32	*The permit holder must amend the SWMMP to address any identified issues, or changes or recommendations of the independent environmental auditor to the satisfaction of the responsible authority*		EMP section 14	This has been included in the EMP	Comply
Air	33	*The Air Quality / Dust Control Plan (AQMP) within the EMP must address and ensure compliance with the following requirements:*	Off-site air quality is not adversely affected by the development and use	EMP section 9 Dust deposition spreadsheet	There is an existing site wide dust monitoring program that comprises 3 HiVol samplers and 8 dust deposition gauges. HiVol samples operate 1 day in six and collect a 24 hour sample. The compliance with Australian Standards (3580) Siting criteria for the samplers has not been confirmed. Iluka analyse the samples form the HiVols and is not NATA registered. Iluka has advised that the dust deposition gauge samples are analysed at a NATA registered laboratory.	Siting appears satisfactory. Further dust deposition monitors are being provided and analyses will be conducted in NATA laboratory. Comply
Air		*a. Dust emissions to air must be managed to ensure that beneficial uses of the air environment are protected, and all emissions are reduced as far as is practicable by the application of best practice procedures and arrangements.*		EMP section 9 Dust deposition spreadsheet	There is no information provided on how the data would be monitored by whom and where. The trigger levels are at the criteria (the 50 ug/m^3 is the new NEPM regional standard) and at the PEM standard (60ug/m^3). The triggers are such that they will be exceeded before the site is aware and hence cannot be prevented. The objective of the trigger is to allow for prevention of exceedances. Therefore it is proposed that a shorter term trigger be used with a shorter response time frame. The SEPP AQM has a 1 hour PM10 design criteria of 80ug/m3 that would be appropriate as an initial trigger. As there will be a delay in receipt of the results and the sampling is not real time, an additional trigger is proposed: the emission of visible dust that reaches the site boundary should result in action to mitigate the impacts as per a contingency plan.	Visible dust trigger adopted. Roles and responsibilities defined. Comply

Environmental aspect	Planning Permit Clause	Planning Permit Requirements	Environmental Management Objectives	Documentation reviewed	Assessment based on EMP Revision 2 dated 21 April 2017	Conclusions based on Version 4 dated 6 July 2017
Air		*b. The permit holder must ensure dust does not emanate from the Subject Land so as to exceed the Assessment Criteria for mining and extractive industries specified in Table 2, Clause 3.3 of the SEPP (Air Quality Management) Protocol for Environmental Management: Mining and Extractive Industries or any subsequent replacement document*		EMP section 9 Dust deposition spreadsheet	See comment above	Comply
		Environmental and rehabilitation review regime				
	42	The permit holder must prepare an EMP and Rehabilitation performance review report covering its compliance requirements under the various sub-components of the EMP and R&VMP for provision to a suitably qualified environmental auditor as agreed by the Responsible Authority annually or less frequently as agreed to in writing by the Responsible Authority.		EMP Section 12.2 and 13.2	This requirement is addressed in part through section 11.2 and 11.3. However to meet the requirements of the Planning permit (with respect to the EMP), the additional items to be added are surface water monitoring results, types of material (and quantities) being disposed if at the site, and all noise monitoring. The audit requirement is included in section 12.2	The additional items to be added are surface water monitoring results, types of material (and quantities) being disposed of at the site, and all noise monitoring .
	43	The environmental auditor must review the EMP and Rehabilitation performance review report and provide conclusions on the report's content against its key sub-components, and recommendations for any required amendments to the plans ('auditor's review').		EMP section 13.2	This requirements has been addressed	Comply
	44	The EMP and Rehabilitation performance review report and the auditor's review must be forwarded by the permit holder to the Responsible Authority within 28 days of receipt of the auditor's review and must be published on the website of the permit holder within 60 days of being completed.		EMP Section 12.2	The audit requirement is included in section 11.2	Comply
	45	45. The permit holder must within a further 28 days of submission of the EMP and Rehabilitation performance review report, and the auditor's report to the Responsible Authority, provide to the satisfaction of the Responsible Authority, a description of the steps it intends to take, including timeframes, to address any non-compliances and recommendations identified in the EMP and Rehabilitation performance review report and / or auditor's review.		EMP Section 12.2	This requirement has not been addressed	Section has been amended. Comply
	46	The Responsible Authority will determine based on the above whether amendment to the EMP or R&VMP is then required, to its satisfaction, and the time frame and conditions under which such amendment is to occur.		N/A	N/A	N/A
		Amended EMP and the R&VMP				Comply
	47	If the EMP or R&VMP are required to be amended, then any such amended plan or plans must be placed on the Permit Holder's website from the time of their endorsement or approval by the Responsible Authority.		EMP Section 14	This requirement has been addressed in Section 14	Comply

Table 4 Review of Environmental Management Chapters

Section Number	EMP Chapter	Documentation reviewed	Assessment based on EMP Revision 2 dated 21 April 2017	Conclusions based on Version 4 dated 6 July 2017
1	Introduction	EMP Section 1, Iluka Works Approval Submission, EPA Works approval Assessment	This section adequately describes the purpose and scope of the EMP. In particular the scope addresses activities at the Douglas site and excludes transport to the site or activities at the Hamilton site. It is consistent with the documentation reviewed. The remainder of the site is operating under a Work Plan in particular an EMP and Rehabilitation and Revegetation plan. There are significant interaction between the management of stormwater, ground water and dust. The site has been operational since 2002 as a mining site and has been receiving waste into Pit 23 for many years (under a Work Plan). This information should be provided in the introduction.	Wider project context, Iluka Environment Management Systems and regulatory systems in the Introduction. Comply
2	Project Description	EMP Section 2, Iluka Works Approval Submission, EPA Works approval Assessment	This section is consistent with the documentation reviewed. It should include the other regulatory instruments being used to manage the remainder of the site.	Other Regulatory instruments addressing the remainder of the site included. Comply
3	Environmental Context.	EMP Section 3, Iluka Works Approval Submission, EPA Works approval Assessment	This section provides a summary of the environmental context. Further information is provided in sections 6-9 relevant to the particular environmental issues discussed in those sections. It is consistent with the documentation reviewed.	No changes required
4	Environmental management Objectives	EMP Section 4, Iluka Works Approval Submission, EPA Works approval Assessment	The Planning Permit (Clause 19) requires that Iluka "*prevent any adverse impact on the Environment"*. Iluka has a legal obligation to comply with relevant environmental regulations. Iluka commits to, as an objective of the EMP, "*to ensure that potential environmental impacts from the disposal and site rehabilitation are appropriately identified and mitigated to minimise adverse impacts on the environment such that impacts are limited to acceptable levels as defined in the planning permit.* Table 2 in Section 4 provides an adequate description of the Objectives to be met through the application of the EMP.	No changes required
5	Roles and Responsibilities	EMP Section 5	Roles and Responsibilities section was not included	Roles and Responsibilities have been included. No changes required.

Table 5 Review of Section 10 –Other Environmental Aspects

Environmental aspects	Planning Permit Requirements	Environmental Management Objectives	Documentation reviewed	Assessment based on EMP Revision 2 dated 21 April 2017	Conclusions based on Version 4 dated 6 July 2017
Noise	N/A	Noise emissions from the development and use comply with limits determined in accordance with EPA publication 1411, Noise from Industry in Regional Victoria, October 2011 (NIRV)	EMP section 10.1, NIRV Environmental Performance Reporting P1368 2016 Iluka Resources Limited v Horsham Rural CC (270117) ILUKA-_Works-Approval-Application-and-Attachments	1. The times/days shown in Table 25 for recommended maximum noise levels at sensitive receptors is incorrect. Meaning that some time periods are not covered by the table. The correct time periods are shown below: Day time = M-F (0700-1800) and Saturday (0700-1300) Evening = M-F (1800-2200), Sat (1300-2200), Sun (0700-2200) Night = M-S (2200-0700) 2. The reference to 'Table 24' (final paragraph on p78) is incorrect, as it should refer to the noise level table. Update reference to 'Table 25'. 3. Although it is unlikely that noise would be an issue due to distance from receptors, the increase of the daytime noise limit by 10dB during placement of topsoil and subsoil is subject to the following conditions. These conditions should be noted in the EMP. *This allowance should be approved for a limited period of exposure for each noise-sensitive area. The operator should specify indicative working periods (start and finish dates), which they should communicate to affected neighbours.* *• Where the project continues over a significant number of years, an allowance for multiple, well separated periods may be given (e.g. initial works and final site rehabilitation).* *• An allowance period (e.g. three months) is counted as the total period, from start to finish, in which the noisier works are programmed.* *• Weather conditions that increase noise at sensitive areas to make it above the recommended levels (propagation conditions 'favourable to noise propagation') should be assumed for noise modelling and works programming, regardless of the actual conditions when the works occur.* 4. Have noise mitigation measures been implemented (section 9.1.3)? Yes. Sign posted speed limits on site 5. The EMP and works approval application specify that routine noise monitoring will not be conducted. This is appropriate for the level of risk posed by the site activities and location of the pit. Iluka's 'Environmental Performance Reporting' notes that noise measurements will be part of the sites routine 6-monthly reporting. This should be updated to reflect the EMP.	Section updated. Comply
Weeds	N/A	Populations of weeds and feral species are actively managed to minimise spread and reduce numbers. No adverse impact to native vegetation communities	EMP Section 10.2	1. Somewhat unclear how the Wimmera invasive weed and animal strategy 2010-2015 relates to the site. 2. Suggest that weed management is also achieved through the sourcing of clean topsoil. 3. 3- No indication of how regularly weed monitoring will be undertaken. 4. 4- Glyphosate formulations may not work on all identified weeds at the site. 5. 5- the seems to be an intent to only control CaLP act listed weeds- many weed threats to revegetation may not be CaLP act listed.	Section updated. Comply
Vehicle Hygiene	N/A	Populations of weeds and feral species are actively managed to minimise spread and reduce numbers. No adverse impact to native vegetation communities	EMP Section 10.3	Section satisfactory	Comply
Feral Animals	N/A	Populations of weeds and feral species are actively managed to minimise spread and reduce numbers. No adverse impact to native vegetation communities	EMP Section 10.4	Section satisfactory	Comply
Geotechnical Stability	N/A	The development and use does not pose an unacceptable risk to the public, site personnel or contractors and the creation of stable final landforms is assured.	EMP Section 10.5	Section updated to address placement of other materials	Comply
Site Safety and Security	N/A	The development and use does not pose an unacceptable risk to the public, native fauna and domestic livestock	EMP section 10.6 Radiation Management Licence 300042022	Risk to public health and safety, managed by: • Warning signs indicate that access is restricted to authorised personnel with visitors being required to: - use approved access routes; - report to the site administrative office; and - be accompanied by a designated Iluka representative when on-site. • The main access gate consists of a boom-gate operated by a swipe-card issued to inducted employees and	Comply

Environmental aspects	Planning Permit Requirements	Environmental Management Objectives	Documentation reviewed	Assessment based on EMP Revision 2 dated 21 April 2017	Conclusions based on Version 4 dated 6 July 2017
				contractors, or which can be opened by site staff in response to a visitor request over the access gate intercom. After hours or on non-working days the security boom-gate is supplemented by a closed and padlocked mesh farm gate. • All alternative farm gate entry points into the site are padlocked. A chain mesh security fence constructed along the outer toe of the overburden stockpiles at the northern end of Pit 23 prevents unauthorised access to the pit crest. This is adequate to manage the risks to site safety and security.	

4.0 Endorsement

On the basis of the review reported herein, the following endorsement was prepared.

Iluka Resources Limited (Iluka) was issued a planning permit (15-105) by the Horsham Rural City Council for the development and use of land for the disposal of waste by-products associated with or sourced through mineral sands processing undertaken at the Hamilton Mineral Separation Plant (MSP), including waste by-products and contaminated materials resulting from the processing and transport operations as follows:

- By-products from the processing of heavy mineral concentrate at the Hamilton MSP;
- used dust filter bags from the Hamilton MSP; and
- Other chemically inert material contaminated with naturally occurring radioactive material;

in accordance with the endorsed plans.

The land being:

- Vol: 10234, Fol: 134, Crown Allotment: 91, Elliotts Road, Kanagulk VIC 3401
- Vol: 10325, Fol: 229, Crown Allotment: 94, Elliotts Road, Kanagulk VIC 3401
- Vol: 10325, Fol: 230, Crown Allotment: 95, Elliotts Road, Kanagulk VIC 3401
- Vol: 10325, Fol: 231, Crown Allotment: 96, Elliotts Road, Kanagulk VIC 3401

The conditions of that permit include:

Clause 16: Within 90 days of the commencement of this permit coming into operation an Environmental Management Plan (EMP) to the satisfaction of the Responsible Authority must be submitted for its approval. Three copies of the EMP and an electronic version must be provided.

Clause 17: The EMP must be accompanied by written endorsement from an environmental auditor appointed under the Environment Protection Act 1970.

Iluka has defined the endorsement as an assessment of whether

- the EMP meets the requirements of the planning permit; and
- whether the EMP is reasonably expected to meet the EMP objectives.

The scope of the EMP is described in sections 16-33 of the planning permit.

The scope of work comprised a review of the draft EMP to assess whether it meets the requirements of the planning permit and whether it is reasonably expected to meet the EMP objectives.

The scope excludes actions and activities addressed through the Radiation Management Plan, the Radioactive Waste Management Plan and the Rehabilitation and Vegetation Management Plan. We have assumed that these plans have been approved or will be approved by the Department of Human and Health Services and Horsham Rural City council respectively.

Dr Harry Grynberg an Environmental Auditor (Industrial Facilities) appointed pursuant to the Environment Protection Act 1970 led the review. Dr Grynberg is a Technical director –Environment at AECOM Australia Pty Ltd (AECOM).

The draft EMP was reviewed for the following matters:

- compliance with the key planning permit conditions (16-33), including:
  - technical and practical basis for proposed management measures;
  - scope and appropriateness of the risk assessment;
  - whether the risk assessment and proposed monitoring and risk mitigation measures are congruent;

- inclusion of other measures required in the EMP by the planning permit (e.g. reporting processes required by clause 42).

Comments arising from the review of Revision dated 21 April 2017 were provided to Iluka for response and update of the EMP (Revision 4 dated 6 July 2017).

AECOM was asked to prepare the Risk Assessment and Response Plan (RARP) and was advised by Iluka that Horsham Rural City Council was comfortable with AECOM preparing the RARP as well as undertaking the review of the EMP.

On the basis of the review of the EMP that I have conducted I am endorse the EMP (Revision 4 dated 6 July 2017) as:

- Complying with the relevant conditions of the permit (16-33) and including elements to address requirements outlined in conditions 42-45;
- Can reasonably be expected to meet the objectives outlined in it (Table 2 in Section 4);

subject to the following limitations:

Actions and activities addressed through the Radiation Management Plan, the Radioactive Waste Management Plan and the Rehabilitation and Vegetation Management Plan (RVMP) have not been review other than the RVMP with respect to preparation of the RARP. We have assumed that these plans have been approved or will be approved by the Department of Human and Health Services and Horsham Rural City Council respectively.

I have assumed that the EMP will be implemented in full..

Dr Harry Grynberg (Technical Director – Environment) along with his support team from AECOM has prepared this endorsement in accordance with the usual care and thoroughness of the consulting profession for the use of Iluka and Horsham Rural City Council. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this endorsement. It is prepared in accordance with the scope of work and for the purpose outlined in the proposal dated 3rd April 2017.

It is acknowledged that the endorsement may be used by Iluka and Horsham Rural City Council in reaching conclusions about the site. The scope of work performed in connection with the audit may not be appropriate to satisfy the needs of any other person. Any other person's use of, or reliance on, the Report, or the findings, conclusions, recommendations or any other material presented to them, is at that person's sole risk.

The review and this endorsement were prepared between April 2017 and July 2017 and is based on the conditions encountered and information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred or may occur after this time.

The methodology adopted and sources of information used by Dr Harry Grynberg and the support team are outlined in an associated report. Dr. Harry Grynberg and the support team have made no independent verification of this information beyond the agreed scope of works and we assume no liability for any inaccuracies in or omissions to that information. No indications were found during our investigations that information used as basis for this endorsement as provided to Dr Harry Grynberg and the support team was false.

This endorsement should be read in full. No responsibility is accepted for use of any part of this endorsement in any other context or for any other purpose. This Report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Except as required by law, no third party may use or rely on this endorsement unless otherwise agreed by AECOM, in writing. Where such agreement is provided, AECOM will provide a letter of reliance to the agreed third party in the form required by AECOM.

To the extent permitted by law, AECOM expressly disclaims and excludes liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this endorsement. AECOM does not admit that any action, liability or claim may exist or be available to any third party.

AECOM does not represent that this Report is suitable for use by any third party. Except as specifically stated in this section, AECOM does not authorise the use of this Report by any third party.

Dr Harry Grynberg

Technical Director- Environment, AECOM Australia Pty Ltd.

Environmental Auditor (Industrial Facilities) appointed pursuant to the Environment Protection Act (1970)

Date: 10 July 2017

5.0 References

Iluka Resources limited (2017) Mineral Sands By-Product Disposal Environmental Management Plan Rev1 19 April 2017

Environmental Earth Sciences (2016) Independent Desk top Review for the Continuation of Mineral By-Product Disposal into Pit 23 at Iluka's Douglas Mine site Northwest Victoria V2 April 2016

EPA (2016) Iluka Resources Works Approval Assessment Report 5 May 2016

Iluka Resources Limited (2016) Radiation Management Plan-Murray Basin Operations Redacted August 2016

Iluka Resources Limited (2016) Radioactive Waste Management Plan-Murray Basin Operations Redacted September 2016

DHHS (2016) Management Licence Certificate - Iluka Resources Limited - 300042022_Redacted

Iluka 2016 Supplementary Further Information General response –General

Iluka 2016 Supplementary Further Information General response-Appendix C Surface water Management Plan

Iluka 2016 Supplementary response to amended Notice to supply Further Information- General

Iluka 2016 Supplementary response to amended Notice to supply Further Information-Appendix A Groundwater Monitoring and Management Plan

Iluka 2016 Response to s22 notice non-hydrogeological GW Appendix B Geomorphological Investigation

Iluka 2015 Iluka-Groundwater-Risk-Assessment Jacobs December 2014

ATTACHMENT C

Revised Page 11 of the Rehabilitation and Vegetation Management Plan

6 Rehabilitation risk assessment

A Risk Analysis and Response Plan (RARP) was prepared by AECOM Australia Pty Ltd (AECOM) and a copy of AECOM's report (The RARP Report) is contained in Appendix A to the EMP.

It can be seen from the RARP report that:

- a Risk Register was developed in which 26 risk events were identified for assessment, ten of which related specifically to rehabilitation;
- the likelihoods and consequences of each identified risk event were assessed and combined to give a "risk score" where a score of 0.1 indicates a negligible risk, 1 a minor risk, 10 a moderate risk, 100 a major risk and 1000 an extreme risk;
- two of the ten risk events related to rehabilitation, drought and bushfire, were determined to have a risk score marginally above 0.1, i.e. slightly above negligible. The risk score of majority of the other rehabilitation related risk events were determined to be less than 0.01;
- While risks of drought and bushfire were assessed as being close to negligible, in response to the fact that they were the two top ranked risks, they were given additional consideration, which led to:
    - recognition that while the likelihoods of occurrence of these events cannot be controlled, the consequences will be reduced by implementation of the mitigating measures included in the R&VMP (Section 9.4), i.e. increasing soil moisture, monitoring of vegetation, replacement plantings and a bushfire management plan;
    - identification of an additional mitigation measure to ensure a sufficient supply of tubestock.

It is recognised that in times of drought or immediately following a bushfire the availability of seed for harvesting and propagation to produce tubestock will be limited to some extent. To ensure that sufficient tubestock can be accessed to complete the required replacement planting during drought and following a bushfire, the following actions will be taken:

- the advice of a suitably qualified ecological consultant will be obtained to determine the tubestock requirements, in terms of species mix and quantities, required for replacement planting during drought or following a bushfire; and
- one or more nurseries will be commissioned to do what is necessary to maintain sufficient stocks of tubestock to meet the established requirements. It is expected that this will include seed collection, seed storage, precautionary propagation and tubestock storage.

In this way an adequate supply of tubestock will be maintained.