Mulga Rock Uranium Project

Public Environmental Review

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Invitation to make a submission

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. The environmental impact assessment process is designed to be transparent and accountable, and includes specific points for public involvement, including opportunities for public review of environmental documentation. In releasing this document for public submissions, the EPA advises that no decisions have been made to allow this proposal to be implemented.

Vimy Resources Limited (Vimy) proposes to develop the Mulga Rock Uranium Project in the Goldfields-Esperance Region of Western Australia. In accordance with the *Environmental Protection Act 1986*, a Public Environmental Review (PER) document has been prepared which focuses on the preliminary key environmental factors or issues, describes this proposal, and provides evidence of mitigation measures to avoid, minimise, rehabilitate impacts to demonstrate that the EPA's environmental objectives can be met. The PER document is available for a public review period of twelve weeks from 14 December 2015 closing on 7 March 2016.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

The proponent will be required to provide adequate responses to points raised in submissions. In preparing its assessment report for the Minister for Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information.

Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*, and may be quoted in full or in part in the EPA's report.

Why not join a group?

If you prefer not to write your own submission, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER document or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the PER document:

- clearly state your point of view giving reasons for your conclusions;
- indicate the source of your information where applicable; and
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER document;

- if you discuss different sections of the PER document, keep them distinct and separate, so there is no confusion as to which section you are considering; and
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Copies of this document

Printed and electronic copies of this document may be obtained from Julian Tapp at Vimy Resources, Ground Floor, 10 Richardson Street, West Perth 6005 and 9386 2700 at a cost of $10 (including postage and handling) or a CD version is available free of charge.

The document/s may also be accessed through the proponent's website at www.vimyresources.com.au.

How to make a submission

The EPA prefers submissions to be made at: https://consultation@epa.wa.gov.au

Alternatively submissions can be:

- posted to: Chairman, Environmental Protection Authority, Locked Bag 10, EAST PERTH WA 6892; or
- delivered to the Environmental Protection Authority, Level 8, The Atrium, 168 St Georges Terrace, Perth.

Remember to include:

- Mulga Rock Uranium Project and Assessment No. 1979
- your name and address;
- date of your submission; and
- whether you want your submission to be confidential.

The closing date for submissions is: 7 March 2016.

The EPA's website http://epa.wa.gov.au/ contains information about the environment impact assessment process, should you have any queries. However, if you have any questions on how to make a submission, please ring the Office of the EPA on 6145 0800 (quoting the Mulga Rock Uranium Project and Assessment No. 1979).

Executive Summary

Vimy Resources Limited (Vimy), as the Proponent, proposes to develop the Mulga Rock Uranium Project (MRUP) in the Goldfields-Esperance Region of Western Australia (the Proposal).

This document is a Public Environmental Review (PER) for the Proposal and has been prepared in accordance with Part IV of the *Environmental Protection Act 1986* (EP Act). This document also satisfies the requirements for assessment under *The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in accordance with the Agreement between the Commonwealth of Australia and the State of Western Australia relating to Environmental Impact Assessments.

Proposal Overview

The MRUP is located approximately 240km east-northeast of Kalgoorlie-Boulder in the Shire of Menzies. The Project will involve the open pit mining of four poly-metallic deposits with commercial grades of contained uranium hosted in carbonaceous material. Processing will be undertaken onsite at a central mill.

The MRUP area is remote, covers an area of 102,000 hectares (ha) of dune fields and is located within granted mining tenure on Unallocated Crown Land (UCL), on the western flank of the Great Victoria Desert. Access is limited and is only accessible by four wheel drive vehicles. The nearest residential town is Laverton which is approximately 200km to the northwest. Other regional residential communities include Pinjin Station Homestead, located approximately 100km to the west; Coonana Aboriginal Community, approximately 130km to the south-southwest; Kanandah Station Homestead, approximately 150km to the south-east; and the Tropicana Gold Mine approximately 110km to the north-east.

Up to 4.5 Million tonnes per annum (Mtpa) of ore will be mined by traditional open cut techniques, crushed, beneficiated and then processed at an onsite acid leach and precipitation treatment plant to produce, on average, 1,360 tonnes of uranium oxide concentrate (UOC) per year over the life of the Project.

Other metal concentrates (copper, zinc, nickel and cobalt) will be extracted using sulphide precipitation after the uranium has been removed and sold separately. The anticipated life of mine (LOM) is sixteen years, based on the currently identified resources. The drummed UOC will be transported by road from the minesite in sealed sea containers to a suitable port, approved to receive and ship Class 7 materials (expected to be Port Adelaide), for export.

The Project will require clearing of vegetation, mine dewatering and reinjection, creation of overburden (non-mineralised) landforms (OLs), construction of onsite processing facilities and waste management systems. Major built infrastructure will include a processing plant, Run of Mine (ROM) ore stockpile areas, construction of above-ground overburden landforms for non-mineralised mined materials, an initial above-ground tailings storage facility (TSF) and small scale water storage facilities. Once a suitable mining void has been created, tailings will be deposited back into the unlined pit and capped with non-mineralised overburden and rehabilitated. Rehabilitation of disturbed areas will be undertaken in accordance with the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030) and the Mine Closure Plan (MRUP-EMP-031).

Required project infrastructure will include mine administration and workshop facilities, fuel and chemical storage, a diesel or gas (LNG) fired power plant of up to 20 megawatt (MW) capacity, a brackish water extraction borefield and mine dewatering water reinjection borefield and associated pipelines and power supply, an accommodation village for a fly-in fly-out workforce, an airstrip, laydown areas and other supporting ancillary infrastructure such as communication systems, roads, waste water treatment plant and solid waste landfill facilities. Transport to site for consumables, bulk materials and general supply items will be via existing public road systems linked to dedicated project site roads.

At completion of operations the site will be decommissioned and rehabilitated in accordance with an approved Mine Closure Plan.

Key Characteristics

The key characteristics of the Proposal are shown in the tables below.

A summary of the Proposal is provided in Table E-1, with key physical and operational characteristics of the Proposal summarised in Table E-2 and Table E-3.

Table E-1 Proposal Summary

Summary of the Proposal	
Proposal Title	**Mulga Rock Uranium Project (MRUP)**
Proponent Name	**Vimy Resources Limited**
Short Description	This Proposal is to develop four poly-metallic deposits containing commercial concentrations of uranium and to produce uranium oxide concentrate and other metal concentrates for sale. The Proposal includes: • Open cut pits, mine dewatering and reinjection infrastructure. • Low profile non-mineralised overburden landforms. • ROM stockpile areas. • Transport corridors through which ore will be pumped in pipelines to a central processing facility and oversized material will be trucked. • Central processing plant including an above-ground short term TSF and process water storage facilities. • Long term tailings storage in mine voids followed by backfilling with non-mineralised overburden. • A water extraction borefield and associated pipelines and power supply. • A reinjection borefield. • Associated infrastructure including offices, maintenance workshops, laydown areas, ancillary infrastructure (e.g. communications systems, wastewater treatment plant solid waste landfill, etc.), accommodation facilities, airstrip. • Mine roads and fuel and chemical storage. • Up to 20MW diesel or gas (LNG) fired power station.

Table E-2 Physical Elements

Element	Proposed Extent
Open cut pits and dewatering infrastructure	Clearing of up to 2,374ha of native vegetation within a 9,998ha Development Envelope.
Reinjection infrastructure – borefield and pipelines	Clearing of up to 18ha of native vegetation within a 9,998ha Development Envelope.
Overburden landforms and soil stockpiles	Clearing of up to 937ha of native vegetation within a 9,998ha Development Envelope.
Roads, borrow pits and services including corridor for slurry pipelines	Clearing of up to 143ha of native vegetation within a 9,998ha Development Envelope.
Processing plant, ROM stockpiles and administration buildings	Clearing of up to 41ha of native vegetation within a 9,998ha Development Envelope.
Extraction borefield and supporting infrastructure	Clearing of up to 27ha of native vegetation within a 9,998ha Development Envelope.
Accommodation village	Clearing of up to 7ha of native vegetation within a 9,998ha Development Envelope.
Above-ground TSF	Clearing of up to 106ha of native vegetation within a 9,998ha Development Envelope.
Miscellaneous disturbance area (including power generation and reticulation and laydown associated with construction)	Clearing of up to 18ha of native vegetation within a 9,998ha Development Envelope.
Airstrip	Clearing of up to 38ha and disturbance of up to 78ha of native vegetation within a 9,998ha Development Envelope.

Table E-3 Operational Elements

Element	Proposed Extent
Water abstraction for process water and domestic supply	At this stage, operational demand will require extraction of up to 3 Gigalitres/annum (GL/a) of groundwater (with an average of 1.8GL/a over LOM). The final volume will depend on the availability for reuse of suitable quality water from mine dewatering.
Mine dewatering and reinjection infrastructure	Dewatering to allow mining varies over LOM. Extraction estimated up to 2.5GL/a, with surplus water reinjected into down gradient paleo-aquifer system where water quality permits.
Power supply	Up to 20MW to be supplied by a small remote area diesel or gas (LNG) fired power station. Borefield and pumping stations- options being considered include mine grid power or small dedicated diesel generators.
Overburden disposal	Up to 60Mtpa of overburden (with an average of 40-45Mtpa over LOM).
Waste materials from ore processing and beneficiation rejects disposal	Up to 3Mtpa of beneficiation rejects and up to 2Mtpa of post-leaching tailings material.
Surplus mine dewatering water reinjection	Injection of up to 1.5GL/a of surplus mine dewatering not used in processing or for dust suppression purposes.
Waste management – wastewater and solid wastes	Sufficient to accommodate a workforce of around 315 people.

Justification for the Proposal

The demand for uranium to be used as a fuel for nuclear reactors generating electricity, in one of the safest and cleanest ways available, is expected to increase significantly. This will ultimately result in a shortage. The Proposal seeks to meet that demand in a manner that will have a very low environmental impact.

Stakeholder Consultation

Vimy has undertaken consultation about the Mulga Rock Uranium Project over many years including when it was known under its former name of Energy and Minerals Australia Limited (EMA). Consultation regarding the MRUP area of land has been with representatives of the Wongatha people who are broadly accepted as the traditional owners for the area. There is no native title claim over the MRUP area. A pre-existing native title claim by Wongatha people overlapped the area where the extraction borefield is expected to be located.

Regional stakeholders have included the Shire of Menzies, Shire of Kalgoorlie-Boulder and Tropicana Gold Mine. Consultation regarding the MRUP development has predominantly been with Decision Making Authorities (DMAs) and other relevant State government departments, local government authorities as well as environmental and non-government organisations. All consultation activities have been detailed in Appendix J1.

Key Environmental Factors

Key environmental factors relevant to the Proposal were identified through the scoping process undertaken for the Environmental Scoping Document (ESD) and the outcomes of environmental studies and investigations undertaken to date. The ESD is Appendix L1. Key environmental factors addressed in this PER are:

- Flora and Vegetation,
- Terrestrial Fauna,
- Subterranean Fauna,
- Hydrological Processes,
- Inland Waters Environmental Quality,
- Air Quality and Atmospheric Gases,
- Human Health,
- Heritage,
- Rehabilitation and Decommissioning,
- Offsets.

In accordance with the EPBC Act Referral Decision issued by the Department of the Environment (DoE) (Reference: EPBC 2013/7083), Matters of National Environmental Significance (MNES) of relevance to the Proposal are:

- Listed threatened species and communities (s.18 and s.18A), including:
  - Sandhill Dunnart *(Sminthopsis psammophila),*
  - Southern Marsupial Mole *(Notoryctes typhlops),*
  - Malleefowl (*Leipoda ocellata*),
  - Ooldea Guinea-flower *(Hibbertia crispula),*
  - Night Parrot *(Pezoporus occidentalis),*

  - Princess Parrot *(Polytelis alexandrae).*
- Migratory species protected under international agreements
  - Rainbow Bee-eater (*Merops orantus*).
- The environment because the Proposal is a nuclear action (s.21 and s.22A).

Impact Assessment Summary

Vimy has completed a range of specialist biological, botanical, hydrological, hydrogeological and heritage investigations for the Proposal, in accordance with regulatory guidelines. These investigations have formed the basis for assessing the potential environmental impacts and risks associated with the Proposal. To manage the potential impacts and risks, Vimy has developed design considerations, mitigation measures and environmental management commitments. These measures have been developed so that the Proposal will be constructed and operated in an environmentally and sustainably responsible manner.

A summary of the environmental factors, management objectives, potential impacts, proposed management strategies and predicted environmental outcomes for the Proposal are shown in Table E-4.

Residual Impacts and Offsets

Based on the assessment of risk, the Proposal will result in the following significant impacts:

- Direct disturbance of approximately 3,787ha of native vegetation with following attributes:
  - Approximately 80% has recently burned (November 2014 and so there will be few individual conservation significant flora within the proposed Disturbance Footprint.
  - Approximately 24ha of potential prime Sandhill Dunnart (*Sminthopsis psammophila*) habitat (unburnt E3 and S6 vegetation communities).
    - Surveys suggest that likely presence of Sandhill Dunnarts is low
  - Approximately 11ha of potential Southern Marsupial Mole (*Notoryctes typhlops*) habitat (defined as S6 and S8 vegetation communities situated within interlinked dunes);
    - Surveys suggest that the likely presence of Marsupial Moles is very low.
  - Represents 7.36% of mapped community, the impact on the species will be negligible given that the Project lies at the SW edge of very wide distribution within the sandy deserts of central Australia.
  - The Project will not cause any major habitat fragmentation.
  - Less than 2ha of the Disturbance Footprint is regarded as potentially suitable breeding habitat for Malleefowl (*Leipoa ocellata*);
    - Surveys suggest that Malleefowl are not likely to exist in the area as absence of any signs of Malleefowl.
  - 38 +/- 13 plants Ooldea Guinea-flower (*Hibbertia crispula*) at one location are likely to be disturbed.
  - All disturbed areas will be rehabilitated.
  - Very small proportion of the total 14,269 +/- 25 plants surveyed in the region to date.
- Up to 3GL/a of brackish water will be extracted from a borefield and will, after being used in processing, be deposited with tailings in tailings storage facilities.
  - Average annual extraction is estimated at 1.8GL/a over LOM.

  - The water body it is being extracted from is estimated at 167GL.
  - There are no associated groundwater dependent ecosystems.
  - No significant stygofauna were present.
  - Water drawdown does not present a threat to the small number of aquatic worms identified as present.
- Up to 2.5GL/a of saline water will be extracted from the mine as a result of dewatering most of which will be used for processing and other activities:
  - Any surplus will be reinjected into the same aquifer downstream where water quality is worse.
  - No stygofauna are present in this aquifer.
  - There are no associated groundwater dependent ecosystems.
- Tailings will be stored in a surface tailings storage facility during an initial period until suitable mining voids are available to become an in-pit tailings facilities and tailings will be deposited in-pit thereafter:
  - Any seepage from the surface tailings storage facility will move down to the aquifer where contaminants will be attenuated by carbonaceous matter and will not be distinguishable from natural variation in groundwater at the mining lease boundary.
  - Drainage from in-pit tailings facilities will be directly into aquifer where contaminants will be attenuated by carbonaceous matter and will not be distinguishable from natural variation in groundwater at the mining lease boundary.
- Dust levels generated will be within natural variability in the area.
- Associated radionuclides present no threat to humans, non-human biota or any ecosystems present.
- No significant Aboriginal heritage sites will be impacted.
- Considered globally the development will have a net benefit in terms of greenhouse gas emissions.

After the application of measures designed to avoid, minimise and rehabilitate environmental impacts no significant residual environmental impacts will remain. There will therefore be no significant residual environmental impacts that require counterbalancing offsets.

Environmental Acceptability

Vimy believes that the Proposal can be implemented in a manner which will meet the EPA's objectives. The avoidance and mitigation measures will ensure that environmental impacts are kept to the minimum necessary to implement the Proposal. Vimy will continue to demonstrate its commitment to environmental compliance in the implementation of the Proposal.

On the basis of the findings of this PER, the Proposal is considered environmentally acceptable if implemented in accordance with the management measures contained within the document.

Table E.4 Summary of Impacts and Proposed Management Measures

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
Flora and Vegetation	To maintain representation, diversity, viability and ecological function at the species, population and community level.	**Legislation** • *Wildlife Conservation Act 1950 (WA)* (WC Act). • *Environmental Protection Act 1986 (WA)* (EP Act). • *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act). **Guidance and Position Statements** • Environmental Protection Authority (EPA) (2000) Position Statement No. 2 – *Environmental Protection of Native Vegetation in Western Australia – Clearing of Native Vegetation, with particular reference to the Agricultural Area*. • EPA (2002) Position Statement No. 3 – *Terrestrial Biological Surveys as an Element of Biodiversity Protection.* • EPA (2004) Guidance Statement No. 51 – *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. • EPA (2003) Guidance Statement No. 55 – *Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process*. **Other for consideration** • Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (2014) *Technical Report 167 – A review of existing Australian radionuclide activity concentration data in non-human biota inhabiting uranium mining environments*. • Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008) *Approved Conservation Advice – Ooldea Guinea-flower* (*Hibbertia crispula*) Canberra, ACT. • EPA (2012) *Checklist for documents submitted for EIA on terrestrial biodiversity* Appendix 2 of the EPA's Draft Environmental Assessment Guideline No. 6 on Timelines for Environmental Impact Assessment of Proposals. • Department of Sustainability, Environment, Water, Population and Communities DSEWPaC (2012) EPBC Act *Environmental Offsets Policy*, Canberra, Australian Capital Territory. • Government of Western Australia (2011) *Environmental Offsets Policy*, Perth, Western Australia. • Government of Western Australia (2014) *Environmental Offsets Guidelines*, Perth, Western Australia.	The Project area occurs within the Great Victoria Desert Shield subregion (GVD1) of which 100% of the pre-European vegetation association remains intact. The dominant Pre-European Vegetation Association 84 resembles the Mattiske Consulting Pty Ltd (MCPL) Vegetation Community E3 which consists mainly of a tree steppe of Marble Gum (*Eucalyptus gongylocarpa*) over Ooldea Mallee (*Eucalyptus youngiana*) over spinifex (*Triodia basedowii*), and comprises 31.86% of the total Development Envelope. A total of 26 vegetation community types were identified in the Project area of which all are also found in the Disturbance Footprint. The condition of the vegetation ranges between Good and Pristine for areas not recently affected by fire, and Degraded (at least temporarily) where there has been recent fire. Recent fire has affected 78% of the Disturbance Footprint. No weed species or Declared Rare Flora (DRF) have been recorded in the Project area. Eleven Priority flora species were recorded in the Project area: • *Hibbertia crispula* (P1 and Vulnerable) • *Dampiera eriantha* (P1) • *Neurachne lanigera* (P1) • *Isotropis canescens* (P2) • *Styphelia* sp. Great Victoria Desert (N. Murdock 44) (P2) • *Baeckea* sp. Sandstone (C.A. Gardner s.n. 26 Oct. 1963) (P3) • *Comesperma viscidulum* (P4) • *Conospermum toddii* (P4) • *Dicrastylis cundeeleensis* (P4) • *Grevillea secunda* (P4) • *Olearia arida* (P4). No Threatened Ecological Communities (TECs) are known to occur within the Project area. There is one Priority 3(ii) ecological community (PEC) that is likely to occur in the Project area and it is described as the 'Yellow Sand Plain Communities of the Great Victoria Desert'. The conservation category defines the PECs as ecological communities identified as threatened, but not listed as TECs. These communities are under threat, but there is insufficient information available concerning their distribution to make a proper evaluation of their conservation status.	The Proposal involves the clearing of up to 3,787ha of native vegetation (78% of which has recently burnt). This has the potential to cause the loss of conservation significant flora species, important vegetation units and habitat and disruption to ecosystem function. However, it will be cleared in a progressive manner due to the sequential mining method and will be restricted to the minimum amount necessary and it will also be progressively rehabilitated. No Priority flora species will be threatened as a result of clearance. In total only the following will potentially be disturbed: • 38 *Hibbertia crispula* plants (P1-vulnerable); 0.27% of regional total. • 8 *Dampiera eriantha* plants (P1); 0.43% of regional total. • 128 *Isotropis canescens* (P2); 4.25% of regional total. • 2 *Styphelia* sp. Great Victoria Desert plants (P2); 1.84% of regional total. • 63 *Comesperma viscidulum* plants (P4); 3.32% of regional total. • 3,941 *Conospermum toddii* plants (P4); 8.62% of regional total. • 945 *Grevillea secunda* plants (P4); 7.40% of regional total. • 22 *Dicrastylis cundeeleensis* plants (P4); 0.31% of regional total. • 56 *Olearia arida* plants (P4); 1.83% of regional total). There are also potential indirect impacts on flora and vegetation which may result from dust deposition, altered fire patterns, radiation (potential uptake of radionuclides or other contaminants from dust, groundwater and surface water), the spread of weeds and feral animals, altered hydrological regimes, from dewatering and reinjection, changes in air or surface water quality and accelerated erosion/soil loss or movement. No vegetation will be affected by water extraction or reinjection as the underlying aquifer is not connected to surface ecosystems. Other indirect impacts will be mitigated through the application of Environmental Management Plans and measures designed to limit impacts.	The areas being cleared will be managed through the application of a Ground Disturbing Activity Permit (GDAP). This will ensure that any key locations regarded as environmentally sensitive (such as location of conservation significant flora or refuge areas created by fire) are avoided where practical and the extent of all clearances is minimised. The same system will monitor clearances and ensure that rehabilitation takes place as soon as is practical. Indirect impacts will be limited by the application of the following management plans (MPs): • Flora and Vegetation MP (MRUP-EMP-001) • Conservation Significant Flora and Vegetation MP (MRUP-EMP-002) • Weed MP (MRUP-EMP-003) • Feral Animal MP (MRUP-EMP-006) • Groundwater MP (MRUP-EMP-010) • Groundwater Operating Strategy (MRUP-EMP-011) • Managed Aquifer Recharge MP (MRUP-EMP-012) • Tailings MP (MRUP-EMP-013) • Ground Disturbance MP (MRUP-EMP-019) • Dust MP (MRUP-EMP-024) • Fire MP (MRUP-EMP-025) • Radiation MP (MRUP-EMP-028) • Radioactive Waste MP (MRUP-EMP-029) • Rehabilitation and Revegetation MP (MRUP-EMP-030) Additional operational measures will be applied to ensure that unnecessary disturbance to flora and vegetation does not occur. These will include: • Restricted off-road driving • Enforced vehicle speed limits • Control of dust suppression runoff.	The impact of the Proposal will be relatively restricted and short term and all disturbed areas will be progressively rehabilitated, including the overburden landforms and all tailings storage facilities. Approximately 78% of the vegetation in the Disturbance Footprint is currently temporarily classed as degraded due to denudation by fire. Rehabilitation will be managed to ensure that suitable vegetation communities similar to analogue sites are established and become self-sustaining. No significant residual environmental impacts to flora and vegetation are expected to remain post rehabilitation.

Terrestrial Fauna	To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	**Legislation** • *Wildlife Conservation Act 1950 (WA)* (WC Act). • *Environmental Protection Act 1986 (WA)* (EP Act). • *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act). **Guidance and Position Statements** • EPA (2002) Position Statement No. 3 – *Terrestrial Biological Surveys as an Element of Biodiversity Protection.* • EPA (2004) Guidance Statement No. 56 – *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.* • EPA (2009) Guidance Statement No. 20 – *Sampling of Short-Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia*. • EPA (2012) *Checklist for documents submitted for EIA on terrestrial biodiversity* Appendix 2 of the EPA's Draft Environmental Assessment Guideline No. 6 on Timelines for Environmental Impact Assessment of Proposals. **Other for consideration** • *Animal Welfare Act 2002 and Animal Welfare Regulations (Scientific Purposes) Regulations 2003.* • National Health and Medical Research Council (NHMRC) (2013) *Australian Code for the Care and Use of Animals for scientific purposes*, 8th Edition. • Department of Infrastructure, Planning and Environment (2004) *Recovery Plan for Marsupial Moles* (*Notoryctes typhlops* and *N. caurinus*) 2005-2010, Alice Springs NT. • Department of Environment and Natural Resources (2011) *National Recovery Plan for the Sandhill Dunnart Sminthopsis psammophila,* South Australia. • Department of Environment and Conservation (DEC) (2011) *Standard Operating Procedure 5.2 – Remote Operation of Cameras*, Version 1.0, Perth, Western Australia. • DSEWPaC (2011) *Survey guidelines for Australia's threatened mammals*: *Guidelines for detecting mammals listed as threatened under the EPBC Act*, Canberra, ACT. • EPA & DEC (2010) Technical Guide: *Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*, Perth, Western Australia. • ARPANSA (2014) *Technical Report 167 – A review of existing Australian radionuclide activity concentration data in non-human biota inhabiting uranium mining environments*.	The harsh environment of the region does not support a great diversity of birds or mammals but does sustain a high diversity of reptiles. Amphibians are almost entirely absent. Targeted surveys for Sandhill Dunnarts (*Sminthopsis psammophila*) , Southern Marsupial Moles (*Notoryctes typhlops*) and Malleefowl (*Leipoa ocellata*) have been undertaken: • Sandhill Dunnart – Surveys suggest that the likely presence of this species in the MRUP area is low and given recent bushfire only around 24ha of prime habitat remains within the Disturbance Footprint. • Southern Marsupial Moles (SMM) – Evidence of past existence in area but molehole density far lower than found in all other SMM surveys. Project area is at the edge of known distribution range. Suitable habitat within Disturbance Footprint (defined as S6/S8 situated within interlinked dunes) is only ~11ha. • Malleefowl – Less than 2ha of suitable habitat found to exist in the Disturbance Footprint and no signs of presence in the area by individuals. Recent fire has burnt 78% of the proposed Disturbance Footprint resulting in an environment that will not support Sandhill Dunnarts or Malleefowl until suitable regrowth has occurred. Several species of Short Range Endemics (invertebrates) were found during reconnaissance surveys and none of these were considered to be at risk from the development of the Proposal (Appendix B7).	Clearing of vegetation may result in loss or fragmentation of fauna habitat and consequential displacement of fauna or to the isolation of populations or subpopulations of fauna. However the Project area was extensively burnt in 2014 and thus currently has a greatly reduced protective cover for mammals or reptiles. Death or injury of individual fauna may occur during the construction and operational phase of the Project. It is advantageous that the disturbance of areas will be progressive due to the mining methodology, and progressive rehabilitation will minimise the areas of disturbance as much as is possible. Indirect fauna impacts from the Project may result from radiation, altered fire regimes, increases in feral animal numbers, noise and light spill and any changes in air quality. Such impacts will be prevented or mitigated through the application of various Management Plans with detailed measures designed to limit such impacts.	Ground disturbance during the construction and operational phases of the Project will be managed through the application of a Ground Disturbing Activity Permit (GDAP) via the Ground Disturbance Management Plan. This will ensure that any key locations regarded as environmentally sensitive (such as interlinked sand dunes or refuge unburnt areas) are avoided where practical. The extent of all disturbance will be minimised to limit habitat loss. The same GDAP system will monitor disturbance and ensure that progressive rehabilitation takes place as soon as is practical. Indirect impacts will be limited by the application of the following management plans (MPs): • Weed MP (MRUP-EMP-003) • Terrestrial Fauna MP (MRUP-EMP-004) • Conservation Significant Fauna MP (MRUP-EMP-005) • Feral Animal MP (MRUP-EMP-006) • Ground Disturbance MP (MRUP-EMP-019) • Transport MP (MRUP-EMP-022) • Emergency Response MP (MRUP-EMP-023) • Dust MP (MRUP-EMP-024) • Fire MP (MRUP-EMP-025) • Radiation MP (MRUP-EMP-028) • Radioactive Waste MP (MRUP-EMP-029) • Rehabilitation and Revegetation MP (MRUP-EMP-030) In addition, site-wide management practices will be enforced to ensure no unnecessary disturbance occurs to fauna, and will include: • Restricted off-road driving • Enforced vehicle speed limits An ongoing program of fauna monitoring will be undertaken to ensure feral animal numbers are not increasing and fauna is not encouraged to site by attraction to any facilities.	The impact on fauna by the Proposal will be predominantly through ground disturbance and habitat removal. It should be noted that ~78% of the Disturbance Footprint has been recently burnt and had all vegetative cover (and consequently habitat) removed. All disturbed areas will be progressively rehabilitated. Progressive rehabilitation will be managed to ensure that self-sustaining vegetation communities comparable to selected analogue sites are re-established. One such analogue site is expected to be the E3 vegetation community – a prime habitat for Sandhill Dunnarts (Vimy 2015a). No significant impacts on terrestrial fauna are expected to result from the construction and operational stages of the Project. There will only be minimal residual environmental impacts to terrestrial fauna once closure is complete, and these should be eliminated once revegetation cover returns to pre-existing levels.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
		• DSEWPaC (2012) EPBC Act *Environmental Offsets Policy*, Canberra, Australian Capital Territory. • Government of Western Australia (2011) *Environmental Offsets Policy*, Perth, Western Australia. • Government of Western Australia (2014) *Environmental Offsets Guidelines*, Perth, Western Australia.				
Subterranean Fauna	To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	**Legislation** • *Wildlife Conservation Act 1950 (WA)* (WC Act). • *Environmental Protection Act 1986 (WA)* (EP Act). • *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act). **Guidance and Position Statements** • EPA (2013) Environmental Assessment Guideline No. 12 – *Consideration of Subterranean Fauna in Environmental Impact Assessment in WA.* • EPA (2007; Draft) Interim Guidance Statement No. 54a (Technical Appendix to Guidance Statement No. 54) – *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia.* **Other for consideration** • DSEWPaC (2012) EPBC Act *Environmental Offsets Policy*, Canberra, Australian Capital Territory. • Government of Western Australia (2011) *Environmental Offsets Policy*, Perth, Western Australia. • Government of Western Australia (2014) *Environmental Offsets Guidelines*, Perth, Western Australia.	**Stygofauna** The aquifer underlying the mining area and the reinjection area is saline to hypersaline (up to 147,000mg/L TDS – Appendix D2) and no stygofauna were detected during surveys (Rockwater 2015c). The Kakarook North aquifer, from which water will be extracted for processing and other purposes, is brackish (average TDS of around 5,500mg/L TDS – Appendix D2). Only two species of aquatic worms were detected from two of the 12 holes sampled. The groundwater oligochaete *Enchytraeus* sp. 1 (PSS) is a species complex that has been recorded in other parts of WA including the Pilbara, Kimberley and Northern Goldfields regions. *Tubificidae* sp. MR1 is a potential new species and has only been recorded from the Kakarook North area. (Appendix C2). **Troglofauna** Three species of troglofauna were detected during site sampling: *Trichorhina* sp., *Hanseniella* sp. and *Symphella* sp. (Rockwater 2015c). Two of these species may be affected by the Project development, but both were also sampled well beyond the development footprint. The study found that the troglofauna habitat is potentially widespread over a distance of at least 50km in the broader region (Appendix C2).	**Extraction borefield** Groundwater abstraction from the proposed borefield may potentially impact on subterranean fauna present. Stygofauna present in the borefield sampling was comprised of two aquatic worm species sampled in low densities from the proposed borefield site. The rate of water extraction from the Kakarook North aquifer will represent ~1% of the volume of water conservatively modelled to be present (Appendix D2). Therefore it is expected that the Project will only have minimal impact on the stygofauna of the area. **Mining area** Open cut mining, and the mine dewatering that will precede it, may potentially impact on any stygofauna or troglofauna in the area of disturbance. However no stygofauna were detected in the mining area, and the high salinity of the ground water of the proposed mining zone indicates that the presence of any stygofauna is unlikely (Appendix C1). It also appears unlikely that the abundance, diversity and geographic distribution of the troglofauna community or the conservation status of any individual troglofauna species at MRUP would be impacted by the Project (Appendix C2). **Reinjection borefield** Water reinjection could potentially impact on subterranean fauna present. However, levels of salinity at the site of reinjection are higher than or equal to that of the groundwater at the proposed pits (Appendix D1). The area is unlikely to support stygofauna as maximum salinities for prospective stygofauna are 50,000mg/L (EPA 2003) and the average salinity in the reinjection borefield groundwater system is 73,900mg/L. Troglofauna were not recorded lower than 10m in the area (Appendix C2). Mounding is not expected to exceed 2m (Appendix D2)) and no troglofauna are expected to be present just above the aquifer at 30-50m below ground level (Appendix D2). **General Site** Habitat could be impacted via accidental spills of hydrocarbons, chemicals or other materials toxic to subterranean fauna.	Areas cleared will be minimised through the application of a Ground Disturbing Activity Permit (GDAP) system. Management and monitoring of groundwater will be undertaken as part of the following management plans (MPs): • Subterranean Fauna MP (MRUP-EMP-007) • Soil MP (MRUP-EMP-008) • Groundwater MP (MRUP-EMP-010) • Groundwater Operating Strategy (MRUP-EMP-011) • Managed Aquifer Recharge MP (MRUP-EMP-012) • Ground Disturbance MP (MRUP-EMP-019) • Operational Environment MP (MRUP-EMP-020) • Water Operating Strategy (MRUP-EMP-021) • Waste MP (MRUP-EMP-026) • Spill Response MP (MRUP-EMP-027) • Rehabilitation and Revegetation MP (MRUP-EMP-030) Hydrocarbons, chemicals and any toxic materials will be appropriately stored and bunded to minimise the potential for spillage according to protocols detailed within the Chemical and Hydrocarbon MP (MRUP-EMP037). This management plan will also detail the protocols for immediate reporting and management of hydrocarbon or chemical spills occurring onsite.	There are not expected to be any significant residual environmental impacts in relation to subterranean fauna in the long term.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
Hydrological Process	To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.	**Legislation** • *Rights in Water and Irrigation Act 1914 (WA)* (RIWI Act). • *Environmental Protection Act 1986 (WA)* (EP Act). • *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act). **Guidance and Position Statements** • Australian and New Zealand Environment and Conservation Council (ANZECC) / Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) National Water Quality Management Strategy Paper No.4: *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Canberra, ACT. • Department of Water (DoW) (2009) Operational Policy No.5.12 – *Hydrogeological Reporting Associated with a Groundwater Well License*, Perth, Western Australia. • DoW (2011) Operational Policy 5.08 – *Use of Operating Strategies in the Water Licensing Process*, Perth, Western Australia. • DoW (2009) Operational Policy no.1.02 – *Policy on water conservation/efficiency plans: Achieving water use efficiency gains through water licensing*, Perth, Western Australia. • DoW (2010) Operational policy 1.01 – *Managed aquifer recharge in Western Australia*, Perth, Western Australia. • DoW (2013) Strategic policy 2.09 – *Use of mine dewatering surplus*, Perth, Western Australia. • DoW (2013) Water licensing delivery series – Report No.12: *Western Australian water in mining guideline*, Perth, Western Australia. • Government of WA (2004) State Water Quality Management Strategy No. 6: *Implementation Framework for Western Australia for the Australian and New Zealand Guidelines for Fresh and Marine Water Quality and Water Quality Monitoring and Reporting (*Guidelines Nos. 4 & 7: National Water Quality Management Strategy), Perth, Western Australia. • Water Authority of Western Australia (1994) *Goldfields Groundwater Area Management Plan*, Western Australia.	**Surface Water** There are no surface water flows within the MRUP Development Envelope. Rainfall mostly infiltrates directly into sand. Water collects in local depressions following heavy rainfall and either evaporates or infiltrates. **Ground Water** The local ground water is relatively deep, mainly saline and mainly acidic There are no groundwater dependent ecosystems associated with the local aquifers. **Users** The only use for local water is for mining and mining related purposes.	**Surface Water** There are no surface waters to be impacted. **Ground Water** There are no dependent ecosystems connected to local ground waters that could be impacted. No flora or fauna of any sort will be impacted. **Users** There are no other users of water in the area and none are expected.	Management and monitoring of groundwater will be undertaken as part of the following management plans (MPs): • Surface Water MP (MRUP-EMP-009) • Groundwater MP (MRUP-EMP-010) • Groundwater Operating Strategy (MRUP-EMP-011) • Managed Aquifer Recharge MP (MRUP-EMP-012) • Operational Environment MP (MRUP-EMP-020) • Water Operating Strategy (MRUP-EMP-021) Impacts will also be limited by the application of the: • Radiation MP (MRUP-EMP-028) • Radioactive Waste MP (MRUP-EMP-029) • Mine Closure Plan (MRUP-EMP031)	There are not expected to be any significant residual environmental impacts in relation to hydrological processes.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
Inland Waters Environmental Quality	To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.	**Legislation** • *Rights in Water and Irrigation Act 1914 (WA)* (RIWI Act). • *Environmental Protection Act 1986 (WA)* (EP Act). • *Mining Act 1978 (WA)* (Mining Act). • *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act). **Guidance and Position Statements** • ANZECC/ARMCANZ (2000) National Water Quality Management Strategy Paper No.4: *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Canberra, ACT. • DoW 2013, Water licensing delivery series – Report No.12: *Western Australian water in mining guideline*, Perth, Western Australia. • DoW (2009) Operational Policy no.5.12 – *Hydrogeological reporting associated with a groundwater well license*, Perth, Western Australia. • DoW (2011) Operational Policy 5.08: *Use of Operating Strategies in the Water Licensing Process*, Perth, Western Australia. • DoW (2009) Operational Policy no.1.02 – *Policy on water conservation/efficiency plans: Achieving water use efficiency gains through water licensing*, Perth, Western Australia. • DoW (2010) Operational policy 1.01 – *Managed aquifer recharge in Western Australia*, Perth, Western Australia. • DoW (2013) Strategic policy 2.09 – *Use of mine dewatering surplus*, Perth, Western Australia. • Department of Minerals and Energy WA (2000) *Water Quality Protection Guidelines No. 10 Mining and Mineral Processing – Above-ground Fuel and Chemical Storage*, Perth, Western Australia.	There are no surface water flows within the MRUP Development Envelope. Water from the dewatering of the mining areas, which will be saline/hypersaline will be used in processing and for dust suppression and other purposes. Any surplus water from dewatering will be reinjected into the same aquifer downstream where the quality is worse. The only water being reinjected will have come from mine dewatering or from desalination. Process water (needing to be less saline) will be extracted from the brackish extraction borefield. Waste processing water will be pumped to tailings disposal. The initial above-ground tailings storage facility will be lined and any seepage will move vertically downwards into the local aquifer. Subsequently tailings will be deposited in-pit and designed so that drainage is directly into the aquifer at the base of the pit. All contaminants from tailings that reach the local aquifer (which will be around 40m below surface) are expected to move horizontally and to be attenuated by passage through the sedimentary layers containing organic matter.	There are no surface water bodies capable of being impacted. However areas where spills could occur will be sealed and bunded. There will be no adverse impact to groundwater as a result of reinjecting mine dewatering water as the mine dewatering water will be put into what is essentially the same aquifer downstream where the water quality is worse. There will be no enduring adverse impact to the groundwater as a result of tailings seepage or drainage as the contaminants will be attenuated by passage through sedimentary layers containing organic matter. By the time tailings seepage or drainage reaches the mining lease boundary the composition of the plume of contaminants will be indistinguishable from natural variation within the existing ground water.	Management and monitoring of groundwater will be undertaken as part of the following management plans (MPs): • Surface Water MP (MRUP-EMP-009) • Groundwater MP (MRUP-EMP-010) • Groundwater Operating Strategy (MRUP-EMP-011) • Managed Aquifer Recharge MP (MRUP-EMP-012) • Tailings Management Plan (MRUP-EMP-013) • Acid and Metalliferous Drainage MP (MRUP-EMP-016) • Water Operating Strategy (MRUP-EMP-021) • Radioactive Waste MP (MRUP-EMP-029) • Chemical and Hydrocarbon MP (MRUP-EMP-037) Impacts will also be limited by the application of the: • Radiation MP (MRUP-EMP-028) • Radioactive Waste MP (MRUP-EMP-029) • Mine Closure Plan (MRUP-EMP031)	There are not expected to be any significant residual environmental impacts to the quality of inland waters.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
Air Quality and Atmospheric Gases	To maintain air quality for the protection of the environment and human health and amenity.	**Legislation** • *Environmental Protection Act 1986 (WA)* (EP Act). • *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act). • *National Greenhouse and Energy Reporting Act 2007* (NGER Act). • *Mines Safety and Inspection Act 1994 (WA)* (MSIA Act) *& Mines Safety and Inspection Regulations 1995.* • *Radiation Safety Act 1975 (WA)* (RS Act). • *Radiation Safety (General) Regulations 1983-2003.* • *Radiation Safety (Transport of Radioactive Substances) Regulations 2002.* **Guidance and Position Statements** • National Environment Protection Council (NEPC) (2013) *National Environment Protection (Ambient Air Quality) Measure*, Canberra, ACT. • WA Environmental Protection Authority (EPA) Guidance Statements. • Department of Mines and Petroleum (DMP) (2010) *Managing Naturally Occurring Radioactive Material (NORM) in Mining and Mineral Processing – Guidelines ('The WA NORM Guidelines')* Perth, Western Australia **Other for consideration** • Department of Environment (DoE) (2006) *Guidance Notes: Air Quality and Air Pollution Modelling*, Perth, Western Australia. • DEC (2011) *A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities*, Perth, Western Australia. • EPA (2002) Guidance Statement No. 12: *Minimising Greenhouse Gas Emissions*, Perth, Western Australia.	The Project area has an elevated, highly variable natural background dust concentration, typically ranging between 2.6μg/m^3 and 35μg/m^3. This is partly contributed to by sources such as bush fires or wind erosion. There are limited anthropogenic sources of pollutants in the area with the closest being Tropicana Gold Mine (~110km to the north-east) and the Pinjin settlement (~105km to the west). Existing anthropogenic greenhouse gas emissions within the Project area are minimal and associated with exploration activities.	The construction and operational stages of the Project have the potential to increase dust generation at the site by mechanical sources, such as trucking, and increased erosional sites from land clearance. Modelling using the highest mining throughput (and greatest dust emissions – Year 10) results indicate all impacts will be lower than the relevant assessment criteria, and summarised as follows: • The highest predicted concentration impacts are at the closest receptor (MRUP Accommodation) and range between 22% and 52% of the various assessment criteria for the all modelled scenarios. • Predicted concentrations at MRUP site boundaries during mining years range between 5% and 42% of the guidelines for the scenarios. • When considering the three population receptors surrounding MRUP, as they are a significant distance from the MRUP, the predicted concentrations during mining years range from 0.1% to 0.7% percent of any of the criteria. • Predicted concentrations at receptors during the closure scenario are lower than those during mining years (Appendix E1) The modelling showed predicted dust deposition is highest at MRUP mining village, though well below the monthly deposition criteria (less than 1%). Deposition at other sites is predicted to be much lower (Appendix E1).There is unlikely to be cumulative impacts of dust generation from the MRUP as the Tropicana minesite 110km away is the nearest major dust source, and the measurable dust impact predicted from the MRUP operations (taken as 10% of the assessment criterion) is approximately 30km (Appendix E1). The level of radionuclides in dust and radon emissions were modelled and it was found that the MRUP presents no radiological risk to reference plants and animals from emissions from the proposed project. (Appendix F1). Power is expected to be provided from local power generation utilising hydrocarbon based fuels (diesel or gas) and this will result in carbon dioxide and sulphur dioxide emissions. The principal emissions of criteria pollutants from the diesel Gensets would be products of combustion including oxides of nitrogen (NOX), sulphur dioxide (SO2), particulate matter less than 10 and 2.5 microns in aerodynamic diameter (PM10 and PM2.5) and volatile organic compounds (VOCs). Modelling conducted showed the predicted concentrations at all receptors are below the assessment criteria for all assessed pollutants. Predicted dust concentrations due to power generation are only elevated directly at the power station (dust generation .point) during low dispersion events	The areas of ground disturbance will be managed through the application of a Ground Disturbing Activity Permit (GDAP) which will minimise clearance and ensure progressive rehabilitation of all disturbed sites as soon as is practical. The following management plans (MPs) have been developed for the MRUP to manage air quality and atmospheric gases: • Dust MP (MRUP-EMP-024) • Rehabilitation and Revegetation MP (MRUP-EMP-030) • Conceptual Mine Closure Plan (MRUP-EMP-031) • Radioactive Waste MP (MRUP-EMP-029) The following management plans will be developed for the MRUP to also manage air quality and atmospheric gases: • Greenhouse Gas MP (MRUP-EMP-017) Operation of the diesel Gensets will be monitored continuously and any performance degradation will be identified using the board sensors. Diesel Gensets installed for the power station will automatically start up and shut down based on the required load, conserving fuel and reducing emissions. Emissions from the diesel Gensets are minimised by ensuring each is well maintained and operated using ultra low sulphur (50 ppm) diesel. • For the identified impacts, Vimy has adopted the hierarchy of controls to reduce the risk to a level that is as low as reasonably achievable.	Dust generated during the construction and operational phases of the MRUP, including any potential radionuclides in dust, is not expected to produce any significant residual environmental impacts on air quality. Taking into account the MRUP design and proposed management measures to be implemented the proposal will meet the EPA's objective with regard to air quality and atmospheric gases.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
				The following are the most significant Green House Gas (GHG) emissions sources onsite. • Vehicle movement (combustion of diesel). • Energy production from the power station (combustion of diesel) for operation of minesite and the borefield. • Use of carbonates for production of uranium oxide and other precious metal concentrates. The neutralisation of acidic material during processing and prior to deposition as tailings will involve the use of calcium carbonate which will produce CO_2 as a by-product. Overall the development of the Proposal is expected to result in the equivalent of the generation of an additional CO_2-e of ~224kt per year.		

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<tr><th>Environmental Factor</th><th>EPA Objective</th><th>Relevant Guidance</th><th>Existing Environment</th><th>Potential Impacts</th><th>Environmental Management</th><th>Predicted Outcomes</th></tr>
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<td>Human Health</td>
<td>To ensure that human health is not adversely affected.</td>
<td>Legislation
• Radiation Safety Act 1975 (WA) (RSA).
• Mines Safety and Inspection Act 1994 (WA) (MSIA).
• Australian Radiation Protection and Nuclear Safety Act 1998 (Cth) (ARPANS Act).
• Environmental Protection Act 1986 (WA) (EP Act).
• Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act).
Guidance and Position Statements
• ARPANSA (2005) Radiation Protection Series (RPS) – Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing – particularly:
– RPS C-2 (Code for the Safe Transport of Radioactive Material (2014)).
– RPS No.9 (Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005))
– RPS No. 20 (Safety Guide for Classification of Radioactive Waste (2010)).
• DMP (2010) Managing Naturally Occurring Radioactive Material (NORM) in Mining and Mineral Processing – Guidelines (Numerous), Perth, Western Australia – particularly:
– Managing NORM 2.2 – preparation of radiation management plan – mining and processing – guideline.
– Managing NORM 3.1 – pre-operational monitoring requirements – guideline.
– Managing NORM 4.2 – controlling NORM – management of radioactive waste – guideline.
– Managing NORM 4.3 – controlling NORM – transport of NORM – guideline.
– Managing NORM 5 – dose assessment – guideline.
Other for consideration
• Nuclear Non-Proliferation (Safeguards) Act 1987
• Customs Act 1901 (Prohibited Exports) Regulations.
• Weapons of Mass Destruction (Prevention and Proliferation) Act 1995</td>
<td>Natural background radiation is highly variable; worldwide annual average dose to the human population is quoted by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) to be about 2.4mSv/year (UNSCEAR 2008) but local variations can be up to more than 10 times that amount. The general Australian background dose is 1.5mSv/y.
Gamma Radiation
The background gamma radiation for the Project area (0.06 µSv/h) is similar to the Kintyre Project in WA (0.09 µSv/h) and the Australian average (0.07 µSv/h) based on environmental Thermoluminescent Dosimeters (TLD) surveys.
Generally speaking, the radionuclide levels are low across the Southwest Great Victoria Desert (where the MRUP is located) in comparison to world averages (UNSCEAR 2008),
Radon and Radon Decay Products
The average radon concentration across the project was found to be approximately 25 Bq Rn/m^3. This is comparable with other uranium project and mining areas across Australia.
Background Radiation Summary
Measured radioactivity levels in environmental media (water, soils and air) in the vicinity of the MRUP is lower than in the wider region. The orebody is overlain by a substantial layer of non-mineralised soils which limit the surface radioactivity observed at the site.</td>
<td>Uranium and its daughter products (including Thorium, Protactinium, Radium, Radon, Polonium, Bismuth and Lead) are radioactive.
There are four pathways by which radioactive material can adversely impact human health:
• Internal exposure from inhalation of dust containing radioactive material.
• Internal exposure from ingestion of radioactive materials.
• Internal exposure from inhalation of radon and radon decay products.
• External exposure from gamma radiation or ‘shine’.
Dust emissions from all operation will be managed. Workers spending the most time in mine pits during operations and exposed to mine dust will be subject to low doses, in the order of 3 to 4mSv/yr, and thus a small fraction of the maximum allowable limit of 20mSv/yr (Appendix F1).
Radon gas will emanate from disturbed areas. However inhalation of radioactive gases (radon and other daughter products) will not lead to any significant exposure. Air quality in mining pits will be monitored as part of the Radiation Management Plan (MRUP-EMP-028) and if conditions warrant it access to the pits by workers without protection will be limited.
Gamma radiation will result from exposed ore and non-ore materials in the open pit, ore stockpiles, exposed tailings material and material being processed, stored and transported. The maximum exposure for workers in-pit without any shielding is estimated at ~ 2.6µSv/hr. In practice any worker spending extended periods in-pit will be shielded by the vehicle being operated. Exposure for process plant workers was calculated at 2.8mSv/yr.
An assessment of gamma radiation to transport workers carrying product to port and public exposure along that route indicated the exposure to a hypothetical member of the public following behind the product for 6 hours from a dose of 1.4mSv/y to be 0.006mSv/y.
In the event of any contamination or spillage there are potential low level localised impacts to soils. Impact to humans could occur if the spillage is not address creating a dust source.
Bush tucker is a potential pathway for human exposure to radiation. A conservative assessment was undertaken and evaluated the ingestion of bush tuckers’ contribution to overall doses to the public. The assessment found the contribution to be negligible (Appendix F1).</td>
<td>Impacts will be limited by the application of the following management plans (MPs):
• Dust MP (MRUP-EMP-024)
• Ground Disturbance MP (MRUP-EMP-019).
• Radiation MP (MRUP-EMP-028)
• Radioactive Waste MP (MRUP-EMP-029)
• Rehabilitation and Revegetation MP (MRUP-EMP-030).
• Mine Closure Plan (MRUP-EMP-031).
The requirements of the Radiation MP (MRUP-EMP-028) are specified in detail in the WA NORM 2.2 Guide. The basic elements include:
(i) management control over work practices
(ii) personnel qualification and training
(iii) control of occupational and public exposure to radiation
(iv) planning for unusual situations.
These broad goals will be achieved through:
• Worker notification of radiation sources.
• Work procedures and protective clothing to limit worker dose.
• Incorporating radiological controls into design of the plant and mine.
• Application of engineering controls where appropriate.
• Worker training to control and reduce worker dose.
• A worker dosimetry program to measure the workers doses received.
• Reporting of worker doses to the regulatory authorities.
These measures have been showed to be effective at other uranium mines and will be used in development of the Proposal.</td>
<td>The radiation assessment complete for the MRUP demonstrates that the project is being designed with recognition of radiation hazards, processes and tasks to enable effective control of worker and public doses as a result of the project. The predicted dose assessment for both workers and member of the public without the controls detailed are a small fraction of the regulatory limit.</td>
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Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
Heritage	To ensure that historical and cultural associations are not adversely affected.	**Legislation** • *Aboriginal Heritage Act 1972 (WA)* (AHA). • *Environmental Protection Act 1986 (WA)* (EP Act). • *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act). • *Native Title Act 1993 (Cth)* (NTA). **Guidance and Position Statements** • Department of Aboriginal Affairs and Department of Premier and Cabinet (DAA & DPC) (2013) *Aboriginal Heritage – Due Diligence Guidelines*, Version 3.0, Perth, Western Australia. • EPA (2004) Guidance Statement No.41: *Assessment of Aboriginal Heritage*, Perth, Western Australia.	There is no Native Title Claim over any area that is proposed to be disturbed. There are no significant Aboriginal heritage sites (ethnographic or archaeological) located in the Disturbance Footprint. There are five registered sites (artefact scatters).	There will be no disturbance to known Aboriginal heritage sites. If any unknown Aboriginal heritage sites are discovered they will be assessed and managed as appropriate under the *Aboriginal Heritage Act 1972.*	If a suspected Aboriginal site is located during site activities, protocols within the MRUP Heritage MP (MRUP-EMP-034) (subject to the *Aboriginal Heritage Act 1972)* will be implemented immediately. Site inductions for all employees will incorporate awareness training for the need for such protocols (as detailed within the Environmental Induction and Training MP: MRUP-EMP-039). Impacts will also be limited by the application of the following management plans (MPs): • Ground Disturbance MP (MRUP-EMP-019). • Document and Data Control MP (MRUP-EMP-038).	There are not expected to be any significant residual environmental impacts to historical and cultural sites as areas proposed to be disturbed have been intensively surveyed (Appendix G1 and Appendix G4).
Rehabilitation and Closure	To ensure that premises are closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State.	**Legislation** • *Environmental Protection Act 1986 (WA)* (EP Act). • *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act). • *Mining Act 1978 (WA)* (Mining Act). • *Radiation Safety Act 1975 (WA)* (RS Act). • *Radiation Safety (General) Regulations 1983-2003.* • *Radiation Safety (Transport of Radioactive Substances) Regulations 2002.* • *Contaminated Sites Act (2003) (WA) Perth.* **Guidance and Position Statements** • ANZECC/ARMCANZ (2000) National Water Quality Management Strategy Paper No.4: *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Canberra, ACT. • Australian and New Zealand Minerals and Energy Council (ANZMEC) and the Minerals Council of Australia (MCA) (2000) *Strategic Framework on Mine Closure –* Discussion Paper.	There is currently no disturbance to the proposed Project site. A recent natural bushfire that has affected approximately 78% of the vegetative cover of the proposed Disturbance Footprint. Areas not burnt are currently classed of Excellent-Pristine condition (Appendix A1).	The Strategic Framework for Mine Closure (Australian and New Zealand Minerals and Energy Council and the Minerals Council of Australia (ANZMEC/MCA) emphasises that mine closure planning is not an "end of mine process" but is integral to the "whole of mine life" Plan. Closure plans must adequately consider the long term physical, chemical, biological and social land use effects on the natural ecosystems. Poor rehabilitation and closure procedures, planning, and management practices may result in a number of undesirable impacts. Primary areas of concern are associated with the post closure physical stability of built infrastructure such as TSFs and overburden landforms potentially resulting in increased risk to the public and the environment (and ongoing erosion and inadequate vegetative cover) and lack of chemical stability such that contaminants can migrate into receiving environments at concentrations that are harmful.	The construction of safe, stable, non-polluting landforms that demonstrate sustainable closure land uses will be managed through following key management plans (MPs): • Soil MP (MRUP-EMP-008) • Overburden Landform MP (MRUP-EMP-015) • Rehabilitation and Revegetation MP (MRUP-EMP-030) • Mine Closure Plan (MRUP-EMP-031). • Tailings Operating Strategy (MRUP-EMP-014) • Tailings Management Plan (MRUP-EMP-013) will facilitate efficient and safe operation of the facilities. • AMD Management Plan (MRUP-EMP-016) • Radiation Waste Management Plan (MRUP-EMP-029) Update Rehabilitation and Revegetation MP (MRUP-EMP-030) and Conceptual Mine Closure Plan (MRUP-EMP-031), where applicable, with results of trials, research and rehabilitation monitoring results and outcomes from analysis.	The potential for successful rehabilitation and ultimate closure of the post-mine landforms is considered high given there is a sufficient, readily available volume of beneficial materials for use in rehabilitation, and that the (potentially) problematic materials have been identified and characterised. The handling and utilisation requirements of these materials has been identified within the various management plans, and through the implement of these the reconstructed soil profiles will have adequate capacity to ensure the sustainable growth of vegetation consistent with the agreed-end land use. It is therefore expected that all post-mine landforms will be decommissioned and rehabilitated in an ecologically sustainable manner meeting the agreed closure objectives. Through the implementation of the closure objectives, it is anticipated that: • No significant long term physical offsite impacts will occur as a result of operations. • No significant long term impact on baseline surface or groundwater flow patterns and quality will occur as a result of operations. • No unsafe areas will remain after closure whereby members of the general public and animals could be harmed. • Rehabilitated and closed operational areas will be aesthetically consistent with the surrounding landform and consider stakeholder expectations. Following cessation of mining, and subsequent rehabilitation and closure of post-mine landforms, the land use of the area will be self-sustaining native ecosystems of regional relevance.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
		• ANCOLD (2012) *Guidelines on Tailings Dams- Planning, Design, Construction, Operation and Closure*. • ARPANSA (2005) *Radiation Protection Series (RPS) – Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing*. • ARPANSA (2014) *Technical Report 167 – A review of existing Australian radionuclide activity concentration data in non-human biota inhabiting uranium mining environments*. • ARPANSA (2011) *Joint convention on the safety of spent fuel management and on the safety of radioactive waste management*, Australian National Report. • Department of Industry, Tourism and Resources (DTIR) (2006) *Mine Closure and Completion, Leading Practice Sustainable Development Program for the Mining Industry*. Dept. of Industry Tourism and Resources, Canberra, ACT. • DITR (2015). *Leading Practice Sustainable Development Program for the Mining Industry – Risk Assessment and Management.* Department of Industry, Tourism and Resources, Canberra, Australia. • DMP & EPA (2015) *Guidelines for Preparing Mine Closure Plans*, Perth, Western Australia. • DMP (2013) Code of Practice – *Tailings Storage Facilities in Western Australia*. Perth, Western Australia. • DMP (2015) *Guide to Departmental requirements for the management and closure of tailings storage facilities (TSFs)* Perth, Western Australia. • DMP (2015) *Guide to the preparation of a design report for tailings storage facilities (TSFs)* Perth, Western Australia. • EPA (2006) Guideline for the Assessment of Environmental Factors: *Guidance Statement No. 6. Rehabilitation of Terrestrial Ecosystems*. Environmental Protection Authority, Perth, Western Australia. • International Atomic Energy Agency (IAEA) (2009). *Establishment of Uranium Mining and Processing Operations in the Context of Sustainable Development:* Nuclear Energy Series- NF-T-1.1. • IAEA (2010). *Best Practice in Environmental Management of Uranium Mining:* Nuclear Energy Series No NF-T-1.2.				

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
Offsets	To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.	**Legislation** • *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act). **Guidance and Position Statements** • DSEWPaC (2012) EPBC Act *Environmental Offsets Policy*, Canberra, Australian Capital Territory. • Government of WA (2011) *Environmental Offsets Policy*, Perth, Western Australia. • Government of WA (2014) *Environmental Offsets Guidelines*, Perth, Western Australia.	**Land clearance** The Proposal involves clearing up to 3,787ha of land. **Mine pits** Mining and the associated dewatering will involve digging pits down more than 40m and dewatering the local aquifer to around 1m below pit floor. **Water extraction and reinjection** In addition to mine dewatering, water will be extracted from a borefield. Surplus mine dewatering water will be reinjected into a reinjection borefield. Processing waste water will be deposited in TSFs. **Radioactivity** Additional radioactivity associated with the development of the Proposal poses no threat to humans, no threat to non-human biota. **Tailings** Tailings will be deposited initially in an above-ground TSF from which it will eventually seep. Tailings will subsequently deposited in in-pit tailings disposal facilities and will drain into the local aquifer.	Impacts from land clearance: • No local vegetation communities will be threatened. • No conservation significant species will be threatened. • Approximately 24ha of potential prime Sandhill Dunnart habitat will be cleared – no Sandhill Dunnarts have been recorded in the affected area since 1985. • Approximately 11ha of land deemed potentially suitable for Southern Marsupial Moles will be cleared; mole hole density suggest a very low presence in the area. • No Malleefowl breeding habitat will be cleared; Malleefowl are not believed to exist in the local area. • No conservation significant invertebrates will be disturbed. Impacts from mine pits: • No subterranean fauna will be threatened as a result of digging mine pits or dewatering mining areas. Water extraction and reinjection: • No subterranean fauna will be threatened as a result of water extraction or water reinjection in borefields. • Reinjected water will be of no worse quality than the water in its receiving environment. • Waste processing water to the extent that it seeps or drains from TSFs will be attenuated by organic matter and will be indistinguishable from background levels of contaminants in ground water before it leaves the mining lease boundaries. Radioactivity: • There will be no significant environmental impacts associated with radioactivity. Tailings: • Seepage and drainage from TSFs will be naturally attenuated by the organic material it passes through and will be indistinguishable from background levels of contaminants in ground water before it leaves the mining lease boundaries.	After the application of measures designed to avoidance, minimise and rehabilitate impacts, including implementing all the Environmental MPs (MRUP-EMP-000) there will be no significant residual environmental impacts requiring counterbalancing offsets and therefore no requirement to manage any offsets.	There will be no significant residual environmental impacts and no requirement for offsets.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
Matters of NES	The EPBC Act objectives are to: • Provide for the protection of the environment, especially MNES species. • Conserve Australian biodiversity. • Provide a streamlined national environmental assessment and approvals process. • Enhance the protection and management of important natural and cultural places. • Control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife. • Promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.	**Legislation** • *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act). **Guidance and Position Statements** • EPA (2000) Position Statement No. 2 – *Environmental Protection of Native Vegetation in Western Australia – Clearing of Native Vegetation, with particular reference to the Agricultural Area*. • EPA (2002) Position Statement No. 3 – *Terrestrial Biological Surveys as an Element of Biodiversity Protection.* • EPA (2009) Guidance Statement No. 20 – *Sampling of Short-Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia*. • EPA (2004) Guidance Statement No. 51 – *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. • EPA (2003) Guidance Statement No. 55 – *Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process*. • EPA (2004) Guidance Statement No. 56 – *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.* **Other for consideration** • *Animal Welfare Act 2002 and Animal Welfare Regulations (Scientific Purposes) Regulations 2003.* • NHMRC (2013) *Australian Code for the Care and Use of Animals for scientific purposes*, 8th Edition. • NT Department of Infrastructure, Planning and Environment (2004) *Recovery Plan for Marsupial Moles (Notoryctes typhlops* and *N. caurinus*) 2005-2010, Alice Springs. • Department of Environment and Natural Resources (2011) *National Recovery Plan for the Sandhill Dunnart Sminthopsis psammophila,* South Australia. • DEC (2011) *Standard Operating Procedure 5.2 – Remote Operation of Cameras*, Version 1.0, Perth, Western Australia. • DoE (2015) *Referral Guideline for 14 birds listed as migratory species under the EPBC Act (draft).* • *DSEWPaC* (2011) *Survey guidelines for Australia's threatened mammals: Guidelines for detecting mammals listed as threatened under the EPBC Act*, Canberra, ACT. • *DSEWPaC* (2011) Survey Guidelines for Australia's Threatened Birds. • EPA & DEC (2010) Technical Guide: *Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*, Perth, Western Australia.	Relevant MNES for this Proposal are: • Listed threatened, endangered or vulnerable species: – Sandhill Dunnart (*Sminthopsis psammophila*) – Southern Marsupial Mole (*Notoryctes typhlops*) – Malleefowl (*Leipoa ocellata*) – Night Parrot (*Pezoporus occidentalis*) – Princess Parrot, Alexandra's Parrot (*Polytelis alexandrae*) – Ooldea Guinea-flower (*Hibbertia crispula*) Migratory species have been excluded from this list as they are unlikely to be found within the Development Area as there are no existing permanent or seasonal water bodies.	• Sandhill Dunnart – Little loss of prime habitat will occur from the proposed Project disturbance due to recent extensive burning from a natural bushfire. There is a very low probability of individuals continuing to exist in the area at present. Regrowth of suitable habitat will be delayed in cleared areas. There is a small risk of vehicle strike if individuals return to the Project area whilst it is operational, although noise and activity are likely to discourage such return in the short term. • Southern Marsupial Moles – The preferred habitat is sand dunes, and particularly, the upper slopes of these dunes (Appendix B4). Mine planning has avoided the proposed disturbance of these areas wherever possible. Linear infrastructure, such as pipeline corridors, will be routed around sand dunes where possible. The low density of the species in the region, combined with a restricted area of habitat proposed to be disturbed (~11ha of suitable dune country), will result in minimal impact to the species by the Project. • Night Parrot – There is unlikely to be any suitable habitat for this species present in the Project area and therefore the species is not likely to occur in the area and there will be no direct or indirect impact on the bird. • Princess Parrot – There is unlikely to be any suitable habitat for this species present in the Project area and therefore the species is not likely to occur in the area and there will be no direct or indirect impact on the bird. • Malleefowl – There is not likely to be any impact from the Project on this species as there is no suitable habitat within the vicinity of the Project, and no evidence of individuals was detected during site surveys (Appendix B5). • Ooldea Guinea-flower – There is not likely to be any significant impact from the Project on this species as at most 38 individual plants out of a regional total exceeding 14,000 will be impacted..	The overall objective for the management of impact to MNES species, is to ensure that the disturbance as a result of the development of the MRUP will be minimised. This will be achieved through the implementation of the following management plans (MPs): • Weed MP (MRUP-EMP-003) • Terrestrial Fauna MP (MRUP-EMP-004) • Conservation Significant Fauna MP (MRUP-EMP-005) • Feral Animal MP (MRUP-EMP-006) • Ground Disturbance MP (MRUP-EMP-019) • Transport MP (MRUP-EMP-022) • Emergency Response MP (MRUP-EMP-023) • Dust MP (MRUP-EMP-024) • Fire MP (MRUP-EMP-025) • Radiation MP (MRUP-EMP-028) • Radioactive Waste MP (MRUP-EMP-029) • Rehabilitation and Revegetation MP (MRUP-EMP-030)	The MRUP is an action that will require approval under the EPBC Act due to the Project having the potential to have an impact upon a number of species listed under the categories of endangered or vulnerable, and a nuclear action due to the intended mining and milling of uranium ore.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcomes
		• DEWHA (2008) *Approved Conservation Advice – Ooldea Guinea-flower* (*Hibbertia crispula*) Canberra, ACT. • EPA (2012) *Checklist for documents submitted for EIA on terrestrial biodiversity* Appendix 2 of the EPA's Draft Environmental Assessment Guideline No. 6 on Timelines for Environmental Impact Assessment of Proposals. • NHMRC (2014) *A Guide to the Care and use of Australian Native Mammals in Research and Teaching*, EA29, Canberra. • National Heritage Trust (2007) *National Manual for the Malleefowl Monitoring System Standards, Protocols and Monitoring Procedures*. • ARPANSA (2014) *Technical Report 167 – A review of existing Australian radionuclide activity concentration data in non-human biota inhabiting uranium mining environments*. • DSEWPaC (2012) EPBC Act *Environmental Offsets Policy*, Canberra, Australian Capital Territory. • Government of Western Australia (2011) *Environmental Offsets Policy*, Perth, Western Australia. • Government of Western Australia (2014) *Environmental Offsets Guidelines*, Perth, Western Australia.				

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1. Introduction

Vimy Resources Limited (Vimy) is an Australian company which has been listed on the Australian Securities Exchange (ASX) since 2008 (it was formerly known as Energy and Minerals Australia Limited (EAMA)) and whose principal activities are focused on the exploration for and development of uranium projects. Vimy (the Proponent) proposes to develop the Mulga Rock Uranium Project (MRUP; the Project; or the Proposal) in the Goldfields-Esperance Region of Western Australia. The location is presented in Figure 1.1.

The Project will involve the shallow open pit mining of four poly-metallic deposits with commercial grades of contained uranium hosted in carbonaceous material. Processing will be undertaken onsite at a central mill. The Project is in a remote location, covering 102,000 hectares (ha) of dune fields, and is located within granted mining tenure on Unallocated Crown Land (UCL) in the Shire of Menzies, on the western flank of the Great Victoria Desert. Access is limited and is only accessible by four wheel drive vehicles.

Up to 4.5 Million tonnes per annum (Mtpa) of ore will be mined using traditional open cut techniques, crushed, screened and beneficiated and then processed at an onsite acid leach and precipitation treatment plant to produce up to 1,360 tonnes of uranium oxide concentrate (UOC) per year over the life of the Project. Other metal concentrates will be extracted using sulphide precipitation after the uranium has been removed and sold separately – they will not be classified as radioactive. The anticipated Life-of-Mine (LOM) is up to 16 years, based on the currently identified resource. The drummed UOC will be transported by road from the minesite in sealed sea containers to a suitable port, approved to receive and ship Class 7 materials (expected to be Port Adelaide), for export.

The Project will require clearing of vegetation, mine dewatering and reinjection, creation of overburden (non-mineralised) landforms, construction of onsite processing facilities and waste management systems.

Major built infrastructure will include:

- Processing plant.
- Run of Mine (ROM) ore stockpile area.
- Construction of above-ground overburden landforms for non-mineralised mined materials.
- An initial above-ground Tailings Storage Facility (TSF).
- Water storage facilities.

Once sufficient voids have been created, tailings will be deposited back into the unlined pit below the biologically active zone and capped with non-mineralised waste rock and rehabilitated. Rehabilitation of disturbed areas will be undertaken in accordance with an approved Mine Closure Plan (MCP). Construction of the Proposal is scheduled to commence in early 2017, following receipt of approvals.

1.1 Background

The Proposal represents a green fields operation, and was initially referred to the Environmental Protection Authority (EPA) on 31 July 2013 under Part IV (Section 38) of the Western Australian *Environmental Protection Act 1986* (EP Act). On 2 September 2013, the EPA Chairman determined that the Project would be subject to a Public Environmental Review (PER) with a 12 week public review period and that the Proponent should prepare an Environmental Scoping Document (ESD) (Appendix L1) which would also be subject to a public review period of two weeks. The ESD was released for public comment between 8 December and 22 December 2014. The final version of the ESD was approved by the EPA on 26 February 2015.

The Proposal has been referred and determined to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and will be assessed under the Bilateral Agreement between the Commonwealth of Australia and the State of Western Australia, made under Section 45 of that Act.

The relevant Matters of National Environmental Significance (MNES) for this Proposal are:

- Listed threatened species and communities (s18 and s18A) and
- The environment because the Proposal is a nuclear action (s21 and 22A).

1.2 Purpose of this Document

This PER has been prepared as part of the process to seek State and Federal approval for the Project under the WA EP Act and the Commonwealth EPBC Act.

This PER is the key document for the bilateral assessment of the Project by:

- EPA and the WA Minister for Environment (the Minister) and
- Commonwealth's Department of the Environment (DoE) and the Minister of the Environment.

The PER will also be made available to the public to review the Project. Comments received from the public and government agencies during the public review period, and Vimy's response to these comments, will assist the EPA in preparing an assessment report in which it will make recommendations to the Minister and the Minister of the Environment.

1.3 Proposal Location

The Proposal is located in the Shire of Menzies, approximately 240km east-northeast of Kalgoorlie (Figure 1.1). The Proposal layout is presented in Figure 1.4.

1.4 Tenure

The MRUP is located on Unallocated Crown Land (UCL) and includes the leases and licences listed in Table 1.1.

Table 1.1 Leases and Licences

Lease Category	Reference Number
Mining Lease	M39/1080 and M39/1081
Miscellaneous Licence	L39/193 and L39/219

Figure 1.3 presents a map showing the various leases and licences.

1.5 Document Structure

In accordance with the requirements of the Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012, this document contains the following information:

- Description of the Proposal and alternatives considered, including alternative locations with a view to avoiding or minimising environmental impacts (Section 1.8).
- Details of the consultation process and outcomes (Section 3).
- Description of the receiving environment, its conservation values and key ecosystem processes, and a discussion of their significance in a regional setting focusing on affected elements (Section 2).

- Identification of the key environmental factors relevant to the Proposal, any issues related to the Proposal's development and any potential direct, indirect, or cumulative impacts on the environment (Sections 6 to 15).
- Risk analysis around impacts to key environmental factors.
- Evidence of mitigation measures and where necessary environmental offsets demonstrating how the EPA's environmental objectives for each environmental factor and any MNES can be met in spite of the Proposal's impacts; this should also include an assessment of potential 'fatal flaws' (Sections 6 to 15).
- Findings of surveys and investigations undertaken to support the analysis undertaken when evaluating the above impacts (Sections 6 to 15). Technical reports are provided as appendices.
- Identification of other potential impacts or activities that can be regulated by other government agencies under other statutes and an acknowledgement of the need to comply with these (Sections 6 to 15).
- Justified statement of how the object of the EP Act (Section 4A) and the 'Principles of Environmental Impact Assessments (EIA) for the Proponent' have been addressed along with other relevant environmental policies, guidelines and standards (Sections 6 to 15).
- Spatial datasets, information products and databases are provided as appendices.
- A glossary of terms, abbreviations, acronyms and units and a list of references are provided at the end of the document (Sections 17 and 18).

The appendices contain copies of relevant technical study reports referenced in this PER and Geographical Information System data files. These can be found on a data CD/DVD-ROM inside the back cover of this report or on the disc containing the electronic version of this report.

The ESD outlined work required to be completed as part of the PER to address potential impacts and risks to the key environmental factors for the proposal. Table 1.2 documents the work requirements outlined in the ESD and corresponding location of the outcomes in the PER.

Table 1.2 ESD Required Work for Key Environmental Factors and Corresponding PER Location

ESD Required Work for Key Environmental Factors	Location in PER
Flora and Vegetation	
1. Characterisation of the flora and vegetation within the proposed project area including its relevance within a wider regional context.	Section 6 (Appendix A1)
2. Flora and vegetation surveys to be undertaken in accordance with the requirements of EPA Guidance Statement No.51 in areas that are likely to be directly or indirectly impacted as a result of the proposal – to include a description of the surveys undertaken, the baseline data collected, and the environmental values identified. Details of the methodology used in undertaking targeted flora surveys and in the identification of vegetation mapping units.	Section 6.3 & 9.3.1 (Appendix A1 Section 4.3)

ESD Required Work for Key Environmental Factors	Location in PER
3. Detailed descriptions of all the direct and indirect impacts associated with the project on the flora and vegetation. A quantitative analysis of the likely extent of these impacts on vegetation units and conservation significant flora species (as defined in Guidance Statement 51, page 29). Analysis of impacts on vegetation to include: • the area (in ha) of each vegetation unit to be impacted (directly and indirectly) in a 'worst case' scenario • the total area (in ha) of each vegetation unit within the project area • a summary of the known regional distribution of vegetation units and • identification of vegetation units which may be a component of threatened or priority ecological communities. Analysis of impacts on conservation significant species to include: • the number of plants, and number of populations of plants, to be impacted (directly and indirectly) in a 'worst case' scenario • the total number of plants and populations within the local area/study area and • a summary of the known populations of the species (including distribution, number of populations and the number of plants (or an estimate of the number of plants)).	Section 6.3 & 6.4 Section 9.3 & 9.4 (Appendix A1 & A2)
4. Assessment of potential radiation impacts using various approaches including the Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) tool using Australian specific data where available.	Section 6.3.8
5. Figures showing the extent of clearing or loss of vegetation and conservation significant flora species, including but not limited to TECs and PECs where clearly identified and defined, Declared Rare Flora (DRF), Priority Flora and other conservation significant flora (new or undetermined flora species), from direct and indirect impacts.	Figure 6.2 Figure 6.4 Figure 6.5-Figure 6.26 Figures 9.1 (a, b, c)
6. Targeted surveys of the Project area for *Hibbertia crispula* (Ooldea Guinea-flower) to establish the predicted local extent and distribution of this Matter of MNES listed species; the PER will address all MNES listed species known to occur or having the potential to occur in the proposed development envelope discussing how any potential direct or indirect impacts on MNES listed species will be avoided or mitigated.	Section 9 Appendix A2
7. Completion of checklist for documents submitted for Environmental Impact Assessment (EIA) on terrestrial biodiversity.	Appendix L2
8. Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plans, to ensure impacts (direct and indirect) are not greater than predicted.	Section 6.5
9. Discussion of the mitigation hierarchy to the impacts from the proposal upon identified environmental values and an assessment of the residual impacts after the mitigation measures have been implemented.	Section 6.5
10. Discussion of residual impacts, including as appropriate monitoring programs to measure residual impacts, and management programs to further mitigate these residual impacts and to deal with circumstances where outcomes fall short of intended objectives.	Section 6.5
11. To the extent that residual impacts cannot be avoided, reduced, mitigated, or subsequently restored – the identification of appropriate offsets.	Section 6.6
Terrestrial Fauna	
1. Characterisation of the terrestrial fauna within the proposed project area including its relevance within a wider regional context.	

ESD Required Work for Key Environmental Factors	Location in PER
2. Description of all surveys undertaken, the baseline data collected and the environmental values identified. Maps of all sampling sites from all surveys, both within and outside the proposed development envelope, with comparison to mapped fauna habitats.	Section 7.3
3. Completion of a Level 1 Desktop Study with comparisons of recent fauna surveys conducted at the MRUP with other surveys conducted in the Great Victoria Desert region, including the works by Eric R. Pianka and Department of Parks and Wildlife and WA Museum regional surveys.	Section 7.3 (Appendices B1-8)
4. Desktop studies and Level 1 fauna surveys, consistent with EPA Guidance Statement No.56, to provide a comprehensive listing of fauna known or likely to occur in the habitat present, and identification of conservation significant fauna species likely to occur in the development envelope and wider project area.	Section 7.3 (Appendices B1-8)
5. Where desktop study and habitat analysis indicates that it is appropriate, conduct targeted Level 2 surveys for conservation significant vertebrate species that are known to or likely to occupy habitats in the project area.	Section 7.3
6. Further surveys for *Sminthopsis psammophila* (Sandhill Dunnart) will take the form of a targeted survey utilising specialised wildlife cameras to identify the existence or otherwise of specimens within and surrounding the proposed areas of disturbance in accordance with a Department of Parks and Wildlife approved monitoring program.	Section 9.3.2.2 Appendix B3
7. Ongoing surveys of *Notoryctes typhlops* (Southern Marsupial Mole) will take the form of a Level 2 Targeted survey and a report of the results using the methodology outlined in the 'Survey guidelines for Australia's threatened mammals: Guidelines for detecting mammals listed as threatened under the EPBC Act' (2010).	Section 9.3.3 Appendix B5
8. Potentially suitable habitat for the *Leipoa ocellata* (Malleefowl) has not been identified in the Project area during fauna, flora and geological surveys over a period of 7 years. Road traverse surveys in sand dune terrain units commenced in 2010.	Section 9.3.4 Appendix B6
9. A quantitative analysis of the extent of clearing, including area in hectares and percentages of habitat types to be cleared or indirectly impacted, and determination of significance of impact in relation to terrestrial fauna. The analysis is to include identification and mapping of the known regional distribution of conservation significant species affected to assist in the determination of the significance of impacts. The assessment will also include an evaluation of the impact of activities on areas of potential habitat (including an assessment of their condition) for conservation significant species.	Sections 7.4 & 9.4
10. Completion of a Level 1 survey as outlined in Guidance Statement 20 for Short Range Endemic (SRE) fauna, and if required based on findings of the Level 1 survey, a Level 2 comprehensive survey and a report of the results.	Section 7.3.4 Appendix B7
11. Description (including figures showing extent of clearing) of the expected direct and indirect impacts to vertebrate and SRE invertebrate fauna and their associated habitat from all aspects of the proposal.	Section 7.4 Appendix B7
12. Description of impacts resulting from fauna, both native and feral being attracted to the evaporation ponds.	Section 7.5.2.7
13. Discussion of potential impacts to terrestrial fauna as a result of the proposal, with particular regard to State listed threatened fauna and MNES, and provision of quantitative data on impacts of the proposal to species of conservation significance.	Section 7.3.5 & 9.4
14. Evaluation of potential radiation impacts on terrestrial fauna and any other non-human biota, using the ERICA tool with Australian specific data where available.	Section 7.3.6
15. Completion of checklist for documents submitted for EIA on terrestrial biodiversity.	Appendix L2
16. Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plans, to ensure impacts (direct and indirect) are not greater than predicted.	Section 7.5

ESD Required Work for Key Environmental Factors	Location in PER
17. An application of the mitigation hierarchy to the impacts from the proposal upon identified environmental values and an assessment of the residual impacts after the mitigation measures have been implemented.	Section 7.5
18. Discussion of residual impacts, including as appropriate monitoring programs to measure residual impacts, and management programs to further mitigate these residual impacts and to deal with circumstances where outcomes fall short of intended objectives.	Section 7.5
19. To the extent that residual impacts cannot be avoided, reduced, mitigated, or subsequently restored – the identification of appropriate offsets.	Section 7.6
Subterranean Fauna	
1. Characterisation of the subterranean fauna within the proposed project area including its relevance within a wider regional context.	Section 8.2
2. Description of the subterranean fauna surveys undertaken, the baseline data collected and the environmental values identified.	Section 8.3
3. Subterranean fauna surveys to be undertaken in accordance with the requirements of EPA Guidance Statement No.54a and EAG12 in areas that are likely to be directly or indirectly impacted as a result of the proposal – to include a description of the surveys undertaken, the baseline data collected, and the environmental values identified.	Section 8.3
4. Description of the expected impacts on subterranean fauna from all aspects of the proposal including indirect impacts (i.e. excavation, dewatering, groundwater extraction and re-injection).	Section 8.4
5. Completion of checklist for documents submitted for EIA on terrestrial biodiversity.	Appendix L2
6. Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plans, to ensure impacts (direct and indirect) are not greater than predicted.	Section 8.5
7. An application of the mitigation hierarchy to the impacts from the proposal upon identified environmental values and an assessment of the residual impacts after the mitigation measures have been implemented.	Section 8.5
8. Discussion of residual impacts, including as appropriate monitoring programs to measure residual impacts, and management programs to further mitigate these residual impacts and to deal with circumstances where outcomes fall short of intended objectives.	Section 8.5
9. To the extent that residual impacts cannot be avoided, reduced, mitigated, or subsequently restored – the identification of appropriate offsets.	Section 8.6
Hydrological Processes	
1. Characterise baseline surface, hydrological and hydrogeological regimes, flood risks and water quality – including description of surveys undertaken, baseline data collected and environmental values identified.	Section 10.2 & 10.3
2. A H3 Hydrogeological survey for proposed mine dewatering, Managed Aquifer Recharge (MAR) and water supply for the entire project. The hydrological assessment will cover the entire project life, including closure and all of the mine planning options for dewatering, MAR, water supply and contingencies and water disposal. It will take account of impacts on other users, the environment and the maintenance of groundwater aquifer integrity.	Section10.3 Appendix D2
3. An evaluation of the impact of abstracting and reinjecting water on environmental receptors.	Section 10.4, 10.5 & 10.7
4. Contingency plan for water supply should a viable source of water not be identified.	Section 10.8
5. Predictive assessment of post-mining pit void hydrology and water quality.	Section 10.6

ESD Required Work for Key Environmental Factors	Location in PER
6. Characterisation of discharge zones identified for injection purposes, including local transmissivity, standing water levels, ground water chemistry and the development of a conceptual model of the receiving aquifer.	Section 10.7
7. Field studies to assess the suitability of local aquifers to receive up to 1.5GL/a of water.	Section 10.7 Appendix D2
8. Drilling to assess water supply options.	Section 10.3.2 & 10.8
9. Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plans, to ensure impacts (direct and indirect) are not greater than predicted.	Section 10.9 & 10.10
10. An application of the mitigation hierarchy to the impacts from the proposal upon identified environmental values and an assessment of the residual impacts after the mitigation measures have been implemented.	Section 10.10 & 10.11
11. Discussion of residual impacts, including as appropriate monitoring programs to measure residual impacts, and management programs to further mitigate these residual impacts and to deal with circumstances where outcomes fall short of intended objectives in relation to (a) minimising the potential for contamination, (b) ensuring the sustainable use of any aquifer, and (c) considering the potential for climate change to impact on ground and surface waters hydrological flows over the life of the project.	Section 10.11 & 10.12
12. To the extent that residual impacts cannot be avoided, reduced, mitigated, or subsequently restored – the identification of appropriate offsets.	Section 10.12
Inland Waters Environmental Quality	
1. Characterise the environmental quality of the inland waters within the proposed project area including its relevance within a wider regional context.	Section 11.2
2. Describe surveys undertaken to establish water quality, the baseline data collected and the environmental values identified.	Section 11.3 & 11.5
3. Describe the impacts from this proposal on the associated inland water quality including direct and indirect impacts.	Section 11.10
4. Develop of a whole of site Water Balance that examines water quality of the various sources and the disposal options. This will include an analysis of the capability of evaporation ponds to hold this saline water and the ability to re-inject such water into aquifers where the water quality is comparable.	Section 11.4 Figure 11.6
5. Analysis of expected radionuclides distribution in both extracted ground waters and process effluent and flow path modelling of any water discharged both from reinjection and tails deposition.	Section 11.5
6. Characterise wastes, including intermediate processing wastes, effluents and tailings according to contaminant and leachable concentrations including base metals present in the deposits to allow for waste processing and tailings seepage issues to be addressed. Leach tests will include the use of onsite water.	Section 11.6
7. Describe the long term containment of waste material and process water, designed to be consistent with best practice. Demonstrate A and B below through multiple lines of evidence: A. the effectiveness of the containment B. that any release of waste material and process water to the environment does not lead to above background levels of radionuclides and other contaminants; or undertake suitable modelling of the long term movement (10,000 years) of waste material and process water or until background levels are reached.	Section 11.6, 11.7, 11.8 & 11.9

ESD Required Work for Key Environmental Factors	Location in PER
8. For the proposed pits demonstrate the extent to which enriched remaining (*in situ*) material and mined waste have the potential to leach metals and metalloids: A. Provide a geological/hydrological diagram to show the relationship between mining and mining activities (such as de-watering) and the potential to mobilise metals and metalloids. B. Characterise clay enriched lignite and lignite including analysis for total sulphur, acid neutralising capacity and metal and metalloid concentrations. Determine if clay enriched lignite and lignite is likely to produce excess acid through appropriate acid base accounting. C. Establish triggers to identify the potential for metal and metalloids to leach and if triggers are exceeded undertake appropriate testing such as sequential leach testing on representative samples of clay enriched lignite and lignite to ascertain the potential for oxidation to release metals and metalloids from neutral or acid mine drainage. D. Where results show that metals and metalloids are likely to be released into the groundwater above background concentrations in the local vicinity to the groundwater drawdown cone and/or pits, undertake an appropriate risk assessment and propose suitable management actions.	Section 11.6 – Section 11.12 Figure 11.7, Figure 11.13 & Figure 11.14
9. Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plans, to ensure impacts (direct and indirect) are not greater than predicted.	Section 11.11
10. An application of the mitigation hierarchy to the impacts from the proposal upon identified environmental values and an assessment of the residual impacts after the mitigation measures have been implemented.	Section 11.12
11. Discussion of residual impacts, including as appropriate monitoring programs to measure residual impacts, and management programs to further mitigate these residual impacts and to deal with circumstances where outcomes fall short of intended objectives.	Section 11.13 & 11.14
12. To the extent that residual impacts cannot be avoided, reduced, mitigated, or subsequently restored – the implementation of appropriate offsets.	Section 11.14
Air Quality and Atmospheric Gases	
1. Characterise air quality in the project area, including a description of survey work undertaken, baseline data collected and environmental values identified.	Section 12.2 & 12.3
2. Describe expected impacts upon air quality from the implementation of the proposal including direct and indirect impacts.	Section 12.5
3. Modelling of dust emission sources, particularly in relation to near surface mineralisation and dispersion modelling to predict radionuclide activities in airborne and deposited dust and to ensure compliance with NEPM standards.	Section 12.4 Appendix E1
4. Modelling of potential emissions from power generation and the impacts upon sensitive receptors such as minesite accommodation.	Section 12.5.2 Appendix E1
5. Estimation of potential greenhouse gas emissions associated with the construction and operation of the mine and associated infrastructure.	Section 12.5.3
6. Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plans, to ensure impacts (direct and indirect) are not greater than predicted.	Section 12.6
7. An application of the mitigation hierarchy to the impacts from the proposal upon identified environmental values and an assessment of the residual impacts after the mitigation measures have been implemented.	Section 12.6
8. Discussion of residual impacts, including as appropriate monitoring programs to measure residual impacts, and management programs to further mitigate these residual impacts and to deal with circumstances where outcomes fall short of intended objectives.	Section 12.6

ESD Required Work for Key Environmental Factors	Location in PER
9. Discussion of proposed best practice management, monitoring and control/mitigation methods to be implemented for a remote site so that the cumulative impacts from all sources do not pose an unacceptable risk to the health and amenity of site personnel or the environment.	Section 12.5 & 12.6
10. To the extent that residual impacts cannot be avoided, reduced, mitigated, or subsequently restored – the implementation of appropriate offsets.	Section 12.7
Human Health	
1. Characterisation of expected levels of radioactivity associated with each stage of the process including transportation of the final product.	Section 13.2 – 13.4
2. Assessment of the potential radiological impacts on workers (including transport workers) and members of the public both during operation and post closure, including a radiological dose assessment.	Section 13.5, 13.6 & 13.7
3. Collection and analysis of radiological baseline data.	Section 13.2
4. Description of potential implications for health and safety due to the mining or processing of lignite materials, during operations and to infrastructure.	Section 13.3.3
5. Assessment of risks to human health from bush tucker consumption in the region from radiological sources and other contaminants, based on local diet. Where a local community is not present a hypothetical model should be used, taking into account a 'worst case' scenario.	Section 13.7.7
6. Discussion of proposed best practice management, monitoring and control/mitigation methods to be implemented for a remote site so that the cumulative impacts from all sources do not pose an unacceptable risk to the health and amenity of site personnel or the environment.	Section 13.8
7. Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plans, to ensure impacts (direct and indirect) are not greater than predicted.	Section 13.8
Heritage	
1. Characterisation of heritage within the proposed project area including its relevance within a wider regional context.	Section 14.2 & 14.3
2. Description of surveys for Aboriginal heritage sites within the project area, data collected and significance of sites identified.	Section 14.4
3. An assessment of impacts on any Aboriginal sites of significance in accordance with EPA Guidance Statement No.41.	Section 14.5
4. Description of impacts on heritage sites and/or cultural associations associated with the development of the proposal.	Section 14.5
5. Measures proposed to be undertaken in order to ensure impacts on heritage sites and/or cultural associations are avoided or minimised and where not possible what measures would be implemented to restore or otherwise offset any impacts.	Section 14.6
6. Outline the outcomes/objectives, management, monitoring, trigger and contingency actions, within environmental management plans, to ensure impacts (direct and indirect) are not greater than predicted.	Section 14.8
Rehabilitation and Decommissioning	
1. Conceptual characterisation of project area once operations have ceased, infrastructure has been decommissioned and area has been rehabilitated.	Section 15.2
2. Comparison between initial conditions and expected post-closure conditions identifying residual impacts resulting from implementation of proposal including all expected rehabilitation measures.	Section 15.3

ESD Required Work for Key Environmental Factors	Location in PER
3. Closure planning is initially conceptual and progressively becomes more detailed following start up as operational changes take effect, rehabilitation techniques and technologies are tested and advances in knowledge from monitoring are obtained.	Section 15.4 Figure 15.7
4. A preliminary Radioactive Waste Management Plan (RWMP) will be prepared and included in the PER. The RWMP will: • Consider the PKEFs and demonstrate how the environmental objectives of the ARPANSA Radiation Protection Series (incl. RPS6, RPS 9 and RPS 15) and International Atomic Energy Agency (IAEA) Safety Standard SSR-5 'Disposal of Radioactive Waste' 2011 are to be achieved. • Identify, characterise and classify each waste stream (including intermediate processing waste) associated with the operation of the mine, in accordance with ARPANSA RPS20. • Include controls and determine risk categories for the management of tailings, process and surface waters based on Australian National Committee On Large Dams Incorporated (ANCOLD) guidelines entitled 'Guidelines on tailings dams Planning, Design, Construction, Operation and Closure' (May 2012).	Section 15.5 Appendix H3
5. A conceptual mine closure plan will be developed as an initial planning and consultation tool to guide the project direction in respect to closure outcomes and best practice technology goals during design and construction. The plan will be prepared in accordance with EPA/DMP Guidelines for Preparing Mine Closure Plans (2011), the site Radiation Management Plan and the Mining Code (2005) and will cover radiological considerations in respect to long term secure management and disposal of radioactive materials and plant under planned and unplanned scenarios. Further guidance would be obtained from IAEA Nuclear Energy Series publications.	Section 15.6 Appendix H1
6. Review of potential impacts from radiation associated with the project to non-human biota will be analysed using a program known as ERICA. Australian specific data will be used where available.	Section 15.7
7. Physical and geochemical characterisation of process residues, waste rock and overburden.	Section 15.8
8. An assessment of the radon exhalation performance of the cap and its significance will be undertaken.	Section 15.9
9. Long term behaviour and performance of built landforms and associated containment systems, including tailings storage facility capping systems, modelled under a range of climatic events including appropriate landform evolution modelling.	Section 15.10
10. Estimate of waste quantities and documentation of expected timing of land disturbance, waste generation and progressive rehabilitation.	Section 15.11
11. Sequencing of mining, tailings deposition/backfilling and progressive rehabilitation.	Section 15.11 & 15.12
12. Assessment of hydrological characteristics of the post-closure voids.	Section 15.13 Figure 15.20
13. A conceptual diagram of pits post-closure.	Figure 15.16 – Figure 15.19
14. Determination of expected cumulative residual impacts post closure, ongoing monitoring and remediation measures required if appropriate and any offset measures required where remediation is deemed not sufficient.	Section 15.14 & 15.15
Offsets	
1. All the potential impacts and risks needs to be considered in the context of the application of mitigation measures and other management techniques to control or lessen or rectify the impacts and risks, and to then determine the residual impacts and risks.	Section 16.2 - 16.5 Table 16.1

ESD Required Work for Key Environmental Factors	Location in PER
2. The application of the residual impact significance model to show whether there are significant residual impacts. Should significant residual impacts be determined Vimy will propose an offsets package to be included in the PER document.	Section 16.5 Table 16.1

1.6 Proponent Details

The Project is 100% owned by Vimy who will also be responsible for its development and subsequent operation. Details for Vimy are as follows:

ABN:	56 120 178 949
Office address:	Ground Floor, 10 Richardson Street, West Perth, WA 6005, Australia
Postal address:	PO Box 23, West Perth, WA 6872, Australia
Telephone:	+61 (0) 8 9389 2700
Facsimile:	+61 (0) 8 9389 2722
Contact:	Mr Julian Tapp, Executive Director

Vimy's 'Vision' is:

'Mining a cleaner tomorrow'

Vimy believes that uranium, as a fuel, represents a cost competitive low carbon emission source for the generation of electricity and that the mining of uranium makes a contribution towards limiting the amount of greenhouses gases in the atmosphere thereby contributing to a cleaner tomorrow.

Vimy's 'Mission' is that:

'Vimy aims to become a reliable and respected uranium producer'. This means that Vimy will act in the best interests of its stakeholders through:

- Caring for our people.
- Embracing a safe work culture.
- Operational excellence and innovation.
- Continuous and sustainable company growth.
- Focused and inclusive leadership.

Vimy's 'Core Values' are:

'Responsibility', 'Credibility' and 'Open-mindedness'. These core values should be interpreted as follows:

- Responsibility – Together we are responsible for:
  - The safety and well-being of our co-workers
  - Ensuring a positive social and environmental impact
  - Shareholders' capital.

- Credibility – We are committed to building and maintaining our credibility through:
  - Excellence
  - Leadership
  - Commitment to our Vision and Mission.
- Open-mindedness – We believe curiosity and openness to other views will lead to improved outcomes.

Vimy is a small company (with approximately 20 full time equivalent (FTE) employees) that will grow as the Project is developed and will employ the necessary expertise to ensure that it achieves its mission without compromising its core values or losing sight of its vision.

1.7 Assessment Approach

1.7.1 Applicable Legislation

In addition to the EP Act and the EPBC Act, implementation of the Proposal will require compliance with other key Australian legislation and regulations. These are listed below.

Further to these statutory requirements, a range of other guidelines, standards and policies are relevant to the Proposal. The applicable standards, policies and guidelines are listed in Sections 1.7.2 and 1.7.3.

Australian Government Legislation

The Proposal has been declared a controlled action by the Federal Minister for Environment and will be assessed by DoE according to the terms of the Bilateral Agreement between the Commonwealth of Australia and the State of Western Australia. The Bilateral Agreement is authorised under Section 45 of the EPBC Act. Under the terms of the Bilateral Agreement, the EPA will provide its assessment report and any other assessment documentation, including this PER, to DoE upon completion of its assessment. The DoE will consider the impacts from the Proposal on MNES. An assessment of impacts to MNES is provided in Section 9.

Other key Australian Government legislation relevant to the environmental aspects of this Proposal includes:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984.*
- *Customs Act 1901.*
- *Native Title Act 1993.*
- *National Greenhouse and Energy Reporting Act 2007.*
- *Nuclear Non-Proliferation (Safeguards) Act 1987.*
- *Nuclear Safeguards (Producers of Uranium Concentrates) Charge Act 1993.*

State Legislation

Other legislation relevant to the Proposal may include:

- *Aboriginal Heritage Act 1972 (AH Act).*
- *Biosecurity and Agriculture Management Act 2007 (BAM Act).*
- *Bush Fires Act 1954.*
- *Conservation and Land Management Act 1984 (CALM Act).*
- *Dangerous Goods Safety Act 2004.*

- *Dangerous Goods (Transport) Act 1998.*
- *Health Act 1911.*
- *Heritage of Western Australia Act 1990.*
- *Land Administration Act 1997.*
- *Local Government Act 1960.*
- *Mining Act 1978.*
- *Mines Safety and Inspection Act 1994.*
- *Occupational Health and Safety Act 1984.*
- *Planning and Development Act 2005.*
- *Rights in Water and Irrigation Act 1914 (RIWI Act).*
- *Soil and Land Conservation Act 1976.*
- *Pollution of Waters by Oil and Noxious Substances Act 1987.*
- *Wildlife Conservation Act 1950 (WC Act).*
- *Radiation Safety Act 1975.*

1.7.2 Standards, Guidelines and Policies

Assessment of the environmental impacts of the Proposal is based on various Position Statements and Guidance Statements. Standards, Guidelines and Policies related to specific environmental factors or individual aspects of the Proposal are listed in the individual sections relevant to the environmental factor being addressed. The generic documents considered relevant to assessment by the EPA are:

- Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012 (EPA December 2012).
- Guidelines for Preparing a Public Environmental Review (EPA November 2012).
- Environmental Assessment Guidelines No. 6 (EAG 6) – Revised: Timelines for Environmental Impact Assessment of Proposals (EPA March 2013).
- Environmental Assessment Guidelines No. 1 (EAG 1): Defining the Key Characteristics of a Proposal Environmental Protection Act 1986 (EPA May 2012).
- Environmental Assessment Guidelines No. 8 (EAG 8) – Revised: Environmental Principles, Factors and Objectives (EPA January 2015).
- Environmental Assessment Guidelines No. 9 (EAG 9) – Revised: Application of a Significance Framework in the Environmental Impact Assessment process (EPA January 2015).
- Environmental Assessment Guidelines No. 17 (EAG 17) – for Preparation of management Plans under Part IV of the *Environmental Protection Act 1986* (EPA August 2015).

1.7.3 Other WA Approvals

In addition to any requirements for implementation of the Proposal under Part IV of the EP Act, the Proposal may require:

- Works Approvals and Licences under Part V of the EP Act.
- Mining Proposal and Mine Closure Plan under the *Mining Act 1978.*

- Groundwater abstraction licences under the RIWI Act.
- Approval to disturb Aboriginal sites under Section 18 of the AH Act.

1.8 Proposal Justification

Uranium is used as fuel for nuclear reactors with the purpose of generating electricity. The amount of uranium required to fuel the existing fleet of operable nuclear reactors, estimated at 66.8ktU for 2015 (WNA 2015b) exceeds the capacity of existing uranium mines (primary supply) which produced 56.3ktU in 2014 (WNA 2015b). Currently, the shortfall in supply is met from what is known as secondary supplies (previously stockpiled material in a variety of processed forms derived from earlier mining activity) but those secondary supplies are finite and will be eroded over time. The situation will be further exacerbated by a significant net increase in operating reactor capacity globally, mostly driven by a large expansion expected in China. In other words there is currently a shortage in the primary supply of uranium and the situation will worsen over time.

Increases in the supply of mined uranium are essential in order to maintain adequate supplies for the world's nuclear industry which is the only 'low carbon emission' source of baseload electrical power. The Proposal is justified by the requirement to meet the needs of an industry that provides low carbon emission energy and will be an essential part of the energy mix for most countries seeking to increase electrical generating capacity whilst limiting or reducing their carbon emissions.

The Project is located in a very isolated and arid area which is subject to damaging bushfires – most of the area was recently burnt after a lightning strike started a fire that burned through around 79,000ha (Appendix A1), including 78% of the Disturbance Footprint. Previous mining activity undertaken in the 1980s (when a small test pit was dug) has demonstrated that the vegetation will restore naturally following disturbance and with appropriate management the planned rehabilitation will be effective (Section 15).

The mining and processing methodology adopted will enable most of the tailings generated by processing activities to be deposited back into mining voids below the biologically active zone. The mine pits will then be rehabilitated so that there will be no lasting impact at the surface. For a uranium mining project, the potential impact on environmentally sensitive receptors is expected to be negligible due to Vimy's commitment to achieving a very high standard of environmental management and to minimising its impacts upon the environment.

1.8.1 Benefits of Proposal

The Proposal will result in benefits for Australia and Western Australia through:

- Royalty payments from the sale of uranium concentrate:
  - Annual production of 3M pounds of uranium concentrate and an associated price of US$75/lb (A$100/lb; US$/A$ = 0.75) are expected – Royalty payments of 5% would amount to A$15m pa on this basis.
- Employment and training opportunities:
  - When fully implemented, the Proposal is expected to result in the creation of approximately 315 full time positions involved in running the operations.
  - Vimy intends to ensure that both employment opportunities and the purchasing of required services are targeted towards people living in the region and regional suppliers.

Vimy expects that the Project will be profitable and as a result Vimy will pay taxes on those profits. More generally the presence of commercial activity in this region will have a multiplier effect creating more jobs and more commercial activity locally.

1.8.2 Consequences of Not Proceeding

The consequences of not proceeding with this Proposal would be that the uranium resource would not be developed and the associated economic and social benefits would not materialise. Moreover the expected uranium shortage would be exacerbated, the price would rise and ultimately some other uranium resource (possibly one in a jurisdiction where there is far less control over environmental consequences) would be developed.

1.8.3 Alternatives Considered

The location of the Project, and in particular the location of the majority of the area that it is proposed to be cleared, is determined by the location of the target resources. The associated infrastructure is flexible in its location although there is a preference to locate processing facilities as close to the location of the mines as is possible to reduce the distances required to transport the mined material before processing.

To some extent local topography also influences choice of location of infrastructure. It is better to locate plant in an area that is relatively flat as it minimises the extent to which areas must be levelled to facilitate construction. Similarly the choice of location of pipelines is determined by a desire to avoid traversing dunes or any areas that involve significant change of levels. Similarly, overburden landforms (OLs), tailings storage facilities (TSFs) and any other facilities are always preferably located in depressions or low points rather than in elevated areas.

In terms of alternative methods of mining, there are basically three methods of mining uranium:

- *In situ* leaching.
- Open–cut mining.
- Underground mining.

Both *in situ* leaching and underground mining might be regarded as environmentally preferable on the basis that they usually involve far less ground disturbing activity. However the local geology essentially dictates that only open cut mining is possible in the case of the MRUP. The uranium is not situated within a constrained aquifer and is therefore not amenable to *in situ* leaching – the resource sits partially above the water level. The overburden is essentially free digging material composed primarily of sand. It doesn't have the structural integrity required to support the sort of tunnelling associated with underground mining.

In terms of alternative processing methodologies, three options were considered for upfront processing:

- Simply crushing and screening ROM material and putting suitably crushed material straight into the leaching process.
- Enhancing the concentration of the uranium contained in the material due for processing by calcining the material.
- Enhancing the concentration of the uranium contained in the material due for processing by beneficiation.

Although calcining showed considerable potential in terms of achieving an increase in the concentration of contained uranium in the product – it was felt that the environmental implications of heating the ore to the level required to fully oxidise all of the contained carbonaceous material, namely the production of significant carbon dioxide, as well as the generation of various oxides of sulphur (SO_x) produced from the sulphides also present in the ore meant that the option was less favoured.

Although it is possible to only crush and screen the ore before processing, the addition of in-pit beneficiation would appear to offer both environmental and commercial benefits. As a result of the feasibility work already undertaken it appears that the coarse sand, which is essentially barren of uranium and other metals, can be rejected from the ROM material through a beneficiation process allowing it to be deposited back with other non-mineralised material that is removed as overburden. This reduces the amount of material that needs to be transported to the central processing facility, reduces the amount of material that needs to be subjected to the leach process (albeit that it is at a much higher concentration) and reduces the amount of tailings that require disposal.

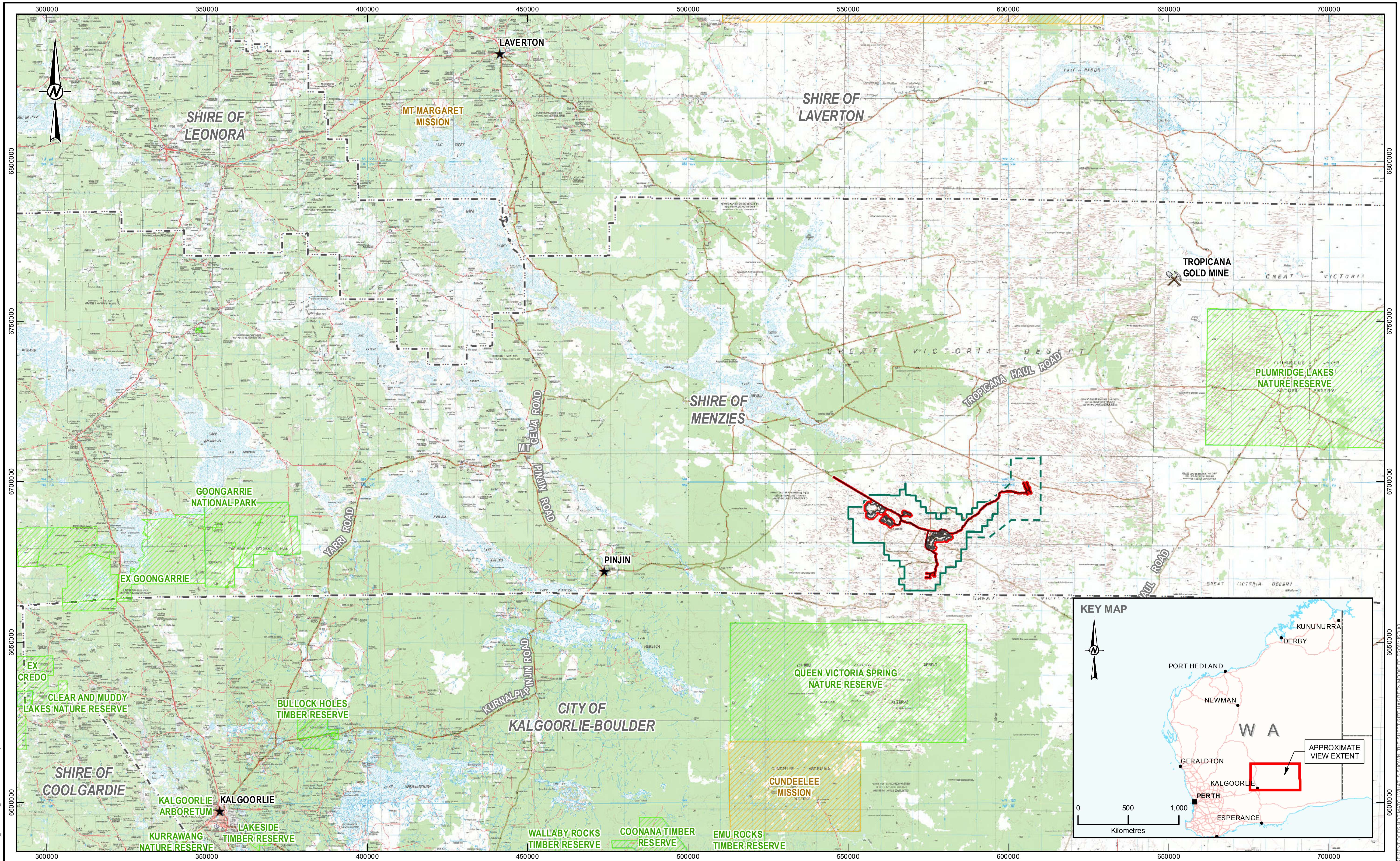
Providing that further feasibility work confirms these findings, there will be some upfront beneficiation prior to processing the material through the leach stage.

In terms of leaching methods, there are two different forms of leaching:

- Acid leach.
- Alkaline leach.

Given the highly acidic nature of the aquifer and the acid forming nature of the material that will be mined alkaline leach would not be practicable or desirable. Acid leaching replicates the process already taking place just above the ore zone where acidity mobilises the uranium and other metals which are then recaptured by the carbonaceous material as they pass through a strongly reducing environment. Vimy has determined that acid leaching is the most efficient method of extracting the uranium and given the high levels of acidity prevailing in the local aquifer it is also the method least likely to cause any harm to the environment when the materials are returned.

Having extracted the uranium from the mined material by dissolving it in acid, Vimy has determined using extensive test work that resin extraction is both environmentally and commercially the best way to reclaim the material and process it into the final product – being uranium oxide concentrate.



LEGEND

- TROPICANA GOLD MINE
- TOWN
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- CONSERVATION RESERVE
- ABORIGINAL LAND TRUST ESTATE
- LOCAL GOVERNMENT AUTHORITY (LGA) BOUNDARY

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
BASE DATA © WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2015)
IMAGE SOURCED FROM GEOSCIENCE AUSTRALIA 250K TOPO
INSET BASE DATA/ROADS SOURCED FROM STREET PRO DATA 2009

0 25 50
1:1,100,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-21
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
REGIONAL LOCATION

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	1.1

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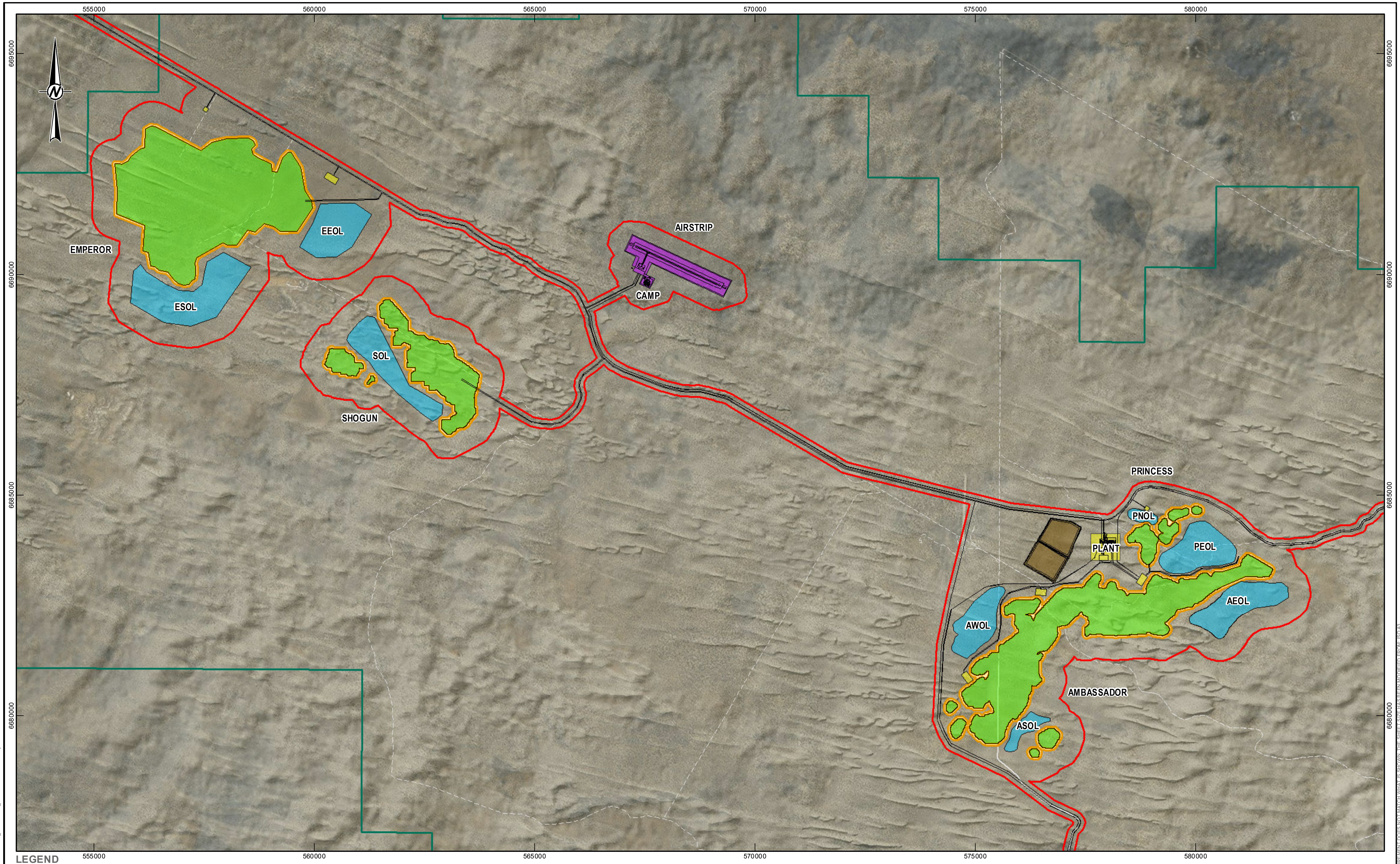

LEGEND

- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- PIT
- OVERBURDEN LANDFORM
- PROCESSING INFRASTRUCTURE
- ABOVE GROUND TSF
- SUPPORTING INFRASTRUCTURE
- PIT CLEARING (50 m BUFFER)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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1:80,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-16
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

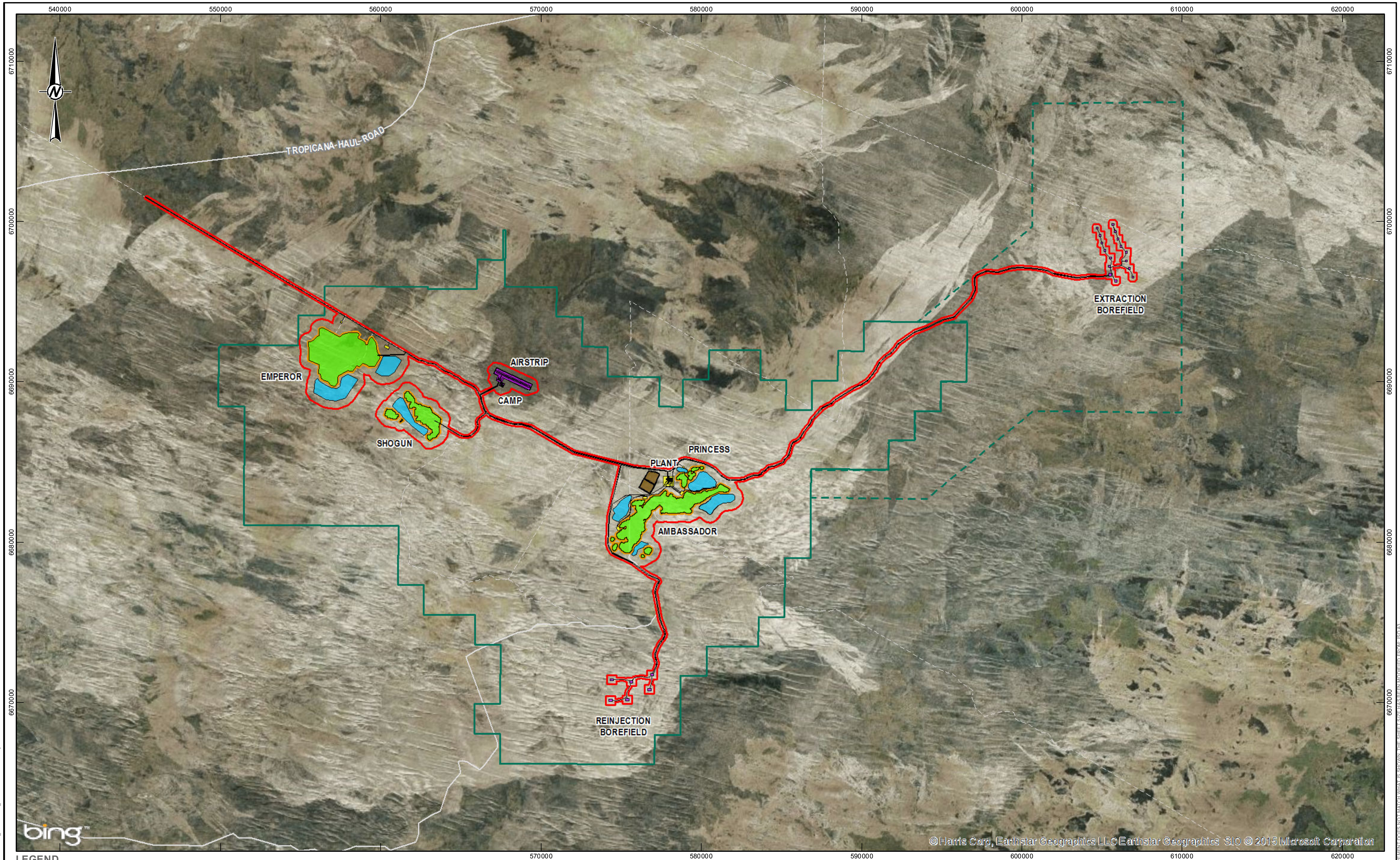
PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
CONCEPTUAL PROJECT LAYOUT PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	1.2

25mm

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3



LEGEND

- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- PIT
- OVERBURDEN LANDFORM
- PROCESSING INFRASTRUCTURE
- ABOVE GROUND TSF
- SUPPORTING INFRASTRUCTURE
- PIT CLEARING (50 m BUFFER)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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1:220,000 KILOMETRES

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT Golder Associates	YYYY-MM-DD: 2015-11-16	TITLE **PROJECT TENURE, PROPOSED DEVELOPMENT ENVELOPE AND DISTURBANCE FOOTPRINT**	
	DESIGNED: MS		
	PREPARED: MS		
	REVIEWED: DCR		
	APPROVED: DCR	PROJECT NO. 1540340 / CONTROL PER / REV. 0	FIGURE **1.3**

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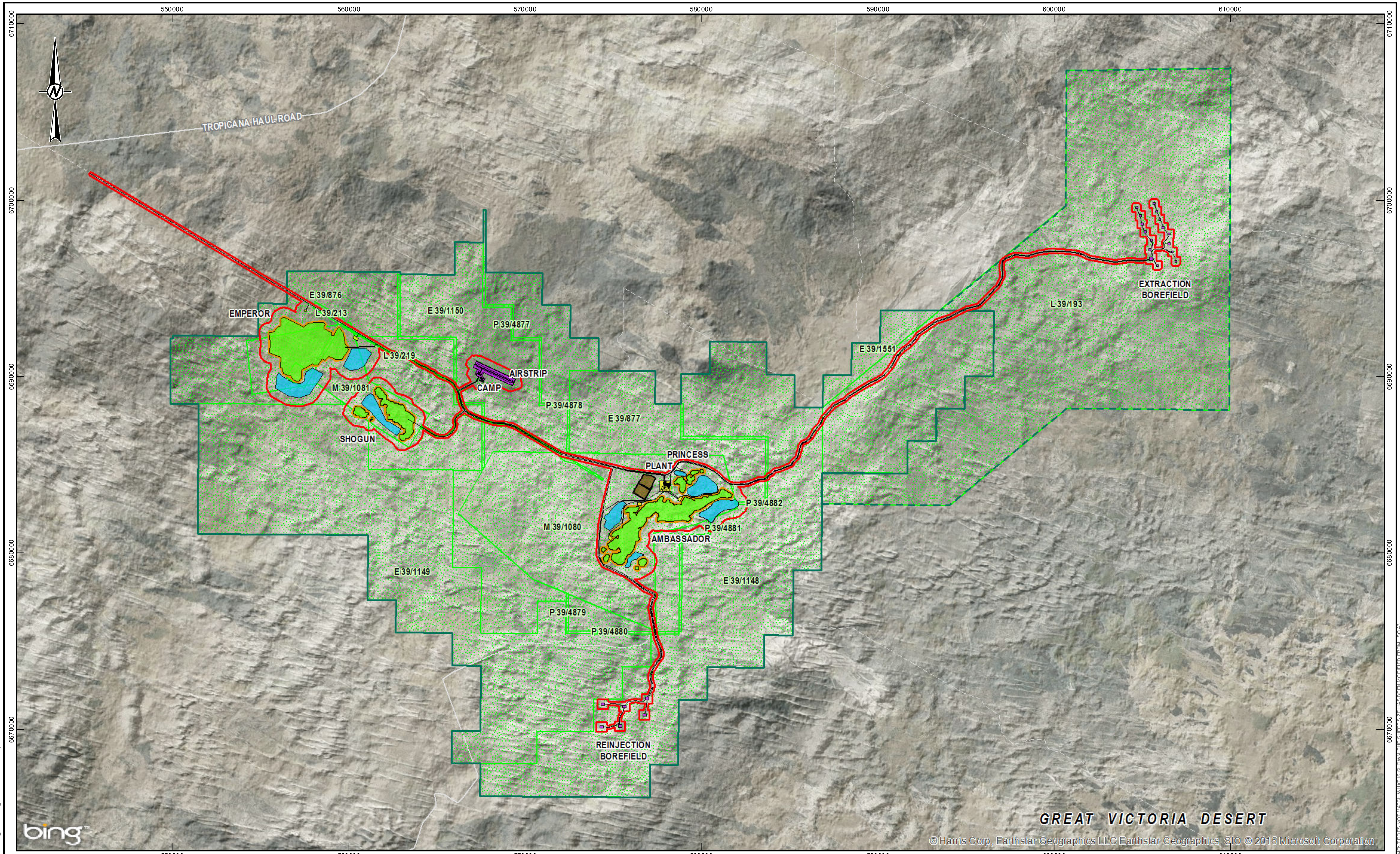
25mm



LEGEND

- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- PROJECT TENEMENT
- PIT
- OVERBURDEN LANDFORM
- PROCESSING INFRASTRUCTURE
- ABOVE GROUND TSF
- SUPPORTING INFRASTRUCTURE
- PIT CLEARING (50 m BUFFER)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
TENEMENTS BOUNDARY © DEPARTMENT OF MINES AND PETROLEUM
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 5 10
1:200,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-16
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
TENEMENTS AND MISCELLANEOUS LICENCES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	1.4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

2. Physical Environmental Setting

2.1 Climate

Regional Climate

The climate of the MRUP is classified as desert with hot summers and cool-mild winters. Rainfall throughout the year does not vary considerably with 20-40mm/month falling in the summer months (November-March), often associated with cyclonic events, and 10-30mm/month in winter (April-October), with a total annual average rainfall of approximately 280mm. Pan evaporation (around 2,650mm/yr) greatly exceeds rainfall throughout the year and thus the environment exists in a water deficit condition. Daily pan evaporation rates vary from 11-12mm/day (330-360mm/month) in summer to 2-3mm/day (75-100mm/month) in winter. The MRUP region therefore exists in a water deficit condition throughout the year, which will strongly influence the functioning of the ecosystem.

Long term monthly totals for rainfall for the three closest Bureau of Meteorology (BOM 2015a) weather stations (Balgair, Laverton and Kalgoorlie) and pan evaporation data is presented in Figure 2.1.

Intensity-Frequency-Duration (IFD) data for the MRUP (as determined at 568,000m East and 6,688,000m North; GDA94 Zone 51) (BOM 2015b) is presented in Table 2.1. Based on this data a 100 year 72 hour event equates to 158.4mm of rainfall.

Table 2.1 IFD Data for the MRUP (BOM 2015b) – Rainfall in mm/hr

Duration	1 year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	36.8	50.0	73.5	89.7	111	140	165
6Mins	34.2	46.4	68.2	83.3	103	130	153
10Mins	27.4	37.2	54.5	66.4	81.7	104	122
20Mins	19.5	26.4	38.3	46.4	56.8	71.7	84.0
30Mins	15.5	20.9	30.3	36.6	44.8	56.5	66.0
1Hr	10.1	13.6	19.6	23.7	28.9	36.4	42.6
2Hrs	6.34	8.56	12.4	15.0	18.3	23.0	26.9
3Hrs	4.81	6.50	9.40	11.4	13.9	17.5	20.5
6Hrs	2.97	4.03	5.86	7.11	8.72	11.0	12.9
12Hrs	1.81	2.47	3.62	4.42	5.44	6.91	8.12
24Hrs	1.07	1.46	2.18	2.69	3.34	4.27	5.04
48Hrs	.597	.819	1.26	1.57	1.97	2.55	3.04
72Hrs	.410	.571	.891	1.11	1.41	1.84	2.20

Local Climate

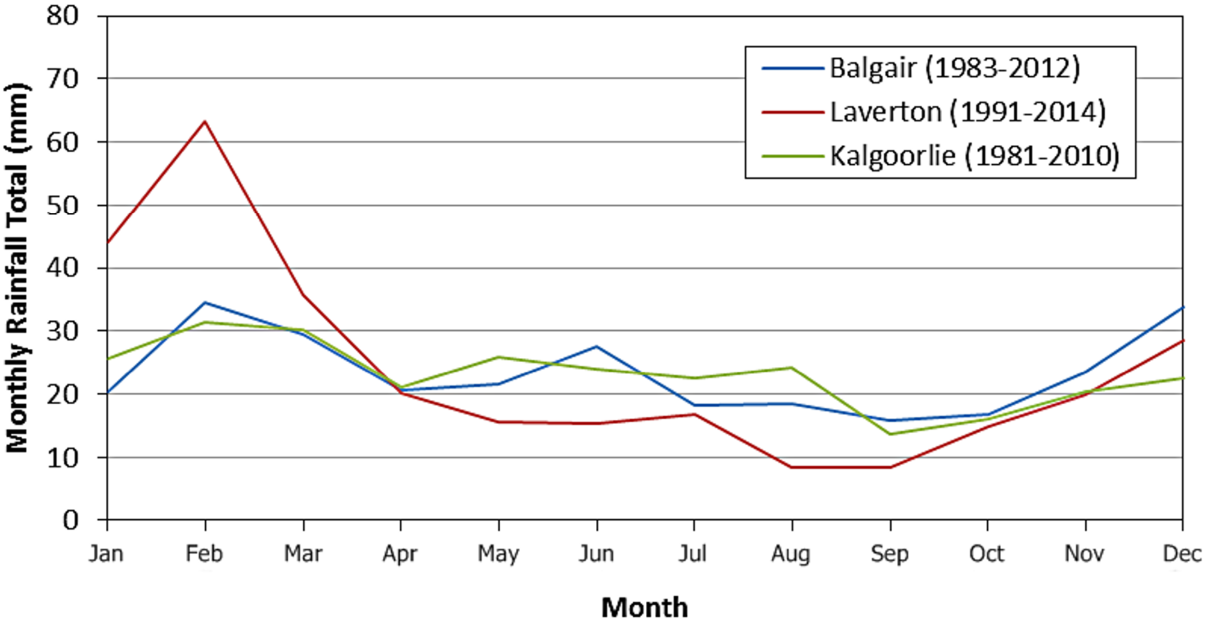
The local climate within the MRUP is captured at four locations to assess spatial variability across the site. The locations of the weather stations are provided in Table 2.2. Data currently collected on an hourly basis includes: air temperature, barometric pressure, relative humidity, rainfall depth, wind speed, and wind direction. Data collection started in March 2009 and a summary of the data to September 2014 is provided in Figure 2.2.

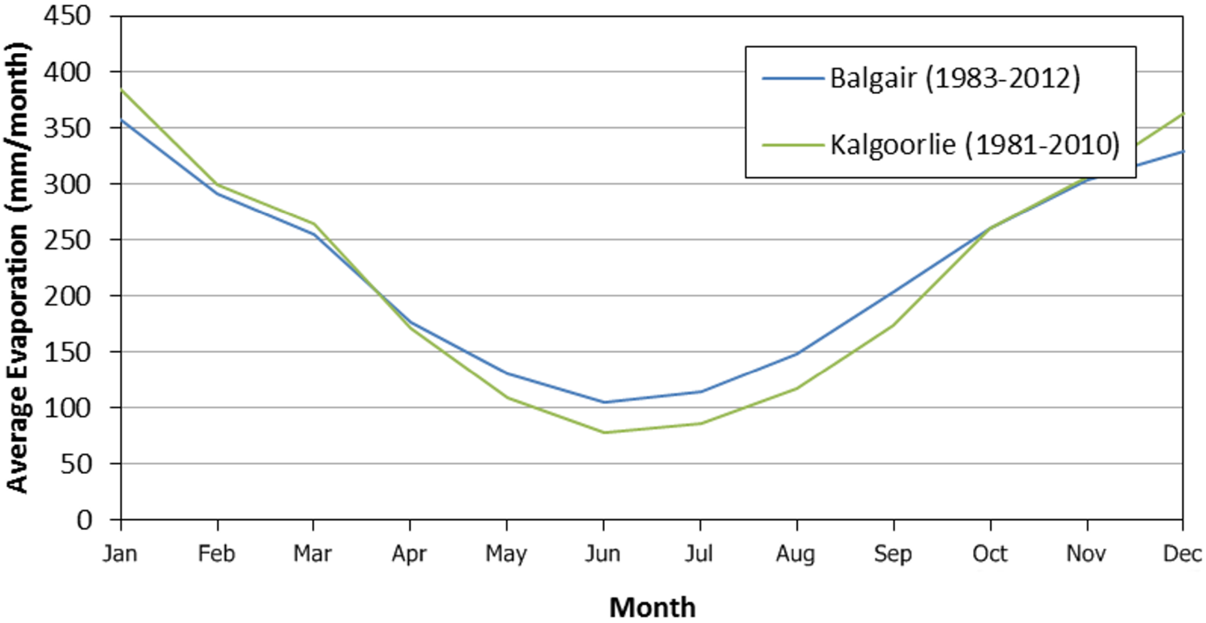
Table 2.2 Location of Onsite Weather Stations

Station	Easting (GDA MGA zone 51)	Northing (GDA MGA zone 51)
Airstrip 904	574,715	6,684,600
Emperor 908	557,391	6,691,424
Shogun 907	563,569	6,687,909
High Volume Sampler (HVS)	575,003	6,684,055

The rainfall data within the MRUP is similar to the regional data with summer (November-March) rainfall varying from 20-70mm/month, and winter (April-October) rainfall varying from 10-20mm/month (Figure 2.2). Calculated pan evaporation data varies from 75-100mm/month during winter to 280-290mm/month during summer. The western side of the MRUP (i.e. Shogun and Emperor Deposits) is noticeably wetter and experiences less evaporation than the eastern side (i.e. Ambassador and Princess Deposits) (Figure 2.2).

Average monthly daily temperatures vary from around 35°C in summer (i.e. January) to a low of around 19°C in winter (i.e. July) (Figure 2.2). The 9:00am wind speeds vary from around 5km/hr during winter to around 11km/hr in summer (Figure 2.2). Wind rose data for the MRUP is provided in Figure 2.3 and shows that during the summer months wind direction is predominately (50-80%) from the southeast (i.e. blowing to the northwest), whilst in winter the prevailing wind direction is easterly.





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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A4

25mm

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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

PROJECT
MULGA ROCK URANIUM PROJECT

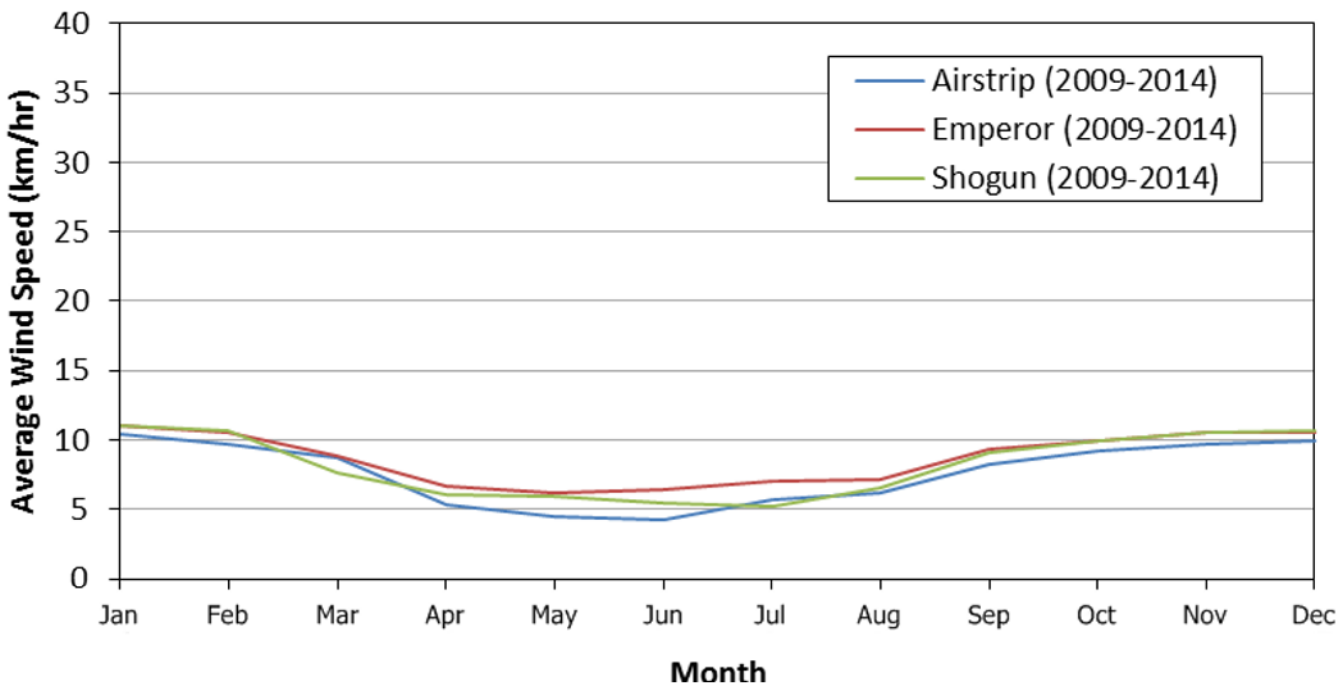
CONSULTANT

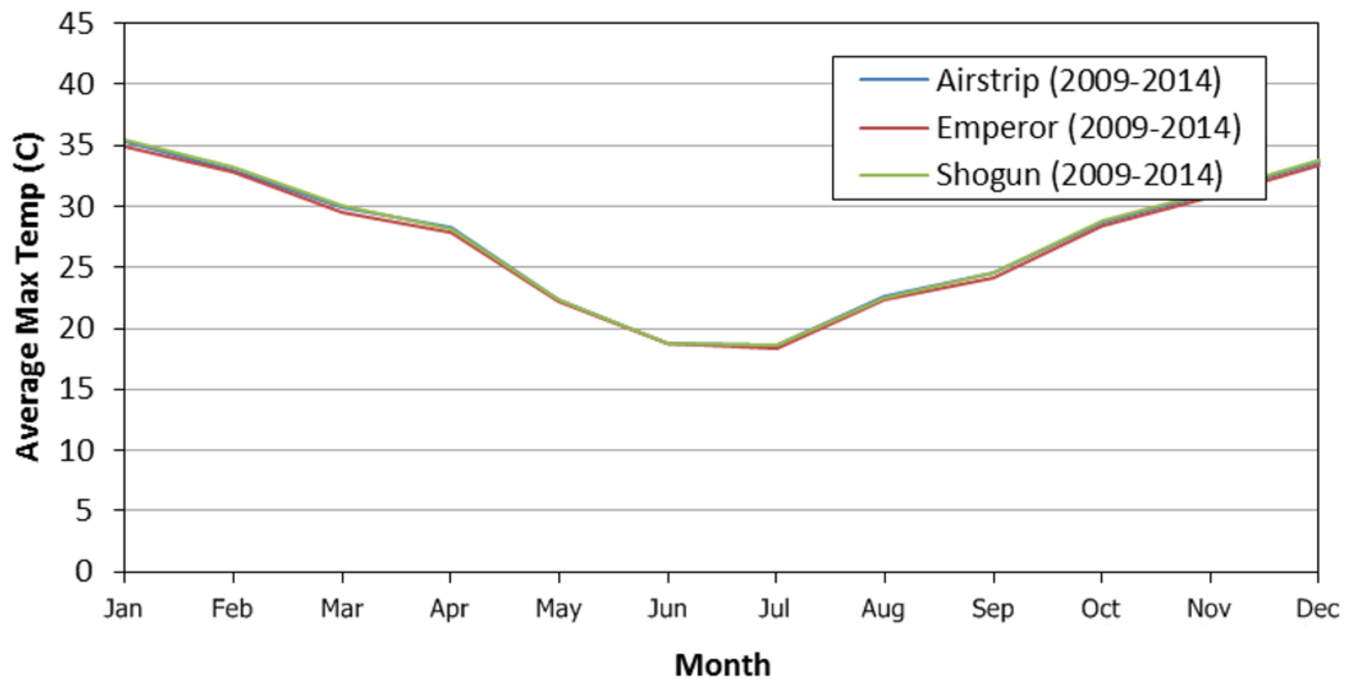
Golder Associates

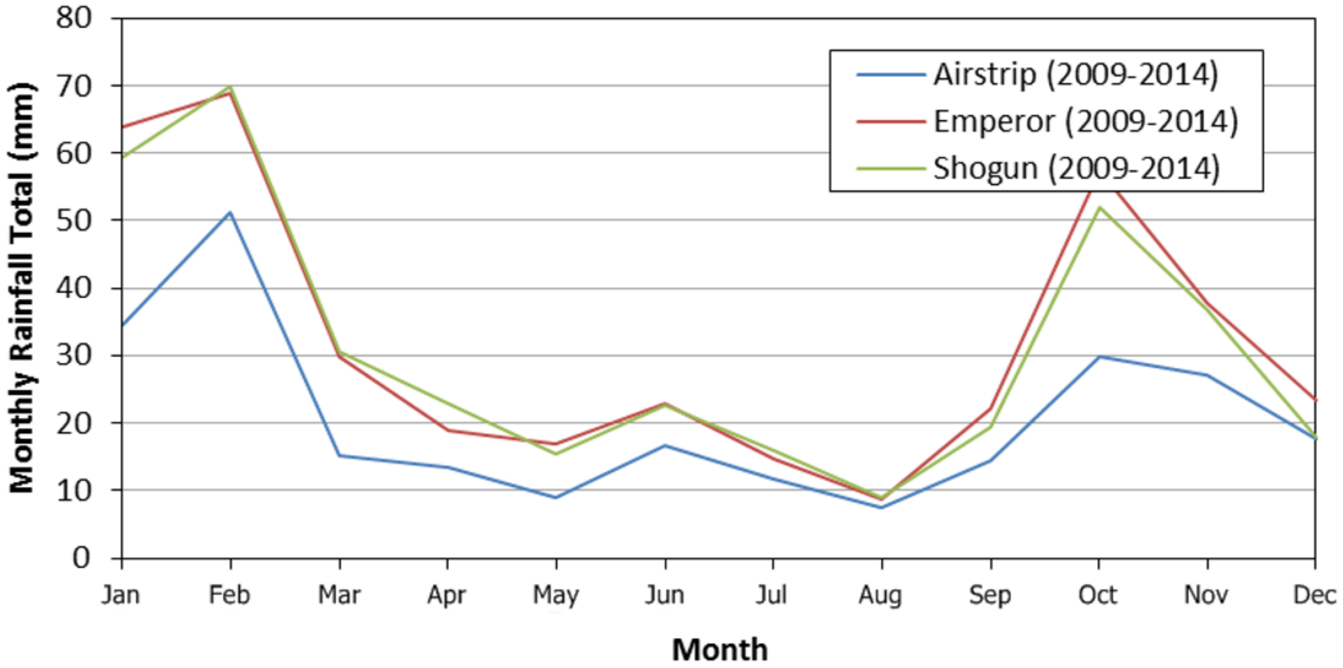
YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

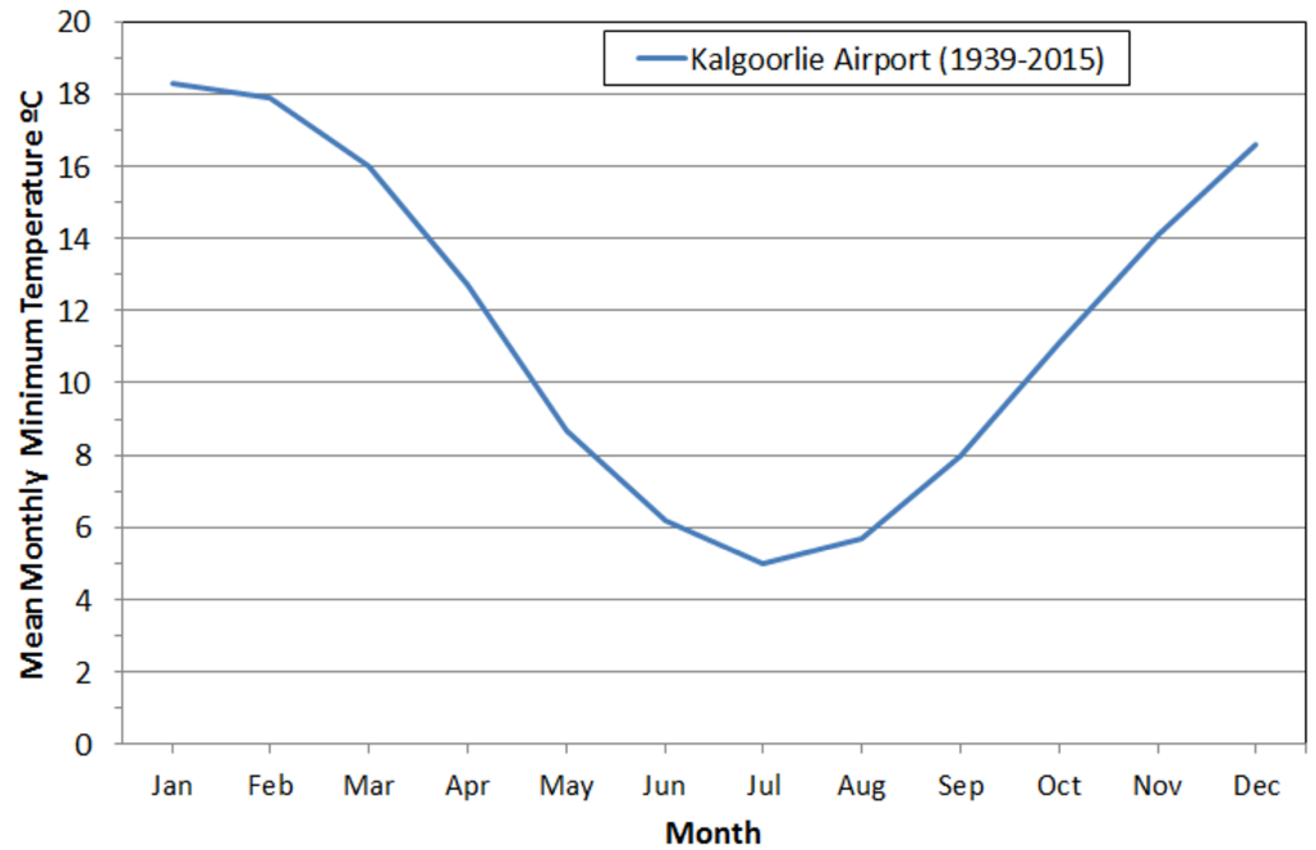
TITLE
REGIONAL MONTHLY AVERAGE RAINFALL AND PAN EVAPORATION DATA

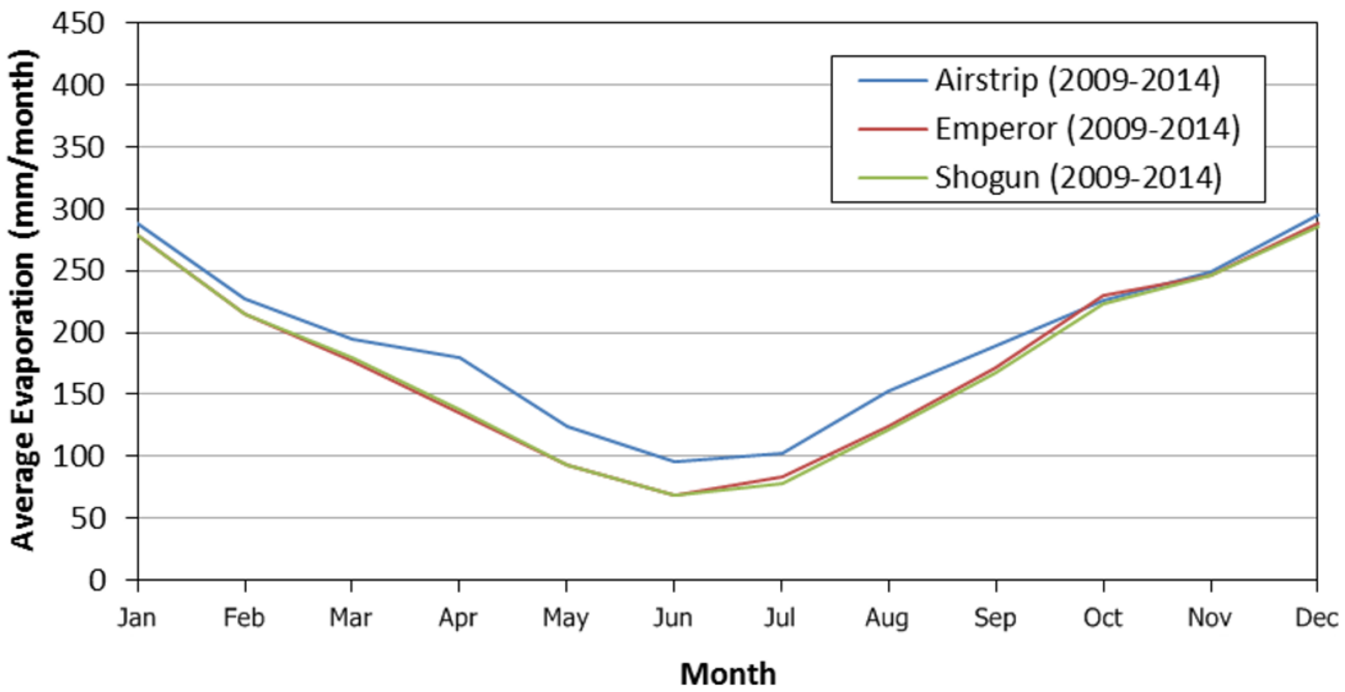
PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**2.1**











CLIENT
VIMY RESOURCES LIMITED

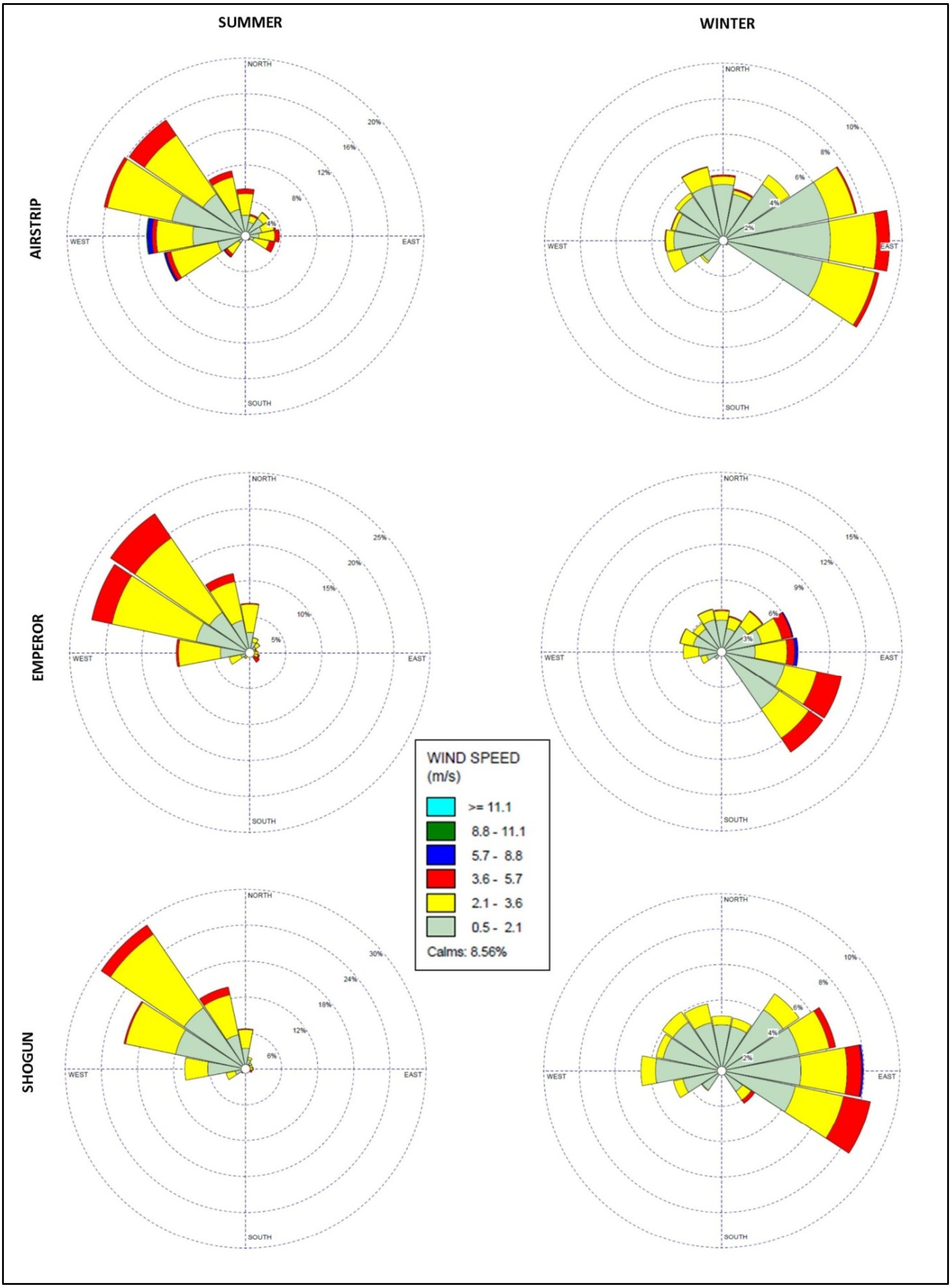
PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT

YYYY-MM-DD	2015-11-01
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

TITLE
LOCAL MONTHLY AVERAGE CLIMATIC DATA

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	2.2



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CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT Golder Associates	YYYY-MM-DD	2015-10-31	TITLE WIND ROSE DATA WITHIN THE MRUP
	DESIGNED	MS	
	PREPARED	MS	
	REVIEWED	DCR	PROJECT NO. 1540340 / CONTROL PER / REV. 0 / FIGURE 2.3
	APPROVED	DCR	

2.2 Soils

The soils throughout the MRUP have been mapped at a regional scale, as part of the Australian Soil Resources Information System (ASRIS; CSIRO 2014), and at a local scale by Soilwater Consultants (Appendix H2). At the regional scale, the MRUP occurs solely within the Southern Great Victorian Desert Zone.

The detailed soil survey undertaken by Soilwater Consultants (Appendix H2) identified that all soils within the MRUP have a depositional origin (colluvial – moved from a higher level by gravity or rain; alluvial – deposited having been transported in rivers; or Aeolian – blown by the wind), with post-depositional pedogenesis (namely the action of climate and biological processes) having modified the characteristics of the original soils. The surficial Quaternary soils were deposited onto an existing overburden profile comprising upper Miocene (23–5.3M years ago (Ma)) and lower Eocene (56-33.9Ma) sediments, extending to around 40m depth when the water table is intersected. The contacts between all stratigraphic units or sedimentary layers (i.e. Quaternary (2.6Ma to present), Miocene and Eocene sediments) are abrupt, resulting in defined unconformities within the regolith profile, with the sediments of each overlying unit having been deposited onto a pre-existing sedimentary surface. At the lower boundary between Miocene and Eocene a defined surface exists (comprising either laterite or silcrete), whilst at the upper boundary between Miocene and Quaternary, a 1-4m thick calcrete layer (in which materials are bound by calcium carbonate) is present.

The uppermost layers (surficial Quaternary sediments) are principally comprised of just two soil materials; these being either dunal sand or reddish brown sandy loam. From examination of deep soil trenches and the geological drilling logs, the reddish brown sandy loam forms a continuous relatively thin (i.e. < 1m in thickness) layer over the calcretised Miocene sediments, such that it was likely deposited under widespread alluvial conditions across the MRUP. Following a change in depositional or climatic processes, Aeolian deposition was favoured resulting in the defined sand dunes that are characteristic of the region.

Based on the distribution of the above two dominant soil materials (i.e. dunal sand and sandy loam), only three morphologically distinct soil types or soil mapping units (SMU) occur across the entire MRUP. These are:

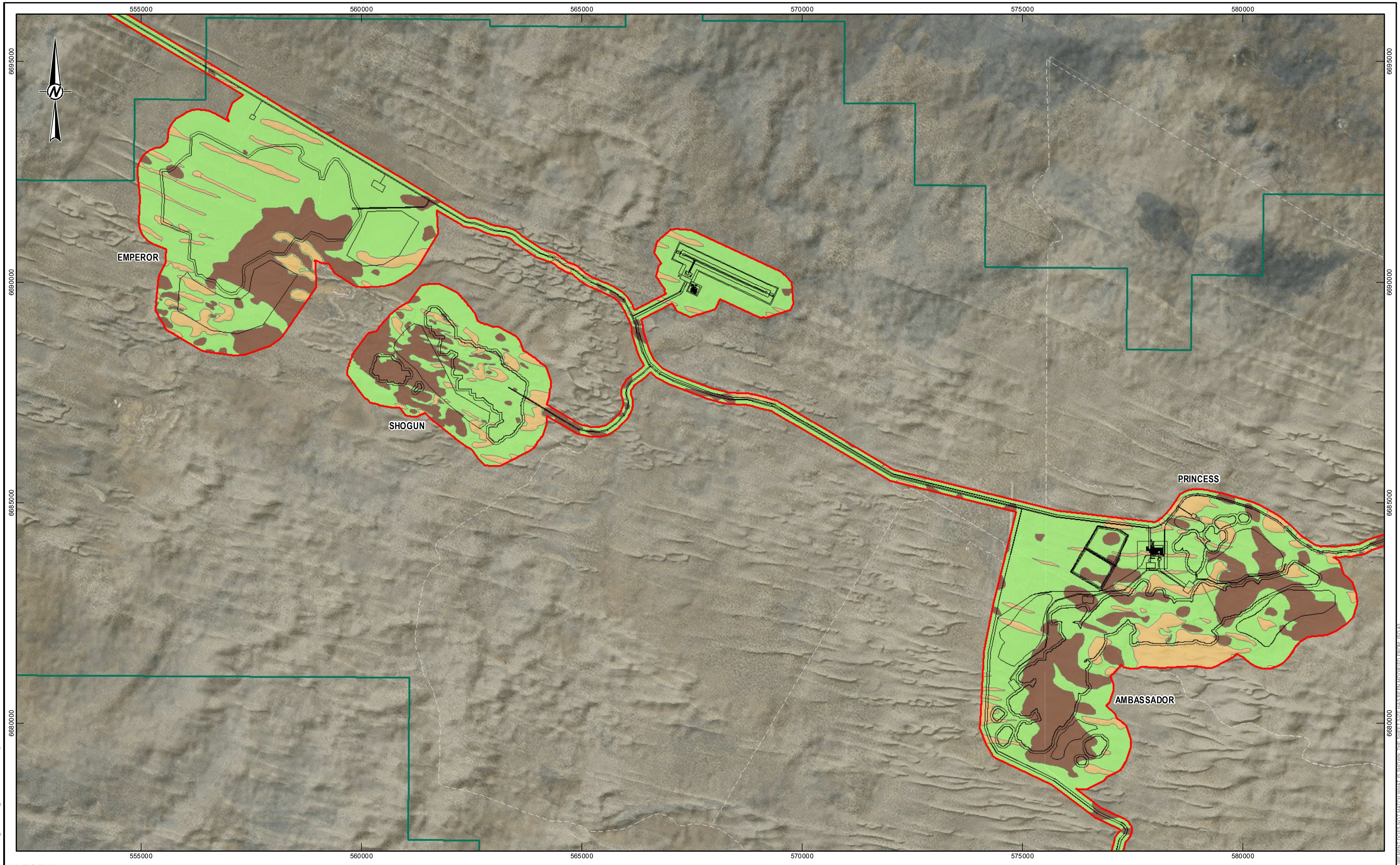
- SMU 1: Deep Dunal Sand – comprises the current sand dunes, with > 5m of yellow Aeolian sand.
- SMU 2: Sandy Duplex Soil – represents the transition between SMU 1 and 3, and consists of 3-5m of yellow, grading to red, dunal sand over the reddish brown loam and underlying calcrete.
- SMU 3: Calcareous Loamy Soils – occurs in areas where there are no overlying sand dunes, often forming localised topographic depressions, with the reddish brown sandy loam exposed at the surface.

A map showing the distribution of the three SMU, or SLU (soil landscape units), across the MRUP is provided in Figure 2.4, whilst a typical landscape cross-section is shown in Figure 2.5. The soil distribution exhibits a systematic and predictable distribution across the MRUP, such that SMU 1 (Deep Dunal Sands) always occupies the upper slopes and crests of the existing dunes, SMU 3 always occurs within the interdunal swales and more widespread across the broad flat plains, and SMU 2 represents the transitional areas between SMU 1 and 3. SMU 2 is the dominant soil type within the MRUP, covering approximately 69% of the land area, whilst SMU 3 covers close to 20%. SMU 1 only occupies approximately 11% of the land area within the proposed Development Envelope.

A defined Soil-Vegetation Association exists within the MRUP (Figure 2.5). The distribution of the vegetation, as mapped by MCPL (Appendix A1), is strongly controlled by the thickness of the surficial dunal sand, which ultimately influences water availability to the vegetation. As the thickness of the dunal sand increases, the accessibility to readily available water stored in the profile decreases, and thus there is a distinct change from taller, denser Eucalypt woodland (i.e. represented by the E3 and E5 vegetation communities) to shorter, more sparse shrub vegetation characterised by the S6 and S8 vegetation communities. Within the topographic depressions, and broad flat plains (represented by SMU 3), water availability is not likely to be limiting (although vertical root growth may be limited due to the presence of consolidated calcrete), and thus these regions support more dense, and higher transpiring Eucalypt woodland vegetation.

The surficial soils generally exhibit optimal physical (i.e. 'non hard-setting', non-dispersive) and chemical (i.e. slightly acidic pH, non-saline) soil properties, such that they are unlikely to impede vegetation growth. All soils are inherently nutrient deficient; however, water availability is considered the principal driver for vegetation growth and survival, as the MRUP exists in a strongly water deficit environment where evapotranspiration greatly exceeds rainfall throughout the year.

The deeper Miocene and Eocene sediments exhibit a diverse range of textures, varying from sandy loams and sandy clays to sands. This contrasting texture results in appreciable variability in soil physical and chemical properties, and over behaviour of the material during handling and utilisation. A detailed description of the beneficial and limiting properties of these materials, and the required handling strategies to be implemented to minimise impacts on the surrounding environment, is provided in Section 15.



LEGEND

- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- SMU 1: DEEP DUNAL SANDS
- SMU 2: SANDY DUPLEX SOILS
- SMU 3: CALCAREOUS LOAMY SOILS

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

SMU AND INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 1 2 3 4 5
1:80,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-16
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SOIL DISTRIBUTION ACROSS THE MRUP

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	2.4

25mm

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

S8 VEGETATION UNIT

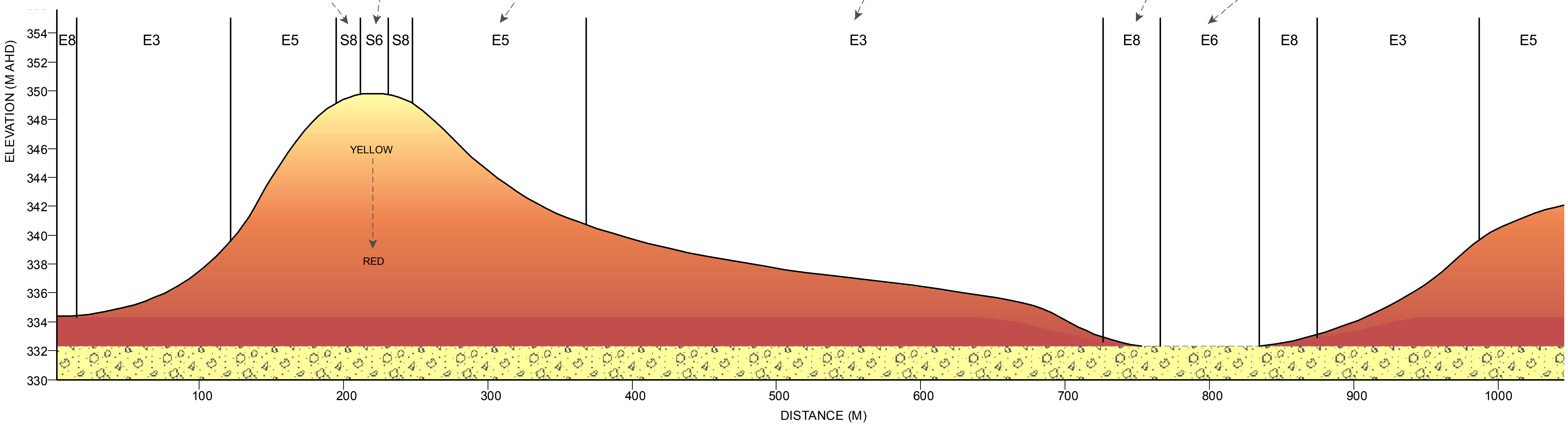
S6 VEGETATION UNIT

E5 VEGETATION UNIT

E3 VEGETATION UNIT

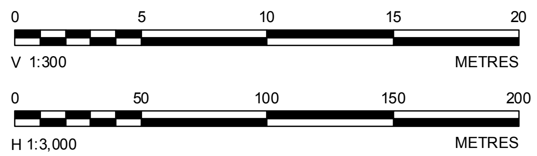
E8 VEGETATION UNIT

E6 VEGETATION UNIT



LEGEND

- DUNAL SAND
- REDDISH BROWN SANDY LOAM
- CALCRETE



CLIENT	VIMY RESOURCES LIMITED
PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT	Golder Associates
YYYY-MM-DD	2015-10-28
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR
TITLE	SOIL AND TOPOGRAPHIC VEGETATION UNIT ASSOCIATION
PROJECT NO.	1540340
CONTROL	PER
REV.	0
FIGURE	2.5

3. Stakeholder Consultation

3.1 Overview

The MRUP has been the priority Project for Vimy, and its predecessor EAMA, since 2005. EAMA undertook consultation with local stakeholders on an ongoing basis, aligning with the early exploration phase of the Project. This consultation process has continued through the pre-feasibility and environmental approvals stage of the MRUP and a record of engagement is provided as Appendix J1. A detailed MRUP Stakeholder Consultation Management Plan (SCMP) has been developed for implementation in the lead-up and during the PER public comment phase (MRUP-EMP-036). Implementation activities are currently underway.

Vimy has sought input and advice from the MRUP's neighbour Tropicana Joint Venture (operated by AngloGold Ashanti Australia) and is collaborating to contribute to shared industry improvements in infrastructure and Indigenous economic development programs. Vimy's stated 'Mission' and 'Core Values' supports an approach to stakeholder consultation which is inclusive, positive and supports sustainable development.

3.2 Consultation Objectives

Vimy's approach to consultation is based on the following objectives:

- Establish and maintain relationships with stakeholders potentially impacted by the development of the MRUP.
- Develop stakeholder knowledge and understanding of uranium mining processes, transport of uranium product (uranium oxide concentrate – UOC) and its role as a non-fossil energy source.
- Develop stakeholder knowledge and understanding regarding perceived risks to human health and non-human biota from the development of uranium mines and handling of uranium products.
- Provide an opportunity for stakeholders to put forward their queries and concerns regarding the MRUP and have them addressed by Vimy.
- Provide an opportunity for stakeholder feedback regarding the MRUP to be considered in Project design, mitigations and management procedures.

3.3 Stakeholder Identification

A comprehensive stakeholder identification process has been undertaken and consultation will continue through the public comment phase of the PER. An increasing scale of engagement is integrated with the project pre-feasibility and feasibility design stages. A summary of recent consultation activities (since 30 June 2015) is presented in Table 3.1. For earlier engagement, please refer to Appendix J1.

Table 3.1 Consultation Activities Undertaken Since June 2015

Date	Stakeholder	Topics discussed
29 October 2015	Shire of Menzies	MRUP Project update
28 October 2015	Kalgoorlie-Boulder Chamber of Commerce and Industry	'What's Down the Track' Industry Forum: MRUP update
27 October 2015	Environmental Protection Authority	MRUP PER Update
23 October 2015	AngloGold Ashanti	Community and stakeholder engagement
29 September 2015	Department of Aboriginal Affairs	Cultural heritage
23 September 2015	Department of Mines and Petroleum	MRUP update and comments on draft PER

Date	Stakeholder	Topics discussed
14 September 2015	Department of Environment Regulation and Environmental Protection Authority	MRUP update and comments on draft PER
25 August 2015	WA Minister for Environment	MRUP update
18 August 2015	AngloGold Ashanti – Tropicana site	Site-based query
6 August 2015	Aubrey Lynch (Wongatha)	Indigenous employment opportunities
6 August 2015	Linda Cook (Rick Wilson, MP, office)	MRUP update
5 August 2015	Kalgoorlie-Boulder Chamber of Commerce	MRUP update
5 August 2015	Tisala Pty Ltd (Pinjin Station)	Capacity for Tisala to provide earthworks contracting
3-5 August 2015	Diggers and Dealers Conference	Industry update to partners and investors
30 July 2015	Office of Environmental Protection Authority	MRUP update
14 July 2015	Department of Minerals and Petroleum	MRUP Update

The Stakeholder Consultation Management Plan (MRUP-EMP-036) has classified stakeholders according to the potential impacts of the MRUP on their interests or activities. The remote location of the mining activities and distance from permanent residences determines that very few stakeholders will be directly impacted by the extraction activities in the Project area itself. The transport of UOC from the processing plant on-site to the Port of Adelaide delineates a corridor of communities between Western Australia and South Australia where local residents may have an interest in the development of MRUP, with a very low level of impact anticipated on day-to-day activities. Additionally, the predicted regional economic benefits brought about by the development of a new resource in the Shire of Menzies, with opportunities for businesses in Kalgoorlie-Boulder, provides an additional group of stakeholders with an interest in its development. Finally, the contentious nature of uranium mining and ongoing global debate regarding nuclear fuel sources expands the need to engage stakeholders from a broader group – including elected officials and non-government organisations (NGOs).

Vimy's priority engagement with local and regional stakeholders prior to this submission has been with the following stakeholders:

- Wongatha people.
- Pinjin Station (operated by Tisala Pty Ltd).
- Tropicana Gold operated by AngloGold Ashanti Australia Ltd.
- Shire of Menzies.
- City of Kalgoorlie-Boulder.
- Kalgoorlie-Boulder Chamber of Commerce and Industry.
- Regulatory agencies (DMAs) with a role to review, approve and/or comment on the PER.

No pastoral stations occur within 75km of the MRUP and no native title exists over the area (Section 14).

For a complete list of the identified stakeholders, refer to the SCMP (MRUP-EMP-036).

3.4 Engagement Methods

The usual method of engagement has been face-to-face meetings and feedback sessions, supported by telephone contact and site visits with key stakeholders. Vimy has also participated in industry events and forums in Kalgoorlie-Boulder and Perth and taken part in selected media interviews regarding the Project. A register of stakeholder meetings and activities is provided as Appendix J1.

Future planned activities are further detailed in the SCMP (MRUP-EMP-036). These include a Transport Corridor Roadshow to discuss the containerised transport of ore with local government authorities and a stakeholder site visit to the Port of Adelaide to understand handling and transfer onto ships. It is also envisaged that future workshops with key community and regulatory agencies will be held, as appropriate, to convey the continued development of the MRUP.

Vimy is also preparing for the public comment period of the PER by launching and maintaining an enhanced Project website which will include:

- Summary information about the MRUP and key issues.
- Electronic copy of the full PER, once approved for public release by the EPA.
- A frequently asked questions (FAQ) regarding uranium mining and safety issues.
- Links to external resources including the DMP webpage *Uranium Mining in Western Australia* and the Minerals Council of Australia's (MCA) webpage *Australia's Uranium Industry.*

3.5 Key Issues

Key issues for stakeholders have reflected their area of interest in the Project. For example, regulatory agencies have been interested in their particular areas of responsibility (DOW, groundwater and reinjection; DPAW Sandhill Dunnart and ecological communities). These issues have been addressed through the completion of specialised studies which are reported in the PER.

In a broader community context, Vimy is aware that the following key issues will continue to drive current and future engagement with external stakeholders:

- Perceptions of safety around potential exposure to radiation (for humans and the environment) during mining, processing and transport of UOC.
- Potential environmental impacts from management and disposal of tailings following mining and processing.
- Potential impacts to local fauna from loss of habitat, due to clearing.
- Human health impacts through radionuclide dust generation and bush tucker.
- Opportunities for benefits, such as employment, training or business contracts.
- Entrenched opposition to any new uranium mines.

Vimy is confident these issues have been addressed through the completion of specialist studies for the PER. Where opportunities for local or regional benefits are possible, Vimy will work with stakeholders to maximise those benefits.

3.6 Ongoing Consultation

Future planned activities are further detailed in the SCMP (MRUP-EMP-036). These include a Transport route road trip to discuss the containerised transport of ore with local government authorities and a stakeholder site visit to the Port of Adelaide to understand handling and transfer onto ships. Vimy will invite a small group of key stakeholders to participate in the visit to Adelaide.

Vimy is also preparing for the public comment period of the PER by launching and maintaining its enhanced Project website (discussed above) and developing summary information material to support face-to-face meetings with stakeholders.

A schedule for future consultation is included as part of the Stakeholder Consultation Management Plan (MRUP-EMP-036) and is summarised as follows:

- Industry forums to discuss opportunities with business operators in the Goldfields region.
- Ongoing key stakeholder briefings (face-to-face meetings) for DMAs, LGAs, political representatives, industry representatives and Wongatha representatives.
- Open House community meeting in Kalgoorlie-Boulder.
- A stand-alone meeting for Wongatha and other traditional owners in Kalgoorlie.
- Transport road trip through LGAs where UOC will be transported.
- Site visit to Port Adelaide.

4. Socio-economic Setting

4.1 Local Setting

The Project area is located approximately 240km east-northeast of Kalgoorlie-Boulder within the Shire of Menzies and within the Goldfields-Esperance Region of Western Australia. It is located on the western flank of the Great Victoria Desert (GVD) in an area that was traditionally too arid, with insufficient water sources, to support any form of permanent settlement. There are no local communities located within 100km of the Project area; the closest town is Laverton which is approximately 200km to the northwest.

The closest residences (as shown in Figure 4.1) are:

- Pinjin Station Homestead – approximately 100km to the west.
- Coonana Aboriginal Community – approximately 130km to the south-southwest.
- Kanandah Station Homestead – approximately 150km to the southeast.

The Pinjin Pastoral Lease is held by Tisala Pty Ltd, an Aboriginal company which owns and operates the lease. The Coonana Aboriginal Community is understood to have only one occupied household as previous residents have relocated to other communities or to regional centres, such as Kalgoorlie-Boulder. Kanandah Station, on the Nullarbor Plain, is operated by the Forrester family and runs cattle.

There is mining activity in the area. The closest mines sites are:

- Tropicana Gold Mine – approximately 110km to the northeast.
- Sunrise Dam Gold Mine – approximately 140km to the northwest.

Tropicana is a joint venture between AngloGold Ashanti Australia Ltd (70% and manager) and Independence Group NL (30%) through the Tropicana Joint Venture (Tropicana Joint Venture 2015). It was opened in March 2014 and is anticipated to have an 11-year mine life. Sunrise Dam Gold Mine is also operated by AngloGold Ashanti Australia. In addition to these existing mine operations, the eastern margin of the Yilgarn, and adjacent Eucla Basin Eocene shorelines, incorporating the Albany-Fraser Belt, are a highly prospective mineral resource region with numerous proposed uranium, gold and mineral sands deposits.

The Shire of Menzies local government area (LGA) extends to 125,000 sq km and has a total population of 384 people (Australian Bureau of Statistics (ABSa 2011). Almost half the population in this LGA are identified as Australian Aboriginal (43.6%) and the Central Desert Indigenous languages of Pitjantjatjara, Ngaanyatjarra and Wangkatha are the most common to be spoken other than English. Only 131 (34%) people reported being in the labour force at the last Census, with 49.6% of those people employed full-time, compared to 60.7% of working West Australians who were employed full-time. Of those working in Menzies, most were employed as labourers and machinery operators or drivers. The town of Menzies has some areas of non-indigenous historical significance due to its history as a gold rush town. In more recent years, it has attracted tourists as the destination point for viewing the Antony Gormley sculptures installed at Lake Ballard. The sculptures were created from laser scans of Menzies residents as part of the Perth International Arts Festival in 2003 (Shire of Menzies 2015).

The Shire of Laverton has a population of 1,227 people and covers almost 180,000 sq km. Census data showed there was a higher rate of employment than Menzies with 72.9% of working people employed full-time. The majority of workers were employed as machinery operators and drivers, technicians or trade workers and labourers. Most were employed in metal ore mining (41.9% of people employed and aged 15 years and over) (ABSb 2011).

4.1.1 Land Use

The only use for land in the MRUP area is for mining and mining related purposes. The arid climate and absence of suitable quality surface or groundwater, restricts land uses and no pastoral activities are active within the area. Ethnographic surveys did not highlight any currently active use of the area for traditional purposes (Section 14).

There are no areas of conservation significance within 20km of where mining and related activities will take place. The closest areas of conservation significance (as shown in Figure 4.1) are:

- Queen Victoria Spring Nature Reserve – is approximately 30km to the south.
- Plumridge Lakes Nature Reserve – is approximately 80km to the northeast.

4.1.2 Native Title Rights

There are no registered or unregistered native title claims over land within the proposed MRUP. Ethnographic surveys were undertaken by Wongatha people (both a men's group and a women's group separately). These surveys confirmed earlier findings that there were no known ethnographic sites in the area (Section 14).

4.2 Regional Setting

Kalgoorlie-Boulder is the nearest significant urban centre in the region of the proposed MRUP. The City of Kalgoorlie-Boulder has a population of more than 30,000 people, including many who are employed in the mining sector. Support industries and contractors (such as technicians and trades) are also based in Kalgoorlie-Boulder. Employment rates are high, with 70.2% of workers employed in full-time positions. This compared to a WA rate of 60.7% (ABS 2011c). Industry groups, such as the Kalgoorlie-Boulder Chamber of Commerce and Industry (KBCCI), support the development of local business partnerships and promote local capacity for business and contracting. As such, Kalgoorlie-Boulder provides a potential source of employees, contractors and suppliers during construction and operations for MRUP.

4.3 Transport Route

Vimy proposes to transport UOC by road from MRUP to the Port of Adelaide, which is licenced to receive and ship Class 7 Dangerous Goods. The product will be packaged in sealed steel drums which will be loaded and secured, by a specialised webbed Kevlar-based strapping system, into 20-foot ISO sea freight containers and then onto road trains. Transport of the UOC is governed by the Uranium Council (2012) document *Guide to Safe Transport of Uranium Oxide Concentrate*, and documented in the Transport Radiation Management Plan (MRUP-EMP-022). UOC is a low volume product and as such, it is anticipated that the MRUP will generate an average of one truck movement carrying UOC away from the site per week. The proposed transport route (Figure 4.2) is 2,450km long and will traverse through the following LGAs in Western Australia:

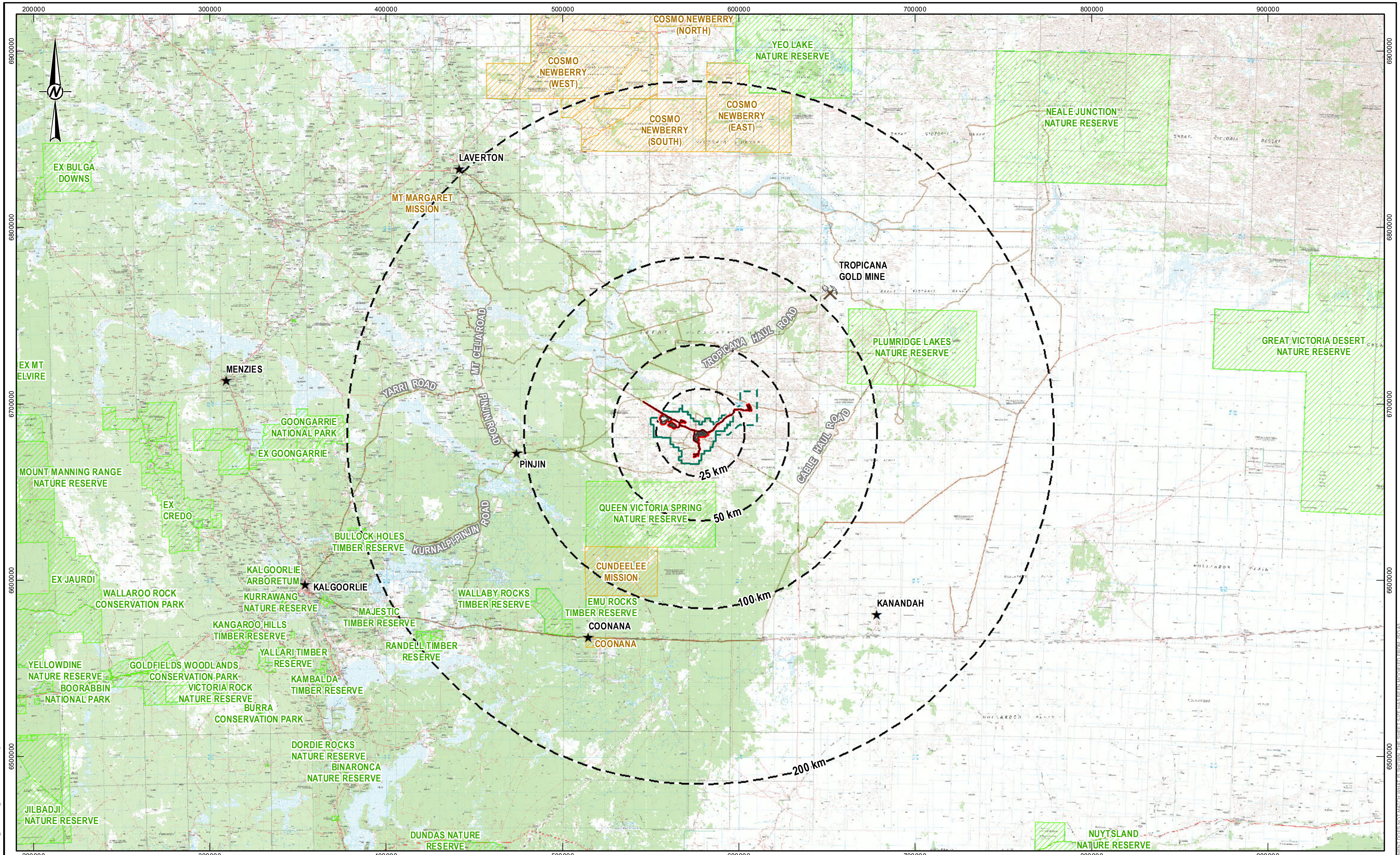
- Shire of Menzies.
- City of Kalgoorlie-Boulder.
- Shire of Coolgardie.
- Shire of Dundas.

In South Australia the LGAs will be:

- Outback Communities Authority.
- District Council of Ceduna.
- District Council of Streaky Bay.

- District Council of Wudinna.
- District Council of Kimba.
- Port Augusta City Council.
- District Council of Mount Remarkable.
- Port Pirie Regional Council.
- Wakefield Regional Council.
- District Council of Mallala.
- City of Playford.
- City of Salisbury.
- City of Port Adelaide Enfield.

Consultation with stakeholders along the transport route is described in Vimy's Stakeholder Consultation Management Plan (MRUP-EMP-036).



LEGEND

- TROPICANA GOLD MINE
- TOWN
- MRUP RADIUS
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- CONSERVATION RESERVE
- ABORIGINAL LAND TRUST ESTATE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
IMAGE SOURCED FROM GEOSCIENCE AUSTRALIA 250K TOPO

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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-28
DESIGNED	MS
PREPARED	MS
REVIEWED	CWC
APPROVED	CWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
DISTANCE FROM MRUP TO NEARBY COMMUNITIES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	4.1

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25mm

LEGEND

- TROPICANA GOLD MINE
- TOWN
- PROPOSED TRANSPORT ROUTE
- MRUP DEVELOPMENT ENVELOPE
- LOCAL GOVERNMENT AUTHORITY (LGA) BOUNDARY

NOTES

1. COORDINATE SYSTEM: GCS GDA 1994

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
IMAGE SOURCED FROM GEOSCIENCE AUSTRALIA 250K TOPO

0 50 100 150 200 250
1:5,000,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-28
DESIGNED	MS
PREPARED	MS
REVIEWED	CWC
APPROVED	CWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
PROPOSED PREFERRED URANIUM OXIDE CONCENTRATE TRANSPORT ROUTE

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	4.2

5. Project Description

5.1 Proposal Overview

The MRUP lies approximately 240km east-northeast of Kalgoorlie-Boulder in the Shire of Menzies. The Project will involve the open pit mining of four poly-metallic deposits with commercial grades of contained uranium hosted in carbonaceous material. The Project comprises two distinct mining centres, Mulga Rock East (MRE), containing the Princess and Ambassador deposits, and Mulga Rock West (MRW), containing Emperor and Shogun deposits. MRE and MRW are approximately 20km apart. Processing will be undertaken onsite at a central mill adjacent to the Princess deposit.

The MRUP area is remote and covers an area of 102,000ha of dune fields within granted mining tenure (primarily M39/1080 and M39/1081) within Unallocated Crown Land (UCL) on the western flank of the Great Victoria Desert, comprising a series of large, generally parallel sand dunes, with inter-dunal swales and broad flat plains. Access to the Project area is limited and is only possible using four wheel drive vehicles. The nearest residential town to the Project is Laverton which is approximately 200km to the northwest. Other regional residential communities include Pinjin Station homestead, located approximately 100km to the west; Coonana Aboriginal Community, approximately 130km to the south-southwest; Kanandah Station homestead, approximately 150km to the southeast and the Tropicana Gold Mine approximately 110km to the northeast of the Project (refer to Figure 4.1).

Up to 4.5 Million tonnes per annum (Mtpa) of ore will be mined using traditional open cut techniques, crushed, beneficiated, and then processed at an onsite acid leach and precipitation treatment plant to produce, on average, 1,360 tonnes of uranium oxide concentrate (UOC) per year over the life of the Project. The anticipated Life-of-Mine (LOM) is up to 16 years, based on the currently identified resource.

The drummed UOC will be transported by road from the minesite in sealed sea containers to a suitable port, approved to receive and ship Class 7 materials (expected to be Port Adelaide), for export. Other metal concentrates (copper (Cu), zinc (Zn), nickel (Ni) and Cobalt (Co)) will be extracted using sulphide precipitation after the uranium has been removed and sold separately.

The Project will require clearing of vegetation, mine dewatering and reinjection, creation of overburden (non-mineralised) landforms (OLs), construction of onsite processing facilities and waste management systems. Major built infrastructure will include a processing plant, ROM ore stockpile areas, construction of above-ground OLs for non-mineralised mined materials, an initial short term above-ground tailings storage facility (TSF) and water storage facilities. Once sufficient void space has been created, tailings will be deposited back into the unlined pit(s) and capped with non-mineralised waste rock and the pit surface will then be rehabilitated. Rehabilitation of disturbed areas will be undertaken in accordance with an approved Mine Closure Plan (MCP).

Required project infrastructure will include mine administration and workshop facilities, fuel and chemical storage, a diesel or gas (LNG) fired power plant of up to 20 megawatt (MW) capacity, a brackish water extraction borefield and mine dewatering water reinjection borefield and associated pipelines and power supply, an accommodation village for a fly-in fly-out workforce, an airstrip, laydown areas and other supporting ancillary infrastructure such as communication systems, roads, waste water treatment plant and solid waste landfill facilities. Transport to site for consumables, bulk materials and general supply items will be via existing public road systems linked to dedicated project site roads.

At completion of operations the site will be decommissioned and rehabilitated in accordance with an approved MCP.

5.2 Key Characteristics

The key characteristics of the Proposal are shown in the tables below.

A summary of the Proposal is provided in Table 5.1, with key physical and operational characteristics of the Proposal summarised in Table 5.2 and Table 5.3. The location of most of the MRUP physical and operational components is indicated in Figure 1.2 to Figure 1.4. However, the location of some of the Project infrastructure within the Development Envelope such as the remote area power station and waste management facilities, including wastewater treatment plant and landfill, is yet to be determined.

Table 5.1 Proposal Summary

Summary of the Proposal	
Proposal Title	**Mulga Rock Uranium Project**
Proponent Name	**Vimy Resources Limited**
Short Description	This Proposal is to develop four poly-metallic deposits containing commercial concentrations of uranium and to produce uranium oxide concentrate and other metal concentrates for sale. The Proposal includes: • Open cut pits, mine dewatering and reinjection infrastructure. • Non-mineralised overburden landforms (OLs). • ROM stockpile areas. • Transport corridors through which ore will be pumped in pipelines to a central processing facility and oversized material will be trucked. • Central processing plant including an above-ground TSF and process water storage facilities. • Long term tailings storage in mine voids followed by backfilling with non-mineralised overburden. • A water extraction borefield and associated pipelines and power supply. • A reinjection borefield and associated pipelines. • Associated infrastructure including offices, maintenance workshops, laydown areas, ancillary infrastructure (e.g. communications systems, wastewater treatment plant, solid waste landfill, etc.), accommodation facilities and airstrip. • Mine roads and fuel and chemical storage. • Up to 20MW diesel or gas (LNG) fired power station.

Table 5.2 Physical Elements

Element	Proposed Extent
Open cut pits and dewatering infrastructure	Clearing of up to 2,374ha of native vegetation within a 9,998ha Development Envelope.
Reinjection infrastructure – borefield and pipelines	Clearing of up to 18ha of native vegetation within a 9,998ha Development Envelope.
Overburden landforms and soil stockpiles	Clearing of up to 937ha of native vegetation within a 9,998ha Development Envelope.
Roads, borrow pits and services including corridor for slurry pipelines	Clearing of up to 143ha of native vegetation within a 9,998ha Development Envelope.
Processing plant, ROM stockpiles and administration buildings	Clearing of up to 41ha of native vegetation within a 9,998ha Development Envelope.
Extraction borefield and supporting infrastructure	Clearing of up to 27ha of native vegetation within a 9,998ha Development Envelope.

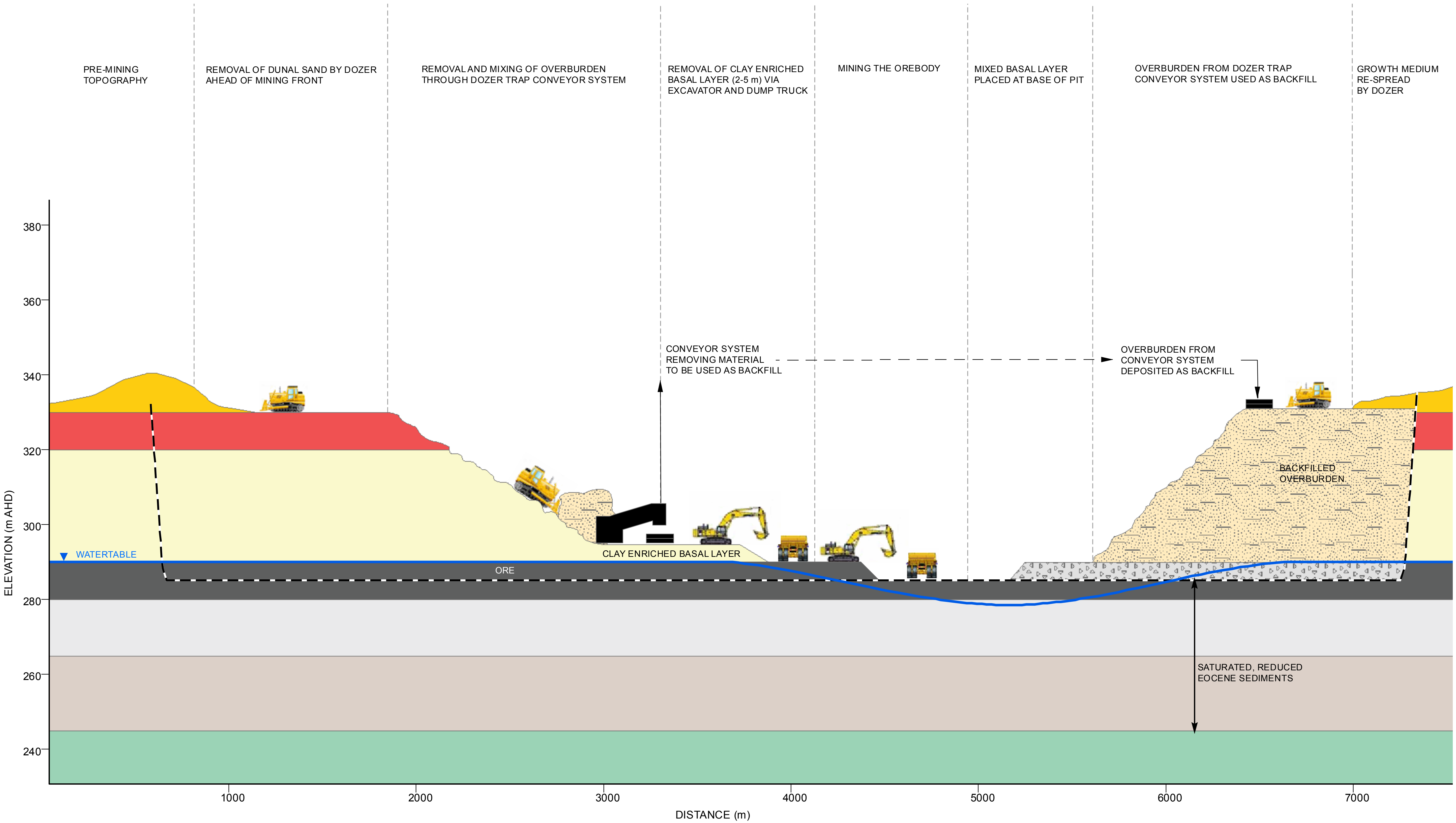
Element	Proposed Extent
Accommodation village	Clearing of up to 7ha of native vegetation within a 9,998ha Development Envelope.
Above-ground TSF	Clearing of up to 106ha of native vegetation within a 9,998ha Development Envelope.
Miscellaneous disturbance area (including power generation and reticulation and laydown associated with construction)	Clearing of up to 18ha of native vegetation within a 9,998ha Development Envelope.
Airstrip	Clearing of up to 38ha and disturbance of up to 78ha of native vegetation within a 9,998ha Development Envelope.

Table 5.3 Operational Elements

Element	Proposed Extent
Water abstraction for process water and domestic supply	At this stage, operational demand will require extraction of up to 3 Gigalitres per annum (GL/a) of groundwater. The final volume to be extracted will depend on the availability for reuse of suitable quality water from mine dewatering.
Mine dewatering and reinjection infrastructure	Dewatering to allow mining varies over LOM. Extraction estimated up to 2.5GL/a, with surplus water reinjected into down gradient paleo-aquifer system.
Power supply	Up to 20MW to be supplied by a small remote area diesel or gas (LNG) fired power station. Borefield and pumping stations – options being considered include mine grid power or small dedicated diesel generators.
Overburden disposal	Up to 60Mtpa (with an average of 40-45Mtpa over LOM).
Waste materials from ore processing and beneficiation rejects disposal	Up to 3Mtpa of beneficiation rejects and up to 2Mtpa of post-leaching tailings material.
Surplus mine dewatering water reinjection	Injection of up to 1.5GL/a of surplus mine dewatering not used in processing or for dust suppression purposes.
Waste management – wastewater and solid wastes	Sufficient to accommodate a workforce of around 315 people.

5.3 Mining Method

Due to the large lateral extent and horizontal geometry, the MRUP deposits lend themselves to open cut strip mining techniques, allowing the pits to be progressively backfilled at the same time that the deposits are mined. It will be necessary to backfill pits in stages to optimise the placement of growth medium and overburden from the mining front and avoid double handling where possible. A conceptual diagram of the proposed mining method, including internal management of soil and overburden materials, is contained in Figure 5.1.



LEGEND

- PROPOSED MINE PIT
- QUATERNARY SEDIMENTS
- MIOCENE SEDIMENTS
- OXIDISED EOCENE SEDIMENTS
- U-ENRICHED LIGNITE, CLAY, SILT
- REDUCED EOCENE SEDIMENTS
- HIGH PERMEABILITY BASAL SAND
- PERMIAN SEDIMENTS (BASEMENT)
- MIXED BASAL OVERBURDEN & BENEFICIATED SAND PREFERENTIALLY PLACED AT BASE OF PIT
- MIXED MIOCENE AND OXIDISED EOCENE SEDIMENTS

0 10 20 30 40 50
V 1:1,000 METRES

0 200 400 600 800 1,000
H 1:20,000 METRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
PROPOSED MINING OF THE MINE PITS AND INTERNAL MANAGEMENT OF SOIL AND OVERBURDEN MATERIALS

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	5.1

The growth medium will be progressively stripped from the surface of pits ahead of the mining front using both truck and shovel and dozer methods. This material will either be stockpiled around the edge of pits to be reinstated later on top of backfilled pit voids or be used for capping OLs.

Pits will be initiated with the truck and shovel excavation of an initial slot to expose the ore, with the overburden placed in an overburden landform (OL) adjacent to the initial slot. This OL will remain as it is not practicable to return it to the pit for backfilling. After mining the ore exposed by the first slot, a pit void is created approximately 200-300m in length. At this point a dozer trap and conveyor waste handling system is installed to progress the mining front and convey the overburden to backfill the mined out section of the pit (initial slot). The backfilling of the pit progresses along the strike length at a similar rate as the mining front (dozer trap) progresses. In some cases, smaller satellite pits which are not large enough for a dozer trap system will be mined with conventional truck and shovel (AMEC Foster Wheeler 2015).

Following the development of the starter pit, semi-mobile dozer traps and an extensive conveyor system will be used to remove the majority of overburden material (down to the kaolinite layer directly above the ore) to backfill mining voids. Truck and shovel will then be used to remove the kaolinite layer immediately above the ore (this cannot be mined via the dozer trap due to its material strength) and then the ore itself. The kaolinite material will be preferentially backfilled in each mining void. The mining methods will mix the relative similar Miocene and oxidised Eocene sediments and these will be backfilled (using the dozer trap system) to the proposed final reconstructed post-mine land surface.

At the completion of mining all pits will be either fully backfilled (tailings or overburden) or partially backfilled to 10m above the water table. The waste from the satellite pits will be either placed within an OL located outside the pit or be used to backfill the void resulting from the vacated dozer trap. Either way, it is not possible to completely backfill all pits, as voids will remain at the completion of mining of each deposit. Subsequently, there will be three final pit types as described below:

- Fully backfilled pits. These pits will be backfilled to the natural surface with either tailings or overburden or a combination. The backfilling will be progressive.
- Partially backfilled pits. These pits will be backfilled to not less than 10m above the water table. The backfilling will be progressive.
- Combination backfilled pits. These pits will have sections completely backfilled with remaining sections backfilled to not less than 10m above the water table. The backfilling will be progressive.

Where pit backfilling occurs, dozers will be used to push stockpiled growth medium a nominal distance of 100m from the pit edge where it has been stockpiled. This method will reinstate an existing landform of undulating sand rises intervened with clayey-sandplains. This landform is found across each proposed mining pit. Growth medium will be used for capping and rehabilitation of OL.

For the partially backfilled pits, stockpiled growth medium will be pushed across the slopes to the edge of the clayey-sandplain base.

For OLs, the design is anticipated to be approximately 30m high (RL 360), which is approximately 16m above the height of the local dunes (RL 344) but approximately 10m lower than the highest regional dunes several kilometres to the south. The OL will be constructed in three 10m lifts which will be reshaped to a nominal 12 degree slope (10 to 15 degrees). It is acknowledged that wind erosion under the prevailing climatic conditions plays an important role in shaping the current dunal landscape and the final design may alter depending on the results of trials undertaken.

5.4 Processing

5.4.1 Beneficiation Plant

Run of mine (ROM) ore feed is initially crushed and then conveyed from the pit to a semi-mobile beneficiation plant. At the beneficiation plant, the crushed ore will be pulped in a log washer to fully liberate the fine carbonaceous clay material from the coarse sands. The resulting slurry is screened at 2mm and the coarse oversized material stacked in a stockpile to be trucked to the main process plant where it will be fed to a semi-autogenous grinding mill. The <2mm slurry is then de-slimed at 0.045mm and the resulting fines, which are high in uranium are sent to the main process plant.

The mid-size fraction (<2mm >0.045mm) representing approximately 75% of the initial ROM feed, is then beneficiated using a two-stage spiral gravity circuit. The coarse grained sands and gravels are generally non-mineralised waste and so removal of this material results in an upgrade of the plant feed. The light carbonaceous material is separated from the heavy coarse sand fraction and the resulting sand fraction from the spiral circuit is pumped to the pit void, where it is dewatered and stacked as back fill in the pit. The final beneficiated slurry is then pumped to the mill at the main process plant (AMEC Foster Wheeler 2015).

5.4.2 Main Process Plant

MRUP uranium mineralisation is unique in that it is either present as adsorbed uranium onto the surface of the carbonaceous material in its oxidised form, or as ultra-fine (nanometre scale) uraninite grains (UO_2). This means acid can be used to simply desorb the uranium from the carbonaceous ore before resin beads are used to selectively extract uranium from solution.

The main process plant will receive beneficiated ore from the mine and then grind this feed to 80% passing a size of 150µm using a mill circuit. The milled ore is then leached for 4 hours at 40°C using sulphuric acid at an addition of 30kg acid per tonne of leach feed. Uranium is typically leached within 1-2 hours and shows very fast kinetics.

The leach discharge is then pumped to a resin-in-pulp (RIP) circuit where the slurry is contacted with an ion-exchange resin to recover the uranium present in solution. The RIP circuit has eight contact stages and is analogous to a gold carbon-in-pulp circuit except resin is used instead of activated carbon.

Uranium-loaded resin is then recovered and uranium stripped from the resin using a sodium chloride solution. The strip solution, which now contains the uranium, is further concentrated and then precipitated using concentrated caustic to generate a sodium diuranate (SDU) precipitate. The SDU precipitate is then re-dissolved using sulphuric acid and precipitated from solution using hydrogen peroxide to generate a final uranyl peroxide or "yellowcake" product. The final uranium product is washed, filtered, dried and packaged in steel drums ready for transport.

The slurry from the uranium RIP circuit has no recoverable uranium remaining but is further processed to recover the base metals still in solution. The uranium-barren leach solution is recovered using a counter current decantation circuit. The solution is neutralised to pH ~4.0 using lime. A gypsum precipitate containing iron, aluminium and other impurities is removed and sent to tails. The purified base metal solution is then contacted with sodium sulphide to produce separate copper-zinc and nickel-cobalt mixed sulphide precipitates. These products are thickened, filtered, washed and packaged in to 2 tonne bulk bags for final sale (AMEC Foster Wheeler 2015).

A schematic of the proposed process is contained in Figure 5.2.

5.5 Schedule

The LOM schedule, shown in Figure 5.3, has been generated to maintain a uranium production rate of 3 Million pounds (Mlb) of uranium oxide (U_3O_8) per annum by varying the amount of ore delivered to the mill. In Years 1 to 7, the feed grade is at, or better than, the design nameplate feed grade of 600ppm U_3O_8. From Year 8 onwards, the average feed grade decreases and therefore to accommodate for the additional ROM feed, an incremental expansion will be necessary in Year 7.

Once all environmental and other approvals have been obtained, Vimy will initiate the detailed design process. Project implementation will only commence following financial closure. It is expected that production will commence approximately 18 months after financial closure is achieved.

It is anticipated that some further 'investigation works' (designed to inform the design and planning of the Proposal) will need to be undertaken prior to approval being granted. It is also anticipated that some 'minor or preliminary works' (works associated with the implementation of the Proposal, but not of sufficient scale so as to compromise the EPA's assessment or the Minister's future decisions) will be beneficial to the timely implementation of the Project.

5.6 Resources

5.6.1 Uranium Overall Resource Estimate

A summary of the total Mineral Resource estimate for the MRUP is shown in Table 5.4. This information is extracted from ASX announcement entitled "Significant Resource Upgrade for Mulga Rock Uranium Project" released on 20 April 2015. MRUP has a total resource estimate of 65.6Mt at 520ppm U_3O_8 for a contained 75.0Mlbs U_3O_8. Approximately one third of the total resource is in the indicated category.

Table 5.4 Mulga Rock Uranium Project Total Resource – 20 April 2015

Deposit / Resource	Classification	Cut-off Grade (ppm U_3O_8)[5]	Tonnes (Mt)[4]	U_3O_8 (ppm)[5]	U_3O_8 (Mlb)
Princess[1]	Indicated	200	1.3	690	1.9
Princess[1]	Inferred	200	2.5	380	2.1
Ambassador[3]	Indicated	200	13.2	750	21.7
Ambassador[3]	Inferred	200	16.1	460	16.3
Sub-Total			**33.1**	**580**	**42.0**
Emperor[2]	Inferred	1500	28.4	450	28.1
Shogun[2]	Inferred	150	4.1	550	4.9
Sub-Total			**32.5**	**460**	**33.0**
Total Resource			**65.6**	**520**	**75.0**

1. Princess Resource estimate was reviewed by Coffey Mining and announced to the ASX on 18 December 2014.
2. Emperor and Shogun estimates were prepared by Coffey Mining and initially disclosed to the ASX on 13 January 2009 under the JORC Code 2004. They have subsequently been reviewed by Coffey Mining and re-released to the ASX on 18 December 2014 in accordance to the JORC Code 2012.
3. Ambassador Resource estimate was reviewed by Coffey Mining and announced to the ASX on 20 April 2015.
4. t = metric dry tonnes; appropriate rounding has been applied.
5. Using cut combined U_3O_8 composites (combined chemical and radiometric grades).

5.6.2 By-products Resource Estimates

The Ambassador and Princess deposits also contain a base metal (BM) resource. BM mineralisation is associated with uranium but also occurs outside the boundaries of the uranium resource. BMs will be recovered as part of the processing of the uranium ore. However, since the economic extraction of BM independently of uranium is unlikely at this time, the BM resource estimate reported in Table 5.5 represents only the BM mineralisation found inside the boundaries of uranium resource. The Princess and Ambassador BM resources are provided in Table 5.5.

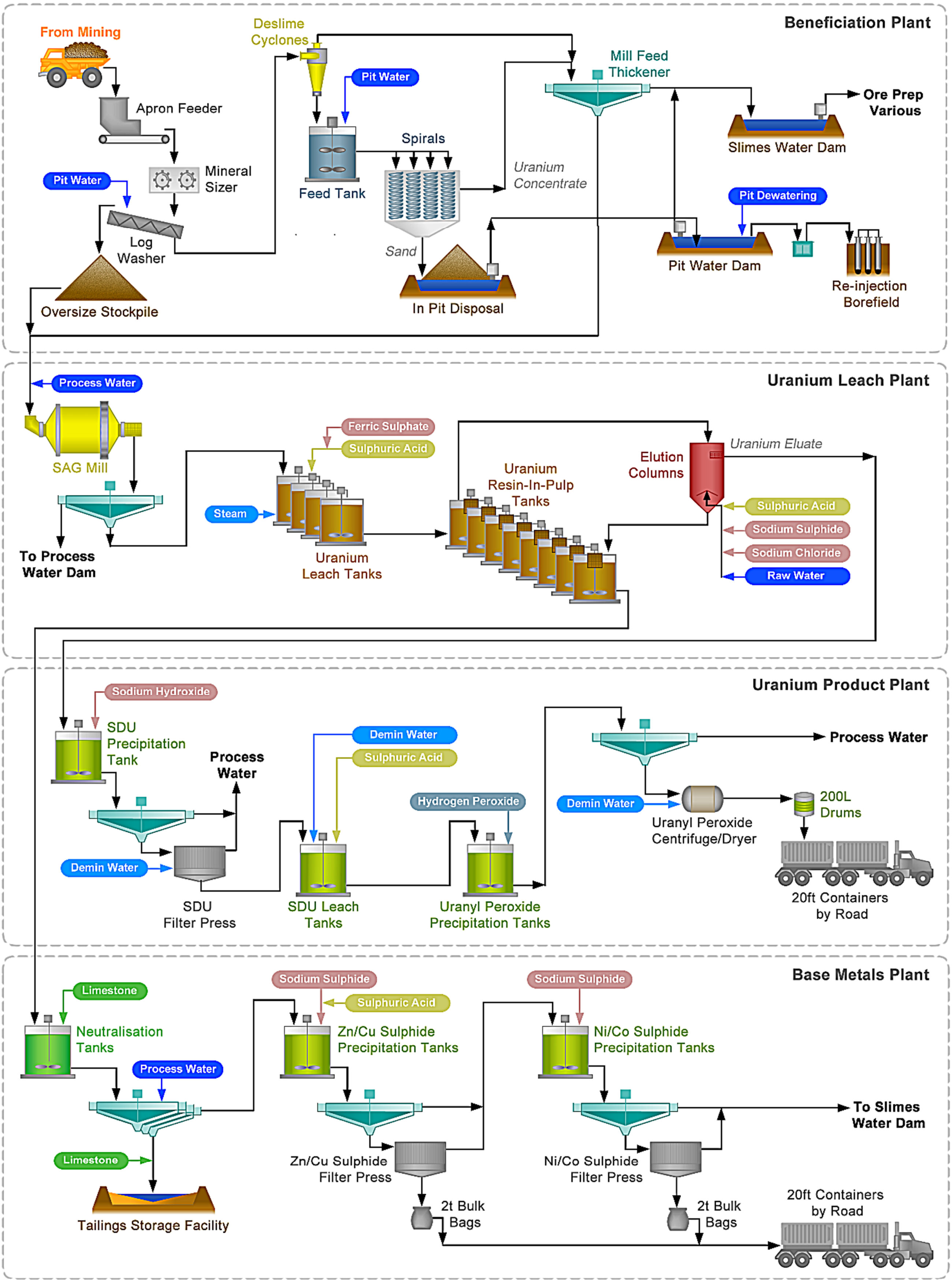
Previous explorers did not assay for BM during previous drilling at the Emperor and Shogun deposits and therefore no BM resource estimation can be determined for these deposits at this stage. Future drilling at Emperor and Shogun will investigate this, although the geology is very similar to the Princess and Ambassador deposits. If similar BMs are present, Vimy expects to determine a BM resource at Emperor and Shogun based on the same assumptions, and applying the BM flow-sheet developed for Princess and Ambassador.

Table 5.5 Base Metal Resource – Mulga Rock Uranium Project

Deposit / Resource	Tonnes (Mt)	Cu (ppm)[1]	Zn (ppm)[1]	Ni (ppm)[1]	Co (ppm)[1]
Princess – Indicated	1.3	750	1280	440	210
Princess – Inferred	2.5	270	500	250	140
Ambassador – Indicated	13.0	340	1350	600	250
Ambassador – Inferred	15.1	170	320	300	160
Total (or average grade)	**31.9**	**270**	**790**	**420**	**200**

Deposit / Resource	Classification	Cu (kt)	Zn (kt)	Ni (kt)	Co (kt)
Princess	Indicated	0.9	1.6	0.6	0.3
Princess	Inferred	0.7	1.3	0.6	0.4
Ambassador	Indicated	4.4	17.5	7.8	3.3
Ambassador	Inferred	2.6	4.8	4.6	2.4
Total		**8.6**	**25.2**	**13.6**	**6.4**

1 The base metal resource is contained wholly within the uranium resource. It is reported using the same cut-off grade of 200ppm U_3O_8 with no additional base metal grade cut-offs applied.



CLIENT
VIMY RESOURCES LIMITED

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

TITLE
PROPOSED PROCESS FLOWSHEET

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	5.2

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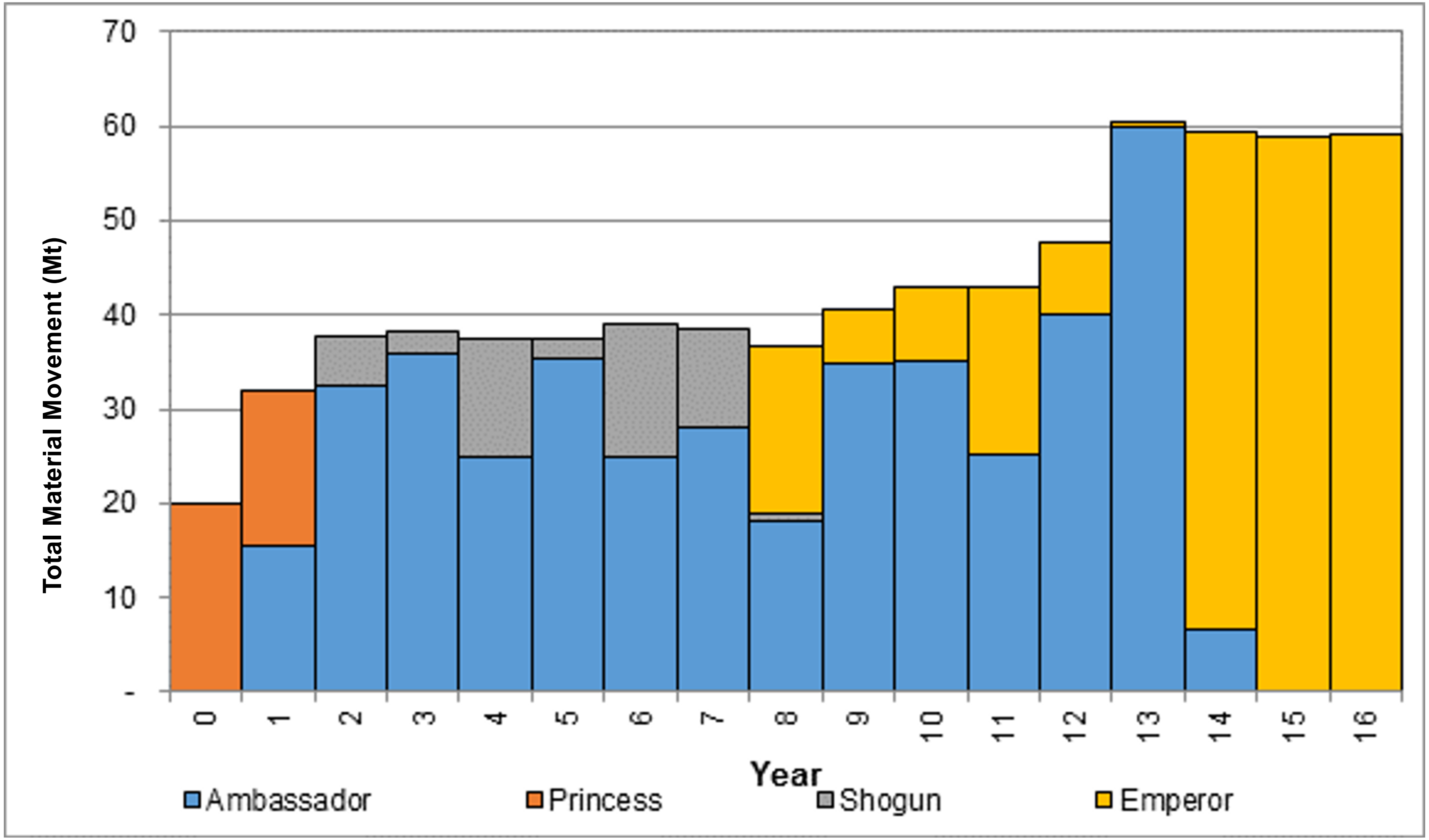

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT	YYYY-MM-DD	2015-11-16	TITLE **MINE SCHEDULE**
Golder Associates	DESIGNED	MS	
	PREPARED	MS	
	REVIEWED	DCR	
	APPROVED	DCR	

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**5.3**

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6. Flora and Vegetation

6.1 Relevant Environmental Objectives, Legislation, Policies and Guidelines

6.1.1 EPA Objective

The Environmental Protection Authority (EPA) applies the following objectives to the assessment of proposals that may affect flora and vegetation:

To maintain representation, diversity, viability and ecological function at the species, population and community level.

6.1.2 Regulatory Framework

6.1.2.1 Applicable Legislation

The protection of flora and vegetation is covered by the following statutes:

- *Wildlife Conservation Act 1950 (WA) (WC Act).*
- *Environmental Protection Act 1986 (WA) (EP Act).*
- *Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act).*

6.1.2.2 Applicable Guidance and Position Statements

The following EPA position and guidance statements set the framework for identification and assessment of impacts to flora and vegetation:

- EPA December 2000, EPA Position Statement No. 2 – Environmental Protection of Native Vegetation in Western Australia – Clearing of Native Vegetation, with particular reference to the Agricultural Area.
- EPA March 2002, EPA Position Statement No. 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection.
- EPA June 2004, EPA Guidance Statement No. 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia.
- EPA December 2003, EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.

6.1.2.3 Others

Consideration was also given to the following:

- ARPANSA 2014, Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Technical Report 167 – A review of existing Australian radionuclide activity concentration data in non-human biota inhabiting uranium mining environments.
- DEWHA 2008, Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Approved Conservation Advice – Ooldea Guinea-flower (*Hibbertia crispula*) Canberra, ACT .
- EPA 2012, Checklist for documents submitted for EIA on terrestrial biodiversity from Appendix 2 of the EPA's Draft Environmental Assessment Guideline No. 6 on Timelines for Environmental Impact Assessment of Proposals.
- In relation to offsets:

- DSEWPaC 2012, Department of Sustainability, Environment, Water, Population and Communities (EPBC Act Environmental Offsets Policy, Canberra, ACT .
- Government of Western Australia 2011, Environmental Offsets Policy, Perth, Western Australia.
- Government of Western Australia 2014, Environmental Offsets Guidelines, Perth, Western Australia.

6.2 Existing Environment

6.2.1 Geology and Soils

The Proposal area occurs within an area traditionally defined as the Helms Botanical District, but more recently classified as occurring within the Shield subregion (GVD1) of the Great Victoria Desert bioregion (Barton and Cowan 2001). Geologically, the survey area lies within the Officer Basin and is characterised by quaternary sandplain over Cenozoic, Mesozoic and Permian rocks (Beard 1990). Sandplains with patches of seif (longitudinal) dunes running east-west are characteristic of this region (Barton and Cowan 2001). Parts of the region have a duricrust surface comprised of silicon oxide (Shephard 1995). Soils between the dunes are characterised by shallow earthy soils overlying red-brown hardpan, and other soils are red earthy sands or red-brown sands of the dunes (Beard 1990). Two soil units occur in the MRUP area with the dominant soil unit being AB47, described as plains and dunes with longitudinal and ring dunes with interdune corridors and plains and the occasional salt pan. Soil unit My99 also occurs in the MRUP area and is described as plains with extensive gravel pavements and small tracts of longitudinal dunes (Northcote *et al.* 1968). Detailed investigation of MRUP soils verified this, and identified that sand dunes represent <10% of both the Development Envelope and Disturbance Footprint, with the remaining flat (or plain) area consisting of a deep sandy duplex (60-75% of the area) and calcareous topographic lows (20-30%) (Figure 2.4) (Appendix H2).

6.2.2 Vegetation

Under the Interim Biogeographic Regionalisation for Australia (IBRA) characterisation, the Project area corresponds to ‘Pre-European Vegetation Association 84’, within the GVD1 Shield IBRA subregion (Government of Western Australia 2013) (Figure 6.1). This vegetation is described as Aeolian sandplains dominated by *Triodia basedowii* (Lobed Spinifex) with mainly mallees over Hummock Grassland. Scattered *Eucalyptus gongylocarpa* (Marble Gum) and *Callitris* (Cypress-Pine) occur on the deeper sands, whilst Mulga (*Acacia aneura*) Woodlands occur mainly on colluvial and residual soils (Barton and Cowan 2001). Halophytes (such as Samphires) occur on salt lake margins and saline drainage areas in the region.

6.2.3 Threatened and Priority Ecological Communities

There are no Threatened Ecological Communities (TECs), as defined by the EPBC Act or the EP Act (DoE 2015, DPaW 2014), known to occur in, or near to, the MRUP area. There is one Priority 3ii ecological community that is likely to occur in the area and it is described as the ‘Yellow Sand Plain Communities of the Great Victoria Desert’ containing very diverse mammalian and reptile fauna, with distinctive plant communities’ (DPaW 2014) (Figure 6.2). The conservation category defines the PECs as ecological communities identified as threatened, but not listed as TECs. These communities are under threat, but there is insufficient information available concerning their distribution to make a proper evaluation of their conservation status. The category P3ii is further defined as a community known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (DPaW 2014).

6.2.4 Climate

The climate of the Helms Botanical District is arid with rain during summer and winter, receiving approximately 200mm of rainfall annually. Rainfall is unpredictable and highly variable. Onsite temperatures range from an average of 4 to 14°C in July to 17 to 37°C in January (Figure 2.1 and Figure 2.2).

6.3 Surveys and Investigations

The flora and vegetation of the MRUP has been intensively surveyed, with 13 field trips from 2007-2015 (Table 6.1). All field surveys were conducted in accordance with methods outlined in *Guidance for the Assessment of Environmental Factors – terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia, No. 51* (EPA 2004). All botanists held valid collection licences to collect flora for scientific purposes, issued under the WC Act.

Table 6.1 Vegetation Surveys of the MRUP Area

Year	Date	Number of MCPL Field Personnel	Survey Type	
2007	20-24 August	2	Reconnaissance	Level 1
2008	18-24 February	4	Mapping	Level 1
2008	8-12 December	2	Mapping & targeted surveys	Level 2
2009	17-23 August	4	Mapping & targeted surveys	Level 2
2009	14-18 September	4	Mapping & targeted surveys	Level 2
2009	9-13 November	1	Targeted survey	Level 2
2010	18-23 March	4	Mapping & targeted surveys	Level 2
2010	22-28 May	4	Mapping and update on survey work completed	Level 2
2010	15-23 July	4	Mapping and update on survey work completed	Level 2
2010	2-5 November	4	Mapping and update on survey work completed	Level 2
2013	N/A	n/a	Update on survey work completed to date	Level 2
2014	7-14 April	3	Mapping	Level 2
2014	8-15 August	3	Targeted survey	Level 2
2015	2-9 September	4	Mapping update	Level 2
8 years	***13 site visits***	All the above report references are in the consolidated report prepared by Mattiske Consulting (Appendix A1 & A2)		

6.3.1 Desktop Assessments

Desktop assessments were made before every field trip, utilising Florabase (DPaW 2015) and NatureMap (DPaW2007) databases to determine likelihood of species to be encountered in the field (Appendix A1). Searches were made of the databases with a 40km radius circle centred on the MRUP Project. A similar search was also made of the EPBC Act Protected Matters Search Tool (DoE 2013).

Historical information of any surveys and vegetation mapping of the area was also reviewed, including Beard (1990), Northcote *et al.* (1968), Shepard (1995) and Barton and Cowan (2001). Previous survey work specifically for the MRUP by MCPL was also reviewed before each field trip. Information from the Tropicana Gold Mine vegetation surveys was obtained from AngloGold Ashanti by Vimy and utilised to provide a regional context for any conservation significant species located.

Rainfall data was obtained from the Bureau of Meteorology (BOM 2015) for the year preceding each field survey. The closest two BOM weather stations to the Project were at Kalgoorlie-Boulder airport and the Rawlinna Homestead. Information on the local weather was also obtained from the three onsite weather stations at

Ambassador, Emperor and Shogun. This information was utilised to determine any above or below average rainfall periods preceding the field surveys that may affect the life forms present (e.g. a potential higher proportion of annuals) and quality of flowering or fruiting available to assist in the identification of species and therefore a potential influence on the field survey data.

6.3.2 Targeted Flora Surveys

If conservation significant species were recorded at any time during surveys, counts were made at the site along with an estimate of population range and details on habitat (particularly soil and topography) and associated species. Any unidentifiable specimens were collected and compared to reference material held by MCPL and the Western Australian Herbarium.

Specific targeted searches were made for:

- Priority species along exploration lines

  In 2008 and 2009, existing exploration tracks were surveyed prior to commencement of drilling programs. An area of at least 25m on either side of each track was surveyed for conservation significant species. At all 543 proposed drill holes locations, all threatened flora (as *Conospermum toddii* (P4) was listed as Rare at the time) were surveyed within a 50m radius of the location. All Priority and unknown species were surveyed within a 20m radius from of each proposed drill hole.

- *Hibbertia crispula* (P1 / Vulnerable)

  More details on the targeted searches on pre-selected sand dune crests are provided in Section 9.3.1.

- *Conospermum toddii*

  Previously, *Conospermum toddii* was listed as a Declared Rare Flora under WA legislation, and as Endangered under federal legislation (but is now categorised as Priority 4). Identification of 55 dune systems with a specific type of yellow sand, and thought to be potential habitat, was made with satellite imagery and 1:250,000 topographical maps. Two helicopter surveys were conducted in 2009 and 2010. The helicopter flew over each selected dune at 20m. If large populations of *Conospermum toddii* were identified, two botanists traversed the ridge, upperslope and mid slope in 5m transects either side of the dune ridge. The number of any conservation significant flora species were recorded within each transect. The species was found at 38 sites up to 70km from the MRUP area.

Further details on specific searches are provided in Appendix A1 and A2.

6.3.3 Vegetation Mapping

A total of 239 permanent monitoring plots (50m × 50m) have been established across the Project area from 2008-2010. An additional 622 relevé mapping sites (also 50 × 50m) were set up during the 2007-2015 field surveys. The following floristic and environmental parameters were monitored at each survey site:

- GPS location (based on GDA94 datum, zone 51).
- Topography.
- Soil type and colour.
- Outcropping rocks and their type.
- Percentage litter cover and percentage bare ground.
- Approximate time since fire.

- Habitat condition (based on Keighery 1994) (Appendix A1).

The average height and percentage cover (both dead and alive material) was also recorded for each vascular plant species (Appendix A1). In addition, surface soil samples were taken from the quadrats, relevé sites and *Hibbertia crispula* sites. Each sample was approximately 200g of top 5-10cm soil collected from the centre of the plot and were utilised for each update of vegetation mapping.

Rainfall and temperature data from the Bureau of Meteorology sites at Kalgoorlie-Boulder Airport and Rawlinna Homestead and from the three Vimy onsite weather stations was analysed to determine if above or below average rainfall had occurred prior to surveys to alter the lifeforms present and fruiting availability during each survey.

Vegetation condition of monitoring plots and mapping sites was assessed as per the criteria developed by Keighery (1994). Vegetation descriptions were based on structural forms of Australian vegetation, as outlined by Beard (1990). Details on the analysis of data for the mapping are provided in Appendix A1. There were no surveys limitations for the MCPL mapping, except for the change in resolution of satellite imagery and changing fire scars which added difficulty in merging survey results. Small areas of the mapping were extrapolated by use of detailed satellite imagery, experience from previous traverses by MCPL and from adjacent mapping for minor changes in the Development Envelope for the updated PER document (such as the western section of the access road). Large portions of the survey work have been carried out within three years of a fire, which increases the difficulty in identification of species due to the lack of fruiting in such species as *Eucalytpus* spp. after a fire.

Table 6.2 Flora and Vegetation Survey Sites at MRUP

Area	Number of Permanent Plots (2008-2010)	Number of Relevé Mapping Sites (2007-2015)
Inside Development Envelope	39	249
Inside Disturbance Footprint	17	128
Outside of Development Envelope	200	373
TOTAL	**239**	**622**

These sites are shown in Figure 6.3.

6.3.4 Yellow Sand Plain Communities of the Great Victoria Desert

The outline of the Yellow Sand Plain Communities of the Great Victoria Desert, presented in the 2010 Tropicana Joint Venture Exploration Referral to the now DoE, represented 1,692,000ha and was utilised to determine the proportion of sand dunes within the Disturbance Footprint compared to the regional extent. Dune crest areas were calculated using an average crest width of 15m, based on 100 measurements of dunes from satellite imagery. The calculation of the MCPL S6 community was calculated by assigning an 80m width to the dune flanks, and adding this to the dune crest area. The S6 community has affinities to the broadly defined PEC community of 'Yellow Sand Plain Communities of the Great Victoria Desert.'

6.3.5 Flora

A total of 335 vascular plant taxa, representative of 140 genera and 43 families, have been recorded during surveys at the Project area. The majority of taxa recorded were representative of the Fabaceae (52 taxa), Myrtaceae (40 taxa), Goodeniaceae (25 taxa) and Proteaceae (23 taxa) families, with no introduced species recorded. Nine annual/biennial species were recorded, which represented 2.7% of the total species recorded (Appendix A1).

A species accumulation curve indicated that 87% of the flora species potentially present within the MRUP had been recorded (Appendix A1).

Table 6.3 Conservation Significant Flora Surveyed at MRUP

Conservation Listing		Species	Family	Preferred Habitat (Florabase & MCPL surveys)	Vegetation communities recorded in	Surveyed number at MRUP (number of sites)	Number of Plants (Number of Localities)			Percent of regional number in Development Envelope (Direct + Indirect Impacts)	Percent of regional number in Disturbance Footprint (Direct Impacts)
EPBC Act	Priority (DPaW)						Regionally	Development Envelope (Direct + Indirect Impacts)	Disturbance Footprint (Direct Impacts)		
Vulnerable	P1	*Hibbertia crispula*	Dilleniaceae	Yellow sand dune crests	S6 and S8	2691 (38)	14269	182 (4)	38 (1)	1.28	0.27
-	P1	*Dampiera eriantha*	Goodeniaceae	Yellow sand dune crests	E3, S6 and S8	1415 (114)	1877 (189)	51 (4)	8 (1)	2.72	0.43
-	P1	*Neurachne lanigera*	Poaceae	Red sandplains and lateritic outcrops	E3, S9 and S10	25 (6)	25 (6)	1 (1)	0 (0)	4.00	0.0
-	P2	*Isotropis canescens*	Fabaceae	Yellow clayey sandplains	E3, E4, E5, E6, S7 and S8 (burnt only)	3011 (49)	3012 (50)	986 (16)	128 (3)	32.74	4.25
-	P2	*Malleostemon* sp. Officer Basin (D. Pearson 350)	Myrtaceae	Yellow sand dune crests	S6 and S8	1231 (50)	2137 (106)	0 (0)	0 (0)	0	0
-	P2	*Styphelia* sp. Great Victoria Desert (N. Murdoch 44)	Ericaceae	Yellow-orange sandy slopes	E3, E8, E13, E14, S6, S9 and S10	104 (59)	109 (61)	49 (21)	2 (2)	44.95	1.84
-	P3	*Baeckea* ?sp. Sandstone (C.A. Gardner s.n. 26 Oct. 1963)*	Myrtaceae	Orange sand, flats	E3	1 (1)	452 (19)	1 (1)	0 (0)	0.22	0
-	P3	*Labichea eremaea*	Fabaceae	Orange-red sandplains	E3 and S7	284 (8)	284 (8)	0 (0)	0 (0)	0	0

Conservation Listing		Species	Family	Preferred Habitat (Florabase & MCPL surveys)	Vegetation communities recorded in	Surveyed number at MRUP (number of sites)	Number of Plants (Number of Localities)			Percent of regional number in Development Envelope (Direct + Indirect Impacts)	Percent of regional number in Disturbance Footprint (Direct Impacts)
EPBC Act	Priority (DPaW)						Regionally	Development Envelope (Direct + Indirect Impacts)	Disturbance Footprint (Direct Impacts)		
-	P3	*Ptilotus blackii*	Amaranthaceae	Orange-red sand	S7	39 (4)	39 (4)	0 (0)	0 (0)	0	0
-	P4	*Comesperma viscidulum*	Proteaceae	Orange-red sandplains	E3, E5, E6, E7, E8, E12, E13, E14, S6, S7, S8, S9 and S10	563 (126)	1898 (132)	123 (50)	63 (18)	6.48	3.32
-	P4	*Conospermum toddii*	Polygalaceae	Yellow sand dune crests (S6) and slopes	E3, E4, E5, E8, E11, E12, S5, S6, S7, S8 and S10	37147 (402)	45699 (533)	6267 (218)	3941 (164)	13.71	8.62
-	P4	*Dicrastylis cundeeleensisglossum*	Lamiaceae	Yellow-orange undulating sandplains	E3, E4, E5, S10 & Disturbed	748 (252)	7172 (149)	48 (4)	22 (9)	0.67	0.31
-	P4	*Grevillea secunda*	Proteaceae	Yellow-orange undulating sandplains	E3, E5, E6, E8E13, E14, S4, S6, S7, S8, S9 and S10	10107 (574)	12839 (654)	5939 (304)	945 (128)	46.26	7.40
-	P4	*Olearia arida*	Asteraceae	Yellow-orange-red flat to undulating sandplains	E3, E4, E5, E6, E8, E12, S4, S6, S7, S10 and Disturbed	595 (69)	3063 (241)	196 (38)	56 (20)	6.40	1.83

Data sourced from Appendix A1.

Orange cells = species with potential for highest impact

Thirteen Priority flora species have been positively identified during the flora and vegetation surveys at MRUP (Table 6.3). *Hibbertia crispula* is discussed with other Matters of National Environmental Significance (MNES) species in Section 9. Another specimen was unable to be positively identified as *Baekea* sp. Sandstone (C.A. Gardner s.n. Oct. 1963) (P3) due to a lack of flowering material. Five species with the potential to occur in the area were not surveyed: *Caesia rigidifolia*, (P1), *Physopsis chrysotricha* (P2), *Trachymene pyrophila* (P2), *Thryptomene eremaea* (P2) and *Eucalyptus pimpiniana* (P3). Both *Neurachne lanigera* (P1) and *Labichea eremaea* (P3) were recorded at MRUP, but were not previously noted on NatureMap (DPaW 2007). The location of the conservation significant species is provided in Figure 6.4.

There were four flora species that were recorded outside of the current known distribution:

- *Leucopogon aff. planifolius* (600km extension).
- *Euphorbia drummondii* (250km extension).
- *Ophioglossum polyphyllum* (300km extension).
- *Grevillea ?striata* (600km extension).

The records for *Brunonia australis* var. A Kimberley Flora (KF Kenneally 5452) and *Schoenus* sp. A1 Boorabbin (KL Wilson 2581) represent a smaller range extension, as these species have been previously recorded in the south-west corner of the Great Victoria Desert (GVD).

Comesperma viscidulum (P4), *Conospermum toddii* (P4), *Grevillea secunda* (P4) and *Olearia arida* (P4) were recorded across numerous vegetation communities. *Isotropis canescens* (P2) is a perennial herb was not recorded at MRUP until the September 2015 survey when it was recorded across numerous vegetation communities, but only in areas burnt less than one year ago (Appendix A1). Other species commonly recorded in burnt areas were *Labichea eremaea* and *Dicrastylis cundeeleensis*.

It is thought probable that further survey work in the wider region will increase the extent of many of these conservation significant species, as they do not necessarily have a geographically restricted distribution but merely appear restricted due to the limited understanding of the flora and vegetation in the area (Appendix A1).

6.3.6 Vegetation

A total of 29,961ha of vegetation in and around the MRUP area has been mapped to date. A total of twenty six vegetation communities have been defined within the MRUP area, with fourteen 'Eucalypt woodland communities' (E1-E14), one '*Acacia* woodland community' (A1), ten 'Shrubland communities' (S1-S10) and one 'Chenopod shrubland community' (C1) (Table 6.4). The most recent vegetation mapping update (October 2015, Appendix A1) is provided in Figure 6.5 to Figure 6.26 (Appendix A1).

The vegetation communities which occupy the largest proportion of the proposed Development Envelope for MRUP are E3, E4, E5, E6, E8, S8 and S10. This varies slightly within the Disturbance Footprint with the most predominant plant communities being E3, E5 and E8 totalling 66.8% and vegetation communities E4, E6, E7 and E8 representing another 26% of the area. Conversely, A1 and S2 do not occur within the Development Envelope.

Eleven Priority species were recorded within the most common vegetation community type of E3.

Vegetation community E9 is highly restricted to the MRUP area with 88.6% of the mapped distribution occurring within the Development Envelope. However, only 13.53% of the mapped distribution lies within the Disturbance Footprint. The chenopod shrubland, vegetation community C1, is restricted to areas between the Emperor and Shogun pits and has 18.28% of its mapped area occurring within the Disturbance Footprint (Table 6.4).

Vegetation community S6 has 7.36% of the mapped distribution occurring within the Disturbance Footprint, and the yellow sand dunes is largely restricted by topography and landform type. The MCPL S6 shrub community supports a high number of Priority flora species (eight of the current 14 recorded at MRUP). Some species, such as *Dampiera eriantha* (P1) and *Conospermum toddii* (P4) appear to respond well after fire. However, *Hibbertia crispula* (P1) and *Malleostemon* sp. Officer Basin (D. Pearson 350) were often recorded on unburnt dunes and do not appear to respond well to fire (Appendix A1). The targeted surveys for such species as *Hibbertia crispula* (P1) on the yellow sand dune crests may have created a bias of early surveys in this vegetation community (Appendix A1).

6.3.7 Vegetation Condition

Other than exploration activity and small areas of Vimy infrastructure, the vegetation within and surrounding the MRUP has not been affected by human activities, and are regarded as Excellent – Pristine in condition (Appendix A1).

Wildfires of various intensities are a regular occurrence in the region, usually started by lightning strikes. In 2007, a fire burnt the Emperor pit area and sections of the north-east Ambassador pit area. A large section of the proposed borefield extraction area and corridor was burnt in 2009. In November 2014, approximately 74% of the MRUP Development Envelope and 78% of the Disturbance Footprint was burnt by a low intensity but large fire. The total fire scar from the 2014 event is 79,203ha, with approximately 1806ha of refuge areas within that where vegetation has remained intact (Figure 6.27 and Figure 7.3).

6.3.8 Radiation

A radiological assessment was made on the non-human biota in the vicinity of the MRUP site (Appendix B of Appendix F1). The ERICA (Environmental Risk from Ionising Contaminants: Assessment and Management) software tool is a widely used method for assessing radiological impacts on plants and animals. The ERICA software accesses a standard set of databases to determine radionuclide uptake by various species, which are northern hemisphere species. The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) has endorsed the use of the latest version of ERICA (released in November 2014) in Australia.

A Tier 2 ERICA assessment undertaken on all reference species in the ERICA database which included:

- Grasses and herbs.
- Lichen and bryophytes.
- Shrubs.
- Trees.

The air modelling for the MRUP site was utilised to provide a measure of the change in radionuclide composition in the soils at the sensitive receptors due to the proposed operations.

The ERICA assessment was conducted using a soil radionuclide concentration of 0.862Bq/kg (for each long lived uranium-238 series radionuclide) as it was the highest predicted radionuclide deposition, being at the proposed accommodation village site.

Table 6.4 Vegetation Communities of MRUP

Vegetation Community		Description	Total Mapped Area (ha)	Area Mapped within Development Envelope (ha) (Direct + Indirect Impacts)	Proportion of Mapped Community within Development Envelope (%) (Direct + Indirect Impacts)	Area Mapped within Disturbance Footprint (ha) (Direct Impacts)	Proportion of Mapped Community within Disturbance Footprint (%) (Direct Impacts)	Proportion of Disturbance Footprint (%) (Direct Impacts)
Woodlands	E1	Low woodland to low open woodland of *Eucalyptus concinna* with *Callitris preissii* over *Westringia cephalantha*, *Melaleuca hamata*, *Acacia colletioides*, *Acacia hemiteles* and *Scaevola spinescens* over *Triodia desertorum*. This community occurs on red-orange sandy loams on flats. No Priority flora species recorded.	230.49	25.19	10.93	4.61	2.00	0.12
	E2	Low woodland to open scrub mallee of *Eucalyptus trivalva* and *Eucalyptus platycorys* with *Callitris preissii* and *Hakea francisiana* over *Acacia colletioides*, *Acacia hemiteles*, *Melaleuca hamata*, *Westringia cephalantha*, *Bertya dimerostigma* and mixed shrubs over *Triodia desertorum* with occasional emergent *Eucalyptus gongylocarpa*. This community occurs on red-orange sandy loams on flats. No Priority species recorded.	161.84	36.39	22.49	3.06	1.89	0.08
	E3	Low open woodland of *Eucalyptus gongylocarpa* over *Eucalyptus youngiana*, *Eucalyptus ceratocorys*, *Grevillea juncifolia*, *Hakea francisiana* and *Callitris preissii* over *Acacia helmsiana*, *Cryptandra distigma* and mixed low shrubs over *Triodia desertorum*, *Chrysitrix distigmatosa* and *Lepidobolus deserti*. This community occurs on yellow and yellow-orange sands on flats, slopes and between dunes. It resembles Pre-European Vegetation Association 84 and is therefore widespread throughout this region. Eleven Priority flora species recorded.	10407.01	3,315.72	31.86	1,395.93	13.41	36.86
	E4	Low open woodland of *Eucalyptus gongylocarpa* over *Callitris preissii* with *Hakea francisiana* and *Grevillea juncifolia* over *Bertya dimerostigma*, *Westringia cephalantha* and mixed shrubs over *Triodia rigidissima* and *Triodia desertorum*. This community occurs on orange sands on flats and slopes. Four Priority flora species recorded.	2373.06	775.87	32.69%	281.82	11.88	7.4

Vegetation Community		Description	Total Mapped Area (ha)	Area Mapped within Development Envelope (ha) (Direct + Indirect Impacts)	Proportion of Mapped Community within Development Envelope (%) (Direct + Indirect Impacts)	Area Mapped within Disturbance Footprint (ha) (Direct Impacts)	Proportion of Mapped Community within Disturbance Footprint (%) (Direct Impacts)	Proportion of Disturbance Footprint (%) (Direct Impacts)
	E5	Low open woodland of *Eucalyptus gongylocarpa* over *Eucalyptus rigidula* and *Eucalyptus* sp. Mulga Rock (K.D. Hill and L.A.S. Johnson KH 2668) with *Hakea francisiana* and *Grevillea juncifolia* over *Westringia cephalantha*, *Acacia helmsiana*, *Acacia rigens*, *Eremophila platythamnos* subsp. *platythamnos*, *Cryptandra distigma* and mixed low shrubs over *Triodia desertorum*, *Triodia rigidissima* and *Chrysitrix distigmatosa*. This community occurs on yellow and orange sands on flats and slopes. Six Priority species recorded.	2513.61	1,588.65	63.20%	630.78	25.09	16.66
	E6	Open scrub Mallee to Very Open Scrub Mallee of *Eucalyptus rigidula* and/or *Eucalyptus* sp. Mulga Rock (K.D. Hill and L.A.S. Johnson KH 2668) over *Acacia hemiteles*, *Hakea francisiana*, *Westringia rigida*, *Cryptandra distigma*, *Grevillea acuaria* and mixed low shrubs over *Triodia rigidissima* with *Halgania cyanea*. This community occurs on red-orange sandy loams on flats and low lying swales. Four Priority species recorded.	899.72	603.47	67.07	330.77	36.76	8.73
	E7	Open scrub mallee to very open scrub mallee of varying *Eucalyptus* spp. over *Grevillea acuaria*, *Acacia hemiteles*, *Cryptandra distigma*, *Westringia cephalantha* and mixed shrubs over *Triodia desertorum*. This community occurs on red-orange sandy loams in low lying swales. *Comesperma viscidulum* (P4) only Priority flora recorded.	555.61	417.67	75.17	213.14	38.36	5.63
	E8	Open scrub mallee to very open scrub mallee of *Eucalyptus ceratocorys* and *Eucalyptus mannensis* subsp. *mannensis* with *Eucalyptus youngiana*, *Hakea francisiana* and *Grevillea juncifolia* over *Acacia fragilis*, *Acacia helmsiana* and mixed low shrubs over *Triodia desertorum*, *Chrysitrix distigmatosa* and *Lepidobolus deserti* with emergent *Eucalyptus gongylocarpa*. This community occurs on yellow sands on flats and slopes. Six Priority flora species recorded.	4117.56	1,115.48	27.09	504.62	12.26	13.33

Vegetation Community		Description	Total Mapped Area (ha)	Area Mapped within Development Envelope (ha) (Direct + Indirect Impacts)	Proportion of Mapped Community within Development Envelope (%) (Direct + Indirect Impacts)	Area Mapped within Disturbance Footprint (ha) (Direct Impacts)	Proportion of Mapped Community within Disturbance Footprint (%) (Direct Impacts)	Proportion of Disturbance Footprint (%) (Direct Impacts)
	E9	Very open scrub mallee of *Eucalyptus mannensis* subsp. *mannensis* with *Grevillea juncifolia* and *Hakea francisiana* over *Cryptandra distigma*, *Acacia ligulata* and mixed low shrubs over *Triodia desertorum* with emergent *Eucalyptus gongylocarpa*. This community occurs on yellow sand on slopes and flats. No Priority species recorded.	188.96	167.38	88.58	25.56	13.53	0.67
	E10	Open scrub mallee to very open scrub mallee of *Eucalyptus concinna* with *Eucalyptus platycorys* over *Hakea francisiana*, *Cryptandra distigma*, *Acacia rigens* and mixed shrubs over *Triodia rigidissima* and *Chrysitrix distigmatosa* with *Leptosema chambersii*. This community occurs on orange-red sandy loams on slopes and flats. No Priority flora species recorded.	170.37	3.33	1.96	0.11	0.07	0.003
	E11	Open scrub mallee to very open scrub mallee of *Eucalyptus platycorys* with *Eucalyptus concinna* over *Acacia helmsiana*, *Grevillea juncifolia*, *Hakea francisiana* and mixed shrubs over *Triodia desertorum* and *Chrysitrix distigmatosa*. This community occurs on orange-yellow sandy loams on slopes and flats. *Conospermum toddii* only Priority species recorded to date in this community.	441.00	17.83	4.04	1.67	0.38	0.04
	E12	Open scrub mallee to very open scrub mallee of *Eucalyptus trivalva* with *Eucalyptus rigidula* over *Hakea francisiana*, *Bertya dimerostigma*, *Acacia helmsiana*, *Cryptandra distigma* and *Grevillea juncifolia* over *Triodia rigidissima*, *Triodia desertorum*, *Chrysitrix distigmatosa* and *Halgania cyanea*. This community occurs on orange and red-orange sandy loams on flats and swales. Three Priority flora species recorded.	96.91	32.60	33.64	13.03	13.45	0.34

Vegetation Community		Description	Total Mapped Area (ha)	Area Mapped within Development Envelope (ha) (Direct + Indirect Impacts)	Proportion of Mapped Community within Development Envelope (%) (Direct + Indirect Impacts)	Area Mapped within Disturbance Footprint (ha) (Direct Impacts)	Proportion of Mapped Community within Disturbance Footprint (%) (Direct Impacts)	Proportion of Disturbance Footprint (%) (Direct Impacts)
	E13	Low open mallee woodland of *Eucalyptus youngiana* over low shrubland of *Grevillea didymobotrya* subsp. *didymobotrya*, *Cryptandra distigma*, *Banksia elderiana*, *Calothamnus gilesii*, *Acacia desertorum* var. *desertorum* and other *Acacia* spp. over open *Triodia* spp. Hummock Grassland with *Chrysitrix distigmatosa* and some low myrtaceous shrubs (and occasional emergent *Eucalyptus gongylocarpa*). This community occurs on orange-yellow sandy loams on lower slopes and flats. Three Priority flora species recorded.	329.67	53.89	16.35	1.30	0.39	0.03
	E14	Low open mallee woodland of *Eucalyptus leptophylla* or *Eucalyptus horistes* over open low shrubland of *Daviesia ulicifolia* subsp. *aridicola*, *Callitris verrucosa* and mixed *Acacia* spp., over *Triodia* spp., *Androcalva melanopetala*, *Dysphania kalpari* and other short-lived perennial or annual herbs. This community occurs on highly leached red-brown-white sandy-clayey soils in swales and drainage areas. Three Priority flora species recorded.	18.10	11.37	62.82	0.30	1.68	0.008
	A1	Low woodland to tall shrubland of *Acacia aneura* over *Aluta maisonneuvei* subsp. *auriculata*, *Eremophila latrobei*, *Phebalium canaliculatum, Prostanthera* spp. and mixed shrubs. This community occurs on orange sandy loams or clay loams with some laterite pebbles on flats. No Priority flora species recorded.	114.30	0	0	0	0	0
Shrublands	S1	Shrubland of *Melaleuca hamata* with *Hakea francisiana* and mixed shrubs over *Triodia desertorum* with emergent *Eucalyptus* spp. This community occurs on yellow and orange sand on slopes and flats. No Priority flora species recorded.	14.66	11.01	75.16	1.08	7.40	0.03
	S2	Shrubland of *Acacia sibina* with *Grevillea juncifolia* and *Eucalyptus youngiana* over *Phebalium canaliculatum*, *Grevillea acuaria* and mixed shrubs over *Triodia desertorum*. This community occurs on red clay loams in seasonally wet areas. No Priority flora species recorded.	14.23	0	0	0	0	0

Vegetation Community		Description	Total Mapped Area (ha)	Area Mapped within Development Envelope (ha) (Direct + Indirect Impacts)	Proportion of Mapped Community within Development Envelope (%) (Direct + Indirect Impacts)	Area Mapped within Disturbance Footprint (ha) (Direct Impacts)	Proportion of Mapped Community within Disturbance Footprint (%) (Direct Impacts)	Proportion of Disturbance Footprint (%) (Direct Impacts)
	S3	Shrubland of *Allocasuarina spinosissima* and *Allocasuarina acutivalvis* subsp. *acutivalvis* with *Grevillea juncifolia* and *Hakea francisiana* over *Triodia desertorum* with emergent *Eucalyptus youngiana* and *Eucalyptus gongylocarpa*. This community occurs on yellow sand on slopes. No Priority flora species recorded.	66.09	5.43	8.21	0.54	0.82	0.01
	S4	Shrubland to open shrubland of *Acacia desertorum* var. *desertorum* and mixed low shrubs over *Triodia desertorum* with occasional emergent mallee *Eucalyptus* spp. This community occurs on yellow or orange sands on mid-slopes. *Grevillea secunda* (P4) & *Olearida arida* (P4) recorded.	325.00	57.72	17.76	6.03	1.86	0.16
	S5	Shrubland to open shrubland of *Acacia sibina* with *Phebalium tuberculosum* over *Enekbatus eremaeus*, *Bertya dimerostigma*, *Homalocalyx thryptomenoides*, *Baeckea* sp. Great Victoria Desert (A.S. Weston 14813), *Melaleuca hamata* and mixed low shrubs over *Triodia desertorum* and *Chrysitrix distigmatosa* with occasional emergent *Eucalyptus gongylocarpa* and *Eucalyptus youngiana*. This community occurs on yellow-orange sands on flats and lower slopes. *Conospermum toddii* (P4) recorded.	120.06	14.78	12.31	10.10	8.41	0.27
	S6	Low shrubland of *Thryptomene biseriata*, *Allocasuarina spinosissima*, *Allocasuarina acutivalvis* subsp. *acutivalvis*, *Jacksonia arida*, *Calothamnus gilesii*, *Acacia fragilis*, *Conospermum toddii* (P4), *Pityrodia lepidota*, *Lomandra leucocephala*, *Anthotroche pannosa* and mixed low shrubs over *Triodia desertorum* with *Lepidobolus deserti* with emergent *Eucalyptus gongylocarpa*, *Eucalyptus youngiana*, *Eucalyptus ceratocorys* and *Eucalyptus mannensis* subsp. *mannensis*. This community occurs on yellow sand dunes. Vegetation community S6 has affinities with the broadly defined "Yellow sand Plain Communities of the Great Victoria Desert" Priority 3 (ii) ecological community. Eight Priority species recorded.	964.92	199.49	20.67	70.98	7.36	1.87

Vegetation Community		Description	Total Mapped Area (ha)	Area Mapped within Development Envelope (ha) (Direct + Indirect Impacts)	Proportion of Mapped Community within Development Envelope (%) (Direct + Indirect Impacts)	Area Mapped within Disturbance Footprint (ha) (Direct Impacts)	Proportion of Mapped Community within Disturbance Footprint (%) (Direct Impacts)	Proportion of Disturbance Footprint (%) (Direct Impacts)
	S7	Low shrubland to low open shrubland of *Enekbatus eremaeus*, *Acacia desertorum* var. *desertorum*, *Verticordia helmsii*, *Homalocalyx thryptomenoides*, *Leptospermum fastigiatum*, *Allocasuarina spinosissima*, *Baeckea* sp. Great Victoria Desert (A.S. Weston 14813), *Leptosema chambersii* and mixed low shrubs over *Triodia desertorum* and *Chrysitrix distigmatosa* with occasional emergent mallee *Eucalyptus* species, *Grevillea juncifolia* and *Hakea francisiana*. This community occurs on yellow and orange sands on lower slopes, undulating plains and swales. Six Priority species recorded.	1199.36	320.61	26.73	83.40	6.95	2.20
	S8	Low open shrubland of *Calothamnus gilesii*, *Persoonia pertinax*, *Thryptomene biseriata* and *Leptospermum fastigiatum* with *Anthotroche pannosa*, *Acacia helmsiana*, *Microcorys macredieana*, *Micromyrtus stenocalyx* and mixed low shrubs over *Triodia desertorum* with *Lepidobolus deserti*, *Chrysitrix distigmatosa* and *Caustis dioica* with emergent *Eucalyptus youngiana*, *Eucalyptus gongylocarpa* and *Eucalyptus ceratocorys*. This community occurs on yellow sands flats adjacent to yellow sand dunes and undulating sandplains. Seven Priority flora species recorded.	2099.03	519.01	24.73	159.88	7.62	4.22
	S9	Low open shrubland of *Melaleuca hamata* and mixed *Acacia* spp. (including *Acacia fragilis*, *Acacia ligulata* and *Acacia sibina*) with *Hannafordia bissillii* subsp. *bissillii*, *Grevillea didymobotrya* subsp. *didymobotrya*, *Mirbelia seorsifolia* over *Triodia* spp. Hummock Grassland with *Leptosema chambersii*, *Chrysitrix distigmatosa*, *Aristida contorta* and *Goodenia xanthosperma*, with emergent Eucalypt mallees. This community occurs on orange-red sandy clay loam, in swales and on flats. Four Priority species recorded.	509.34	143.78	28.23	4.01	0.79	0.11

Vegetation Community		Description	Total Mapped Area (ha)	Area Mapped within Development Envelope (ha) (Direct + Indirect Impacts)	Proportion of Mapped Community within Development Envelope (%) (Direct + Indirect Impacts)	Area Mapped within Disturbance Footprint (ha) (Direct Impacts)	Proportion of Mapped Community within Disturbance Footprint (%) (Direct Impacts)	Proportion of Disturbance Footprint (%) (Direct Impacts)
	S10	Low open shrubland of *Banksia elderiana, Calothamnus gilesii, Grevillea didymobotrya* subsp. *didymobotrya, Acacia desertorum* var. *desertorum* and *Grevillea secunda* (P4) with *Leptospermum fastigiatum* and emergent *Eucalyptus youngiana* (and *Eucalyptus rosacea*) over *Triodia* spp. Hummock Grassland with *Chrysitrix distigmatosa*. This community occurs on orange-yellow undulating sandplains and flats. Seven Priority flora species recorded.	1934.71	500.07	25.85	22.78	1.18	0.6
	C1	Low shrubland of *Atriplex ?vesicaria* with *Eremophila decipiens* subsp. *decipiens* and *Acacia colletioides*. This community occurs on red-brown clay loams on clay pans. *Callitris preissii* with *Eucalyptus* spp. over mixed shrubs are found in adjacent pockets. No Priority flora species recorded.	67.70	36.19	53.46	12.38	18.28	0.33
Other	D	Disturbed – burnt	28.57	20.56	n/a	8.88	n/a	0.23
TOTAL			**29,961.90**	**9,993.48**	**-**	**3,786.80**	**-**	**100**

Orange cells are those of highest proportion of total mapped area within Develop Envelope and Disturbance Footprint, whilst green is highest proportion of area within the Disturbance Footprint.

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Table 6.5 Results of ERICA Assessment

Organism	Concentration Ratio Source	Predicted Dose Rate (µGy/H)
Lichens and bryophytes	ERICA default	0.182
Grasses and herbs	ERICA default	0.035
Shrub	ERICA default	0.051
Tree	ERICA default	0.004

The screening level is the radiation dose rate below which no effects would be observed, and the ERICA default level is 10µGy/h. All dose rates are seen to be well below this.

6.4 Potential Impacts

The implementation of the MRUP proposal has the potential to have both direct and indirect impacts upon the flora and vegetation in and adjacent to the Project area. The potential impacts are listed in Table 6.7.

6.4.1 Direct Impacts

Direct impacts are likely to occur within the Disturbance Footprint due to clearing and/or disturbance of an area of 3,787ha or less. This area will not be immediately cleared in its entirety, but an initial 400ha will be cleared during the construction phase. Due to progressive rehabilitation and the ongoing backfilling of voids, the disturbance area will increase to 1,000ha at Year 10 and will peak at 1,500ha at mine closure in Year 16.

6.4.1.1 Vegetation Communities

Approximately 876,295.94ha of the Pre-European Vegetation Association 84 occurs within the GVD1 Shield IBRA subregion (Govt of WA 2013). It resembles MCPL vegetation community E3 which occupies 34.7% of the area currently mapped by MCPL in the MRUP area. The MRUP is likely to have a low impact on this vegetation association due to the large regional scale of the community and because 100% remains intact within the GVD1 Shield IBRA subregion (Appendix A1).

The extent of the potential direct impacts on vegetation communities within the Disturbance Footprint, and of the potential impacts which may occur indirectly within the Development Envelope, are provided in Table 6.4. The vegetation communities with the higher proportion of direct impacts are summarised in Table 6.6.

The vegetation communities E5, E6, E7, E9, E14 and S1 have between 62-89% of the MCPL mapping distribution within the Development Envelope. Of these, E5, E6 and E7 have 25-39% of their mapped distribution within the Disturbance Footprint. Vegetation community C1 has a high proportion (18%) of the mapped vegetation community within the Disturbance Footprint. It is a small area of the Disturbance Footprint, however, at 0.33% (12.4ha) of the total Disturbance Footprint area. The chenopod community C1 is restricted to areas between the Shogun and Emperor pits (Appendix A1).

It must be noted that 78% of the Disturbance Footprint for the Project was burnt in 2014, and so the condition of the affected areas would be considered temporarily Degraded, rather than Excellent-Pristine. It is thought that dominant vegetation species may take over five years, even with above average rainfall events, to recover after a fire (Appendix A1).

Most vegetation communities are adequately represented in the wider region. Therefore, the overall potential impacts upon the vegetation from the MRUP will be low in the context of the surrounding area (Appendix A1).

6.4.1.2 MCPL S6 Community

The MCPL vegetation community S6 has similarities with the poorly defined PEC 'Yellow Sand Plain Communities of the Great Victoria Desert' (Yellow Sand Plains), and may therefore have conservation significance (Appendix A1). The Yellow Sand Plains are estimated to cover 1,692,000ha in the southwest corner of the GVD (Figure 6.2). Approximately 0.76% is likely to be the S6 vegetation community upon the yellow sand dune crests. Within the MRUP area approximately 965ha of the S6 community has been mapped, with only 1.87% within the Disturbance Footprint. The S6 community extends well beyond the MRUP area (Appendix A1). There will be no cumulative effects upon the Yellow Sand Plains community, as it does not occur within the Tropicana Gold Mine footprint. No TECs as defined by the EPBC Act are known to occur within, or in close proximity to, the Project area.

Table 6.6 Vegetation Communities

Vegetation Community	Total MCPL Mapped Area	Mapped Area in Development Envelope (ha)	Proportion of Mapped Area in Development Envelope (%)	Mapped Area in Disturbance Footprint (ha)	Proportion of Mapped Area in Disturbance Footprint (%)	Proportion of Vegetation Community Within Total Disturbance Footprint Area (%)
E5	2513.61ha	1,588.6	63.20	630.78	25.09	16.66
E6	899.72ha	603.47	67.07	330.77	36.76	8.73
E7	555.61ha	417.67	75.17	213.14	38.36	5.63
E9	188.96ha	167.38	88.58	25.56	13.53	0.67
E14	18.10ha	11.37	62.82	0.30	1.68	0.008
S1	14.66ha	11.01	75.16	1.08	7.40	0.03
C1	67.70ha	36.19	53.46	12.38	18.28	0.33

Orange cells = highest proportion of potential impacts.

6.4.1.3 Conservation Significant Flora

The impact upon *Hibbertia crispula* (P1) will be considered in Section 9. The two Priority species that will be most affected by the Project are *Conospermum toddii* (P4) and *Grevillea secunda* (P4) (Table 6.3). Based on the MCPL surveys, over 35,000 individual *Conospermum toddii* plants have been recorded in the MRUP area on both burnt and unburnt areas. Approximately 8.6% of these mapped individual plants occur within the Disturbance Footprint (Table 6.3). There will be 748 of the 10,107 mapped plants of *Grevillea secunda* potentially impacted within the Disturbance Footprint. High densities of the *Grevillea secunda* and *Comesperma viscidulum* (P4) were recorded in areas of the proposed extraction borefield, and that were also burnt in 2005. It is unknown if these high densities are a response to the fire (in combination with high rainfall events) (Appendix A1).

Grevillea secunda (P4), *Dicrastylis cundeeleensis* (P4), *Conospermum toddii* (P4), *Olearia arida* (P4) and other conservation significant species have been recorded within the Queen Victoria Spring Nature Reserve and the Plumridge Lakes Nature Reserve. This indicates that the abundance of these species extends well beyond the immediate MRUP area and therefore local impacts to such species will be low (Appendix A1).

Although it has a wide distribution, only a small number of *Neurachne lanigera* (P1) were recorded in the MRUP area. None were located within the Disturbance Footprint.

From survey mapping results to date, *Isotropis canescens, Styphelia* sp. Great Victoria Desert (N Murdock 44) and *Grevillea secunda* have more than 30% of their estimate regional numbers within the MRUP Development Envelope and so may be both directly and indirectly impacted.

Table 6.7 Potential Environmental Impact of the MRUP upon Flora and Vegetation

Potential Impacts	Description
Direct	Clearing and/or disturbance of up to 3787ha of vegetation communities and flora species.
	Loss of some conservation significant flora.
	Loss of a proportion of the MCPL S6 vegetation community – aligned to the PEC community: “Yellow Sand Plain Communities of the Great Victoria Desert.”
Indirect	Dust deposition on flora and vegetation reducing the health of the plants.
	Increased fire frequency/intensity of background fire patterns in the region, which in turn may modify the vegetation communities and species form.
	The uptake of radionuclides and other contaminants from dust, groundwater and surface water.
	The introduction and spread of weed species.
	Altered hydrological regimes associated with dewatering and aquifer reinjection, or modification to surface water hydrology.
	Potential reduction of health of vegetation, or death, from saline water spray during dust suppression of transport routes etc.
	Introduced fauna may reduce the health of the vegetation by grazing.

Table 6.8 Potential Impacts to Priority Flora Species Recorded by MCPL in the MRUP Surveys, 2007-2015

Note: 1 Based on MCPL records associated with the MRUP (2007-2015); "No. individuals" was calculated from the median (if recorded as a range), and the error associated with that range; the bolded records indicate that at least one individual occurs at each of the known locations (population numbers were not recorded for all locations of this species); ^ includes '?' specimens in MCPL numbers; regional numbers include records from MCPL, VMY dune traverses, Tropicana Joint Venture and DPaW in the south-west corner of the GVD bioregion; DE refers to the wider 'development envelope'; DF refers to 'disturbance footprint', or the direct impact areas; Orange highlighted cells indicate species with the highest impact.

SPECIES	CONSERVATION STATUS	MCPL MAPPING - Number of individuals ± error[1] (number of localities	REGIONAL (GVD) – Number of individuals (number of localities)	DEVELOPMENT ENVELOPE – Number of MCPL individuals ± error (number of localities)	DEVELOPMENT ENVELOPE – % of regional numbers	DISTURBANCE FOOTPRINT – Number of MCPL individuals ± error (number of localities)	DISTRUBANCE FOOTPRINT - % of regional numbers
Hibbertia crispula	P1 & Vulnerable	2691 ± 98 (38)	14269 ± 25	182 ± 13(4)	1.28	38 ± 13(1)	0.27
Dampiera eriantha	P1	1415± 132 (114)	1877 ± 137 (189)	51 ± 2 (4)	2.72	8 ± 2 (1)	0.43
Neurachne lanigera	P1	**25 ± 0 (6)**	**25 ± 0 (6)**	**1 ± 0 (1)**	**4.00**	0 ± 0 (0)	0.00
Isotropis canescens	P2	3011 ± 0 (49)	3012 ± 0 (50)	986 ± 0 (16)	32.74	128 ± 0 (3)	4.25
Malleostemon sp. Officer Basin (D. Pearson 350)	P2	1231 ± 132 (50)	2137 ± 174 (106)	0 ± 0 (0)	0.00	0 ± 0 (0)	0.00
Styphelia sp. Great Victoria Desert (N. Murdoch 44)	P2	104 ± 0 (59)	109 ± 2 (61)	49 ± 0 (21)	45.16	2 ± 0 (2)	1.84
Baeckea ?sp. Sandstone (C.A. Gardner s.n. 26 Oct. 1963)*	P3	**1^ ± 0 (1^)**	452^ ± 30 (19^)	**1^ ± 0 (1^)**	**0.22^**	0 ± 0 (0)	0.00
Labichea eremaea	P3	284 ± 92 (8)	284 ± 92 (8)	0 ± 0 (0)	0.00	0 ± 0 (0)	0.00
Ptilotus blackii	P3	39^ ± 15 (4^)	39^ ± 15 (4^)	0 ± 0 (0)	0.00	0 ± 0 (0)	0.00
Comesperma viscidulum	P4	563 ± 24 (126)	1898 ± 29 (132)	123 ± 21 (50)	6.48	63 ± 19 (18)	3.32

SPECIES	CONSERVATION STATUS	MCPL MAPPING - Number of individuals ± error[1] (number of localities	REGIONAL (GVD) – Number of individuals (number of localities)	DEVELOPMENT ENVELOPE – Number of MCPL individuals ± error (number of localities)	DEVELOPMENT ENVELOPE – % of regional numbers	DISTURBANCE FOOTPRINT – Number of MCPL individuals ± error (number of localities)	DISTRUBANCE FOOTPRINT - % of regional numbers
Conospermum toddii	P4	37147 ± 3502 (402)	45699 ± 3723 (533)	6267 ± 2078 (218)	13.71	3941 ± 1282 (164)	8.62
Dicrastylis cundeeleensisglossum	P4	748 ± 252 (40)	7172 ± 267 (149)	48 ± 19 (4)	0.67	22 ± 9 (2)	0.31
Grevillea secunda	P4	10107^ ± 674 (574^)	12839^ ± 699 (654^)	5939^ ± 219 (304^)	46.26^	945^ ± 117 (128^)	7.40^
Olearia arida	P4	595 ± 81 (69)	3063 ± 171 (241)	196 ± 24 (38)	6.40	56 ± 13.5 (20)	1.83

6.4.2 Indirect Impacts

Activity associated with the Project may have indirect impacts outside the Disturbance Footprint. Such indirect impacts include dust deposition, altered fire patterns, radiation, weeds, feral animals, altered hydrological regimes, changes in air and/or water quality and erosion issues.

6.4.2.1 Dust

Dust levels can be naturally high in the Project area due the low rainfall, high evaporation rates, relatively sparse vegetation, frequent winds and occasional uncontrolled bushfires (Appendix E1). However dust build-up on vegetation is naturally mitigated by periodic heavy rainfall. Mining will predominantly take place in open pits below surface levels on material that has an average moisture level of around 10% and will be mined using techniques that do not require the use of explosives. Vehicle movements will also generate dust, but this will be limited by the application of dust suppression measures to all roads. All potential dust generating activities will be subject to a Dust Management Plan (MRUP-EMP-024) and so the indirect impact from dust emissions associated with mining activities will be minimised and therefore not expected to have a significant impact on vegetation or flora.

Dust emissions will also be limited through minimising vegetation clearing and ground disturbing activity where possible, as required under the Vimy Ground Disturbance Management Plan (MRUP-EMP-019) and through progressive rehabilitation under the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030).

Vegetation and flora located in close proximity to mining areas will be monitored through the application of the Flora and Vegetation Management Plan (MRUP-EMP-001) to determine the impacts of dust. Any detected impacts upon the vegetation will result in increased dust suppression (or other such measures) being implemented to reduce such impacts.

6.4.2.2 Fire

Bushfires can occur at any time of year, occur in the MRUP region at a high frequency (Appendix H2) and are predominantly the result of lightning strikes. An increase in the rate of bushfires could modify the vegetation structure of the affected areas. Some species are encouraged by fire and will increase in abundance immediately after fire, such as *Isotropis canescens*. Other species will decrease in density with an increase in the rate of fire frequency, such as the Mulga Woodlands (Appendix B1). Eucalypts are more likely to take a mallee form if the frequency of burning increases (Appendix B1).

A Fire Management Plan (MRUP-EMP-025) will be implemented with measures designed to protect infrastructure onsite from fire damage and to ensure that emergency response procedures and preparedness to deal with all forms of bushfires, whether natural or anthropogenic in nature. Therefore, the MRUP will manage activities to minimise the risk in increasing the natural frequency of fires in the region, and will prevent the spread of local fires with the protection of mining infrastructure. The recent burning of 74% of the Development Envelope has significantly reduced the fuel load of the MRUP area and will decrease the intensity of any fires in the area in the near future.

Plate 6.1 Reduction of Fuel Load after November 2014 Bushfire (Source: A. Pratt, Vimy)

6.4.2.3 Radiation

The levels of radiation associated with the Project will not be sufficiently high to have any adverse impact on local vegetation and flora (Table 6.5). Exposure levels are well below the trigger level for further assessment under Tier 2 ERICA (Appendix B of Appendix F1).

6.4.2.4 Weeds

There have been no recorded weed species at the MRUP site to date. Vehicles and machinery entering the site could introduce and spread weeds in the Project area. To manage this risk, hygiene measures will be implemented to ensure that, where appropriate, vehicles entering the site are cleaned by passing through wash-down bays. If any weed species are detected during regular monitoring of vegetation and rehabilitation sites, appropriate weed control measures, detailed within the Weed Management Plan (MRUP-EMP-003), will be implemented onsite.

6.4.2.5 Feral Animals

There is the potential for MRUP activities to increase the number of feral animals in the area and, consequently, decrease the health of the local vegetation communities. As part of the Feral Animal Management Plan (MRUP-EMP-006), feral animal numbers will be monitored and appropriate measures implemented if any noticeable impact on the health of the local vegetation communities is evident.

6.4.2.6 Altered Hydrological Regimes

Surface water flows are not normally apparent in the MRUP area due to infiltration rates associated with sandy soils (Appendix H2). There are no groundwater dependent ecosystems in the region of the Kakarook North extraction borefield as the water table is too deep, at around 20m below ground level, to support such a system (Appendix D9). There are no groundwater dependent ecosystems associated with the MRUP mining areas as the water is even deeper, mostly around 30-40m below ground level, and is too saline to support the growth of vegetation, ranging from 7,500 to 37,600mg/L TDS at Mulga Rock East and mostly greater than 50,000mg/L at Mulga Rock West (Appendix C2). Similarly, the groundwater in the proposed area for water reinjection is too deep and too saline to support surface vegetation.

The Project will extract water from aquifers (from the mine pits and Kakarook North borefield) that are therefore not connected with any groundwater dependent ecosystems. Water will be reinjected into the same aquifer as exists below the mining area but significantly downstream from the mine. There is no possibility that mounding will result in any reinjection water reaching surface vegetation as the estimated extent of mounding is approximately 2m (Appendix D1). Monitoring of any mounding at the reinjection bores will occur for the LOM as part of the Managed Aquifer Recharge Management Plan (MRUP-EMP-012). Water from tailings disposal will either be contained (in the surface facilities) or will be deposited (in-pit disposal) below the level at which it can interact with any vegetation or troglofauna as required under the Tailings Management Plan (MRUP-EMP-013).

6.4.2.7 Other Issues

Saline water, generally sourced from pit dewatering, will be used for dust suppression purposes. There is a risk that spray and runoff from the roads could affect nearby vegetation. The application of both the Flora and Vegetation Management Plan (MRUP-EMP-001) and Dust Management Plan (MRUP-EMP-024) will minimise the potential risk. Roads will be constructed according to the Operational Environment Management Plan (MRUP-EMP-020) with road drainage systems designed to collect runoff and ensure that saline water does not have an adverse impact. Landforms will be designed to minimise the impact of erosion and, consequently, sediment runoff on surrounding flora and vegetation. Sediment generation from overburden landforms will be controlled, but is not expected to be significant due to the sandy nature of the soils.

6.5 Management of Impacts

The following management plans (MPs) have been prepared to ensure that impacts (direct and indirect) are no greater than those impacts outlined in Section 6.4 and that the impacts are avoided or minimised the greatest extent that is practical:

- Flora and Vegetation Management Plan (MRUP-EMP-001).
- Conservation Significant Flora and Vegetation Management Plan (MRUP-EMP-002).
- Weed Management Plan (MRUP-EMP-003).
- Feral Animal Management Plan (MRUP-EMP-006).
- Groundwater Management Plan (MRUP-EMP-010).
- Groundwater Operating Strategy (MRUP-EMP-011).
- Managed Aquifer Recharge Management Plan (MRUP-EMP-012).
- Tailings Management Plan (MRUP-EMP-013).
- Ground Disturbance Management Plan (MRUP-EMP-019).
- Dust Management Plan (MRUP-EMP-024).
- Fire Management Plan (MRUP-EMP-025).

- Radiation Management Plan (MRUP-EMP-028).
- Radioactive Waste Management Plan (MRUP-EMP-029).
- Rehabilitation and Revegetation Management Plan (MRUP-EMP-030).

These management plans are contained in Appendix K1. Additional operational measures will be applied to ensure that unnecessary disturbance to flora and vegetation does not occur. These will include:

- Restrictions to off-road driving.
- Enforcement of vehicle speed limits.
- Control of dust suppression runoff.

The overall objective of the application of all these management plans to the key environmental factor of Flora and Vegetation is to ensure that the impact upon the flora and vegetation resulting from the development of the MRUP is minimised in terms of both its extent and duration. The achievement of the following objectives will assist in delivering such an outcome:

- Minimise disturbance activities where possible.
- Confine disturbance to areas within what has been agreed under the Vimy Ground Disturbance Activity Permit (GDAP).
- Avoid clearing Priority flora where practicable.
- Maintain overall health of flora and vegetation by minimising indirect impacts.
- Progressively rehabilitate disturbed areas.
- Ensure awareness of environmental factors amongst operating workforce.

6.5.1 Ground Disturbance Activity Permit

The management of environmental impacts to flora and vegetation will be predominantly achieved through the use of a clearing permit system that will prevent any ground disturbing activity from being commenced on the MRUP site until an appropriate permit, known as a GDAP (MRUP-POL-001), has been issued. Vimy will maintain a database containing the spatial location of soil associations, vegetation communities, individual conservation significant flora and any other environmentally significant locations. In order to obtain a GDAP, the coordinates of the proposed disturbance site will have to be identified and compared against this central database to ascertain whether such disturbance would involve any impacts to conservation significant flora or vegetation communities.

Where it is practical, the clearance of areas where conservation significant flora or vegetation communities occur will be avoided. This has already occurred, to some extent, by the design of the layout of the infrastructure (as opposed to the mining pits which are determined by the location of the orebodies) taking into account the known location of areas where conservation significant flora are likely to occur and, in particular, areas containing complex interlinked dunes. However, there is considerable local flexibility in the location of linear infrastructure, such as water pipelines and roads, and the exact route followed will be altered by the small amount necessary to avoid known locations of conservation significant flora, significant habitat trees or any other localised environmentally significant areas to the extent practical.

The same system of GDAPs will be used to monitor both the exact area of ground disturbance and, initially, the extent of the proposed disturbance in relation to the purpose for such disturbance to ensure that areas cleared are kept to the minimum required. The implementation of the authorised GDAP will be managed to ensure that the extent of ground disturbance will be equal to or less than that internally authorised. A log of all GDAPs issued and the surveyed areas of actual disturbance will be maintained according to the Document and Data Control Management Plan (MRUP-EMP-038).

For some tasks, the area required to be disturbed will be larger for construction than is required for ongoing operations and maintenance. These differences will be identified before the application for a GDAP is lodged. When such a difference occurs, those additional areas that have been disturbed for construction purposes but are no longer required for operations and maintenance purposes will be progressively rehabilitated as soon as is practicable. Considerations for the distance to be maintained between operational areas and native vegetation will be controlled through the Fire Management Plan (MRUP-EMP-025). The GDAP system will be used to manage the efficient timing of the progressive rehabilitation. All disturbance areas that have been rehabilitated will be logged into a central Vimy database and rehabilitation success will be monitored according to protocols detailed within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030).

The cumulative area of authorised disturbance under the GDAP system will be regularly analysed to determine how the areas of disturbance compare to those expected for specific sites and for the MRUP site overall. Excessive clearances (being 10% above what was expected to be required) in relation to particular tasks will be further investigated to determine the cause of the variance and whether further management action is required to reduce the areas being cleared for particular tasks. Where cumulative clearances suggest that the overall amount of clearance projected for the life of the MRUP will exceed the amount of clearance authorised, management action will be taken to reduce the amount of clearance associated with future tasks to ensure that the overall limit is not breached.

6.5.2 Progressive Rehabilitation

Once the activity associated with an area that has been cleared has been completed (such as when an area has been mined) it will be rehabilitated as far as is practicable to the extent necessary to establish a local vegetation community similar to those prevailing in the area. Previous rehabilitation work in the area (undertaken by PNC – the initial owner of the tenements) to rehabilitate an area where a trail pit was dug within the Shogun Deposit area showed that good regrowth results can be expected to be achieved. However the recent bushfire has burnt almost all the surface vegetation and it is currently not clear what impact the absence of any vegetable matter (normally collected as part of the initial clearing of the surface and subsequently used to provide cover as part of rehabilitation activity) will have on rehabilitation or what proportion of the seeds collected in salvaged topsoil will have remained viable after the fire.

Revegetation will predominantly occur through the collection and subsequent application of seeds and other plant material (including the lignotubers) harvested during the initial clearing process. To the extent that vulnerable species are affected by clearing activities, their seeds and potentially other plant material capable of regrowth will be part of the material harvested and subsequently used for rehabilitation purposes.

Rehabilitation will also be managed through the GDAP system, and consequently through the Document and Data Control MP (MRUP-EMP-038). For every rehabilitation site, records will be kept of all site works and associated factors including:

- Source and depth of growth medium.
- Seed mix species, provenance, proportions, rate, pre-treatment and method of application.
- Potential for seeding of conservation significant species.
- Application, density and source of any additional vegetable matter ('tree trash') utilised.
- Specifications of site works including depth of ripping and type and rate of any soil ameliorants added.
- Any other variations in rehabilitation protocol.

The rehabilitation process will be progressively implemented and will be monitored for effectiveness, including the ability or otherwise of vulnerable species to regrow from seed or plant material harvested. Monitoring will be conducted according to the methodology and scheduling specified within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030), in conjunction with associated climate data recorded according to specifications within the Environmental Monitoring Management Plan (MRUP-EMP-032). Rehabilitation success will be regularly reviewed against the Key Performance Indicators (KPIs) to be developed to ensure completion criteria for mine closure are being demonstrably met.

An investigation will be conducted in the event it becomes apparent that when an area containing vulnerable species has been cleared there is no regrowth in the area where the material has subsequently been applied. The investigation will establish the reason why there was no regrowth and whether alternative measures could be implemented to ensure that there is representation in rehabilitated area of vulnerable species that have been previously growing in cleared areas.

Monitoring results will be reported annually within the Annual Environmental Report submitted to regulators. These results will also be examined to determine avenues for continual improvement and best practice for rehabilitation practices. In addition to the direct impacts of the Project, any potential indirect impacts upon flora and vegetation will be managed under the Flora and Vegetation Management Plan (MRUP-EMP-001) which will require regular inspections to determine whether factors such as dust, fire, radiation, weeds or feral animals are having an adverse impact upon the local flora and vegetation and where such impacts are observed remedial action will be implemented as required under the appropriate Management Plan for the observed problem.

6.5.3 Monitoring

Monitoring of any potential indirect impacts by the Project upon the flora and vegetation will be undertaken by visual inspection by the Environmental Officer. This will occur both ad hoc, during daily activities, and once a year when a complete site inspection will made and recorded. An inspection of the condition of all vegetation adjacent to operations will be made by either walking or driving along all roads and pipelines within the Project area and around the perimeter of all mining and processing operations and infrastructure to determine if the condition of the vegetation has been modified. The details of the monitoring protocol will be specified within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030), including the attempted determination of the cause of condition change (such as by dust, feral animal activity, weeds, vehicular activities, fire or reduced annual rainfall). If deterioration of vegetation condition is attributed to operational activities of the Project, measures detailed within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030) will be implemented to prevent further deterioration and, where possible, to ameliorate the effects.

As discussed, monitoring of rehabilitation success will occur regularly as scheduled within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030). Methodology of monitoring specified within that management plan will ensure the determination of success, or otherwise, of meeting the KPIs established within the Mine Closure Plan (MRUP-EMP-031). An effective feedback loop will safeguard that continual improvement in rehabilitation success will occur. It will also guarantee that remedial work will be scheduled for any rehabilitation areas not meeting KPIs for the particular site.

All employees involved in undertaking clearing activities will be educated as part of their induction program, as required under the Environmental Induction and Training Management Plan (MRUP-ERMP-039) to recognise the appearance of all conservation significant flora known to exist within the local area. Identification guides will be made available and employees undertaking clearing or any other field activities will be encouraged to look for these species and to avoid their destruction where practicable.

Site monitoring will also include the identification of any weed presence within the MRUP. Protocols specified within the Weed Management Plan (MRUP-EMP-003) will ensure that immediate eradication of the plant or infestation will occur. The environmental induction process, detailed within the Environmental Induction and Training Management Plan (MRUP-EMP-039), will assist site personnel to identify and therefore observe the presence of any weeds and to report their observations to environmental staff.

The following would lead to contingency actions:

- Area of disturbance for a particular site exceeds that internally approved by 10%:
  - **Contingency action** – an investigation to determine the reasons behind the exceedance, implementation of appropriate remedial measures and modification of GDAP protocols to prevent reoccurrence.
- Total area of actual surveyed site disturbance approaches the life of mine total area of regulatory approved ground disturbance:
  - **Contingency action** – implementation of tighter controls over future areas of disturbance to ensure that the total approved area of disturbance is not exceeded.
- A significant deterioration in the condition of vegetation within the vicinity of any MRUP operational area.
  - Identify the cause of the deterioration, and if associated with the MRUP operations, implement measures to prevent further deterioration and, where possible, ameliorate the effects. Examples of such measures would be:
    - If Dust – utilise appropriate measures to further reduce dust emissions, such as increasing dust suppression activities (such as watering) or reducing the cause (such as reducing speed limits) as specified within the Dust Management Plan.
    - If Feral animal activity – attempt to determine if MRUP operations are encouraging animals to the area of activity and implement measures as specified within the Feral Animal Management Plan.
    - If Weeds – undertake the local eradication of weeds according to the protocols specified in the Weed Management Plan, and attempt to identify the source of introduction and determine future prevention strategies.
    - If Vehicle damage – investigate why vehicles are driving off designated tracks and ensure prevention of reoccurrences.

The direct impact upon flora and vegetation from the development of this Proposal will result in the disturbance of 3,787ha of native vegetation. The mitigation hierarchy requires that, where possible, these impacts are avoided. The Ground Disturbance Management Plan (MRUP-EMP-019) and under that plan the issue of GDAPs (MRUP-POL-001) will be utilised to avoid, where practicable, the disturbance of conservation significant flora and any other areas deemed to have environmental significance.

The same GDAP system will be utilised to ensure that where disturbance cannot be avoided, the extent will be minimised and progressive rehabilitation will occur as soon as is practicable.

Rehabilitation of previously disturbed areas within the Project area has demonstrated that good revegetation results are achievable at the site (Shogun test pit and exploration sites). The rehabilitation program will ensure continual improvement by use of monitoring results of the progressive rehabilitation throughout the life of the mine and the associated feedback loops into rehabilitation techniques and strategies detailed in the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030). Vimy aims to demonstrate best practice rehabilitation procedures for the local conditions.

Any indirect impacts upon flora and vegetation will require remedial action dependent upon the cause of the problem. It is expected that existing management measures will prevent such impacts from occurring or deal with them very quickly should any eventuate.

6.6 Predicted Outcomes

It is intended that the process of avoiding and minimising the disturbance of native vegetation through the use of GDAP system will result in no more than 3,787ha of native vegetation being cleared. Management measures should ensure that indirect impacts are quickly identified and remedied and that any lasting impact will be prevented from developing.

All areas that have been disturbed will ultimately be rehabilitated under the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030). Any areas cleared for construction purposes that are not subsequently required during operations will be progressively rehabilitated. The progressive rehabilitation of any available disturbed sites will be monitored and information on rehabilitation success will be reviewed and fed back into continual improvement of rehabilitation protocols.

After application of the management and mitigation measures described in Section 6.5, the MRUP is expected to result in the following outcomes in relation to flora and vegetation:

- Disturbance of approximately 3,787ha of native vegetation, which is broadly representative of the wider region.
- Negligible indirect impacts will occur given the nature of the proposed operations and the existing environment (i.e. no groundwater dependent ecosystems (GDE) present and dust, radiation, weeds and feral animals can be effectively managed using the management strategies presented in Section 6.5).
- Negligible potential direct impact on Conservation Significant Flora Species will occur due to their limited distribution within the proposed Disturbance Footprint. In total only the following will potentially be disturbed by the MRUP development:
  - 38 *Hibbertia crispula* plants (P1-vulnerable); 0.27% of regional total
  - 8 *Dampiera eriantha* plants (P1); 0.43% of regional total
  - 128 *Isotropis canescens* (P2); 4.25% of regional total
  - 2 *Styphelia* sp. Great Victoria Desert plants (P2); 1.84% of regional total
  - 63 *Comesperma viscidulum* plants (P4); 3.32% of regional total
  - 3,941 *Conospermum toddii* plants (P4); 8.62% of regional total
  - 945 *Grevillea secunda* plants (P4); 7.40% of regional total
  - 22 *Dicrastylis cundeeleensis* plants (P4); 0.31% of regional total and
  - 56 *Olearia arida* plants (P4); 1.83% of regional total.
- The risk of indirect impacts on Conservation Significant Flora Species is low given their limited distribution within the Development Envelope and the restricted nature of these impacts.
- No change in the conservation status of conservation significant flora species is therefore expected.
- Rehabilitation will restore some of the vegetation values of the pre-existing landscape.

Following rehabilitation of the MRUP, no significant residual impact is expected to occur for any environmental factor, and thus the requirement for direct offsets (i.e. land acquisition) is negated. Geographical distribution, productivity, and ecosystems are expected to be maintained through management and mitigation measures.

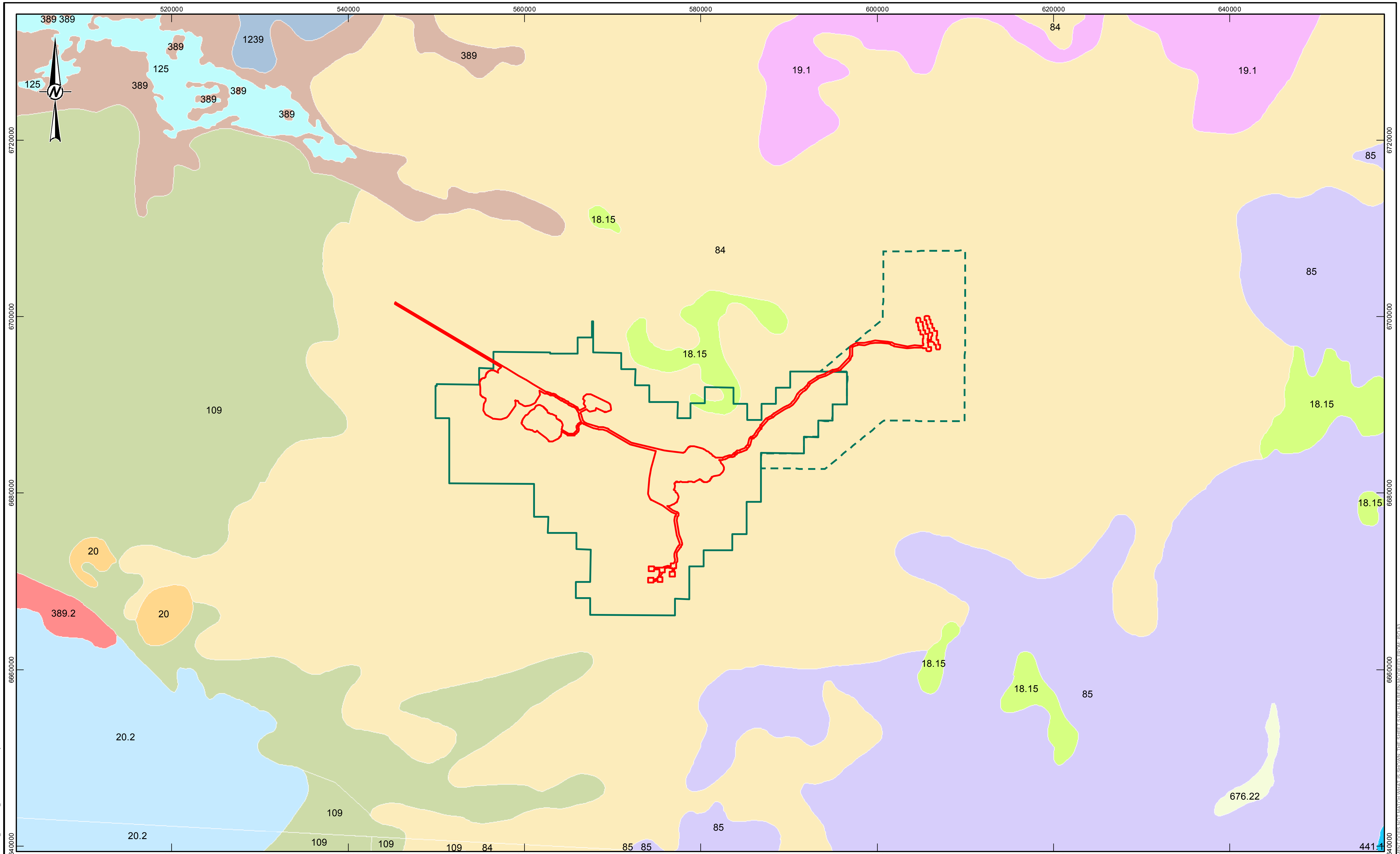
In considering the outcome as described, the MRUP is expected to meet the EPA objectives for vegetation and flora to maintain representation, diversity, viability and ecological function at the population and community level.

The Project area is located in a region where the condition of the vegetation usually lies somewhere between Good and Pristine depending mainly on the fire history. Recent fire activity (November 2014) burnt around 74% of the entire Development Envelope reducing its condition temporarily to Degraded (Appendix A1). Fire activity may be the greatest threat to conservation significant flora growing in the area, as large areas burn quite frequently and some species of flora are not entirely well adapted to survive intense fires (Appendix A1).

In total, around 3,787ha of native vegetation will be cleared and that area will have hosted a large variety of different vegetation communities and some conservation significant flora. Once activity has ceased in a particular area, the surface will be progressively rehabilitated to establish a self-sustaining ecosystem; seed selection will consider the reconstructed soil profile and corresponding vegetation communities in the vicinity.

Very little material will be removed from the Project site. Due to backfilling of the majority of pit voids, and utilisation of in-pit tailings deposition for the majority of the mine operation, the majority of voids will be filled and progressive rehabilitation will take place. The overburden dumps and the one above-ground TSF will also require rehabilitation. Rehabilitation will seek to return the disturbed areas to a condition similar to existing local vegetation communities and so the residual adverse impacts on the environment will be limited. Due to the progressive nature of the rehabilitation, the opportunity will be utilised to trial the establishment of appropriate conservation significant flora in areas being rehabilitated, and ensure continual improvement.

Rehabilitation will be undertaken to a standard that ensures that the residual impacts after rehabilitation of previously cleared areas are not significant and do not warrant any offset. However, it is acknowledged that there is a time lag between the loss of a vegetation community or any conservation significant flora and when appropriate self-sustaining vegetation communities can be properly re-established (including any conservation significant flora) and that this temporary loss may be regarded as an adverse impact. Further consultation with the Commonwealth's Department of Environment will be undertaken to establish the extent to which such a temporary loss might be regarded as a residual impact and might be regarded as significant thereby necessitating an offset requirement.



LEGEND

VEGETATION ASSOCIATION CODE

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19.1	85	441.1	PROJECT BOUNDARY (MINING TENURE)		
20	109	676.22	PROJECT BOUNDARY (MISCELLANEOUS TENURE)		
20.2	125	1239			
	389				

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
PRE-EUROPEAN VEGETATION © DEPARTMENT OF AGRICULTURE, WESTERN AUSTRALIA

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CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-28
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
PRE-EUROPEAN VEGETATION

PROJECT NO.	CONTROL	REV.	FIGURE
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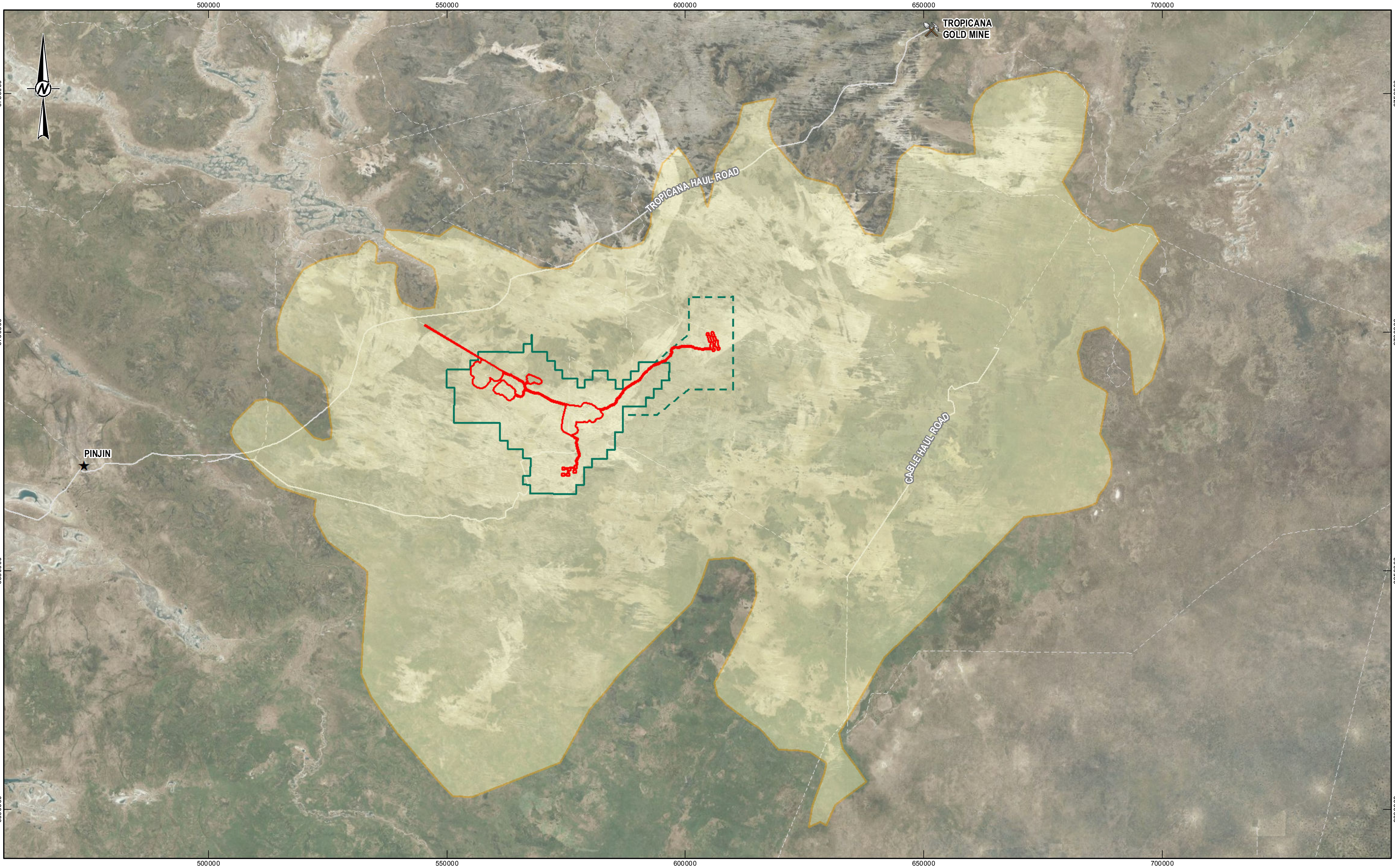

LEGEND

- MINOR ROAD/TRACK
- ROAD
- YELLOW SANDPLAIN BOUNDARY
- AMENDED MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE

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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-28
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

TITLE
MRUP AREA WITHIN THE PEC - "YELLOW SANDPLAIN COMMUNITIES IN THE GREAT VICTORIA DESERT"

PROJECT NO.	CONTROL	REV.	FIGURE
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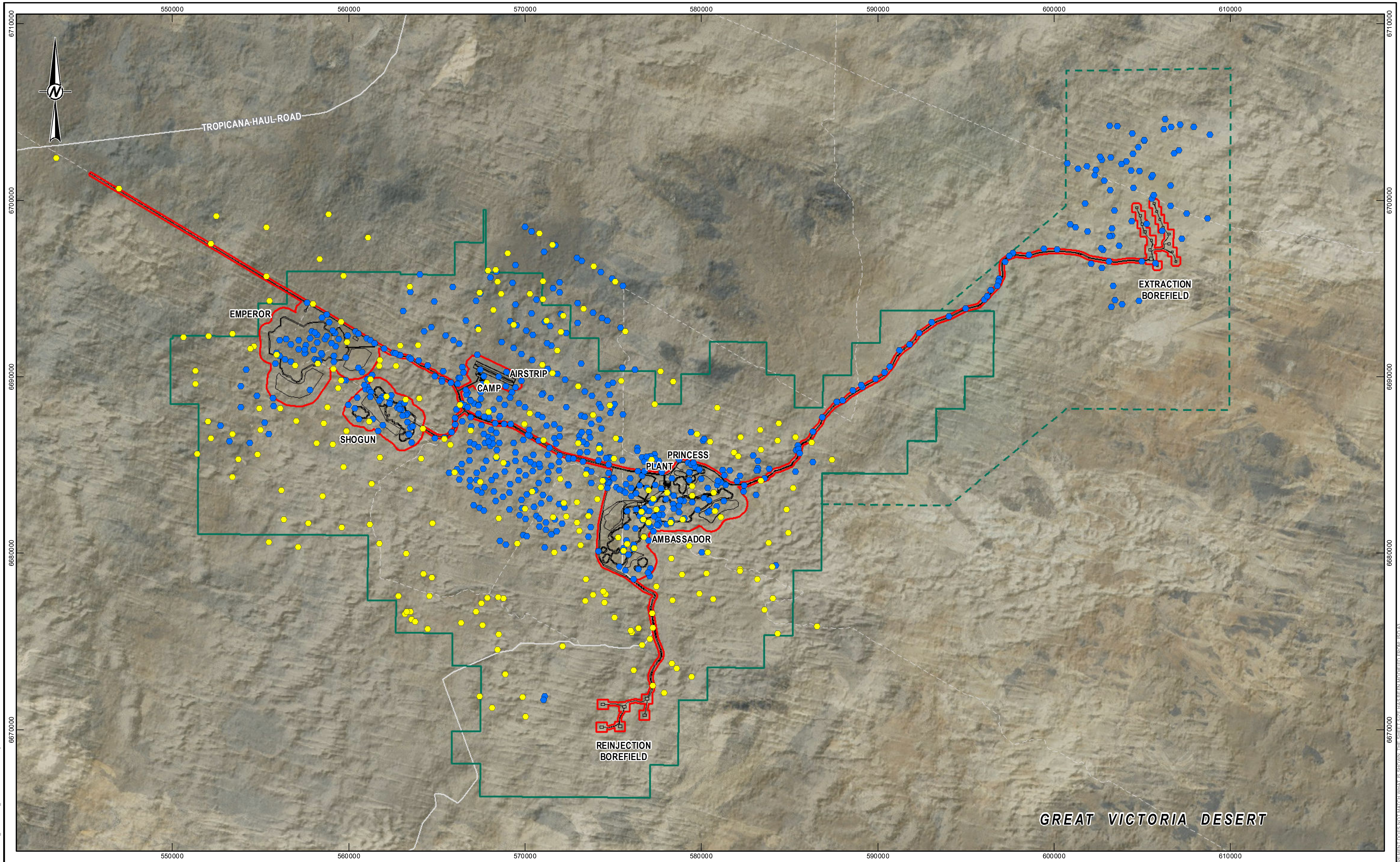

LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

VEGETATION PLOT, RELEVE SITES AND INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 5 10
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CLIENT	VIMY RESOURCES LIMITED
PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT	Golder Associates
YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB
TITLE	VEGETATION PLOT AND RELEVE SITES
PROJECT NO.	1540340
CONTROL	PER
REV.	0
FIGURE	6.3

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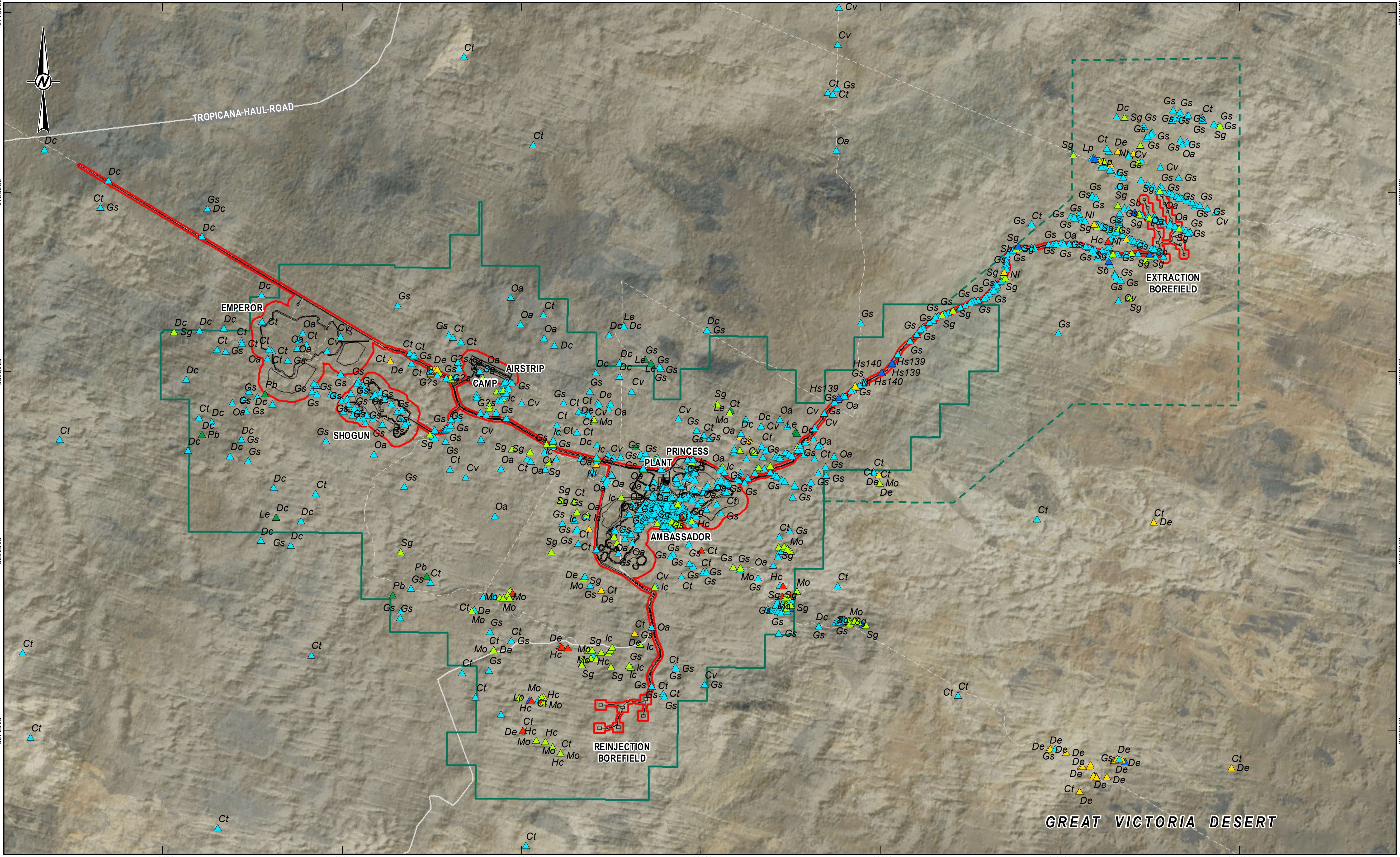

LEGEND

- MINOR ROAD/TRACK
- ROAD
- THREATENED & PRIORITY SPECIES
  - P1 & VULNERABLE
  - P1
  - P2
  - P3
  - P4
  - OTHER
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

THREATENED & PRIORITY SPICIES AND INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

TITLE
THREATENED AND PRIORITY SPECIES

PROJECT NO.	CONTROL	REV.	FIGURE
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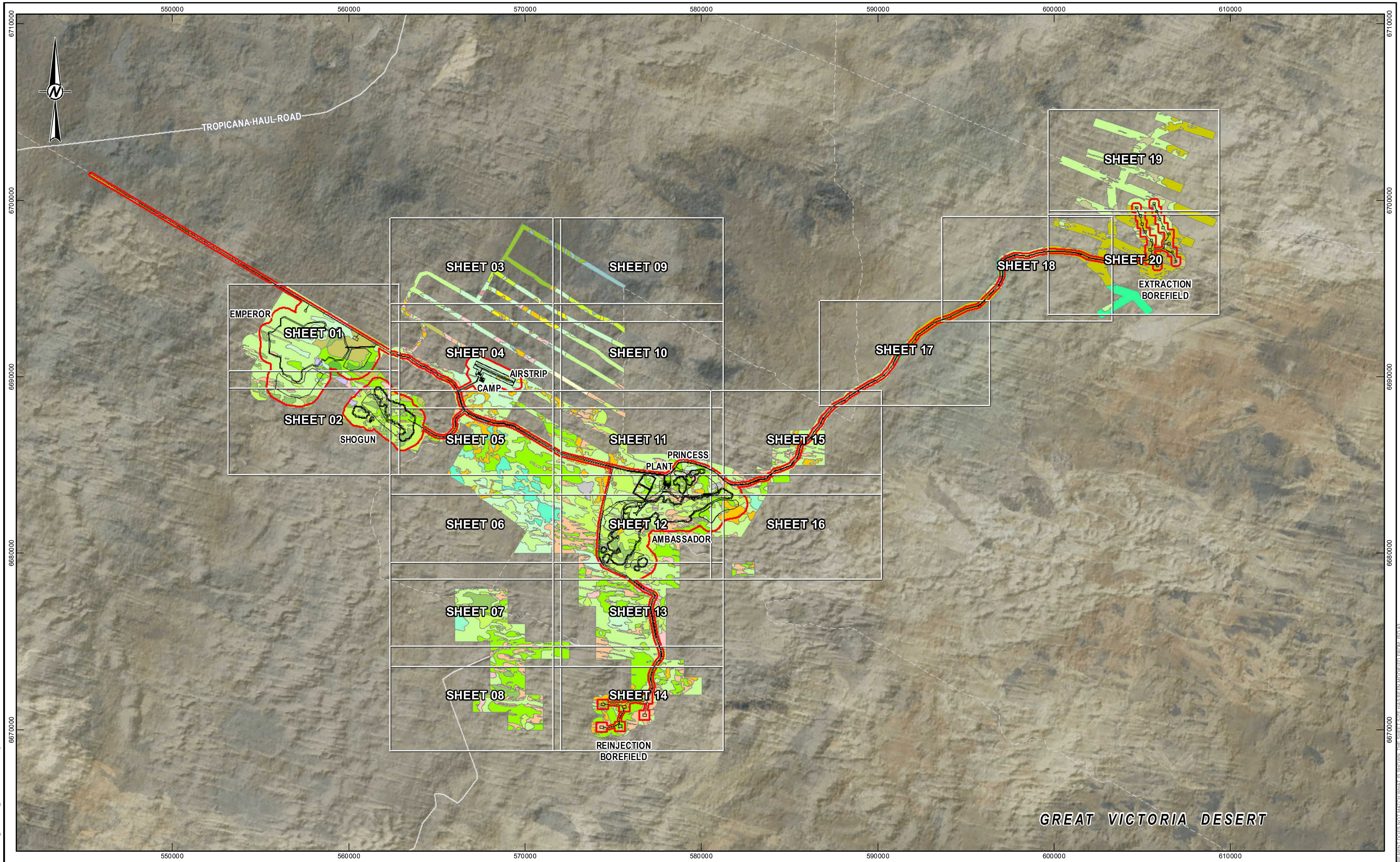

LEGEND

- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- VEGETATION SHEET

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 5 10
KILOMETRES
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CLIENT
VIMY RESOURCES LIMITED

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

TITLE
VEGETATION MAPPING SHEET LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.5

Eucalypt Woodlands

E1 Low Woodland to Low Open Woodland *of Eucalyptus concinna* with *Callitris preissii* over *Westringia cephalantha*, *Melaleuca hamata*, *Acacia colletioides*, *Acacia hemiteles* and *Scaevola spinescens* over *Triodia desertorum*. This community occurs on red-orange sandy loams on flats.

E2 Low Woodland to Open Scrub Mallee of *Eucalyptus trivalva* and *Eucalyptus platycorys* with *Callitris preissii* and *Hakea francisiana* over *Acacia colletioides*, *Acacia hemiteles*, *Melaleuca hamata*, *Westringia cephalantha*, *Bertya dimerostigma* and mixed shrubs over *Triodia desertorum* with occasional emergent *Eucalyptus gongylocarpa*. This community occurs on red-orange sandy loams on flats.

E3 Low Open Woodland of *Eucalyptus gongylocarpa* over *Eucalyptus youngiana*, *Eucalyptus ceratocorys*, *Grevillea juncifolia*, *Hakea francisiana*, *Cryptandra distigma* and mixed low shrubs over *Triodia desertorum*, *Chrysitrix distigmatosa* and *Lepidobolus deserti*. This community occurs on yellow and yellow-orange sands on flats, slopes and between dunes.

E4 Low Open Woodland of *Eucalyptus gongylocarpa* over *Callitris preissii* with *Hakea francisiana* and *Grevillea juncifolia* over *Bertya dimerostigma*, *Westringia cephalantha* and mixed shrubs over *Triodia rigidissima* and *Triodia desertorum*. This community occurs on orange sands on flats and slopes.

E5 Low Open Woodland of *Eucalyptus rigidula* and *Eucalyptus* sp. Mulga Rock with *Hakea francisiana* and *Grevillea juncifolia* over *Westringia cephalantha*, *Acacia helmsiana*, *Acacia rigens*, *Eremophila platythamnos* subsp. *platythamnos*, *Cryptandra distigma* and mixed low shrubs over *Triodia desertorum*, *Triodia rigidissima* and *Chrysitrix distigmatosa*. This community occurs on yellow and orange sands on flats and slopes.

E6 Open Scrub Mallee to Very Open Scrub Mallee of *Eucalyptus rigidula* and/or *Eucalyptus* sp. Mulga Rock over *Acacia hemiteles, Hakea francisiana*, *Westringia rigida*, *Cryptandra distigma*, *Grevillea acuaria* and mixed low shrubs over *Triodia rigidissima* with *Halgania cyanea*. This community occurs on red-orange sandy loams on flats and low lying swales.

E7 Open Scrub Mallee to Very Open Scrub Mallee of varying *Eucalyptus* spp. over *Grevillea acuaria*, *Acacia hemiteles*, *Cryptandra distigma*, *Westringia cephalantha* and mixed shrubs over *Triodia desertorum*. This community occurs on red-orange sandy loams in low lying swales.

E8 Open Scrub Mallee to Very Open Scrub Mallee of *Eucalyptus ceratocorys* and *Eucalyptus mannensis* subsp. *mannensis* with *Eucalyptus youngiana, Hakea francisiana* and *Grevillea juncifolia* over *Acacia fragilis*, *Acacia helmsiana* and mixed low shrubs over *Triodia desertorum, Chrysitrix distigmatosa* and *Lepidobolus deserti* with emergent *Eucalyptus gongylocarpa*. This community occurs on yellow sands on flats and slopes.

E9 Very Open Scrub Mallee of *Eucalyptus mannensis* subsp. *mannensis* with *Grevillea juncifolia* and *Hakea francisiana* over *Cryptandra distigma*, *Acacia ligulata* and mixed low shrubs over *Triodia desertorum* with emergent *Eucalyptus gongylocarpa*. This community occurs on yellow sand on slopes and flats.

E10 Open Scrub Mallee to Very Open Scrub Mallee of *Eucalyptus concinna* with *Eucalyptus platycorys* over *Hakea francisiana*, *Cryptandra distigma*, *Acacia rigens* and mixed shrubs over *Triodia rigidissima* and *Chrysitrix distigmatosa* with *Leptosema chambersii*. This community occurs on orange-red sandy loams on slopes and flats.

E11 Open Scrub Mallee to Very Open Scrub Mallee of *Eucalyptus platycorys* with *Eucalyptus concinna* over *Acacia helmsiana*, *Grevillea juncifolia*, *Hakea francisiana* and mixed shrubs over *Triodia desertorum* and *Chrysitrix distigmatosa*. This community occurs on orange-yellow sandy loams on slopes and flats.

E12 Open Scrub Mallee to Very Open Scrub Mallee of *Eucalyptus trivalva* with *Eucalyptus rigidula* over *Hakea francisiana*, *Bertya dimerostigma*, *Acacia helmsiana*, *Cryptandra distigma* and *Grevillea juncifolia* over *Triodia rigidissima*, *Triodia desertorum*, *Chrysitrix distigmatosa* and *Halgania cyanea*. This community occurs on orange and red-orange sandy loams on flats and swales.

E13: Low open mallee woodland of *Eucalyptus youngiana* over low shrubland of *Grevillea didymobotrya* subsp. *didymobotrya*, *Cryptandra distigma*, *Banksia elderiana*, *Calothamnus gilesii*, *Acacia desertorum* var. *desertorum* and other *Acacia* spp. over open *Triodia* spp. hummock grassland with *Chrysitrix distigmatosa* and some low myrtaceous shrubs (and occasional emergent *Eucalyptus gongylocarpa*). This community occurs on orange-yellow sandy loams on lower slopes and flats.

E14: Low open mallee woodland of *Eucalyptus leptophylla* or *Eucalyptus horistes* over open low shrubland of *Daviesia ulicifolia* subsp. *aridicola*, *Callitris verrucosa* and mixed *Acacia* spp., over *Triodia* spp., *Androcalva melanopetala*, *Dysphania kalpari* and other short-lived perennial or annual herbs. This community occurs on highly leached red-brown-white sandy-clayey soils in swales and drainage areas.

Acacia Woodland

A1 Low Woodland to Tall Shrubland of *Acacia aneura* over *Aluta maisonneuvei* subsp. *auriculata*, *Eremophila latrobei*, *Phebalium canaliculatum*, *Prostanthera* spp. and mixed shrubs. This community occurs on orange sandy loams or clay loams with some laterite pebbles on flats.

Mixed Shrublands

S1 Shrubland of *Melaleuca hamata* with *Hakea francisiana* and mixed shrubs over *Triodia desertorum* with emergent *Eucalyptus* spp. This community occurs on yellow and orange sand on slopes and flats.

S2 Shrubland of *Acacia sibina* with *Grevillea juncifolia* and *Eucalyptus youngiana* over *Phebalium canaliculatum*, *Grevillea acuaria* and mixed shrubs over *Triodia desertorum*. This community occurs on red clay loams in seasonally wet areas.

S3 Shrubland of *Allocasuarina spinosissima* and *Allocasuarina acutivalvis* subsp. *acutivalvis* with *Grevillea juncifolia* and *Hakea francisiana* over *Triodia desertorum* with emergent *Eucalyptus youngiana* and *Eucalyptus gongylocarpa*. This community occurs on yellow sand on slopes.

S4 Shrubland to Open Shrubland of *Acacia desertorum* var. *desertorum* and mixed low shrubs over *Triodia desertorum* with occasional emergent mallee *Eucalyptus* species. This community occurs on yellow or orange sands on mid-slopes.

S5 Shrubland to Open Shrubland of *Acacia sibina* with *Phebalium tuberculosum* over *Enekbatus eremaeus*, *Bertya dimerostigma*, *Homalocalyx thryptomenoides*, *Baeckea* sp. Great Victoria Desert (A.S. Weston 14813), *Melaleuca hamata* and mixed low shrubs over *Triodia desertorum* and *Chrysitrix distigmatosa* with occasional emergent *Eucalyptus gongylocarpa* and *Eucalyptus youngiana*. This community occurs on yellow-orange sands on flats and lower slopes.

S6 Low Shrubland of *Thryptomene biseriata*, *Allocasuarina spinosissima*, *Allocasuarina acutivalvis* subsp. *acutivalvis*, *Jacksonia arida*, *Calothamnus gilesii*, *Acacia fragilis*, *Conospermum toddii* (P4), *Pityrodia lepidota*, *Lomandra leucocephala*, *Anthotroche pannosa* and mixed low shrubs over *Triodia desertorum* with *Lepidobolus deserti* with emergent *Eucalyptus gongylocarpa*, *Eucalyptus youngiana*, *Eucalyptus ceratocorys* and *Eucalyptus mannensis* subsp. *mannensis*. This community occurs on yellow sand dunes.

S7 Low Shrubland to Low Open Shrubland of *Enekbatus eremaeus*, *Acacia desertorum* var. *desertorum*, *Verticordia helmsii*, *Homalocalyx thryptomenoides*, *Leptospermum fastigiatum*, *Allocasuarina spinosissima, Baeckea* sp. Great Victoria Desert (A.S. Weston 14813), *Leptosema chambersii* and mixed low shrubs over *Triodia desertorum* and *Chrysitrix distigmatosa* with occasional emergent mallee *Eucalyptus* species, *Grevillea juncifolia* and *Hakea francisiana*. This community occurs on yellow and orange sands on lower slopes, undulating plains and swales.

S8 Low Open Shrubland of *Calothamnus gilesii*, *Persoonia pertinax*, *Thryptomene biseriata*, and *Leptospermum fastigiatum* with *Anthotroche pannosa, Acacia helmsiana*, *Microcorys macredieana*, *Micromyrtus stenocalyx* and mixed low shrubs over *Triodia desertorum* with *Lepidobolus deserti*, *Chrysitrix distigmatosa* and *Caustis dioica* with emergent *Eucalyptus youngiana*, *Eucalyptus gongylocarpa* and *Eucalyptus ceratocorys*. This community occurs on yellow sands flats adjacent to yellow sand dunes and undulating sandplains.

S9: Low open shrubland of *Melaleuca hamata* and mixed *Acacia* species (including *Acacia fragilis, Acacia ligulata* and *Acacia sibina*) with *Hannafordia bissillii* subsp. *bissillii*, *Grevillea didymobotrya* subsp. *didymobotrya*, *Mirbelia seorsifolia* over *Triodia* spp. hummock grassland with *Leptosema chambersii*, *Chrysitrix distigmatosa*, *Aristida contorta* and *Goodenia xanthosperma*, with emergent eucalypt mallees. This community occurs on orange-red sandy-clay loam, in swales and on flats.

S10: Low open shrubland of *Banksia elderiana*, *Calothamnus gilesii*, *Grevillea didymobotrya* subsp. *didymobotrya*, *Acacia desertorum* var. *desertorum* and *Grevillea secunda* (P4) with *Leptospermum fastigiatum* and emergent *Eucalyptus youngiana* (and *Eucalyptus rosacea*) over *Triodia* spp. hummock grassland with *Chrysitrix distigmatosa*. This community occurs on orange-yellow undulating sandplains and flats.

Chenopod Shrublands

C1 Low Chenopod Shrubland of *Atriplex ?vesicaria* with *Eremophila decipiens* subsp. *decipiens* and *Acacia colletioides*. This community occurs on red-brown clay loams on clay pans. *Callitris preissii* with *Eucalyptus* spp. over mixed shrubs are found in adjacent pockets.

D Disturbed

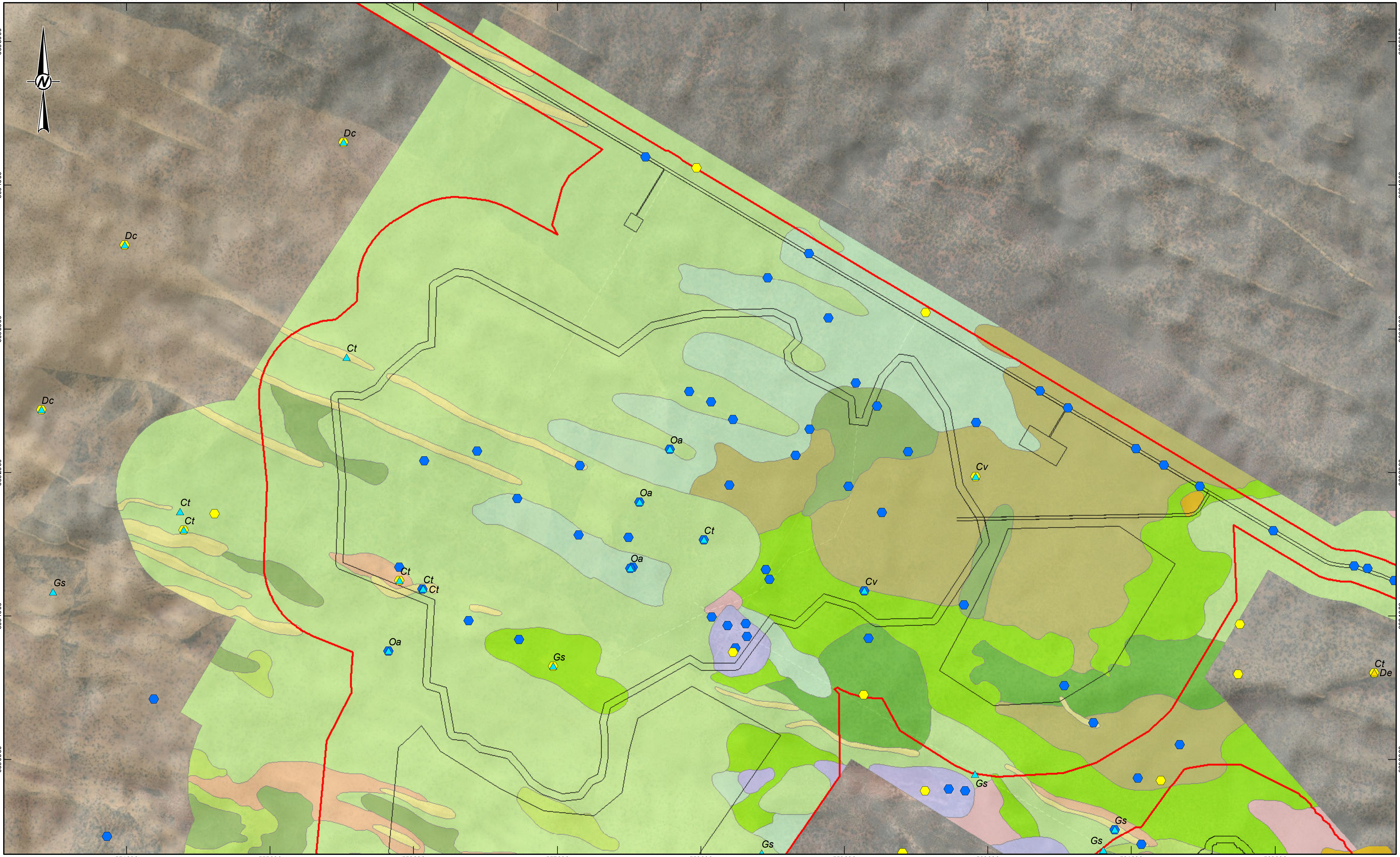
Priority Species

Code	Species	Status
Aen	Acacia eremophila numerous-nerved variant (A.S. George 11924)	P3
Aev	Acacia eremophila var. variabilis	P3
As	Acacia aff. sorophylla	Other
Bs	Baeckea ?sp. Sandstone (C.A. Gardner s.n. 26 Oct. 1963)	P3
Ct	Conospermum toddii	P4
Cta	Caesia talingka ms	P2
Cv	Comesperma viscidulum	P4
Dc	Dicrastylis cundeeleensis	P4
De	Dampiera eriantha	P1
E?u	Eremophila ?undulata	P2
Gs	Grevillea secunda	P4
Hc	Hibbertia crispula	P1 & Vulnerable
Hs139	Hakea sp. (LAC 139 13/04/14)	Other
Hs140	Hakea sp. (LAC 140 13/04/14)	Other
Ic	Isotropis canescens	P2
Le	Labichea eremaea	P3
Lp	Leucopogon aff. planifolius	Other
Mo	Malleostemon sp. Officer Basin (D. Pearson 350)	P2
Nl	Neurachne lanigera	P1
Oa	Olearia arida	P4
Pb	Ptilotus ?blackii	P3
Pc	Physopsis chrysotricha	P2
Sb	Schoenus sp. A1 Boorabbin (K.L. Wilson 2581)	Other
Sg	Styphelia sp. Great Victoria Desert (N. Murdock 44)	P2

REFERENCE

VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

CLIENT VIMY RESOURCES LIMITED			PROJECT MULGA ROCK URANIUM PROJECT
CONSULTANT	YYYY-MM-DD	2015-10-28	TITLE VEGETATION UNIT DISTRIBUTION – LEGEND
	DESIGNED	MS	
	PREPARED	MS	
	REVIEWED	GB	PROJECT NO. 1540340 · CONTROL PER · REV. 0 · FIGURE 6.6
	APPROVED	GB	



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

PROJECT
MULGA ROCK URANIUM PROJECT

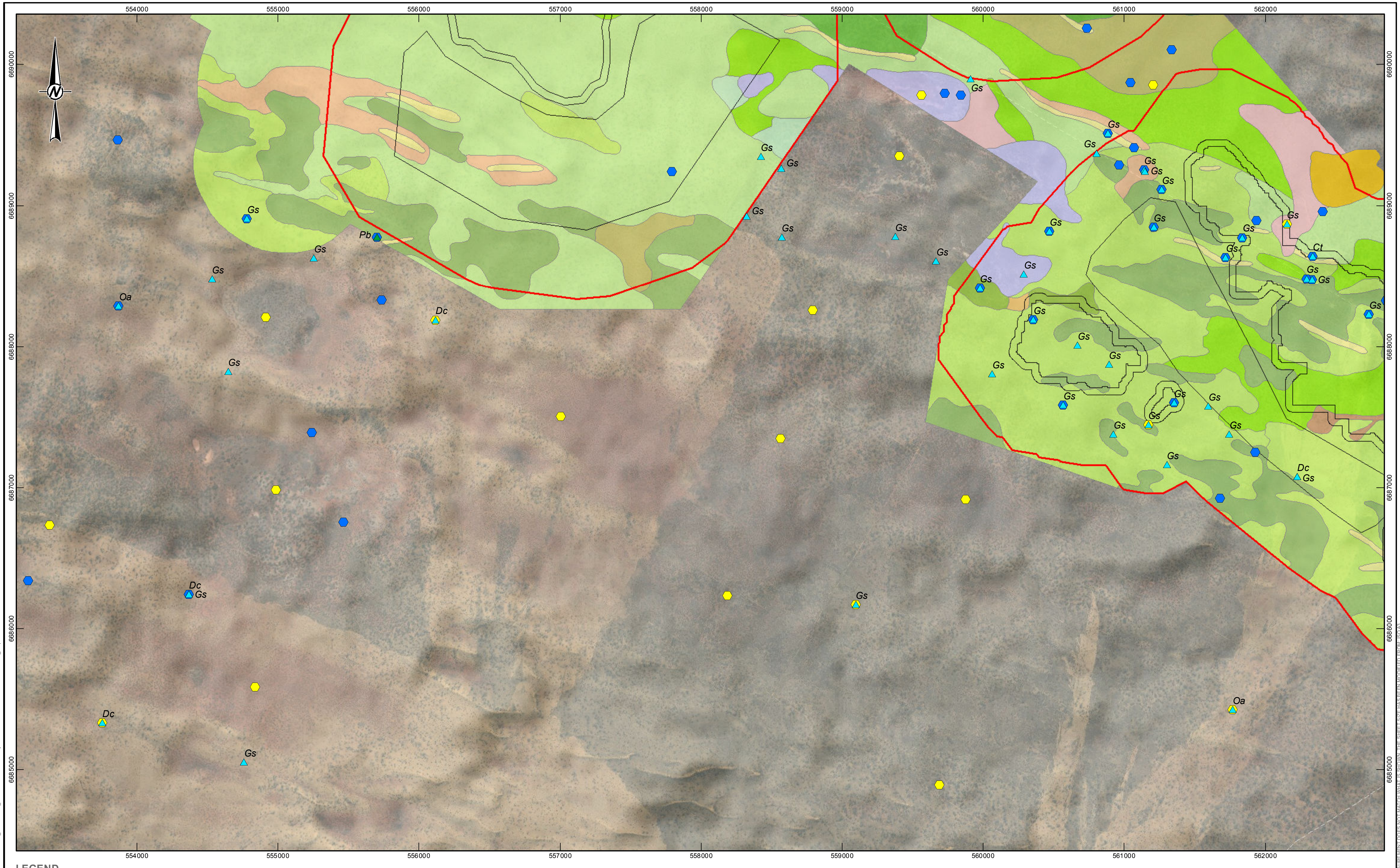
CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

TITLE
VEGETATION
SHEET 1 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.7



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

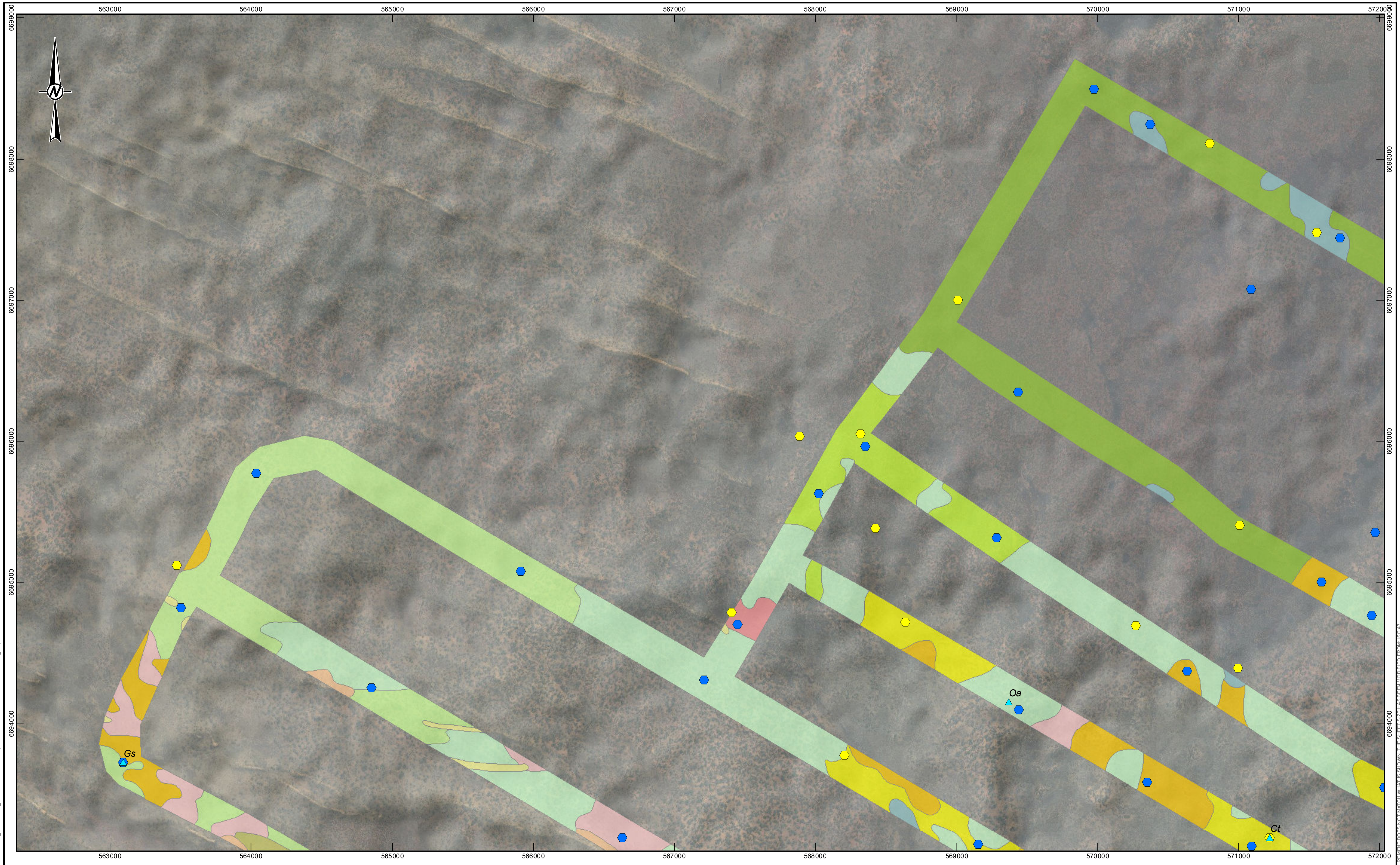
1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500
1:25,000 METRES

CLIENT	VIMY RESOURCES LIMITED
PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT	Golder Associates
YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB
TITLE	**VEGETATION SHEET 2 OF 20**
PROJECT NO.	1540340
CONTROL	PER
REV.	0
FIGURE	**6.8**



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

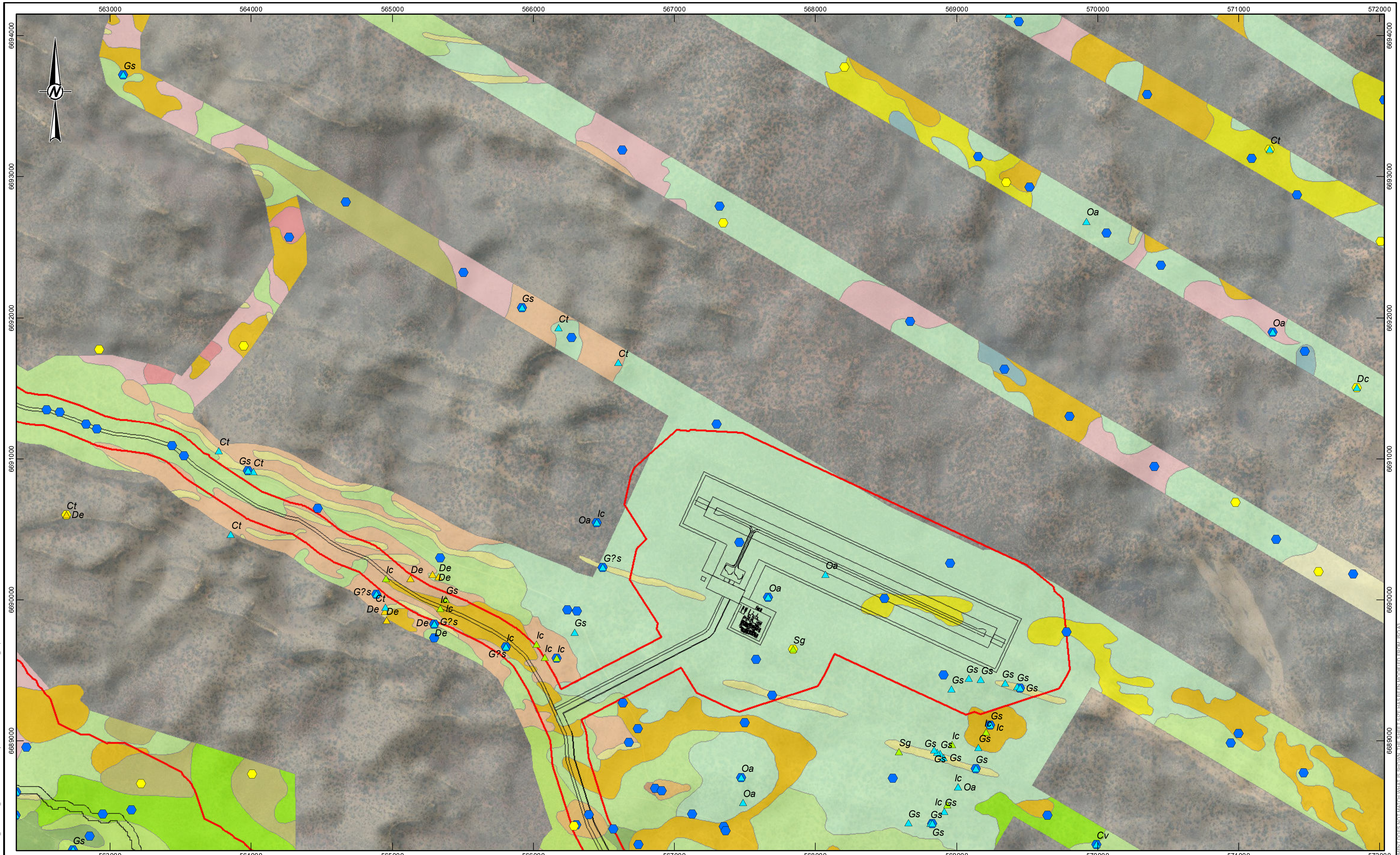
REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500
1:25,000 METRES

CLIENT	VIMY RESOURCES LIMITED
CONSULTANT	Golder Associates
YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB
PROJECT	MULGA ROCK URANIUM PROJECT
TITLE	VEGETATION SHEET 3 OF 20
PROJECT NO.	1540340
CONTROL	PER
REV.	0
FIGURE	6.9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT	VIMY RESOURCES LIMITED
CONSULTANT	Golder Associates
YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB
PROJECT	MULGA ROCK URANIUM PROJECT
TITLE	**VEGETATION SHEET 4 OF 20**
PROJECT NO.	1540340
CONTROL	PER
REV.	0
FIGURE	**6.10**

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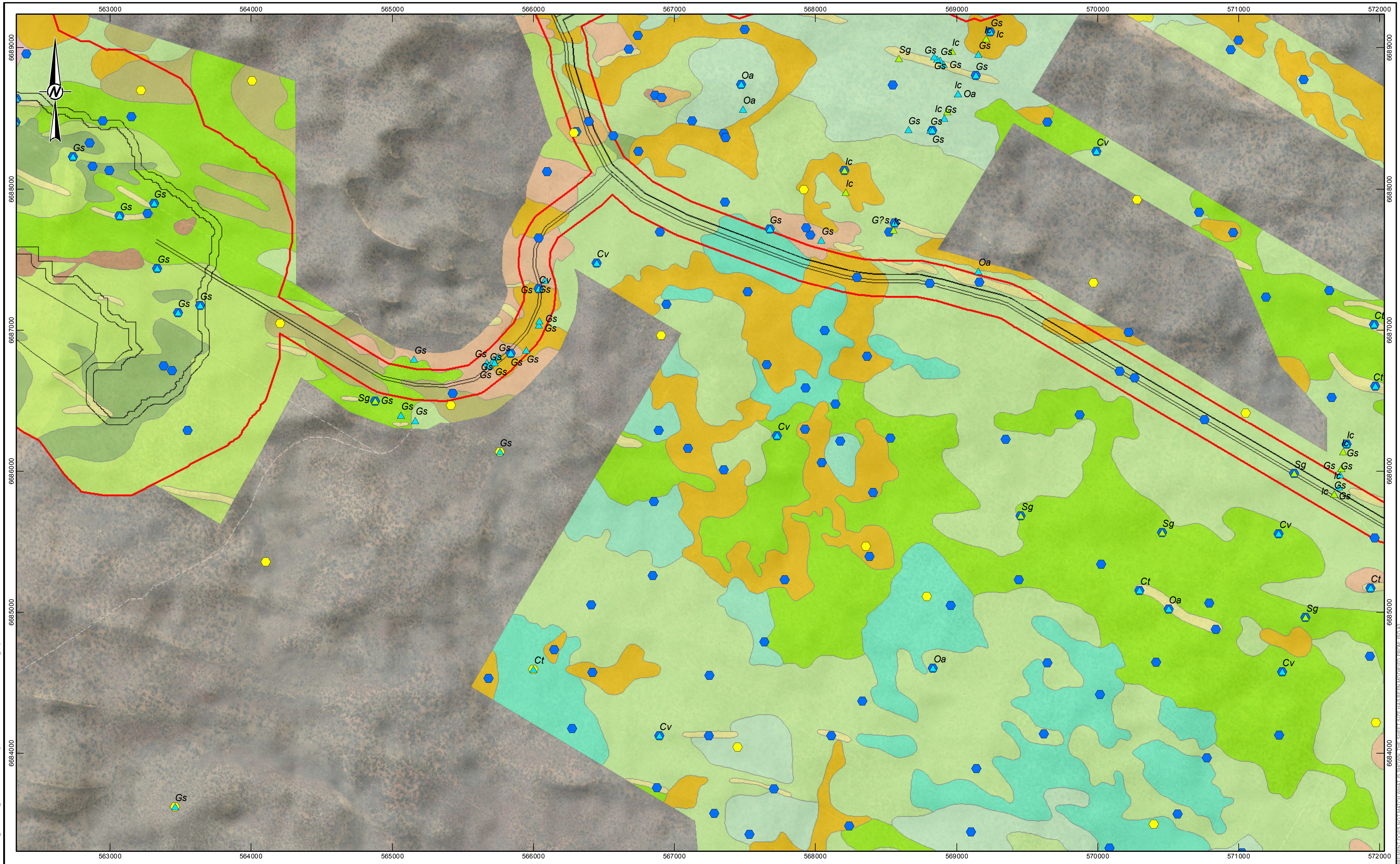

LEGEND

VEGETATION PLOT LOCATION

RELEVE SITE

THREATENED & PRIORITY SPECIES

P1 & VULNERABLE

P1

P2

P3

P4

OTHER

MINOR ROAD/TRACK

ROAD

INFRASTRUCTURE

MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 5 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**6.11**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

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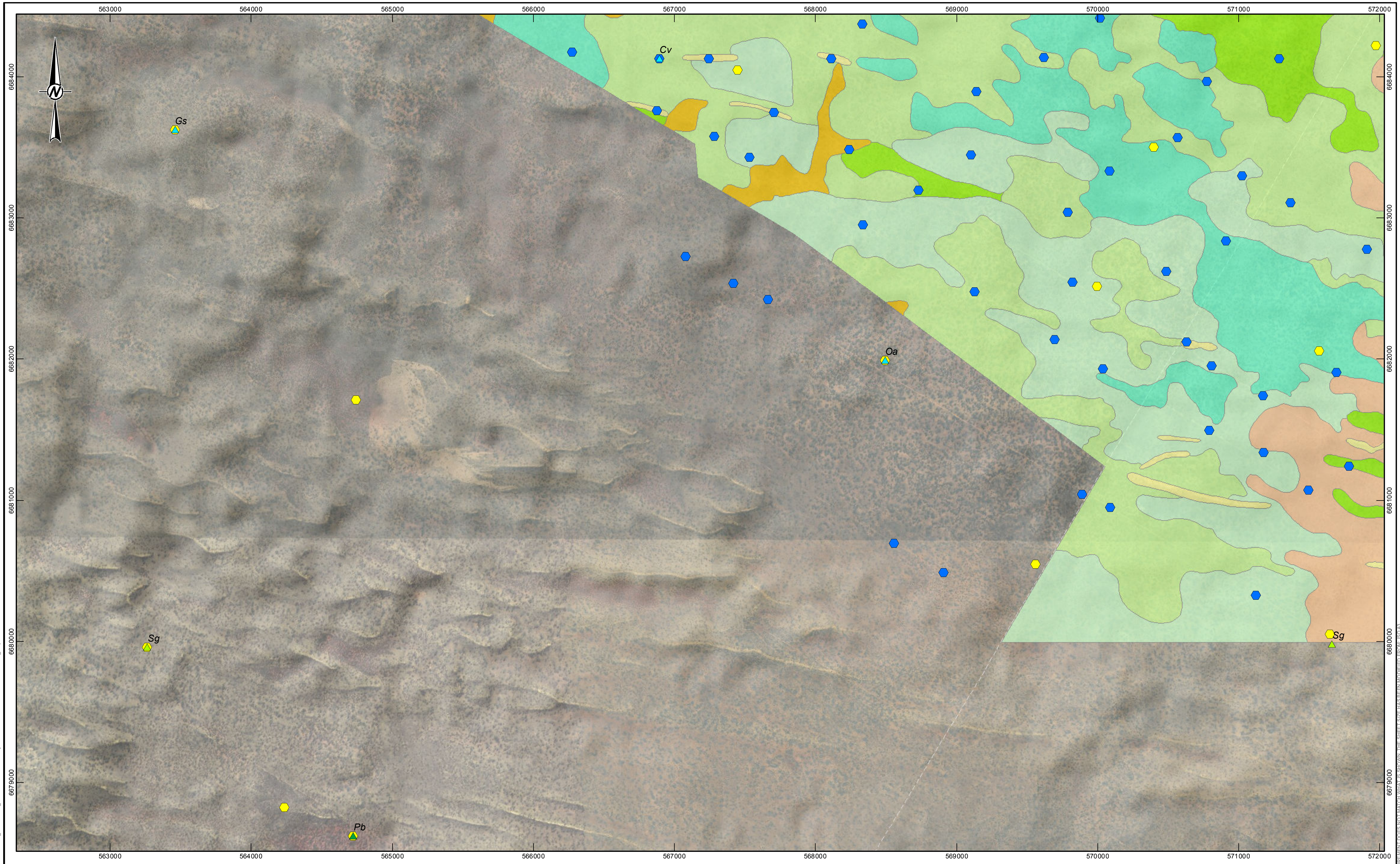

LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER

- MINOR ROAD/TRACK
- ROAD

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT	VIMY RESOURCES LIMITED
CONSULTANT	Golder Associates
YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 6 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**6.12**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
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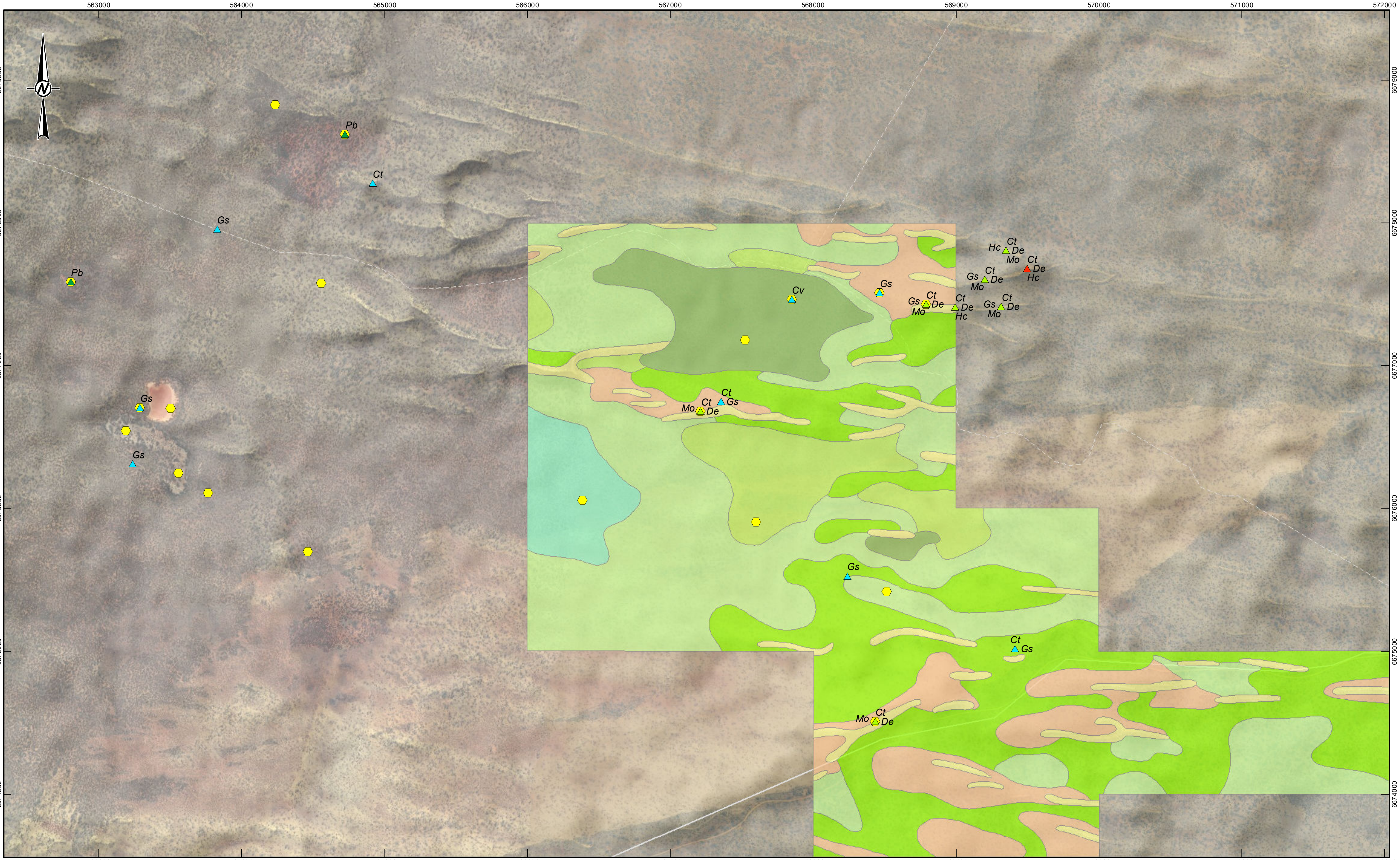


LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

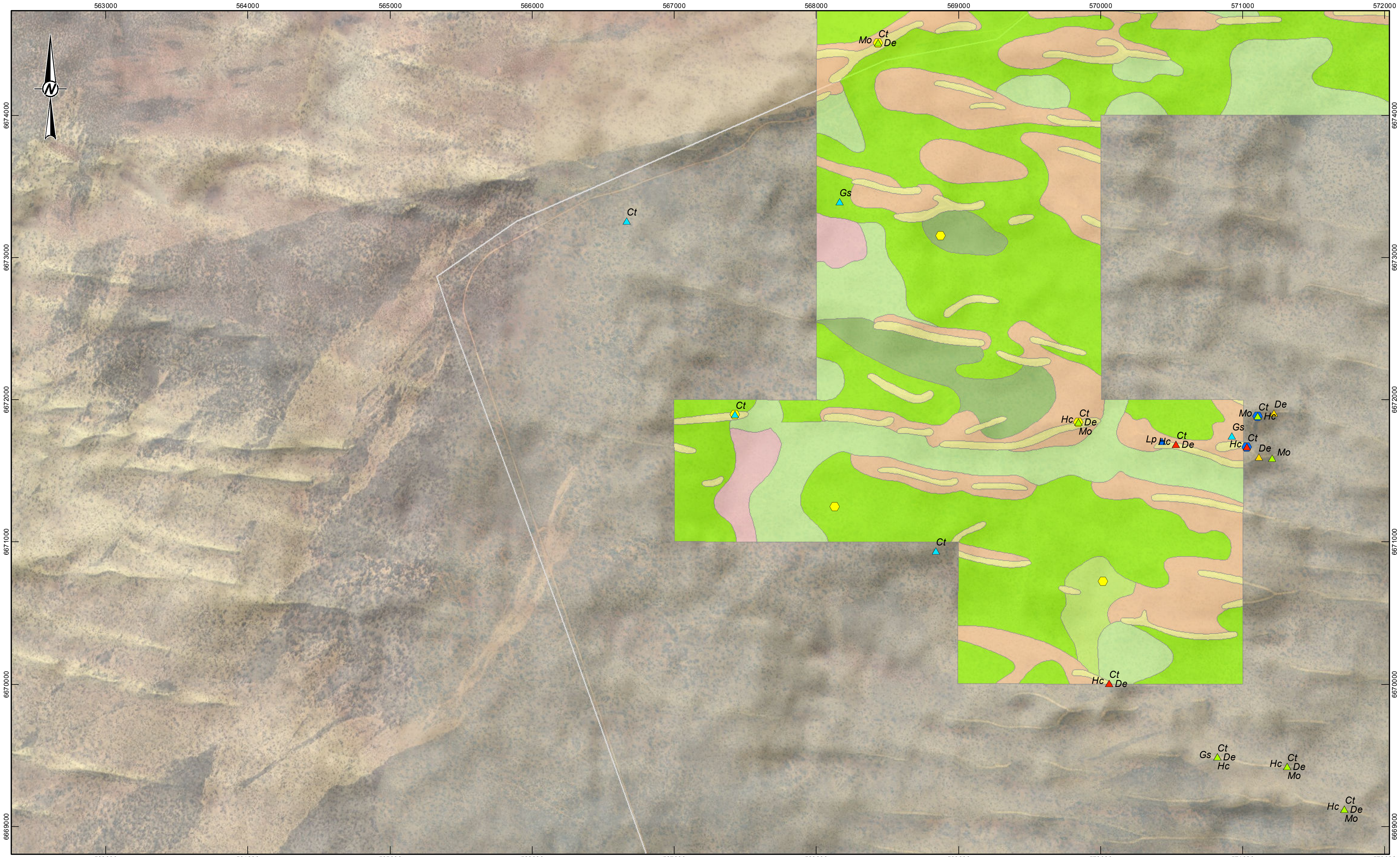
PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

TITLE
VEGETATION
SHEET 7 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**6.13**



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500
1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

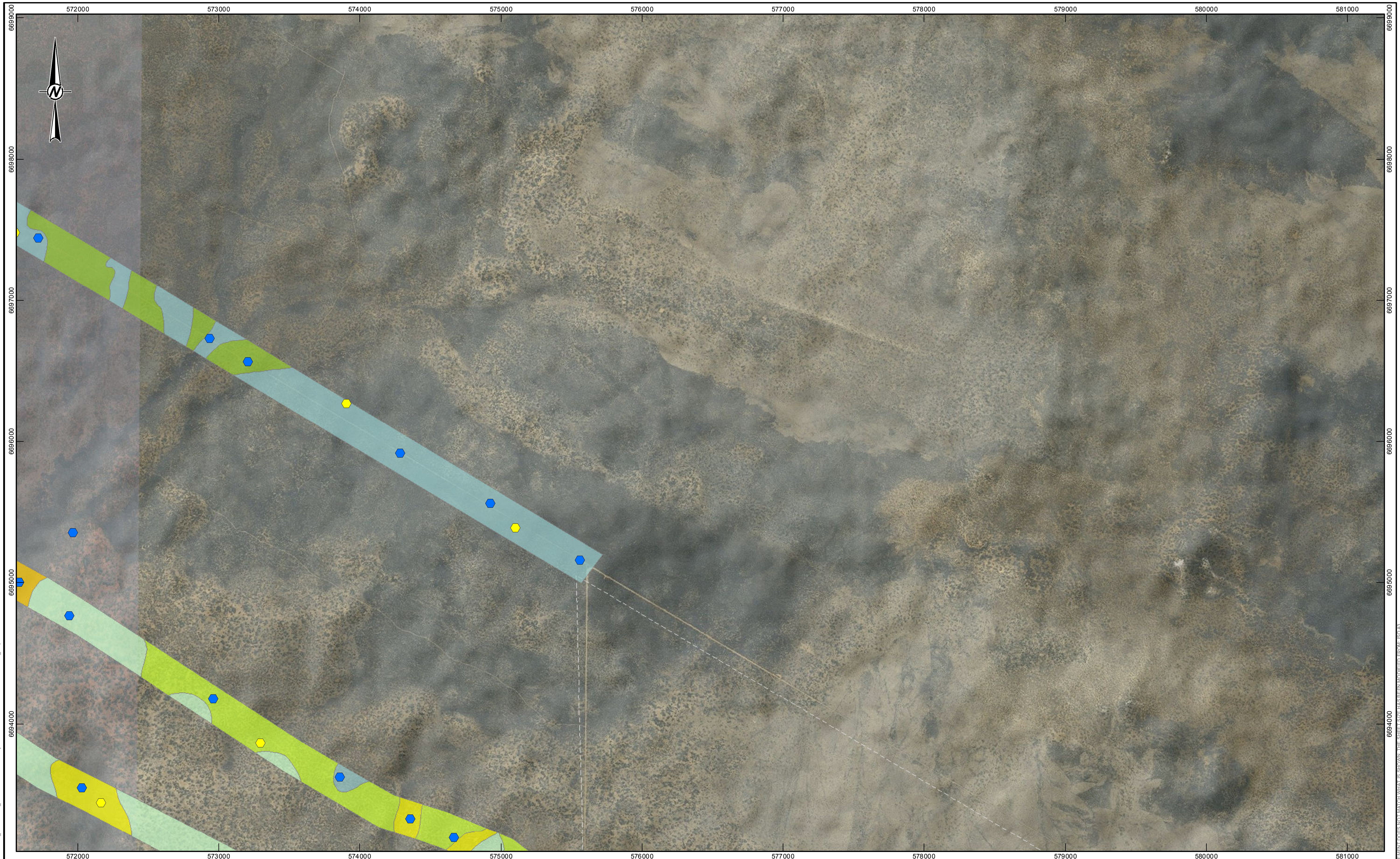
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 8 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**6.14**



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500
1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

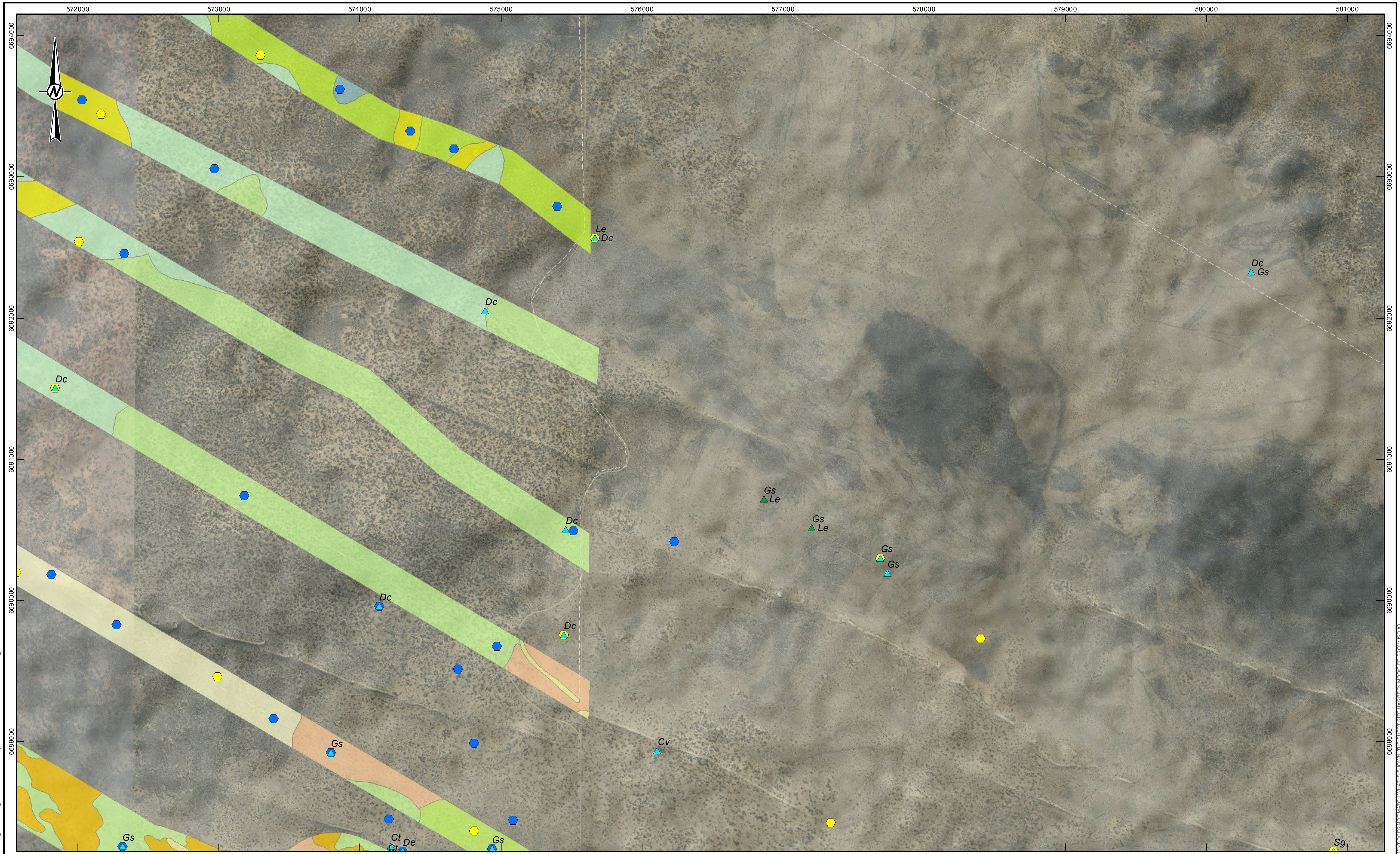
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 9 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.15



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500
1:25,000 METRES

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT	YYYY-MM-DD: 2015-10-31	TITLE **VEGETATION** **SHEET 10 OF 20**	
	DESIGNED: MS		
	PREPARED: MS		
	REVIEWED: GB	PROJECT NO. 1540340	CONTROL PER
	APPROVED: GB	REV. 0	FIGURE **6.16**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
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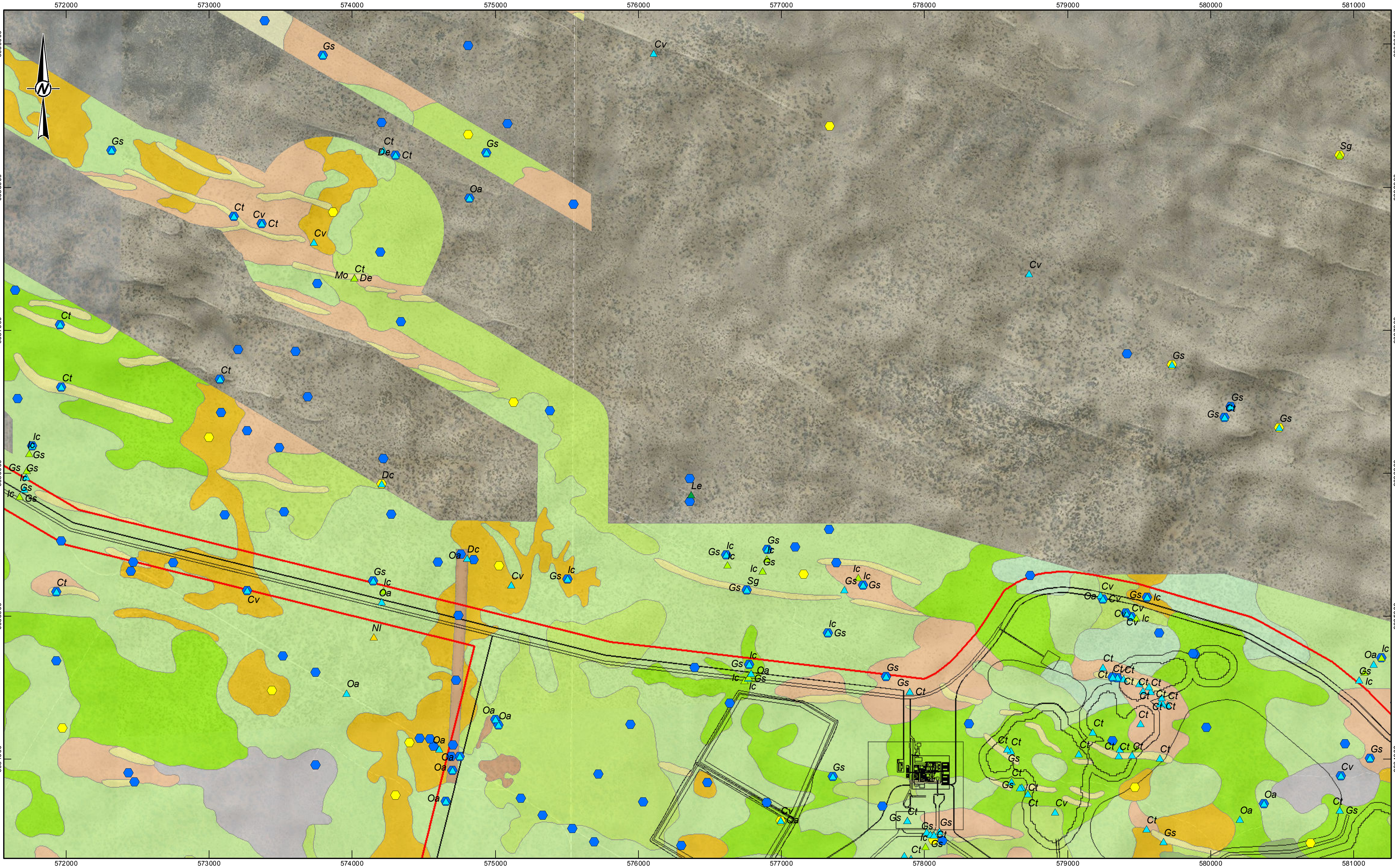


LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

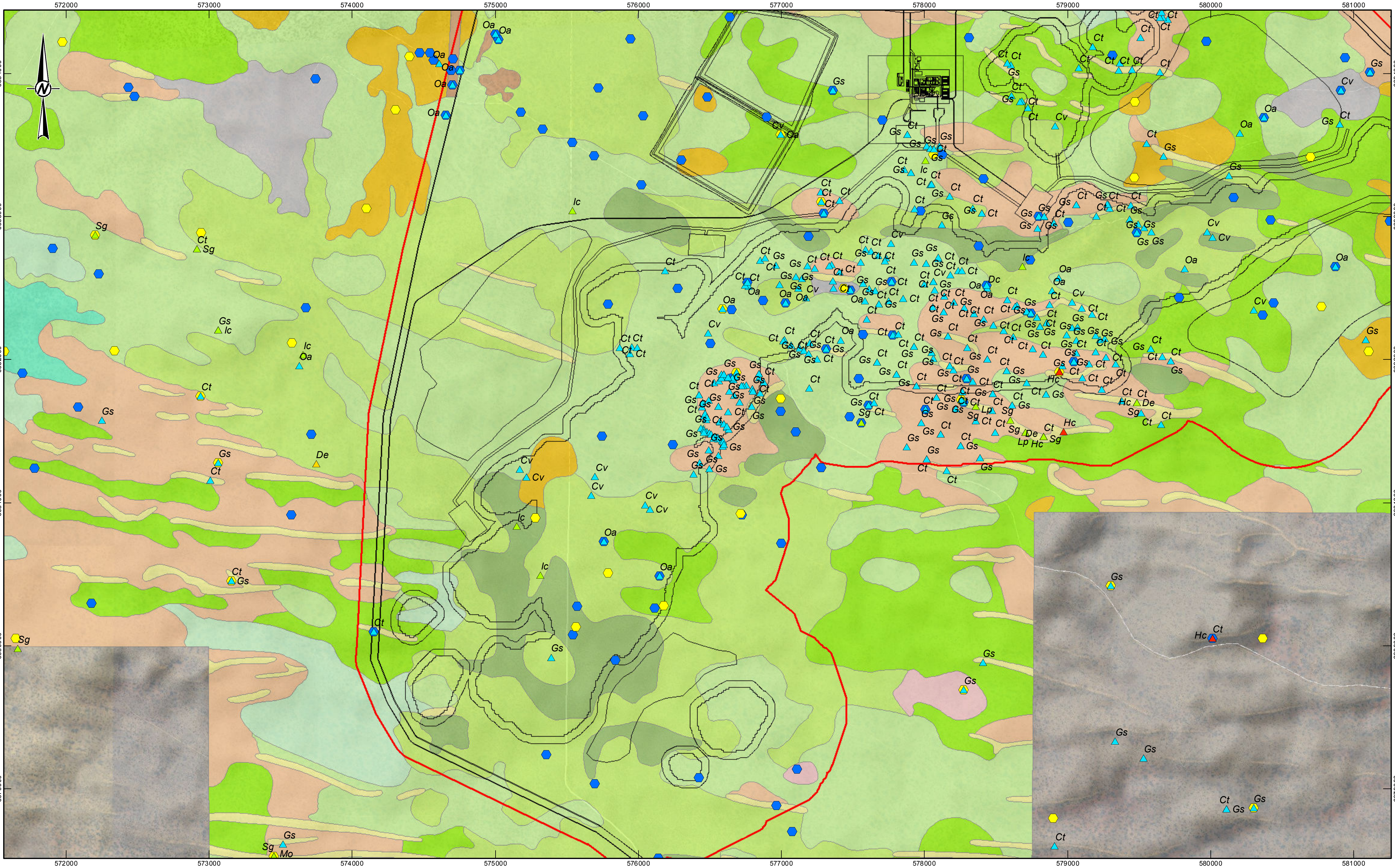
PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 11 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**6.17**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 12 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.18

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

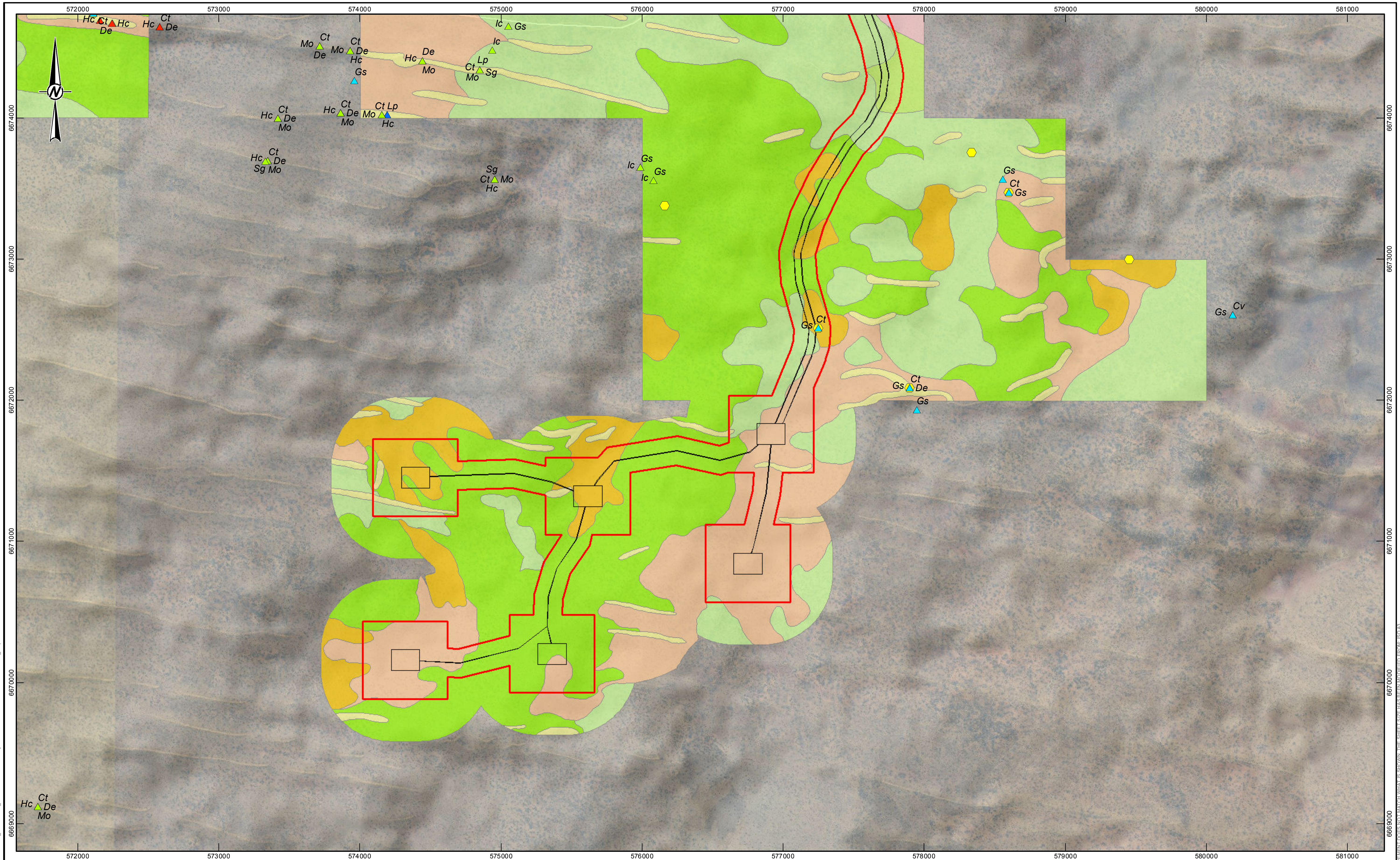
PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 13 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.19

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

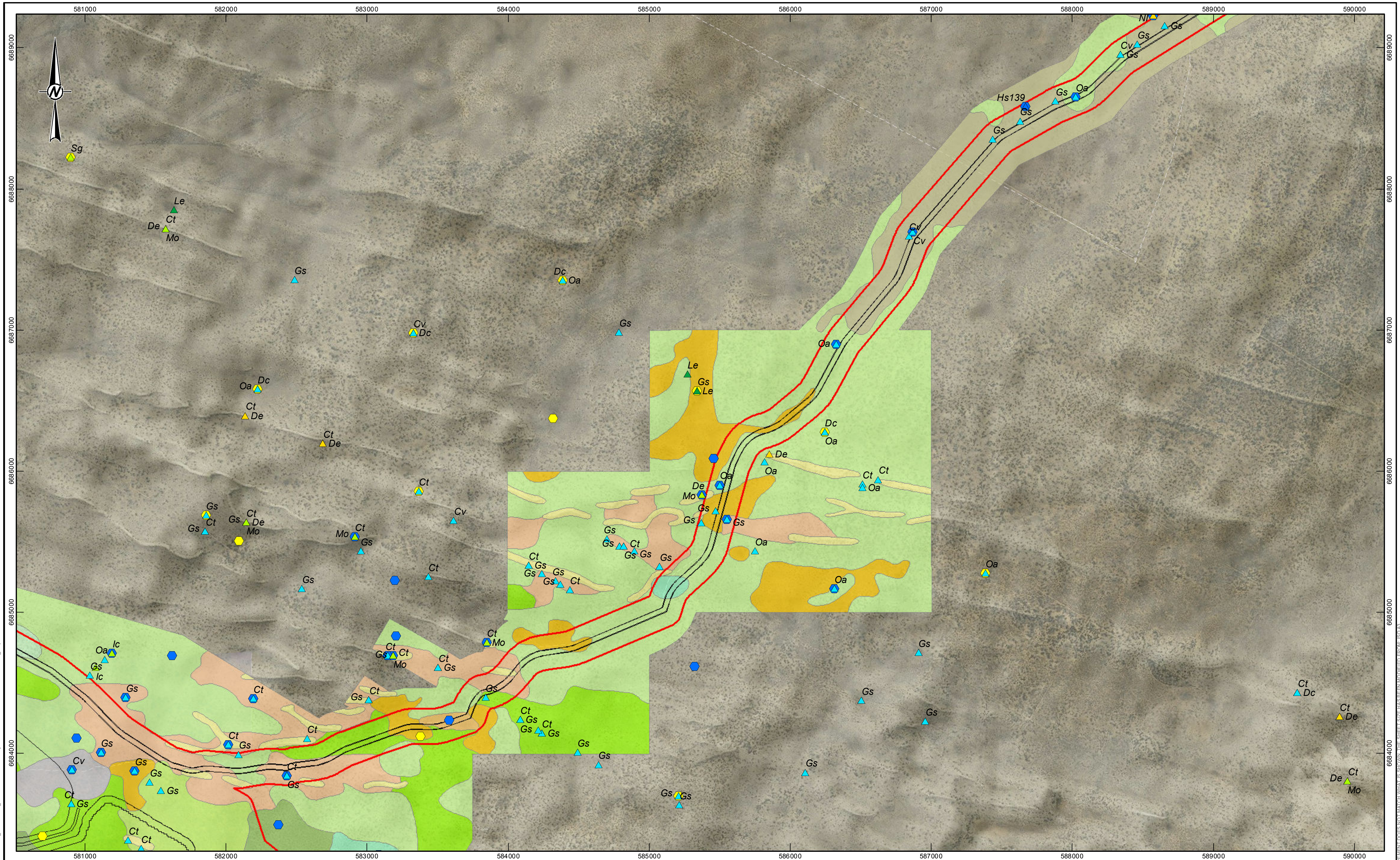
PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 14 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.20

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500
1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

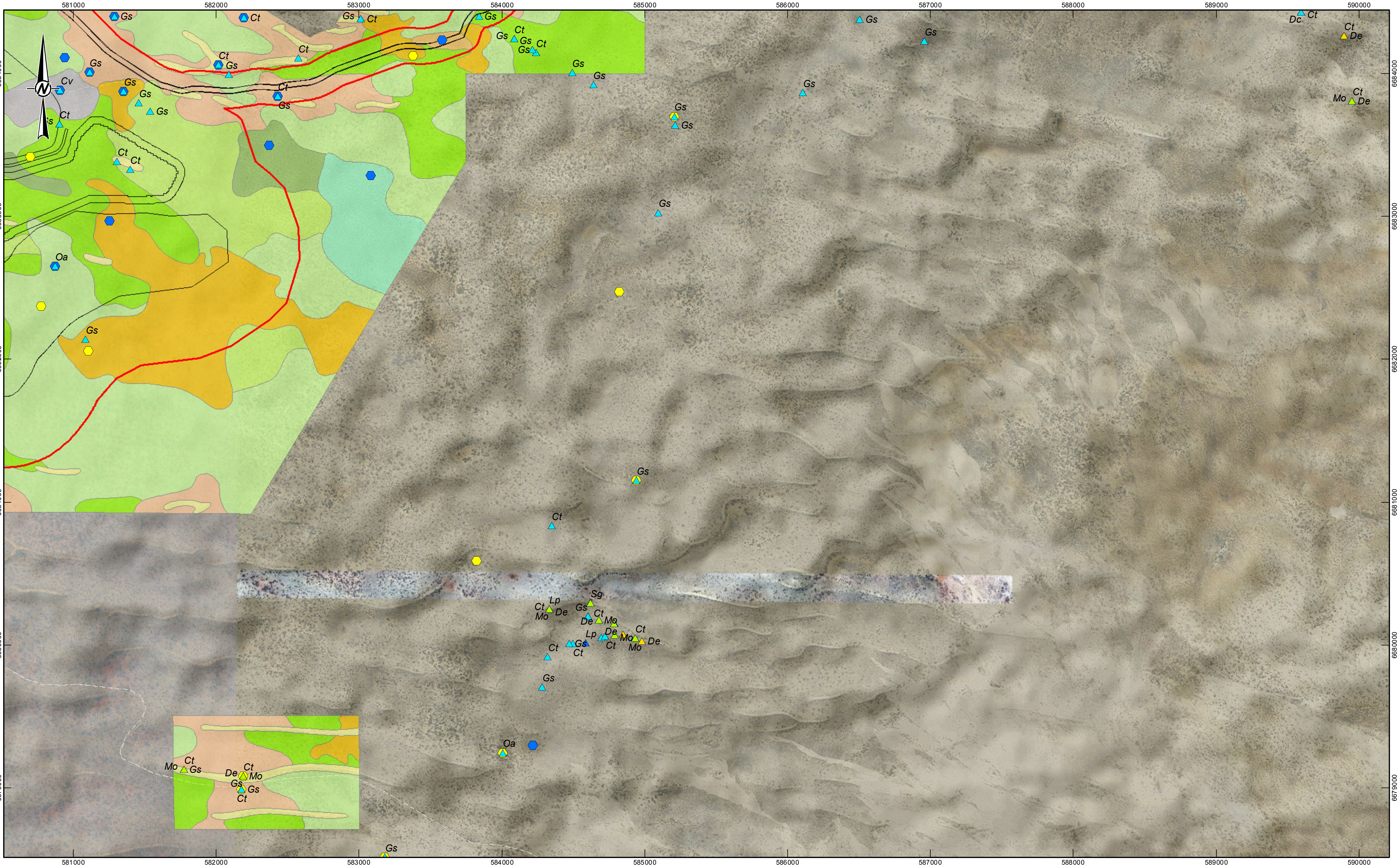
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 15 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.21



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

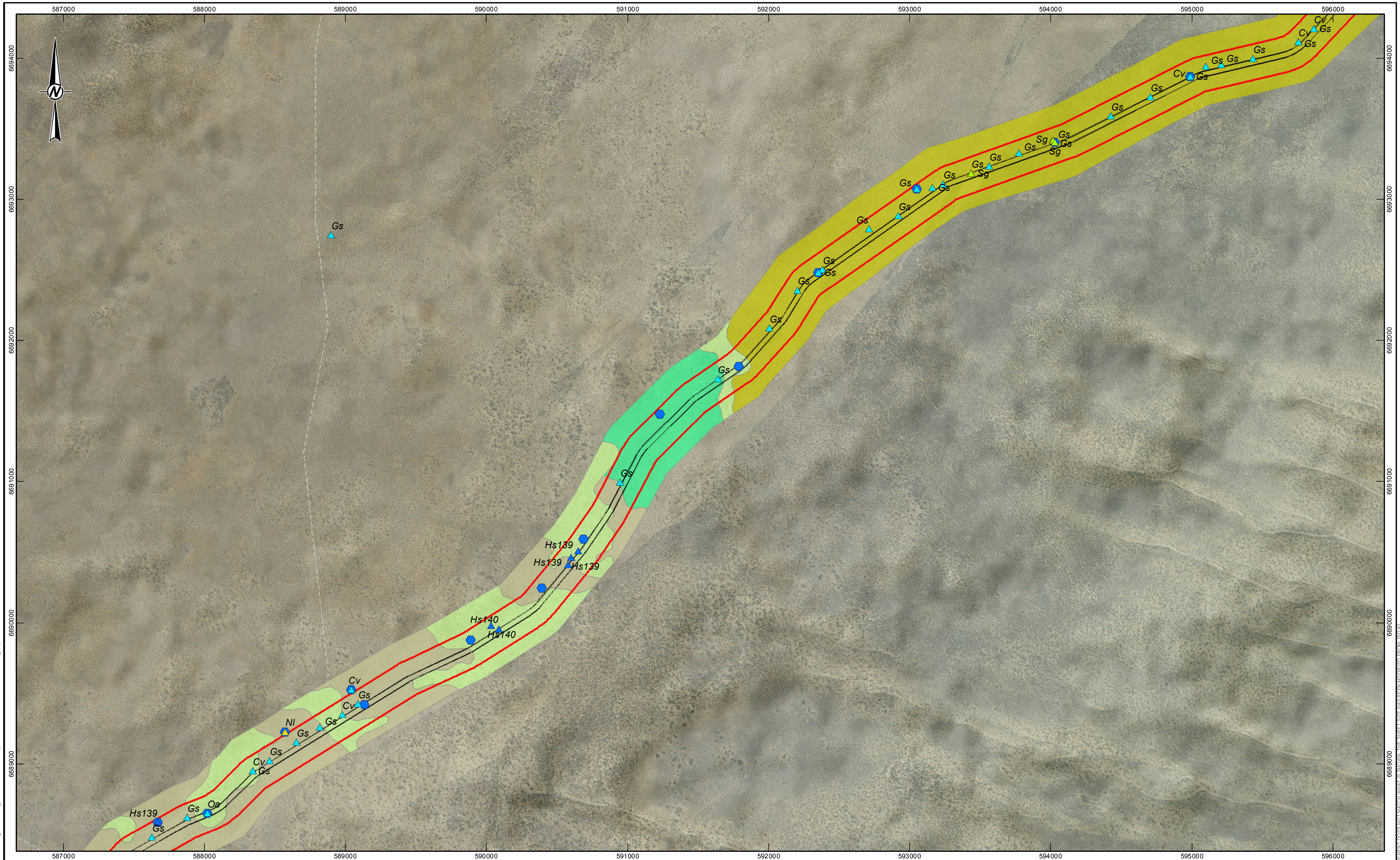
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 16 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.22



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 17 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.23

LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500

1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

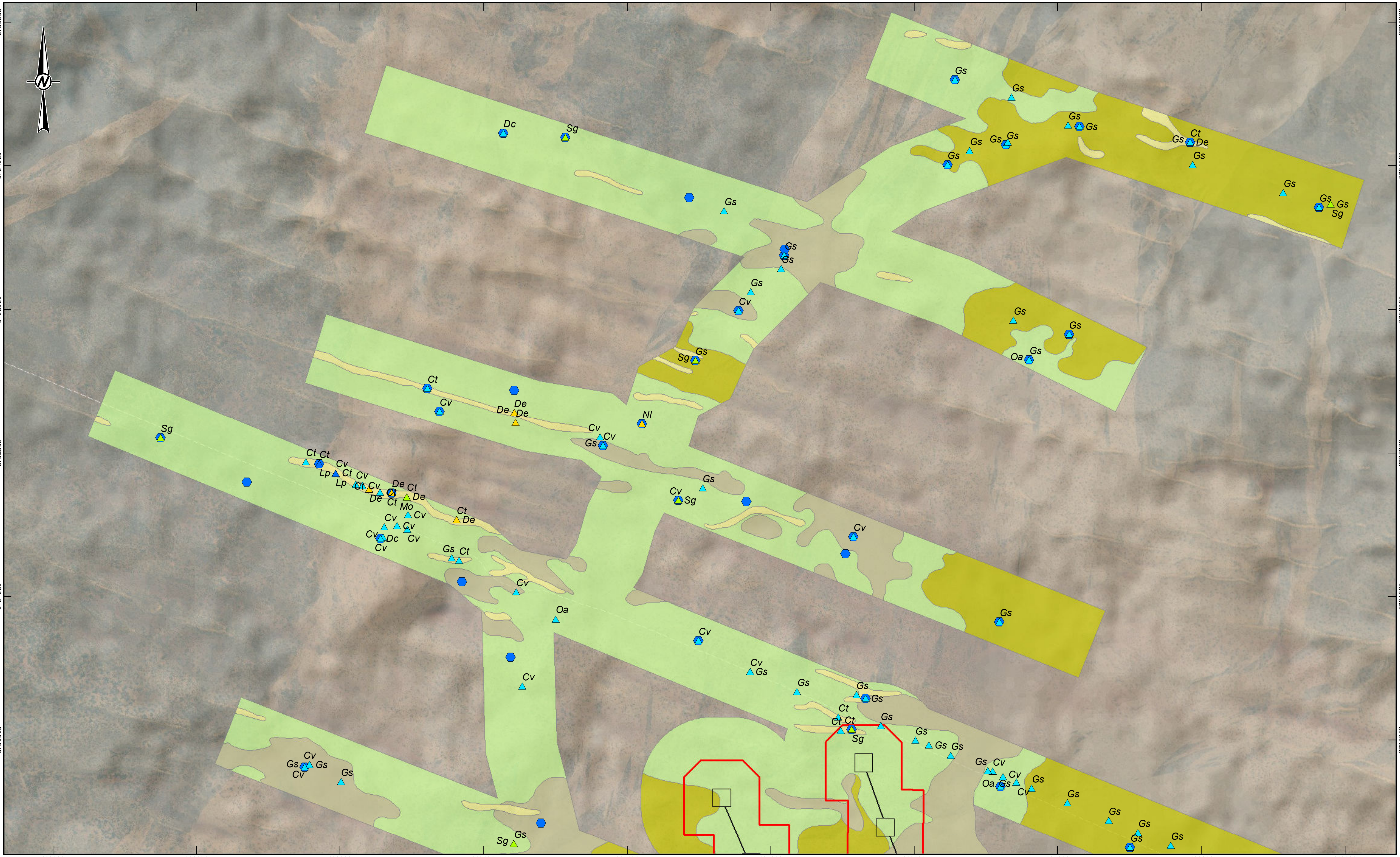
PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 18 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.24

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500
1:25,000 METRES

CLIENT
VIMY RESOURCES LIMITED

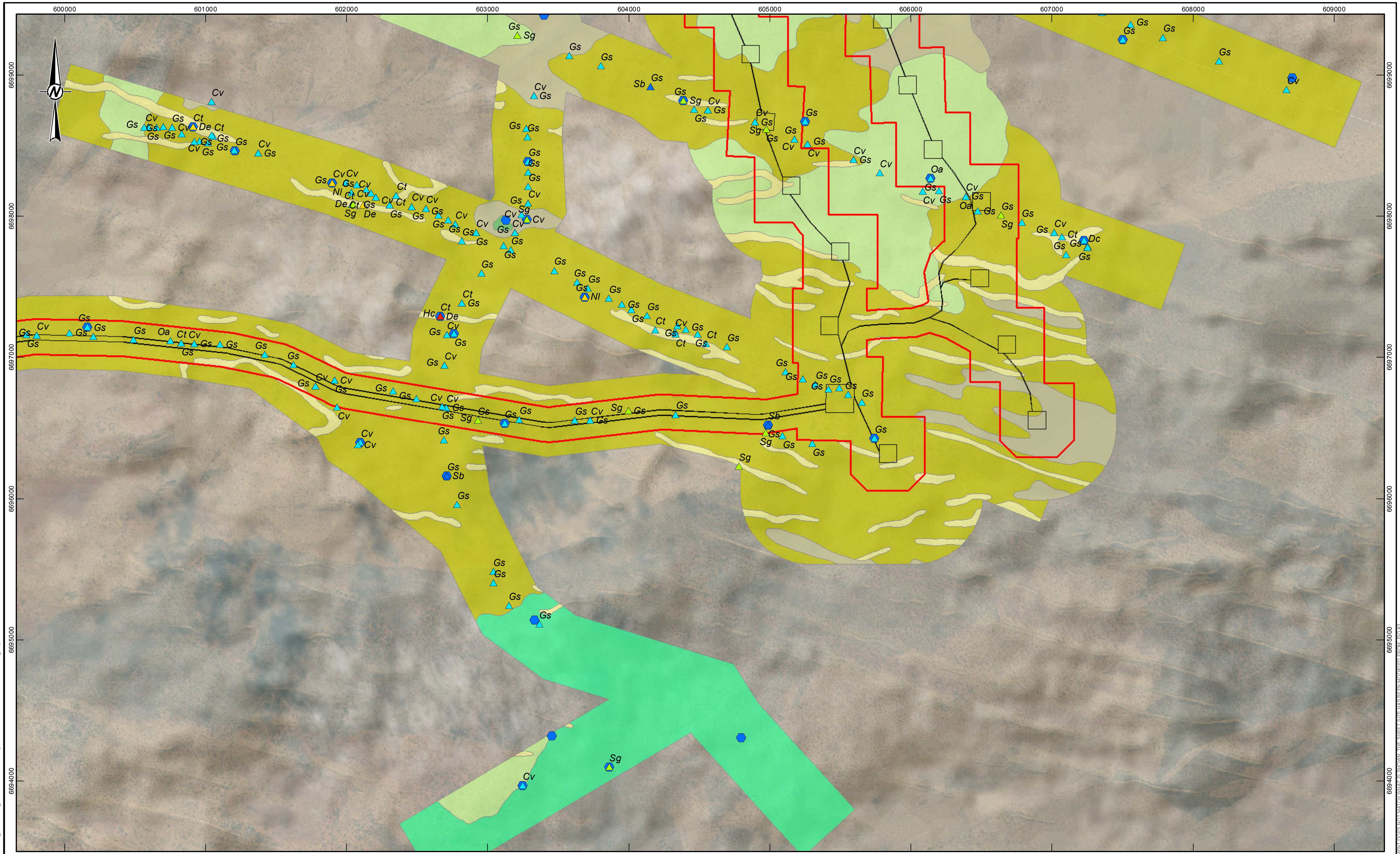
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
VEGETATION
SHEET 19 OF 20

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.25



LEGEND

- VEGETATION PLOT LOCATION
- RELEVE SITE

THREATENED & PRIORITY SPECIES

- P1 & VULNERABLE
- P1
- P2
- P3
- P4
- OTHER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
VEGETATION MAPPING - MATTISKE (MCPL, 2015A)

0 500 1,000 1,500
1:25,000 METRES

CLIENT	VIMY RESOURCES LIMITED
PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT	Golder Associates
YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB
TITLE	VEGETATION SHEET 20 OF 20
PROJECT NO.	1540340
CONTROL	PER
REV.	0
FIGURE	6.26

LEGEND

MINOR ROAD/TRACK
ROAD
INFRASTRUCTURE
MRUP DEVELOPMENT ENVELOPE
PROJECT BOUNDARY (MINING TENURE)
PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

2011 AERIAL IMAGERY AND INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 5 10

1:220,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-01
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
BUSHFIRE SCARS REVEALING EXTENT OF FIRES IN MRUP AREA SINCE 2005

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	6.27

7. Terrestrial Fauna

7.1 Relevant Environmental Objectives, Legislation, Policies and Guidelines

7.1.1 EPA Objective

The EPA applies the following objectives to the assessment of proposals that may affect terrestrial fauna:

> *To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.*

7.1.2 Regulatory Framework

7.1.2.1 Applicable Legislation

The protection of terrestrial fauna is covered by the following statutes:

- *Wildlife Conservation Act 1950 (WA)* (WC Act).
- *Environmental Protection Act 1986 (WA)* (EP Act).
- *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act).

Wildlife Conservation Act 1950

In Western Australia, native fauna of conservation significance are listed under the Wildlife Conservation (Specially Protected Fauna) Notice 2014 according to the following codes:

- Schedule 1 (T) – Fauna that is rare or is likely to become extinct.
- Schedule 2 (X) – Fauna presumed to be extinct.
- Schedule 3 (IA) – Migratory birds protected under an international agreement.
- Schedule 4 (S) – Other specially protected fauna.

Threatened fauna are further recognised by Department of Parks and Wildlife (DPaW) according to their level of threat using the International Union for the Conservation of Nature (IUCN) Red List criteria:

- Critically Endangered (CR) – considered to be facing an extremely high risk of extinction in the wild.
- Endangered (EN) – considered to be facing a very high risk of extinction in the wild.
- Vulnerable (VU) – considered to be facing a high risk of extinction in the wild.
- Extinct (EX) – there is no reasonable doubt that the last individual has died.

Fauna are also listed by DPaW as Priority species if they are potentially threatened but for which there is insufficient evidence to properly assess their conservation significance. Rankings range from Priority 1 to 5 according to the following criteria:

- Priority 1 – Poorly known species (on threatened lands). These are species that are known from one or a few locations (generally five or less) which are potentially at risk, and where occurrences are either very small or on lands not managed for conservation or otherwise under threat of habitat destruction or degradation.

- Priority 2 – Poorly known species (on conservation lands). These are species that are known from one or a few locations (generally five or less) some of which are on lands managed primarily for nature conservation.
- Priority 3 – Poorly known species (some on conservation lands). These are species that are known from several locations and the species do not appear to be under imminent threat, or from a few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Such species are in need of further survey.
- Priority 4 – Rare, Near Threatened and other species in need of monitoring.

  Rare – species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and are not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.

  Near Threatened – species that do not qualify for Conservation Dependent, but that are close to qualifying as Vulnerable.

  Other species in need of monitoring – Species that have been removed from the list of threatened species during the past 5 years for reasons other than taxonomy.

- Priority 5 – Conservation Dependent species. These are species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (DPaW 2015).

7.1.2.2 Applicable Guidance and Position Statements

The following EPA position and guidance statements set the framework for identification and assessment of impacts to terrestrial fauna:

- EPA March 2002, EPA Position Statement No. 3 – *Terrestrial Biological Surveys as an Element of Biodiversity Protection*.
- EPA June 2004, EPA Guidance Statement No. 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.
- EPA May 2009, EPA Guidance Statement No. 20 – Sampling of Short-Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia.
- EPA 2012, Checklist for documents submitted for EIA on terrestrial biodiversity from Appendix 2 of the EPA's Draft Environmental Assessment Guideline No. 6 on Timelines for Environmental Impact Assessment of Proposals.

7.1.2.3 Others

Consideration was also given to the following when designing and undertaking the surveys:

- *Animal Welfare Act 2002 and Animal Welfare Regulations (Scientific Purposes) Regulations 2003.*
- Australian Code for the Care and Use of Animals for scientific purposes 8th Edition (2013).
- Benshemesh, J 2004, Recovery Plan for Marsupial Moles (*Notoryctes typhlops* and *N. caurinus*) 2005-2010. NT Department of Infrastructure, Planning and Environment. Alice Springs.
- Department of Environment and Natural Resources South Australia 2011, National Recovery Plan for the Sandhill Dunnart *Sminthopsis psammophila*.

- Department of Environment and Conservation (DEC) 2011, Standard Operating Procedure 5.2 – Remote Operation of Cameras, Version 1.0, Perth, Western Australia.
- DSEWPaC 2011, Survey guidelines for Australia's threatened mammals: Guidelines for detecting mammals listed as threatened under the EPBC Act, Canberra, ACT.
- EPA & DEC 2010, Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment, Perth, Western Australia.

When undertaking an assessment of the impact of radionuclide activity, the following reference was consulted

- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Technical Report 167 – A review of existing Australian radionuclide activity concentration data in non-human biota inhabiting uranium mining environments.

The following documents were considered in relation to considerations pertaining to offsets:

- DSEWPaC 2012, EPBC Act Environmental Offsets Policy, Canberra, ACT.
- Government of Western Australia 2011, Environmental Offsets Policy, Perth, Western Australia.
- Government of Western Australia 2014, Environmental Offsets Guidelines, Perth, Western Australia.

A range of birds are listed under the Japan-Australia (JAMBA), China-Australia (CAMBA) and Republic of Korea-Australia (ROKAMBA) Migratory Bird Agreements. The main aim of these international agreements is to protect migratory birds and their breeding and/or feeding habitats.

7.2 Existing Environment

The MRUP area is located on the western edge of the Great Victoria Desert (GVD) within an area previously defined as the Helms Botanical District (Beard 1990), and more recently classified under the Interim Biogeographical Regionalisation for Australia (IBRA) as occurring within the Shield subregion (GVD1) of the Great Victoria Desert bioregion (Barton and Cowan 2001).

The vegetation of the Helms Botanical District is very consistent and is characterised by tree steppe of *Eucalyptus gongylocarpa* (Marble Gum or Desert Gum) and *Triodia basedowii* (Lobed Spinifex) (Beard 1974). The sandy areas are a mosaic of tree and shrub communities with *Eucalyptus gongylocarpa* dominant only between the sand dunes (Beard 1990). Patches of *Acacia aneura* complex (low Mulga Woodland) also occur in the Great Victoria Desert Region (Beard 1974 & 1990).

Under the IBRA characterisation, vegetation of the Shield subregion (GVD1) is described as Aeolian sandplains dominated by spinifex with mainly mallees over Hummock Grassland. Scattered *Eucalyptus gongylocarpa* and *Callitris* (Cypress-Pine) occur on the deeper sands, whilst Mulga Woodlands occur mainly on colluvial and residual soils (Barton and Cowan 2001). Halophytes (such as Samphires) occur on salt lake margins and saline drainage areas in the region, but these do not occur in the Project area.

Within the GVD1 Shield IBRA subregion, the area of the Project corresponds to 'Pre-European Vegetation Association 84', which consists of tree steppe of *Eucalyptus gongylocarpa* over *Eucalyptus youngiana* (Ooldea Mallee) over *Triodia basedowii* (DoE 2015).

Three distinct soil types that characterise the MRUP region (SMU 1-3) and there is a strong association between these different soil types (Appendix H2) and the mapped local vegetation communities (Appendix A1). The Eucalypt woodland communities are mostly located on red/orange, orange or yellow/orange sands that characterise the lower areas between the dunes or the lower slopes of dunes where there are yellow sands – these areas correspond to SMU2 and 3. Mixed shrubland communities are mostly located on yellow or yellow/orange sand located in locally elevated areas with relatively thick layers of looser underlying sands. An important fauna habitat is the MCPL S6 vegetation community which occurs on yellow sand dunes and closely resembles the Priority 3(ii) ecological community known as the Yellow Sand Plain Communities of the Great Victoria Desert. The softer soils associated with this soil type (SMU1) are the most suitable habitat for *Notoryctes typhlops* (Southern Marsupial Mole – listed as Endangered both federally and in Western Australia) which prefer sand dune crests and slopes where suitable 'tunnelling sand' is present (Benshemesh 2004). MCPL vegetation community E3 was identified as potential prime habitat for *Sminthopsis psammophila* (Sandhill Dunnart) – also listed federally as Endangered (Appendix B3).

Detailed investigation of MRUP soils identified that sand dunes represent <10% of both the Development Envelope and Disturbance Footprint, with the remaining flat (or plain) area consisting of a deep sandy duplex (60-75% of the area) and calcareous topographic lows (20-30%) (Appendix H2).

Wildfires of various ages and intensities have burnt large sections of land around the MRUP area. A fire in late 2007 burnt part of the Emperor resource area and sections northeast of the Ambassador area. A large section of the borefield and pipeline route was burnt in 2009. In August 2014, approximately 8% of the vegetation mapped in the MRUP area was rated as recently burnt. In November 2014, a large (but of low to moderate intensity) bushfire affected 74% of the MRUP Development Envelope and 78% of the Disturbance Footprint. The fire burnt over 79,000ha and a number of "refuge" areas (approximately 1,800ha) within the fire scar remain intact and unaffected to a certain extent (Figure 7.3).

7.3 Surveys and Investigations

There have been multiple fauna surveys conducted in the Project area since the mid-1980s. A summary of these surveys is provided in Table 7.1, and each is summarised below. The location of each of the surveys is provided in Figure 7.1. Specific targeted searches for Matters of National Environmental Significance (MNES) listed species are discussed within Section 9.

7.3.1 Mulga Rock: Flora, fauna and radioecology survey (W.G. Martinick & Associates Pty Ltd 1986) [Appendix B1]

Report commissioned by: PNC Exploration (Australia) Pty Ltd.

Date of survey: 17 June to 2 July 1985

Area of survey: MRUP area concentrating on the Emperor, Shogun and Ambassador orebodies.

Scientists involved: W.G. Martinick & Associates: Dr Ray Hart, Dr Wolf Martinick and Dr Arthur Weston.

Scope of survey: Survey of vegetation, vascular flora and vertebrate fauna of the MRUP area & collection of biological samples for radionuclide and heavy metal testing to provide baseline data.

7.3.1.1 Vegetation

The vegetation survey was carried out between 17 and 26 June 1985. Eighty sites were selected from aerial photographs to be surveyed and to ensure the following were sampled:

- A range of vegetation structure and dominance.
- Anomalous areas noted on aerial photographs.
- Both fire regeneration and mature vegetation.
- Replication within more widespread vegetation types.

- Fauna sample sites.

Thirty one vegetation associations were described and 157 species, varieties and subspecies of vascular plants were recorded in the MRUP survey area. There were no plant species of conservation significance recorded. These vegetation surveys were reviewed and updated by Mattiske Consulting (Appendix A1 and Appendix A2) and so are not discussed here in any further detail.

Table 7.1 List of Fauna Surveys Undertaken in the Project area

Survey	PER Appendix	Timing of Survey	Comment
Mulga Rock: Flora, fauna and radioecology survey	Appendix B1: W.G. Martinick & Associates Pty Ltd (1986)	June/July 1985	A Level 2 ecological survey of MRUP was completed for PNC Exploration. It included collection and preparation of animal and plants samples for radionuclide testing, though no reporting of such tests was sourced.
A fauna survey of the proposed Mulga Rock Project area, Great Victoria Desert, Western Australia	Appendix B2: Ninox Wildlife Consulting (Ninox 2010)	October 2009	A Level 2 survey completed for Energy and Minerals Australia Ltd. This survey focused upon the Mulga Rock East area but included a site in the Mulga Rock West area.
Camera Trapping Protocol – Sandhill Dunnart	Appendix B3: Vimy Resources (2015a)	August-November 2014; ongoing	A targeted survey for Sandhill Dunnart (*Sminthopsis psammophila*) utilising camera traps, with detailed discussion on camera trapping protocol.
A report of the Southern Marsupial Mole, Mulga Rock Uranium Project, Great Victoria Desert, Western Australia	Appendix B5: Ninox Wildlife Consulting (Ninox 2015a)	January 2013 – March 2014	A targeted survey for Southern Marsupial Mole (*Notoryctes typhlops*) involving trenches surveyed for mole holes.
Fauna assessment for the Malleefowl (*Leipoa ocellata*)	Appendix B6: Vimy Resources (2015b)	2009-2014 (Helicopter 2009-2010)	Targeted surveys for Malleefowl (*Leipoda ocellata*) involving helicopter surveys and track surveys.
An updated report on the herpetofauna of the proposed Mulga Rock Project Area, Great Victoria Desert, Western Australia	Appendix B7: Ninox Wildlife Consulting (Ninox 2015b)	October 2014	A Level 1 Desktop Study to update and complement previous survey completed by Ninox (2010).
Short-range endemic fauna at the Mulga Rock Uranium Project	Appendix B8: Bennelongia (2015)	October 2014	A Level 1 desktop study and reconnaissance SRE survey.

7.3.1.2 Fauna

Fauna were sampled and observed at 14 sites on or near to the Emperor, Shogun and Ambassador ore bodies. Sites were selected to represent a range of vegetation, topography and soil types. Pit traps with drift fences and Elliott traps were utilised for sampling at each site. Locations of sample sites are provided in Figure 7.2. Bats were sampled by mist netting and larger animals were recorded by observation. Birds were recorded either opportunistically or on transects for 30 minute observation periods at each site on five consecutive days. Opportunistic collecting and observations were carried out whilst driving on tracks (day and night), by digging (in burrows and under litter) and by searching for other evidence such as bones, tracks, diggings or scats. Calls of animals were also recorded if they could be identified.

Both plant and animal samples were taken and prepared for radionuclide and heavy metal sampling. As these samples were not processed and subsequently lodged but misplaced by the WA Museum, they will not be discussed further here.

Amphibians

No amphibians were recorded and potential habitat was noted to be limited. Species such *Neobatrachus centralis* (Trilling Frog), *Neobachtrachus sutor* (Shoemaker Frog) and *Pseudophryne occidentalis* (Orange-crowned Toadlet) are likely to be present but are widespread in the region and only in areas of suitable habitat, such as clay pans.

Reptiles

The survey recorded 93 individual reptile specimens and included four species of gecko, eleven species of skink, one species of legless lizard, three species of dragon and two monitor species. No snakes were recorded, although are likely to be widespread in the area. The survey data was pooled with that collected by Dr D King (Agriculture Protection Board) who surveyed the area near Ambassador in October 1985. No conservation significant species were recorded, and all species had wide ranges over large areas of arid Australia. The survey was thought to have recorded most of the species likely to be present in the area.

Birds

During the survey, 28 species of birds were recorded including two that were identified by calls only.

The report indicated that this was unlikely to be the total number of species to be present at the survey sites due to both the mobility and seasonality of birds. *Smicrornis brevirostris* (the Weebill) was the dominant avifauna recorded at 39% of all individuals recorded and 41.5% of these individuals were recorded in mallee rather than woodland habitat. The second most commonly recorded species was *Manorina flavigula* (the Yellow-throated Miner) at 26.5% of all individuals recorded and which conversely favoured woodland habitat over mallee.

Mammals

During the survey, 113 specimens of 10 species of small native mammals were recorded. These included eight small dasyurid species and two native rodents (Table 7.2).

Table 7.2 Species of Small Mammals Trapped by Martinick (1986) (Appendix B1)

Scientific Name	Common Name	Numbers Captured
Dasycercus blythi	Brush-tailed Mulgara	1
Ningaui ridei	Wongai Ningaui	15
Ningaui yvonneae	Sminthopsis Ningaui	14
Notomys alexis	Spinifex Hopping Mouse	11
Pseudomys hermannburgensis	Sandy Inland Mouse	32
Sminthopsis crassicaudata	Fat-tailed Dunnart	2
Sminthopsis dolichura	Little Long-tailed Dunnart	6
Smithopsis hirtipes	Hairy-footed Dunnart	15
Sminthopsis ooldea	Ooldea Dunnart	5
Sminthopsis psammophila	Sandhill Dunnart	5

Sminthopsis psammophila (Sandhill Dunnart) had not been recorded in Western Australia before this survey. All other species had wide distributions over various parts of arid Australia, although may not be common within their ranges. The Sandhill Dunnart will be further discussed in Section 9.3.2. *Dasycercus blythi* had been incorrectly identified as *Dasycercus cristicauda*, in the original report (Appendix B1).

Two single specimens of two species of bats were recorded: *Chalinolobus gouldii* (the Little Chocolate Bat) and *Nyctophilus major* (the Greater Long-eared Bat). Bats appeared to only congregate near to the camp lights and above some brackish water tanks.

Macropus fuliginosus (the Grey Kangaroo) was common in the area whilst *Megaleia rufus* (the Red Kangaroo) was observed to the west of the survey area where grasses were more prevalent.

Feral species recorded on site were *Mus musculus* (House Mouse), *Canus lupus familiaris* (wild dogs), *Canus lupis dingo* (dingoes), *Oryctolagus cuniculus* (rabbits) and *Felis catus* (feral cats).

7.3.2 A fauna survey of the proposed Mulga Rock Project area, Great Victoria Desert, Western Australia (Ninox Wildlife Consulting, 2010) [Appendix B2]

Report commissioned by: Energy and Minerals Australia Pty Ltd.

Date of survey: 7-14 October 2009

Area of survey: MRUP area concentrating on the Ambassador orebody region.

Scientists involved: Ninox Wildlife Consulting: Jan Henry, Greg Harold, Maureen Francesconi & Kevin Fairbairn.

Scope of survey:

- Determine inventory of vertebrate fauna at MRUP.
- Compare to list of potentially occurring species.
- Review conservation significant fauna.
- Assess status of introduced flora and fauna in Project area.
- Assess relationship between flora and fauna to identify significant habitats.
- Assess local and regional conservation significance of species and ecosystems at Project area.
- Assess potential impact of proposed mining upon fauna.
- Suggest strategies for environmental management of the fauna and habitat in the MRUP area.

This survey was designed as part of a Level 2 survey (EPA & DEC 2010) and incorporated modifications on survey design following detailed discussions with the DEC (Kalgoorlie). Ten sampling sites were chosen to represent a range of dominant vegetation associations and soil types utilising descriptions provided by Mattiske Consulting of the Project area (MCPL 2008), and incorporating three of the four sites where *Sminthopsis psammophila* (SHD) had been recorded previously in the area (Appendix B1). Due to the high level of activity indicated on dune crests by small mammal tracks, two camera traps and two lines of Elliott traps were also established in this habitat. Further details of the survey design utilising pitfall traps, Elliott traps and traplines are described within Ninox 2010 (Appendix B2). These totalled the equivalent of 2,036 trap nights. Bats were sampled by two echolocation recorders, and birds were sampled both opportunistically and with regular 45 minute observation periods on each day. Six traplines surveyed at Ambassador in 1985 (Martinick 1986) were duplicated as close as possible in October 2009. The location of the sampling sites is provided in Figure 7.1.

Targeted surveys were completed for conservation significant species that were determined by a desktop study to potentially occur at the MRUP site.

- A review of the targeted searches for the *Notorytes typhlops* (Southern Marsupial Mole) was provided in a separate report (Appendix B5), discussed in Section 9.3.3.
- Utilising DEC advice, five of each of the ten pitfall traps at each sampling site were plastic tubes 160mm × 600mm deep to ensure the adequate sampling of any potential *Sminthopsis psammophila* (Sandhill Dunnart), *Dasycercus blythi* (Brush-tailed Mulgara) or *Dasycercus cristicauda* (Crest-tailed Dunnart).
- The distinctive *Leipoa ocellata* (Malleefowl) tracks and nests were searched for during the systematic bird observation period, and on 92km of verges and tracks during the survey period.

Although not flagged within a MNES search or a DEC (now DPaW) NatureMap search of the MRUP area, targeted searches were also made for *Liopholis kintorei* (Great Desert Skink), *Aspidites ramsayi* (Woma) and *Burhinus magnirostris* (Bush Stone-curlew).

Table 7.3 Targeted Site Surveys

Scientific Name	Common Name	Conservation Level		
		EPBC Act	WC Act	DPaW
Dasycercus blythi	Brush-tailed Mulgara	-	-	Priority 4
Dasycercus cristicauda	Crest-tailed Mulgara	Vulnerable	Schedule 1	Vulnerable
Notorytes typhlops	Southern Marsupial Mole	Endangered	Schedule 1	Endangered
Sminthopsis psammophila	Sandhill Dunnart	Endangered	Schedule 1	Endangered
Burhinus magnirostris	Bush Stone-curlew	-	-	-
Leipoa ocellata	Malleefowl	Vulnerable	Schedule 1	Vulnerable
Liopholis kintorei	Great Desert Skink	Vulnerable	Schedule 1	Vulnerable
Aspidites ramsayi	Woma Python	-	Schedule 4	P1 (only southwest population)
Lerista puncticauda	Dotty-tailed Robust Slider	-	-	P2

7.3.2.1 Fauna

Amphibians

There were no amphibians recorded in this 2009 survey.

Reptiles

A total of 42 species of reptiles were recorded during this survey: six dragons, eight geckoes, four legless lizards, 15 skinks, three monitors, two blind snakes and four elapid (venomous) snakes (Appendix B7). This diversity was not expressed at each individual site, with a maximum of 16 species at two sites (MR05 & MR08 – Vegetation Associations S6 & S7 – Figure 7.1), and a minimum number of species of eight at another MRUP survey site (MR10 – Vegetation Community S1).

The abundance of individuals also varied between survey sites. The largest number of individuals recorded at a site was 39 at MR04 (vegetation community E6) and 38 at MR08 whilst MR10 only recorded 13 individuals. Therefore the sites with the highest diversity also recorded the larger numbers of individuals and the sites with lower numbers of individuals captured also revealed lower diversity.

The likely reason for the increase in diversity and abundance of reptiles in this survey than the 1985 survey within the MRUP area (Appendix B1) is that the survey in 1985 was conducted in winter, a season when reptiles are least active (Appendix B2).

Despite a specific search for the *Liopholis kintorei* (Great Desert Skink), it was not recorded in this survey, or the one in 1985. As mentioned, it is not listed as likely to occur in the MRUP area.

Aspidites ramsayi (Woma Python) was not recorded at the MRUP site in either 1985 or in this survey. A dead specimen was located close to MR03 (Figure 7.1) on 26 November 2008 by onsite personnel.

Birds

A total of 28 species of birds were recorded during the survey, of which 26 were from the sample sites and two were observed opportunistically. The maximum diversity was at MR08, with 14 species, and this site also had the greatest number of individuals recorded (54), at least double that of any of the other sites. The lowest species richness of five was recorded at three sites, including MR01. This site also had the lowest abundance with eight individuals recorded during the survey.

Although the number of species recorded in this survey were similar to that in 1985 (Martinick 1986) (25 species compared to 28), only 16 were common to each survey. The most commonly recorded species was *Smicrornis brevirostris* (Weebill) with 48 individuals recorded at ten sites. Forty seven individual *Artamus personatus* (Masked Woodswallow) were recorded at six sites, with 30 recorded in a single flock at MR08.

There were no conservation significant bird species recorded during the MRUP surveys in 1985 or 2010, despite targeted searches for *Leipoa ocellata* (Malleefowl) and *Burhinus magnirostris* (Bush Stone-curlew).

Mammals

During the survey, thirteen species of native mammal were recorded. The presence of *Tachyglosus aculetus* (Echidna) was noted due to the presence of scats. *Macropus fuliginosus* (Western Grey Kangaroos) were infrequently observed. Five species of bat were recorded, with *Chalinolobus gouldii* (Gould's Wattled Bat) being the most common and was detected at eight of the ten sites. Dingoes were noted by the presence of footprints.

The highest number of small marsupials recorded was of *Ningaui yvonneae* (Southern Ningaui) and *Sminthopsis hirtipes* (Hairy-footed Dunnart) located at eight of the ten sampling sites. No *Dasycercus blythi* or *Dasycercus cristicauda* (Mulgaras) were recorded during this survey. *Sminthopsis psammophila* (Sandhill Dunnart) were not recorded during this survey despite resampling the Martinick sites of previous captures (Appendix B1). The number of species and abundance of individual small marsupials varied from 1985 indicating population fluctuations over time (Appendix B2).

Table 7.4 Species of Small Native Marsupials and Rodents Recorded by Ninox (2010)

Scientific Name	Common Name	Numbers Captured
Ningaui ridei	Wongai Ningaui	4
Ningaui yvonneae	Southern Ningaui	22
Pseudomys hermannsburgensis	Sandy Inland Mouse	2
Sminthopsis dolichura	Little Long-tailed Dunnart	8
Sminthopsis hirtipes	Hairy-footed Dunnart	20

Introduced Species

During this survey, it was noted that *Camelus dromedaries* (One-humped Camel) were widespread and abundant. *Felis catus* (feral cat) and *Equus africanus asinus* (donkey) were also recorded in the survey area but were uncommon (Appendix B2).

7.3.3 An update report on the herpetofauna of the proposed Mulga Rock Uranium Project Area, Great Victoria Desert, Western Australia (Ninox Wildlife Consulting, 2015) [Appendix B7]

Report commissioned by: Vimy Resources Limited.

Desktop review: April 2015

Source of review data: Martinick (1985), Ninox (2010) and camera trapping results (2009-2014)

Author of review: Ninox Wildlife Consulting

Scope of review:

- Consider all available herptile survey data from previous 1985 & 2009 MRUP surveys (Appendix B1 and Appendix B2) and camera trapping results, in conjunction with other survey results of the GVD, for a regional comparison.
- Develop a risk assessment of potential long term changes to reptile habitats within the Project area.

Methodology of sampling is summarised previously in Section 7.3.1 and 7.3.2 above, or in the MRUP camera trapping protocol in Section 9.3.2 and Appendix B3.

The previous survey results, in conjunction with the extensive literature review, satisfy the requirements of a Level 2 Detailed Survey (EPA 2004).

7.3.3.1 Fauna

Amphibians

No amphibians were recorded in either survey. A small number of burrowing species could occur in the MRUP area, and *Neobatrachus sutor* (Shoemaker's Frog) was listed by DPaW's NatureMap as potentially occurring at the site. These burrowing species require substantial rain to breed, and indeed one specimen of this species was recorded at the MRUP exploration camp in January 2014 after heavy rainfall, and tadpoles of an unknown species were noted east of the campsite at the same time. Habitat would be mainly confined to areas subjected to seasonal flooding, such as claypans, which are not evident in the MRUP area (Appendix B7).

In regional surveys, *Neobrachtrus* specimens (5 *N.sutor* and 2 × unidentified N. sp) have been recorded at the Tropicana Gold Mine operations site and pipeline corridor.)

Reptiles

A total of 53 species of reptile are known to be present within or in the vicinity of the MRUP. A total of 14 species had been identified by camera trapping or photos by Vimy personnel from 2009-2014, including additional records of *Asidites ramsayi* (Woma Python). The Woma Python is listed as Schedule 4 (other specially protected fauna) under the *WA Wildlife Conservation Act 1950*. The national distribution of the Woma is provided in Figure 7.4. The only additional species of reptile, not previously been previously recorded onsite and noted in the previous Ninox fauna survey report (Appendix B2), was *Pseudonaja mengdeni* (Gwardar).

A list of 97 reptile species was compiled for known records within the GVD. However, the required habitats for a number of these species, such as the geckoes, are unlikely to occur at the MRUP. The sampling efficacy from the 2009 survey indicated that there would be a slow accumulation of extra species recorded if sampling continued, but the majority of the common species had been recorded (Appendix B7).

7.3.4 Short-range endemic fauna at the Mulga Rock Uranium Project (Bennelongia, 2015) [Appendix B8]

Report commissioned by: Vimy Resources Limited.

Date of survey: 9-15 October 2009

Area of survey: MRUP Disturbance Footprint and three analogue sites in the vicinity

Scientists involved: Bennelongia Environmental Consultants

Scope of survey and report:

- Characterise the habitats and classify landforms according to their suitability for listed or SRE invertebrate species.
- Ground truth the habitat mapping.
- Identify any listed or SRE invertebrate species that may occur in the vicinity of the Project.
- List those species identified as occurring at the MRUP.
- Assess likelihood of identified SREs occurring in habitat restricted to Disturbance Footprint of the Project.
- Evaluate the likelihood of threat to listed or SRE species from the Project.

Short-range endemic invertebrate species (SREs) are those species with distributions of less than 10,000km^2 and whose occurrence within that distribution is patchy due to discontinuous habitats (Appendix B8). The small ranges, combined with poor dispersal capacities, slow growth and low fecundity result in a vulnerability to habitat loss and/or disturbance.

This Level 1 survey comprised a desk top review and an onsite reconnaissance survey, satisfying Guidance Statement 20 (EPA 2009). Seven SRE groups were targeted, as is the protocol for arid zones of Australia, and these were Chilopoda (centipedes), Pulmonata (land snails), Diplopoda (millipedes), Pseudoscorpiones (Pseudoscorpions), Isopoda (slaters), Scorpiones (scorpions) and Araneae (spiders) (EPA 2009).

7.3.4.1 Desktop Survey and Habitat Analysis

The desktop study search area consisted of a large 250km × 250km search area surrounding the MRUP, which included the western section of the GVD and the Eastern Goldfields, due to the limited information in the immediate vicinity of the Project.

Due to the aridity, lack of topographic diversity and predominance of open vegetation, the GVD is unlikely to be suitable for SRE species with high moisture dependence. The nearest survey of relevance to the MRUP is that at Tropicana Gold Mine located 110km to the northeast. This survey reported a high diversity of 46 species of SRE groups with 19 (41%) of conservation significance. This was thought to have been due to geological causes creating relatively high moisture holding capacity and thus a greater potential for SREs. Unlike Tropicana Gold Mine, MRUP has no rocky outcrops, lateritic breakaways or deep ferruginous hard caps which provide local refugia for SRE fauna due to such higher moisture holder capacity (Appendix B8).

Preliminary habitat characterisation was undertaken using satellite imagery, contours and vegetation mapping. Habitats likely to support suitable microclimates for SREs are long unburnt sites with high vegetation cover, south facing slopes, breakaways and tributaries. The four potential SRE habitats in the Project area are:

- Flat and exposed sandplains.
- Aeolian sand dunes and associated swales.
- Dry sand lakes and associated lunettes.
- Closed *Eucalyptus/Callitris* woodlands on red sands.

The sandplains and Aeolian dunes are the most common and widespread habitat. The closed woodlands on red sands are less common and restricted to the northern section of the Emperor pit. Dry salt lakes and lunettes were least common and found in a small area between Shogun and Emperor.

Overall, the MRUP appeared to be without landforms suitable for SRE communities because of:

- Uniform surface geology predominated by Aeolian sands with low moisture holding capacity.
- Lack of topographic diversity other than seif dunes and associated swales and flats.
- Absence of water retaining features, such as river tributaries.
- Open vegetation that does not provide shade or ground cover.
- Bushfire cycle that demonstrates major episodic denudation of understorey (Appendix B8).

There were no species of conservation significant recorded in the GVD. Three were listed to have been recorded in the Eastern Goldfields, but none are likely to occur at the MRUP (Appendix B8).

On analysis of available data, there appeared to be seven species regarded as SREs and 16 species regarded as potential SREs that may occur at the Project area. These comprised of 16 species of mygalomorph spiders, three millipedes, two centipedes, one pseudoscorpion and one isopod.

7.3.4.2 Field Survey

Eighteen sites were sampled across the Disturbance Footprint, with three reference sites located outside of this zone (Figure 7.2). The sampling was done mainly by foraging, with cup traps also used. Thirteen sites were searched for burrow sites after removing the leaf litter with a leaf blower. Scorpions were collected at night with a blacklight torch (Appendix B8). Smaller species such as Pseudoscorpions were collected by sieving leaf litter, and other species were collected in the bark detritus at the base of *Eucalyptus* trunks. All prospective microhabitats, including spinifex clumps, were sampled.

Sites sampled had not been burnt for over 20 years. SRE species are generally most active after rain. Approximately 14mm of rain fell two weeks prior to the sampling period, and some species behaviour indicated the presence of relatively high moisture levels (Appendix B8).

During the survey no listed species were collected. A total of 223 specimens, and 32 species within the seven SRE groups were collected (Table 7.5) and of these only 12 were categorised as having a SRE ranking.

Table 7.5 Invertebrate Specimens Collected During MRUP Targeted Survey

Taxonomic Group		Number of Species	SRE Status
Arachnida	Araneae (Mygalomorph spiders)	15	8 × R2
	Pseudoscorpiones (pseudoscorpions)	5	0
	Scorpiones (scorpions)	4	0
Crustracea	Isopoda (slaters)	3	2 × R2
Chilopoda	Geophilomorpha (centipedes)	2	1 × R2
Diplopoda	Polydesmida (millipedes)	1	1 × R1
	Polyxenida (bristly millipedes)	1	0
Gastropoda	Pupilloidea (land snails)	1	0

The myalomorph spiders were the most diverse group with 15 species recorded and over half categorised as potentially SRE species. There was a single species, the millipede *Antichiropus* sp. indet., categorised as a Rank 1 and thus having a high probability of being a SRE as it belongs to a group that has been well studied taxonomically and contains a high proportion of regionally endemic species. This species was identified by two cuticle fragments collected at a single site outside of the Disturbance Footprint. It was categorised as Rank 1 as the only other record of this genus in the GVD is at Tropicana Gold Project, and the fragment samples may represent a new species.

Eleven species were considered a Rank 2 SRE with a moderate probability of being a SRE based on belonging to a group with a high proportion of SRE species, and having either has been collected from single microhabitat or have an ecology or morphology suggesting habitat specialisation and range restriction. Seven potential SRE species were recorded at sample sites only within the proposed Disturbance Footprint (listed in bold in Table 7.6). Despite this, it was determined that all of the Rank 2 SREs identified, including those only sampled within the proposed Disturbance Footprint, were likely to be more widespread than the vicinity of the Project due to the wider occurrence of the habitats in which they occurred, and are therefore unlikely to be threatened by the MRUP Project (Appendix B8).

There were no SRE species located within the very common alluvial sand dunes habitat which are generally exposed, dry and without groundcover or litter. The sandplains habitat had a higher proportion of SRE species, especially in tall Eucalypt woodlands on yellow and red sands where shade and sufficient ground cover provided a suitable microhabitat. There were two species of myalomorph spiders collected within the third habitat type of dry salt lakes, from the clay banks of a dry salt lake between the Shogun and Emperor deposits. The closed Eucalyptus Woodland landform was associated with diverse habitats with shade and ground cover, and a higher moisture retention than elsewhere.

Table 7.6 SRE Ranked Invertebrates Collected During MRUP Targeted Survey

Taxonomic Group		Species	SRE Status (*)	# Sites
POLYDESMIDA (millipedes)	Paradoxosomatidae	*Antichiropsus* sp. indet.	R1	1
ARANEAE (mygalomorph spiders)	Barychelidae	***Aurecocrypta* sp. B05**	R2	1
		***Synothele* sp.10**	R2	1
		***Synothele* sp.11**	R2	2
		***Synothele* sp.12**	R2	2
	Idiopidae	*Anidiops* sp. B7	R2	1
		Anidiops sp. B8	R2	1
	Nemesiidae	*Aname* sp. B17	R2	1
		***Yilgarnia* sp. B02**	R2	1
ISOPODA (slaters)	Armadillidae	***Acanthodillo* sp. B15**	R2	2
	Platyarthridae	*Trichorhina* sp. B20	R2	2
GEOPHILOMORPHA (centipedes)	Chilenophilidae	**Genus indet., sp. indet**	R2	1

(Bold = found only within proposed Development Envelope)

Analysis of species accumulation curves indicate that 70-80% of the SRE species were collected during the survey, and it was determined that it is likely that the number of species at MRUP is similar to that at Tropicana (Appendix B8).

Given the habitat uniformity of the MRUP and the paucity of landforms suitable for SRE communities, the SRE species recorded as present are likely to be locally widespread, and there is unlikely to be more diversified SRE fauna than currently documented (Appendix B8).

7.3.5 Conservation Significant Fauna

A list of conservation significant fauna that potentially occur at the MRUP area are listed in Table 7.7.

Table 7.7 List of Conservation Significant Fauna Recorded as Potentially Occurring at the MRUP Area and Immediate Vicinity

Species		Conservation Listing			Observations
Scientific name	Common name	EPBC Act	WC Act	DPaW	Comments
Notoryctes typhlops	**Southern Marsupial Mole**	Endangered	Schedule 1	Endangered	Very low density of 'moleholes' observed at MRUP by trenching.
Sminthopsis psammophila	**Sandhill Dunnart**	Endangered	Schedule 1	Endangered	Observed in MRUP area in 1985 and more recently recorded two individuals by camera trapping.
Leipoa ocellata	**Malleefowl**	Vulnerable	Schedule 1	Vulnerable	No individuals or mounds observed at MRUP, and no suitable habitat located within Disturbance Footprint during targeted surveys.
Aspidites ramsayi	Woma Python	-	Schedule 4	P1 (only southwest population)	Opportunistic sightings by Vimy staff.
Dasycercus cristicauda	Crest-tailed Mulgara	Vulnerable	Schedule 1	Vulnerable	'*D. blythi'* incorrectly classified as '*D. cristicauda*' in 1985; no recordings during surveys**.**
Dasycercus blythi	Brush-tailed Mulgara	-	-	Priority 4	1 specimen captured in 1985; with no captures since, except for observations of Mulgaras during camera trapping targeting Sandhill Dunnarts.
Lerista puncticauda	Dotty-tailed Robust Slider	-	-	Priority 2	Surveyed in Queen Victoria Spring Reserve but no records within MRUP area to date.
Liopholis kintorei	Great Desert Skink	Vulnerable	Schedule 1	Vulnerable	No records at MRUP.
Merops ornatus	**Rainbow Bee-eater**	Migratory	Schedule 3	-	Recorded at MRUP in 2009. Observed in 2009
Ardeotis australis	Bustard	-	-	Priority 4	Opportunistic sighting in 1985

The MNES listed species (bold) are discussed further in Section 9, with the distribution ranges of the Sandhill Dunnart and Southern Marsupial Mole in Figure 9.2 and Figure 9.4.

7.3.6 Radiation

A radiological assessment was made on the non-human biota in the vicinity of the MRUP site (Appendix B of Appendix F1). The ERICA (Environmental Risk from Ionising Contaminants: Assessment and Management) software tool is a widely used method for assessing radiological impacts on plants and animals. The ERICA software accesses a standard set of databases to determine radionuclide uptake by various species, which are northern hemisphere species. The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) has endorsed the use of the latest version of ERICA (released in November 2014) in Australia.

A Tier 2 ERICA assessment undertaken on all reference species in the ERICA database (Table 7.8).

The air modelling for the MRUP site was utilised to provide a measure of the change in radionuclide composition in the soils at the sensitive receptors due to the proposed operations.

The ERICA assessment was conducted using a soil radionuclide concentration of 0.862Bq/kg (for each long lived uranium-238 series radionuclide) as it was the highest predicted radionuclide deposition, being at the proposed accommodation village site.

Table 7.8 Results of ERICA Assessment

Organism	Concentration Ratio Source	Dose Rate (µGy/h)
Detritivorous arthropod	ERICA default	0.007
Flying insect	ERICA default	0.006
Gastropod mollusc	ERICA default	0.007
Bird	ERICA default	0.005
Amphibian	ERICA default	0.009
Reptile	ERICA default	0.009
Kangaroo	ARPANSA 2014	0.020
Small burrowing mammal	ERICA default	0.008
Large mammal	ERICA default	0.008

The screening level is the radiation dose rate below which no effects would be observed, and the ERICA default level is 10µGy/h. All dose rates are predicted to be well below this.

7.4 Potential Impacts

The potential direct and indirect impacts upon the MNES list species is discussed within Section 9.4 and are not specifically referred to in this section.

7.4.1 Direct Impacts

7.4.1.1 Vegetation Clearing

The Project requires the disturbance of 3787ha of vegetation which will result in the direct loss of fauna habitat and could potentially lead to habitat fragmentation, and therefore, potentially, isolation of fauna populations.

The death or injury of individual fauna will be unavoidable during vegetation clearing operations. Birds, larger fauna and larger reptiles, such as monitors, may be able to egress from the area, but smaller reptiles and mammals, and burrowing frogs are unlikely to escape during construction operations and will be at greater risk from large machinery or from predators. The displacement of the larger species into adjacent areas may cause an increase in stress to existent populations. Vehicle movements associated with either construction or operation may also result in death or injury of individual fauna.

Individual fauna may also become trapped or injured onsite within hazards including trenches without adequate means of escape and TSFs.

There will be no impact on fauna habitats as a result of water extraction and water reinjection activities as there is no connection between the aquifers and native vegetation. There is no groundwater dependant vegetation in the Project area (Appendix A1).

7.4.2 Indirect Impacts

Indirect impacts to fauna can include such factors as radiation, altered fire regimes, increased access for feral animals to resources, noise and light spill, and any changes in air quality.

There will be no indirect impact upon terrestrial fauna or fauna habitats as a result of water extraction and water reinjection activities as there is no ground water dependent vegetation (Appendix A1).

7.4.2.1 Radiation

The levels of radiation associated with the Project will not be sufficiently high to have any adverse impact on local fauna (Appendix B of Appendix F1). Exposure levels are well below the trigger level for further assessment under Tier 2 ERICA (Appendix F1).

7.4.2.2 Altered Fire Regimes

Bushfires occur in the region at a high frequency (Appendix H2) and are predominantly the result of lightning strikes. The Project has the potential to increase the risk of bush fires occurring as a result of operational activities (such as hot works and machinery movements). The local bush fire in November 2014 substantially diminished the condition of any available habitat in the Project area with 78% of the Disturbance Footprint burnt. The potential immediate impacts of mining upon fauna and fauna habitat will be less than would have been otherwise. Regenerating vegetation will require adequate time to establish and provide suitable habitat to much of the local fauna (such as density of shrubs required for smaller bird species) (Appendix B2). An increase in the frequency of fire has the potential to modify habitat. For example, frequent fires promote the mallee growth habit of *Eucalyptus*. As well as the direct loss of habitat due to fire, and increase in fire frequency will also increase the risk of fauna to death or injury, displacement of larger mobile species to adjacent areas and for increased predation during movement across burnt sites.

7.4.2.3 Increase in Feral Animal Populations

Refuse from the accommodation facilities, such as food waste, can encourage the presence of feral animals and support an increase in numbers. Water will be stored at surface during MRUP operations and may encourage feral animal presence and support an increase in numbers.

7.4.2.4 Noise, Vibration and Light Spill

Noise and vibration may disrupt animals (especially bats) and act as a deterrent away from areas close to the source. Light sources can either act as an attractant or a deterrent to animals. The spread of the light associated with mining activities will be naturally limited by its location within pits below the level of the ground surface. The lighting associated with all MRUP operations will be directed towards the activities to limit light spill.

7.4.2.5 Changes in Air Quality

Ambient dust levels can be naturally high in the Project area due the low rainfall, high evaporation rates, relatively sparse vegetation, frequent winds and occasional uncontrolled bushfires (Appendix E1). Mining will predominantly take place in open pits below the ground level on material that has an average moisture level of around 10% and will be mined using techniques that do not require the use of explosives. Vehicle movement will also generate dust. Such dust levels may reduce the health of the vegetation, and therefore the quality of the habitat for fauna.

There will be no other changes in air quality that could have a significant impact on fauna (see Section 12).

7.4.2.6 SREs

The SRE survey at MRUP indicated the presence of eleven possible, and one confirmed SRE species. Two of these species occurred exclusively outside of the Disturbance Footprint, including the single Rank 1 SRE species *Antichiropus* sp. indet. These, plus the species located both within and outside of the Disturbance Footprint of the Project are unlikely to be threatened by the Project.

Only nine species were collected from within the Disturbance Footprint, including seven mygalomorph spiders, one slater and one centipede. These species are found primarily within tall or closed Eucalyptus woodlands and salt lakes. These habitats are widespread in the vicinity of the Project. Therefore, as no landforms or microhabitats were unique to the Disturbance Footprint of the Project, and the nine species of SREs are likely to be more widespread outside and within the Project area, the development poses no long term risk to the SREs of the MRUP.

7.4.2.7 TSF Access

Fauna may gain access to TSF, attracted to the water source, and either become stuck in the tailings, or ingest potentially contaminated water.

7.5 Management of Impacts

The overall objective for the management of impacts to fauna is to ensure that the impact upon native fauna as a result of the development of the MRUP will be minimised. The implementation of the following principles will assist in delivering such an outcome:

- Minimise ground disturbance where possible.
- Avoid clearing habitat suitable for MNES listed species where practicable.
- Avoid or minimise the introduction and spread of invasive weeds.
- Avoid or minimise the introduction and spread of feral competitors (such as rabbits).
- Avoid or minimise the introduction and spread of feral predators.
- Progressively rehabilitate disturbed areas.
- Ensure awareness of environmental factors amongst operating workforce.

These guiding principles have been incorporated into the following management plans which have been prepared to ensure that impacts (direct and indirect) are no greater than those impacts outlined in Section 7.4 and that the impacts are avoided or minimised as much as practicable the greatest extent that is practicable:

- Weed Management Plan (MRUP-EMP-003).
- Terrestrial Fauna Management Plan (MRUP-EMP-004).

- Conservation Significant Fauna Management Plan (MRUP-EMP-005).
- Feral Animal Management Plan (MRUP-EMP-006).
- Ground Disturbance Management Plan (MRUP-EMP-019).
- Transport Radiation Management Plan (MRUP-EMP-022).
- Emergency Response Management Plan (MRUP-EMP-023).
- Dust Management Plan (MRUP-EMP-024).
- Fire Management Plan (MRUP-EMP-025).
- Radiation Management Plan (MRUP-EMP-028).
- Radioactive Waste Management Plan (MRUP-EMP-029).
- Rehabilitation and Revegetation Management Plan (MRUP-EMP-030).

These management plans are contained in Appendix K1.

7.5.1 Direct Impacts

7.5.1.1 Vegetation Clearance

Around 25% of the initial construction clearance relates to the construction of general infrastructure (mainly roads, and pipelines associated with borefields) and some plant and administration buildings and these areas will remain cleared through the life of the Project (although some pipeline areas will be rehabilitated and only the associated maintenance track will remain cleared). The linear clearing associated with most of this activity will be done progressively and doesn't involve the clearance of very wide areas – although roads may involve up to 40m, the pipelines associated with borefields will involve a width of only about 10m. The remaining areas to be cleared are mainly mining areas where clearance will precede mining on a pit by pit basis spread over around 16 years. Progressive backfilling will occur during operations within each pit and progressive rehabilitation will be taking place as soon as practicable thereafter.

The management of direct environmental impacts to terrestrial fauna will be predominantly achieved through the use of a clearing permit system that will prevent any ground disturbing activity from being commenced on the MRUP site until an appropriate internal Vimy permit, known as a Ground Disturbance Activity Permit (GDAP) (MRUP-POL-001), has been issued. Vimy will maintain a database containing spatial information such as the location of fire refugia habitat. In order to obtain a GDAP, the coordinates of the proposed disturbance site will have to be determined and compared against this central database to ascertain whether such disturbance would involve the potential impact to habitat suitable for conservation significant species, or any other areas considered environmentally important in relation to the conservation of local native fauna.

Where it is practicable, the clearance of habitat suitable for conservation significant species or other areas regarded as environmentally sensitive will be avoided and clearing protocols will be contained within the Vimy Construction Environment Management Plan (MRUP-EMP-018). This has already been implemented, to some extent, with the design phase of the Project with the infrastructure layout taking into account the known location of areas containing complex interlinked dunes which are regarded as habitat for both Sandhill Dunnarts and Southern Marsupial Moles (Section 9.5.1). Obviously, the location of the mine pits is determined by the orebodies. However, since there is considerable local flexibility in the location of linear infrastructure, such as water pipelines and roads, the exact route followed can, if practicable, be altered by the small amount necessary to avoid small areas of habitat suitable for conservation significant species, significant habitat trees or any other localised environmentally significant areas.

The same system of GDAPs will be used to monitor both the exact area of ground disturbance and, initially, the extent of the proposed disturbance in relation to the purpose for such disturbance to ensure that areas cleared are kept to the minimum required. The implementation of the authorised GDAP will be managed to ensure that the extent of ground disturbance will be equal to or less than that internally authorised. A log of all GDAPs issued and the surveyed areas of actual disturbance will be maintained according to the Document and Data Control Management Plan (MRUP-EMP-039). The GDAP system will then be subsequently used to manage the efficient timing of progressive rehabilitation. All disturbance areas that have been rehabilitated will be logged into a central Vimy database and rehabilitation success will be monitored according to protocols detailed within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030).

7.5.2 Indirect Impacts

7.5.2.1 Fauna Hazards

The Terrestrial Fauna Management Plan (MRUP-EMP-004) will ensure that all disturbance activities are monitored and regularly inspected to ensure that animals are not inadvertently trapped (e.g. within a trenches or the TSFs), and any potential hazards are minimised.

7.5.2.2 Noise

Mining activity will mostly take place within pits and below the surface level and therefore the noise will be attenuated. Wherever practicable, high efficiency low noise equipment will be selected to further limit the noise generated. The mine activity noise may discourage fauna approaching the operational areas.

7.5.2.3 Transport Routes

The issue of the interaction between native fauna and vehicles will be managed as part of the Transport Radiation Management Plan (MRUP-EMP-022). In essence, this management plan will require adherence to the following:

- Drive only on established roads.
- Compliance with speed limits, including variable speed limits imposed in sensitive areas or at key times.
- Limitation of vehicle use at dawn/dusk whenever practicable.
- Education of the workforce on the risks of fauna strikes.

7.5.2.4 Dust

The issue of the risk to native fauna from dust emissions will be managed as part of the Dust Management Plan (MRUP-EMP-024). In essence it will require the following measures to be implemented:

- Control impact to ambient dust levels from all activities.
- Control dust from roads by suitable application of dust suppression measures (saline water).
- Dust generating activities avoided if practicable near environmentally sensitive areas such as habitat suitable for conservation significant fauna.
- Incorporate further dust suppression measures, such as binding agents, if dust generation is perceived to be a problem in an area regarded as environmentally sensitive. Vehicle movements will also generate dust, but this will be limited by the application of dust suppression measures to all roads.

7.5.2.5 Fire

It is essential that the MRUP does not increase the likelihood of fire in the area. A Fire Management Plan (MRUP-EMP-025) will be implemented to significantly reduce the risk of modifying the local fire regime, and this is discussed further in Section 6.5. The bushfire refugia (areas of unburnt vegetation within the recent fire scar) require specific adaptive management to ensure the protection, where practicable, of these important habitat islands (Figure 7.3). The Fire Management Plan (MRUP-EMP-025) will also involve ensuring that all ground disturbance activities are undertaken in accordance with its required protocols, including such measures as the provision of appropriate firefighting systems (equipment, training, procedures), prior approval for hot works, a site fire ban, and potentially mosaic burning, if appropriate, around the Project area.

7.5.2.6 Weeds

The implementation of a site-wide vehicle hygiene strategy, regulated under the Weed Management Plan (MRUP-EMP-003), will combat the issue of invasive weed species and their potential to adversely impact fauna habitat.

7.5.2.7 Feral Animals

The Feral Animal Management Plan (MRUP-EMP-006) will be utilised to manage the issue of feral animals, both competitors and predators, by monitoring feral animal numbers. If numbers are found to increase, and investigation into the possible cause will be made and, if necessary, the appropriate control measures will be implemented which may include the installation of fencing around any obvious attractants and humanely and legally reducing the numbers.

7.5.2.8 TSFs

The TSFs will be checked at least daily and fauna sighted will be reported to the Vimy Environmental Department. Measures to deter fauna from gaining access to the TSF will be implemented if required. These measures will be dependent upon the species involved.

7.5.3 Monitoring

Monitoring of the disturbance of fauna habitat will be undertaken using the protocols established within the Ground Disturbance Management Plan (MRUP-EMP-019). Prior to the issue of a GDAP (MRUP-POL-001) authorising ground disturbance, a comparison between the area proposed for disturbance will be made with a central Vimy database containing the locations of areas of known environmentally sensitivity. This database will be regularly updated to reflect the most current information under the Document and Data Control Management Plan (MRUP-EMP-038).

Information being entered into the database will include any relevant observations that result from the regular site inspections undertaken by the Environmental Officer. Such observations will occur ad hoc, during daily activities and annually when a complete site environmental inspection will occur. This annual inspection will include an inspection of the condition of specific fauna habitat types or locations, evidence of increased feral animals activity adjacent to, or within, operational areas by either walking or driving along all roads and pipelines within the Project area and around the perimeter of all mining and processing operations and infrastructure. The details of the monitoring protocol will be specified within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030) and the Feral Animal Management Plan (MRUP-EMP-006).

If deterioration in the condition of fauna habitat or an increase in feral animal activity is attributed to operational activities of the Project, measures detailed within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030) and the Feral Animal Management Plan (MRUP-EMP-006) will be implemented to prevent further deterioration and, where possible, to ameliorate the effects. The Vimy Environmental Department will investigate the potential reasons for the increase in feral animal number, and will implement appropriate measures to either mitigate the operational activity increasing numbers, prevent the ingression of animals from offsite and/or eradicate feral animal population from Project site as specified within the Feral Animal Management Plan (MRUP-EMP-006).

Monitoring of rehabilitation success will occur regularly as scheduled within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030). Methodology of monitoring specified within that management plan will ensure the determination of success, or otherwise, of meeting the Key Performance Indicators (KPIs) established within the Mine Closure Plan (MRUP-EMP-031). An effective feedback loop will be a safeguard to ensure continual improvement in rehabilitation success will occur. It will also guarantee that remedial work will be scheduled for any rehabilitation areas not meeting KPIs for the particular site.

Vimy employees and contractors will be encouraged to report any observations indicating the potential presence of any conservation significant fauna. All such observations will be entered into the central database system, according to protocols within the Document and Data Control MP (MRUP-EMP-038).

Continuous monitoring of selected habitats will also occur, both inside and outside the Project area; throughout all stages of the Project (construction, mining and closure). Fauna monitoring will be undertaken within the discipline of the Camera Trapping Protocol (CTP) system (Appendix B3). Long term monitoring sites outside of the Project area will be used as control sites against which fauna sightings within the Project area can be referenced. Particular attention will be paid to the CTP monitoring of suitable habitats for MNES listed species. As part of the Transport Radiation Management Plan (MRUP-EMP-022), all vertebrate fauna strikes will be recorded with information including the location, date, time and particular species believed to be involved. For any fauna strikes or deaths potentially involving conservation significant fauna, the Environmental Officer will be informed and will have the responsibility of endeavouring to properly identify the fauna (which may not be possible if the fauna has been struck but has left the immediate location). All strikes will be recorded on the central database according to protocols within the Document and Data Control MP (MRUP-EMP-038). If more than one conservation significant fauna strike is recorded in a specific location in a 12 month period, then the Vimy Environmental Department will investigate if a population or specific habitat of the conservation significant fauna are located in the vicinity of the incidents, and will instigate measures to reduce the potential for future incidents. Such measures will be dependent upon the species and the situation. If vertebrate fauna deaths recorded in a specific location are greater than five incidents per quarter, then the Vimy Environmental Department will investigate the likely cause of the concentration of incidents, and implement appropriate preventative measures to prevent or greatly reduce potential for future incidents.

Fauna habitats will be subject to a matrix of monitoring activities designed to track changes to the health of the habitats as a result of Project activities. Habitat monitoring activities include:

- Weed monitoring, conducted in accordance with the Weed Management Plan (MRUP-EMP-003). If weed populations are detected, a local weed eradication will be implemented according to the protocols specified in the Weed Management Plan (MRUP-EMP-003), and there will also be an attempt to identify the source of introduction and to determine future prevention strategies.
- Dust Monitoring, conducted in accordance with the Dust Management Plan (MRUP-EMP-024). If dust is negatively affecting fauna habitat, appropriate measures to further reduce dust emissions by increasing dust suppression activities (such as watering) or reducing the cause (such as reducing speed limits) as specified within the Dust Management Plan (MRUP-EMP-024).
- Vegetation community condition and baseline monitoring, conducted in accordance with the Flora and Vegetation Management Plan (MRUP-EMP-001) and the Threatened and Conservation Significant Flora and Vegetation Management Plan (MNES listed species) (MRUP-EMP-002).

All monitoring activities are governed by protocols within the Environmental Monitoring Management Plan (MRUP-EMP-032) which will ensure that compliance with relevant management plans takes place.

7.6 Predicted Outcomes

It is intended that the process of avoiding and minimising the disturbance of fauna habitat through the use of GDAP system will result in no more than 3,787ha of native vegetation being disturbed. The same process will ensure that habitat for conservation significant fauna is avoided as far as is practicable. Management measures will also ensure that any indirect impacts upon terrestrial fauna are quickly identified and remedied and that any lasting impact can be prevented.

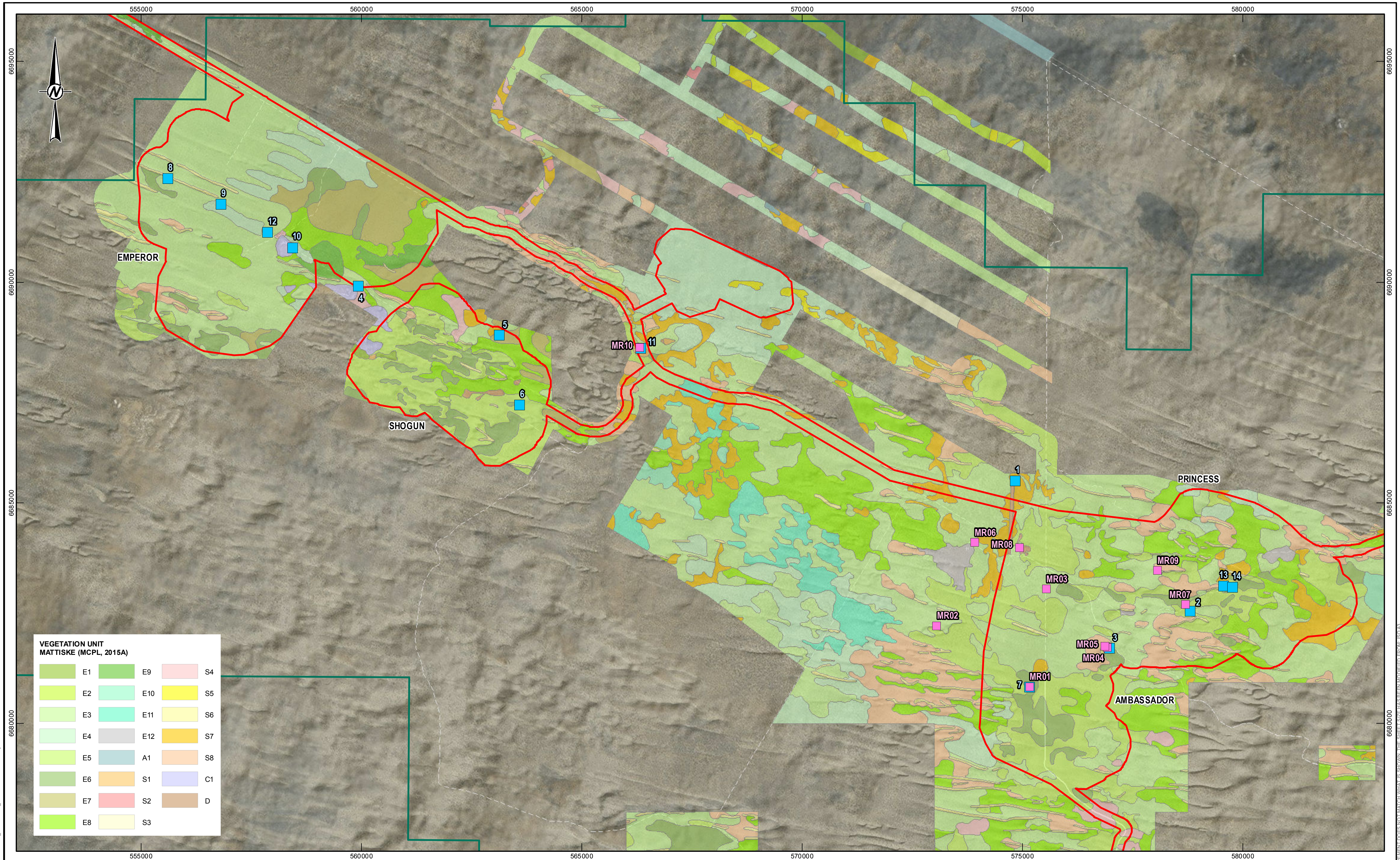
All areas that have been disturbed will ultimately be rehabilitated under the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030) and the Mine Closure Plan. Any areas cleared for construction or mining purposes that are not subsequently required during operations, including overburden landforms and any backfilled mining areas, will be progressively rehabilitated. The progressive rehabilitation of disturbed sites will be monitored and information on rehabilitation success will be reviewed and fed back to ensure continual improvement of rehabilitation protocols. This aims to ensure that established KPIs on functioning and stable ecosystems to closely resemble analogue sites will be met.

There will inevitably be some impact upon terrestrial fauna as a result of vehicle strikes. The numbers will be monitored and further mitigation measures will be introduced in the event that numbers of fauna strikes exceed those discussed in Section 7.5.2.

Following the cessation of mining, Vimy will decommission the mine in accordance with the Mine Closure Plan (Appendix H1) and any remaining disturbed areas will be rehabilitated in accordance with the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030). It is expected that over time the revegetated areas will become established and provide suitable fauna habitat resulting in minimal residual impacts.

Taking into account the recent fire degradation of the vegetation, the minimisation of ground disturbance through the application of control procedures, the progressive nature of the proposed rehabilitation that will be undertaken and control measures designed to minimise the effect of fire and feral predators, the residual impact on terrestrial fauna as a result of the development of the Project is not expected to be significant. It is acknowledged that there is a time lag between the loss of potential fauna habitat as a result of clearing and its restoration as part of rehabilitation to a habitat capable of supporting fauna, and that this temporary loss may be regarded as an adverse impact. Subsequently, further consultation with the Commonwealth's Department of the Environment will be undertaken to establish the extent to which such a temporary loss might be regarded as a residual impact and might be regarded as significant thereby necessitating an offset requirement.

Vimy is confident that the EPA's objective with respect to terrestrial fauna can be met.



LEGEND

- NINOX (2009) TRAP SITE
- MARTINICK & HART (1985) TRAP SITE
- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 1 2 3 4 5
1:80,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

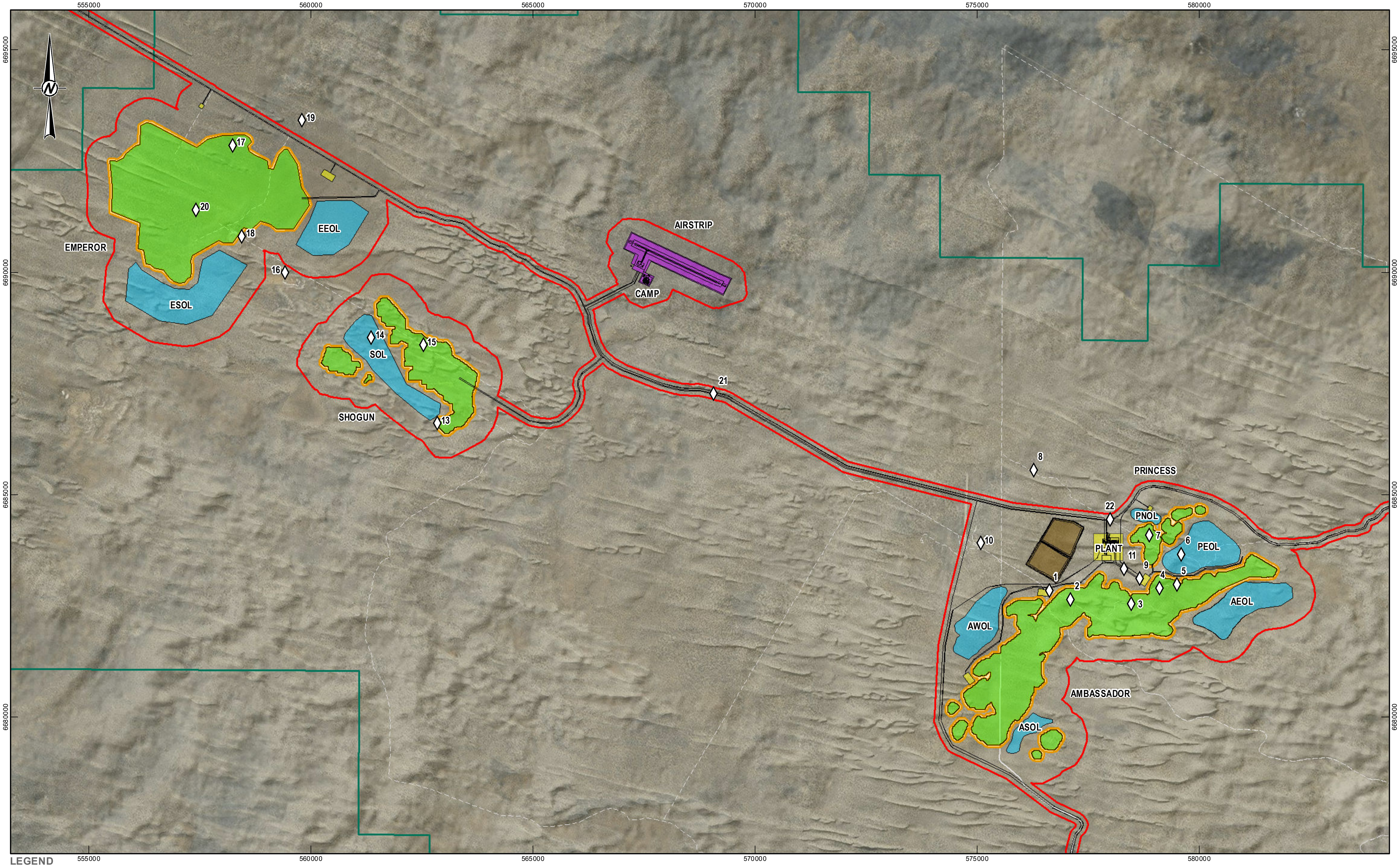
YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
1985 AND 2009 VERTEBRATE FAUNA SAMPLING LOCATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	7.1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25mm



LEGEND

◊	SRE FORAGE SITE		PIT
	MINOR ROAD/TRACK		OVERBURDEN LANDFORM
	ROAD		PROCESSING INFRASTRUCTURE
	MRUP DEVELOPMENT ENVELOPE		ABOVE GROUND TSF
	PROJECT BOUNDARY (MINING TENURE)		SUPPORTING INFRASTRUCTURE
	PROJECT BOUNDARY (MISCELLANEOUS TENURE)		PIT CLEARING (50 m BUFFER)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 1 2 3 4 5
1:80,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SRE SAMPLE SITES AND ASSOCIATED POTENTIAL SRE HABITATS

PROJECT NO.	CONTROL	REV.	FIGURE
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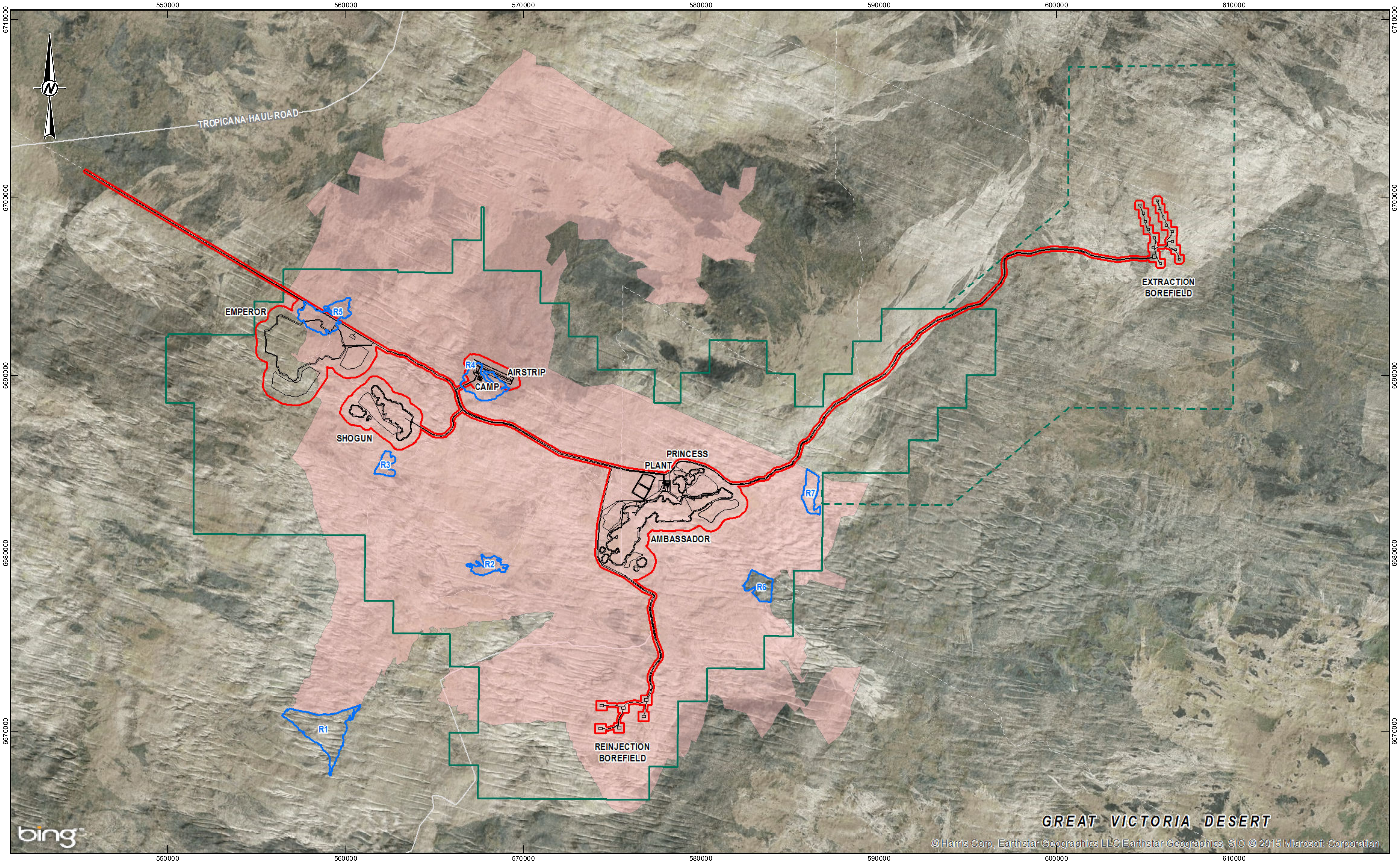


LEGEND

- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- NOVEMBER 2014 FIRE SCAR
- BUSHFIRE REFUGE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 5 10
1:200,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

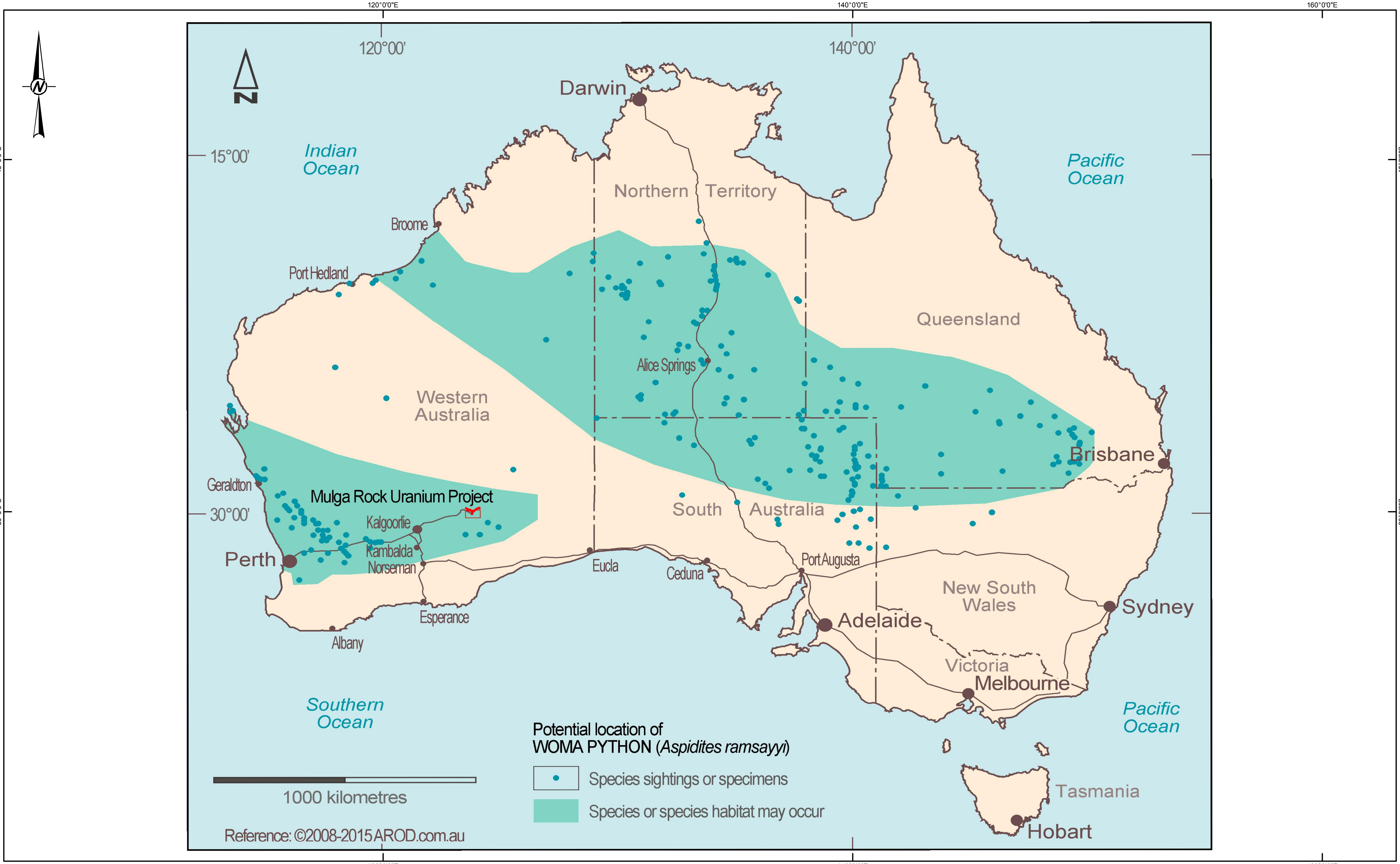
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
NOVEMBER 2014 FIRE SCAR SHOWING BUSHFIRE REFUGES (MATTISKE 2015)

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	7.3



LEGEND

MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GCS GDA 1994

0 500 1,000

1:17,000,000 KILOMETRES

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT	YYYY-MM-DD: 2015-10-31	TITLE NATIONAL DISTRIBUTION OF WOMA PYTHON	
	DESIGNED: MS		
	PREPARED: MS		
	REVIEWED: GB		
	APPROVED: GB	PROJECT NO. 1540340 / CONTROL PER / REV. 0	FIGURE 7.4

8. Subterranean Fauna

8.1 Relevant Environmental Objectives, Legislation, Policies and Guidelines

8.1.1 EPA Objective

The EPA applies the following objectives to the assessment of proposals that may affect terrestrial fauna, including subterranean fauna:

> *To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.*

8.1.2 Regulatory Framework

8.1.2.1 Applicable Legislation

The protection of subterranean fauna is covered by the following statutes:

- *Wildlife Conservation Act 1950 (WA) (WC Act).*
- *Environmental Protection Act 1986 (WA) (EP Act).*
- *Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act).*

8.1.2.2 Applicable Guidance and Position Statements

The following EPA position and guidance statements set the framework for identification and assessment of impacts to subterranean fauna:

- EPA June 2013, Environmental Assessment Guideline No. 12 – Consideration of Subterranean Fauna in Environmental Impact Assessment in WA.
- EPA August 2007; Draft, EPA Interim Guidance Statement No. 54a (Technical Appendix to Guidance Statement No. 54) – Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia.

8.1.2.3 Others

In addition the following documents were considered in relation to offsets:

- DSEWPaC 2012, Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) EPBC Act Environmental Offsets Policy, Canberra, ACT.
- Government of Western Australia 2011, Environmental Offsets Policy, Perth, Western Australia.
- Government of Western Australia 2014, Environmental Offsets Guidelines, Perth, Western Australia.

8.2 Existing Environment

Subterranean fauna are defined as animals, usually invertebrates, which live beneath the land surface. Troglofauna are species typically associated with vadose zone environments (i.e. unsaturated zone between the surface and groundwater whilst stygofauna are aquatic species associated with saturated groundwater or aquifers.

8.2.1 Hydrogeology

8.2.1.1 Paleodrainage Channel

The MRUP deposits lie within the Narnoo sub-basin, which contains up to 100m of fluvial, lacustrine and marine sediments of Tertiary and Cretaceous age that include sandstone, claystone, lignite and minor conglomerate which commonly occur on graded beds. Groundwater levels typically occur around 30-50m below the land surface (Appendix D1), with mineralisation primarily occurring in the lignite and underlying sandstone, primarily at the redox boundary (Appendix C1). Salinity in the groundwater system increases downstream and towards the main paleodrainage channel, and consequently salinity with the Princess and Ambassador deposits (which occur within an upstream tributary to the main channel) are appreciably lower (average 20,000-25,000mg/L, but range of 7,519-75,200mg/L) than that occurring either within Shogun and Emperor Deposit (average of 50,000-70,000mg/L) or the reinjection borefield (average of 73,900mg/L). The pH of the groundwater within the paleodrainage channel is typically between 3.5 to 4.3 (Appendix D1) with Cl/SO_4 ratios often below 4.2 suggesting that the acidity is due to contemporary sulphide oxidation.

8.2.1.2 Kakarook North Aquifer

The Kakarook North aquifer, which will be accessed to supply lower chloride (lower salinity) groundwater for the processing plant, is located approximately 30km northeast of the current camp site. The aquifer system is hydraulically disconnected from the Narnoo paleodrainage channel, which hosts the uranium deposits, and represents a graben style geological basin filled with sandstone. Given the style and composition of this basin, the groundwater system is actively replenished by infiltrating rainfall: hence it has a brackish salinity (average TDS of around 5,500mg/L) and is slightly acid-neutral (average pH 6.7).

8.2.1.3 Hydrogeological Modelling

H3 hydrogeological modelling has been undertaken for the proposed mining areas (Section 9) and the Kakarook North borefield (Appendix D1) to establish the required dewatering volume to access the orebody and the impact of this dewatering on groundwater levels. As discussed above, the mineralised deposits to be mined at the MRUP occur at the water table or redox boundary and in most cases only extend 5m below the groundwater level. Consequently, the requirement for dewatering and the impacts on groundwater levels will be localised and have a limited depth.

8.2.2 Stygofauna

The type of aquifers found regionally in the Goldfields which are considered to have a high or very high probability of containing diverse stygofauna communities are those found within calcrete, alluvium or banded ironstone (EPA 2013) and these are not found within the proposed Project area. The water quality at the four MRUP deposits, the clayey stratigraphy and the direct association of the paleochannel aquifer with the lignite mineralisation, suggest that there is a low potential for stygofauna to exist through most of the area proposed to be mined (Appendix C1), and Database searches provided no records of stygofauna within a 100km radius of the Project area nor within the type of carbonaceous aquifer that characterises the area where mining activity is proposed to take place (Appendix C1 and Appendix C2). Furthermore, previous stygofauna studies undertaken for the Tropicana Gold Project (approximately 110km northeast) did not find any stygofauna in the proposed water supply area or operational mining areas and concluded that there were negligible groundwater stygofauna habitats in this area (Appendix C2).

The sandstone hosted groundwater aquifer in the area around the proposed extraction borefield at Kakarook North is likely to be more conducive to stygofauna habitat association, and this is further promoted by the lower salinity and circumneutral pH of this aquifer (Appendix C2).

8.2.3 Troglofauna

Troglofauna are confined to, and dependent upon, subterranean spaces or pores/vughs which have some vertical and lateral connectivity through to the surface in order to supply the required air, humidity and food (Appendix C2).

The superficial Aeolian sands that mostly characterise the Project area are not considered preferred habitat for troglofauna, as these materials effectively have moisture or matric potentials at or well below -1,500kPa, and hence they exist at suboptimal humidity levels for troglofauna, and the upper sandy unit underlying these tertiary sediments is also unlikely to contain any suitable fissures or voids (Appendix C2). The only likely exception to this may be the ancient root channels which may have created voids in this soil profile and which preferentially create a local humid environment (Appendix C2).

The deeper vadose zone Miocene and Eocene sediments, whilst existing at optimal humidity levels for troglofauna, are unlikely to contain sufficient porosity of pore size to support troglofauna, given their sedimentary and pedogenic history.

There are no PECs or TECs relating to stygofauna or troglofauna within 150km of the Project (Appendix C2).

8.3 Surveys and Investigations

There have been two subterranean fauna surveys undertaken in the Project area:

- Stygofauna Pilot Assessment undertaken in February 2013 (Appendix C1).
- Subterranean Fauna Pilot Study undertaken in October 2014 (Appendix C2).

8.3.1 Stygofauna Sampling – 2013

8.3.1.1 Methodology

Following discussions with the Department of Environment and Conservation (DEC) in 2011, Vimy was advised to undertake a pilot study for the presence of stygofauna at the MRUP. Due to the local environment, and the corresponding low potential for stygofauna to be present, a Level 1 survey was determined to be sufficient according to Environmental Guideline Assessment 12 (EPA 2013). A Level 1 survey consists of a desktop study and usually a basic reconnaissance survey which involved selective low intensity sampling to establish whether subterranean fauna are present or likely to be present within the MRUP. The results of the desktop data search are summarised in Section 8.2. The subterranean sampling was undertaken under a DPaW Licence to Take Fauna for Scientific Purposes.

Eleven sample sites, or boreholes, were investigated (Figure 8.1). Four were water bores, two with ages greater than 25 years since construction, six were diamond drill holes drilled within the previous five years and one was an air core exploration hole (also drilled within the previous 5 years). These sites were selected for sampling in this study due to ease of access, known construction history and stratigraphic and aquifer characteristic documentation (Appendix C1). All bores had not been pumped for the previous three years, had casing diameters greater than 48mm and were within the potential zones of impact associated with drawdown from the proposed MRUP mining activities. Seven sample sites were at Ambassador, two at Kakarook North and one each at Emperor and Shogun. Princess was not sampled in this survey as it had only recently been discovered, and there were no suitable bore holes available for sampling. Results for Princess were expected to be similar as that of Ambassador due to a shared geology of the saturated profile indicating on open hydrological system between the two areas, and similar upstream tributary position.

Sampling was carried out from 27 February to 3 March 2013 according to protocols within the EPA Guidelines 54A (EPA 2007), and that described by Hose & Lategan (2012) (Appendix C1). A current DPaW Licence to Take

Fauna for Scientific Purposes was held. Groundwater samples were taken before the biological sampling, and recorded for the following parameters:

- Acidity (pH).
- Electrical conductivity (µS/cm).
- Dissolved oxygen (mg/L).
- Oxygen reduction potential (ORP) (mV).

Stygofauna samples were collected using phreatic haul nets of 150µm (for first three hauls) and 50µm (for second three hauls) mesh size, with diameters varying according to bore hole width. The net was gently agitated against the base of the borehole to resuspend any sediment and to increase the capture of any periphytic or benthic stygofauna. Further details of the subterranean fauna sampling technique are described within Appendix C1.

8.3.1.2 Results

Groundwater Quality

The groundwater quality data recorded for these bores, prior to stygofauna sampling, approximated the regional quality and thus was considered representative of the broader groundwater environment. The Emperor sampling site had the highest salinity at 102.20mS/cm (approximately 56,210mg/L) and lowest pH at 3.81. Ambassador samples varied in salinity from 1.43 to 62.10mS/cm (approximately 786 to 34,155mg/L) and acidity was circum-neutral (pH 5.62 to 7.14). The samples from Kakarook North had low pH (4.65 and 5.48) and salinity levels of 11.50 and 15.40mS/cm (approximately 6.325 and 8,470mg/L). The Emperor sample site recorded the lowest dissolved oxygen level, the highest TDS and the highest oxidation-reduction potential suggesting that this groundwater is highly reduced (Appendix C1).

Biological Results

A total of 104 invertebrates were recorded from only seven of the eleven sample sites. All taxa were terrestrial, and no subterranean fauna were identified from these specimens (Appendix C1). The dominant sampled invertebrates were ants (Formicidae) followed by mites (Acarina).

Although subterranean fauna have been recorded in hypersaline environments (such as Lake Maitland), there are no records within an environment where there is also low groundwater pH, such as at MRUP. The seasonal variation in the groundwater conditions and soil temperatures in the MRUP area are also preventative in supporting subterranean fauna (Appendix C1).

8.3.2 Subterranean Fauna Sampling – 2014

8.3.2.1 Methodology

The subterranean sampling methodology was implemented in accordance with the relevant EPA Guidance Statements (EPA 2007 & 2013) and under a DPaW Licence to Take Fauna for Scientific Purposes (Appendix C2). It constituted a pilot scale Level 1 survey (Appendix C2). Sampling occurred from 6-10 October 2014, and samples were retrieved on 28 November 2014.

Stygofauna

Stygofauna were sampled within the Kakarook North aquifer. Interpretation of geological data and bore completion logs were reviewed to enable the selection of the most suitable monitoring bores for stygofauna sampling, which were generally bores that produced the most water during bore development. Twelves bores from the Kakarook North area were sampled for stygofauna. Stygofauna samples were collected using modified plankton haul nets of 150µm (for first three hauls) and 50µm (for second three hauls) mesh size. The net was gently agitated against the base of the borehole to resuspend any sediment and to increase the capture of any periphytic or benthic stygofauna. Five single haul samples were also taken at Emperor (Appendix C2) (Figure 8.2).

Further details of the stygofauna sampling technique are described within Appendix C2. Groundwater water quality measures of conductivity, pH, redox potential and temperature were also measured immediately after the sample was collected (Appendix C2).

Troglofauna

For the troglofauna assessment, the lithological and geological cross-sections of drill cores onsite were examined for the selection of appropriate exploration drill holes to sample troglofauna. In November 2014, there were 18 samples taken in the Princess/Ambassador area and 15 samples collected from within the Emperor /Shogun area. Samples were collected using modified haul nets and baited traps. Scrape samples were taken immediately before baited traps were utilised. The baits used were moist native vegetative litter that was soaked overnight and microwaved on maximum power for 10-15 minutes to kill any surface invertebrates and to assist in the breakdown of the material. Scrape and trap samples were processed separately, but considered as one sample. Further details on the sampling methodologies are provided within the Rockwater report (Appendix C2).

8.3.2.2 Results

Groundwater Quality

The water quality sampling from 11 bores from the Kakarook North borefield indicated slightly acidic groundwater with pH ranging from 5.24 to 6.26. The salinity ranged from brackish to slightly saline at 2,040 to 7,550mg/L TDS and generally below 5,300mg/L (Appendix C2).

Biological Samples

<u>Stygofauna</u>

Of the thirteen bores sampled for stygofauna (12 installed by Rockwater and one where preserved samples were collected by Vimy), only two recorded the presence of stygofauna. There were 64 individuals sampled at these two bores representing three potential stygal species of two higher taxonomic groups Oligochaeta (Table 8.1). There were no stygofauna detected within the Emperor samples (Appendix C2) (Figure 8.3).

Table 8.1 Stygofauna Sampled

Order	Family	Taxon	Number of animals recorded	Site
OLIGOCHAETA				
Enchytraeida	Enchytraeidae	*Enchytraeus* sp. 1 (PSS)	18	Kakarook North – NGW14(3) NGW17(15)
Haplotaxida	Tubificidae	Tubificidae sp. MR1	45	Kakarook North – NGW17(45)
		TOTAL	63	

The Tubificidae sp. MR1 has only been recorded by this pilot study. The *Enchytraeus* sp. 1 (PSS) is a species complex that has been recorded in other parts of Western Australia including the Pilbara (Appendix C2).

There were also nematodes sampled at one site in Kakarook North. As this specimen was also collected at a dry drill hole at Emperor and another at Ambassador, this specimen was not considered as stygofauna (Appendix C2).

Troglofauna

There were 13 individual troglofauna of two orders recovered from eight sample bore holes (three bores at Emperor, three at Ambassador and two at Kakarook North) from a total of 33 samples (Table 8.2). Only two trap sites recorded troglofauna, and these were at Ambassador at 5m and 10m indicating that the subterranean habitat is within the surficial sands and sandstone of Eocene and Miocene age (Appendix C2). Other troglobotic animals were collected by either scrape-sampling or as stygofauna by-catch (Figure 8.4).

The three taxa are likely to represent new species of genera previously collected in the Yilgarn region and taxonomic advancement is unlikely until further specialist work is undertaken on the relevant taxonomic group. Based on the sampling intensity of this pilot study, the capture rate and the diversity of samples, the troglofauna population is comparable with moderately diverse communities in the Yilgarn (Appendix C2).

Table 8.2 Troglofauna Sampled

Order	Family	Taxon	Number of animals recorded	Site
CRUSTACEA				
Isopoda	Platyarthridae	*Trichorhina* sp. B21	9	Ambassador – NNA5366 (2) NNA5108 (1) NNA5380 (1) Emperor - NNA5710 (4) Kakarook North – NGW17(1)
SYMPHYLA				
Cephalostigmata	Scutigerellidae	*Hanseniella* sp. B28	3	Emperor - NNA5498 (1) NNA5709 (2)
Cephalostigmata	Scutigerellidae	*Symphyella* sp. B19	1	Kakarook North - NGW14 (1)

8.4 Potential Impacts

8.4.1 Stygofauna

8.4.1.1 Direct Impacts

The potential direct impacts of the proposed MRUP upon stygofauna include:

- Destruction of habitat and removal of any local communities by mining (which may lead to the extinction of endemic species).
- Alteration of water levels due to groundwater dewatering to access the ore and abstraction from the proposed extraction borefield at Kakarook North.
- Alteration of groundwater quality through changes in hydrology and recharge.
- Interference with stygofauna as a result of the reinjection of mine dewatering water into the aquifer in a different location downstream from the mining area, and potential for habitat loss or modification.

8.4.1.2 Indirect Impacts

Indirect impacts are those threatening processes which may result from the proposed MRUP and may lead to a reduction in population size of subterranean fauna and/or cause secondary impacts to subterranean fauna habitat. The potential indirect impact of the proposed MRUP upon stygofauna populations could result from:

- Seepage from the base of in-pit tailings facilities and the potential for the modification of groundwater quality.
- Oxidation of sulphides exposed in the pit walls and subsequent acidification of local groundwater.

As discussed, stygofauna were not recorded at any of the sample sites within the MRUP mining area due to the lack of appropriate habitat type, as a result of the high acidity and salinity of the groundwater. Within the paleodrainage channel therefore, mining of the deposit, dewatering of the groundwater, potential oxidation and acidification of the aquifer system and reinjection of excess water, will not impact upon stygofauna.

Any direct or indirect impacts of the MRUP on stygofauna will be limited to the Kakarook North borefield area. Sampling for stygofauna in the area where it is proposed to locate the extraction borefield did not yield any stygofauna in 10 of the 12 sites sampled. The remaining two locations yielded one species of aquatic worm (*Enchytraeus* sp. 1) that was found at both of these sites and is a species complex that has been recorded in other parts of Western Australia. One location also yielded another species of aquatic worm (Tubificidae sp. MR1) which is a potential new species having only been recorded from the Kakarook North area (Appendix C2). Although it was not recorded in any other sample sites, similar Tubificidae recorded in the Pilbara and Kimberly have distribution ranges at least an order of magnitude greater than the size of the Kakarook North investigation area. The alluvial channel or basin at Kakarook North has a recorded thickness of up to 42m over a length of about 16km with width varying between 5 and 8km. Suitable habitat for this species therefore extends well beyond the area of the proposed borefield (Appendix C2).

The Kakarook North aquifer has been modelled as containing around 167GL of water and the MRUP is expecting to extract up to 3.6GL/a (with an average of 1.8GL/a over the LOM). The cone of depression around the borefield (the area where the level of the water would fall) is not expected to significantly extend to the limits of the basin, and there will, therefore, be areas where any resident stygofauna will be unaffected. The relative small amount of water being extracted (when compared to the size of the aquifer) is not expected to represent a threat to any species present. Indeed the amount of drawdown is not expected to exceed natural variations in the level occurring in the aquifer as a result of varying rainfall and will be small compared to the thickness of the associated habitat. Accordingly, no significant impact upon stygofauna is expected to occur as a result of the extraction of water from the Kakarook North borefield.

8.4.2 Troglofauna

8.4.2.1 Direct Impacts

The potential direct impacts of the proposed MRUP upon troglofauna include:

- The destruction of habitat by mining, and removal of any local communities by mining (which may lead to the extinction of endemic species).
- Hydrocarbon spills contaminating troglofauna habitat.
- Vibrations from heavy equipment that could cause subterranean voids to collapse during construction and operations.
- A reduction in organic inputs (i.e. vegetation clearing and stockpiling of topsoil may reduce the flow of organic material into shallow subterranean systems).
- Changes in local hydrology (which could alter local recharge/discharge points).

The sampling results for troglofauna indicated that the MRUP area only contained a moderate diversity of troglofauna when compared to that of the Yilgarn (Appendix C2). No species were located at Ambassador or Shogun. Only three species were sampled and none were located solely within the proposed Development Envelope. Only two species are likely to be directly impacted by the Project.

The slater *Trichorhina* sp.B21 was sampled in an area over 50km wide, at the Kakarook North, Emperor and Ambassador sites suggesting that the distribution of the species is widespread (Appendix C2). The pseudocentipede (*Hanseniella* sp. B28) was recorded at Emperor both within and outside of the proposed Development Envelope (Appendix C2). Based on the results of other research, both *Hanseniella* sp B28 and *Symphella* sp. B19 are likely to have distribution ranges greater than the MRUP area (Appendix C2). It is likely that all troglofauna recorded in the Project area are present at shallow depth in layers that are widespread in the region (Appendix C2). Therefore, it is unlikely that the abundance, diversity and geographic distribution of the troglofauna community, or the conservation status of any individual species at MRUP will be impact by the proposed Project (Appendix C2).

8.4.2.2 Indirect Impacts

Accidental spills of hydrocarbons or any other chemicals could adversely impact both stygofauna and troglofauna. This will be managed through the implementation of a Chemical and Hydrocarbon Management Plan (MRUP-EMP-037) to be developed before the commencement of operations. Site procedures such as appropriate storage of hydrocarbons, with adequate bunding to contain any potential spillage will aim to minimise any adverse impacts to subterranean fauna. Measures will also include spill kits to deal with potential spillage in areas where there is no bunding and facilities to capture and treat drainage from areas where hydrocarbons and other chemicals are handled.

8.5 Management of Impacts

The overall objective for the management of subterranean fauna is to ensure that the impact upon subterranean fauna as a result of the development of the MRUP will be minimised. The following management targets will assist in delivering such an outcome:

- Minimise disturbance to potential habitats of stygofauna.
- Minimise disturbance to potential habitats of troglofauna.
- Avoid hydrocarbons or other chemicals entering the soil or groundwater.
- Progressively rehabilitate disturbed environments of subterranean fauna, particularly troglofauna.
- Ensure awareness of environmental factors amongst operating workforce.

The above guiding principles have been incorporated into the following environmental management plans which have been, or will be, prepared to ensure that impacts (direct and indirect) are no greater than those impacts outlined above and that the impacts are avoided or minimised to the greatest extent that is practicable:

- Subterranean Fauna Management Plan (MRUP-EMP-007).
- Soil Management Plan (MRUP-EMP-008).
- Groundwater Management Plan (MRUP-EMP-010).
- Groundwater Operating Strategy (MRUP-EMP-011).
- Managed Aquifer Recharge Management Plan (MRUP-EMP-012).
- Ground Disturbance Management Plan (MRUP-EMP-019).
- Operational Environment Management Plan (MRUP-EMP-020).

- Water Operating Strategy (MRUP-EMP-021).
- Waste Management Plan (MRUP-EMP-026).
- Spill Response Management Plan (MRUP-EMP-027).
- Rehabilitation and Revegetation Management Plan (MRUP-EMP-030).
- Chemical and Hydrocarbon Management Plan (MRUP-EMP-038).

These management plans are contained in Appendix K1.

The management of environmental impacts to subterranean fauna will be predominantly achieved through the use of a Ground Disturbance Activity Permit (GDAP) (MRUP-POL-001) to minimise disturbance to troglofauna habitat and the implementation of the Groundwater Management Plan (MRUP-EMP-010), Groundwater Operating Strategy (MRUP-EMP-011), Managed Aquifer Recharge Management Plan (MRUP-EMP-012) and the Water Operating Strategy (MRUP-EMP-021) to minimise disturbance to potential habitats of stygofauna.

The Water Operating Strategy (MRUP-EMP-021) will ensure water use efficiency and minimise the requirement to extract water from the extraction borefield at Kakarook North. The Groundwater Management Plan (MRUP-EMP-010) will be used to manage the process of extracting groundwater from Kakarook North to ensure that there is not excessive drawdown assisted by the monitoring of both water levels and quality undertaken as part of the Water Operating Strategy (MRUP-EMP-011). The process of reinjecting the mine dewatering water back into the aquifer will be managed under the Managed Aquifer Recharge Management Plan (MRUP-EMP-012), although subterranean fauna surveys undertaken for the Project concluded there are no stygofauna in the aquifer in the reinjection area (to be adversely impacted).

The management of impacts resulting from chemical or hydrocarbon spills will be undertaken under the Chemical and Hydrocarbon Management Plan (MRUP-EMP-037) to ensure that any such spills do not reach subterranean fauna habitats, by such measures as bunding areas where spills are more likely to occur, and other measures designed to limit the movement of potential spills. There will also be the implementation of a Spill Response Management Plan (MRUP-EMP-027) to ensure that any spills are cleaned up as quickly as possible and that appropriate remediation measures are implemented.

The management of the rehabilitation of potential troglofauna habitat will be dealt with under the Soil Management Plan (MRUP-EMP-008) and the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030) which will ensure that the reconstruction of soil profiles and revegetation methodology will successfully establish an ecosystem that will provide the organic material that ultimately feeds subterranean fauna.

The Environmental Monitoring Management Plan (MRUP-EMP-032) will incorporate checks for spills or leaks that could enter the environment and ultimately impact upon subterranean fauna.

8.6 Predicted Outcomes

It is intended that the process of minimising the clearance of troglofauna habitat through the use of the MRUP GDAP system will result in no more than 3,787ha of disturbance. Some of the clearing associated with the disturbance will be limited to the surface or only minimal disturbance to the soil profile and so the impact on troglofauna habitat will be much smaller than this disturbance total. Areas that are cleared will be rehabilitated as soon as is practicable. No conservation significant troglofauna were detected.

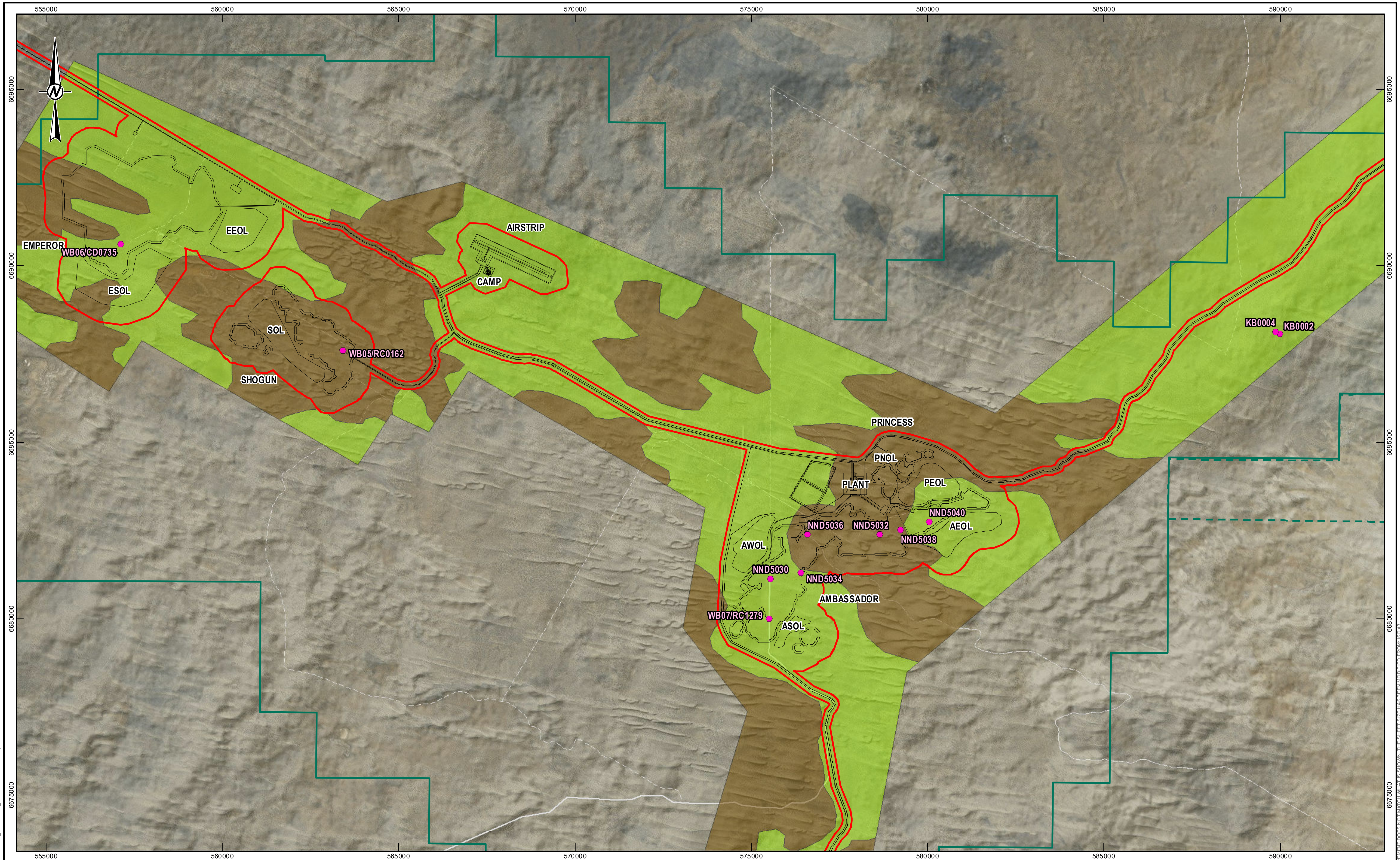
Water extraction from the extraction borefield is projected to be approximately 1.8GL/a on average, and no more than a maximum of 3GL in any one year, from a water body believed to contain in excess of 167GL in total. The amount of water taken per year therefore represents less than 2% of the water present in the aquifer and that rate of extraction is highly unlikely to present a threat to any mobile stygofauna residing within the water body.

Monitoring will be undertaken to ensure that there isn't excessive drawdown in any local area and therefore the residual impact on stygofauna is expected to be negligible.

The troglofauna species that reside within the Project area are present at shallow depths in strata that are widespread in the region. The sedimentary lithologies from which troglofauna have been recorded at MRUP occur over a linear range of at least 50km and are well represented in other parts of the Great Victoria Desert bioregion and are not unique in a regional context (Appendix C2).

In all areas where groundwater is being extracted or reinjected, the groundwater levels will be monitored to ensure that there is no excessive drawdown or mounding that could result in a detrimental impact to subterranean fauna. Kakarook North is the only area where stygofauna are present and could be impacted by excessive drawdown. Similarly the mine dewatering and the reinjection of mine dewatering water back into the same aquifer downstream will not adversely impact any stygofauna as there are none present within that particular habitat due to groundwater quality. There have been no recorded instances of troglofauna living at a depth of 10m or more. Therefore, troglofauna are unlikely to be present just above the water table and, subsequently there is no possibility that mounding in the area where reinjection is expected to take place could adversely impact troglofauna.

There will be no impact of the MRUP upon the abundance, diversity or geographic distribution of the troglofauna or stygofauna communities of the Project area and it is anticipated that the EPA's objective of maintaining representation, diversity, viability and ecological function at the species, population and assemblage level will be met. Other than the management measures described, no other actions are deemed necessary in relation to the protection of subterranean fauna and the residual impacts do not warrant any offset.



LEGEND

- 2013 STYGOFAUNA SURVEY SITE
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

SOIL LANDFORM ASSOCIATIONS

- DUNES
- PLAIN

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
STYGOFAUNA SURVEY SITES (2013 PILOT STUDY)

PROJECT NO.	CONTROL	REV.	FIGURE
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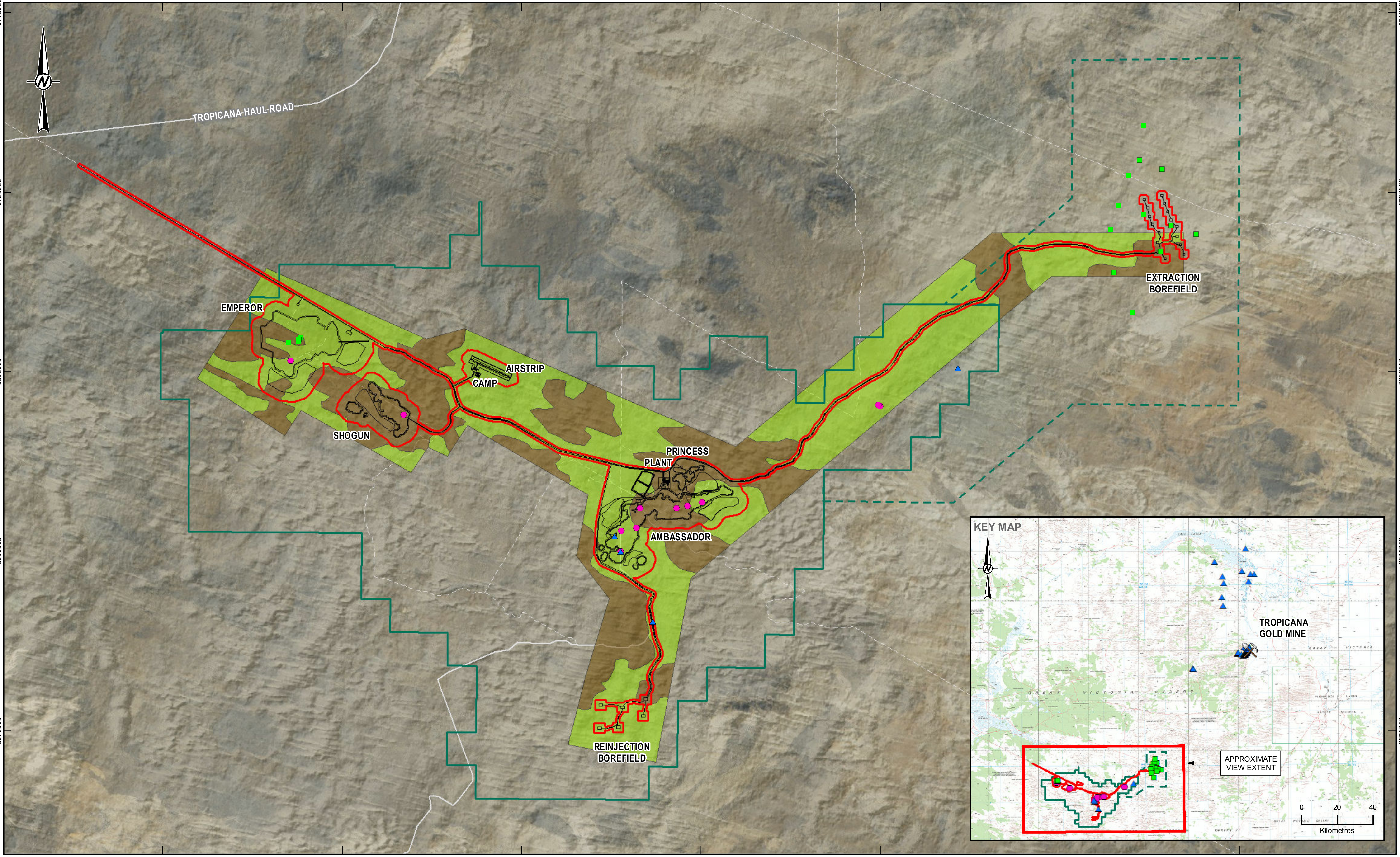

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- 2013 STYGOFAUNA PILOT SITE
- 2014 ROCKWATER SURVEY SITE
- TGM STYGOFAUNA SAMPLE SITE
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

SOIL LANDFORM ASSOCIATIONS

- DUNES
- PLAIN

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

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CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SUBTERRANEAN FAUNA SURVEY SITES FOR MRUP AND TROPICANA GOLD MINE

PROJECT NO.	CONTROL	REV.	FIGURE
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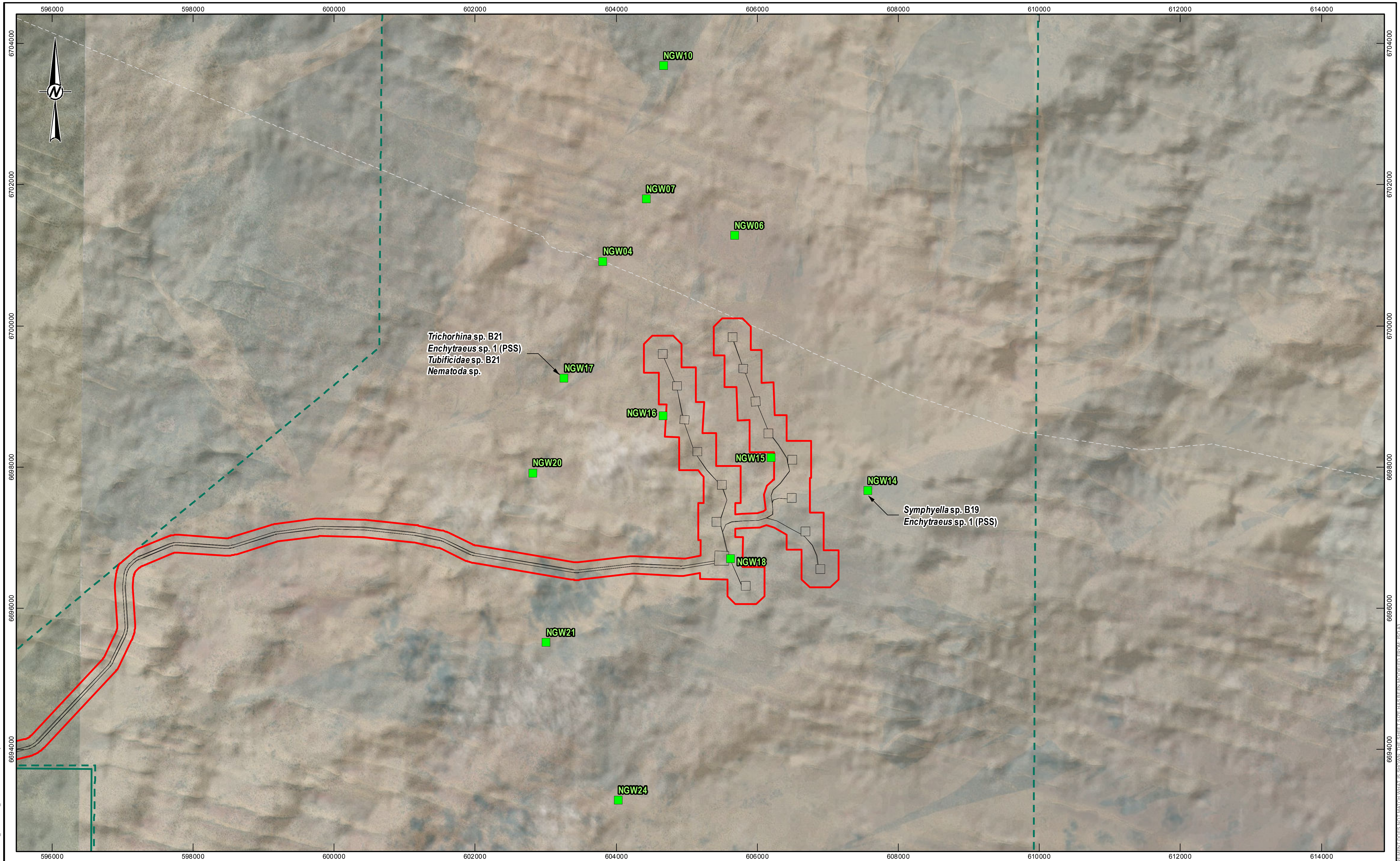

LEGEND

- 2014 ROCKWATER SURVEY SITE
- MINOR ROAD/TRACK
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

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CLIENT
VIMY RESOURCES LIMITED

CONSULTANT

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
STYGOFAUNA SURVEY SITES - KAKAROOK NORTH BOREFIELD

PROJECT NO.	CONTROL	REV.	FIGURE
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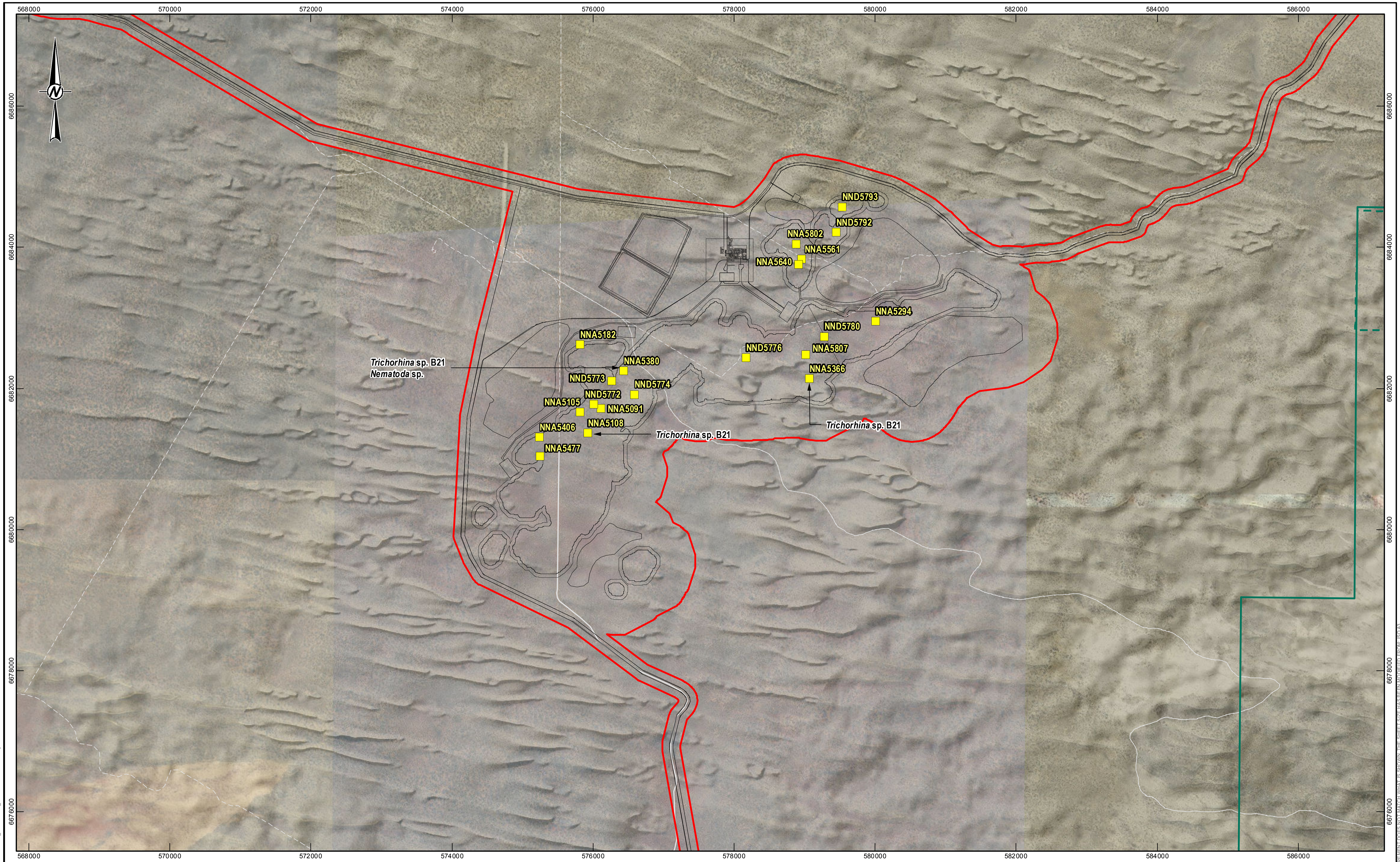

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TROGLOFAUNA SURVEY SITE	INFRASTRUCTURE
MINOR ROAD/TRACK	MRUP DEVELOPMENT ENVELOPE
ROAD	PROJECT BOUNDARY (MINING TENURE)
	PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

TITLE
TROGLOFAUNA SURVEY SITES - PRINCESS AND AMBASSADOR DEPOSITS

PROJECT NO.	CONTROL	REV.	FIGURE
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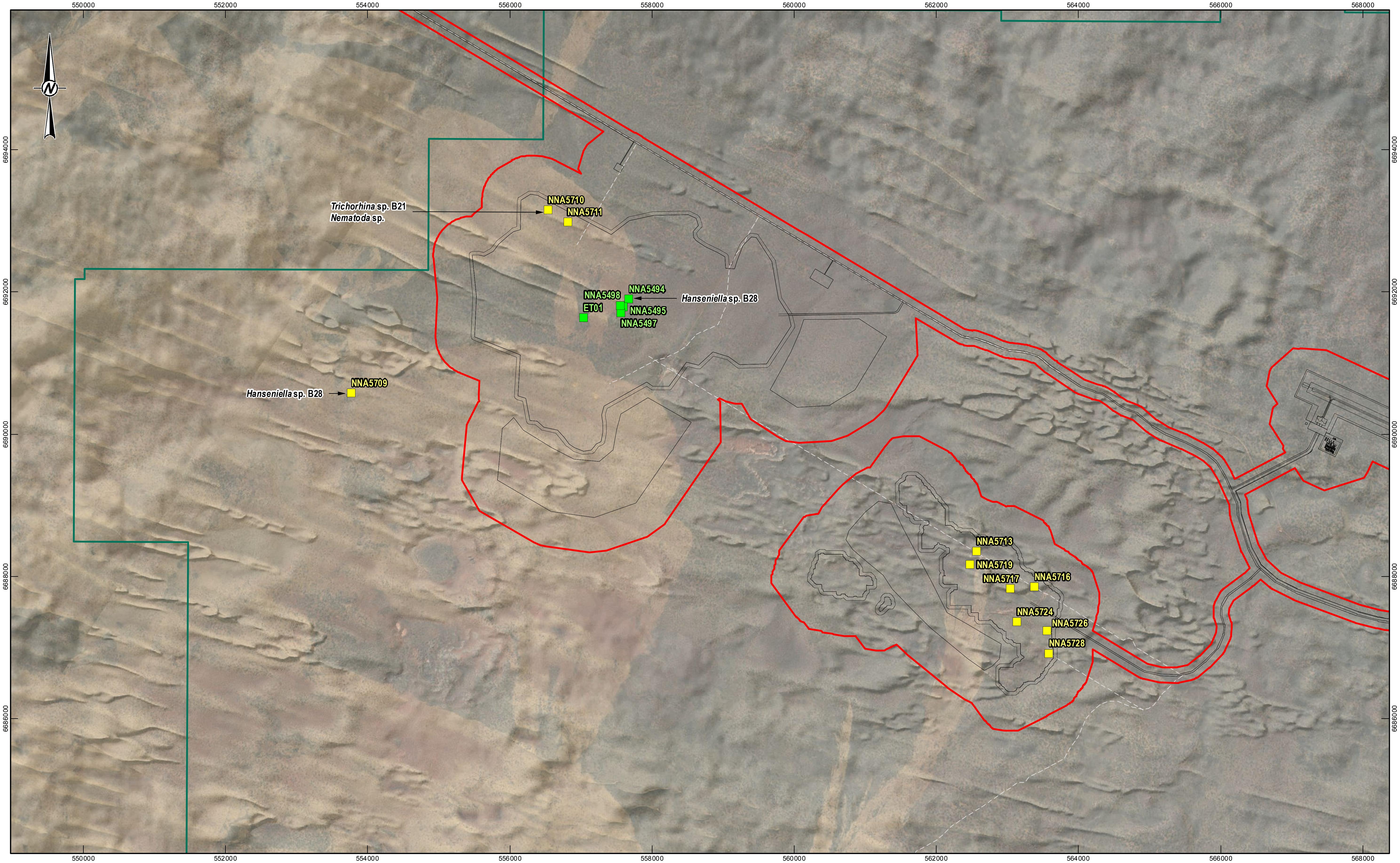

LEGEND

- TROGLOFAUNA SURVEY SITE
- 2014 ROCKWATER SURVEY SITE
- MINOR ROAD/TRACK
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SUBTERRANEAN FAUNA SURVEY SITES - EMPEROR AND SHOGUN DEPOSITS

PROJECT NO.	CONTROL	REV.	FIGURE
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9. Matters of National Environmental Significance (MNES) Species

9.1 Relevant Environmental Objectives, Legislation, Policies and Guidelines

9.1.1 EPBC Act Objective

The EPBC Act objectives are to:

- Provide for the protection of the environment, especially MNES species.
- Conserve Australian biodiversity.
- Provide streamlines national environmental assessment and approvals process.
- Enhance the protection and management of important natural and cultural places.
- Control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife.
- Promote ecologically sustainable development through the conservation and ecological sustainable use of natural resources.
- Recognise the role of Indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity.
- Promote the use of Indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.

9.1.2 Regulatory Framework

9.1.2.1 Applicable Legislation

The Matters of National Environmental Significance (MNES) are listed within the *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act).

The MNES can be one or more of the following:

- Nationally threatened species and ecological communities.
- Migratory species.
- Ramsar wetlands of international importance.
- Commonwealth marine areas.
- World Heritage properties.
- National Heritage places.
- Great Barrier Reef Marine Park.
- Nuclear actions (including uranium mining).
- A water resource, in relation to coal seam gas development and large coal mining development.

The MRUP is an action that will require approval under the *EPBC Act* due to the Project being classified as a nuclear action, with the intended mining and processing of uranium ore, and the potential to have an impact upon a number of species listed under the categories of endangered and vulnerable. There is also the potential for migratory species that are protected under international agreements to be in the MRUP area. These MNES species are discussed further in this section.

9.1.2.2 Guidance and Position Statements

The following EPA position and guidance statements set the framework for identification and assessment of impacts to terrestrial fauna and flora:

- EPA December 2000, EPA Position Statement No. 2 – Environmental Protection of Native Vegetation in Western Australia – Clearing of Native Vegetation, with particular reference to the Agricultural Area.
- EPA March 2002, EPA Position Statement No. 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection.
- EPA May 2009, EPA Guidance Statement No. 20 – Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia.
- EPA June 2004, EPA Guidance Statement No. 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia.
- EPA December 2003, EPA Guidance Statement No. 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process.
- EPA June 2004, EPA Guidance Statement No. 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.

9.1.2.3 Others

Consideration was also given to the following legislation and guidance documents when designing and undertaking the surveys, and analysing survey results:

- *Animal Welfare Act 2002 and Animal Welfare Regulations (Scientific Purposes) Regulations 2003.*
- Australian Code for the Care and Use of Animals for scientific purposes 8th Edition (2013).
- Benshemesh, J 2004, Recovery Plan for Marsupial Moles (*Notoryctes typhlops* and *N. caurinus*) 2005-2010. NT Department of Infrastructure, Planning and Environment. Alice Springs.
- Department of Environment and Natural Resources South Australia 2011, National Recovery Plan for the Sandhill Dunnart *Sminthopsis psammophila*.
- Department of Environment and Conservation (DEC) 2011, Standard Operating Procedure 5.2 – Remote Operation of Cameras, Version 1.0, Perth, Western Australia.
- Department of the Environment 2015, *Referral Guideline for 14 birds listed as migratory species under the EPBC Act (draft)*. September 2015.
- Department of Sustainability, Environment, Water, Population and Communities 2011, Survey guidelines for Australia's threatened mammals: Guidelines for detecting mammals listed as threatened under the EPBC Act, Canberra, ACT.
- Department of Sustainability, Environment, Water, Population and Communities 2011, Survey Guidelines for Australia’s Threatened Birds.
- EPA & DEC 2010, Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment, Perth, Western Australia.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) 2008, Approved Conservation Advice – Ooldea Guinea-flower (*Hibbertia crispula*) Canberra, ACT.
- EPA 2012, Checklist for documents submitted for EIA on terrestrial biodiversity from Appendix 2 of the EPA’s Draft Environmental Assessment Guideline No. 6 on Timelines for Environmental Impact Assessment of Proposals.

- National Health and Medical Research Council 2014, A Guide to the Care and use of Australian Native Mammals in Research and Teaching. EA29. Canberra.
- National Heritage Trust 2007, *National Manual for the Malleefowl Monitoring System Standards, Protocols and Monitoring Procedures*. Ed. L. Hopkins.

When undertaking an assessment of the impact of radionuclide activity, the following report was utilised:

- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Technical Report 167 – A review of existing Australian radionuclide activity concentration data in non-human biota inhabiting uranium mining environments.

In relation to considerations pertaining to offset, the following information was consulted:

- DSEWPaC 2012, EPBC Act Environmental Offsets Policy, Canberra, ACT.
- Government of Western Australia 2011, Environmental Offsets Policy, Perth, Western Australia.
- Government of Western Australia 2014, Environmental Offsets Guidelines, Perth, Western Australia.

A range of birds are listed under the Japan-Australia (JAMBA), China-Australia (CAMBA) and Republic of Korea-Australia (ROKAMBA) Migratory Bird Agreements. The main aim of these international agreements is to protect migratory birds and their breeding and/or feeding habitats.

- CAMBA: The China–Australia Migratory Bird Agreement is a treaty between Australia and China to minimise harm to the major areas used by migratory birds which migrate between the two countries. CAMBA was first developed on 20 October 1986 and came into force on 1 September 1988. The agreement includes 81 species of migratory birds.
- JAMBA: The Japan-Australia Migratory Bird Agreement (JAMBA) is a treaty between Australia and Japan to minimise harm to the major areas used by birds which migrate between the two countries. JAMBA was first developed on 6 February 1974 and came into force on 30 April 1981. The agreement includes 61 species of conservation significant migratory bird species.
- ROKAMBA: The Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA) is part of international efforts to conserve migratory birds of the East Asian – Australasian Flyway, along with the bilateral migratory bird agreements between Australia and Japan (JAMBA) and Australia and China (CAMBA). ROKAMBA was signed in Canberra on 6 December 2006 and came into force on 13 July 2007. ROKAMBA formalises the relationship between Australia and the Republic of Korea in respect to the conservation of 59 species of migratory birds listed in the agreement and provides a basis for collaboration on the protection of their habitat

9.2 Existing Environment

The existing environment for flora and fauna at MRUP has been described previously in Sections 6.2 and 7.2. There are a number of species that have the potential to occur in the MRUP area that are protected pursuant to section 179 of the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Protected Matters Search Tool currently lists three birds, two mammals, one plant, and six migratory/marine bird MNES species as potentially occurring within a 20km radius of the MRUP tenure boundary (Appendix I1) (Table 9.1). There are no World Heritage areas, no National Heritage places, no wetlands of international importance, no Threatened Ecological Communities and no state or territory reserves within, or in the vicinity of the MRUP area.

Eight species of invasive fauna were listed as potentially occurring in the area: Rock Pigeon (*Columba livia)*, one-humped camel *(Camelus dromedaries)*, goat (*Capra hirtus*), horse (*Equus caballus*), feral cat (*Felis catus)*, house mouse (*Mus musculus)*, rabbit (*Oryctolagus cuninulus*) and Red Fox (*Vulpes vulpes).* In MRUP surveys, camels were found to be particularly common and widespread (Appendix B2). There has been no evidence of the goat (*Capra hircus*), horse (*Equus caballus*), fox (*Vulpes vulpes*) or domestic pigeon (*Columba livia*) at the Project area to date. In addition to those listed within the MNES search, wild dogs (*Canis lupus familiaris*), dingoes (*Canis lupus dingo*) and donkeys (*Equus asinus*) have also been surveyed in the Project area (Appendix B1 & Appendix B2).

There have been no exotic flora surveyed in the Project area to date, and no Weeds of National Significance (WoNS) were listed within the MNES search (Appendix I1).

As the distribution ranges for the Fork-tailed Swift *(Apuc pacificus),* Grey Wagtail *(Motacilla cinerea)* and Yellow Wagtail (*Motacilla flava)* do not include the MRUP area (DoE 2015), these three species are not discussed further. A summary on the biology and habitat of each of the other MNES listed species as potentially occurring in the MRUP area is provided in Table 9.2. The targeted survey information is then provided on *Hibbertia crispula* and Sandhill Dunnart (*Sminthopsis psammophila)* which have been surveyed at MRUP, and the SMM (*Notoryctes typhlops)* which potentially occurs in the Project area. Malleefowl (*Leipoa ocellata*) is also discussed in more detail due to the targeted survey of the species in the MRUP area. The Princess Parrot (*Polytelis alexandrae)* and Night Parrot (*Pezoporus occidentalis)* are unlikely to occur in the MRUP area as there is no preferred habitat in the area, and there have been no sightings in the fauna searches of the area to date.

Table 9.1 MNES Species Listed for the MRUP Area (with 20km buffer from tenure / Search dated October 2015)

Scientific name	Common name	Conservation Status	Type of Presence
BIRDS			
Leipoa ocellata	Malleefowl	Vulnerable	Species or species habitat likely to occur within area
Pezoporus occidentalis	Night Parrot	Endangered	Species or species habitat likely to occur within area
Polytelis alexandrae	Princess Parrot, Alexandra's Parrot	Vulnerable	Species or species habitat likely to occur within area
MAMMALS			
Notoryctes typhlops	Southern Marsupial Mole	Endangered	Species or species habitat likely to occur within area
Sminthopsis psammophila	Sandhill Dunnart	Endangered	Species or species habitat likely to occur within area
PLANTS			
Hibbertia crispula	Ooldea Guinea-flower	Vulnerable	Species or species habitat likely to occur within area
MIGRATORY MARINE SPECIES			
**Apus pacificus*	Fork-tailed Swift	Threatened	Species or species habitat likely to occur within area
MIGRATORY TERRESTRIAL SPECIES			
**Merops ornatus*	Rainbow Bee-eater	Threatened	Species or species habitat likely to occur within area
**Motacilla cinerea*	Grey Wagtail	Threatened	Species or species habitat likely to occur within area
**Motacilla flava*	Yellow Wagtail	Threatened	Species or species habitat likely to occur within area
MIGRATORY WETLANDS SPECIES			
**Ardea alba*	Great Egret, White Egret	Threatened	Species or species habitat likely to occur within area
**Charadrius veredus*	Oriental Plover, Oriental Dotteral	Threatened	Species or species habitat likely to occur within area
MARINE SPECIES			
**Apus pacificus*	Fork-tailed Swift	Threatened	Species or species habitat likely to occur within area
**Ardea alba*	Great Egret, White Egret	Threatened	Species or species habitat likely to occur within area
**Charadrius veredus*	Oriental Plover, Oriental Dotteral	Threatened	Species or species habitat likely to occur within area
**Merops ornatus*	Rainbow Bee-eater	Threatened	Species or species habitat likely to occur within area
**Motacilla cinerea*	Grey Wagtail	Threatened	Species or species habitat likely to occur within area
**Motacilla flava*	Yellow Wagtail	Threatened	Species or species habitat likely to occur within area

*Listed in multiple categories

Table 9.2: Biology and Habitat of MNES Listed Species for MRUP

MNES Species		*EPBC Act* Conservation Status	Biology	Habitat
Scientific Name	Common Name			
Birds				
Leipoa ocellata	Malleefowl	Vulnerable	The Malleefowl belongs to the family *Megapodiidae*, the megapodes or mound builders, and the only species in the genus *Leipoa* (Benshemesh 2007). The adult Malleefowl has a greyish head and neck, with a short dark bill, brown irises, a narrow white stripe beneath each eye, chestnut colouring on the chin, a dark-brown to blackish medial stripe that extends from the forehead to the base of the head, and a broad black stripe that extends from the throat to the upper breast. The upper surfaces of the wings have a complex pattern of markings, consisting of mottled brown, white, grey and black. The upper surface of the tail is mostly greyish, with narrow brown-black barring and some small patches of white. The breast, belly and flanks are a creamy white colour, and the legs and feet range from pale grey to blackish-brown in colour, and have darker claws (Johnstone and Storr 1998). The sexes are similar in appearance but adult males (65-67.5cm in length) are slightly larger than females (56.5-62.0cm in length) and are much heavier (1.7-2.1kg versus 1.5-1.6kg). The Malleefowl usually occurs singly when away from its breeding mounds, and in pairs when present at active mounds. It breeds in solitary pairs. The birds are generally monogamous and, once breeding begins, appear to pair for life. It is a mainly terrestrial species that rarely flies, preferring to walk slowly across the terrain. If disturbed, the bird will usually run rapidly through the vegetation to escape (DoE 2015). Established pairs and adult individuals tend to be sedentary and remain in the same area throughout the year, although local shifts in home range over longer timeframes are recorded (DSEWPaC 2011). Young birds are recorded as dispersing over substantial distances (DoE 2015). Sexual maturity occurs at about 3 years of age, and individuals live, on average, to 15 years (DoE 2015). Breeding can occur every year, except in drought, with an average clutch size of 15 to 20 eggs. Each is laid every 5 to 17 days into a mound of sand or soil and organic matter. The Malleefowl has developed a sophisticated and elaborate technique of incubation involving the integration of solar and vegetative matter fermentation. The first heat for incubation of eggs is derived from fermentation of leaf matter but, as the litter dries, the male increasingly relies on solar heat, exposing the nest chamber to the sun in the morning and filling it in during the afternoon to maintain an egg temperature of about 34°C (Johnstone and Storr 1998). Hatching occurs after an average of 60 days and no parental care is provided. Mortality rates are very high (DoE 2015). It is an opportunistic, generalist forager that feeds mainly on seeds but will take flowers, fruits and foliage, invertebrates and tubers. Malleefowl forage on the ground and peck food items from the ground and from low vegetation and use their feet to search amongst leaf litter and to scratch at the soil to expose tubers and invertebrates. Access to food resources is an important factor for what are largely sedentary birds and the mounds so far recorded in the western GVD1 are located in areas where *Acacia* seed resources are available.	Malleefowl (*Leipoda ocellata*) had a pre-European distribution extending across the southern half of Australia from the west coast of Western Australia to the Great Dividing Range in New South Wales. Its geographic range has contracted in recent years, particularly in arid areas and where agricultural practices have resulted in significant habitat modification (Benshemesh 2007) (Figure 9.6). In Western Australia, Malleefowl currently have a patchy distribution and current records suggest a wide distribution over the rangelands in low numbers where suitable habitat is preserved (Benshemesh 2007) (Figure 9.7). The habitat requirements of the Malleefowl are poorly understood, but there are clear requirements for sandy clay substrate gravel and an abundance of leaf litter for the construction of the birds' nesting mounds (Appendix B6). It occurs in semi-arid and arid zones of temperate Australia, occupying shrublands and low woodlands that are dominated by mallee vegetation. It also occurs in other habitat types including eucalypt or native pine *Callitris* woodlands, Acacia shrublands, Broombush *Melaleuca uncinata* vegetation or coastal heathlands (DoE 2015). Malleefowl favour old growth habitat that is long unburnt and a timeframe of 30 to 60+ years post-fire has been suggested as necessary to maintain viable breeding populations (Benshemesh 1992). Densities of the breeding birds are positively influenced by rainfall, soil fertility, shrub diversity and density of canopy cover (Benshemesh 2007). Extensive surveys have not identified the presence of Malleefowl or suitable woodland habitat in the MRUP area, indicating that the birds are not present in the Project area.
Pezoporus occidentalis	Night parrot/ Spinifex Parrot	Endangered	The Night Parrot is a medium sized parrot of 22-25cm length with wingspan of 44-46cm. Adults are predominantly green in colour, with black and yellow bars and spots over the body with bright yellow colouring on the belly and vent with black tips to the wings and tail. Both sexes look similar. Few specimens are within museum records, and distribution is poorly known. Small numbers of confirmed records in arid and semi-arid areas of Queensland, South Australia, Western Australian and Northern Territory. No recording of individuals have been made since 1990 (DoE 2015). Little is known about the biology. Nests are built with a few small sticks and/or *Triodia* leaves at the end of a 'tunnel' within a *Triodia* or small bush. Green plant material may comprise part of its diet. It is nocturnal. It may travel up to 8km per night to drink from the nearest source of water.	The Night Parrot inhabits arid and semi-arid areas that are characterised with dense, low vegetation, thought to consist of *Triodia* grasslands in stony or sandy environments, and of samphire and chenopod shrublands on floodplains and claypans, and on margins of saltlakes, creeks and other sources of water. It has been found on one occasion in *Acacia* woodland. The Night Parrot is a ground dwelling species that is unlikely to occur in the MRUP area due to the lack of surface water supply.
Polytelis alexandrae	Princess Parrot, Alexandra's Parrot	Vulnerable	The Princess Parrot is a slim, medium sized parrot that is 40-45cm weighing 90-120g. It is multi-coloured, including blue-grey on top of the head, pink on the chin and throat, dull olive green on hind neck and upper part of back, yellow green on shoulders, violet on lower back and rump with black with pink strip under long and tapered tail. It has an orange bill and grey legs and feet. Females are usually duller than males with shorter tail. The bird can occur singly, in pairs or in flocks up to 30, or in loose flocks of 100 or more. Confined to arid regions of WA, NT and SA. Population is mainly concentrated in the Great Sandy, Gibson, Tanami and GVD deserts. Thought to breed in response to rainfall. Thought to live up to 30 years and breed in first or second year. Tends to nest in hollows in *Eucalytpus* trees close to water courses (occasionally in Allocasuarina away from water), with nests of decaying wood dust with 3-6 eggs. It feeds on seeds, and some flowers, nectar and leaves. It forages on or near to the ground, and amongst foliage of shrubs and trees in morning and at dusk (DoE 2015).	The Princess Parrot inhabits sand dunes and sand flats in the arid zone of western and central Australia. It occurs in open savannah woodlands and shrublands usually consisting of scattered stands of Eucalyptus (including *E. gonogylocarpa, E. chippendalei* and mallee species), Casuarina trees with an understorey of shrubs such as Acacia, Eremophila and Hakeas with a groundcover of *Triodia* species (DoE 2015). The Princess Parrot has not been surveyed in the MRUP area to date. The bird may be in the region, but as it tends to nest in hollows in *Eucalytpus* trees close to water courses, its preferred habitat is not present at MRUP.

MNES Species		EPBC Act Conservation Status	Biology	Habitat
Scientific Name	**Common Name**			
Notoryctes typhlops	Southern Marsupial Mole	Endangered	Recent work proposes a northern and southern form of the Southern Marsupial Mole (SMM) – which is a separate species to the Northern Marsupial Mole. The SMM is highly adapted to living underground and is blind, has a tubular body shape, an absence of ear pinnae, a heavily keratinised skin on the snout, and a reduced tail and dense fur. Neck bones are fused to make their bodies more rigid. Its pouch opens posteriorly as a protection against the entry of soil. The males have no visible scrotum as the testes lie between the skin and the abdominal wall It rarely ventures to the surface. The body is covered with dense, silky, golden-brown to pale cream fur. They have large, spade-like claws attached to short and powerful forelimbs. The species grows to a maximum length of 16cm with a tail length of 2.6cm, and weight of 30-70g. The species has a general diet of invertebrate prey and their larvae, with ants, beetle larvae and arthropods as preferred prey. Termites are not commonly eaten (DoE 2015). In captivity they also feed on geckos, spiders and centipedes. It is assumed that SMM lead solitary lives.	The SMM is most often recorded in the crest and slope of sandy dunes which are vegetated with *Acacia* spp. and other shrubs which is a widespread habitat typical of the sandy deserts. It may also occur in some sandy plains or sandy river flats, especially in areas where Aeolian dunes occur nearby (Appendix B5). Deep, loose sand appears to be a requirement for the species, and evidence of the animal is more often found on yellower sands than on redder sands. Rocky and hard substrates such as calcrete are likely to represent an impenetrable barrier, and animals mostly travel underground and are slow and vulnerable on the surface (DoE 2015). The marsupials may be able to disperse through suitable soil conditions in areas where dunes are absent. However, swales between dunes are less likely to provide the conditions for 'tunnelling' (Appendix B5).
Smithopsis psammophila	Sandhill Dunnart	Endangered	The Sandhill Dunnart is a small nocturnal insectivorous marsupial and is the largest of Australia's nineteen dunnart (*Sminthopsis*) species of the family Dasyuridae. Adult males weigh 26–55g (mean 36g) and adult females weigh 25-42g (mean of 33g). The tail is distinctive and can be bicolour being pale above and dark grey below tapering towards the crested tip with stiff black hairs along the ventral surface of the distal portion (Hart and Kitchener 1986). Tail length (up to 12.8cm long) is longer than the head-body length (up to 11.4cm long). The fur colour is generally drab grey with buff fur above and white fur on the underside of feet, a pale grey head and a black pencilling extending from the shoulders to the wedge between the eyes, large dark eyes and a black eye-ring. The ears are large and foot length is approximately 22 to 26mm (Way 2008). The species lies within the 'critical weight range' for terrestrial mammals that have an elevated likelihood of extinction or significant decline, especially in arid areas (Burbidge and McKenzie 1989). Burrows range up to 110cm in length and penetrate up to 46cm below the surface. On Eyre Peninsula, Churchill (2001b) recorded SHDs nesting in large spinifex hummocks that had started to die off in the centre. They build a circular depression or space within the dead spinifex needles usually 10 to 15cm in diameter. Adult female SHDs occasionally dug burrows; starting from the inside of the spinifex with the burrows spiralling down under the plant. These burrows were up to 90cm long and had a small terminal chamber that contained nesting material of leaves and shredded bark. Male SHDs were found to use a greater variety of nest sites than females, including small burrows between spinifex clumps, hollow logs and *Notomys mitchelli (*Mitchell's Hopping-mouse) burrows. The SHD is a generalist, opportunistic feeder with a diet that can include ants, beetles, spiders, grasshoppers, termites, wasps and centipedes. Female Sandhill Dunnarts have eight teats and have up to five young per litter (DoE 2015). Both males and females reach sexual maturity in their first year. They are seasonal breeders with an average interval from mating to birth of 18 days (Lambert *et.al* 2011). The pattern of reproduction appears to be mating in September; with young being born in September/October; and pouch young weaned in December/January (van Weenen, Ward and Churchill 2011). However, young have also been captured in October and April showing that the species has a broader period of reproduction. It is likely only a single litter is produced each year, but may be able to vary or extend the timing of reproduction or perhaps produce a second litter if conditions permit (Churchill 2001b). In South Australia the average home range size for SHD was 7.8ha (range 1.8ha to 19.0ha) (Churchill 2001b). The males' home ranges overlap those of other males and females. The females may have exclusive home ranges. SHD generally move 200 to 300m per foraging period but have the ability to traverse long distances in short periods of time (Churchill 2001b). In South Australia, densities of SHD in suitable habitat have varied from 25 to 90 animals per square km density (Ward *et al.* 2008). Trapping data for Western Australian populations suggests substantially lower densities per square km.	The Sandhill Dunnart occurs in semi-arid habitats of sand dunes, often 30-50m high, with an understorey of spinifex (*Triodia* spp.) hummock grass, and an overstorey that varies widely. The Great Victoria Desert populations in WA occur in a mosaic of Marble Gum (*Eucalyptus gongylocarpa*) and mallee woodland, both with spinifex and some shrubs as the understorey. It has a relatively large distribution across the south-western Great Victoria Desert in both Western Australia and South Australia including the nearby Queen Victoria Spring Nature Reserve in Western Australia. All sites have diverse but open shrub layers and spinifex ranging from 10-70% of the ground cover. Spinifex is a critical habitat component for the species, with hummocks of a particular age and structure necessary for the species to build a nest within the dead centre of larger plants for protection and insulation from the extremes of temperature found in their arid environment (DoE 2015). Studies of the SHD (Churchill 2001b, Churchill 2009) have shown that large spinifex (*Triodia* species) hummocks are favoured for nest sites. Fire has been identified as an important element for the continuation of the spinifex habitat required by the Sandhill Dunnart. Lack of fire in older areas of spinifex leads to a break down in its habitat from hummocks to large broken rings providing little cover for Sandhill Dunnarts. Fire that is too frequent reduces the size of hummocks providing unsuitable cover. A suitable fire interval of 8 to 20 years may be beneficial to the species (DoE 2015).
Hibbertia crispula	Ooldea Guinea-flower	Vulnerable	*Hibbertia crispula* (Ooldea Guinea-flower) (Dilleniaceae) is a small, wiry shrub to 50cm tall that produces yellow flowers (Plate 9.1). This species is usually glabrous (without hair), except for a minute curly tomentum (tiny hairs) on the inner side of the leaf base. Stamens number 12-35 and are arranged in five groups around the ovary (Appendix A2). This Hibbertia is more likely to reproduce via seeds than vegetative suckering roots. It has variable, year-round phenology patterns with flowering heavily reliant on adequate rainfall (Appendix A2). This species has been recorded predominantly on long unburnt yellow sand dune ridges in the Officer Basin area. There are also two disjunct populations in South Australia (from where it was originally known and described) and its 'Vulnerable' conservation status was based upon its original narrow delineation recorded near Ooldea in South Australia (Appendix A2).	*Hibbertia crispula* is restricted to yellow sand dune crests in the south-west corner of the Great Victoria Desert of 340-370m height that have not been burnt for at least 15 years, but more likely for over 20-30 years. This species has been recorded in the Officer Basin area but also has two disjunct populations in South Australia (from where it was originally known and described) (Appendix A2).

MNES Species		*EPBC Act* Conservation Status	Biology	Habitat
Scientific Name	Common Name			
Merops ornatus	Rainbow Bee-eater	Listed within *EPBC Act* as Marine and Migratory species. Listed under JAMBA.	The Rainbow Bee-eater is a medium sized bird, and males measure 25cm in length and the females 22cm. The adults have green or blue-green colouring on the forehead and chestnut on the back of the head. The adult males and females are similar in appearance, but can usually be distinguished by differences in the length and shape of the tail-streamers. The Rainbow Bee-eater is usually seen in pairs or small flocks, although when migrating it may occur in groups of up to 500 birds or more. It usually nests in loose colonies that may contain up to about 50 pairs, but some pairs nest solitarily. The bird lives to approximately 24 months in the wild. In Australia, the breeding season extends from August to January. The nest is located in an enlarged chamber at the end of long burrow or tunnel that is excavated each year. It feeds on insects, and will occasionally take other animal items including earthworms, spiders and tadpoles (DoE 2015).	The Rainbow Bee-eater is distributed across much of mainland Australia, and occurs on several near-shore islands. It is not found in Tasmania, and is only thinly distributed in the most arid regions of central and Western Australia. It usually occurs in cleared areas or open woodlands and shrublands, including mallee, and in open forests that are usually dominated by eucalypts that are often, but not always, located in close proximity to permanent water. It also occurs in grasslands and, especially in arid or semi-arid areas, in riparian, floodplain or wetland vegetation assemblages (DoE 2015).
Ardea alba	Great Egret, White Egret	Listed within *EPBC Act* as Marine and Migratory species. Listed under JAMBA and CAMBA as *Egreta alba*	This bird is a moderately large (83-103cm in length, 700-1200g in weight) with white plumage, a black or yellow bill and long reddish and black legs. It will often occur solitarily or in small groups when feeding but roost in large flocks that may consist of hundreds of birds. The species also usually nests in colonies but rarely in solitary pairs. The breeding season is variable but usually between November and April. Pairs construct a shallow platform-like nest of loosely woven sticks in the upper strata of trees or shrubs standing in or near water or sometimes in inundated reed beds. The diverse diet includes fish, insects, crustaceans, molluscs, frogs, lizards, snakes and small birds and mammals (DoE 2015).	It is a widespread species of southern and eastern Asia and Australasia occurring in all states/territories of mainland Australia and in Tasmania but the largest breeding colonies, and greatest concentrations of breeding colonies, are located in near-coastal regions of the Top End of the Northern Territory with no breeding colonies listed for WA except for the Kimberley. Non-breeding birds have been recorded across much of Australia, but avoids the driest regions of the western and central deserts. Its preferred habitat is wetlands including inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial. These are not present at MRUP.
Charadrius veredus	Oriental Plover, Oriental Dotterel	Listed within *EPBC Act* as Marine and Migratory species. Listed under JAMBA and ROKAMBA.	The Oriental Plover is an elegant, medium sized (length: 21–25cm; weight: 95g) plover with long legs. Sexes differ when in breeding plumage, but are inseparable when in non-breeding plumage. In non-breeding plumage, both sexes have a brown crown and nape, a pale brown hind neck, and the rest of the upperparts are brown. The species is generally gregarious, and usually occurs in small parties or flocks of hundreds or occasionally thousands, though some are seen singly. Little is known of this species' diet and has been recorded eating insects, including termites, beetles, grasshoppers, crickets and bugs.	The Oriental Plover is a migratory species seldom recorded in southern Australia with such vagrants recorded in saltmarsh. It breeds in the Northern Hemisphere in scattered sites mainly in northern and eastern Mongolia, and flying south for the boreal winter, arriving in north-western Australia in early to mid-September. The species is unlikely to occur in the Project area due the few sightings made in southern Australia have been in salt marshland which does not occur at the Project site.

9.3 Surveys and Investigations

There have been multiple fauna and flora surveys conducted in the Project area since the mid-1980s (Table 6.1 and Table 7.1), including a number of targeted surveys for MNES listed species potentially present at the MRUP site (Table 9.3).

Table 9.3 Targeted Biological Surveys for MNES Listed Species in MRUP Area

Survey	Timing of Survey	Reference
Targeted survey for *Hibbertia crispula*, in addition to 12 other flora surveys at MRUP area.	August 2014	MCPL 2015b PER Appendix A2
Targeted survey for Sandhill Dunnart (*Sminthopsis psammophila*) utilising camera traps.	August-November 2014; ongoing	Vimy 2015a PER Appendix B3
Targeted survey for Southern Marsupial Mole (*Notoryctes typhlops*) involving trenches surveyed for moleholes.	January 2013 – March 2014	Ninox 2015a PER Appendix B5
Targeted surveys for Malleefowl (*Leipoda ocellata*) involving helicopter surveys and track surveys.	2009-2014 (Helicopter search: 2009-2010)	Vimy 2015b PER Appendix B6

The only recordings of currently listed MNES species at the MRUP site to date have been of the Ooldea Guinea-flower (*Hibbertia crispula)* and Sandhill Dunnart (*Sminthopsis psammophila*)*,* with the Rainbow Bee-eater (*Meerops ornatus)* recorded only singly in the 2009 vertebrate survey. A low density of SMM (*Notorytes typhlops)* mole holes have also been recorded at a few sites in the Project area. The targeted surveys for *Hibbertia crispula,* SHD, SMM and Malleefowl *(Leipoda ocellata)* are discussed below.

9.3.1 *Hibbertia crispula* (Vulnerable)

9.3.1.1 Hibbertia crispula Survey

Twelve flora and vegetation surveys have occurred at the MRUP area over an eight year period by Mattiske Consulting (Appendix A1). A targeted survey of *Hibbertia crispula* and other conservation significant species in the Project area was also commissioned by Vimy in July 2014 (Appendix A2).

Previous surveys had indicated that, of the 26 vegetation communities mapped in the MRUP area, the preferred habitat of *Hibbertia crispula* was associated with the S6 community defined by MCPL (Appendix A1) as:

S6: Low shrubland of *Thryptomene biseriata*, *Allocasuarina spinosissima*, *Allocasuarina acutivalvis* subsp. *acutivalvis*, *Jacksonia arida*, *Calothamnus gilesii*, *Acacia fragilis*, *Conospermum toddii* (P4), *Pityrodia lepidota*, *Lomandra leucocephala*, *Anthotroche pannosa* and mixed low shrubs over *Triodia desertorum* with *Lepidobolus deserti* with emergent *Eucalyptus gongylocarpa*, *Eucalyptus youngiana*, *Eucalyptus ceratocorys* and *Eucalyptus mannensis* subsp. *mannensis*. This community occurs on yellow sand dunes.

Plate 9.1 *Hibbertia crispula* inflorescence (MCPL 2015b/Appendix A2)

The scope of this survey was to target the *Hibbertia crispula* to enable:

- Morphological molecular comparisons with known South Australian populations.
- Confirm populations identified by Vimy personnel.
- Survey regional localities for presence.
- Collect numerous voucher specimens and DNA samples for ongoing analysis.
- Map the locations of *Hibbertia crispula* located by Vimy and MCPL sand dune traverses.
- Search for other flora of conservation significance.
- Map the location of all threatened and Priority flora located within the MRUP.
- Quantify impacts of the November 2014 fire upon the MRUP *Hibbertia crispula* populations.

Regarding the approved conservation advice for *Hibbertia crispula* (Ooldea Guinea-Flower) (Threatened Species Scientific Committee 2008), this survey work addressed the following research priorities:

- More precise assessment of population size, distribution, ecological requirements and relative impacts of threatening processes including feral animals.
- Undertake survey work in suitable habitat and potential habitat to locate any additional populations/occurrences/remnants.

The survey occurred onsite from 8 to 15 August 2014 by three experienced botanists, in accordance with methods outlined in EPA Guidance Statement No. 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA June 2004).

All botanists held valid collection licences to collect flora for scientific purposes, issued under the WC Act.

From previous botanical surveys having determined the potential habitat of *Hibbertia crispula*, 89 yellow sand dunes were selected from the MRUP area based upon dune morphology, elevation and fire history (having been unburnt for 15 years or more). The dunes with these criteria were mostly to the south and east of the Officer Basin Airstrip. These dunes were traversed from December 2013 to June 2014. *Hibbertia crispula* was observed on 26 of the 89 dunes surveyed and, of these, 13 were selected for a more detailed survey based on the following criteria: high population counts of *Hibbertia crispula*; low population counts of *Hibbertia crispula* (to provide a wide distribution of confirmed locations) and a high presence of other Priority species along the dune. An additional ten dunes were selected to provide more regional sites to the northeast and east of the Project area (Figure 9.1A-C).

Two of the ten ‘regional’ dunes had *Hibbertia crispula* recorded as present. For the sites of known *Hibbertia crispula* presence, the presence and density of *Hibbertia crispula* plants were confirmed, associated species were recorded, and a soil sample was taken. Sample specimens were taken from a selection of individuals for morphological and molecular analysis to enable the comparison of Western Australia specimens to known populations in South Australia. Further details on the selection protocol for samples, and methodology of associated species sampling, are provided in Appendix A2. At each dune location of know populations, the GPS location, topography, soil type and colour, habitat condition and fire history were also recorded.

9.3.1.2 MRUP Hibbertia crispula Survey Results

During the survey it was found that most *Hibbertia crispula* plants exhibited a “multi-stemmed” form resulting from the shrub trapping moving sand and burying the lower branches below surface level, although there were some single-stemmed forms which appeared to have the upper portion of their root system exposed from erosion of the sandy soil surface (Appendix A2). The largest plants recorded were up to 1.5m wide by 1.0m high (Plate 9.2).

The field surveys confirmed that *Hibbertia crispula* grows in large clusters along the crest of yellow sand dunes. Many of these plants were growing within a few metres of one another. Population numbers varied from a minimum of 20 plants to a maximum of around 2,400 plants and the length of dune occupied varied from as little as 100m to as much as 1,100m.

A number of *Hibbertia crispula* plants were excavated partially or fully to determine the distribution of their roots and to determine any evidence of sucker roots (as had previously been suggested in the literature). Both adult and juvenile plants were excavated to varying depths up to a maximum of 0.9m and lateral spread to 1.0m. None of the excavated plants showed signs of root suckering, even when in close proximity to other *Hibbertia crispula* individuals. All plants displayed similar root architecture with a main tap root and numerous lateral roots and no lignotubers were observed (Plate 9.3) (Appendix A2). These roots play an important role in the stabilisation of the dune crests from wind erosion, with lateral roots enabling maximum water and nutrient acquisition. Deeper root excavations, undertaken later (SWC 2015), indicated that the taproots typically extend three to four metres below the ground surface. Herbivory on fallen seed by ants and other insects was also noted.

The MRUP surveys mapped 2,691 +/- 98 plants with the MRUP area at 38 locations. Of these plants, 182 +/- 13 were at 4 sites in the Development Envelope and 38 +/- 13 plants were located at one site in the Disturbance Footprint (Figure 6.4); this was in an area that subsequently burned.

Combining the eight year survey results at MRUP and regional surveys in the surrounding region, over 14,000 individual plants have been recorded at thirty different locations, in an area spanning 20 × 25km (Figure 9.1). At sand dunes of known *Hibbertia crispula* locations, the average density was 0.03 plants/m^2 whilst the density of the *Hibbertia crispula* plants in specific sections of the dune where individuals were recorded increased to 0.07 plants/m^2 (Appendix A2).

Plate 9.2 *Hibbertia crispula* plant on sand dune at MRUP (MCPL S6 vegetation community) (Appendix A2)

Plate 9.3 *Hibbertia crispula* root excavation at MRUP (Appendix A2)

All *Hibbertia crispula* plants were located within the S6 vegetation community, and at 90% of the sand dune sites where the *Hibbertia crispula* were recorded, the following plant species were also recorded: *Lomandra leucocephala, Caustis dioica, Jacksonia arida, Thryptomene biseriata, Conospermum toddii* (P4), *Lepidobolus deserti* and *Anthotroche pannosa* (Appendix A2).

In the flora surveys at MRUP to date, *Hibbertia crispula* has been recorded as flowering in all months except for March and July. It is thought that flowering is heavily reliant on heavy rainfall events (Appendix A2). *Hibbertia crispula* was only recorded on unburnt dunes that had not been burnt for at least 15 years and, more commonly, not burnt for at least 20-30 years (Appendix A2). It appeared that *Hibbertia crispula* does not tolerate fire, with no germinant or resprouting plants on dunes burnt at least 10 years ago. Fire is therefore thought to be the major threat to the *Hibbertia crispula* populations in the MRUP area although the main threats for the species are listed as exotic weeds, grazing by feral animals, and habitat fragmentation (DEWHA 2008). There was no grazing evident during the August 2014 survey, and no weed species have been recorded at MRUP to date.

The November 2014 fire in the local area (Figure 7.3) is estimated to have potentially impacted 76% (10,823 plants) of the regional populations of *Hibbertia crispula.* Almost one year after the fire, contrary to expectations from the previous survey results, many *Hibbertia crispula* plants have survived and are resprouting after the lower intensity fire (Appendix A2). Future surveys will further contribute to the relationship between fire intensity and plant survival for this species.

9.3.2 Sandhill Dunnart (*Sminthopsis psammophila)* (Endangered)

9.3.2.1 Previous SHD Surveys

In 1985 the first recording of a SHD in Western Australia was documented at the MRUP (Appendix B1). Previous to that recording, SHDs had only been documented on the Eyre Peninsula in South Australia in the mid-1960s and from a historic 1894 record from the Lake Amadeus region in the Northern Territory. It has since been recorded in several conservation reserves in South Australia in the upper Eyre Peninsula and in the Yellabinna Ooldea region of the southern Great Victoria Desert (Woinarski *et al.* 2014). Since the initial discovery at MRUP, several ecologists have undertaken studies on the Western Australian populations of SHD including Pearson and Robinson (1990), Churchill (2001a, 2001b and 2009), Gaikhorst and Lambert (2008 and 2010), Gaikhorst and Churchill (2009), Ninox (2010) (Appendix B2) and Turpin (2014).

A significant factor guiding research for the conservation of the SHD, and reported from both Western and South Australia, is that long term occupancy is not assured at sites where animals have been previously detected (Woinarski *et al.* 2014). Therefore, the exact distribution and abundance of the taxa is uncertain, although extensive areas of potentially suitable hummock grasslands on sand terrain habitats occur in the southern GVD (Churchill 2009). Previous survey and capture locations in Western Australia are shown on Figure 2 in Appendix B3 (Gaikhorst and Lambert 2014).

Although reconnaissance surveys have been undertaken, no detailed regional habitat assessment has been made for the SHD across the full expanse of the Great Victoria Desert (Churchill 2009), and there does appear to be large areas of potentially suitable habitat types throughout the southern GVD. The locations of recorded SHD trap and capture sites in the GVD in Western Australia are shown in Figure 2 in Appendix B3.

The presence of large spinifex hummocks appears to be a critical factor for this species on the Eyre Peninsula where suitable spinifex occurs in areas approximately >20 years post-fire and these sites are usually associated with mallee communities. Early regrowth of mallee (less than 10 years old) appears to favour spinifex growth, but after 20-year regrowth, the spinifex have become sparse, dissected and are shaded by mallee and shrub regrowth. This vegetation structure is not present to the same extent at the MRUP where mallee development is controlled by wildfire (Martinick 1986, Appendix B1). Recent variations in capture rates near Immarna in northwest Yellabinna (SA) have indicated that greater spinifex cover was correlated with greater SHD densities and hence capture rates (Ward *et al.* 2008). However, additional trapping has demonstrated that spinifex cover, structure and separation are not, in isolation, reliable predictors of SHD occupancy and density within their known range.

Woinarski *et al.* (2014) described conservation objectives for the SHD as:

- Conduct additional research to aid the development of management prescriptions and establish monitoring sites in Western Australia.
- Locate subpopulations and implement adaptive management strategies to promote conservation of the species.
- Assessment of relative impacts of the threats on the SHD and work with communities and mining companies to manage SHD populations.

The current MRUP Camera Trapping Program described in Section 9.3.2.2 will provide further inventory information on this species that will assist in better defining conservation and management requirements.

Plate 9.4 ***Sminthopsis psammophila***
sourced from http://www.australianfauna.com/images/sandhilldunnart.jpg

9.3.2.2 MRUP SHD Survey

The targeted surveys undertaken within the MRUP have occurred in a range of habitats, including sites where SHDs had been previously recorded (Appendix B2). Due to the large extent of the area (i.e. MRUP is 102,000ha), the range of potential habitats and the documented difficulties in capturing these very small marsupials with conventional trapping techniques (Appendix B3), Vimy sought to pilot the use of camera trapping methods to identify if SHDs were still present within the Development Envelope and potentially in adjacent areas, where fire histories are known and some suitable habitat was preserved.

A Pilot program using a modified trap layout over two 0.1ha grid areas in swale and dune environments utilising Bushnell Trophy Cam HD IR cameras, was conducted in 2012. No SHDs were observed and although other small marsupials were detected, it was identified that faster trigger times and white flash were required to provide clarity of image. Camera type and techniques were modified, in consultation with DPaW, and a new camera trapping technique using 30 Reconyx 550 Hyperfire Led white flash cameras was established in 2013/14.

The original camera trapping program was established at monitoring sites originally set up by Ninox in 2009, which also included sites from the Martinick (1985) survey where SHDs were first recorded in Western Australia. The trap site locations from the 1985 and 2009 surveys are shown in relation to the proposed Development Envelope in Figure 9.3). Given the identified importance of fire history on vegetation composition and structure, and subsequent SHD occurrence, an understanding of site burn history is therefore an important part of the site targeting exercise (Figures 6 and 7 in Appendix B3 show the extent of wildfires in 1999, 2005 and 2007 in relation to SHD survey sites). Paired cameras (same model) were set up in stable horizontal or vertical orientations at selected trap grid sites (Appendix B3). A single camera setup is currently the standard set up at MRUP and will continue to be used in most situations as it allows a larger number of sites to be tested. This approach provides an effective strategy for presence/absence surveying.

Target species at survey sites are passively directed to travel past gaps in 10 to 20m long drift net fences (similar to that employed during normal pitfall trapping programs) positioned at 90° to each other (i.e. forming a cross with the camera located in the centre where there is a gap) where detection zones (which may include bait stations in the future) are established. In most cases, cameras are sited to avoid removal of vegetation. Standardisation of camera set up is necessary to enable consistent and effective image capture, and to enable future program comparisons. Cameras are set up (a) to produce five images per trigger, (b) for rapid fire and (c) to provide high sensitivity. Further details on the camera trapping protocol are provided in Appendix B3. A trial will be undertaken, under the advisement of DPaW, of the efficacy in the use of lures in improve image capture results.

The new double camera protocol was operational at sites selected as potential SHD habitat, and at monitoring sites previously used in 1985 for 60 days before the MRUP area was burnt by a large (up to 90,000ha) low to medium intensity bushfire in November 2014. The extent of the impact of the November 2014 fire on monitoring sites is shown in Figure 9.3. Since the fire, identification of remnant vegetation stands for continued camera trapping surveys is in progress and a revised program will target (a) remnant vegetation patches greater than 5ha in size, (b) road verge vegetation corridors connecting vegetation patches in the development area, and (c) unburnt optimal habitat outside Vimy's tenure. The location of the proposed sites is shown on Figure 9.3.

9.3.2.3 SHD Survey Results

There have been multiple fauna trappings surveys at MRUP with a range of small marsupials captured, but only a few SHD recorded: SHDs were captured at four locations within the MRUP Project area in 1985 (Martinick 1986/Appendix B1), no specimens were captured in 1991 (Churchill 2009), two specimens were captured in 2008 near previous capture sites (Gaikhorst and Lambert 2008) and no SHD were captured in the Ninox Level 2 Survey (Appendix B2).

Regional surveys, undertaken in different seasons in dunefields surrounding the MRUP area, concentrating in long unburnt areas and conservation reserves where optimal habitat was available (Pearson and Robinson 1990, Churchill 2009, Gaikhorst and Lambert 2000-2008 and ecologia 2008), resulted in the capture of 40 individual SHDs in 48,560 trap nights spread over nine years. A further 7,800 camera trap nights have been recorded during the MRUP pilot and targeted surveys in 2013/14 (Vimy 2014). The overall survey effort in Western Australia of one capture per 1,103 trap nights suggests the target species are difficult to trap, are low in abundance and exhibit patchy distribution or seasonal fluctuations in response to wildfires or other influences. Camera trapping was seen as another monitoring tool that would complement previously implemented conventional trap methodology and was not intended to replace these techniques but was proposed to initially provide presence/absence information in the broader dune field remnant patches for impact assessment within the Project Development Envelope. The November 2014 wildfire appears to have removed a high proportion of suitable SHD habitat for at least 10 to 15 years.

Based on previous research, the potential habitats of SHDs into the following categories:

- **Prime**: Core habitat that is functional and able to meet all the needs of a breeding population. Prime habitat has the highest likelihood of supporting a current population and therefore the highest likelihood of sampling success. Note that actual sampling events are rare (high trap effort is usually required), even in the presumed best areas of habitat in the GVD.
- **Likely**: Meets the majority of the needs of a breeding population. May contain small, disjunct areas of Prime habitat within a matrix of lower quality habitat. Medium likelihood of successful sampling.
- **Marginal**: SHDs may use (and have occasionally been sampled in) marginal habitat, but they will not often live in it. Marginal habitat may be used for movement between patches of higher quality habitat, or for foraging if adjacent to appropriate cover/breeding habitat.

- **Potential**: These habitats possess several of the attributes of likely habitats but may have different burn histories, or are located as isolated communities, or exhibit different terrain features. They are worthy of trapping (Churchill 2009).

The prime SHD habitat in the western GVD is defined as:

- Yellow (occasionally orange) sands ranging from very gently undulating sandplains to well defined dunes up to 30m in height.
- Preferred flora and vegetation structure consisting of tall mallee (10-30% cover), mixed shrubland (10-30% cover), and/or a combination of mallee, Marble Gum, Callitris and mixed shrubland (10-30% cover).
- Presence of dense, compact clumps of spinifex (at least 6-30% cover).
- Spinifex life stages of 2 to 3.5 or unburnt for eight to ten years.
- Areas where SHDs have been trapped previously (Appendix B3).

9.3.3 Southern Marsupial Mole (*Notorytes typhlops*) (Endangered)

9.3.3.1 MRUP SMM Survey

Given the subterranean habits of the SMM, none of the direct sampling methods used to trap other Australian marsupials can be applied to SMM. As a result, specific indirect techniques have been developed to assess their distribution and abundance. The most efficient of these methods to date has been the excavation of trenches in suitable habitat to count visible mole holes. These marsupials tunnel through lightly cemented sand, backfilling as they progress, creating oval-shaped changes in sand texture and colour. These backfilled tunnels are referred to as 'mole holes' (Pavey *et al.* 2012). There is no evidence that these mole holes are re-used (Benshemesh 2008), and may persist in the soil profile for many years. As such, these mole holes can provide evidence for the presence of SMM at some time in the past. This method has been used in order to establish whether SMM have been present in various sandy habitats throughout the MRUP area.

The main study objectives for this SMM survey and review were to:

- Review information from a range of sources describing the SMM and the trenching methods.
- Review all available SMM data from the MRUP area, in particular, the results of the work conducted by Ninox in 2009, and all subsequent work conducted by Vimy Resources staff.
- Compare the results of these data with the results from the Tropicana Gold Project.
- Include a risk assessment of long term changes to SMM habitat within the MRUP area.

Between January 2013 and March 2014, 122 trenches were excavated within the MRUP area (Appendix B5). Generally, survey single trenches are excavated at three levels on a dune: near the crest; mid-slope; and at the base. Trenches should be excavated on the north or western side of the dune to facilitate drying of the sand. If surveying flat areas of sand, trenches should be excavated in sets of three approximately 100m apart. When selecting trench locations, disturbance to vegetation should be minimised by placing trenches a suitable distance from trees, shrubs and grasses. This will reduce root penetration into the sides of the trench which can make interpretation difficult (Benshemesh 2005). The trenches were approximately 120cm length × 80cm depth and 40cm wide. The north facing wall, relatively undisturbed by shovel marks, was then inspected for mole holes. Trenches were examined daily until backfilled to prevent any trapped fauna death or injury.

The mole holes were determined by the following criteria:

- The structure is filled with sand, with little if any airspace.

- At least two thirds of the circumference of the mole hole is discernible.
- The mole hole structure is symmetrical.
- The mole hole structure is rounded.
- The mole hole structure is continuous and does not disappear or reduce in minimum dimension when rubbed (Benshemesh 2005).

The Tropicana Project consists of an operational area approximately 330km east-northeast of Kalgoorlie, with two alternative infrastructure routes between the operational area and Kalgoorlie, one via Pinjin Station and one via the existing Trans Australian Railway line Access Road. These three areas were surveyed for the presence of SMM between 2007 and 2009. Within operational areas, 75 sites were surveyed with 225 trenches being excavated. For regional comparisons, 41 sites and 123 trenches to the east of the operational area were surveyed.

Plate 9.5 Southern Marsupial Mole (Photo source: Uluru National Park)

9.3.3.2 MRUP SMM Survey Results

Of the 122 trenches excavated within the MRUP area, nine were noted as having soil disturbance identified as resulting from SMM tunnelling (Figure 9.5) (Appendix B5).

Based on the available information to date, the most suitable sand dune habitat within the Vimy Development Envelope is considered to be the vegetation community S6 (described above in Section 9.3.1.2). This community occurs on yellow sand dunes. This vegetation community contains the highest plant species richness within the MRUP area and has affinities with the Priority 3 (ii) Ecological Community (PEC) within the GVD. A total of 7.36% of the mapped S6 community lies within the MRUP Disturbance Footprint (Appendix A1). Whilst vegetation community S6 probably represents the optimal SMM habitat, it is possible that other sandy vegetation communities could also support this subterranean marsupial (Appendix B5) (Table 9.4).

Table 9.4 Potential Habitat for SMM (in order of potential)

Potential SMM Habitat (MCPL Mapping Description)		Proportion of MCPL Mapped Area within MRUP Disturbance Footprint (%)
S6	Low Shrubland of *Thryptomene biseriata, Allocasuarina spinosissima, Allocasuarina acutivalvis subsp. acutivalvis, Jacksonia arida, Calothamnus gilesii, Acacia fragilis, Conospermum toddii* (P4), *Pityrodia lepidota, Lomandra leucocephala, Anthotroche pannosa* and mixed low shrubs over *Triodia desertorum* with *Lepidobolus deserti* with emergent *Eucalyptus gongylocarpa, Eucalyptus youngiana, Eucalyptus ceratocorys* and *Eucalyptus mannensis* subsp. *mannensis*. This community occurs on yellow sand dunes	7.36
S8	Low Open shrubland of *Calothamnus gilesii, Persoonia petinax, Thryptomene biseriata* and *Leptospermum fastigiatum* with *Anthotroche pannosa, Acaia helmsiana, Microcorys macredieana, Micromyrtus stenocalyx* and mixed low shrubs over *Triodia desertorum* with *Lepidobolus deserti, Chrysitrix distigmatosa* and *Caustis dioica* with emergent *Eucalyptus youngiana, Eucalyptus gongylocarpa* and Eucalyptus ceratocorys. This community occurs on yellow sands adjacent to yellow sand dunes and undulating sandplains	7.62
S3	Shrubland of *Allocasuarina spinosissima* and *Allocasuarinaacutivalvis* subsp. *acutivalvis* with *Grevillea juncifolia* and *Hakea francisiana* over *Triodia desertorum* with emergent *Eucalyptus youngiana* and *Eucalyptus gongylocarpa.* This community occurs on yellow sand on slopes	0.82
S4	Shrubland to open shrubland of *Acacia desertorum* var.*desertorum* and mixed low shrubs over *Triodia desertorum* with occasional emergent mallee *Eucalyptus* spp. This community occurs on yellow or orange sands on midslopes	1.86
E9	Very open scrub mallee of *Eucalyptus mannensis* subsp. *mannensis* with *Grevillea juncifolia* and *Hakea francisiana* over *Cryptandra distigma, Acacia ligulata* and mixed low shrubs over *Triodia desertorum* with emergent *Eucalyptus gongylocarpa.* This community occurs on yellow sand on slopes and flats	13.53
E8	Open scrub mallee to very open scrub mallee of *Eucalyptus ceratocorys* and *Eucalyptus mannensis* subsp. *mannensis* with *Eucalyptus youngiana, Hakea francisiana* and *Grevillea juncifolia* over *Acacia fragilis, Acacia helmsiana* and mixed low shrubs over *Triodia desertorum, Chrysitrix distigmatosa* and *Lepidobolus deserti* with emergent *Eucalyptus gongylocarpa*. This community occurs on yellow sands on flats and slopes	12.26
S1	Shrubland of *Melaleuca hamata* with *Hakea francisiana* and mixed shrubs over *Triodia desertorum* with emergent *Eucalyptus* spp. This community occurs on yellow and orange sand on slopes and flats	7.40
E3	Low open woodland of *Eucalyptus gongylocarpa* over *Eucalyptus youngiana, Eucalyptus ceratocorys, Grevillea juncifolia, Hakea francisiana* and *Callitris preissii* over *Acacia helmsiana, Cryptandra distigma* and mixed low shrubs over *Triodia desertorum, Chrysitrix distigmatosa* and *Lepidobolus deserti.* This community occurs on yellow and yellow-orange sands on flats, slopes and between dunes	13.41
E5	Low open woodland of *Eucalyptus gongylocarpa* over *Eucalyptus rigidula* and *Eucalyptus* sp. Mulga Rock (K.D. Hill & L.A.S. Johnson KH 2668) with *Hakea francisiana* and *Grevillea juncifolia* over *Westringia cephalantha, Acacia helmsiana, Acacia rigens, Eremophila platythamnos* subsp. *platythamnos, Cryptandra distigma* and mixed low shrubs over *Triodia desertorum, Triodia rigidissima* and *Chrysitrix distigmatosa*. This community occurs on yellow and orange sands on flats and slopes	25.09
E4	Low open woodland of *Eucalyptus gongylocarpa* over *Callitris preissii* with *Hakea francisiana* and *Grevillea juncifolia* over *Bertya dimerostigma, Westringia cephalantha* and mixed shrubs over *Triodia rigidissima* and *Triodia desertorum.* This community occurs on orange sands on flats and slopes	11.88

Forty-one of the 270 trenches surveyed at Tropicana were found to have evidence of traces of marsupial mole holes, with the majority in the soft, sandy dune systems on the western side of the operational area. Approximately one third of the mole holes were considered recent or fresh. One survey for the Tropicana Transline placed three or four trenches within three dunes. There were 26 mole holes in three of the four trenches, and most were thought to be fresh (Appendix B5). This site was 75km to the east of the MRUP exploration camp. Five of the 41 regional sites showed evidence of marsupial mole presence with some in habitat not generally associated with preferred mole habitat (*ecologia* Environmental 2009a). The survey indicated mole holes were significantly more common on dunes than in interdunal habitat, and yellow and yellow-red sands were preferred over red sands.

Most surveys of the SMM have indicated that the condition of the sand, its colour and compaction, height of dunes, and their connectivity to surrounding dunefields have a strong influence on the presence and abundance of mole holes, whilst vegetation structure and fire history may have less influence. Thus other potential impacts on SMM such as fire and predation are not considered to be having a major influence on SMM within the MRUP area (Appendix B5).

The results from the MRUP area have been compared with other studies; particularly those conducted within the Tropicana operational area and proposed infrastructure routes, the Simpson Desert and other areas within South Australia. These studies show that the density of SMM is greater in all areas surveyed than at the MRUP area. The MRUP area has a density of 0.01 mole holes/m^2, compared to Tropicana which had approximately 1.99 mole holes/m^2. In addition, the density of mole holes within the MRUP area is very low when compared to the more central deserts of Finke, West Simpson and East Great Sandy which had a density of 3.8 mole holes/m^2.

Benshemesh and Schulz (2008) discuss the strong positive correlation between SMM presence and dune connectivity. This would enable the SMM to travel between preferred habitats without rising to ground level. With a maximum buffer of 100m (100m width on each side of the dune), there is a low index of connectivity (0.12) between sand dunes within the MRUP footprint.

9.3.4 Malleefowl *(Leipoa ocellata)* (Vulnerable)

9.3.4.1 Malleefowl Surveys

Detailed vegetation mapped of the MRUP area has identified 26 vegetation communities consisting of 14 open mallee woodlands, one *Acacia* dominated woodland and 11 shrublands (Appendix A1). A review of potential suitable Malleefowl habitats, based on the vegetation descriptions where mounds had been located in regional surveys (MPG 2009, Ninox 2009, URS 2010 and *ecologia* Environmental 2009a) identified one preferred Mulga woodland habitat (A1) and two potential shrubland communities (S1 and S3) that warranted targeted searches. These were:

A1: Low woodland to tall shrubland of *Acacia aneura* over *Aluta maisonneuvei* subsp. *auriculata*, *Eremophila latrobei*, *Phebalium canaliculatum*, *Prostanthera* spp. and mixed shrubs. This community occurs on orange sandy loams or clay loams with some laterite pebbles on flats.

S1: Shrubland of *Melaleuca hamata* with *Hakea francisiana* and mixed shrubs over *Triodia desertorum* with emergent *Eucalyptus* spp. This community occurs on yellow and orange sand on slopes and flats.

S3: Shrubland of *Allocasuarina spinosissima* and *Allocasuarina acutivalvis* subsp. *acutivalvis* with *Grevillea juncifolia* and *Hakea francisiana* over *Triodia desertorum* with emergent *Eucalyptus youngiana* and *Eucalyptus gongylocarpa.* This community occurs on yellow sand on slopes (Appendix A1).

Field inspections confirmed that vegetation communities S1 and S3 were sub-optimal for Malleefowl and of very limited extent (amounting to less than 74ha out of a total of 27,221 area (<0.3%) area mapped to date at MRUP).

The 2015 review on the Malleefowl incorporated onsite surveys, plus those in the region that reported upon Malleefowl searches (Table 9.5 and Table 9.6). The survey area for this review covers approximately 27,000ha and coincides with the area floristically mapped and reported by Mattiske (Appendix A1). The survey report refers to a Development Envelope covering an area of approximately 10,870ha, which includes the Disturbance Footprint of 3,943ha. This is due to the proposed Project characteristics as defined at the time of the survey. However the MRUP Development Envelope covers an area of 9,998ha, which includes a Disturbance Footprint of 3,787ha. Both are entirely enclosed within the floristic survey area. Vegetation mapping of the Project area by Mattiske Consulting commenced in 2007 and habitat assessment and foot searches for Malleefowl by Mattiske ecologists and Vimy geologists and consultants have continued to the present day.

Two regional helicopter surveys to test the predictive model for the then Declared Rare Flora *Conospermum toddii* in the Yellow Sand Plain Community were undertaken in 2009 and 2010 (MCPL 2010 and Murdock *et al.* 2010). Visual searches at low altitude were undertaken as part of this program for Malleefowl mounds in burnt and unburnt dune environments. Search time exceeded 35 hours. Searches were made at low altitude within a 150km radius of the Project area by observers seated on either side of the helicopter. Location of these search pathways are shown in Figure 9.8. Flyovers were conducted over several Mulga remnants within burnt areas, however thicket density often made it difficult to see the ground. In most sand dune and sand sheet quadrants, ground visibility was good to excellent due to wildfires over the past ten years.

Ninox Consulting undertook pedestrian searches of potential Malleefowl habitat (based on Mattiske's 2009 vegetation mapping) and sand pad road traverses in 2009. Vimy has undertaken targeted searches of remnant Mulga/*Acacia*/Mallee thickets in burnt and unburnt areas outside of the Project area and continued sand pad monitoring on prepared roads, east and west of the MRUP base camp. The locations of these surveys are shown in Figure 9.8. Remnant Mulga and Mallee "thickets" occur outside the Development Envelope within the MRUP tenure boundary. These thickets typically cover areas less than 5ha but can be connected via narrow vegetation corridors to other remnant unburnt patches. Selected sites that appear to exhibit appropriate Malleefowl habitat requirements were tested by grid traversing and searching for signs of tracks, mounds and other evidence using methodology consistent with that developed by the Natural Heritage Trust (2007).

Plate 9.6 Image of Malleefowl (*Leipoda ocellata*)

(Sourced from: Bing
http://www.bing.com/images/search?q=leipoa+ocellata&view=detailv2&qpvt=leipoa+ocellata&id=8B20959C81627495620125B6F48D3FE0DC1BE80A&selectedIndex=10&ccid=GzVxnDCR&simid=608051491662663544&thid=OIP.M1b35719c309164cf086b3392fb549320o0&ajaxhist=0)

Gridline tracks in the MRUP area total approximately 1,200km in length (the majority of which were cleared by a previous tenement holder) and have been utilised over the past seven years by geological personnel, environmental teams and fauna specialists to opportunistically check for mounds in a wide variety of verge vegetation communities. These tracks extend beyond the proposed MRUP Development Envelope.

Selected road alignments totalling 25km have been used for annual sand pad monitoring using a tyre dragged behind a vehicle to "clean" the sand of tracks prior to inspection in early morning light conditions (Plate 9.3). The two sand pad traverse locations are shown in Figure 9.8. This methodology is used to assess the presence/absence of the target species and is also useful for recording the movements of other fauna including introduced predators. The road transects were sited to cover a range of habitats including those where Malleefowl had been recorded elsewhere in the region.

Vimy commenced trialling remote camera trapping in a range of Project habitats for the SHD in 2013. Although designed primarily to test specific SHD habitats, the cameras are spread across the Project area and have recorded a range of local fauna and have provided an indication of predator numbers.

Ninox (2010) conducted targeted gridline searching for tracks covering 92km as part of their Level 2 survey in 2009. Further searches were undertaken as part of daily systematic bird observations. No evidence of Malleefowl was detected during the Ninox Level 2 Survey in 2009 (Appendix B2).

Database searches and literature reviews were undertaken on material that was available in NatureMap, EPBC Protected Matter database and in the public domain. Data on presence/absence was also obtained from baseline consulting reports lodged with EPA as part of the approval for the Tropicana Gold Project.

Table 9.5 Summary of Previous Fauna Surveys in the immediate region to MRUP which reported on Malleefowl Searches

Year	Survey	Proximity to MRUP	Observations			Reference
			Malleefowl	Mounds	Habitat	
Malleefowl Surveys external to the Mulga Rock Uranium Project area						
1975	Queen Victoria Spring Nature Reserve, Yeo Lake	210km N	None recorded	1 inactive	Mulga Woodland (Yeo Lake Area)	Burbridge, McKenzie, Chapman and Lambert (1976)
2006 - 2008	Tropicana Gold Project (TGP) – Operations Area Fauna Assessment	110km NE	None recorded	6 inactive	Sandplain communities, hummock grass, low tree steppe, Mulga/Acacia	*ecologia* Environmental (2009a)
2008	TGP – Malleefowl Mulgara Study Operations Area	100km N	None recorded	13 inactive	Mulga over *Triodia*, red sandy loam, gravel	URS (2008)
2009	TGP – Level 1 Survey Pinjin Corridor	64km SW	Sighted	1 active 1 inactive Tracks	Open Mulga woodland shrub layer, red loam, gravel	Ninox (2009)
2009	TGP – Minigwal Trough Water Area Level 1	140km	None recorded	1 inactive	Dense Mulga woodland	*ecologia* Environmental (2009b)
2009	TGP – Transline Infrastructure Corridor Level 1	35km SE to 83km NE	None recorded	8 inactive	Open Mulga woodland ± shrub layer, red sandy loam	*ecologia* Environmental (2009c)
2009	TGP – Pinjin Infrastructure Corridor	64km SW	None recorded	1 inactive	Open Mulga shrub layer, red sandy loam, gravel	URS (2009)
2009	TGP – Plumridge Lake, East of Queen Victoria Spring Nature Reserve, Malcolm Soak Area	35km SE-NE	None recorded	32 inactive 5 sites	Open Mulga shrub layer, red sandy loam	Malleefowl Preservation Group (2009)
2010 Pinjin	TGP – Group II/III Tenure Malleefowl Habitat Assessment	35km E to 64km SW	None recorded	5 inactive 1 active Tracks	Open Mulga woodland ± shrub, red sandy loam and gravel, pale loam	URS (2010)
2014	TGP – Gas Pipeline to Sunrise Dam Corridor Fauna Assessment	120km N-NW	None recorded	19 inactive	Mulga over shrub layer, red sandy loam with gravel	Turpin J (2014)

Table 9.6 MRUP Malleefowl Surveys

Malleefowl Surveys in the Mulga Rock Project area						
1985	MRUP Area	30km radius of MRUP Camp	None recorded	None recorded	Sandplain communities, hummock grasslands and low tree steppe (Mulga)	Martinick (1986) (Appendix B1)
2007-2015	MRUP Area	35km radius of MRUP Camp	None Recorded	None recorded	Sandplain/dunal communities, hummock grasslands and low tree steppe (Mulga)	Mattiske (2015a, b) (Appendix A1 & A2)
2009	MRUP Area – Level 2	25km radius of MRUP Camp	None recorded	None recorded	Sandplain and sheet communities, tree and shrub steppe, scattered Mulga remnants	Ninox (2010) (Appendix B2)
2009-2010	MRUP and Regional Areas Helicopter Surveys	100km radius of MRUP Camp	None recorded	None recorded	Sandplain and dunal communities, tree and shrub steppe,	Mattiske (2010), Murdock *et. al* (2010)
2009-2014	MRUP Gridline and Sand Pad Track Surveys	Exploration Gridlines, Ambassador, Shogun, and Emperor sites	None Recorded	None recorded	Sandplain communities, hummock grasslands and low tree steppe (Mulga)	Vimy Staff and Woolard (2014) Records on Vimy database

Plate 9.7 Levelling soft road sand for sand pad monitoring transects

9.3.4.2 MRUP Malleefowl Survey Results

The *Acacia* (A1) community which has similar characteristics to those recorded as hosting inactive Malleefowl mounds to the east of the Project area (MPG 2009, ecologia 2009a and URS 2009), occupies 114ha within the Project area mapped. This community is described as:

Low Woodland to Tall Shrubland of Acacia aneura over Aluta maisonneuvei subsp. auriculata, Eremophila latrobei, Phebalium canaliculatum, Prostanthera spp. and mixed shrubs.

This community does not occur in the Development Envelope or Development Footprint (MCPL 2015a).

Surveys undertaken in the Tropicana Gold Project operations area and infrastructure corridors (some elements of which fall within GVD2), identified 87 inactive mounds of varying ages in seven localities and one active mound and a bird sighting near Pinjin, approximately 100km west of MRUP. All presence records were identified in Mulga woodland over a spinifex or shrub layer as the primary habitat. Preferred substrates are recorded as clayey sand or (lateritic) gravel. This habitat, typically identified as a Mulga Woodland Community, is present as remnant patches in the MRUP dunefield but is not recorded within the MRUP Development Envelope (MCPL 2015a).

A substantial effort has been made in searching for Malleefowl presence in the MRUP and immediate surrounds; first in 1985 (Appendix B1) and in the period 2007 to 2015 using a range of survey techniques including targeted searches, gridline searches and wide ranging pedestrian and remnant vegetation monitoring surveys. Targeted searches of suitably sized, remnant Mulga thicket habitat within Vimy's tenure, but outside the Development Envelope, have also not reported the presence of Malleefowl.

Therefore, based on assessment of recent survey data, and the absence of any signs of Malleefowl, it is considered unlikely that a Malleefowl population is present in the Project area.

9.4 Potential Impacts

The MRUP is not considered to have an impact on the identified MNES species as there is not a real chance or possibility that the MRUP will:

- Lead to a long term decrease in the size of the populations.
- Reduce the area of occupancy of the species.
- Fragment an existing population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of a population.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere with the recovery of the species.

This is supported by the limited habitat area within the MRUP utilised by the species relative to the available habitat within the Yellow Sand Plain area within the Shield subregion of the Great Victoria Desert Bioregion of Australia. Table 9.7 quantifies the identified MNES species habitat impacted by the MRUP, specifically the direct and indirect impacts of the MRUP on the MNES species habitat for the four target MNES species within the MRUP area. Direct impacts are defined where the habitat occurs within the planned Disturbance Footprint (DF) while indirect impacts are defined as where the habitat occurs within the planned Disturbance Envelope (DE) but outside the area impacted by the DF.

Table 9.7 shows that the percentage of habitat area directly impacted ranges between approximately 0.04% (potential Malleefowl habitat) to 0.23% (potential Sandhill Dunnart habitat; ignoring the effect of recent fires) of the greater Yellow Sand Plain (YSP). The percentage of habitat area indirectly impacted ranges between approximately 0.24% (potential Ooldea Guinea-flower habitat) and 0.33% (potential Southern Marsupial Mole habitat) of the greater YSP.

A summary of potential impacts (direct and indirect) and management for all MNES species listed by the Protected Matters Search Tool as potentially occurring at the MRUP is provided in Table 9.8.

Table 9.7 Direct and Indirect Impact from the MRUP on Targeted MNES Species Habitat within the Yellow Sand Plain (YSP)

MNES Species		Preferred habitat (VCT)	Estimated total area represented in YSP (ha)	Area/ # Within DE (ha)	Proportion of area within YSP (%)	Direct Impact		Indirect Impact	
Common Name	Scientific Name					Area within DF (ha)	Proportion of area within YSP (%)	Area within DE but outside DF (ha)	Proportion of area within YSP (%)
Sandhill Dunnart	*Sminthopsis psammophila*	E3/S6	641,606	3,515	0.55	1,467	0.23	2048	0.32
		Unburnt E3/S6		158.5	0.02	24.1	< 0.01	134.4	0.02
Southern Marsupial Mole	*Notoryctes typhlops*	S6/S8	148,038	718.5	0.48	230.9	0.16	487.6	0.33
Malleefowl	*Leipoa ocellata*	S1/S3	4,568	16.4	0.36	1.6	0.04	14.8	0.32
Ooldea Guinea-flower	*Hibbertia crispula*	S6	54,482	199.5	0.37	71	0.13	128.5	0.24
		Individual plants identified	14,269*	182 +/- 13	1.3	38 +/- 13	0.27	144 +/- 13	1.01

*In broader MRUP region (i.e. 25 × 20km area around the MRUP area), approximately 14,269 Hibbertia crispula plants have been identified

Table 9.8 Summary of Potential Impacts, Management Strategies and Predicted Outcomes for the MNES Species at MRUP

MNES species		*EPBC Act* Conservation Status	Potential Impact	Management Strategies	Predicted Outcomes
Scientific Name	Common Name				
Hibbertia crispula	Ooldea Guinea-flower	Vulnerable	The November 2014 fire has affected a total of over 79,000ha and 74% of the Project Development Envelope. Calculations by MCPL (Appendix A2) indicate that 10,823 +/- 25 of the regional *Hibbertia crispula* plants (75.8%) will have been impacted by the recent fire. The species is regionally extensive, albeit localised, and further regional mapping would significantly extend the described range of the habitat. Potential direct impacts: Before the November 2014 fire, there was the potential for 38 +/- 13 individual plants at one location, which represents 0.27% of the regional population (Appendix A2), to be directly affected by clearance within the Disturbance Footprint of the Project. The number of the 38 +/- 13 *Hibbertia crispula* plants within the Disturbance Footprint that survived the 2014 fire is, as yet, unknown. The potential 38 individual plants affected are a very small proportion of the total 14,269 +/- 25 plants surveyed in the region to date. *Hibbertia crispula* has only been recorded within the MCPL S6 vegetation community. Of the 964ha mapped in the MRUP area to date, 70.98ha lies within the Disturbance Footprint. The S6 community within the Disturbance Footprint represents 7.4% of the community mapped in the MRUP area to date. Potential indirect impacts: Before the November 2014 fire, there was the potential for indirect impacts of the mining project upon 182 +/- 13 individual plants at 4 locations within the Development Envelope, including the 38 within the Disturbance Footprint, and representing 1.28% of the regional numbers. *Hibbertia crispula* has only been recorded within the MCPL S6 vegetation community. Of the 964ha mapped S6 community in the MRUP area to date, 199.5ha lies within the Development Envelope of the Project, representing 20.7% of the community mapped by MCPL. The S6 community extends well beyond the MRUP area (Appendix A1). Habitat fragmentation will therefore not be a potential impact of the MRUP upon *Hibbertia crispula*. The potential indirect impacts of the Project upon *Hibbertia crispula* are the same as those for all MRUP flora (Section 7.4.2), with the risk for potential indirect impact likely to be minimal due to the low numbers of individual plants in the Development Envelope. • Dust deposition on flora and vegetation reducing the health of the plants. • Increased fire frequency/intensity of background fire patterns in the region, which in turn may modify the vegetation communities and species form. • The uptake of radionuclides and other contaminants from dust, groundwater and surface water. • The introduction and spread of weed species. • Altered hydrological regimes associated with dewatering and aquifer reinjection, or modification to surface water hydrology. • Potential reduction of health of vegetation, or death, from saline water spray during dust suppression of transport routes etc. • Introduced fauna may reduce the health of the vegetation by grazing. Of these, fire may be the greatest threat to the survival of *Hibbertia crispula* plants in and around the Project area. In the eight years of MCPL MRUP botanical surveys, the species was only recorded on unburnt dunes that had not been burnt for at least 15 years and, more commonly, not burnt for at least 20-30 years (Appendix A2). However, since the November 2014 moderate intensity fire, there have been records of many *Hibbertia crispula* plants resprouting.	Potential direct impacts: • It is likely that only a relative few individual specimens will be removed as the Vimy Ground Disturbance Management Plan will closely regulate areas to be cleared. • Vegetation clearance on site will be the minimal required and disturbed areas will be progressively rehabilitated as soon as practicable. • Progressive rehabilitation will incorporate trials to ensure continual improvement in revegetation success, and to determine potential avenues for the return of conservation significant species. Potential indirect impacts: • Weeds have not been located in any of the eight surveys of the past eight years. A Weed Management Plan will be implemented by Vimy to ensure hygiene measures will minimise the risk of introduced flora into the disturbance areas, and will also include vigilant regular inspections and the prompt removal of any located weed plants. • The indirect impact of dust on individual plants in the disturbance envelope will be minimised by the implementation of the Vimy Dust Management Plan with regular dust suppression of transport routes, speed limits and restriction of all off road driving. • A Vimy Fire Prevention Management Plan and firefighting equipment on site will minimise any increase to the fire risk in the area. • Refuge communities (areas of unburnt vegetation remaining from the 2014 fire) will be protected with the Vimy Ground Disturbance Management Plan and employee awareness via environmental inductions. • Further flora and vegetation monitoring will increase the knowledge base on the *Hibbertia crispula*, especially in regard to response to bushfires of different intensities.	Potential direct impacts: The number of the 38 +/- 13 Hibbertia crispula plants within the Disturbance Footprint that survived the 2014 is, as yet, unknown. The 38 are a very small proportion of the total 14,269 +/- 25 plants surveyed in the region to date. The number of mapped individual *Hibbertia crispula* plants in the Development Envelope mapped to date (subtracting those in the Disturbance Footprint) is 144 +/- 13 plants at 3 locations. Vegetation clearance will be managed, and will not remove many, if any, individual specimens. Potential indirect impacts: The risk for potential indirect impact by the Project activities is low. The impact of the Project on *Hibbertia crispula* will be minimal because: • The impact of weeds will be negligible. • The impact of fragmentation of habitat will be negligible. • The indirect impact of dust on specimens will be minimal. • The fire risk to habitat will be similar to the current risk (which is currently lowered due to recent fire reducing fuel load in region). Therefore the Project is unlikely to result in the alteration of the conservation status of this species.

MNES species		*EPBC Act* Conservation Status	Potential Impact	Management Strategies	Predicted Outcomes
Scientific Name	Common Name				
Leipoa ocellata	Malleefowl	Vulnerable	Extensive surveys have not identified the presence of Malleefowl or suitable woodland habitat in the MRUP area, indicating that the birds are not likely to be present in the Project area. (Appendix B6). The recording of a bird sighting near Pinjin and the identification of 86 inactive mounds in more broad surveys suggest that the species is still present within the broader landscape, although in very low densities (Appendix B6). Potential direct impacts: The proposed Project is unlikely to directly impact on any Malleefowl population. Potential indirect impacts: The proposed Project is unlikely to indirectly impact on any Malleefowl population.	Potential direct impacts: Speed limits and employee awareness through environmental inductions will minimise the risk to individual animals that may encroach the Development Envelope, although the event is unlikely due to the absence of Malleefowl habitat in the MRUP area. Potential indirect impacts: No management required	No bird sightings, any evidence of mounds or suitable Malleefowl habitat was located within the proposed Development Envelope, and it is therefore considered highly unlikely that the development of the Project will have a significant impact on Malleefowl.
Pezoporus occidentalis	Night parrot/ Spinifex Parrot	Endangered	There is unlikely to be any suitable habitat for this species present in the Project area and therefore the species is not likely to occur in the area. Potential direct impacts: None likely due to no suitable habitat at MRUP. Potential indirect impacts: None likely due to no suitable habitat at MRUP.	Potential direct impacts: No specific management is required for this species. Potential indirect impacts: The tailings facility will be monitored for the presence of any avifauna, and deterrents will be installed if required.	The Project will not impact this species.
Polytelis alexandrae	Princess Parrot, Alexandra's Parrot	Vulnerable	The Princess Parrot has not been surveyed in the MRUP area to date. The bird may be in the region, but as it tends to nest in hollows in *Eucalytpus* trees close to water courses, its preferred habitat is not present at MRUP. Potential direct Impacts: None likely due to no suitable habitat at MRUP. Potential indirect impacts: None likely due to no suitable habitat at MRUP.	Potential direct impacts: No specific management is required for this species. Potential indirect impacts: The tailings facility will be monitored for the presence of any avifauna, and deterrents will be installed if required.	The Project will not impact this species.
Notoryctes typhlops	Southern Marsupial Mole	Endangered	The Project lies at the SW edge of very wide distribution within the sandy deserts of central Australia and that surveys to date indicate that the population of the Southern Marsupial Mole is of a low density (Appendix B5).The observed density in the MRUP area was 0.01 mole hole/m^2 in suitable habitat, which is a very low density of observation being less than 1/100th of the density levels observed by the Tropicana Project (Appendix B5). Potential direct impacts: Direct impact may occur with the removal of habitat, and the loss of individuals contained within the sands as excavation occurs. Few of these marsupials rise to ground level, and so there is unlikely to be a risk to individuals to death or injury by traffic. The likely preferred habitat of the SMM is the MCPL S6/S8 vegetation community. A total of 148,038ha is estimated to exist in the YSP area. Of this, 719ha (0.5%) lies within the Development Envelope and 231ha (0.2%) lies within the Development Footprint. The orebodies and proposed Development Footprint areas are primarily located within topographic lows, usually characterised by more compacted sands or clayey sands, and as such, only a small proportion of sand dune habitat will be disturbed by development of the MRUP Project. The impact upon the species will be determined by the amount of similar habitat in the surrounding region, and the mobility of the animal. There is a strong positive correlation between SMM presence and dune connectivity (Benshemesh and Schulz 2008). The MRUP area displays a low index of connectivity (0.12) between sand dunes suggesting it is not a conducive habitat. The Project will also not cause any major habitat fragmentation. Potential indirect impacts: The effect of fire on the species is unknown, but survey results in other areas indicate that it does not affect numbers. The effect of fire and habitat loss to diet is unknown.	Potential direct impacts: Employee education will ensure any individual SMM encountered (although unlikely) will be recognised and the Vimy Environmental Department will be informed immediately. Vimy will then immediately contact the appropriate authorities, such as DPaW, for advice on immediate actions, and future management options. Potential indirect impacts: No specific management is required for this species.	The impact on the species as a whole will be negligible given that the Southern Marsupial Mole population within the MRUP appears to be low and the area lies at the south-western edge of the very wide distribution of this animal through the sandy deserts of central Australia (Appendix B5). It is considered highly unlikely that the development of the Project will have a significant impact on the Southern Marsupial Mole.

MNES species		EPBC Act Conservation Status	Potential Impact	Management Strategies	Predicted Outcomes
Scientific Name	**Common Name**				
Smithopsis psammophila	SHD	Endangered	A small number of SHDs have been captured in the MRUP area since 1985. Long term occupancy is not assured at sites where it has previously been detected (Appendix B3), and repeat captures at survey sites have not occurred on subsequent surveys. As the Project area has been extensively burnt, there will be few individuals currently at the Project site. Intensive camera trapping has recorded only two individuals at two separate sites in the past 12 months. Potential direct impacts: The Project requires the clearance/disturbance of up to 3787ha of vegetation for the life of the mine and this will result in the loss of fauna habitat and potentially lead to fragmentation, which in turn could result in the consequential displacement or isolation of fauna. The preferred habitat for the SHD was determined to be Vegetation Community types E3 and S6 (Appendix B3) which in the absence of burnt areas would comprise 1467ha (or 38.7%) of the Disturbance Footprint and 3515ha (35.2%) of the Development Envelope. The criteria for the preferred habitat includes the presence of dense compact clumps of spinifex with at least 6-30% plant cover and having remained unburnt for a minimum of eight years (Appendix B3). Only approximately 24ha remain of such habitat within the Disturbance Footprint that has not been burnt in the past seven years by bushfire. It is likely to recover slowly due to the desert ecology of the GVD. There is extensive suitable habitat in Western Australia, South Australia and the Northern Territory and it is highly likely that the species will occur at more than the presently known locations (DoE 2015). Therefore habitat fragmentation is unlikely. Other potential direct impacts include deaths, injuries or entrapment during the clearing process and during the construction and subsequent operations that follow of individuals by operational equipment, including traffic, in the area. A proportion of the initial ground disturbance during construction of the proposed Project will be linear, aiding the egress of animals from the Disturbance Footprint. Similarly, the disturbance of the site will occur through time due to the nature of the mining. The mine activity may also encourage animals in adjacent areas yet to be cleared to egress from the area before the scheduled ground disturbance. Potential indirect impacts: **Radiation:** An assessment was undertaken to determine changes in soil radionuclide concentrations at various sensitive receptor sites over the life of the mine due to dust deposition. This information was then used to undertake a Tier 2 ERICA (Environmental Risk from Ionising Contaminants: Assessment and Management) assessment. The calculated Total Dose Rate as a result of this dust deposition was estimated to be < 0.1µGy/h which compares to a screening value for a Tier 2 assessment of 10µGy/h (Section 7.3.6). This assessment showed that exposure levels were well below trigger levels (Appendix F1) and that it could be concluded that the ERICA assessment indicated that there will be no radiological risk to reference fauna from emissions from the proposed Project **Increased bushfire frequency:** Bushfires can occur at any time of year, occur in the region at a high frequency and are predominantly the result of lightning strikes. The Project has the potential to increase the risk of bush fires occurring as a result of operational activities (e.g. hot works, machinery movements, etc.). However, with the very large burn in 2014 affecting over 79,000ha in the region, including 74% of the MRUP Development Envelope, the fuel load will be greatly reduced in the area for a number of years. The recovery of the GVD vegetation after a fire is comparatively slow. **Weeds:** Introduction of weed species may deteriorate the condition of the preferred SHD habitat. **Feral animals:** The MRUP may lead to increased access for feral animals to resources. Refuse from the accommodation facilities, in particular food waste can encourage the presence of feral animals and support an increase in their numbers. Water will be stored at surface and may also be accessed by feral animals which will similarly encourage their presence and support an increase in their numbers.	Potential direct impacts: The SHD Camera Trapping Program will continue through mine operation to detect the presence of the animal in the Project area. If any individuals are detected, appropriate management protocol will be swiftly implemented, in consultation with DPaW. Vegetation clearance on site will be the minimal possible and disturbed areas will be progressively rehabilitated as soon as practicable. Refuge communities (areas of unburnt vegetation remaining from the 2014 fire) will be protected with the Vimy Ground Disturbance Management Plan and employee awareness ensured via environmental inductions. Potential indirect impacts: **Radiation:** No additional management practices required for the SHD. **Increase bushfire frequency:** The issue of the risk to native fauna from increased fire risk will be managed as part of the Fire Management Plan (MRUP-EMP-025) and will involve ensuring that all ground disturbance activities are undertaken in accordance with its required protocols. The Fire Management Plan (MRUP-EMP-025) will include such measures as the provision of appropriate firefighting systems (equipment, training, procedures), prior approval for hot works, a site fire ban, and potentially mosaic burning if appropriate around the Project area. **Weeds:** The issue of invasive weed species and their potential to adversely impact fauna habitat will be managed by the implementation of a site-wide vehicle hygiene strategy as required under the Weed Management Plan (MRUP-EMP-003). **Feral animals:** The issue of feral animals, both competitors and predators, will be managed by monitoring feral animal numbers and if necessary implementing the appropriate control measures under the Feral Animal Management Plan (MRUP-EMP-006). These measures will include the installation of fencing around any obvious attractors.	Given the loss of the high proportion of suitable habitat by recent fires and the recordings of only nine SHDs over a 30 year period at MRUP, it is most likely that the SHD occurs in very low numbers in its preferred habitat. It is therefore considered that the impact on the SHD will be minimal.

<table>
<tr><th colspan="2">MNES species</th><th rowspan="2">EPBC Act Conservation Status</th><th rowspan="2">Potential Impact</th><th rowspan="2">Management Strategies</th><th rowspan="2">Predicted Outcomes</th></tr>
<tr><th>Scientific Name</th><th>Common Name</th></tr>
<tr><td></td><td></td><td></td><td>Noise and light spill:
Noise and vibration can disrupt animals, and in particular bats, from areas close to the source. Mining activity will mostly take place within pits and below the surface level and therefore the noise will be naturally attenuated. Light sources can act as both an attractant and a deterrent to animals. The spread of the light associated with mining activities will be naturally limited by its location within pits below the level of the surface.
Air quality:
Dust levels can be naturally high in the Project area due the low rainfall, high evaporation rates, relatively sparse vegetation, frequent winds and occasional uncontrolled bushfires (Appendix E1). Mining will predominantly take place in open pits below surface levels on material that has an average moisture level of around 10% and will be mined using techniques that do not require the use of explosives. Vehicle movements also have the potential to generate dust.
There will be no other changes in air quality that could have a significant impact on fauna (see Section 12).
Water extraction and reinjection:
There will be no impact on fauna habitats as a result of water extraction and water reinjection activities as there is no connection between the local aquifers, from which extraction will take place and into which reinjection will occur, and ground water dependent vegetation.</td><td>Noise and light spill
Wherever practicable, high efficiency low noise equipment will be selected to further limit the noise generated.
The lighting associated with all operations will be directed towards the activities to limit light spill.
Changes in air quality.
The issue of the risk to native fauna from dust emissions will be managed as part of the Dust Management Plan (MRUP-EMP-024). In essence it will require the following measures to be implemented:
• Control impact to ambient dust levels from all activities.
• Control dust from roads by suitable application of dust suppression measures (saline water).
• Dust generating activities avoided if practicable near environmentally sensitive areas such as habitat suitable for conservation significant fauna.
• Incorporate further dust suppression measures, such as binding agents, if dust generation is perceived to be a problem in an area regarded as environmentally sensitive.
Water extraction and reinjection:
No management required.</td><td></td></tr>
<tr><td>Merops ornatus</td><td>Rainbow Bee-eater</td><td>Listed within EPBC Act as Marine and Migratory species.
Listed under JAMBA.</td><td>One individual was recorded at MRUP in 1985. There is likely to be negligible impact to the species as it is not likely to regularly occur in the Project area as there are is no permanent water and therefore no riparian, floodplain or wetland vegetation assemblages in this arid area. Operations will also be likely to deter the bird from the area. The Rainbow Bee-eater is not considered globally threatened.
<u>Direct Impacts:</u>
Unlikely to be any direct impacts as it is a migratory species likely to avoid areas of mining activity
<u>Indirect impacts:</u>
None likely, but may drink from TSF (although salinity also makes this unlikely), with unknown effects</td><td><u>Direct impacts</u>:
No specific management is required for this species.
<u>Indirect impacts:</u>
Inspections of the TSF will determine if birdlife are attracted to the TSF. If so, management measures will be instigated, in consultation with DMAs, to deter fauna from the structures.</td><td>The Project is unlikely to impact this species.</td></tr>
<tr><td>Ardea alba</td><td>Great Egret, White Egret, Eastern Great Egret</td><td>Listed within EPBC Act as Marine and Migratory species.
Listed under JAMBA and CAMBA as Egreta alba</td><td>No suitable habitat of wetlands is present in the Project area and therefore the species is not likely to occur in the area and there will be no direct or indirect impact on the bird.
<u>Direct impacts:</u>
None likely due to no suitable habitat at MRUP
<u>Indirect impacts:</u>
None likely due to no suitable habitat at MRUP</td><td><u>Direct impacts:</u>
No specific management is required for this species.
<u>Indirect impacts:</u>
The tailings facility will be monitored for the presence of any avifauna, and deterrents will be installed if required.</td><td>The Project will not impact this species.</td></tr>
<tr><td>Charadrius veredus</td><td>Oriental Plover, Oriental Dotterel</td><td>Listed within EPBC Act as Marine and Migratory species.
Listed under JAMBA and ROKAMBA.</td><td>The Oriental Plover is not considered globally threatened. The species is unlikely to occur in the Project area due the few sightings made in southern Australia have been in salt marshland which does not occur at the Project site.
<u>Direct impacts:</u>
None likely due to no suitable habitat at MRUP
<u>Indirect impacts:</u>
None likely due to no suitable habitat at MRUP</td><td><u>Direct impacts:</u>
No specific management is required for this species.
<u>Indirect impacts:</u>
The tailings facility will be monitored for the presence of any avifauna, and deterrents will be installed if required.</td><td>The Project will not impact this species.</td></tr>
</table>

9.5 Management of Potential Impacts

A summary of potential impact and management strategies for specific MNES species is summarised in Table 9.8. The following management strategies are appropriate for all of the MNES flora and fauna species.

9.5.1 Management of Potential Impacts upon MNES Species

The overall objective for the management of impact to MNES species, is to ensure that the disturbance as a result of the development of the MRUP will be minimised. The implementation of the following principles will assist in delivering such an outcome:

- Minimise disturbance activities where practicable.
- Confine disturbance to areas within what has been agreed under the Ground Disturbance Activity Permit.
- Avoid clearing habitat suitable for MNES listed species where practicable.
- Maintain overall health of native flora and fauna by minimising indirect impacts.
- Avoid or minimise the introduction and spread of invasive weeds.
- Avoid or minimise the introduction and spread of feral competitors (e.g. rabbits).
- Avoid or minimise the introduction and spread of feral predators.
- Progressively rehabilitate disturbed areas.
- Ensure awareness of environmental factors amongst operating workforce.

These guiding principles have been incorporated into the following Management Plans which have been prepared to ensure that impacts (direct and indirect) are no greater than those impacts outlined in Section 9.4 and that the impacts are avoided or minimised to the greatest extent that is practicable:

- Weed Management Plan (MRUP-EMP-003).
- Terrestrial Fauna Management Plan (MRUP-EMP-004).
- Conservation Significant Fauna Management Plan (MRUP-EMP-005).
- Feral Animal Management Plan (MRUP-EMP-006).
- Ground Disturbance Management Plan (MRUP-EMP-019).
- Transport Radiation Management Plan (MRUP-EMP-022).
- Emergency Response Management Plan (MRUP-EMP-023).
- Dust Management Plan (MRUP-EMP-024).
- Fire Management Plan (MRUP-EMP-025).
- Radiation Management Plan (MRUP-EMP-028).
- Radioactive Waste Management Plan (MRUP-EMP-029).
- Rehabilitation and Revegetation Management Plan (MRUP-EMP-030).

These Management Plans are contained in Appendix K1.

The management of environmental impacts to terrestrial flora and fauna will be predominantly achieved through the use of a clearing permit system that will prevent any ground disturbing activity from being commenced on the

MRUP site until an appropriate permit, known as a Ground Disturbance Activity Permit (GDAP) (MRUP-POL-001), has been issued.

Vimy will maintain a database containing the spatial location of soil associations and vegetation communities that define habitat for conservation significant flora and fauna and any other environmentally significant locations. In order to obtain a GDAP, the co-ordinates of the proposed disturbance site will have to be identified and compared against this central database to ascertain whether such disturbance would involve any impacts to habitat suitable for conservation significant species or any other areas considered environmentally important in relation to the conservation of local native flora and fauna.

Where practicable, the clearance of habitat suitable for conservation significant species or other areas regarded as environmentally sensitive will be avoided; clearing protocols will be contained within a developed Construction Environment Management Plan (MRUP-EMP-018). This has already happened to some extent as the design of the layout of the infrastructure has taken into account the known location of areas containing complex interlinked dunes which are regarded as habitat for both SHDs and Southern Marsupial Moles. Since there is considerable local flexibility in the location of linear infrastructure, such as water pipelines and roads, the exact route followed can, if required, be altered by the small amount necessary to avoid areas of habitat suitable for conservation significant species, significant habitat trees or any other localised environmentally significant areas.

The same system of GDAPs will be used to monitor both the exact area of ground disturbance and, initially, the extent of the proposed disturbance in relation to the purpose for such disturbance to ensure that areas cleared are kept to the minimum required. The implementation of the authorised GDAP will be managed to ensure that the extent of ground disturbance will be equal to or less than that internally authorised. A log of all GDAPs issued and the surveyed areas of actual disturbance will be maintained according to the Document and Data Control Management Plan (MRUP-EMP-039). The GDAP system will then be subsequently used to manage the efficient timing of the progressive rehabilitation. All disturbance areas that have been rehabilitated will be logged into a central Vimy database and rehabilitation success will be monitored according to protocols detailed within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030).

The Terrestrial Fauna Management Plan (MRUP-EMP-004) will ensure that all disturbance activities are monitored and regularly inspected to ensure that any animals that are trapped (e.g. as a result of trenches being dug) are appropriately helped to return to their natural habitat (e.g. by ensuring exit ramps are in place; or by safely capturing and releasing).

The issue of the interaction between native fauna and vehicles will be managed as part of the Transport Radiation Management Plan (MRUP-EMP-022). In essence it will require adherence to:

- Only driving on established roads.
- Complying with speed limits, including variable speed limits imposed in sensitive areas or at key times.
- Limiting vehicular use at dusk/night where practicable.
- Advice given as part of the education of the workforce about the risks of fauna strikes.

All site based employees will be educated as part of their induction program to recognise conservation significant flora and fauna that may potentially inhabit the area, and any evidence of the presence of such flora and fauna, such as Malleefowl mounds. Identification guides will be made available and employees undertaking clearing or any other field activities will be encouraged to look for these species and to avoid areas where their presence is detected, where practicable.

9.5.1.1 Monitoring

The monitoring of the disturbance of vegetation, and consequently fauna habitat, and in particular areas regarded as habitat for MNES species, will be undertaken using the protocols established under the Ground Disturbance Management Plan (MRUP-EMP-019) which requires a comparison between the area proposed for disturbance with a central database containing the location of known environmentally sensitive areas prior to the issue of a GDAP (MRUP-POL-001) authorising such disturbance. This database will be regularly updated to reflect the latest information under the Document and Data Control Management Plan (MRUP-EMP-038).

Information being entered into the database will include any relevant observations that result from the regular site inspections undertaken by the Environmental Officer and will occur both ad hoc, during daily activities, and annually (as part of Annual Environmental Report) when a complete site inspection will made and recorded. An inspection of the condition of all vegetation, and therefore fauna habitat, and any evidence of increased activity by feral animals adjacent to, or within operational areas will be made by either walking or driving along all roads and pipelines within the Project area and around the perimeter of all mining and processing operations and infrastructure to determine if the condition of the vegetation has been modified or there is evidence of increased feral animal activity. The details of the monitoring protocol will be specified within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030) and the Feral Animal Management Plan (MRUP-EMP-006), including the attempted determination of the cause of condition change or increase in activity.

If deterioration in the condition of vegetation, fauna habitat or an increase in feral animal activity is attributed to operational activities of the Project, measures detailed within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030) and the Feral Animal Management Plan (MRUP-EMP-006) will be implemented to prevent further deterioration and, where practicable, to ameliorate the effects. Monitoring of rehabilitation success will occur regularly as scheduled within the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030). Methodology of monitoring specified within that management plan will ensure the determination of success, or otherwise, of meeting the KPIs established within the Mine Closure Plan (MRUP-EMP-031). An effective feedback loop will safeguard that continual improvement in rehabilitation success will occur. It will also guarantee that remedial work will be scheduled for any rehabilitation areas not meeting KPIs for the particular site. Progressive rehabilitation will incorporate trials to ensure continual improvement in revegetation success, and to determine potential avenues for the return of conservation significant species.

Vimy employees and contractors will be encouraged to report any observations indicating the potential presence of such conservation significant flora or fauna. All such observations will be entered into the central database system, according to protocols within the Document and Data Control MP (MRUP-EMP-038).

Regular monitoring of selected flora and habitats will also occur, both inside and outside the Project area; this will be undertaken through all stages of the Project (construction, mining and closure). Flora and fauna monitoring will be undertaken within the discipline of the CTP system (Appendix B3). Long term monitoring sites outside the Project area will be used as control sites against which vegetation surveys and fauna sightings within the Project area can be referenced. Particular attention will be paid to the CTP monitoring of suitable habitats for MNES listed species.

As part of the Transport Radiation Management Plan (MRUP-EMP-022), vertebrate fauna strikes will be recorded where practicable, with information including the location, the time and the particular species believed to be involved. For any fauna strikes or mortalities potentially involving MNES species, the Environmental Manager will be informed and will have the responsibility of endeavouring to properly identify the animal (which may not be possible if it has been struck but has left the immediate location). Vehicle strikes will be recorded on the central database according to protocols within the Document and Data Control MP (MRUP-EMP-038).

Vegetation and fauna habitats will be subject to a matrix of monitoring activities designed to track changes to the health of the habitats as a result of Project activities. Habitat monitoring activities include:

- Weed monitoring, conducted in accordance with the Weed Management Plan (MRUP-EMP-003).
- Dust Monitoring, conducted in accordance with the Dust Management Plan (MRUP-EMP-024).
- Vegetation community condition and baseline monitoring, conducted in accordance with the Flora and Vegetation Management Plan (MRUP-EMP-001) and the Threatened and Conservation Significant Flora and Vegetation Management Plan (MNES listed species) (MRUP-EMP-002).

All monitoring activities are governed by protocols within the Environmental Monitoring Management Plan (MRUP-EMP-032) which will ensure that compliance with relevant Management Plans takes place.

9.5.2 Management Targets and Contingency Actions

The following events would lead to the contingency actions detailed:

- MNES species fauna strikes recorded in a specific location are greater than one incident per year:
  - **Contingency action** – The Vimy Environmental Department will investigate if a population or specific habitat of the conservation significant fauna is located in the vicinity of the incidents, and instigate measures to reduce the potential for future incidents. Such measures will be dependent upon the species and the situation.
- Monitoring of feral animals indicates that numbers encroaching onto, or present on, MRUP area is increasing:
  - **Contingency action** – The Environmental Department will investigate the potential reasons for the increase in number, and will implement appropriate measures to either mitigate the operational activity increasing numbers, prevent the ingression of animals from offsite and/or eradicate feral animal population from Project site.
- Regular monitoring indicates a significant deterioration in the condition of any vegetation or fauna habitat in the areas surrounding the Project's operations:
  - **Contingency action** – The Environmental Department will identify the likely cause of the deterioration and, if associated with the operational activities of the Project, implement measures to prevent further deterioration and to remediate the affected are:
    - Dust – utilise appropriate measures to further reduce dust emissions, such as increasing dust suppression activities (such as watering) or reducing the cause (such as reducing speed limits) as specified within the Dust Management Plan (MRUP-EMP-024).
    - Feral animal activity – attempt to determine if MRUP operations are encouraging animals to the area of activity and implement measures as specified within the Feral Animal Management Plan (MRUP-EMP-006).
    - Weeds – undertake the local eradication of weeds according to the protocols specified in the Weed Management Plan (MRUP-EMP-003), and attempt to identify the source of introduction and determine future prevention strategies.
    - Vehicle damage: investigate why vehicles are driving off designated tracks and ensure prevention of reoccurrences.

9.6 Mitigation Hierarchy

The following mitigation hierarchy will be implemented at the MRUP to reduce the impact on MNES Species:

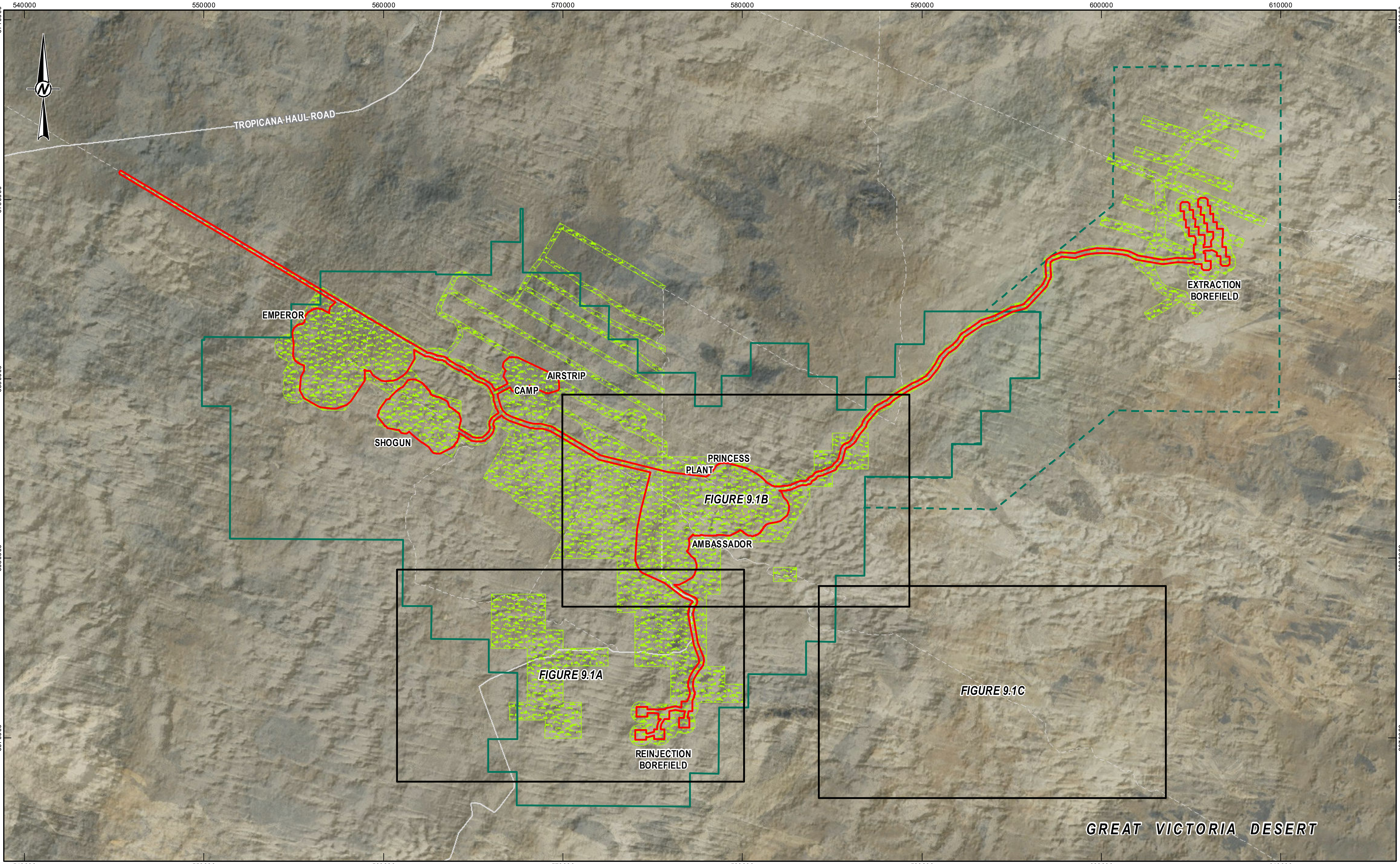
- **Avoid**: Preferred habitats and locations of MNES species are known and recorded. Where practicable, these areas will be avoided to reduce impacts on these conservation significant species.

- **Minimise**: Where practicable, disturbance to known MNES species or their habitats will minimised to reduce the impact on these species.
- **Management**: A range of management plans (Section 9.5.1) have been developed and will be implemented at the MRUP to ensure accurate identification of MNES species and their habitats, control disturbance activities in these areas, monitoring of impacts on these species, reporting of any impacts and contingency actions to be implemented to minimise the potential for future impacts.
- **Rehabilitation**: Disturbance areas will be progressively rehabilitated to re-establish the functioning of the overall ecosystem and with native provenance species that will facilitate access and utilisation by MNES species.

It is considered that through the application of this mitigation hierarchy the impacts on MNES species will be minimised as far as practicable and any resultant impacts quantitatively identified and reported.

9.7 Predicted Outcomes

Predicted outcomes for the MNES listed species with the potential to occur at MRUP are summarised in Table 9.8. There will be no significant outcome from the MRUP on any of the MNES species potentially occurring at the Project area.



LEGEND

- MINOR ROAD/TRACK
- ROAD
- VEGETATION BOUNDARY
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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CLIENT	VIMY RESOURCES LIMITED	PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT		TITLE	*Hibbertia crispula* TARGETED SURVEY - EAMA AND MCPL DUNE TRAVERSE LOCATIONS
YYYY-MM-DD	2015-10-31		
DESIGNED	MS		
PREPARED	MS		
REVIEWED	GB		
APPROVED	GB		

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	9.1

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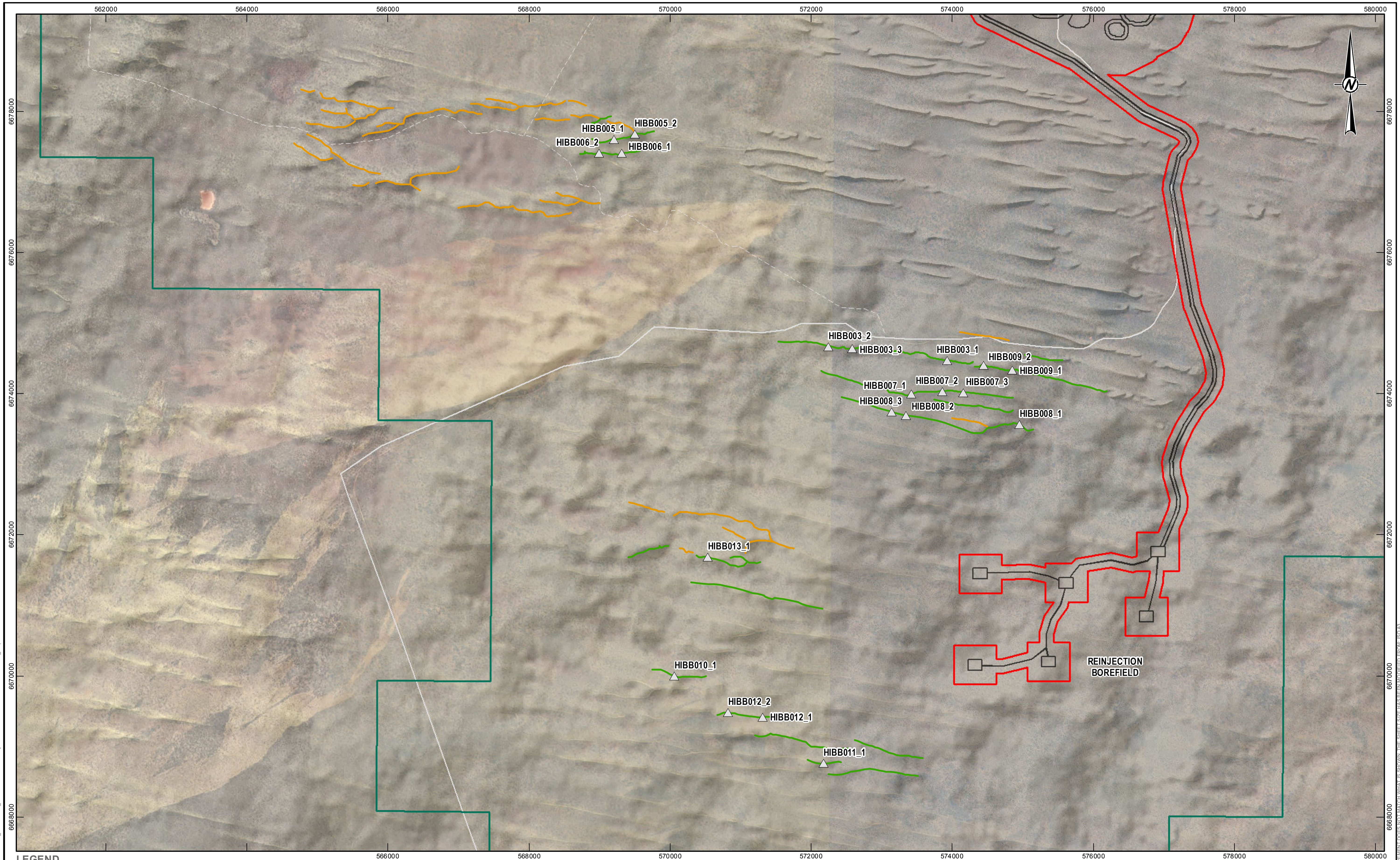

LEGEND

- MCPL Hc SITE CLUSTER
- EAMA TRAVERSE (Hc FOUND)
- EAMA TRAVERSE (NO Hc FOUND)
- MCPL TRAVERSE (NO Hc FOUND)
- NOT TRAVERSED
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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CLIENT
VIMY RESOURCES LIMITED

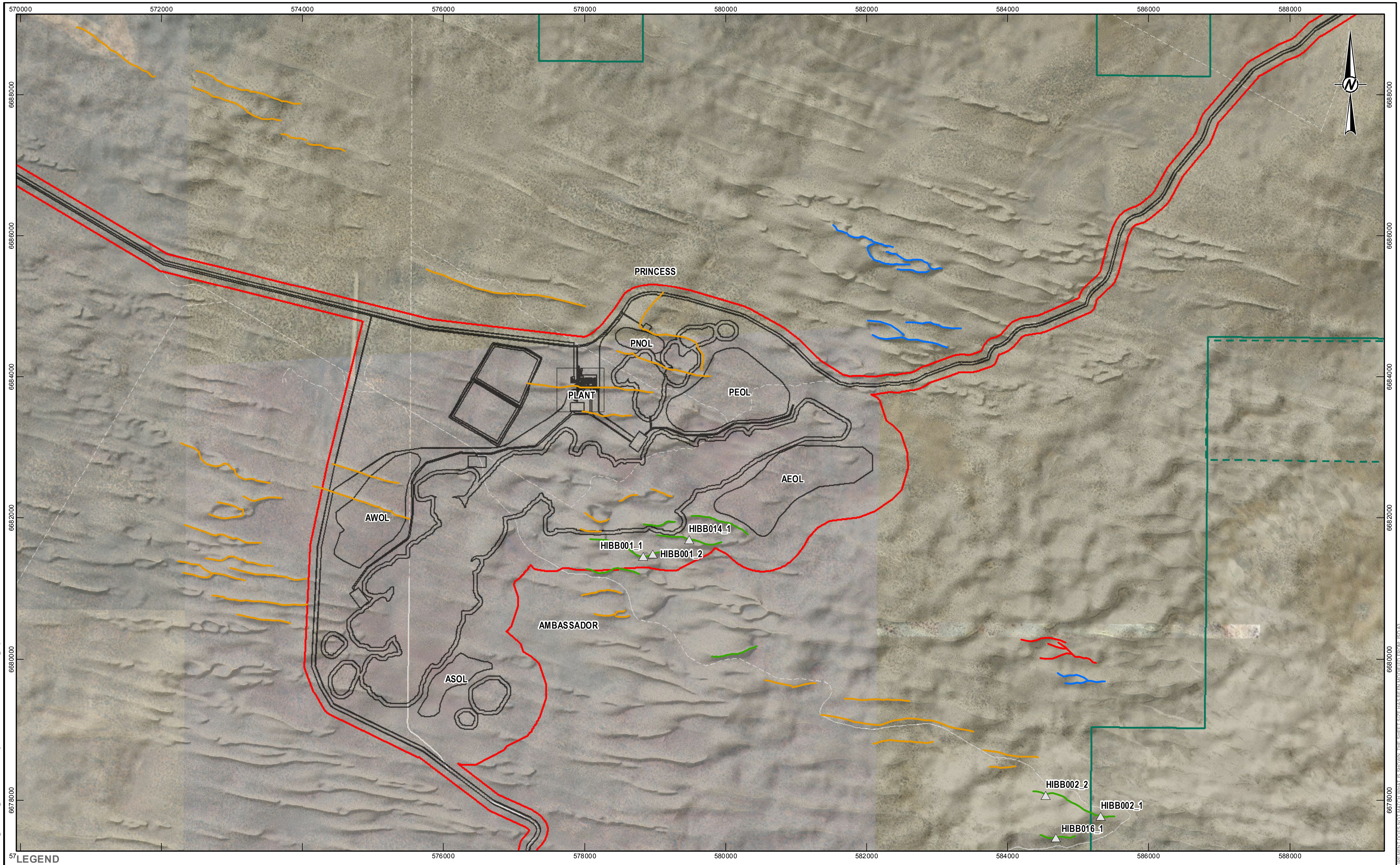
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
Hibbertia crispula **TARGETED SURVEY - EAMA AND MCPL DUNE TRAVERSE LOCATIONS**

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	9.1A



LEGEND

- MCPL Hc SITE CLUSTER
- EAMA TRAVERSE (Hc FOUND)
- EAMA TRAVERSE (NO Hc FOUND)
- MCPL TRAVERSE (NO Hc FOUND)
- NOT TRAVERSED
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

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TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
Hibbertia crispula TARGETED SURVEY - EAMA AND MCPL DUNE TRAVERSE LOCATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	9.1B

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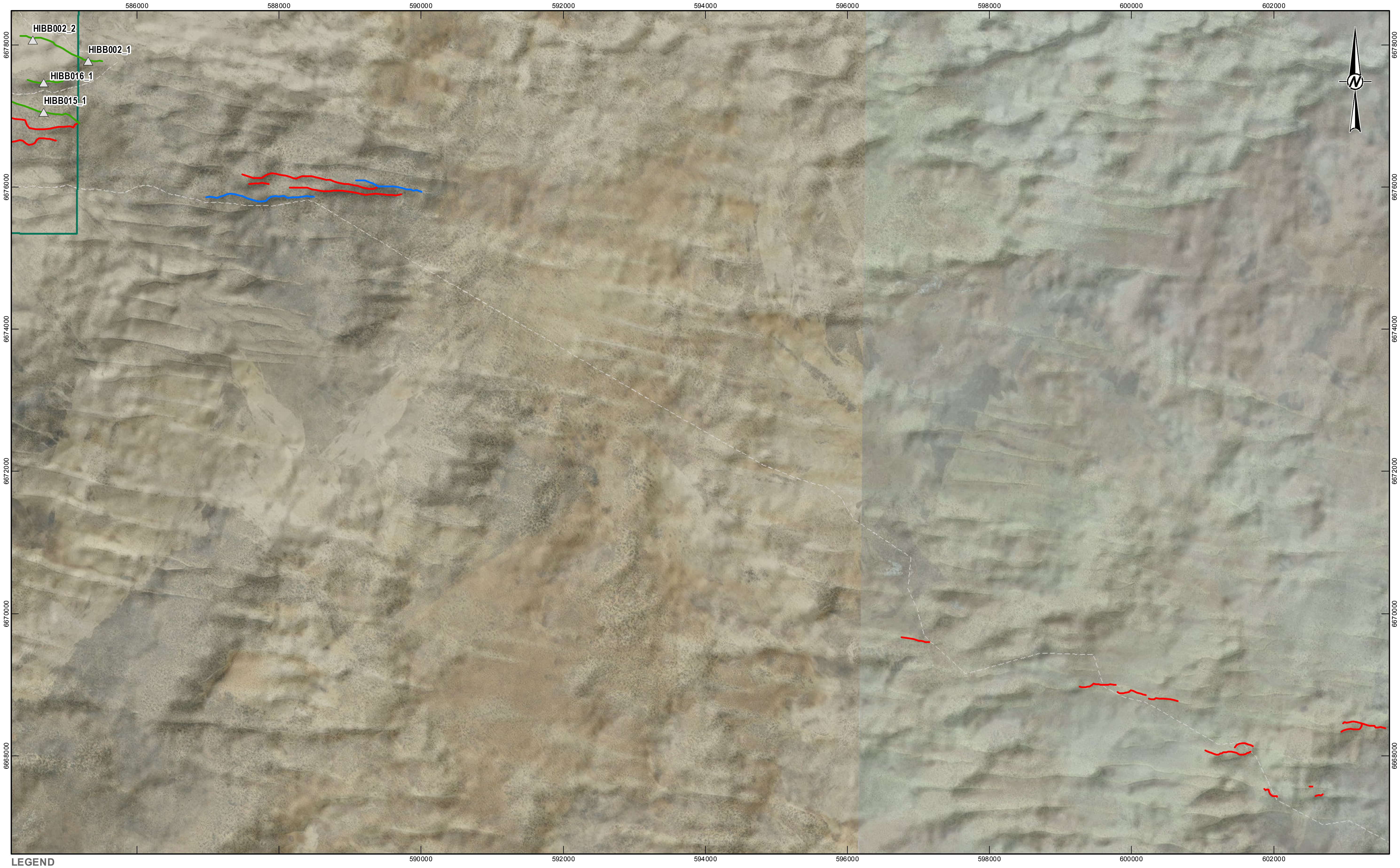

LEGEND

- MCPL Hc SITE CLUSTER
- EAMA TRAVERSE (Hc FOUND)
- EAMA TRAVERSE (NO Hc FOUND)
- MCPL TRAVERSE (NO Hc FOUND)
- NOT TRAVERSED
- MINOR ROAD/TRACK
- PROJECT BOUNDARY (MINING TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
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TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

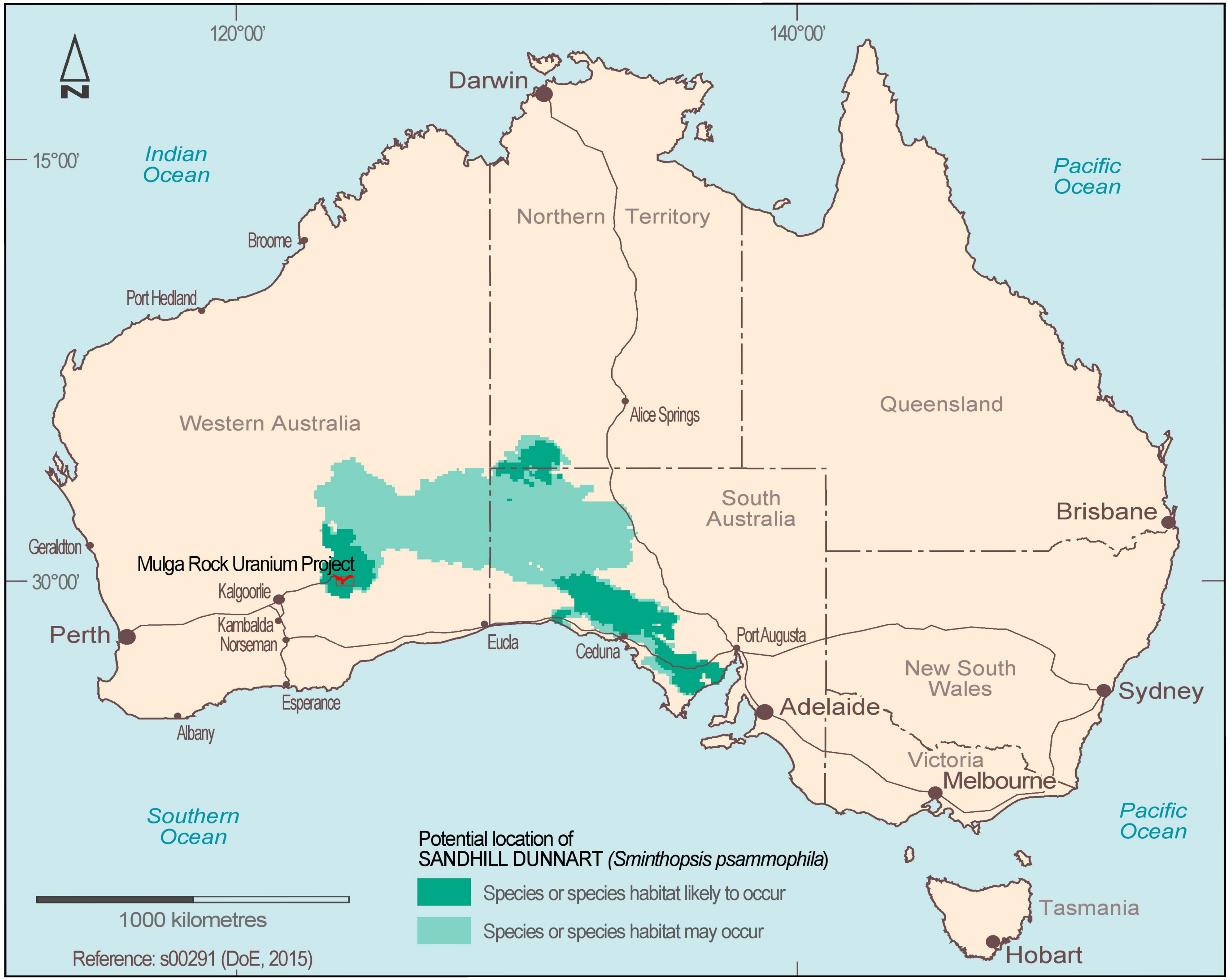
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
Hibbertia crispula **TARGETED SURVEY - EAMA AND MCPL DUNE TRAVERSE LOCATIONS**

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	9.1C



LEGEND

MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GCS GDA 1994

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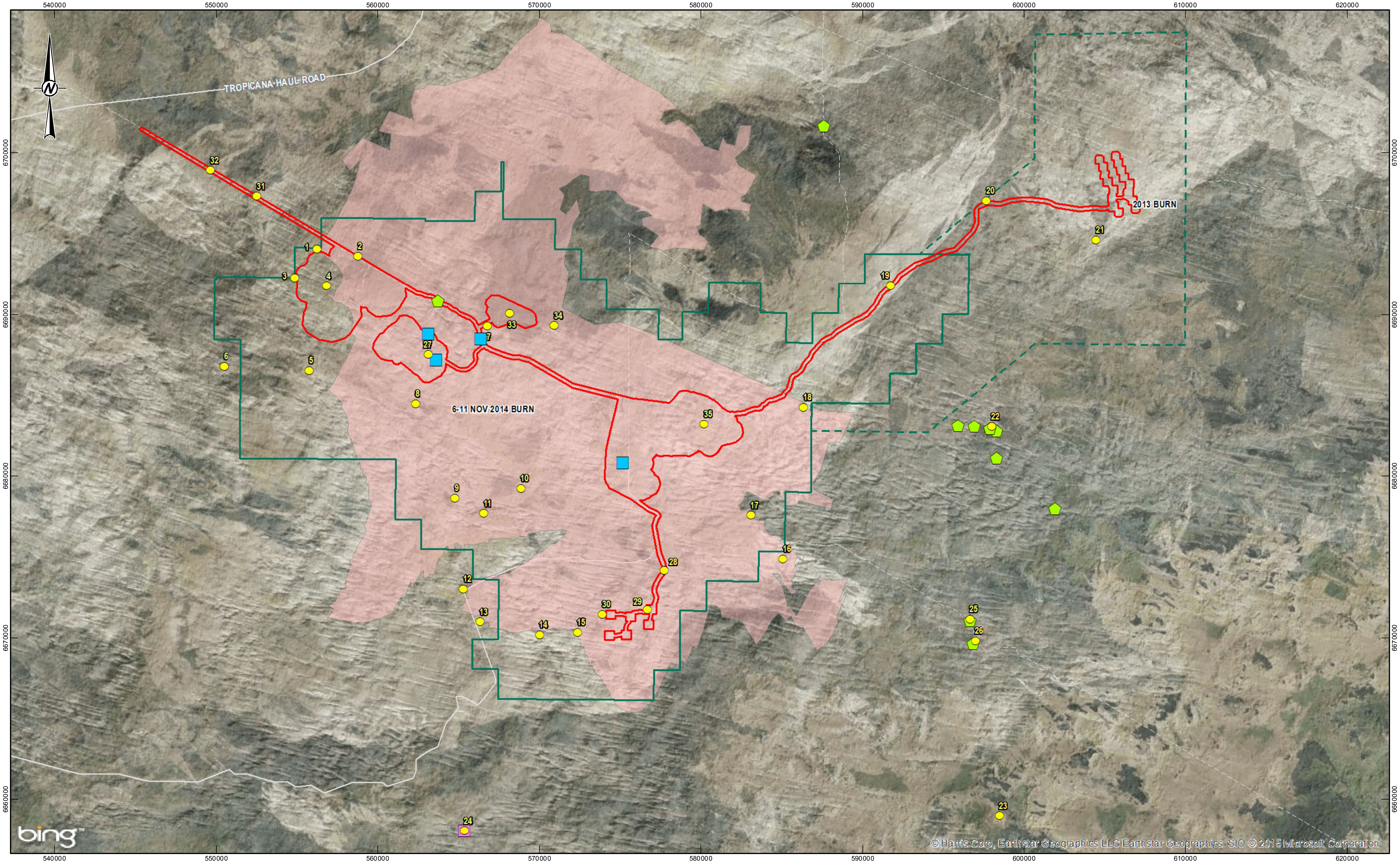
1:17,000,000 KILOMETRES

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT Golder Associates	YYYY-MM-DD 2015-10-31	TITLE NATIONAL DISTRIBUTION OF SANDHILL DUNNART	
	DESIGNED MS		
	PREPARED MS		
	REVIEWED GB	PROJECT NO. 1540340	CONTROL PER
	APPROVED GB	REV. 0	FIGURE 9.2



LEGEND

- PROPOSED 2015/2016 TRAPPING SITE
- PEARSON (CALM) SHD CAPTURE SITE
- MARTINICK & HART (1985) SHD CAPTURE SITE
- GAIKHORST & LAMBERT SHD CAPTURE SITE
- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- NOVEMBER 2014 FIRE SCAR

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
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CLIENT
VIMY RESOURCES LIMITED

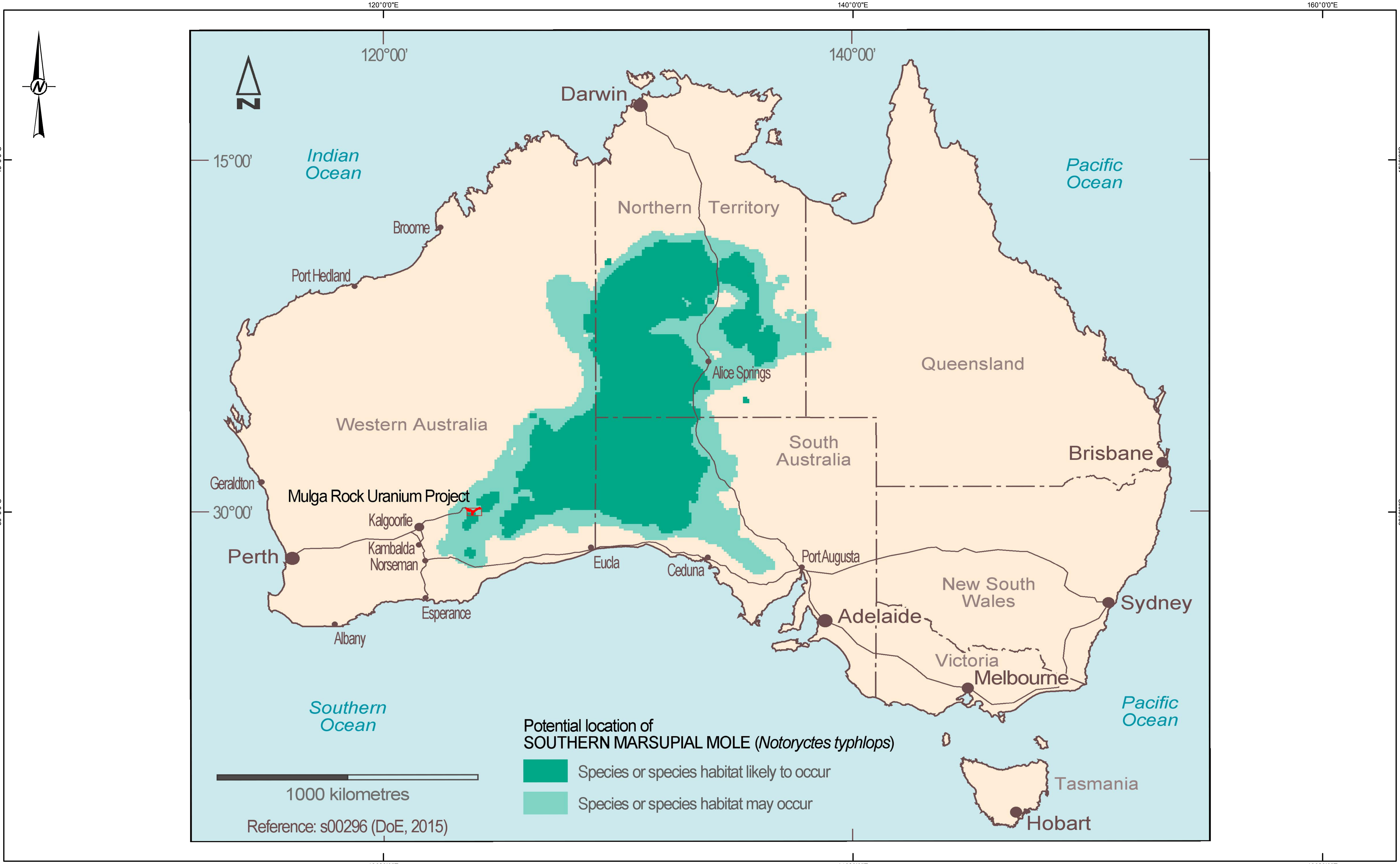
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
PROPOSED POST-2014 BURN TRAP SITES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	9.3



LEGEND

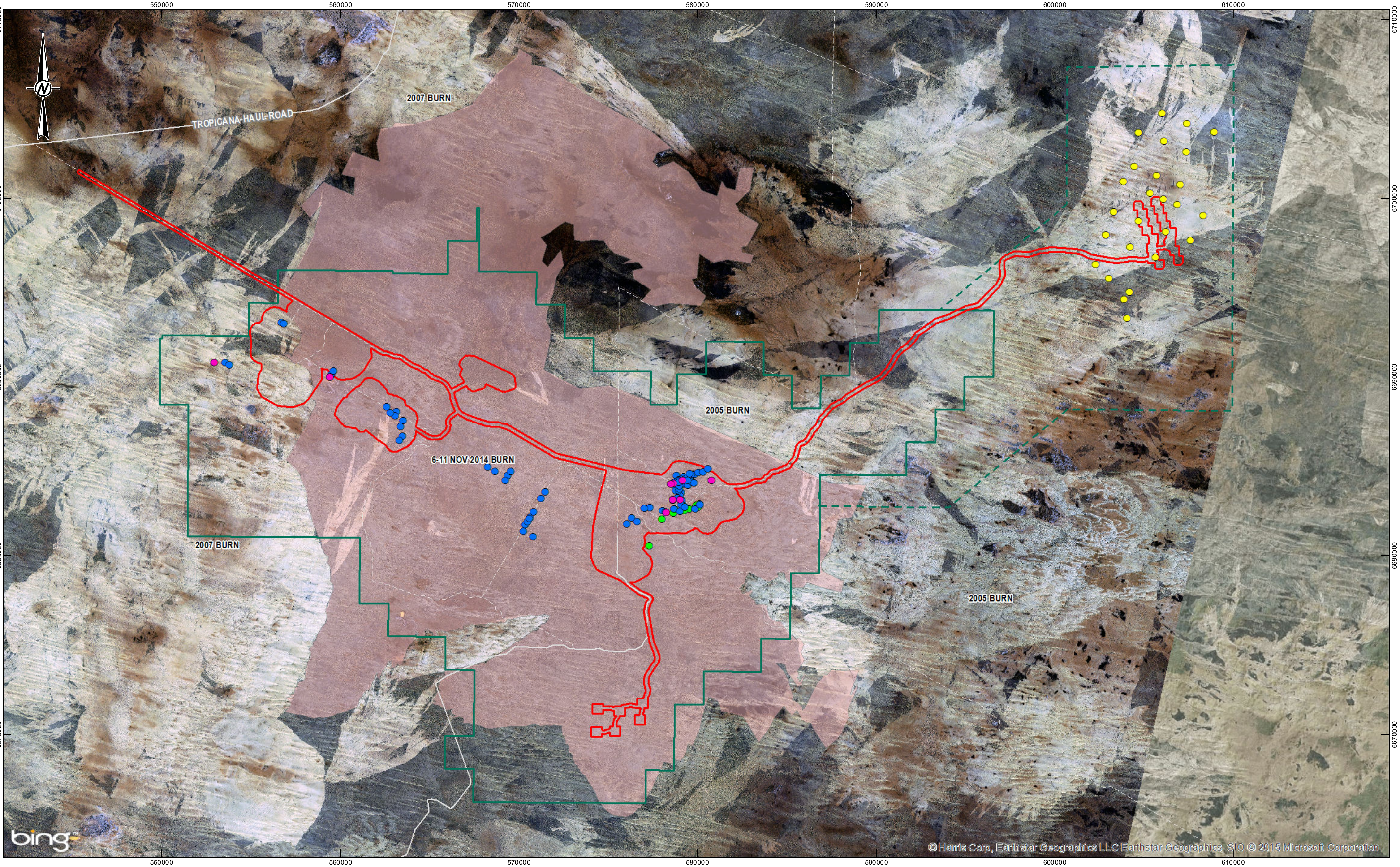
MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GCS GDA 1994

0 500 1,000
1:17,000,000 KILOMETRES

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT Golder Associates	YYYY-MM-DD: 2015-10-31 DESIGNED: MS PREPARED: MS REVIEWED: DCR APPROVED: DCR	TITLE **NATIONAL DISTRIBUTION OF SOUTHERN MARSUPIAL MOLE**	
PROJECT NO. 1540340	CONTROL PER	REV. 0	FIGURE **9.4**



LEGEND

- MOLEHOLE LOCATION
- 2010 TRENCH SURVEY
- 2012 TRENCH SURVEY
- 2013 TRENCH SURVEY
- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- NOVEMBER 2014 FIRE SCAR

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

2011 AERIAL IMAGERY AND INFRASTRUCTURE DATA PROVIDED BY CLIENT
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TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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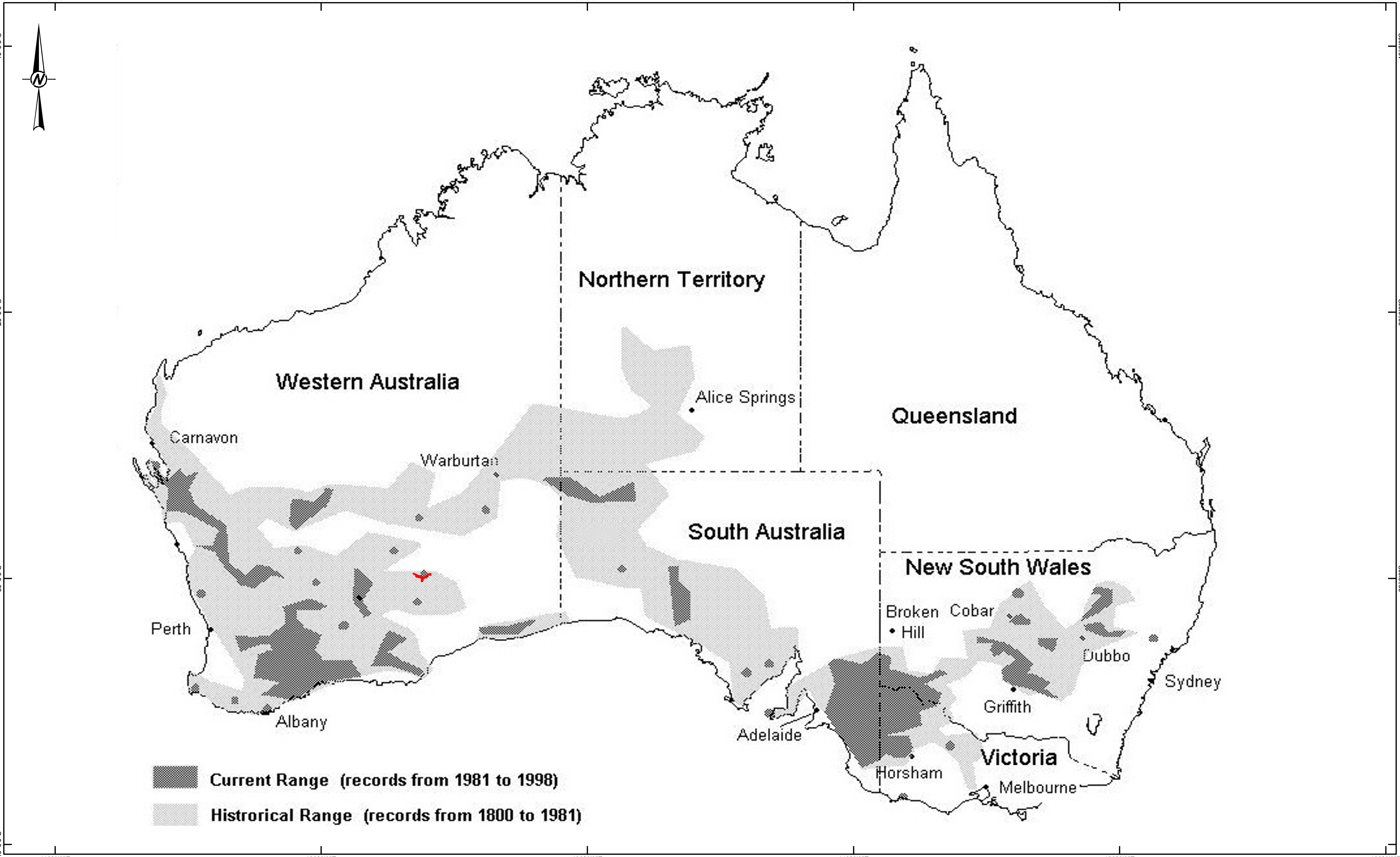
1:200,000 KILOMETRES

CLIENT	VIMY RESOURCES LIMITED
CONSULTANT	Golder Associates
YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB
PROJECT	MULGA ROCK URANIUM PROJECT
TITLE	SOUTHERN MARSUPIAL MOLE SURVEY TRENCH LOCATIONS
PROJECT NO.	1540340
CONTROL	PER
REV.	0
FIGURE	9.5



LEGEND

MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GCS GDA 1994

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1:15,000,000 KILOMETRES

CLIENT	VIMY RESOURCES LIMITED	PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT	Golder Associates	TITLE	CURRENT AND HISTORICAL RANGE OF MALLEEFOWL ACROSS AUSTRALIA (BENSHEMESH 2007)
YYYY-MM-DD	2015-10-30		
DESIGNED	MS		
PREPARED	MS		
REVIEWED	GB		
APPROVED	GB		

PROJECT NO.	CONTROL	REV.	FIGURE
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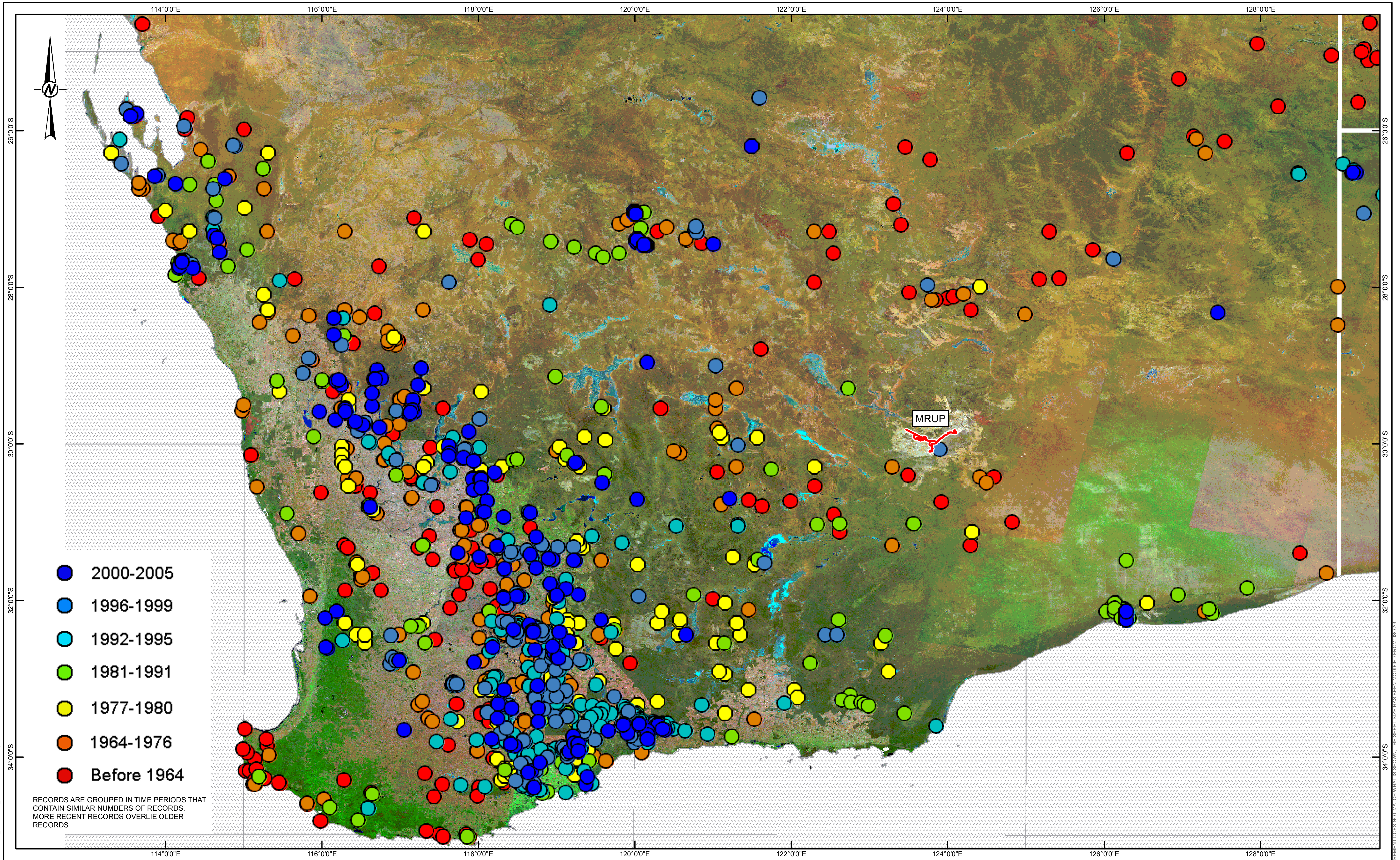

LEGEND

MRUP DEVELOPMENT ENVELOPE

NOTES

1. COORDINATE SYSTEM: GCS GDA 1994

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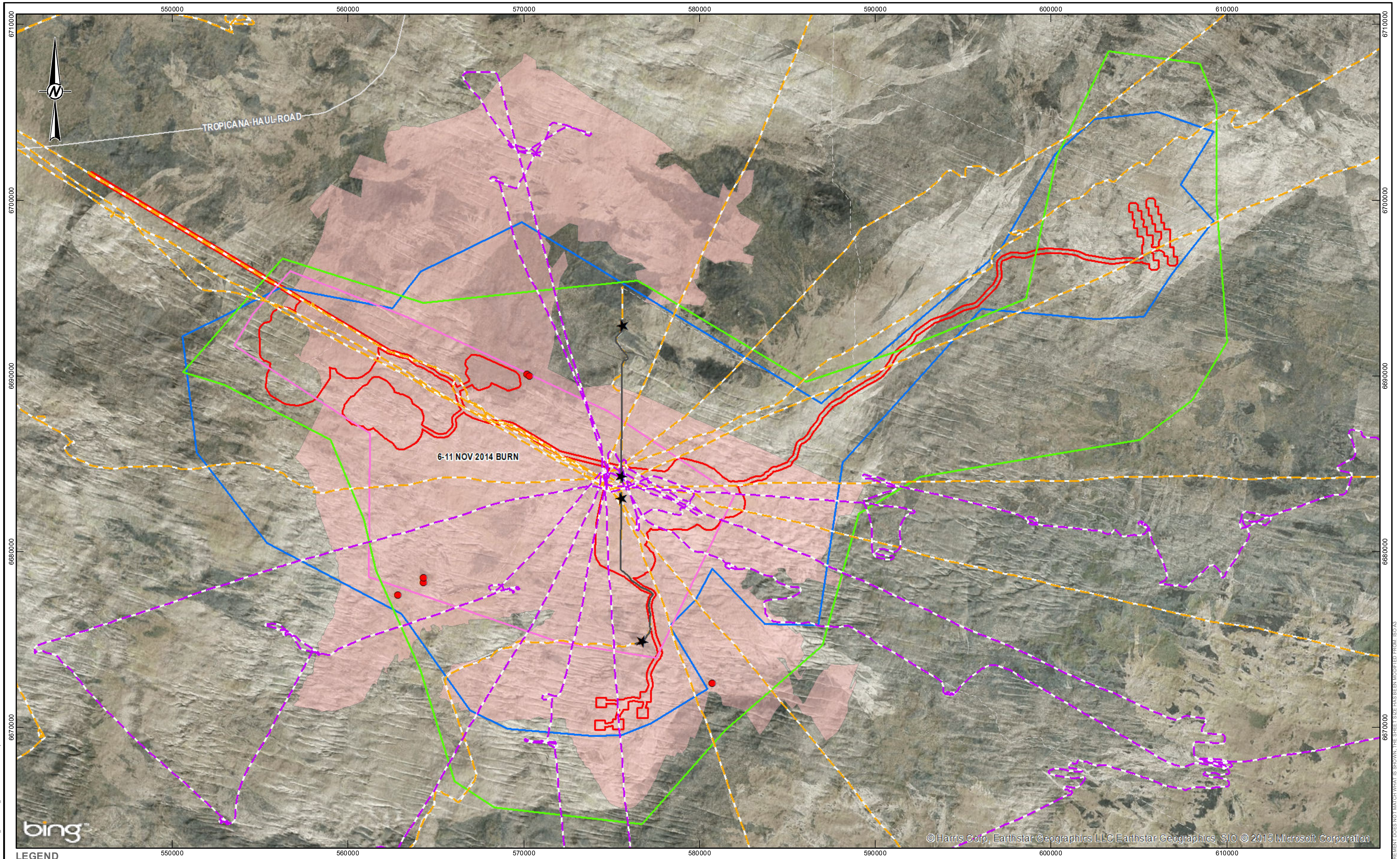
1:5,000,000 KILOMETRES

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT	YYYY-MM-DD: 2015-10-30 DESIGNED: MS PREPARED: MS REVIEWED: GB APPROVED: GB	TITLE **RECORDS OF MALLEEFOWL PRESENCE IN WESTERN AUSTRALIA TO 2005 (BENSHEMESH 2007)**	
		PROJECT NO. 1540340	CONTROL PER · REV. 0 · FIGURE 9.7



LEGEND

- TARGETED SURVEY 2014
- WCPL SANDPAD 2008-2014
- HELI SURVEY 2009
- HELI SURVEY 2010
- MINOR ROAD/TRACK
- ROAD
- VIMY SURVEY 2008-2014
- NINOX 2009
- MCPL 2008-2014
- MRUP DEVELOPMENT ENVELOPE
- NOVEMBER 2014 FIRE SCAR

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 5 10
1:200,000 KILOMETRES

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT Golder Associates	YYYY-MM-DD: 2015-10-31	TITLE **OUTLINE OF PROJECT DEVELOPMENT ENVELOPE AND AREAS SURVEYED FOR MALLEEFOWL: 2008-2014**	
	DESIGNED: MS		
	PREPARED: MS		
	REVIEWED: GB	PROJECT NO. 1540340	CONTROL PER
	APPROVED: GB	REV. 0	FIGURE **9.8**

10. Hydrological Processes

10.1 Relevant Environmental Objectives, Legislation, Policies and Guidelines

10.1.1 EPA Objective

The EPA applies the following objective to the assessment of proposals that may affect hydrological processes:

> *To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.*

In undertaking this assessment, Vimy has considered the relevant regulatory framework and other regulatory guidance as detailed below.

10.1.2 Regulatory Framework

The main potential impacts to hydrological processes associated with the project involve the following:

- Revised hydraulic gradients associated with the operation of an extraction borefield, dewatering of voids ahead of mining and a re-injection borefield, the latter being operated episodically.
- Long term drainage/seepage from tailings leachates from in-pit and surface facilities.

The protection of hydrological processes is covered by the following key statutes:

- *Rights in Water and Irrigation Act 1914* (WA) (RIWI Act).
- *Environmental Protection Act 1986* (WA) (EP Act).
- *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).

Rights in Water and Irrigation Act 1914

This is an Act relating to rights in water resources, which makes provision for the regulation, management, use and protection of water resources and for related purposes.

The Project involves the construction and operation of a borefield in order to obtain water for use in processing activity and to provide water for the accommodation village. The Proposal also involves dewatering the mining areas and reinjecting the dewatering water back into the same aquifer downstream. The production borefield and mine dewatering activities require licensing from the WA Department of Water (DoW) under the *Rights in Water and Irrigation Act 1914* (RIWI Act).

Environmental Protection Act 1986

This is an Act which is designed to protect the environment of the State which includes limiting any alteration of the environment to the detriment or potential detriment of an environmental value, which includes hydrological processes.

The Project proposes to reinject surplus dewatering water, not used for processing purposes and may require licensing from the WA Department of Environment Regulation (DER) under the *Environmental Protection Act 1986* (EP Act).

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Australian Government's key piece of environmental legislation which focuses on the protection of Matters of National Environmental Significance (MNES), of which there are nine matters with one being nuclear actions (including uranium mining).

The Project is a uranium mining project and the environment is considered a protected matter where nuclear actions are involved. Hydrological processes are considered part of the environment.

10.1.3 Other Relevant Guidance

There are non-legislated guidelines and polices that have been developed to ensure water resources are sustainable and protected while providing for economic and social development. These include:

- ANZECC and ARMCANZ 2000, National Water Quality Management Strategy Paper No.4: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Canberra, ACT. These guidelines help to establish whether the water quality of a water resource is good enough to allow it to be used for humans, food production or aquatic ecosystems (environmental vales).
- Department of Water 2009, Operational Policy No.5.12 – Hydrogeological Reporting Associated with a Groundwater Well License, Department of Water, Perth, November 2009. This policy provides guidance on when hydrogeological assessments and groundwater monitoring reports will be required and the information they should contain.
- Department of Water 2011, Operational Policy 5.08: Use of Operating Strategies in the Water Licensing Process, Department of Water, Perth. There are circumstances where the Department of Water requires the development and implementation of operating strategies as a supplement to licence conditions and this is detailed in this policy.
- Department of Water 2009, Operational Policy no.1.02 – Policy on water conservation/efficiency plans: Achieving water use efficiency gains through water licensing, Department of Water, Perth. Where there is a requirement to draft and implement an operating strategy (see above) the Department of Water will also require the inclusion of a water conservation/efficiency plan (WCEP) as part of that strategy in order to ensure the most efficient use of water and to minimise its use.
- Department of Water 2010, Operational policy 1.01 – Managed aquifer recharge in Western Australia, Department of Water, Perth. This policy outlines the Department of Water's position on managed aquifer recharge, and the requirements for proponents seeking to obtain approval for such a scheme.
- Department of Water 2013, Strategic policy 2.09 – Use of mine dewatering surplus. This policy outlines the State government's position on the use of mine dewatering surplus and describes how using this water as a resource may be facilitated.
- Department of Water 2013, Water licensing delivery series – Report No.12: Western Australian water in mining guideline, Perth, Western Australia. This is a guideline applying to mining projects undertaken across Western Australia (under the Mining Act 1978) which sets out how to meet the Department of Water's regulatory requirements for such projects.
- Government of Western Australia 2004, State Water Quality Management Strategy No. 6: Implementation Framework for Western Australia for the Australian and New Zealand Guidelines for Fresh and Marine Water Quality and Water Quality Monitoring and Reporting (Guidelines Nos. 4 & 7: National Water Quality Management Strategy), Perth, Western Australia. This document is part of the State Water Quality Management Strategy (SWQMS) and has been developed to implement the corresponding part of the National Water Quality Management Strategy (NWQMS) in Western Australian.

- Water Authority of Western Australia 1994, Goldfields Groundwater Area Management Plan. This plan allows for the mining of brackish and saline groundwater (managed depletion). Mining and mineral processing is considered to be the main beneficial use for the saline groundwater resources.

10.2 Existing Environment

Water resources in the MRUP can be divided into two categories: surface water and groundwater.

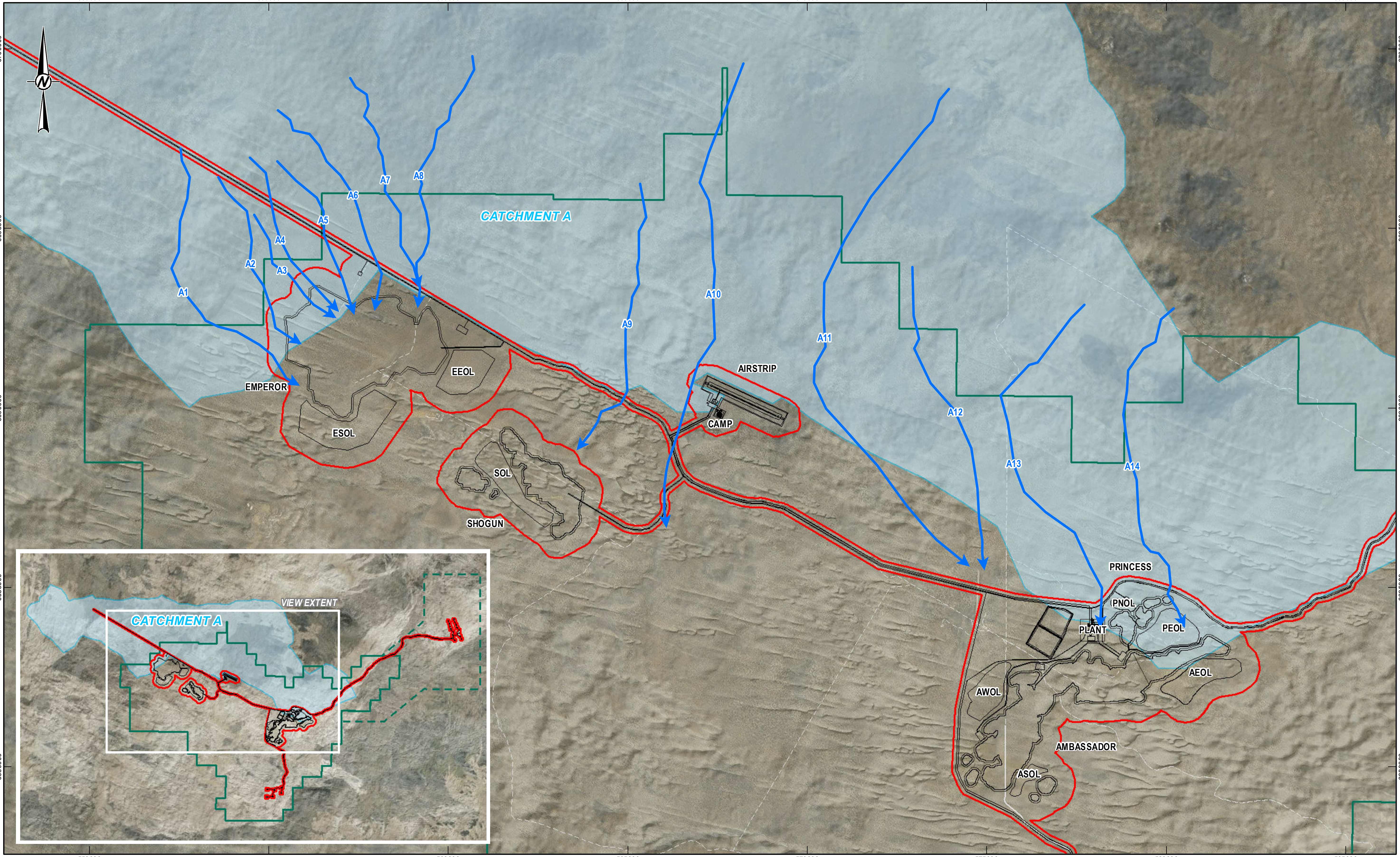
10.2.1 Surface Water

Due to the arid climate, deep water table (typically 30 to 50m below surface) and the porous nature of the soils in the Project area, there are no permanent or ephemeral surface water features. Surface water infrequently flows in the MRUP area, and there are no well-defined creeklines or river beds that indicate the existence of previous significant surface runoff flows. During high rainfall events there is some localised ponding in clay pan areas but the water either rapidly evaporates or infiltrates into the surface soils (Appendix D9). The entire region's landforms facilitate the internal drainage of surface water, as opposed to runoff.

The catchment upslope of the MRUP deposits generally slopes from an average elevation of about 400m AHD on the northern watershed boundary to an elevation of about 350m AHD over a distance of some 10km (Appendix D9). Catchment gradients are therefore low at around 0.5% and less. During a major rainfall event, it is probable that runoff would take the form of sheet flow (Figure 10.1), particularly following summer storms when the infiltration and permeability properties of the surface sands are appreciably less than the rainfall rate, resulting in infiltration-excess overland flow. It is important to note that any sheet flows are directed towards the topographic lows (clay pans), and this is highlighted in Figure 10.2.

Overall the land surface gradually slopes to the south and east (Figure 10.3), and activation of the surface drainage system resulting in surface water flows across the land surface only occurs in storm events exceeding a 1:100 year 72 hour event. This is supported by observations made during a recent high rainfall event in February 2011, when approximately 250mm of rainfall occurred over an eight day period, associated with the tail end of Cyclone Carlos, whereby the clay pans and topographic depressions filled without overtopping and flowing downstream (Plate 10.1 and Plate 10.2).

Given the temporary and sporadic nature of surface water accumulation and absence of defined surface water features within the MRUP, limited surface water quality data has been collected from within ephemeral clayey depressions to the northeast of the Mulga Rock East deposit, the only significant claypan within the project tenure area (10km or more from any proposed infrastructure), and from surface flows in the Ponton Creek, the downstream extension of the regional Lake Raeside drainage. Collection of this data is opportunistic in nature and not relevant to the assessment of the projects' Development Envelope and Disturbance Footprint.



LEGEND

- MINOR ROAD/TRACK
- ROAD
- DRAINAGE LINE
- CATCHMENT BOUNDARY
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
CATCHMENT BOUNDARY AND DRAINAGE LINES DIGITISED FROM ROCKWATER, JUNE 2015, Dwg. No. 345.0.1/15/1-1 and 345.0.1/15/1-2
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 1 2 3 4 5
1:100,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-06
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
CATCHMENT PLAN AND DRAINAGE LINES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	10.1

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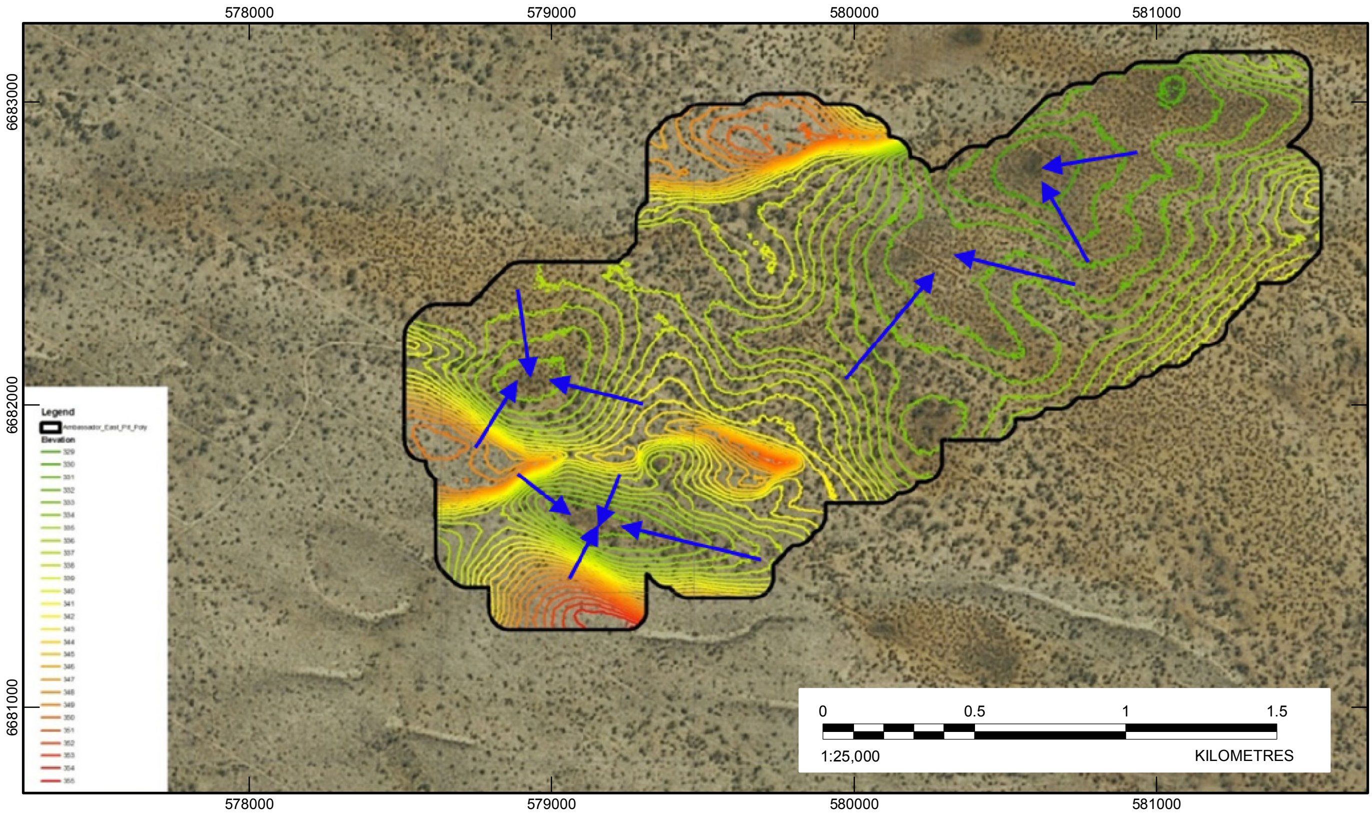
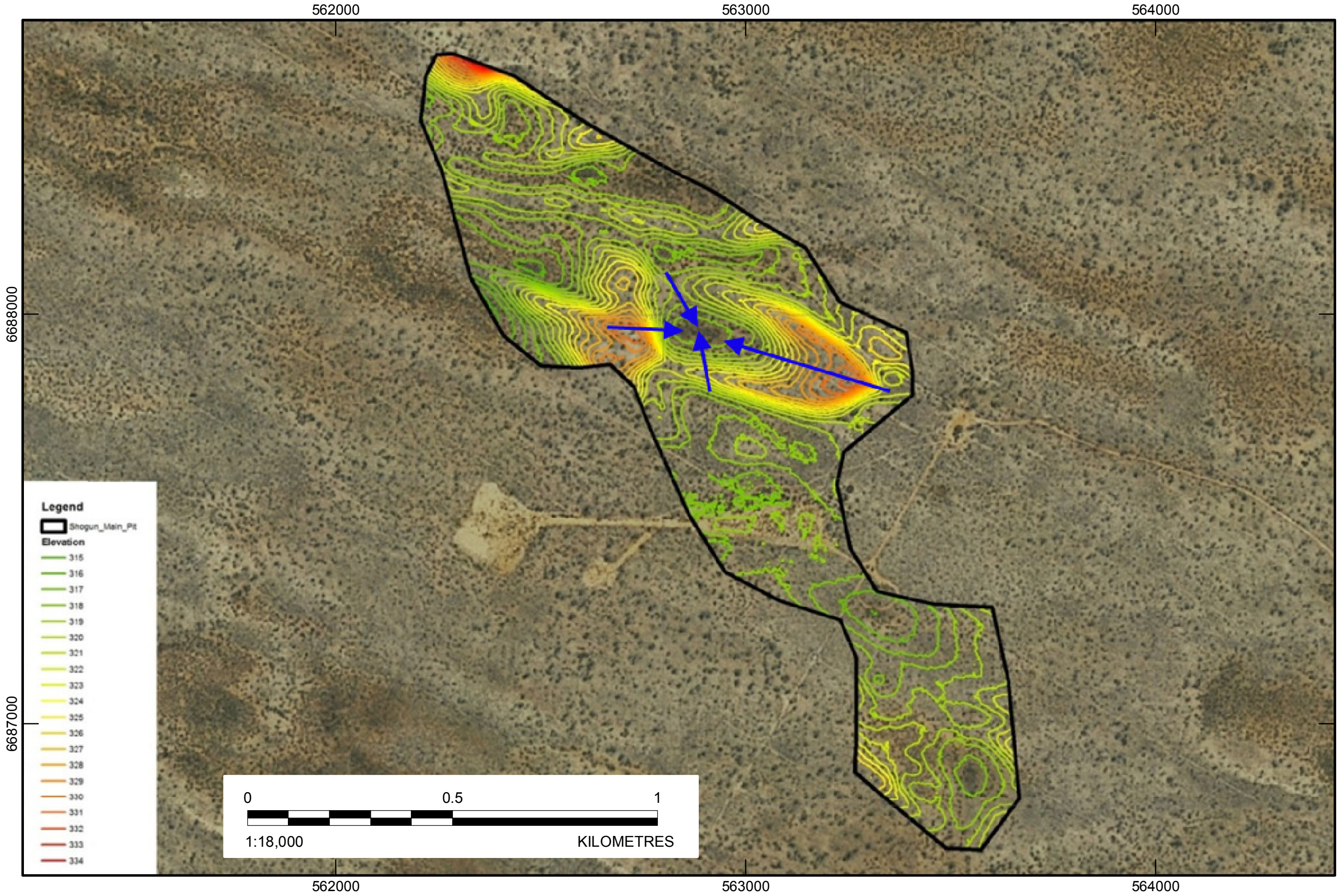
25mm





NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

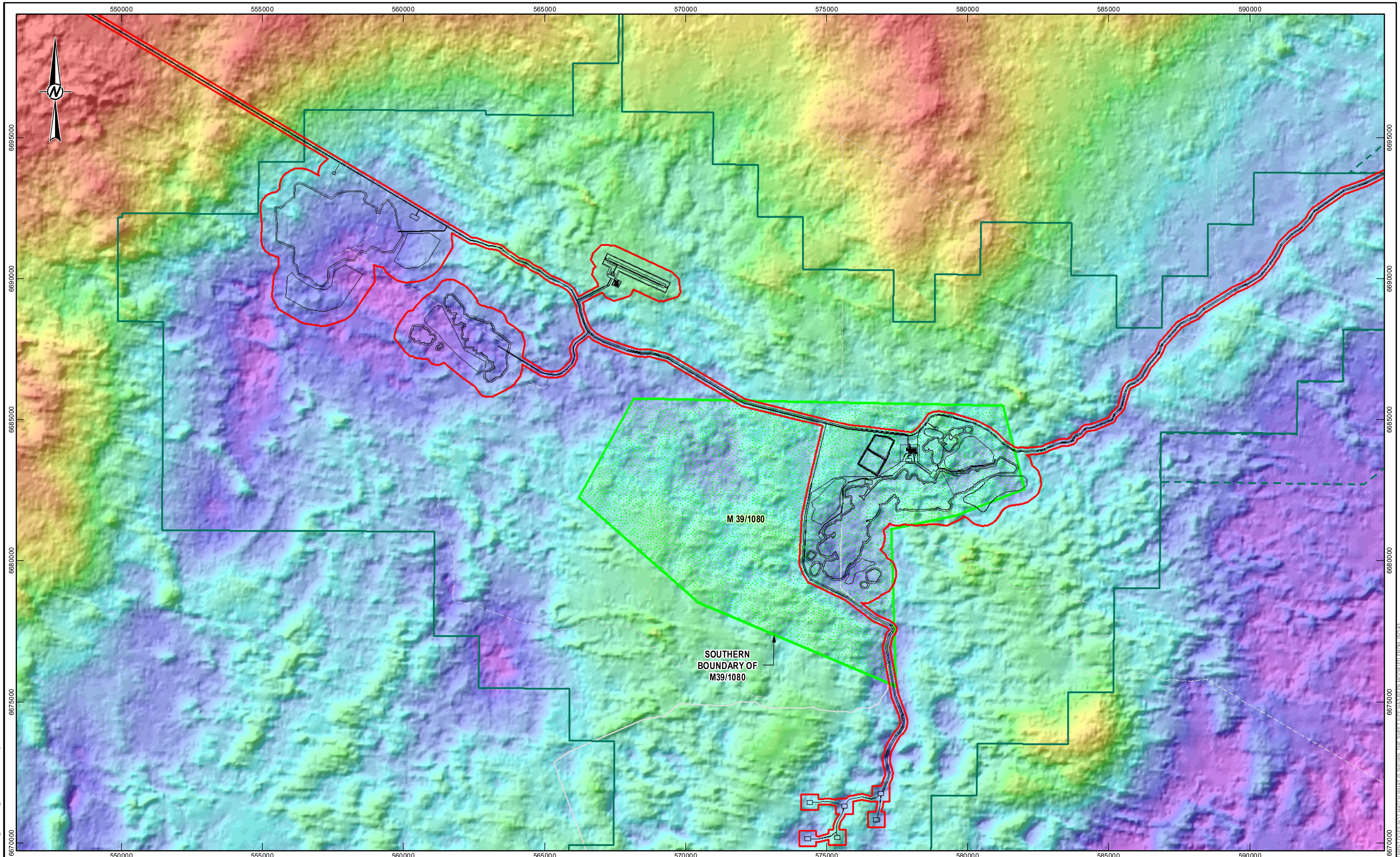
REFERENCE

BASE MAPS PROVIDED BY CLIENT

CLIENT		PROJECT
VIMY RESOURCES LIMITED	VIMY RESOURCES	MULGA ROCK URANIUM PROJECT

CONSULTANT			TITLE
Golder Associates	YYYY-MM-DD	2015-11-06	**LOCALISED SURFACE WATER FLOWS (BLUE ARROWS) WITHIN SELECTED AREAS OF THE AMBASSADOR AND SHOGUN AREAS**
	DESIGNED	MS	
	PREPARED	MS	
	REVIEWED	DCR	
	APPROVED	DCR	

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**10.2**



LEGEND

MINOR ROAD/TRACK

ROAD

GROUND ELEVATION (m AHD)

High : 449.657

Low : 303.599

INFRASTRUCTURE

MRUP DEVELOPMENT ENVELOPE

PROJECT BOUNDARY (MINING TENURE)

PROJECT BOUNDARY (MISCELLANEOUS TENURE)

PROJECT TENEMENT

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
TENEMENTS BOUNDARY © DEPARTMENT OF MINES AND PETROLEUM
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 1 2 3 4 5

1:125,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-10
DESIGNED	SAR
PREPARED	SAR
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SURFACE DIGITAL ELEVATION MODEL FOR THE MRUP

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	10.3

Plate 10.1 Localised flooding within a large claypan in the MRUP in response to Cyclone Carlos (March 2011, 563,371mE/6,676,628mN)

Data collected from areas of surface water ponding is characterised by high turbidity levels in the case of claypans and indicate TDS in the order of tens to hundreds of ppm 3-4 weeks after the rainfall (Plate 10.1).

By contrast, surface water samples collected from the ephemeral Ponton Creek show a rapid increase to about 2-3% TDS after a significant rainfall event, with salinity rapidly increasing to 10%TDS or greater within 3 months.

Plate 10.2 Localised short-term ponding within a topographic depression in the MRUP in response to Cyclone Carlos (March 2011, 585,720mE/6,684,938mN)

10.2.2 Groundwater

The following provides an overview of the groundwater resources in the Project area where there will be groundwater extraction and reinjection, and some drainage/seepage of tailings liquor to groundwater will take place. A schematic diagram showing the broad hydrogeological processes operating within the MRUP is provided in Figure 10.4.

Broadly, in the Project area two main aquifer systems occur:

- Valley-filled paleochannels, representative of the Mulga Rock aquifer system, which is similar to the existing Lake Minigwal, Lake Rebecca, Lake Raeside and Lake Rason. These aquifers generally contain hypersaline groundwater, which increases with distance downstream. They are bound laterally by the margins of the paleovalleys, consisting of poorly transmissive, older sedimentary lithified sediments at Mulga Rock. It is highly likely that groundwater hydraulic heads outside of the paleochannel system are higher than within it, inducing groundwater movement into the unconsolidated sedimentary sequences from the paleovalley flanks and underlying basement.

  Some fault-induced disruption of aquifers and associated groundwater flowpaths within that aquifer is likely at Mulga Rock, resulting in localised divergence between groundwater flows immediately below the water table and the deep axis of the paleochannel, consistent with a density and salinity layering of groundwaters.

- Graben style sandstone aquifers which tend to occur over the Albany-Fraser Province (AFP). By comparison, these are often shallower in depth below the surface than the valley-filled system, and experience greater recharge from infiltrating rainfall; hence, they tend to be brackish as their salinity is continually diluted by recharge.

Access and utilisation of these groundwater sources within the MRUP are outlined below.

Mining Areas (Extraction)

The Mulga Rock paleodrainage channel represents a valley-filled system that has been etched into the underlying Cretaceous and Permian-Carboniferous sediments. This drainage system represents an oxbow Eocene lacustrine system that is effectively cut-off from the Lake Raeside paleodrainage system draining part of the Yilgarn craton.

The location of the Mulga Rock paleodrainage channel and the mineralised sequences to be mined is shown in Figure 10.5. This main paleodrainage area is about 8 to 10km wide in the Project area and is believed to extend for at least 65km along its eastern arm. The water table in the main paleochannel area mostly sits at an elevation of about 288 to 290m AHD or about 30-50m below ground level and has a very flat gradient. Figure 10.6 shows the groundwater elevation contours, with the figure extending further south than on Figure 10.5. Seasonal variations in groundwater level are small and most recharge may be episodic during occasional large summer storms, the overall rate of recharge being low. The rate of groundwater movement across the area is low, shown by the low hydraulic gradient and as a consequence of the low recharge rate. However the gradient of the water level suggests that there is minor flow into the basin from the northeast, i.e. the tributary paleochannel and an even smaller amount flowing in from the northwest. Relevant to this project, and to the movement of tailings liquor in the long term, is the gradient that indicates groundwater movement occurs to the south as indicated on Figure 10.5.

The initial mining area (Mulga Rock East (MRE) which comprises the proposed Princess and the much larger Ambassador Pits) sits in a tributary paleochannel where the groundwater level is higher than the main paleochannel, at up to 300m AHD, and between 29 and 49m below ground level. The groundwater in this area moves south towards the main paleochannel.

Mining in the latter years (Mulga Rock West (MRW) which comprises the proposed Emperor and Shogun Pits) will take place in an area that sits in the area of low water table gradient within the main paleochannel and waters characterised by greater salinity and lower pH.

The rate of groundwater extraction for dewatering the mining area is dependent upon the mining schedule and particularly the depth of mining below the water table. The corresponding H3 hydrogeological model (Appendix D2) suggested that it would vary between 0.1 and 1.5GL/a. This dewatering water will be used for in-pit processing activities and for dust suppression. When the rate of groundwater extraction exceeds these uses, estimated at around 0.85GL/a, the surplus will be injected in a borefield to the south of the MRE (Figure 10.5).

Kakarook North (Extraction)

The Kakarook North groundwater resource represents a graben-style aquifer system located approximately 30km northeast of the initial mining area (Figure 10.7). This sandstone aquifer has a saturated thickness up to 35m and the basin has been investigated along some 16km of its length (and it is open in both directions) and between 5 and 8km wide. This aquifer is recharged directly by infiltrating rainfall, and consequently is brackish to slightly saline (2,400 to 8,800mg/L Total Dissolved Solids (TDS)). The lower salinity of this groundwater is critical to sustain the proposed process flowsheet, as the proposed ion-exchange resin to be used to extract the uranium is sensitive to elevated chloride (Cl^-), and when Cl^- levels exceed 10g/L the Cl^- starts to compete with the uranium for exchange sites on the resin, reducing the efficacy of the extraction process to the extent that it might no longer be economic.

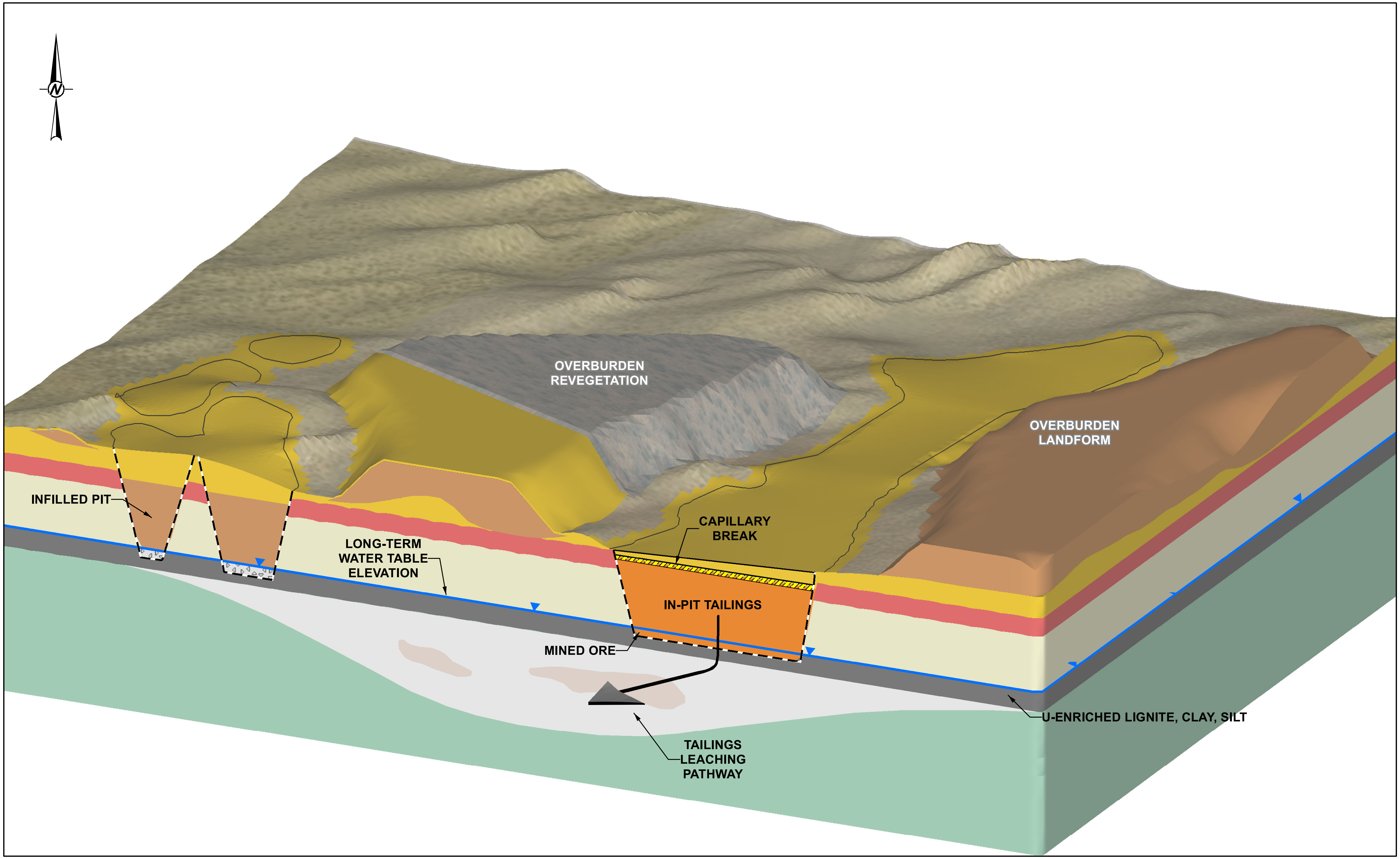
Preliminary estimates suggest that groundwater abstraction for process water will occur at an average rate of 1.8GL/a and that the aquifer has a proven resource of around 167GL; this represents over 90 years of the required supply (Appendix D1), not accounting for natural recharge.

It is important to note that the Mulga rock paleodrainage channel, including the tributary hosting the Ambassador and Princess Deposits is geologically and hydraulically separated based on the studies conducted to date. Consequently, any impacts on either the paleodrainage aquifer in response to mining operations or groundwater abstraction for processing purposes will not impact on the reciprocal source.

Reinjection Borefield (Reinjection)

It is intended that reinjection of surplus water will take place into the main Mulga Rock paleochannel aquifer about 12km south of the Ambassador deposit (Figure 10.5). This is the lateral equivalent of the aquifer that underlies the Emperor and Shogun deposits being mined, but more saline and acidic downstream of the groundwater present in the Ambassador and Princess proposed pits. The surplus groundwater will be reinjected into the more transmissive base of the aquifer, i.e. at a greater depth than that at which mining will take place. The salinity of the reinjected water will be slightly lower than in the aquifer at the reinjection borefield. Current modelling suggests that reinjection will only be required in about two years out of sixteen, when the rate of dewatering is predicted to exceeds around 0.85GL/a. The projected volumes for reinjection suggest that the amount reinjected is unlikely to exceed 0.8GL/a in the years when it is required (Appendix D2).

Importantly, where mounding is found to be a problem (in that it exceeded modelled expectations), the local geology of the chosen reinjection borefield area will afford greater flexibility in the reinjection schedule, with a currently thick unsaturated clean sand sequence overlying the main aquifer. Depending on design considerations, this has the potential to act as an overflow and greatly reduce any mounding and potential clogging of the borefield, and preventing interaction between rootstock and brines (Figure 10.8).



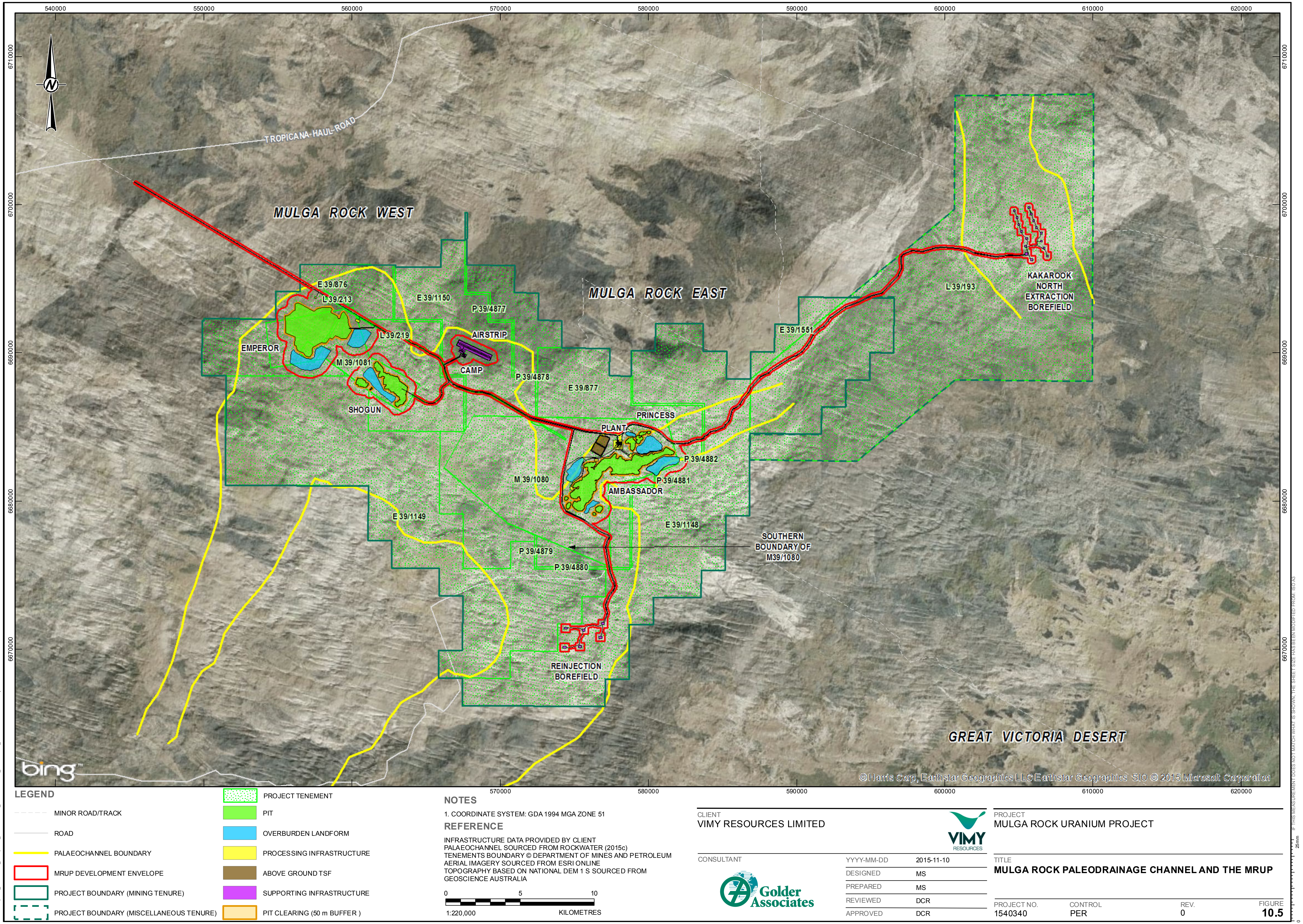
LEGEND

- QUATERNARY SEDIMENTS
- MIOCENE SEDIMENTS
- OXIDISED EOCENE SEDIMENTS
- U-ENRICHED LIGNITE, CLAY, SILT
- REDUCED EOCENE SEDIMENTS
- HIGH PERMEABILITY BASAL SAND
- PERMIAN SEDIMENTS (BASEMENT)
- CAPILLARY BREAK
- MIXED BASAL OVERBURDEN & BENEFICIATED SAND PREFERENTIALLY PLACED AT BASE OF PIT

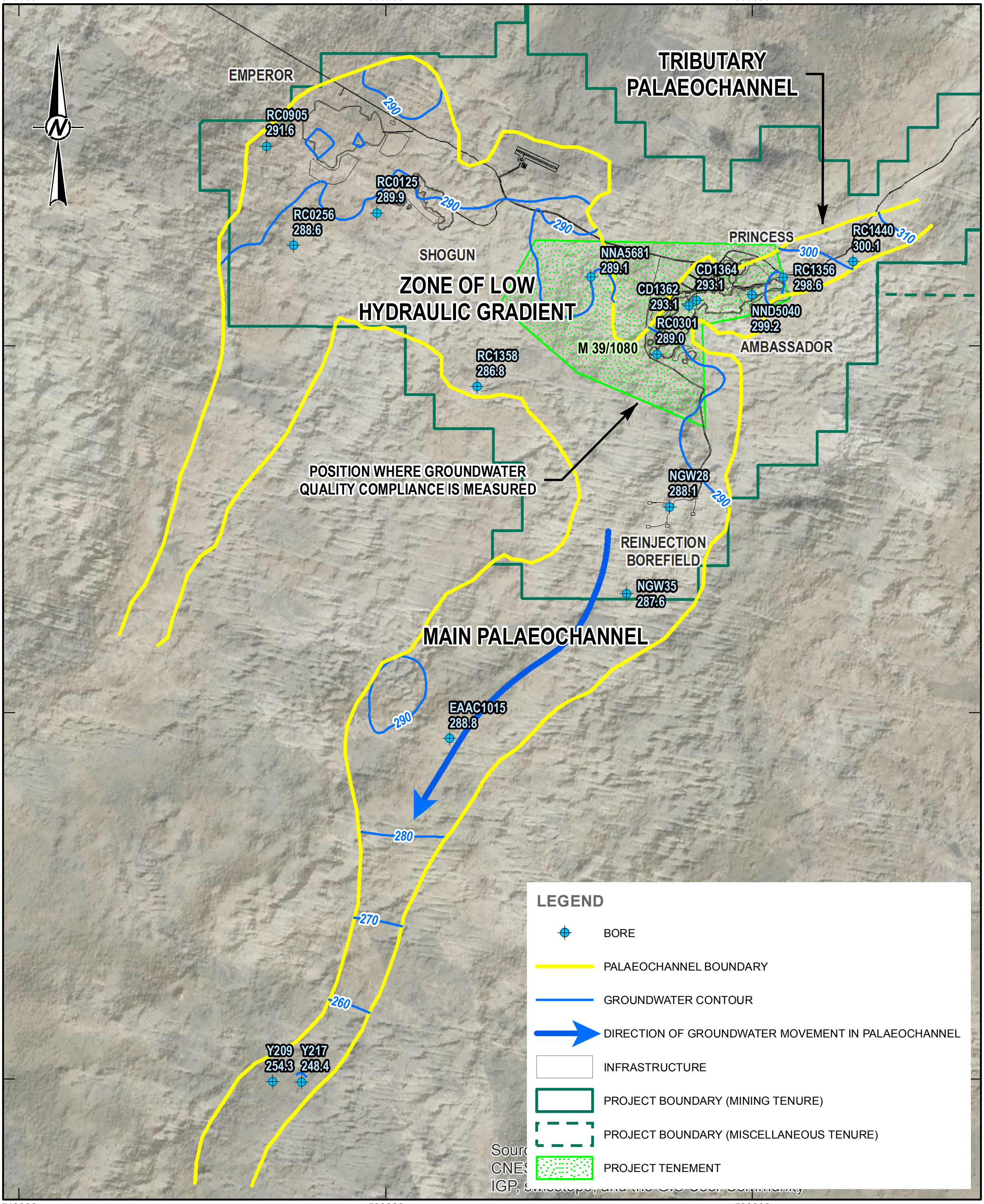
NOTES

MODEL IS SCHEMATIC.

CLIENT	VIMY RESOURCES LIMITED	PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT	Golder Associates	TITLE	BLOCK MODEL ILLUSTRATING SEEPAGE FROM IN-PIT TAILINGS STORAGE
YYYY-MM-DD	2015-11-05	PROJECT NO.	1540340
DESIGNED	SAR	CONTROL	PER
PREPARED	SAR	REV.	0
REVIEWED	DCR	FIGURE	10.4
APPROVED	DCR		



MULGA ROCK WEST
MULGA ROCK EAST
TROPICANA HAUL ROAD
GREAT VICTORIA DESERT
E 39/876
L 39/213
L 39/219
E 39/1150
P 39/4877
AIRSTRIP
CAMP
EMPEROR
M 39/1081
SHOGUN
P 39/4878
E 39/877
PRINCESS
PLANT
P 39/4882
P 39/4881
AMBASSADOR
M 39/1080
E 39/1149
E 39/1148
P 39/4879
P 39/4880
SOUTHERN BOUNDARY OF M39/1080
REINJECTION BOREFIELD
E 39/1551
L 39/193
KAKAROOK NORTH EXTRACTION BOREFIELD
© Harris Corp, Earthstar Geographics LLC Earthstar Geographics SIO © 2015 Microsoft Corporation
LEGEND
MINOR ROAD/TRACK
ROAD
PALAEOCHANNEL BOUNDARY
MRUP DEVELOPMENT ENVELOPE
PROJECT BOUNDARY (MINING TENURE)
PROJECT BOUNDARY (MISCELLANEOUS TENURE)
PROJECT TENEMENT
PIT
OVERBURDEN LANDFORM
PROCESSING INFRASTRUCTURE
ABOVE GROUND TSF
SUPPORTING INFRASTRUCTURE
PIT CLEARING (50 m BUFFER)
NOTES
1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51
REFERENCE
INFRASTRUCTURE DATA PROVIDED BY CLIENT
PALAEOCHANNEL SOURCED FROM ROCKWATER (2015c)
TENEMENTS BOUNDARY © DEPARTMENT OF MINES AND PETROLEUM
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA
1:220,000
KILOMETRES
CLIENT
VIMY RESOURCES LIMITED
CONSULTANT
Golder Associates
YYYY-MM-DD 2015-11-10
DESIGNED MS
PREPARED MS
REVIEWED DCR
APPROVED DCR
PROJECT
MULGA ROCK URANIUM PROJECT
TITLE
MULGA ROCK PALEODRAINAGE CHANNEL AND THE MRUP
PROJECT NO. 1540340
CONTROL PER
REV. 0
FIGURE 10.5



NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
PALAEOCHANNEL AND CONTOURS SOURCED FROM ROCKWATER (2015c)
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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1:300,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

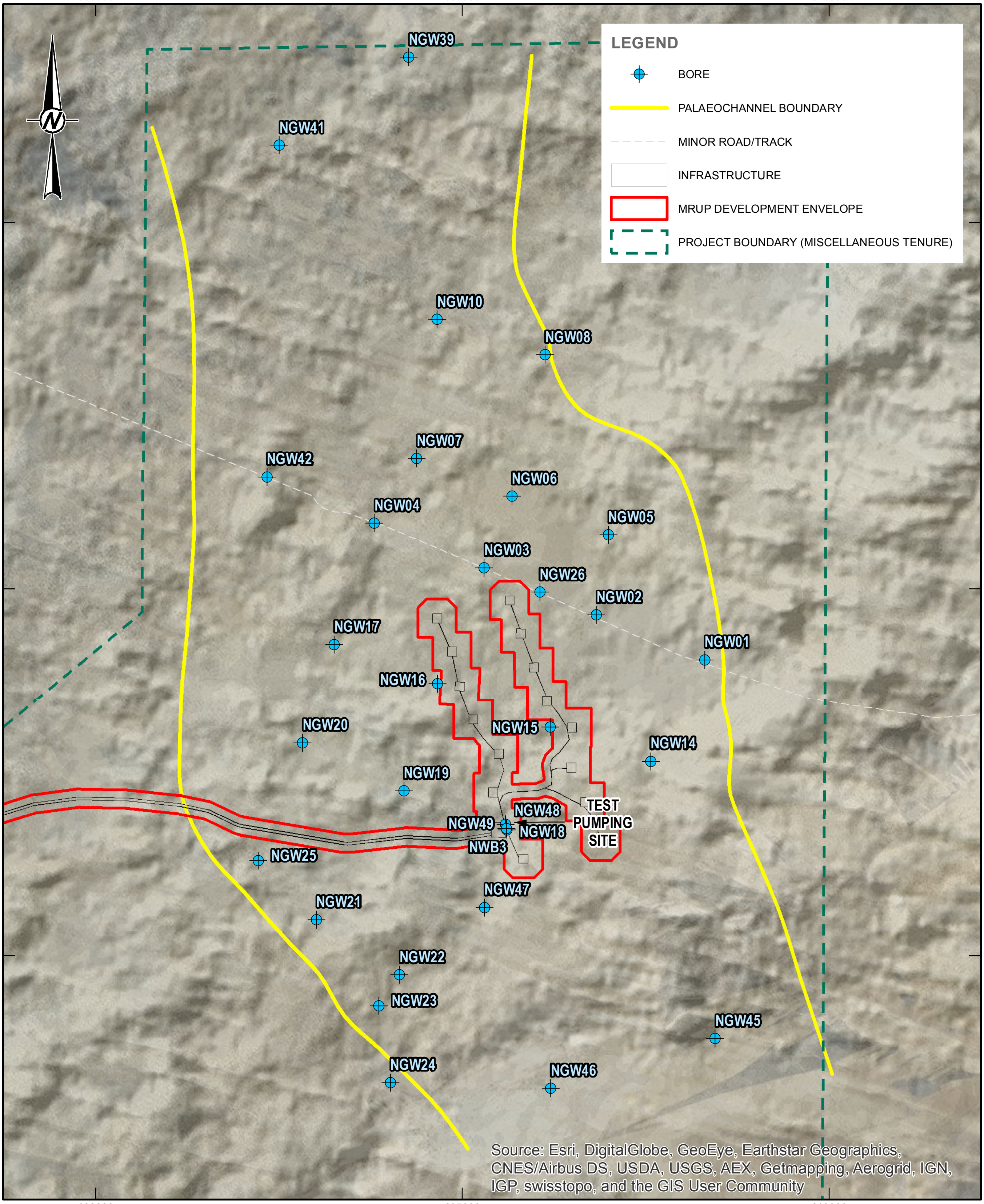
PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT

YYYY-MM-DD	2015-11-05
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

TITLE
GROUNDWATER ELEVATION CONTOURS AND HYDROGEOLOGICAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	10.6



NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
PALAEOCHANNEL DATA SOURCED FROM ROCKWATER (2015d)
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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1:75,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

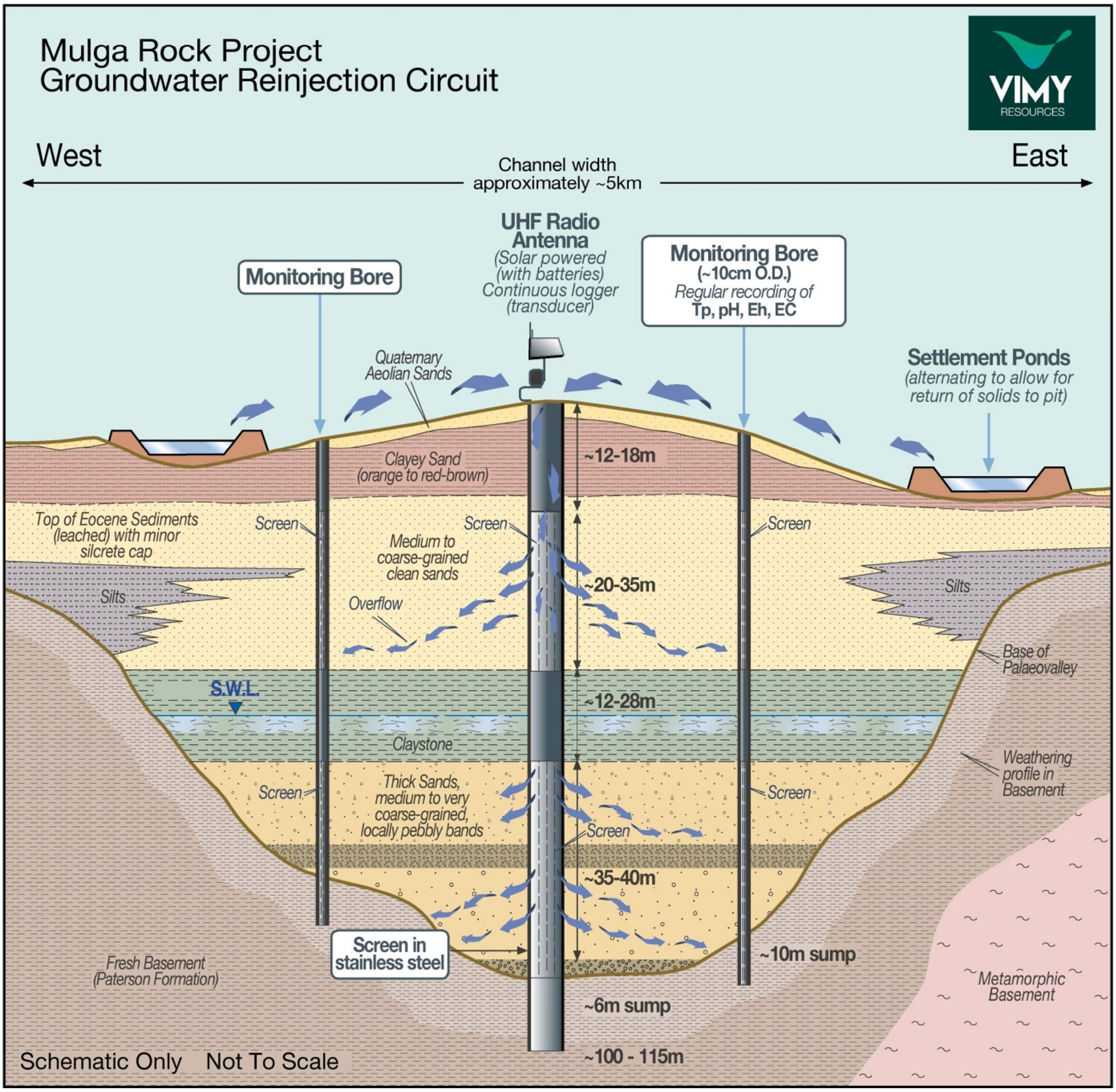
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-05
DESIGNED	MS
PREPARED	MS
REVIEWED	JDW
APPROVED	JDW

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
KAKAROOK NORTH BORE LOCATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	10.7



CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT Golder Associates	YYYY-MM-DD: 2015-11-10	TITLE **SCHEMATIC DESIGN CRITERIA FOR PROPOSED REINJECTION BOREFIELD**	
	DESIGNED: MS		
	PREPARED: MS		
	REVIEWED: DCR	PROJECT NO. 1540340	CONTROL PER
	APPROVED: DCR	REV. 0	FIGURE **10.8**

10.3 Surveys and Investigations

10.3.1 Surface Water

Rockwater (Appendix D9) was commissioned by Vimy to undertake an assessment of surface water hydrology in the area of the MRUP. This investigation identified the regional catchment area that could impact on the planned pits; this catchment area totalled 550km^2 comprising largely flat land (with slopes of around 0.5% and less) with porous soil and no well-defined stream channels into which surface runoff and discharge downstream through the Project area (Appendix D9).

Contour data was analysed to define flow paths to which surface runoff would discharge following more extreme storm events (when some rainfall excess could occur) and local catchment areas that could contribute to discharge at the minesite were also delineated. This analysis indicated there were 14 possible drainage lines that could potentially convey runoff into the Project area (Figure 10.1). However, with infiltration loss rates likely to be in excess of 40mm/h, and possibly exceeding 100mm/hr (Appendix D9), only minimal residual flows would be expected to reach the mining area during more extreme storms on the upslope catchments (Appendix D9). Design rainfall intensities were also assessed, with maximum hourly design rainfalls for the 100 year average recurrence interval (ARI) being around 42mm. Shorter duration storm intensities are higher, although the total rainfall depths for ARIs up to 100 years remain less than the likely local infiltration losses. Twelve local catchment areas were also identified in the immediate vicinity of the pits and associated infrastructure and although infiltration losses would also result in most water being lost some residual flows could reach the pits and infrastructure during more extreme storms due to their close proximity. However most of these flows would be retained locally in depressions upstream of the pits (Appendix D9).

Hydraulic analyses were also undertaken to assess likely flow depths and flow velocities associated with runoffs during more extreme storms in the vicinity of the pits and local infrastructure. This analysis indicated that runoff flowing towards the pits and other infrastructure will pond in upslope depressions, either evaporating of infiltrating into the ground.

The analysis undertaken by Rockwater suggested that overall no major flood mitigation measures were required to protect mine pits and infrastructure (Appendix D9).

10.3.2 Processing Groundwater Supply (Kakarook North Borefield)

Rockwater (Appendix D1) investigated groundwater resources in the proposed borefield area (Figure 10.7). The investigation involved the drilling of 53 holes in the greater Kakarook area, of which 29 were investigation/monitoring bores in the ‘Kakarook North’ area. The sedimentary trough hosting this groundwater appears to extend in length for about 16km (and possibly much longer), varies in width between 5 and 8km and is regarded as hydraulically separate from aquifers at the areas to be mined.

The Kakarook North borefield area is expected to be the main source of supply of relatively low salinity / low Cl^- water for the duration of the Project. Accordingly, a single production bore (NBW3) was constructed close to two existing boreholes (NGW48 and NGW49) in a central part of the proposed borefield area (Figure 10.7). The quality and capacity of water in this production bore is described below.

The salinity of the groundwater in the Kakarook North area is brackish, with the total dissolved solids (TDS) ranging from 1,542mg/L up to 24,400mg/L, with a median of 4,700mg/L. The higher salinities were mostly found at the edges of the trough where the aquifer is thinnest. The fresher groundwater was mostly found near the middle of the aquifer where it is at its thickest (Appendix D1). The groundwater was found to be mildly acidic to slightly alkaline, with pH values ranging from 5.0 to 7.7, potentially reflecting the high recharge rates of infiltrating rainfall.

Drilling results outside the Kakarook North area suggest that the aquifer may extend north, south and to the southwest where another smaller sedimentary trough is located, and waters of comparable quality have been identified.

The production bore (NBW3) was test pumped for 48 hours at a rate of 600kL/d, with recovery measurements for another 2 days. The extracted water was discharged into an unlined dam built around 30m from the bore and was observed to rapidly infiltrate into the sand. After 16-17 hours the drawdown rate reduced, interpreted as recirculation to the aquifer of the water infiltrating from the nearby dam (Appendix D1). This behaviour supports the notion that there may be recharge to the aquifer following a sufficiently large rainfall event in the area. The salinity and pH levels recorded during this test pumping varied but remained within the range observed within the basin.

The suitability of the Kakarook North aquifer for the Project water supply, and the potential impacts on water table levels, was confirmed using H3 hydrogeological model in accordance with the DoW (2009) *Operational Policy 5.12 – Hydrogeological Reporting Associated with a Groundwater Well License* (Appendix D1). This local area numerical groundwater flow model consisted of a rectangular grid extending beyond the whole borefield area with the individual units within the grid consisting of single thickness cells 200m by 200m. Hydraulic conductivity values obtained during the test pumping were applied to these cells.

A low rate of recharge to the aquifer was adopted in the central part of the model area and it was judged to be zero, or close to zero in the northern and southern parts. The low recharge rate is a conservative assumption as the low salinity of the groundwater, relative to other paleochannel aquifers, suggests that recharge rates could be higher. Rapid infiltration observed during project studies and associated with local sandy soils, together with evidence from the test pumping further suggest that occasional high rainfall events would lead to some recharge (Appendix D2). The model suggests an adequate water supply despite the low recharge applied to it.

The analysis was based upon the initial judgement of a total of 16 production bores spread over a rectangular area 3.5km by 1km, each continuously pumping at 305kL/day. The model predicted that after 16 years, the water immediately around the bores was estimated to have fallen by up to 14m which was far less than the available drawdown of around 40m. The contours of the drawdown, shown in Figure 10.12, did not extend to the edges of the modelled basin except for a small area to the southeast.

The modelling results indicate that the aquifer should provide the quantity of low salinity water needed for the Project. The planned pumping rate of about 4,900kL/d may be more than both the rate of recharge to the aquifer and the aquifer through-flow. However, the planned temporary extraction is considered to be sustainable with respect to the project because:

- There are no other potential users of the groundwater or known groundwater dependent ecosystems due to the deep water table (~ 20m below ground level).
- The mining and groundwater extraction will be for a finite period – once extraction ceases the aquifer will gradually recharge.
- There are additional areas of aquifer such as the bore area to the southwest of the Kakarook North borefield that could be developed to spread the impacts of extraction, if necessary.

As is the usual practice and, as required by licensing, the effects of abstraction at Kakarook North will be regularly monitored, and the monitoring data can be used to re-calibrate the model and update the predictions if need be.

10.3.3 Groundwater in the Mining Areas – Dewatering for Proposed Open Pits

Rockwater (Appendix D2) carried out a H3 hydrogeological Assessment in accordance with the DoW (2009) *Operational Policy 5.12 – Hydrogeological Reporting Associated with a Groundwater Well* (Rockwater 2015a; Appendix D1). The conceptual site model (CSM) for the paleodrainage aquifer was established through review of geologic data from 258 drill holes throughout the proposed mining areas (Appendix D2). The groundwater in these locations differs from that found in most other paleochannels in the Yilgarn area, having low oxidation potential and low trace element concentrations (despite acidic conditions), which has been attributed to the geochemistry of the high organic content of the local sediments, which trap dissolved metals (and uranium) as the groundwater moves through the system.

Figure 10.5 shows the extent of the paleochannel system around the four proposed pits, the groundwater level gradients and the location of the reinjection borefield. The large area of low hydraulic gradient is indicated, together with the paleochannel tributary within which Princess and Ambassador Pits are located and the main paleochannel along which groundwater moves to the south.

Hydraulic gradients were derived from an extensive dataset of over 2,500 corrected standing water levels in 440 bores over a period exceeding 30 years. Two extensive phases of exploration activities between 1979 to 1988 and 2008 to 2015 failed to identify any perched water table across the project.

The groundwater at the Ambassador and Princess deposits (MRE) is geochemically distinct from and less saline than the main basin area (and therefore different from MRW). The groundwater ranges in salinity from 7,500mg/L to 37,600mg/L TDS and is moderately acidic to neutral with pH ranging from 4.3 to 7.0, but mostly falling in the range 5.5 to 6.6. The salinity increases both downstream and with depth. To illustrate this, Figure 10.9 shows the salinity versus depth for samples taken during the investigations at the reinjection borefield.

The groundwater at the Emperor and Shogun deposits (MRW) is appreciably more saline, ranging from 13,000mg/L to 139,700mg/L TDS. The highest salinities were found to the south of the Emperor deposit with lower levels at the northern margin of the Eocene channel fill, suggesting that these lower salinities may be the result of recharge with less saline water (Appendix C2). This is supported by rare but sometimes extreme later summer rainfall events, limited evidence of surface water flow or ponding and very limited rootstock below the first 5m of the local soil/overburden profile.

Salinity appeared to increase with the depth of the sample; the groundwater was also more acidic than the eastern deposits with pH ranging from 3.8 to 5.

Slug or falling head tests (where around 20L of water is introduced and water levels monitored) were undertaken in around 60 boreholes around the Princess and Ambassador deposits, as well as low flow recovery tests where water levels were monitored for recovery after pumping. These tests were undertaken to estimate permeability within the different layers of the hydrogeological model used.

Cell sizes for the model domain were 500m by 500m and 250m by 250m in the Ambassador area which extended south to the reinjection area and beyond (Figure 10.10).

The model incorporated three layers:

- Layer 1 representing fine-grained sediments near the water table; with:
  - Horizontal hydraulic conductivity mostly of 0.1m/day; vertical hydraulic conductivity of 0.01m/day.
- Layer 2 consists of interbedded sands and clays and admixtures; with:
  - Horizontal hydraulic conductivity mostly of 1m/day; vertical hydraulic conductivity of 0.1m/day.
- Layer 3 the basal sand/gravel; with:
  - Horizontal hydraulic conductivity around 9m/day, lower in the eastern arm at 1-3m/day and higher at 70-140m/day in the area selected for reinjection; vertical hydraulic conductivity of 0.5m/day.

The base of Layer 3, i.e. the base of the paleochannel and the top of the Permian sediments, was defined from data for the numerous holes drilled for the MRUP and from the PNC and Uranerz geological sections (previous drilling undertaken in the Queen Victoria Spring Nature Reserve area). Recharge was assumed to be zero for much of the modelled area, except for a low average rate of 0.4mm/a on the northwestern edge of the basin and in part of the northeastern tributary. This recharge estimate of 0.4mm/a is a long term average of event-based recharge pulses and is consistent both with experience-based judgement and with the observed groundwater gradient as illustrated in Figure 10.6.

Using representative mine plans the amount of dewatering required was estimated using the numerical groundwater model. The amount of water extracted to achieve the necessary dewatering in order to facilitate the mine schedule was estimated on an annual basis. Figure 10.11 shows predicted groundwater contours for the maximum dewatering at both areas. The figure clearly illustrates the effective independence of each pit within the broad groundwater system and the effective separation between the dewatering and the reinjection wellfield. The pits have maximum dewatering impacts at different times, reflecting the mine plans.

Table 10.1 shows dewatering estimates by year, based on October 2015 mine plans.

Table 10.1 Calculated Dewatering Flows and Injection Rates

<table>
<tr><th rowspan="2">Year</th><th>Annual Dewatering Volume</th><th>Average. pumping rate</th><th>Average. Rate of reinjection</th><th rowspan="2">Dewatering Location</th></tr>
<tr><th>(kL)</th><th>(kL/d)</th><th>(kL/d)</th></tr>
<tr><td>1</td><td>106,000</td><td>290</td><td>0</td><td rowspan="11">Princess & Ambassador</td></tr>
<tr><td>2</td><td>412,000</td><td>1,100</td><td>0</td></tr>
<tr><td>3</td><td>1,420,000</td><td>3,900</td><td>1,600</td></tr>
<tr><td>4</td><td>89,000</td><td>240</td><td>0</td></tr>
<tr><td>5</td><td>800,000</td><td>2,200</td><td>0</td></tr>
<tr><td>6</td><td>486,000</td><td>1,300</td><td>0</td></tr>
<tr><td>7</td><td>91,000</td><td>250</td><td>0</td></tr>
<tr><td>8</td><td>116,000</td><td>300</td><td>0</td></tr>
<tr><td>9</td><td>58,500</td><td>160</td><td>0</td></tr>
<tr><td>10</td><td>1,500,000</td><td>4,100</td><td>1,800</td></tr>
<tr><td>11</td><td>74,000</td><td>200</td><td>0</td></tr>
<tr><td>12</td><td>103,000</td><td>300</td><td>0</td><td rowspan="3">Emperor</td></tr>
<tr><td>13</td><td>486,000</td><td>1,300</td><td>0</td></tr>
<tr><td>14</td><td>607,000</td><td>1,700</td><td>0</td></tr>
<tr><td>15</td><td>634,000</td><td>1,700</td><td>0</td><td rowspan="2">Emperor & Shogun</td></tr>
<tr><td>16</td><td>395,000</td><td>1,100</td><td>0</td></tr>
</table>

Note: numbers have been rounded from Rockwater 2015c (Appendix D2).

The results are based on a simplification of current mine plans, which inevitably will change in detail. It is important to recognise, as illustrated on Figure 10.11, that the drawdown effects are small and limited to within a few kilometres of each pit. This is expected given that mining of the orebody will only extend to 5-10m below the water table. Therefore, changes to mining plans will not materially affect the groundwater impacts.

Due to the thinner orebodies present at the MRW, the modelled drawdowns at Emperor and Shogun upon completion of mining are even more limited than at Ambassador, being typically 2m or less.

An earlier analysis of a leakage test carried out at the Shogun deposit by Groundwater Resource Consultants (GRC, Appendix D4) found that a pit with dimensions of 1,000 × 1,000m, dug to 3m below static water level, would have a leakage rate in the range of 2,000-6,500m^3/day. This is assumed to be a very conservative assumption considering the revised pit floor dimensions associated with the current proposal.

10.4 Potential Impacts

10.4.1 Surface Water Impacts

The hydraulic analysis undertaken by Rockwater (Appendix D9) identifies that no major flood mitigation measures are expected to be required to protect mine pits and infrastructure. The modelling confirms that negligible surface water flows are expected to be generated even under major storm events equating to 1:100 year 72-hour intensity duration (Appendix D9). Given the absence of surface water flows in the Project area, the MRUP will therefore not have any significant impact on surface water flows.

10.4.2 Groundwater Impacts

The impacts from mine dewatering and pumping from the Kakarook North borefield are limited to the associated temporary drawdown of groundwater levels. The impacts from reinjecting water are limited to the associated temporary mounding of groundwater levels near the reinjection borefield and limited localised reversal of hydraulic gradients. In all cases the groundwater levels for abstraction and reinjection will not interact with the surface environment. The groundwater is saline to hypersaline and below the reach of root-stock and the paleochannel system has been found not to host any subterranean fauna (stygofauna or troglofauna) in the areas of interest (Appendix C2).

No impact on Queen Victoria Spring is likely to occur in response to the MRUP due to 1) the actual spring is an ephemeral perched aquifer system and disconnected from the groundwater system, and 2) it is approximately 40km to the southeast of the proposed reinjection borefield, and thus too far away for groundwater effects but, in any case, is believed to be a separate, shallow system (Appendix D2).

There are no existing users of groundwater in proximity of the Project area and given its isolated location none are foreseen over the period during which extraction will occur.

The water that will be reinjected into the aquifer through the reinjection borefield will be of a lower salinity that the receiving environment and the pH will be monitored to ensure that it is no more acidic than its receiving environment. Groundwater level rises or mounding associated with reinjection are predicted to be small therefore not impacting the plant root zone, which stops at around 15 to 18m in the proposed borefield.

Loss of water from the tailings can occur in three ways:

- Evaporation.
- Vertical drainage through the base of the in-pit tailings storage facilities (TSF).
- Leakage laterally through the walls of the in-pit TSF.

The nature of the tailings confers a low hydraulic conductivity, and as a result, low rates of movement from liquor from the tailings into the surrounding groundwater environment, with limited impact on localised hydraulic gradients.

Seepage analyses of the proposed tailings facilities show that the potential for lateral seepage of tailings liquor into the surrounding unsaturated sediments is low due to their very low permeability at moisture levels at or approaching field capacity (Appendix D10). As a result, the primary losses of water from the tailings are expected to occur through slow vertical drainage at the base of the in-pit TSF, resulting in negligible impact to regional hydraulic gradients.

10.5 Sustainability of Water Sources

Rockwater (Appendix D1) predicts that the drawdown at the end of 16 years of production pumping at Kakarook North barely reaches the edge of the basin within which the borefield is to be installed (Figure 10.12). Clearly a greater abstraction could be accommodated.

The groundwater levels will recover in time after pumping ceases, a consequence of groundwater level recovery as a result of through-flow in the aquifer and natural recharge. The supply can be regarded as sustainable for the purposes of this project.

10.6 Pit Void Hydrology and Water Quality

There will be no pit voids or lakes at the cessation of the Project. The mining pits will be progressively backfilled, or partially backfilled to a minimum depth of 10m above the water table, with a combination of overburden and the reject stream from beneficiation (which will mainly consist of unconsolidated sand).

Groundwater levels will return to approximately the same levels that prevailed before dewatering and mining commenced. To the extent that mining pits are used for the disposal of tailings, those pits will also see groundwater levels return to pre-mining levels over a longer period due to the lower transmissivity of tailings and the water quality within those areas will not vary significantly from groundwater in surrounding areas (this matter is dealt with extensively in Section 11).

Where fine to very fine grained sediments are present, a capillary fringe up to 2-5m thick will regenerate, with elevated conductivities associated with soluble salts bound to clay and silt particles, in line with current conditions.

10.7 Reinjection Borefield and Operations

Reinjection is expected to be necessary during about two years of the project operation, based on the current mine plan and groundwater interpretations (see Table 10.1, above).

Groundwater samples collected from the 17 bores in the proposed reinjection area showed that the groundwater was acidic with pH ranging between 3.9 and 6.9, but generally between 4.5 and 5.0. The salinity ranged between 20,000mg/L and 73,000mg/L TDS with an average around 51,500mg/L (seawater is around 35,000mg/L) which is significantly higher than the salinity occurring within the Ambassador and Princess Deposits. At the time of conducting the investigation, the standing water levels in the proposed reinjection area were at 288.2m AHD which is approximately 40m (or more depending on local topography) below ground level. There was also good correlation between sample depth and salinity as shown in Figure 10.9.

Test pumping in the reinjection borefield area showed that the aquifer is highly permeable and although pH and salinity levels fluctuated during extended periods of testing they remained within the range found in the area (Appendix D2). In each case an initial test was undertaken to decide a suitable rate of flow for the constant flow test that was subsequently undertaken. The production bores were pumped at a constant rate for 48 hours (1,210kL/day and 950kL/day for the selected bores). Water levels were monitored in the production bores and in surrounding monitoring bores. At the end of the tests, water levels were allowed to recover and water levels in all bores were monitored. Drawdown and recovery plots were made from the information obtained and analysed using the 'Jacob method' and the 'Theis recovery method' to estimate aquifer transmissivity (T) and storativity (S) estimates varied between 2,500m^2/day and 5,500m^2/day and S estimates ranged from 0.002-0.009 (Appendix D2). This high estimate of local T, taken together with the depth of the aquifer (consistently around 40m) indicates that it would be suitable to receive up to 1.5GL/a by reinjection, suggesting limited mounding would occur as a result.

Groundwater chemistry in the reinjection area, using data from the two production bores is as follows:

- pH – ranges from 4.0 to 4.5
- TDS – ranges from 58,000 to 66,000mg/L
- Cl – ranges from 29,000 to 35,000mg/L
- Na – ranges from 18,000 to 20,000mg/L
- K – ranges from 470 to 490mg/L
- Ca – ranges from 29,000 to 35,000mg/L
- Mg – ranges from 1,800 to 2,000mg/L
- Fe – ranges from 7.5 to 10mg/L
- SO_4 – ranges from 5,700 to 6,500mg/L
- Si – ranges from 12 to 15mg/L and
- B – 6.7 to 7.2mg/L.

The H3 hydrogeological numerical model was run using the maximum amount of water expected to be reinjected in any one year (which was estimated at 1,780kL/day). The modelling showed that mounding around the reinjection borefield (Figure 10.11) would not be expected to exceed 0.5m except close to the borefield.

The reinjection borefield and its associated engineering will be designed in detail as the project details are finalised. The modelling results indicate that the reinjection borefield and the associated aquifer are capable to sustainably receive up to 1.5GL/a.

10.8 Water Supply Options

The current modelling undertaken by Rockwater (Appendix D1) at the Kakarook North Borefield, has identified that the current aquifer has an estimated volume of 167GL, of which only 1.8GL/a will be extracted over the 16 year LOM (i.e. 28.8GL in total or 17% of the total aquifer volume). This estimate does not consider recharge over the catchment area or inflows from upstream areas; hence it is over-conservative.

Although the Kakarook North aquifer has sufficient capacity to meet the MRUP's water requirements, additional drilling and review of geological data indicates that there are several similar graben-hosted sandstone aquifers closer to the mining and processing areas and these will be further investigated to establish their suitability as a proposed source for low salinity / low Cl- process water.

10.9 Management of Hydrogeological Impacts

The following Management Plans (MPs) have been or will be developed to ensure that groundwater and surface water regimes are maintained so that existing and potential uses, including ecosystem maintenance are maintained:

- Surface Water Management Plan (MRUP-EMP-009).
- Groundwater Management Plan (MRUP-EMP-010).
- Groundwater Operating Strategy (MRUP-EMP-011).
- Managed Aquifer Recharge Management Plan (MRUP-EMP-012).
- Operational Environment Management Plan (MRUP-EMP-020).

- Water Operating Strategy (MRUP-EMP-021).

Some of these Management Plans are contained in Appendix K1.

The overall objective of the implementation of these Management Plans to the key environmental factor of Hydrological Processes is to ensure that the impact upon surface water and groundwater as a result of the MRUP will be minimised, that adverse impacts upon associated ecosystems will be avoided and that the existing water bodies will be preserved as much as is practicable and to the extent required for existing and future users. Implementing the following principles will assist in delivering such an outcome:

- Minimise site impact on natural surface water systems
- Minimise the potential environmental impacts associated with the development of groundwater management infrastructure
- Maximise the efficiency of beneficial water use so that borefield extraction volume is minimised
- Ensure that groundwater elevation levels are maintained at or returned to a level consistent with pre-mining hydrogeological regime
- Groundwater quality is maintained within acceptable limits compared to baseline values
- Indirect impacts to existing and potential groundwater users, groundwater dependent ecosystems (GDEs) and subterranean fauna are negligible and
- Monitoring is undertaken to a level that will enable informed decision making.

The management of impacts to the existing hydrological regimes will be predominantly achieved through the use of the:

- Surface Water Management Plan (MRUP-EMP-009), which will ensure that:
  - Potential surface flow lines and flow directions are not impacted by the MRUP or if they are disturbed they are subsequently re-established as far as is practicable
  - All water storage facilities will be monitored to ensure that operational freeboard is maintained sufficient to accommodate a 1:100-yr 72-hr ARI rainfall event
  - All chemical and hydrocarbon storage areas and all fuelling areas are appropriately bunded and able to fully contain a 1:100-yr, 72-hr ARI rainfall event
  - All spills are reported and appropriately dealt with as required by the Spill Response Management Plan (MRUP-EMP-027)
  - Sufficient site safety bunds are installed to exclude any local water runoff and dewatering equipment is in place to remove any direct rainfall onto the pit areas and
  - Appropriate road crossings (floodways) are installed at identified low points in access and haul roads.
- Groundwater Management Plan (MRUP-EMP-010), which will ensure that:
  - Groundwater drawdown is minimised, by reducing borefield extraction volumes as a result of maximising the efficiency of water use
  - Groundwater mounding is minimised by reducing reinjection volumes as a result of preferentially utilising mine dewatering water for processing purposes
  - The quality of all water (mine dewatering water, extraction borefield water, reinjection water and tailings water), is regularly assessed against management targets and

- The potential impacts upon subterranean fauna and GDEs are monitored.

10.9.1 Monitoring

The following water quality parameters will be monitored:

- Water quality parameters associated with dewatering activity including levels (drawdown), quality (including salinity and pH) and flow rates.
- Water quality parameters in process water streams including quantity, quality (including salinity and pH) and flow rates.
- Water quality parameters associated with reinjecting activities including levels (mounding), quality (including salinity and pH) and flow rates.
- Water quality parameters associated with tailings material including levels (in tailings facilities), quality (including salinity, pH and contaminants such as metals) and flow rates.

There will also be additional monitoring activity undertaken under the Environmental Monitoring Management Plan (MRUP-EMP-032) which, when developed, will include checks for leaks or other seepage that could enter the environment and ultimately impact existing hydrological regimes.

10.9.2 Management Targets and Contingency Actions

Exceedances of the following management targets would lead to contingency actions:

- **Target** – Monitoring of any water quality parameters reveals a deviation from expected values that would be sufficient to warrant concern about the associated impact on hydrological regimes:
  - **Contingency action** – Investigate the cause of the deviation and the implementation of appropriate measures to ensure that the impact on associated hydrological regimes is minimised by measures designed to remediate the problem.

10.10 Mitigation Hierarchy

Implementation of the Surface Water Management Plan (MRUP-EMP-009) will ensure that any disturbance to surface water flows is avoided where possible or minimised and that subsequent rehabilitation will ensure that, where practicable, natural surface water flow paths are restored.

Implementation of the Water Operating Strategy (MRUP-EMP-021) and associated Water Conservation and Efficiency Plan will ensure that water use is:

- Avoided by utilising options not requiring water where possible.
- Minimised by using suitable equipment, technology and systems to reduce the amount of water used.
- Recycled where possible to further minimise use.
- Its application will be ‘fit-for-purpose’ with lower quality water being preferentially utilised where practicable.

By ensuring that water is conserved and the efficiency of its use maximised, the amount of water extracted from the Kakarook North borefield will be minimised. Extraction from this borefield will also be monitored in accordance with the Groundwater Management Plan (MRUP-EMP-010), and other relevant management procedures, to avoid excessive drawdown.

All water extracted as a result of mine dewatering will be used for mine and mineral processing activities with any surplus reinjected into the same aquifer downstream. Dewatering and reinjection operations will occur in accordance with the Water Operating Strategy (MRUP-EMP-021), and associated Water Conservation and Efficiency Plan, and other relevant management plans and procedures. Implementation of dewatering and reinjection management measures will ensure the net extraction from the overall aquifer extending from under the mining areas beyond the reinjection area is minimised.

10.10.1 Monitoring and Management

All activity involving the extraction or reinjection of water will be monitored to ensure that the salinity and acidity remains within the expected ranges as a result of the activity and that groundwater levels are behaving as expected (i.e. no excessive drawdown or mounding). The monitoring is described in Section 10.9.1.

Excessive water level height changes will be managed through design of screens in both currently saturated and unsaturated aquifers and by controlling the rate of flow of the associated bore or bores and if necessary implementing some realignment or extension. The extraction of groundwater will be licensed under the RIWI Act and subject to an operating strategy, if deemed necessary by the DoW. Reinjection activities may require licensing under the EP Act.

In the unlikely event that more water is extracted from Kakarook North than expected, the impact would be a greater drawdown and a greater percentage of the overall amount of water in the basin being extracted. Neither of these presents a risk of groundwater contamination or a likely threat to the sustainable use of the aquifer.

Mine dewatering water will be acidic and saline to hyper-saline in nature. There are no environmental impacts associated with increased levels of extraction as there are no GDEs associated with this aquifer. The aquifer has no uses other than for use in mining and mineral processing processes. All water from mine dewatering that is surplus to the requirement for use in mining and mineral processing processes will be reinjected back into the same aquifer downstream. The net extraction from the aquifer is estimated to be approximately 0.85GL/a from an aquifer containing in excess of 500GL of highly saline water. Therefore, there is no risk to the sustainable use of this aquifer.

The water being reinjected into the reinjection area will be comprised entirely of surplus mine dewatering water. If monitoring indicates it is of a lesser quality than the receiving aquifer it will be blended with better quality water to the extent required to avoid adverse impacts to the hydrological regime of the groundwater and associated ecosystem maintenance. There is little to no risk of contamination because the water being reinjected will consist of water that has been extracted from the mining area as part of the dewatering process. There will be no adverse impact upon the potential sustainable use of the aquifer because the only use is for mining and mineral processing and the quality being reinjected will not have any adverse impact on these uses.

All matters related to the monitoring and management of tailings water and the potential for tailings to contaminate groundwater or adversely impact on its sustainable use are dealt with under matters relating to Inland Waters Environmental Quality in Section 11.

10.10.2 Climate Change

The effects of climate change on ground and surface water hydrological flows over the lifetime of the Project is uncertain and it is unlikely that there will be significant differences over the relatively short period under consideration.

However, it is possible that an upward trend in total rainfall affecting a broad belt running north-south throughout Western Australia (Figure 10.13) is a reflection of on-going climate change. That pronounced increase in rainfall (of the order of 20-30mm/10 years for the MRUP) is mitigated by overall low rainfall, rapid infiltration and high evapotranspiration rates. It is possible that the increased frequency of high rainfall events and as such this could lead to increased surface water flows and increased local recharge of the aquifers but would also lead to greater evaporation through changes to the vegetation cover and productivity. The extent of any likely increase in intensity and duration of high rainfall events will not be sufficient over the time period under consideration to alter the conclusions reached about the low probability of significant surface water flow volumes reaching the Project area.

Any increase in the intensity and duration of high rainfall events would have the capacity to increase the quality and quantity of water in the basin where the extraction borefield is located (Kakarook North). However, high rainfall in the mining area is unlikely to lead to local aquifer recharge as clay layers isolate surface water from the deep aquifer. Additional recharge from the north as a result could marginally increase the water level and improve its quality. However, the mine dewatering water is being extracted from an area where the water quality would be more impacted and reinjected into what is the same aquifer downstream where the impact will be less. Therefore, the effect would not be material to ensuring that reinjected water does not adversely impact the receiving environment.

10.11 Residual Impacts after Mitigation Measures

Given the absence of surface water flows and the implementation of a Surface Water Management Plan (MRUP-EMP-009), to ensure that if any such flows were to eventuate they would not be interfered with, there are not expected to be any significant impacts on surface water flows as a result of the MRUP.

The volume of brackish water extracted from the Kakarook North borefield for use in processing will be minimised by the implementation of the Water Operating Strategy (MRUP-EMP-021) and in particular the Water Conservation and Efficiency Plan. The rate of extraction may be up to 3GL/a however it is expected to average approximately 1.8GL/a over the LOM. A conservative estimate of the volume of water in the Kakarook North basin is around 167GL. The annual rate of extraction would therefore represent approximately 1% of the estimated volume of water. The rate of recharge into the aquifer is unknown, and highly dependent upon variable rainfall, but the relatively low levels of salinity and steeper hydraulic gradients suggest that recharge is significant. The total amount of water extracted from this trough over the LOM is not expected to exceed 20% of the available volume and this rate of extraction may not exceed the amount of recharge over the same period. Once extraction ceases the water level will gradually return to pre-mining levels. There will be no significant residual impact on the groundwater at Kakarook North or on any dependent ecosystem or on existing or potential future users of the water body.

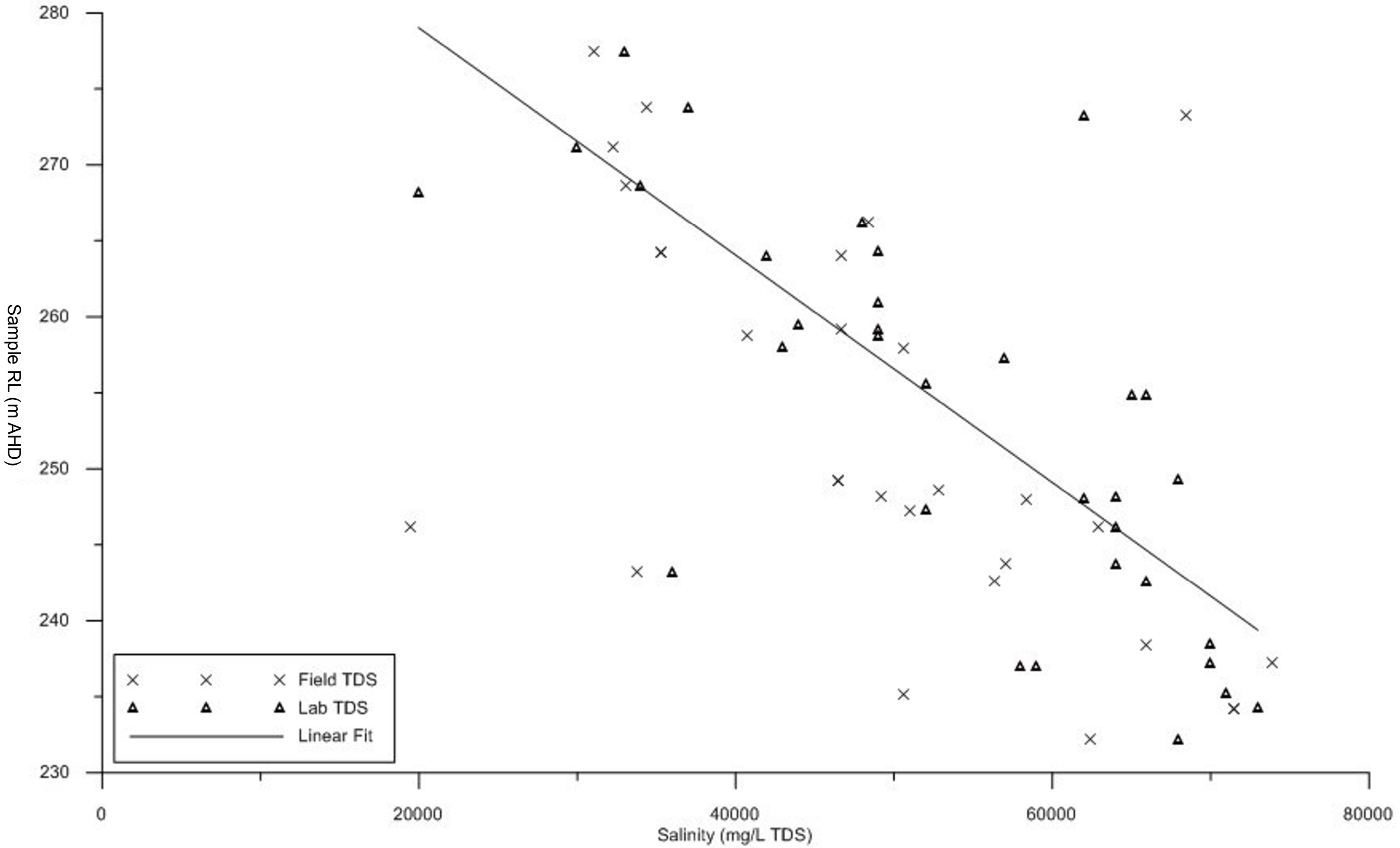
The water extracted for mine dewatering purposes will be hyper-saline and the exact amount being extracted will be determined by the requirements associated with each area being mined. Current estimates suggest that this amount will average less than 0.5GL/a, whilst the processing and other operational requirements suggest that approximately 0.85GL/a will be required. As necessary, additional dewatering of mine water will occur to achieve the volumes required. The dewatering volumes will only exceed the amount used in processing and other operational requirements when mining is taking place in deeper portions of the orebodies. Only in those years will reinjection into the reinjection borefield be required. The water being reinjected will be managed to ensure that the quality is not significantly worse than the quality of the groundwater in the area where reinjection will occur. Therefore, there will be no significant adverse impact on the groundwater or dependent ecosystems in that area. Furthermore, there are no potential users for this water due to its saline and acidic nature.

10.12 Predicted Outcomes

There are no groundwater dependent ecosystems connected to the groundwater being disturbed as part of the Project. The water is brackish or saline (in some areas, such as the reinjection borefield, considerably more saline than seawater) and has no uses other than for use in mining or mineral processing.

The extraction borefield is located in a sedimentary trough estimated to contain at least 167GL of brackish water. The water requirement from this borefield for the entire LOM is less than one fifth of the amount known to be located there. Moreover the aquifer is believed to undergo some recharge, including local recharge during high rainfall events. Modelling work suggests that the cone of depression will mostly not extend to the boundaries of the trough so that a significant portion of the aquifer will be essentially undisturbed (Appendix D1). The aquifer will remain available for future use and will eventually recharge back to approximately the initial conditions.

There will be no residual impacts that adversely impact on the existing hydrological regime or dependent ecosystems, or any existing or potential future users that would require appropriate offsets.



CLIENT
VIMY RESOURCES LIMITED

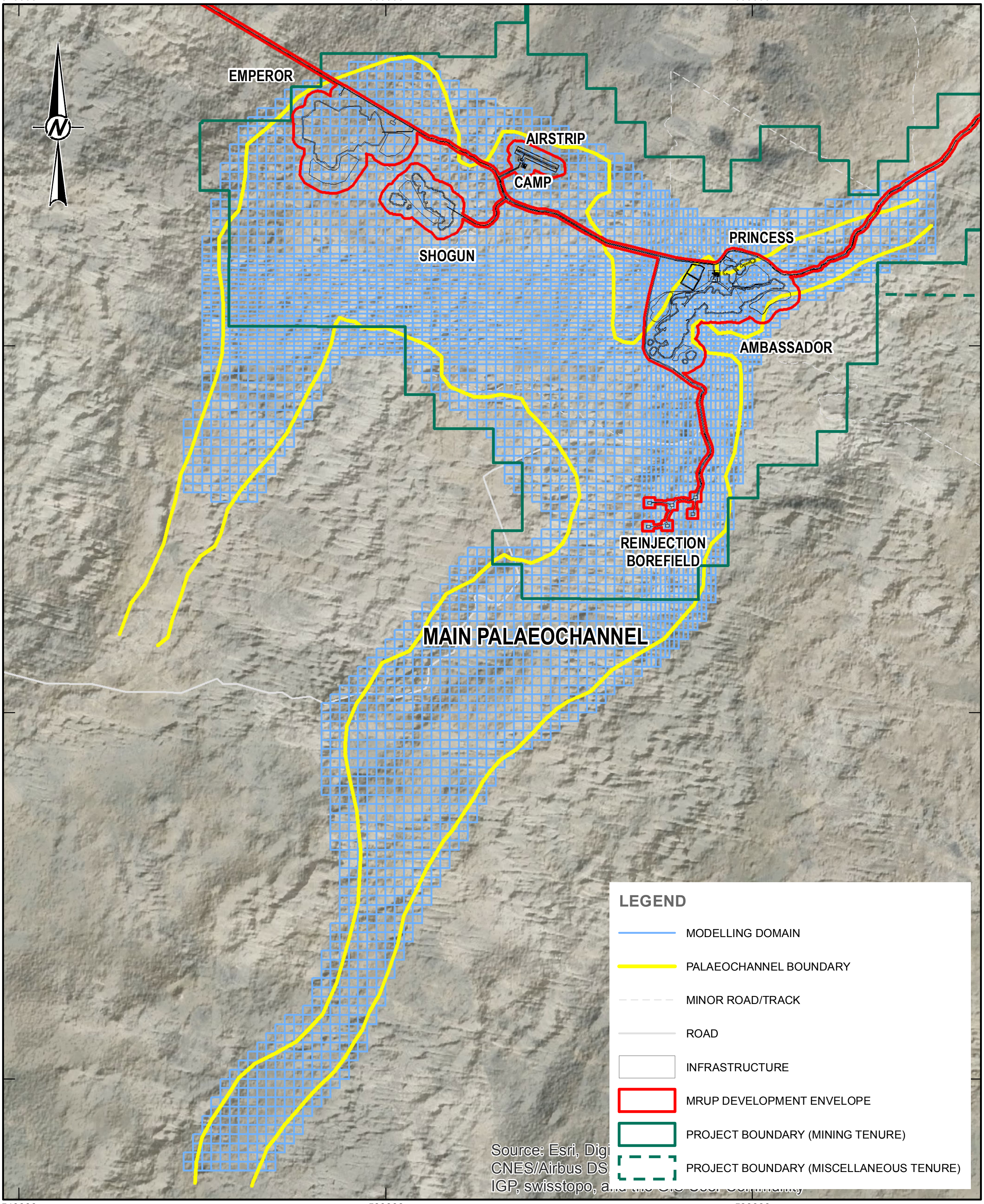
PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT

YYYY-MM-DD	2015-11-06
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

TITLE
GROUNDWATER SALINITY VERSUS DEPTH AT REINJECTION BOREFIELD
SOURCE: ROCKWATER (2015c)

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**10.9**



NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
PALAEOCHANNEL DATA AND MODEL GRID SOURCED FROM ROCKWATER (2015c)
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 10 20
1:300,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

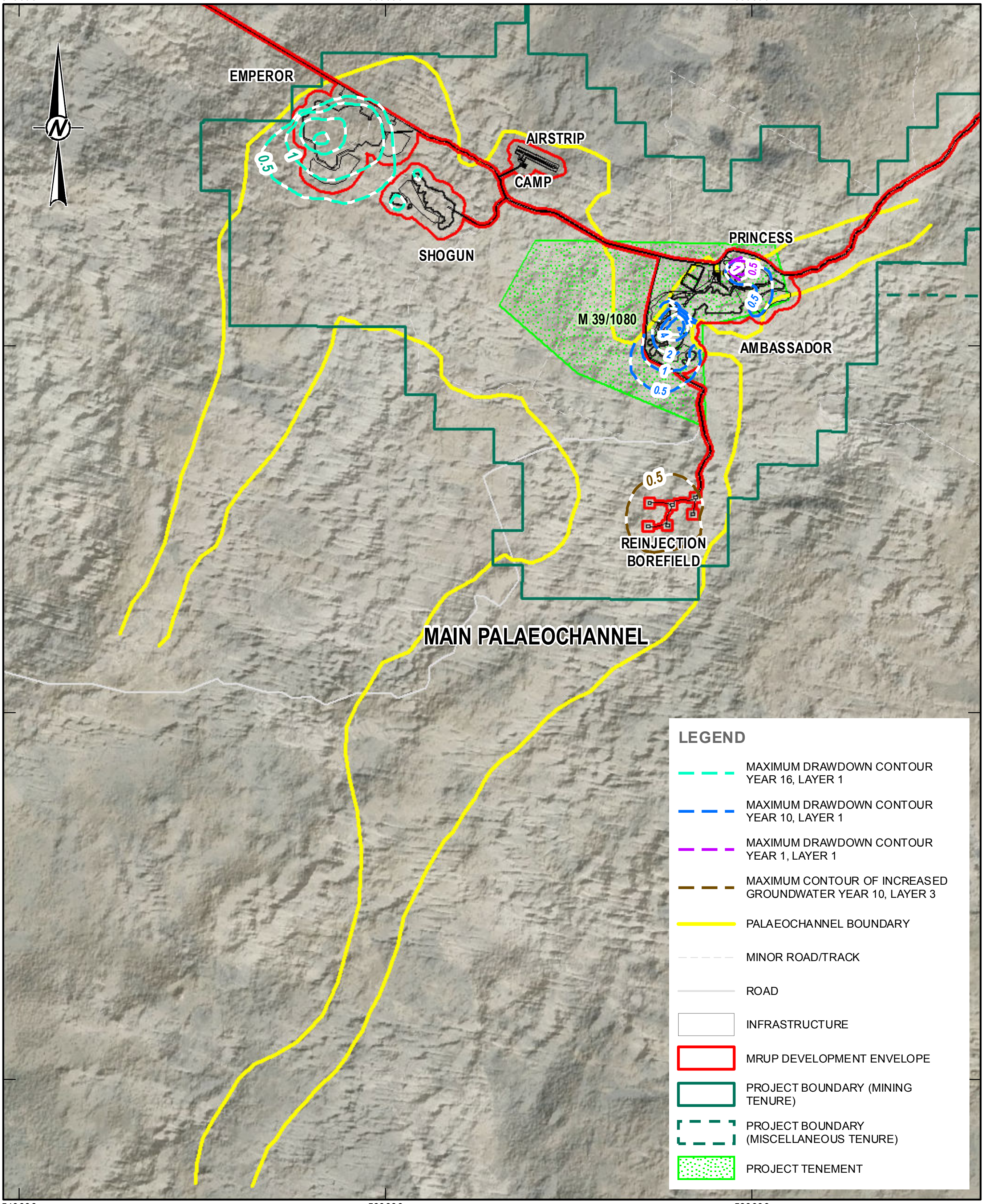
CONSULTANT

YYYY-MM-DD	2015-11-05
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
GROUNDWATER MODELLING DOMAIN

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	10.10



NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
PALAEOCHANNEL DATA AND CONTOURS SOURCED FROM ROCKWATER (2015c)
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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1:300,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

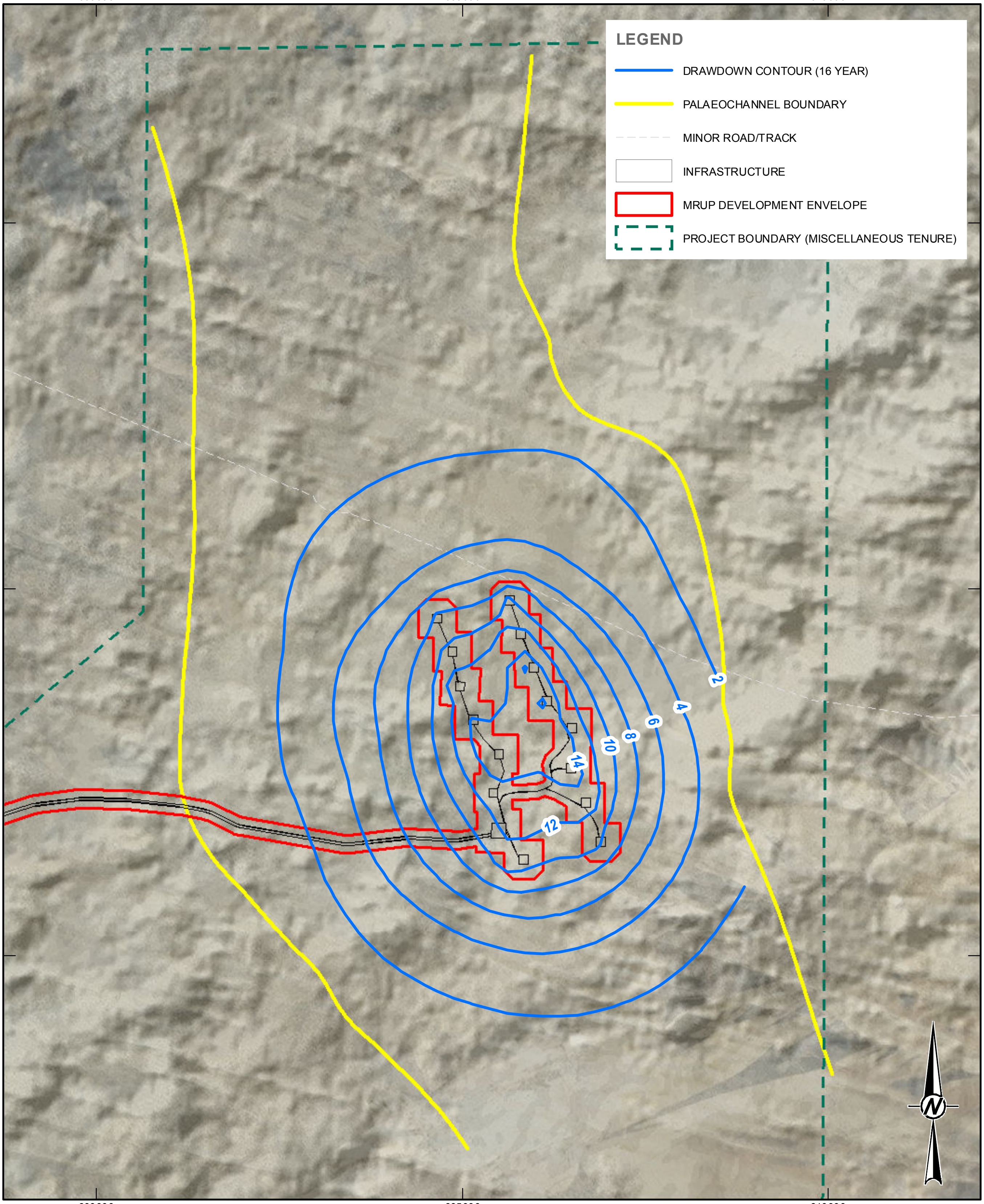
PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-09
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

TITLE
MAXIMUM DEWATERING DRAWDOWN CONTOURS FOR ALL MULGA ROCK PITS AND MAXIMUM GROUNDWATER MOUNDING AT REINJECTION BOREFIELD

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	10.11



NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
PALAEOCHANNEL DATA AND CONTOURS SOURCED FROM ROCKWATER (2015d)
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 1 2 3 4 5
1:75,000 KILOMETRES

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT	YYYY-MM-DD	2015-11-10	TITLE 16 YEAR DRAWDOWN CONTOURS KAKAROOK NORTH BOREFIELD
	DESIGNED	MS	
	PREPARED	MS	
	REVIEWED	DCR	PROJECT NO. 1540340 / CONTROL PER / REV. 0 / FIGURE 10.12
	APPROVED	DCR	

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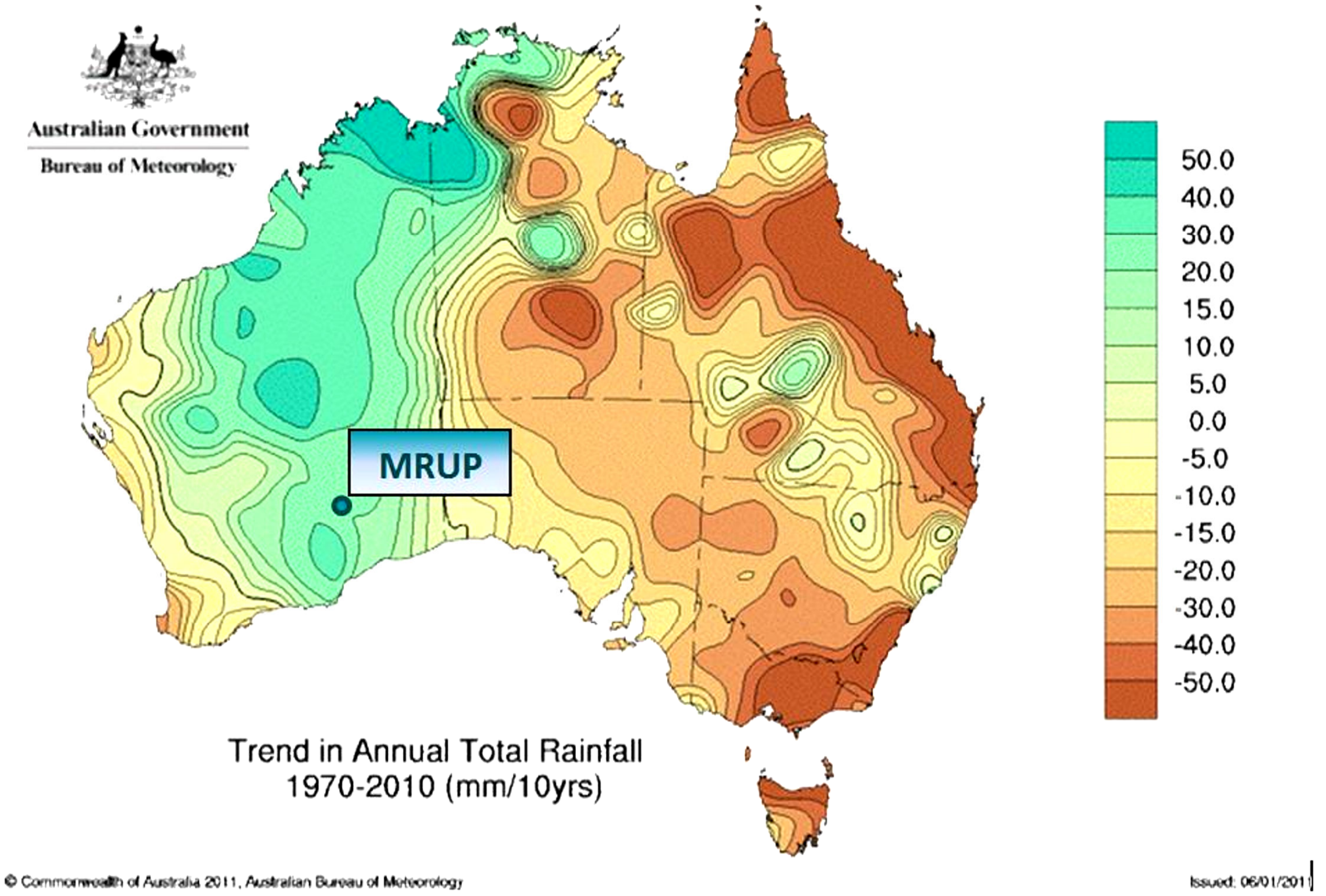

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT Golder Associates	YYYY-MM-DD: 2015-11-10	TITLE **TREND IN ANNUAL TOTAL RAINFALL 1970 - 2010 (mm/10 YEARS)** **SOURCE: AUSTRALIAN BUREAU OF METEROLOGY**	
	DESIGNED: MS		
	PREPARED: MS		
	REVIEWED: DCR	PROJECT NO. 1540340	CONTROL PER
	APPROVED: DCR	REV. 0	FIGURE **10.13**

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11. Inland Waters Environmental Quality

11.1 Relevant Environmental Objectives, Legislation, Policies and Guidelines

11.1.1 EPA Objective

The EPA applies the following objective to the assessment of proposals that may affect the quality of inland waters:

> *To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.*

11.1.2 Regulatory Framework

The protection of inland water quality is covered by the following key statutes:

- *Rights in Water and Irrigation Act 1914* (WA) (RIWI Act).
- *Environmental Protection Act 1986* (WA) (EP Act).
- *Mining Act 1978* (WA) (Mining Act).
- *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).

Rights in Water and Irrigation Act 1914

This is an Act relating to rights in water resources, which makes provision for the regulation, management, use and protection of water resources and for related purposes.

This Project involves the dewatering of groundwater from the mine pits and abstraction of water for processing and other purposes. This activity is governed by the RIWI Act.

Environmental Protection Act 1986

This is an Act which is designed to protect the environment of the State, which includes limiting any alteration of the environment to the detriment or potential detriment of an environmental value, including inland water quality. The establishment and operation of the MRUP is governed by the EP Act.

Note, the reinjection of surplus mine dewatering water back into the same aquifer downstream may also require licensing under the EP Act.

Mining Act 1978

Exploration and mining titles in Western Australia are granted in accordance with the Mining Act 1978 (the Mining Act) with the Department of Mines and Petroleum (DMP) administering this Act. Mineral exploration and mining activities are administered under the Act for onshore areas, and for offshore areas to a limit of (nominally) three nautical miles from the coast. There are a number of types of tenement, including prospecting licences, exploration, retention and miscellaneous licences, and mining and general purpose leases. There are also a number of approvals applicable to the Project administered under the Mining Act, including Mining Proposal and Mine Closure Plan.

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Australian Government's key piece of environmental legislation that focuses on the protection of Matters of National Environmental Significance (MNES) – of which there are nine matters, with one being nuclear actions (including uranium mining).

The Project is a uranium mining project and the environment is considered a protected matter where nuclear actions are involved. Inland water quality is considered part of the environment.

Other Relevant Guidance

There are non-legislated guidelines and policies that have been developed to ensure water resources are sustainable and protected while providing for economic and social development. These include:

- ANZECC and ARMCANZ 2000, National Water Quality Management Strategy Paper No.4: *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Canberra, ACT. These guidelines help to establish whether the water quality of a water resource is good enough to allow it to be used for humans, food production or aquatic ecosystems (environmental vales).
- Department of Water 2013, Water licensing delivery series – Report No.12: *Western Australian water in mining guideline*, Perth, Western Australia. This is a guideline applying to mining projects undertaken across Western Australia (under the *Mining Act 1978*) which sets out how to meet the Department of Water's regulatory requirements for such projects and provides advice on water management issues that need to be considered in mine planning. In particular it covers the following:
    - Ensuring that high quality water is only used in situations where its use is either essential or no other suitable source is available, and otherwise ensuring that fit-for-purpose water is used wherever possible and with the fewest adverse effects.
    - Maximising water use efficiency to reduce the need for water to be extracted from the environment.
    - Minimising the adverse effects of water extraction and any subsequent discharge on environmental, social and cultural values.
    - Ensuring adaptive management of the effects of extraction and discharge of water through the use of suitable monitoring and evaluation processes.
- Department of Water 2009, Operational Policy no.5.12 – *Hydrogeological reporting associated with a groundwater well license*, Department of Water, Perth, November 2009. This policy provides guidance on when hydrogeological assessments and groundwater monitoring reports will be required and the information they should contain.
- Department of Water 2011, Operational Policy 5.08: *Use of Operating Strategies in the Water Licensing Process* Department of Water, Perth. There are circumstances where the Department of Water requires the development and implementation of operating strategies as a supplement to licence conditions and this is detailed in this policy.
- Department of Water 2009, Operational Policy no.1.02 – *Policy on water conservation/efficiency plans: Achieving water use efficiency gains through water licensing*, Department of Water, Perth. Where there is a requirement to draft and implement an operating strategy (see above) the Department of Water will also require the inclusion of a water conservation/efficiency plan (WCEP) as part of that strategy in order to ensure the most efficient use of water and to minimise its use.
- Department of Water 2010, *Operational policy 1.01 – Managed aquifer recharge in Western Australia*, Department of Water, Perth. This policy outlines the Department of Water's position on managed aquifer recharge, and the requirements for proponents seeking to obtain approval for such a scheme.
- Department of Water 2013, *Strategic policy 2.09 – Use of mine dewatering surplus*. This policy outlines the State government's position on the use of mine dewatering surplus and describes how using this water as a resource may be facilitated.
- Department of Minerals and Energy 2000, Water Quality Protection Guidelines No. 10 *Mining and Mineral Processing – Above-ground Fuel and Chemical Storage*, Perth, Western Australia. These guidelines are designed to minimise the potential impacts on water resources from poorly managed above-ground fuel and chemical storage facilities.

11.2 Environmental Quality of Inland Waters and their Regional Context

The hydrological and hydrogeological systems operating within the MRUP are similar to those existing throughout the Yellow Sand Plain (YSP) region of the Great Victorian Desert (GVD). In these arid, dunal-dominated environments permanent surface water features rarely exist; unlike in the eastern Goldfields where surface water features are usually associated with defined surface expressions of underlying paleodrainage channels (i.e. salt lake chains characteristic of Lake Minigwal, Lake Rebecca, Lake Raeside and Lake Rason). These salt lake chains are only activated following large cyclonic storm events, and rarely (i.e. requiring a Probable Maximum Precipitation (PMP) event) do they link-up sufficiently to re-establish their previous southeasterly flow discharging into the Eucla Basin. Such events have only been recorded in 1976, 1995, and 2011 with sustained surface water flow recorded along the Lake Raeside-Ponton Creek drainage system.

The typical valley-filled salt lake chains of the eastern Yilgarn and western portion of the GVD represent catchment-wide solute ‘sinks’ (base cations and anions, as well as metals and metalloids) resulting in the hypersaline conditions, which through evaporative concentration results in the observed salt crust surface within these lake systems. In contrast, the Mesozoic geologic and geomorphic conditions operating within the MRUP (i.e. preferential uplift and peneplanation) prevented the Mulga Rock paleochannel, which hosts the Mulga Rock uranium deposit, from developing into a typical valley filled channel, and thus there is no noticeable surface expression of the underlying paleodrainage system. The uplifted MRUP region therefore remained relatively elevated and stable for a prolonged period facilitating the deposition and formation of the current extensive Aeolian dunal system, which dominates the land surface of the MRUP. The slight topographic low associated with the Mulga Rock paleochannel (as shown in Figure 10.6) represents a post-deposition process, whereby the lacustrine, organic-rich Eocene sediments have oxidised as groundwater levels have dropped in association with continued uplift. This oxidation process, which is still occurring today, and represents an active acid sulphate soil (ASS) weathering front, resulted in the generation of highly acidic soil solutions leading to the destruction and ultimate collapse of the mineral crystal structure, recrystallization and subsequent lowering of the land surface. This is clearly shown in Plate 11.1, which shows the location of the proposed Ambassador deposit within the depressed land surface which has dropped in response to sulphide and organic matter oxidation in the underlying Eocene sediments.

Although the topographic depressions in the land surface of the MRUP represent zones of surface water and solute accumulation during large storm events (this is clearly evident by the accumulation of hematite minerals given the clay pans a defined red colour), their source catchment area and parent materials, are relatively small and consists of non-saline, geochemically benign surficial sands; hence solute accumulation leading to hypersaline conditions is restricted and only occurs in selected areas across the MRUP, typically associated with outcropping gypsiferous kopi areas (Plate 11.2). The finer textured soils existing within the topographic depressions associated with the Narnoo Paleodrainage channel have relatively low salinities and geochemical contents of most metals and metalloids (see Section 11.7). In the region, areas of more persistent (yet ephemeral) accumulation of surface water have been recorded at Queen Victoria Spring (located approximately 40km southwest of the southern mining lease boundary of the MRUP) and at Malcolm Soak (located approximately 24km southeast of the MRUP southern mining lease boundary). Queen Victoria Spring represents a local ephemeral perched system, whilst Malcolm Soak represents gnamma hole in the outcropping granites along the Albany Fraser Province (AFP); both surface water features are disconnected from the groundwater system and are therefore not environmental receptors that could be impacted by proposed activities on the MRUP.

In contrast to the hydrological system operating with the Mulga Rock paleochannel, the hydrogeological system, including flow processes and chemistry of groundwaters, are similar to those existing within the more traditional paleodrainage channels of the Yilgarn Craton (i.e. hypersaline aquifer often containing elevated metals). This contrast highlights the hydraulic disconnect between the surface and ground water systems within the Mulga Rock paleo channel. The groundwater system within the MRUP therefore has limited environmental quality and end uses, as the high salinity, sulphate concentration and acidic conditions within the main channel are not conducive to any groundwater dependant ecosystems (GDEs) and restrict the utilisation of the aquifer to mineral processing.

In addition to the main paleodrainage channel and tributaries, which host the mineralised orebodies, a source of lower salinity and lower chloride (Cl^-) groundwater is required for the processing plant. A groundwater source with a maximum Cl^- content of 10g/L is required to support the proposed ion exchange-based process flowsheet and exploration drilling has identified a large graben-style sandstone aquifer to the north east of the mining areas, overlying the Biranup/Albany-Fraser Province (AFP). This groundwater source is rapidly recharged by infiltrating rainfall, and thus has a brackish salinity. Similar graben-style sandstone aquifers extensively overlie the AFP, due to its fault-bounded nature.

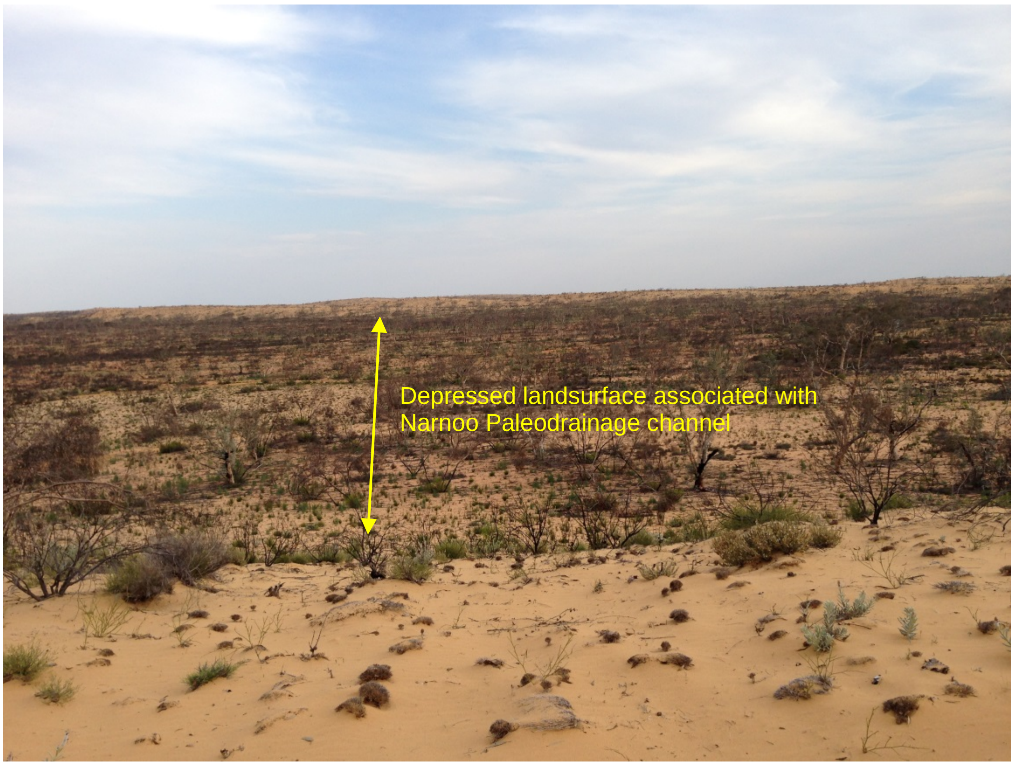


Plate 11.1 Surface expression of the Narnoo Paleodrainage channel in the MRUP area

Plate 11.2 Outcropping of gypsiferous kopi compression mound (or teepee structure) close to the Emperor Deposit (558,257mE/6,690,745mN)

11.3 Baseline Surveys

11.3.1 Surface Water Quality

As discussed in Section 10.3 (Hydrological Processes) baseline hydrological assessment of the MRUP has been completed by Rockwater (Appendix D9). The results from this work highlight that surface flows within the MRUP are rare and only likely to occur following major cyclonic events exceeding 1:100 year 72 hour event duration. Potential surface water flow paths into the Development Envelope, if such an event occurs, are provided in Figure 10.1.

Given the sporadic nature of surface water accumulation and absence of defined surface water features within the MRUP, limited surface water quality data has been collected, from within ephemeral clayey depressions to the northeast of the Mulga Rock East deposit, the only significant claypan within the project tenure area (10km or more from any proposed infrastructure) and surface flows in the Ponton Creek, the downstream extension of the regional Lake Raeside drainage.

Collection of this data is opportunistic in nature, can be problematic and it is difficult to ensure that they are a valid and reliable reflection of the water chemistry. As a result, they are not deemed relevant to the assessment of the projects' Development Envelope and Disturbance Footprint.

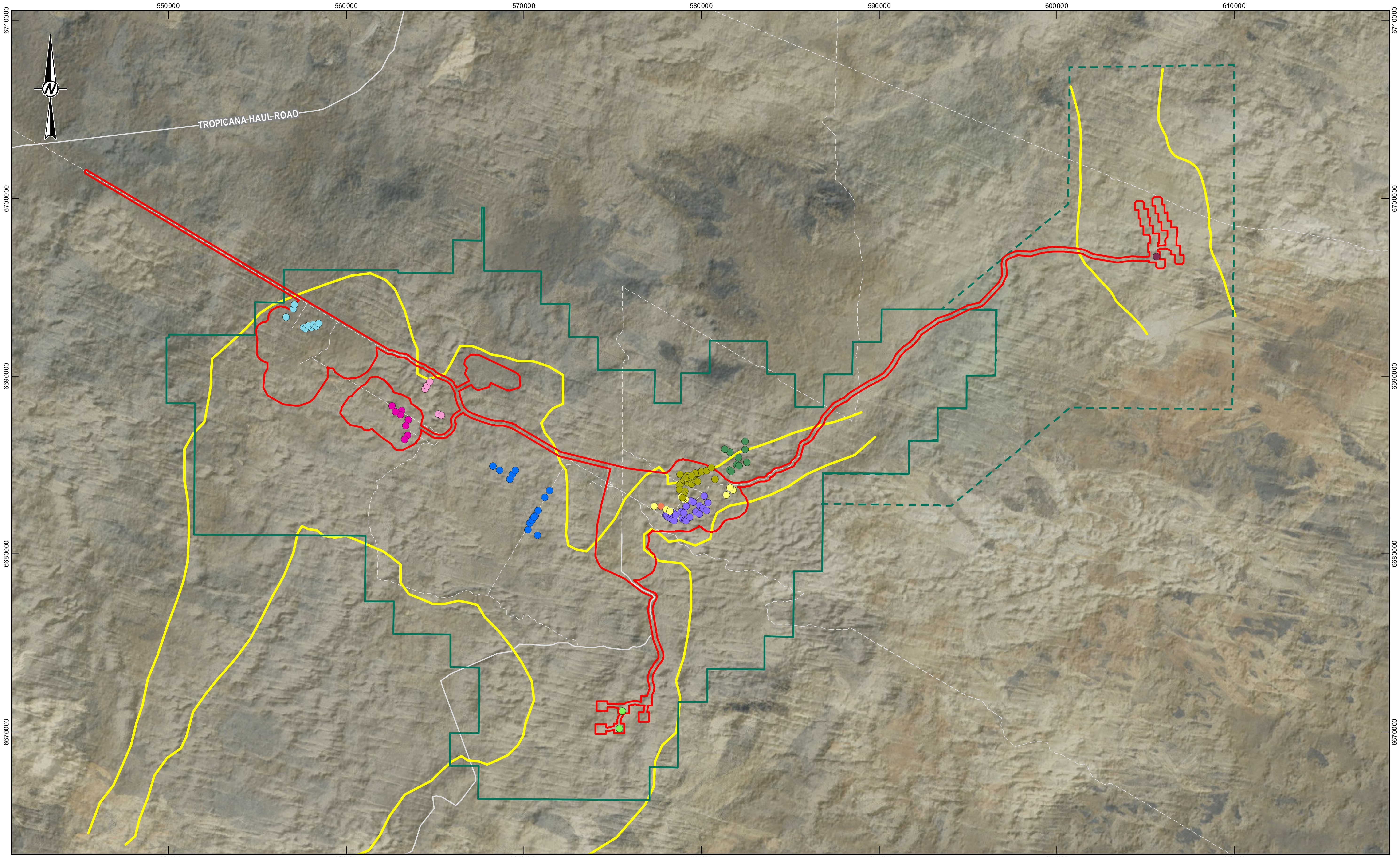
However, the data available has been summarised in Section 10.3 (Hydrological processes) and provides an insight into the chemistry of surface waters accumulated within large scarce claypans (absent within the Development Envelope) and short-lived surface accumulations within localised depressions, both characterised by very low salinities and mildly acidic to neutral (pH 5.2 to 6.4).

11.3.2 Groundwater Quality

11.3.2.1 Mulga Rock Paleochannel

Groundwater quality within the Mulga Rock paleodrainage channel has been characterised by assessing 448 water samples collected from 247 drill holes throughout the overall Project area from 1985 to present using a variety of techniques, including air-lifting, pump sampling and low flow sampling methods. Data on water levels, salinity and acidity were compiled and contour maps constructed to show their distribution. The location of the various boreholes sampled is shown in Figure 11.1. Contours of salinity and pH are shown in Figure 11.2 and Figure 11.3.

Analyses for a further 50 samples from 38 historical drill holes (PNC, Uranerz, Manhattan Corporation) from the west and east arms of the Mulga Rock paleochannel and the Ponton Creek section of the regional Lake Raeside drainage system were also compiled in order to get a better understanding of groundwater quality downstream of the MRUP.



LEGEND

PALAEOCHANNEL	AMB W	AMB	MRUP DEVELOPMENT ENVELOPE
MINOR ROAD/TRACK	EMP	PRINCESS	PROJECT BOUNDARY (MINING TENURE)
ROAD	KAKAROOK NORTH	PROSPECT 1	PROJECT BOUNDARY (MISCELLANEOUS TENURE)
PROSPECT	PRINCESS	SHO	
AMB DOWNSTREAM	PRINCESS NE		
AMB E	SHO NE		

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 5 10
1:200,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-16
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
DRILL HOLES SAMPLED WITHIN THE PALEOCHANNELS

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	11.1

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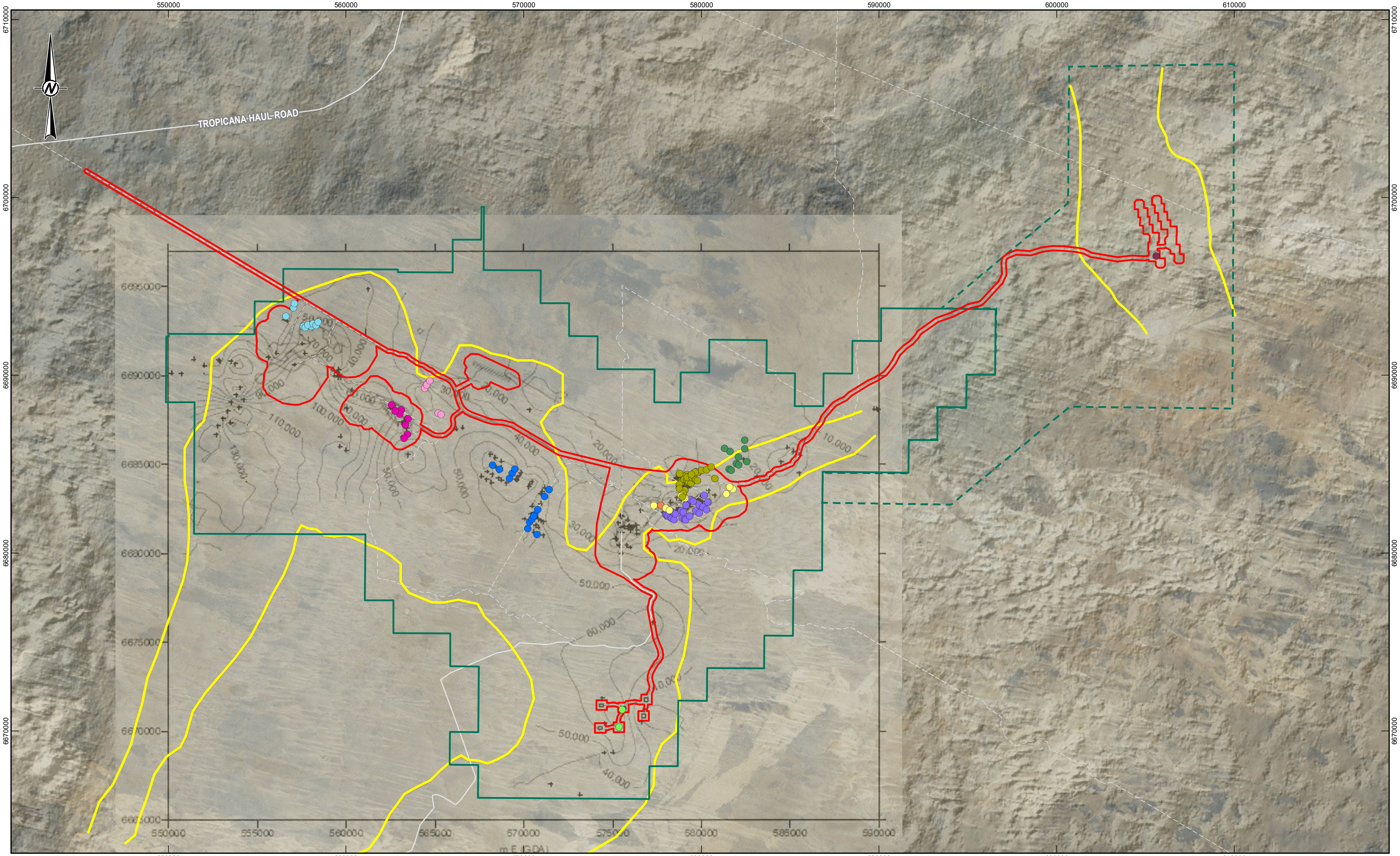

LEGEND

- PALAEOCHANNEL
- MINOR ROAD/TRACK
- ROAD

PROSPECT

- AMB DOWNSTREAM
- AMB E
- AMB W
- EMP
- KAKAROOK NORTH
- PRINCESS
- PRINCESS NE
- SHO NE
- AMB
- PRINCESS
- PROSPECT 1
- SHO
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-06
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SALINITIES (mg/L TDS) MEASURED AT VARIOUS TIMES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	11.2

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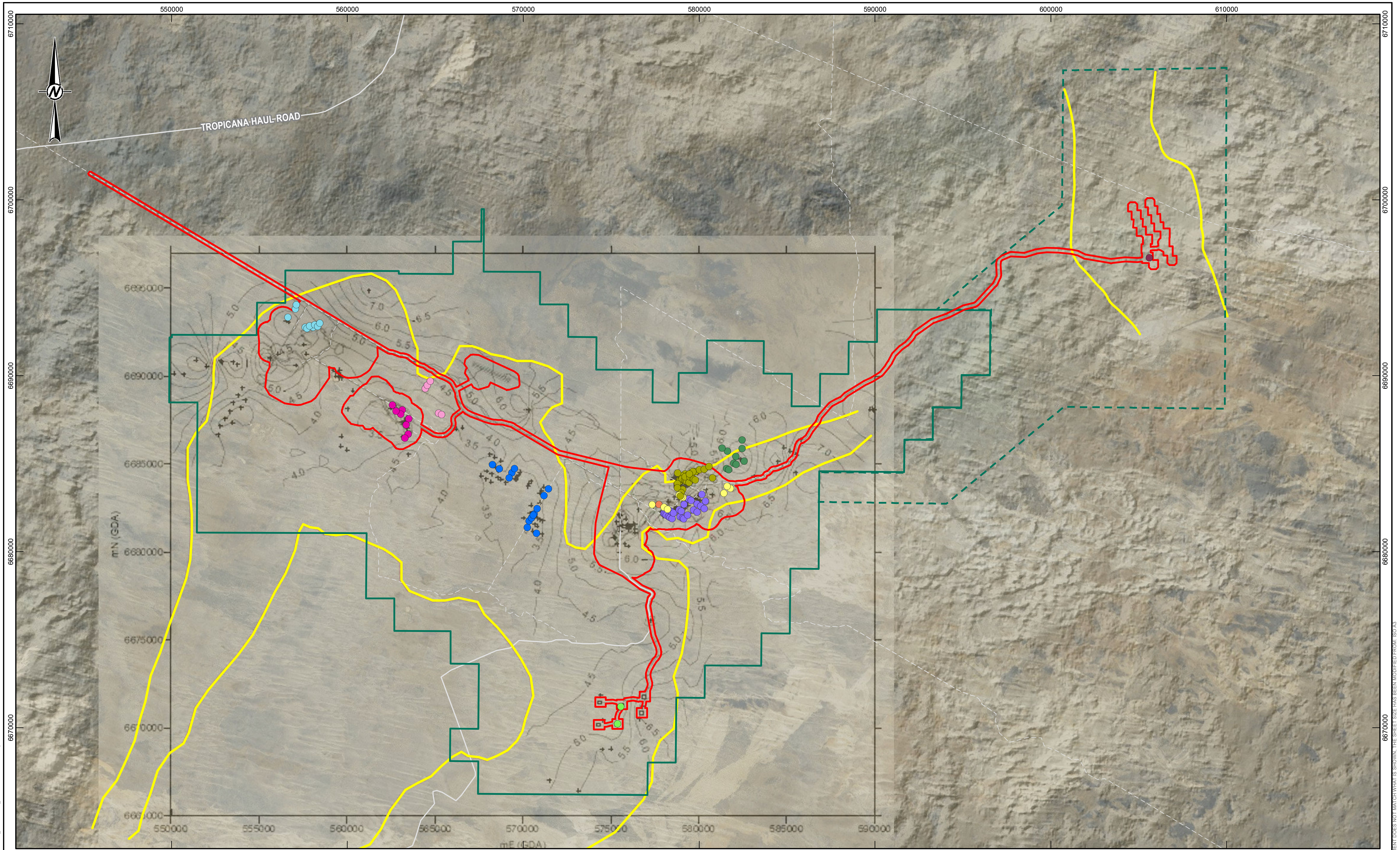


LEGEND

PALAEOCHANNEL
MINOR ROAD/TRACK
ROAD

PROSPECT

AMB DOWNSTREAM
AMB E
AMB W
EMP
KAKAROOK NORTH
PRINCESS
PRINCESS NE
SHO NE
AMB
PRINCESS
PROSPECT 1
SHO

MRUP DEVELOPMENT ENVELOPE
PROJECT BOUNDARY (MINING TENURE)
PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 5 10

1:200,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT

YYYY-MM-DD	2015-11-06
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
pH MEASURED AT VARIOUS TIMES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	11.3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

The pH of water is as low as 2.6 and up to as high as 7.9 with an average of 4.1 (Appendix D2). Similarly the salinity of the water also varies considerably ranging from as little as around 6,000mg/L TDS up to 147,000mg/L with an average of 58,000mg/L (Appendix D2). Notwithstanding the considerable variation, the water is best characterised as saline to hypersaline and generally acidic with low metal concentrations and oxidation reduction potentials (ORP) (Appendix D2).

Relative to other paleochannel aquifers from the Yilgarn, the MRUP groundwaters are reduced, with most of the samples at or below the ORP required for the reduction of iron oxides/hydroxides from a Fe^{3+} to Fe^{2+} valence (Appendix D6). The high iron and sulphate concentrations combined with the low ORP are consistent with early stage oxidation of the sulphide minerals, with a single record from the Ambassador deposit showing potential active bacteriologically-mediated reduction of sulphates (Appendix D6).

The major elements' chemical variability is likely a characteristic of the variability of the water source. Ambassador pit is located within a tributary paleochannel with multiple water sources, while both Shogun and Emperor are considered to be within the main paleochannel (Appendix D2). Groundwaters within the latter are more saline, depleted in potassium, calcium and strontium and enriched in aluminium, iron and manganese than those present at Ambassador, with both of a sodium chloride type with elevated magnesium and sulphate. Piper trilinear diagram analysis indicates that the portions of the major ions are similar to seawater.

Metals, metalloids and various radionuclides throughout the main paleochannel and tributaries are generally at low concentrations, increasing with decreasing pH (for cadmium, copper, lead, cobalt, nickel, uranium - Appendix D8).

This is particularly pronounced within the sections of the Mulga Rock paleochannel aquifer most enriched in organic matter. Concentrations in radium in both the paleochannel and Ambassador tributary show a greater range than that of uranium or thorium, consistent with elevated barium concentrations and secular radiometric disequilibrium observed throughout the project. All waters in the main paleochannel appear to be in equilibrium with barite, with some water samples in the mineralised zone of the Ambassador deposit showing oversaturation (through solubility indices greater than 0), pointing to localised precipitation (Appendix D6).

The potential for additional downstream capture of metals, metalloids and radionuclides in the Mulga Rock paleochannel aquifer and extension is illustrated by additional uranium prospects along the East Arm of the channel, including within the Queen Victoria Nature Spring Reserve (Appendix D8).

Whilst broadly continuous along the length of the paleochannel, the groundwater system is characterised by a clear density layering across the Mulga Rock paleochannel and its Ambassador tributary (Appendix D8). This layering is consistent with the lateral boundaries and inflows to the paleochannel aquifer, deeper groundwater having greater disconnection from the rainfall recharge and greater opportunity for rock-water interaction between the deeper paleochannel and surrounding fractured bedrock aquifers.

This is also supported by geophysical imaging showing a clear localised disconnect between deeper (and more saline) brines from the shallower aquifer within the southern section of the Ambassador deposit and the main Mulga Rock paleochannel (Appendix D8). This important feature of the current hydrogeological system at Mulga Rock will result in potential tailings leachates (which are characterised by lower salinities than that of the shallowest aquifer) preferentially moving through the least transmissive and most reactive portion of the saturated sediments within the paleochannel and tributary sediments.

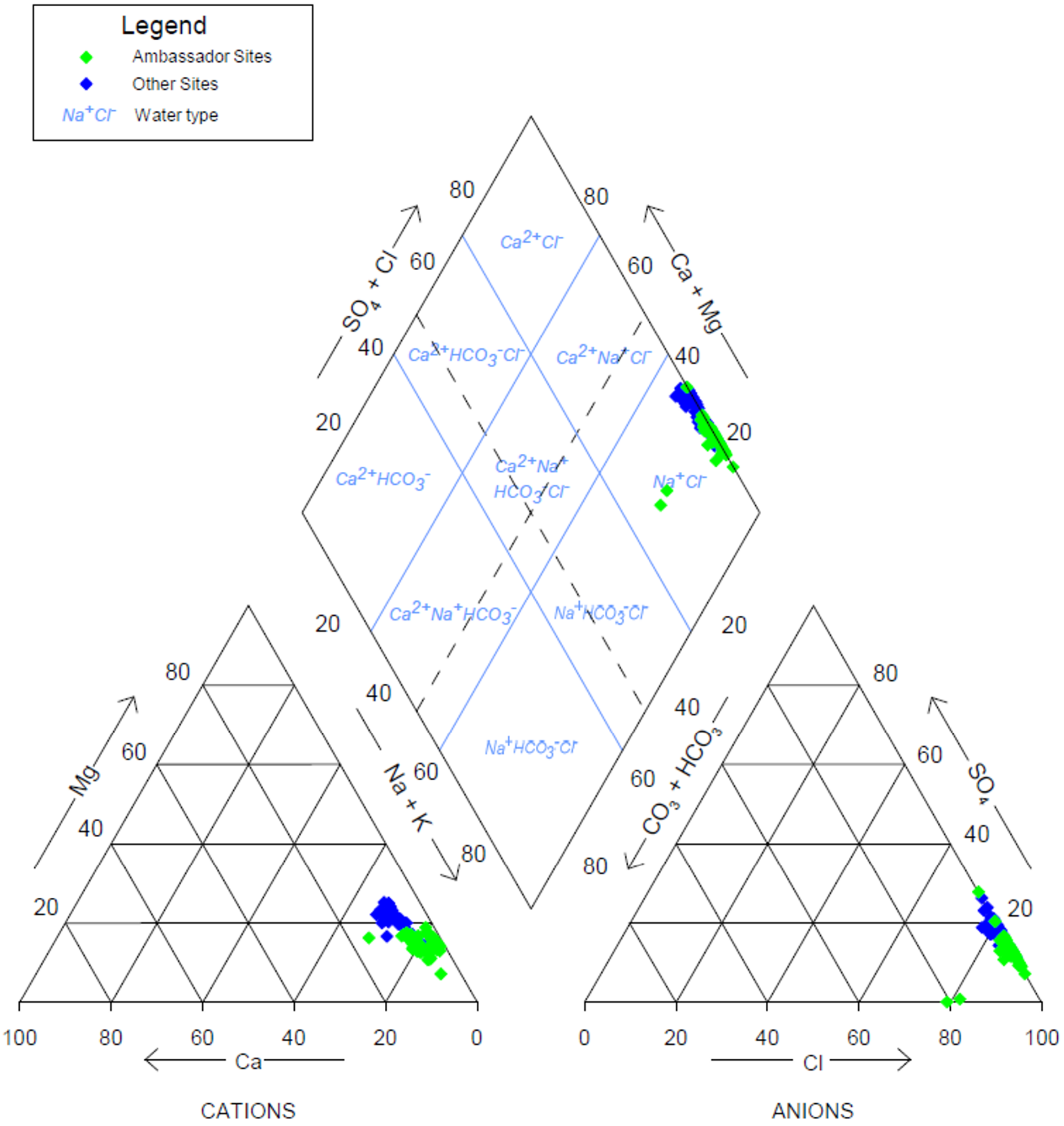
Detailed water quality data for the proposed mining areas within the Mulga Rock paleochannel aquifer are presented in Table 11.1. This aquifer system is relatively stagnant with very low hydraulic gradients to the south and very slow flow rates. Hydrogeological modelling of the proposed project (Appendix D2) identified that liquid within the layer with the highest permeability would be expected to travel a distance of only 2.8km over 1,000 years.

11.3.2.2 Kakarook-Kakarook North aquifers

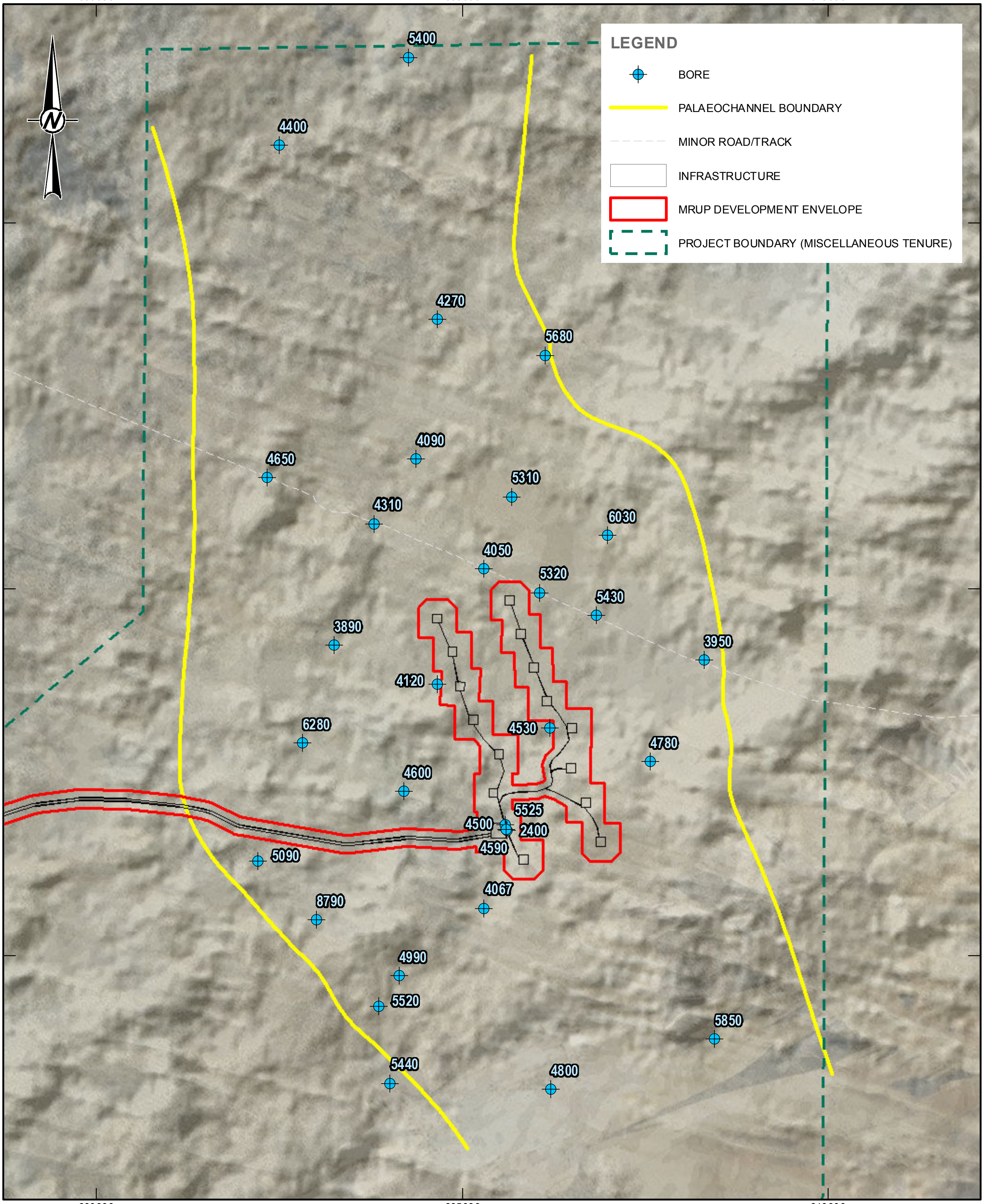
Groundwater quality within the Kakarook-Kakarook North aquifers has been characterised by assessing 117 water samples collected from 55 drill holes from the broader Kakarook region from 1982 to present, using a variety of techniques, including air-lifting, pump sampling and low flow sampling methods. The water quality in these graben-hosted sandstone aquifers is circum-neutral, with pH values varying from 5.0 to 7.7, and salinity (as expressed by TDS) values between 1,500 and 9,200mg/L, with an average of 5,527mg/L and median of 4,700mg/L (Table 11.2). This water contains low levels of base cations and anions, and low concentrations of most metals and metalloids.

The groundwater in this aquifer system is of a mildly acidic to mildly alkaline sodium chloride type, with moderately high sulphate concentrations (up to 1,400mg/L) and ORPs varying from 34 to 295mV. Piper trilinear diagrams are shown in Figure 11.4, whilst the spatial distribution of salinity levels within the aquifer is shown in Figure 11.5.

As discussed in Section 10.3 (Hydrological Processes), the higher salinities were mostly found at the edges of the trough where the aquifer is thinnest, water flow more limited and rock-water interaction at its highest.



CLIENT	VIMY RESOURCES LIMITED
PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT	Golder Associates
YYYY-MM-DD	2015-11-06
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR
TITLE	PIPER DIAGRAM OF GROUNDWATER SAMPLES MULGA ROCK DEPOSITS
PROJECT NO.	1540340
CONTROL	PER
REV.	0
FIGURE	11.4



NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
PALAEOCHANNEL DATA SOURCED FROM ROCKWATER (2015d)
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 1 2 3 4 5
1:75,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT

YYYY-MM-DD	2015-11-06
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

TITLE
GORUNDWATER SALINITY (mg/L TDS)
KAKAROOK NORTH BORE LOCATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	11.5

Path: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\SH5107_MINIGWAL\1540340\Projects\PER\Rev0\1540340-PER-F011.5-Rev0.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A4
25mm

11.3.3 Identified Environmental Values

Based on the above baseline survey data the environmental quality of the various groundwater systems within the MRUP can be summarised as:

- Water quality within the main channel of the Mulga Rock paleochannel system is highly to moderately acidic and generally saline to hypersaline with high sulphate concentrations and low ORPs. These properties restrict the potential applications of this water, limiting it to only mineral processing purposes, and restricts the potential habitat for stygofauna (Appendix C2). Three phases of stygofauna sampling have occurred within the Mulga Rock paleochannel, and all studies have failed to locate any stygofauna, despite a number of these bores having been established for over 30 years and having screens with large slots. This reinforces the fact that the paleochannel and tributaries groundwater chemistry and host sediments are not conducive to GDEs.
- Upstream tributaries to the main Narnoo Paleochannel typically have improved water quality due to recharge of infiltrating rainfall and discharge into the main channel; hence it is more frequently replenished into the main channel. Although this is the case, this water still has limited uses and potential for stygofauna habitat.
- Water quality within the isolated graben-hosted sandstone aquifers of the proposed extraction borefield are generally of reasonably good quality, although still too saline for direct potable, irrigation and livestock applications and has the potential to support subterranean fauna. Subterranean fauna of limited diversity and abundance was observed during a pilot study (comprising two oligochaetes and one nematode potentially captured above the water table and not technically a stygofauna, Appendix C2), with an interpreted habitat extending well beyond the boundaries of the proposed extraction borefield, given the lateral extent of the host sediments and aquifers.
- There are no identified environmental receptors located around or downstream of the proposed mining areas.

Table 11.1 Groundwater Quality Data for Narnoo Paleodrainage Channel

Parameter	Units	Ambassador			Shogun			Emperor			Reinjection Borefield		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Basic Properties													
pH	-	3.50	8.05	6.36	2.91	5.47	3.71	2.89	7.90	4.35	3.93	6.90	4.96
TDS	mg/L	720	75,200	22,047	26,600	113,400	58,289	6,067	146,900	64,860	6,400	73,900	47,951
Conductivity	uS/cm	1,300	122,000	35,928	23,600	177,200	96,540	11,689	229,600	101,605	9,500	121,000	74,246
ORP	mV	-364	335	19	151	167	157	108	108	108	-57	295	159
Redox	mV	-9	181	59	157	157	157	-	-	-	38	181	114
Alkalinity	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Base Cations and Anions													
Cl	mg/L	330	38,000	12,410	7,029	56,090	36,145	17,470	75,620	38,578	2,900	41,000	27,151
Na	mg/L	190	24,000	7,194	4,150	34,500	21,443	10,500	45,000	22,778	1,500	24,000	16,022
K	mg/L	8	740	229	93	675	428	220	935	521	110	610	433
Ca	mg/L	15	1,185	488	438	790	587	220	710	480	150	540	440
Mg	mg/L	19	2,400	716	358	3,195	1,957	550	3,995	2,097	270	2,400	1,650
Fe	mg/L	0.1	51.0	5.5	2.1	55.0	24.7	0.3	190.0	29.9	0.6	10.0	7.2
HCO_3	mg/L	4.9	2,100.0	183.0	0.6	15.0	4.3	0.6	165.9	53.6	6.0	99.0	45.4
$CaCO_3$	mg/L	3.9	1,700.0	200.5	-	-	-	-	-	-	29.0	81.0	45.5
SO_4	mg/L	8	5,600	2,489	3,900	11,500	8,482	2,460	13,600	7,033	880	8,000	5,257
Cl/SO_4	mg/L	3.3	5.9	4.8	1.0	18.0	4.6	0.1	20.0	3.4	3.3	5.1	5.2
NO_3	mg/L	0.10	11.00	3.75	0.10	2.00	1.05	0.70	0.80	0.75	-	-	-
Trace Metals and Metalloids													
As	mg/L	0.030	0.030	0.030	0.009	0.009	0.009	0.002	0.004	0.003	0.026	0.026	0.026
Au	mg/L	0.005	0.021	0.011	-	-	-	-	-	-	-	-	-

Parameter	Units	Ambassador			Shogun			Emperor			Reinjection Borefield		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
B	mg/L	0.85	2.70	1.57	0.03	0.03	0.03	0.03	0.03	0.03	3.00	7.20	5.17
Ba	mg/L	0.02	0.16	0.05	-	-	-	-	-	-	0.02	0.08	0.04
Be	mg/L	0.01	0.02	0.01	22.50	46.40	34.45	30.90	71.40	51.15	-	-	-
Br	mg/L	3.30	23.30	15.67	0.01	0.01	0.01	0.00	0.01	0.01	-	-	-
C	mg/L	0.001	0.377	0.054	-	-	-	-	-	-	-	-	-
Cd	mg/L	0.001	0.319	0.037	0.002	0.077	0.040	0.012	0.012	0.012	0.004	0.004	0.004
Cr	mg/L	0.002	0.065	0.010	-	-	-	-	-	-	0.025	0.027	0.026
Cs	mg/L	0.001	0.022	0.012	-	-	-	-	-	-	-	-	-
Cu	mg/L	0.005	2.800	0.433	0.011	0.011	0.011	-	-	-	0.022	0.980	0.240
Co	mg/L	0.005	4.000	0.581	0.400	0.700	0.550	0.200	0.800	0.467	0.015	0.024	0.020
F	mg/L	0.600	0.600	0.600	-	-	-	-	-	-	0.400	0.600	0.500
Hg	mg/L	0.000	0.000	0.000	0.300	0.520	0.410	0.630	0.940	0.785	0.000	0.001	0.001
I	mg/L	0.010	0.770	0.334	0.004	0.022	0.013	0.008	0.017	0.013	-	-	-
Pb	mg/L	0.001	3.100	0.200	-	-	-	-	-	-	0.005	0.110	0.045
PO4	mg/L	0.010	4.890	1.233	-	-	-	-	-	-	-	-	-
Mo	mg/L	0.008	0.035	0.018	1.450	1.640	1.545	0.950	1.800	1.375	-	-	-
Mn	mg/L	0.050	3.100	0.921	-	-	-	-	-	-	0.094	1.600	0.802
N	mg/L	-	-	-	0.010	0.070	0.043	0.020	0.070	0.045	-	-	-
Ni	mg/L	0.006	3.800	0.406	-	-	-	-	-	-	0.023	0.180	0.066
Sb	mg/L	0.005	0.015	0.010	4.400	14.700	8.033	3.300	40.000	23.167	-	-	-
Si	mg/L	0.3	34.0	11.0	-	-	-	-	-	-	12.0	53.0	26.8
Se	mg/L	0.007	0.100	0.039	9.700	10.100	9.900	7.700	8.800	8.250	-	-	-
Sr	mg/L	1.700	11.800	5.960	0.005	0.005	0.005	0.006	0.009	0.007	-	-	-

Parameter	Units	Ambassador			Shogun			Emperor			Reinjection Borefield		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Th	mg/L	0.005	10.000	1.574	-	-	-	-	-	-	-	-	-
Tl	mg/L	0.000	0.001	0.000	0.007	0.007	0.007	0.007	0.030	0.018	-	-	-
U	mg/L	0.002	0.068	0.021	-	-	-	-	-	-	-	-	-
V	mg/L	0.002	0.009	0.005	-	-	-	-	-	-	-	-	-
W	mg/L	0.003	0.005	0.004	-	-	-	-	-	-	-	-	-
Y	mg/L	0.002	0.008	0.004	0.035	0.180	0.128	0.015	0.155	0.085	-	-	-
Zn	mg/L	0.005	13.000	1.259	-	-	-	-	-	-	0.150	2.400	0.484

Table 11.2 Groundwater Quality Data for the Kakarook Borefield

Parameter	Units	Kakarook Borefield		
		Min	Max	Average
Basic Properties				
pH		5.0	7.7	6.7
TDS	mg/L	1,500	9,200	5,527
Conductivity	uS/cm	2,340	14,400	8,640
ORP	mV	34	295	172
Redox	mV	-21.9	127.3	36.48077
Alkalinity	mg/L	2	120	40.04
Base Cations and Anions				
Cl	mg/L	222	6300	2423
Na	mg/L	146	3600	1313
K	mg/L	11	240	85
Ca	mg/L	10	250	125
Mg	mg/L	14	530	209
Fe	mg/L	0.05	8.30	0.71
HCO_3	mg/L	0.01	170	53.9
$CaCO_3$	mg/L	0.01	140	49.3
SO_4	mg/L	74	1,400	796
Cl/SO_4	-	1.9	4.0	3.1
NO_3	mg/L	0.7	20.7	7.3
Trace Metals and Metalloids				
As_mg_L	mg/L	0.008	0.28	0.057
B_mg_L	mg/L	1.5	4.3	2.179
Ba_mg_L	mg/L	0.019	0.075	0.043
Be_mg_L	mg/L	0.005	0.005	0.005
Cd_mg_L	mg/L	0.001	0.0039	0.002
Cr_mg_L	mg/L	0.005	0.3	0.105
Cu_mg_L	mg/L	0.005	0.061	0.021
Co_mg_L	mg/L	0.035	0.43	0.155
F_mg_L	mg/L	0.2	1.5	0.617
Hg_mg_L	mg/L	0.00007	0.00008	0.00008
Pb_mg_L	mg/L	0.005	0.23	0.053
Mn_mg_L	mg/L	0.021	1.3	0.247
Ni_mg_L	mg/L	0.012	0.43	0.066
Sn_mg_L	mg/L	0.005	0.042	0.014
Se_mg_L	mg/L	0.013	0.018	0.015
Th_mg_L	mg/L	0.005	8	2.672
U_mg_L	mg/L	0.008	0.15	0.035
Zn_mg_L	mg/L	0.01	1.7	0.095

11.4 Water Balance

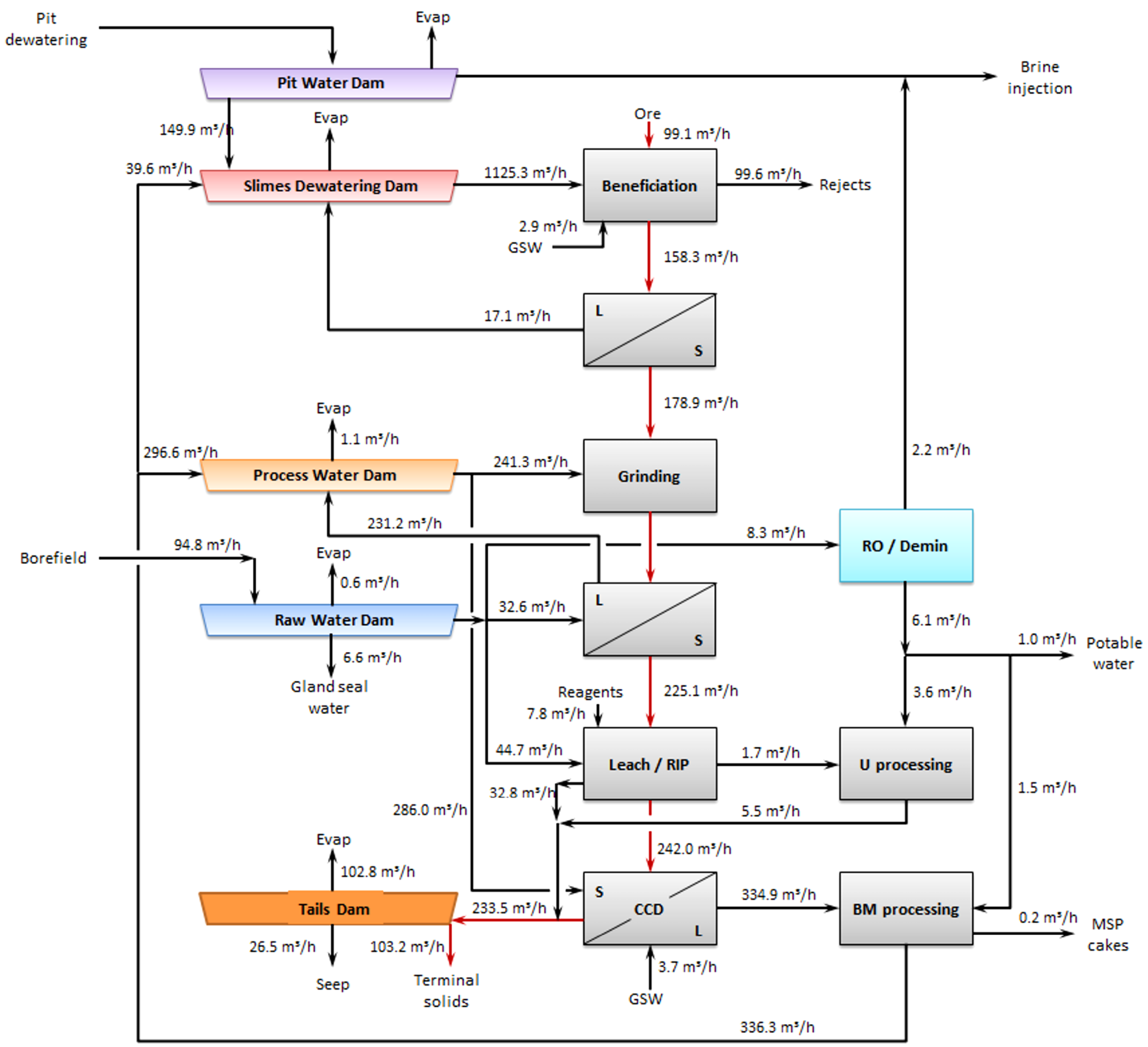
The exact water balance will be a function of a number of different parameters and a schematic of the various water flows and input-outputs are provided in Figure 11.6:

- The mining schedule will determine the amount of mine dewatering water that needs to be extracted in order to dewater the ore in advance of mining it. It has been estimated to average less than 0.5GL/a over the life of the mine (16 years) and to peak at around 1.5GL/a (Appendix D2) in Year 10 of the operation. A sensitivity analysis suggested that in a worst case scenario dewatering flows could be up to 50% higher in years when mining intercepted the deeper high permeability Eocene sands (Appendix D2). Moreover in years when the dewatering requirement to facilitate mining requires the extraction of less than 0.85GL/a, additional dewatering will be undertaken to provide sufficient water to use in the initial stages of processing (beneficiation) and for other mine operations related purposes.
- In years when the mining schedule requires more than 0.85GL of water to be extracted, the surplus water from this dewatering operation (i.e. the extent to which it is above the 0.85GL required for processing and other mine operations related purposes) will be reinjected into the reinjection borefield. The amount being reinjected will therefore vary between zero, when dewatering water extracted is less than 0.85GL up to around 0.65GL/a when the dewatering is at 1.5GL/a. The quality of this water will depend on the area being mined and will essentially be the same as the mine dewatering water as described above.
- The amount of water needed to be extracted from the extraction borefield (Kakarook North) will depend on the salinity of the water being extracted and in particular the chloride levels in the water and the interaction between the chloride ions, the uranium ions and the resins being used. Basically the lower the chloride levels the greater the number of times the water can be recycled within the processing and leach circuit and therefore the less water will be required to sustain the operations. The working assumption based on expected salinity levels and the efficiency of the resins in a high chloride environment is that around 1.8GL of processing water will need to be extracted from the extraction borefield on an annual basis. The quality of the water extracted from the Kakarook North borefield is expected to average under 6,000mg/L TDS (for a chloride concentration of around 3,000ppm) and the pH is expected to be around 5.5 to 6.5.
- Reject process water will co-disposed of with tailings; the volume of this rejected process water will approximate the level of water extracted from the extraction borefield at around 1.8GL/a, plus the pit water used in processing of around 0.8GL/a, making a total of approximately 2.6GL/a going to tails. The salinity will be determined by the resin tolerance to the presence of chlorides and the pH will be around 4-4.5 as a result of the two-step neutralisation associated with the precipitation of the base metals.

There is currently no requirement envisaged for the use of evaporation ponds as the preferred method of disposal of surplus mine dewatering water is to reinject the surplus back into the same aquifer at a downstream location. Current estimates suggest that the volume of water needed to be reinjected will not exceed around 0.7GL in the year when there is the most surplus water requiring reinjection and that the aquifer will easily be able to accommodate this volume (Appendix D2).

MULGA ROCK WATERBALANCE SCHEMATIC

All flows in m^3/h water or aqueous.



CLIENT
VIMY RESOURCES LIMITED

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT

YYYY-MM-DD	2015-11-06
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

TITLE
SITE WATER BALANCE DIAGRAM

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**11.6**

11.5 Radionuclide Distribution in Groundwater and Other Flows

A detailed analysis of the groundwater at Kakarook North (Appendix D1) shows both uranium and thorium levels in the water to be below 0.01mg/L, with the higher average values expressed in Table 11.2 due to anomalously high values obtained prior to 1985.

Analysis of water samples taken from the Mulga Rock paleochannel (Table 11.1) also shows uranium and thorium levels in the water mostly around or below the detection limit of 0.005mg/L, with this being due to the extraction of these elements from the water column onto the solid-phase of the carbonaceous Eocene sediments. Localised elevated levels were reported (Table 11.1), but these are mostly taken from pre-1985 monitoring.

The water that will be reinjected will only be surplus mine dewatering water in years when a surplus occurs. The radionuclide content of this water will be the same as the groundwater in the area from where it is being extracted. The radionuclide content of the groundwater dewatered in the mining areas is equivalent to the concentrations in the reinjection area.

Waste process water will be sent for disposal within tailings facilities (both above-ground and subsequently in-pit) along with processing tails. The processing of the ore will have extracted the majority of the uranium but in terms of radionuclides only around 27% of activity would have been removed (ANSTO 2015). Most of the radionuclides are expected to remain unaffected by the leaching and precipitation processes and remain in the solid matter and to a lesser extent the barren liquors. The radionuclide composition of tailings seepage was estimated to have a level of activity in the range 100-150Bq/L with the main contributors being Lead-210 (^{210}Pb) and Radium-226 (^{226}Ra). Modelling showed that both these radionuclides in tailings drainage would be captured rapidly by the carbonaceous material through which the tailings plume would pass as is detailed in Section 11.7.

Given its relatively long half life, the fate of Radium-226 is the element of most interest in regards to potential downstream migration of radionuclides from tailings leachates.

The behaviour of radium is similar to that of barium due to the similarity of their ionic radii and electronegativity. In waters with high sulphate concentrations such as is the case at Mulga Rock, most of the radium will be present in the sulphate form, with a much smaller fraction in a chloride form. Barium concentrations in groundwaters at Mulga Rock will be controlled by the precipitation of barite (a barium sulphate). Barite can incorporate radium in solid solution as (Ba, Ra) SO_4 also referred to as radiobarite.

Aside from precipitation of radiobarite, radium is readily adsorbed to clays and mineral oxides present in the host sediments, with sorption generally decreasing with decreasing pH. Overall, radium is less efficiently sorbed onto iron oxides and more efficiently sorbed onto secondary minerals with high cation exchange capacity than is uranium (IAEA 2014), such as clays which generally have a high specific surface area due to their fine grained nature. Sediments collected from the downstream extension of the Ambassador tributary showed greater CEC values than those assumed for geochemical modelling purposes (27 and 5-25 meq/100g respectively, Appendix D8). Studies not related to the project have also shown that organic matter adsorbs approximately ten times more ^{226}Ra than clays in unconsolidated sediments (IAEA 2014).

11.6 Waste Characterisation

The waste is likely to consist of three main groups or material types.

1. Oxidised overburden
2. Partially oxidised
3. Process tailings from unoxidised ore.

The mined ore will be sorted into different size fractions. The coarser material, larger than 2mm, will be screened and sent to the processing plant. The material less than 2mm will be de-slimed using upward classifier and the fine material, less than 0.045mm, will be sent to the processing plant. The remaining mid-sized material (between 0.045mm and 2mm) will be beneficiated. The reject material from the beneficiation process will consist primarily of silicates, which will make up around 80-85% of the mass. Almost all the metals and metalloids in the ore will remain with the carbonaceous material and go to processing. The uranium content of the rejects material is estimated to be around 40ppm.

All of the material going into the processing plant leaves as either product (uranium oxide concentrate and some base metal precipitates of cobalt, nickel, copper and zinc) or it goes to the tailings storage facilities as waste.

Geochemical characterisation of the overburden and ore materials has been undertaken by ANSTO (ANSTO 2015) as reported in SWC (Appendix D7) to assess the acid forming potential of the materials. In this work, the multi-elemental composition of the solid-phase has been quantified, either using ICP-OES/MS or XRF and standard Acid Rock Drainage (ARD) techniques (i.e. AMIRA 2002). ANSTO Minerals also carried out leach test work from ore samples provided by Vimy in order to generate leachates from the ore vial the Australian Standard Leachate Procedure (ASLP) method. The ASLP method was considered appropriate given that this method crushes the materials to a similar size to that likely to be produced through the mining process.

The results of the geochemical characterisation are summarised below:

- Overburden materials to within 2 – 5m of the water table are classified as Non-Acid Forming (NAF), with negligible Acid and Metalliferous Drainage (AMD) potential.
- The basal 2 – 5m of the Oxidised Eocene sediments (Overburden) likely contains residual sulphides and elevated mobile metals likely bound to sulphates phases.
- The Overburden materials are inherently moderately acidic (pH 4 – 6) and have low salinities (EC < 100mS/m) in response to an extensive period of weathering and leaching.
- The Ore material is classified as Potential Acid Forming (PAF), with average Total S contents of 1.64% across the orebody and an associated sulphide-S content (80 – 90% of the Total S) of 1.3 – 1.5%. This equates to a Maximum Potential Acidity of around 43kg H_2SO_4/t. Given the ore material also exists in an acid condition, due to previous (and possibly contemporaneous) sulphide oxidation, it contain no effective or readily available Acid Neutralising Capacity (ANC), and thus the MPA is equivalent to the Net Acid Producing Potential (NAPP). The corresponding Net Acid Generation (NAG) of the orebody varies from 15 to 57 H_2SO_4/t.
- ASLP testing of the Ore material shows that Al, Cd, Co, Fe, Se and Zn are expected to leach preferentially from lignite ore material, with all other elements assessed as being below the limits of reporting in the leachate.

Assay data from the exploration phase of the project have not been included in this assessment.

11.6.1 Tailings

ANSTO Minerals leached the ore described above in sulphuric acid to generate a material that would approximate the potential tailings for the MRUP (ANSTO 2015 and Hart 2013).

ANSTO described the tailings material as being potentially more acidic and had higher levels of cobalt, copper, nickel and zinc than are likely to be present in what is ultimately produced (ANSTO 2015). Once the variability of the geological materials at the site has been fully reported this statement will be better justified.

Tailings were further assessed to ascertain how the tailings could be expected to behave and in particular what was likely to leach from such tailings under slightly saline oxidised conditions (Appendix D8). A solution of a synthetic water was produced (the composition was based on an analysis of borefield water provided to ANSTO (by Vimy) as the leachant.

The following leachate composition was obtained:

- Aluminium – 6mg/L
- Calcium – 136mg/L
- Cadmium – 0.195mg/L
- Cerium – 0.725mg/L
- Cobalt – 2.1mg/L
- Chromium – 0.075mg/L
- Copper – 8.5mg/L
- Potassium – 0.245mg/L
- Lanthanum – 0.245mg/L
- Magnesium – 0.09mg/L
- Sodium – 1797mg/L
- Neodymium – 0.37mg/L
- Nickel – 6.3mg/L
- Lead – 7.25mg/L
- Praseodymium – 0.09mg/L
- Scandium – 0.075mg/L
- Selenium < 0.1mg/L
- Silicon – 30.5mg/L
- Strontium – 2.25mg/L
- Thorium < 0.01mg/L
- Titanium – 0.23mg/L
- Uranium – 0.08mg/L
- Vanadium – 0.19mg/L
- Yttrium – 0.27mg/L and
- Zinc – 7.10mg/L.

The chemistry of the resulting leachates with the dominant elements being aluminium, potassium, cobalt, copper, nickel and zinc were expected based on the mineralogical assessment undertaken of the material. The sulphides have dissolved in the acidic leach releasing the associated elements.

Although significant concentrations were recorded for cobalt, copper, nickel and zinc, these metals are likely to be removed by precipitation within the processing plant, thus the levels in any tailings seepage are expected to be lower. This is yet to be quantified. However, aluminium concentration in the seepage provides additional evidence to support the conceptual understanding of the geochemical processes likely to occur as presented at the start of this document; that the acidity within the tailings material may mobilise this element. Importantly the up-front beneficiation process to be applied to the ore will see a greater amount of organic matter present in the actual tailings, enhancing its ability to re-adsorb metals, metalloids and radionuclides.

The issue of potential seepage of these base metals and other metalloids is dealt with in Section 11.7.

The key conclusions of this test work were as follows (ANSTO 2015):

- Although the processing of the ore will extract the majority of the uranium, in terms of radionuclides as measured by their activity, acid leach will only remove around 27% of the total activity within the ore. This is fairly typical of sulphuric acid leach of uranium ores (20-30%).
- Australian Standard Leaching Procedure (ASLP) tests on un-neutralised tailings, without having extracted any base metals, extracted using synthetic site water showed that the radionuclide composition of seepage from tailings could be expected to have a level of activity in the range 100-150Bq/L; the main contributors to this are Lead-210 (^{210}Pb) and Radium-226 (^{226}Ra).
- The salinity of this potential tailings seepage water would be expected to be around 17,000mg/L TDS.
- There is the potential that concentration of base metals found in expected tailings seepage water will be higher than that prevailing in local groundwater.

11.6.2 Mineralogical Studies

CSIRO provided a report on the advanced ore mineralogy of the MRUP (CSIRO 2010). Three samples of ore were examined in detail. The outcome of this study reported that the uranium was not only adsorbed on to the surface of the lignite, but was also present within the lignite cell structure. Thus it was also absorbed (adsorption being added onto something whereas absorption is being added into something). The uranium does not appear to be present within the ore as a distinct mineral but as uraninite nanoparticles and rarer but equally fine grained coffinite coatings. It is disseminated throughout the lignite but its presence does seem to correlate well with the presence of sulphur, sodium, magnesium, and potassium (CSIRO 2010).

Sulphides have been recorded in the ore, with pyrite and covelite being the dominant sulphide minerals recorded (ANSTO 2010, CSIRO 2010). These sulphides are present within both the sandstones (overburden) and the lignites below the base of oxidation. CSIRO reported that the sulphide phases contain lead, copper, uranium, cobalt, in close association with magnesium and aluminium minerals (CSIRO 2010).

Based on these studies, it can be hypothesised that when the uranium is removed from the lignite, sulphur, sodium, magnesium and potassium will also be released. Further, the sulphur is likely to be related to sulphides and these are lead, cobalt, copper phases; thus these elements will also likely be released when the organic matter in the ore are oxidised and or acidified during or post-processing of the ore and tailings deposition.

11.6.3 Planned future geochemical characterisation and radon and thoron emanation test work

Geochemical characterisation, covering primarily AMD, has only been done on a limited number of samples (i.e. 3 ore materials and their derived tailings and only screen testing completed on the overburden materials – Oxidised Eocene and Miocene sediments). Greater characterisation of the ore, tailings and overburden materials are planned to fully characterise the potential and magnitude of the various materials to generate both acidity and metalliferous drainage.

Furthermore, following the completion of two geotechnical investigation trenches at the Ambassador deposit in late 2015-early 2016, Vimy intends on conducting further radon and thoron emanation test work on loose bulk mineralised samples excavated from the base of the trench and measurement of radon and thoron emanation in groundwater in contact with the ore zone in the basal section of the trench. Upon processing of these samples in a pilot plant, similar measurements will be taken of the tailings generated.

11.7 Conceptual Understanding of the Geochemical System at the Mulga Rock Uranium Project

Figure 5.1 provides a summary of the understanding of relationship between mining and mining activities on the geological and hydrogeological units.

The Mulga Rock Uranium Project is situated in paleochannel consisting of carbonaceous clastic lacustrine and estuarine sediments that are enriched in uranium and base metals. The base of oxidation is known to extend to depths of approximately 30 to 50m below the current ground surface. Although described as carbonaceous the carbon is predominantly organic, and not inorganic (carbonate).

Basement rocks (consolidated and in some cases partly metamorphosed sediments or meta-sediments) are thought to be the source of the uranium, with the organic matter contributed by vegetation debris deposited during sedimentation in a flood plain environment; it is that organic matter and the fines fraction of those sediments that contain uranium minerals within the matrix. The organic matter, does not contain uranium minerals in meaningful proportions, the uranium in this media being adsorbed on to the surface of the organic matter, and is highly disseminated.

It is noted that the oxidised organic matter has less of a propensity to adsorb the uranium than organic matter in reducing conditions. This has been demonstrated in other deposits in the region for example the Four Mile East deposit (CSIRO 2010). The enrichment of the base metals is also driven by adsorbtion onto the organic matter's surface. This has been demonstrated by the ore mineralogy study conducted by ANSTO in 2010 which reported that over 50% of the elements of interest were associated with the organic matter in a finely disseminated amorphous state. This was also confirmed through a separate microscopic and Secondary Ion Mass Spectrometry (SIMS) study of uranium concentration in variably oxidised organic matter grains in a lignitic ore (AMTEL 2010), showing a 73-80% drop in uranium concentration in brown (partially oxidised) organic matter grains compared to back ones (unoxidised) and a near total leaching in totally oxidised grains (characterised by high goethite contents).

Sulphides have been recorded in the ore, with pyrite and covelite being the dominant sulphide minerals recorded (ANSTO 2010). These sulphides are present within both the sandstones (overburden) and the lignites below the base of oxidation.

The accumulation of uranium and base metal is likely to be bacterially mediated by obligate anaerobes such as sulphate reducing bacteria (SRB). It is noted that the upper lignitic layer may host both aerobic and anaerobic bacteria (Energy and Minerals 2013).

The highest grade ore is therefore likely to occur below the base oxidation within the lignitic units of the sedimentary sequence.

11.7.1 Natural Release Mechanisms for the Acid and Metals from the Ore

In the oxidised zone, the uranium will be mobile as it is desorbed from the organic matter as the organic matter gradually oxidises to carbon dioxide.

The following reactions will also occur during the oxidation of the sandstones and lignites:

- The sulphides in these units will oxidise to produce sulphuric acid. The resulting acidic conditions and formation of sulphate-complexed uranium, will increase solubility of uranium (through change in speciation); however, the majority of the uranium in the orebody is already present in a hexavalent phase.

- Carbonate will also increase the mobility of uranium and although there are few inorganic carbonates recorded in the sedimentary sequence. It is noted here that the oxidation of organic matter will produce bicarbonate and organic acids as it oxidises, both these products are known to increase the mobility of the elements of interest in this project (CSIRO 2010).

11.7.2 Natural Attenuation

Natural attenuation is the process by which mobile contaminants are captured or removed from solution and immobilised.

This can occur through physical, chemical (geochemical) and biological processes or all three together.

11.7.3 Geochemical Processes

Neutralisation reactions will occur *in situ* when the acid from the pyrite mixes with the alkalinity generated from the oxidising organic matter. This will initiate the formation of gypsum, jarosite and hydrated iron and aluminium oxide and hydroxide phases. These minerals (crystalline and amorphous) have been reported in ore mineralogy studies (ANSTO 2015).

Their formation during neutralisation reaction can be colloidal in the first instance, and with time the colloids can aggregate to form amorphous precipitates. The colloidal phase is a mobile phase.

The amorphous precipitates are known to reduce the hydraulic conductivity of their host units as they fill the pore spaces and coat other mineral surfaces.

The geochemical process of adsorption on these amorphous phases is summarised in Figure 11.7.

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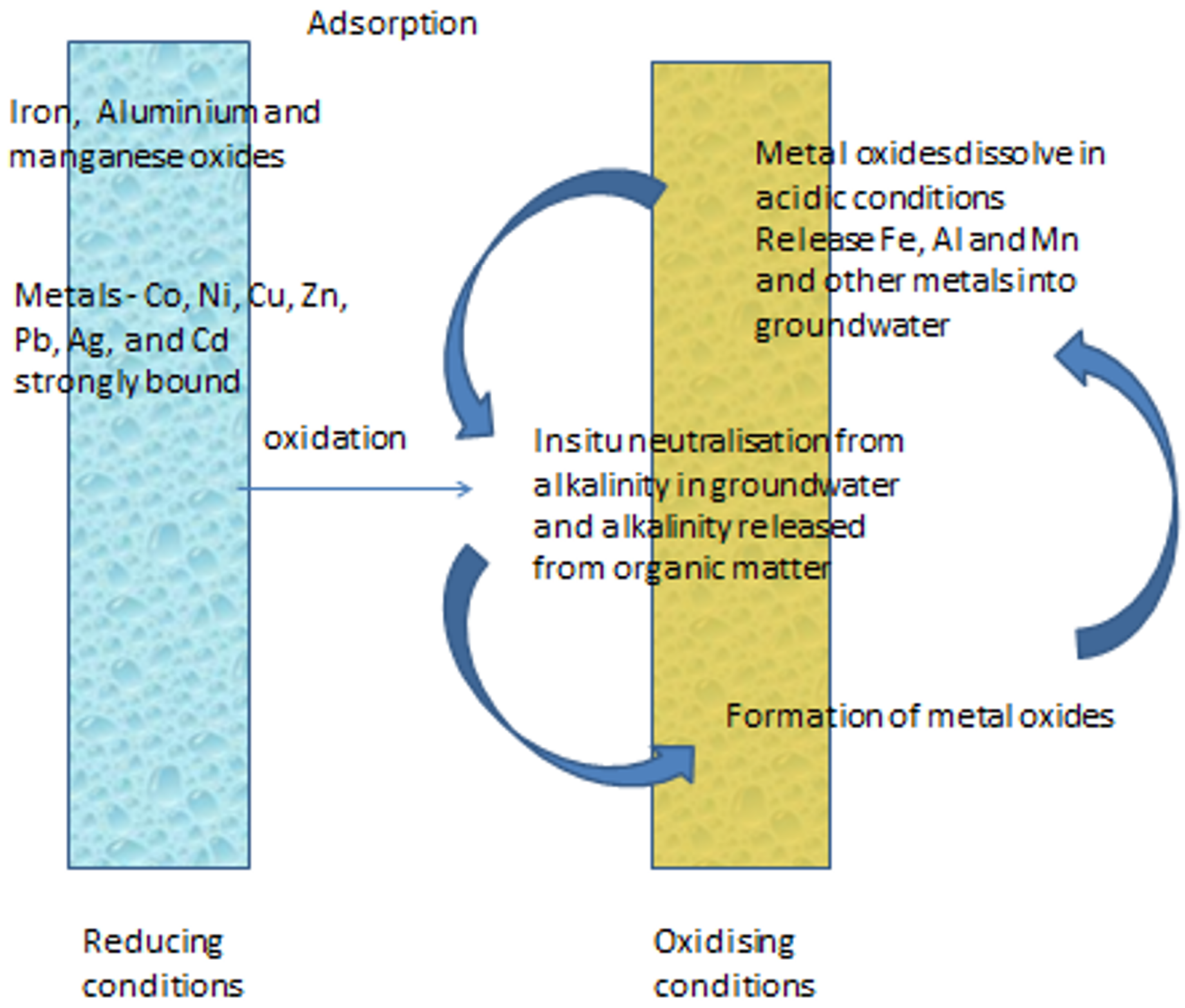

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MULGA ROCK URANIUM PROJECT

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TITLE
GEOCHEMICAL PROCESS OF ADSORPTION ON AMORPHOUS PHASES

PROJECT NO.	CONTROL	REV.	FIGURE
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Through the paleochannel system there is a dynamic system of metal release, complexation (with the labile organics released from the lignites) and adsorption reactions that are possible.

Physical armouring may prevent further pyrite oxidation as the reaction products from neutralisation coat the pyrite grains. CSIRO (CSIRO 2010) demonstrated that the pyrite in the lignite at the site is found in two forms – (i) finely textured and spherical (framboidal); and (ii) crystalline (iodiomorphic or euhedral). The euhedral pyrite having a physical barrier to further oxidation could provide a significant decrease in risk of acidification as it has a smaller surface area to mass ratio. The framboidal pyrite may also be protected from further oxidation but it has the greater potential of being fully oxidised before armouring can take place given the larger surface to mass ratio. It is noted here however, that if the pH of the system lowers to below 3, these products will no longer be stable and will dissolve.

It is recognised that the partial oxidation of organic matter will lower its propensity to provide attenuation of contaminants as this organic matter displays lower fixation capacity (CSIRO 2010). Upon full oxidation the organic matter will likely have released all bound metals including uranium (CSIRO 2010).

11.7.4 Biological Attenuation Mechanisms

The activity of microorganisms in organic-rich media is known to mediate the precipitation of sulphides and various metals. These microorganisms will aid the precipitation of redox sensitive metals such as iron, copper, cadmium, lead, zinc, nickel and uranium and can occur through a variety of processes (Wall, Krumholz 2006):

- Direct enzymatic reduction by microorganisms.
- Indirect reduction through microbial reduction of Fe^{3+}The resulting biogenic Fe^{2+} phases have been shown to reduce U^{6+} (mobile phase) to U^{4+}, which has a low solubility under low pressure and temperature conditions.
- Indirect reduction through microbial sulphate reduction, resulting in the formation of sulphide minerals in the presence of iron.

The product of fixation of uranium by microorganisms has been shown to be nanoparticulate uraninite (Bernier-Latmani *et al.* 2013), akin to that described above, suggesting that the majority of uranium adsorbed on organic matter at Mulga Rock is the by-product of biogenic processes.

Recent work has shown that intermediate fixation of mobile U^{6+} into a non-monomeric form of uraninite can also take place as a result of the production of biofilms or extracellular polymeric substances (EPS) by the microorganisms (Bernier-Latmani *et al.* 2013), a process common in moist or saturated environments and a biological response that improves cellular resistance to metal toxicity. This will act as a further *in-situ* retardant of metals within the tailings facilities, and will facilitate fixation through on-going SRB activity.

Tolerance of the bacteria within the organic matter to elevated uranium concentrations is not well understood however, it has been reported that biological sequestration of uranium can be effective up to concentrations as high as somewhere between 2,000 and 5,000ppm U_3O_8, by which stage radiolytic alteration of the biopolymer constituents of the organic matter and the bacteria it hosts, results in a suppression of its metal fixation potential (Jaraula *et al.* 2014).

11.7.5 How the Mining of these Materials may affect these Attenuation Processes

The dewatering of the pit will likely provide and additional acid load to the system as it will initiate the oxidation of *in situ* sulphides on the pit walls and floor. This will release acids both mineral acids (sulphuric acid) and organic acids.

The materials outside of the mining pit boundaries will be managed in accordance with the strategies outlined in the conceptual Acid and Metalliferous Drainage Management Plan (MRUP EMP 016).

The composition of the tailings is as yet not well defined. Nevertheless, given the likely processes (Figure 5.2), the ore will be leached in a sulphuric acid solution at pH 1.5, the pregnant liquor generated from this leach will contain the majority of the trace elements and will be treated to remove the uranium. The resultant materials will then be neutralised and further processed to remove the cobalt, nickel, zinc and lead.

The residues will likely consist predominantly of calcium sulphate, sodium chloride, aluminium silicates, iron and aluminium hydroxides (based on the mineralogy of the ore units reported by ANSTO 2010); it is acknowledged that trace levels of the other elements cannot be ruled out at the present time.

At pH 4 the residue is acidic, there should therefore not be any free carbonate or bicarbonate in solution as it will have been utilised. The sulphate should have been precipitated as gypsum (calcium sulphate). However, at the low pH, metals that were adsorbed on to the surface of the neutralisation products (aluminium and iron hydroxides) will desorb at this pH and the silicates will gradually dissolve releasing further dissolved aluminium and any other trace elements within their matrix. This release will further increase the acidity of the system, if the pH drops below 3 in the tails, the iron and aluminium hydroxides will start to dissolve, with a concomitant decrease in pH. The residue is reported to contain a high percentage of organic material. This is likely to be a recalcitrant high molecular weight polymeric type material (as it has survived an acid digest and therefore the generation of organic acids from this material is likely to be very slow) consequently this material will unlikely provide much in the way of neutralising potential or attenuation potential, and may be a source of aluminium to the surrounding environment.

Given the above, the placement of tailings will therefore likely provide an additional load of acid to the system.

11.7.6 Attenuation of the Additional Acid Load

The tailings material pH will initially hamper the growth of SRB thereby reducing somewhat their ability to contribute to natural attenuation mechanisms; however over time their growth will gradually increase the pH and with it the effectiveness of this particular biogenic attenuation process. With the high organic and fines content the deposited tails will not produce a free draining dense medium and it will therefore physically impede the transport of the metals and acidity in aqueous solution into the natural environment. For the small amount that does drain, the results of the solute transport modelling conducted by Rockwater (Appendix D10) demonstrate that there is the potential for significant dilution down gradient. This simple mechanism is sufficient to reduce the concentrations of copper and uranium in groundwater by an order of magnitude.

The surrounding physical environment – the paleochannel geometry, groundwater flow patterns and the gradient of density layering – will constrain the physical flows of any acid and associated metalliferous drainage. Attenuation will continue to occur particularly when these flows are through undisturbed reducing conditions with low uranium and base metal bearing organic matter units.

11.7.7 Limitations

The limitations of this conceptual understanding are that there is limited site and project specific data to rely upon. Nevertheless, the studies undertaken as part of the Four Mile East EIA which informed the additional test work completed for the MRUP (ANSTO 2015) provide a basis from which our conclusions have been drawn with regards to the potential impacts to the Project area and surrounding environment.

Summaries of the site-specific studies referenced in the conceptual understanding are provided in the following sections.

11.8 Containment of Waste Material and Process Water

11.8.1 Tailing Liquor Migration within Paleochannel Aquifer System

Groundwater modelling was undertaken to closely examine the rate and details of migration of solutes from the proposed Princess and Ambassador in-pit tailings storage facilities along the layered and density-stratified groundwater system (Appendix D10).

The tailings seepage estimates were provided by adapting Vimy's site water balance (Figure 11.6), since hydraulic properties of the tailings are sufficiently uncertain for incorporation of tailings material as a layer directly integrated into the model. The most likely distance of movement from the southern end of Ambassador Pit in 1,000 years can be seen to pass the southern boundary of the mining lease, M39/1080. Figure 10.6 shows the long term flow path from the southern end of the proposed in-pit tailings storage facility considered at the regional scale.

The model was developed from the earlier regional paleochannel model (Appendix D10) derived from data from over 2,000 drill holes, by simplifying the model mesh and adding capacity to the model to simulate solute transport, to accommodate seepage from an in-pit TSF and, using the SEAWAT package, to account for the effects of increases in groundwater density with depth. The new model was increased from three layers to six layers to improve discretisation of the vertical salinity gradient, reduced in area and simplified in geometry to focus on the southerly migration of groundwater from the in-pit TSFs.

Given the long timeframes and distances (kilometres) of lateral groundwater movement involved for contaminants to reach the mining tenement boundary, there was no practical benefit to the analysis in including the complication of the detailed geometry of the in-pit TSF or allowing for more than one source of tailings liquor. The outcome at the compliance point on the mining lease boundary will not be sensitive to the exact location of seepage input or of the exact timing.

The simulation was run for 10,000 years to comply with post-closure requirements.

The model:

1. Allowed seepage from the TSF into the aquifer system using a combination of head and conductance from the "river" module in Modflow, calibrated to accommodate seepage quantities from the site water balance.
2. Used a total discharge of tailings liquor seepage estimated from the site water balance model for a 16 year LOM.
3. Used a reasonable value of 10% for the effective porosity of the lower layers of the aquifer and 5% for the upper layers characterised by very high organic matter and fines content.
4. Applied dispersivity factors of 25 (longitudinal), 2.5 (traverse) and 0.1 vertical.
5. Did not allow for any attenuation of metals and radionuclides within the aquifer system.
6. Applied the liquor input to the aquifer more or less at a point, not distributed as widely as the in-pit TSFs would ensure.
7. Assumed a zero rate of recharge for most of the modelled area.

The modelling has therefore adopted a deliberately simple and very conservative approach, aiming to give the highest concentration "slug" of contaminants migrating along the flow path to the south. The model is believed to over-estimate the rate of leakage of tailings liquor into the groundwater system and to provide less dilution at source than would occur in practice, for example because of the silty layer between the base of the tailings and the high transmissivity of the aquifer that underlies it. The use of the "river" module necessitated applying a head to drive the seepage, which in turn drove a component of seepage to the most permeable part of the layered aquifer system, overcoming the density gradient. It is not certain that this pathway would be active in practice.

All of these aspects lead to confidence that the model will over-estimate the peak concentrations of metals and radionuclides in the downstream plume. This plume is predicted to develop over a period of some 300 years and then to migrate past the southern boundary of the mining lease at a time scale that will be of the order of centuries to millennia.

Figure 10.4 is a block model that illustrates the seepage from the in-pit TSF at Ambassador Pit into the paleochannel aquifer system, representing the behaviour predicted by the solute transport model.

Figure 11.8 shows the simulated movement of a contaminant plume, expressed as concentrations of uranium versus time, past the southern boundary of the mining lease and beyond. The highest concentrations, in the lowest, most permeable layer, are predicted to pass at about 1,500 years and the lowest, in the upper layer of the model of lower hydraulic conductivity, broadly around 2,500 years. By 10,000 years, the plume is predicted to have passed the M39/1080 boundary completely. However within the plume, peak concentrations of contaminants remain below some naturally occurring concentrations in the paleochannel system and below guideline values, despite the conservative modelling approach. The details of the modelling and further plots of this type are shown in Appendix D10.

Figure 11.9 shows the distance from the in-pit tailings storage facility that groundwater with a concentration of 0.02mg/L uranium is predicted to migrate along the aquifer. The modelling suggests that, after 2,000 years, no concentrations would exceed that 0.02mg/L value due to dispersion and dilution as the plume migrates to the south. As a consequence, while the plume with a concentration of 0.02mg/L uranium, or higher, passes the mining lease boundary, it never reaches the exploration lease boundary.

Figure 11.10 to Figure 11.12 show, as plots of concentration versus distance from the in-pit tailings storage facility, the migration of the plume to the south at 284 years, 1,000 years and 2,000 years respectively. The plume spreads and its peak concentration falls with time as it moves to the south.

The modelling can be repeated when there is a more quantitative understanding of the hydraulic characteristics of the actual tailings.

A detailed investigation of the hydrochemistry of the groundwater from the Ambassador deposit as well as the chemistry and the mineralogy of the lignite was conducted (Douglas *et al*. 1993). A summary of this work is provided in Section 10.

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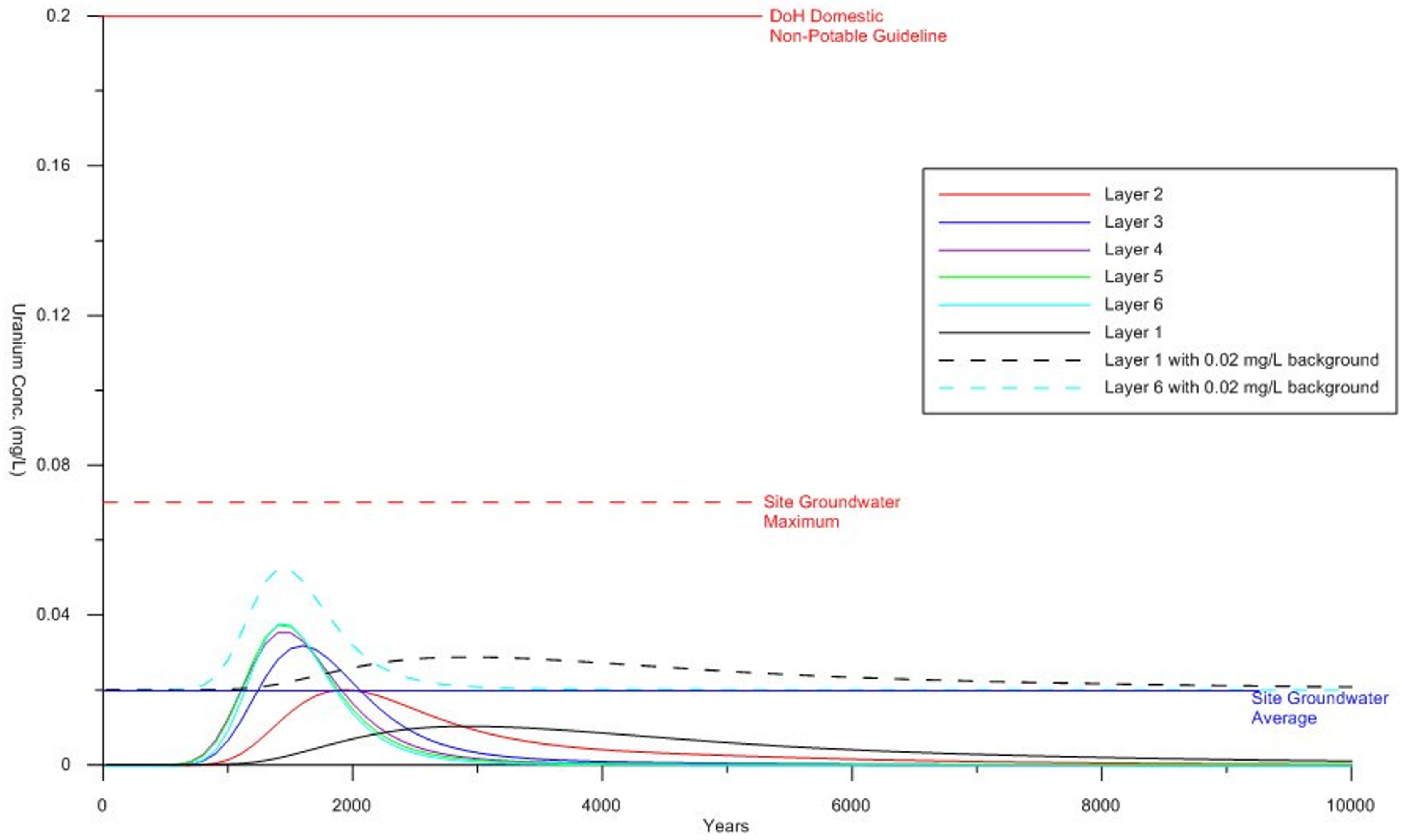

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CONSULTANT	YYYY-MM-DD	2015-11-06	TITLE
	DESIGNED	MS	**PREDICTED URANIUM CONCENTRATIONS VERSUS TIME AT THE LEASE BOUNDARY OF M39/1080**
	PREPARED	MS	**SOURCE: ROCKWATER (2015e)**
	REVIEWED	DCR	PROJECT NO. 1540340 · CONTROL PER · REV. 0 · FIGURE **11.8**
	APPROVED	DCR	

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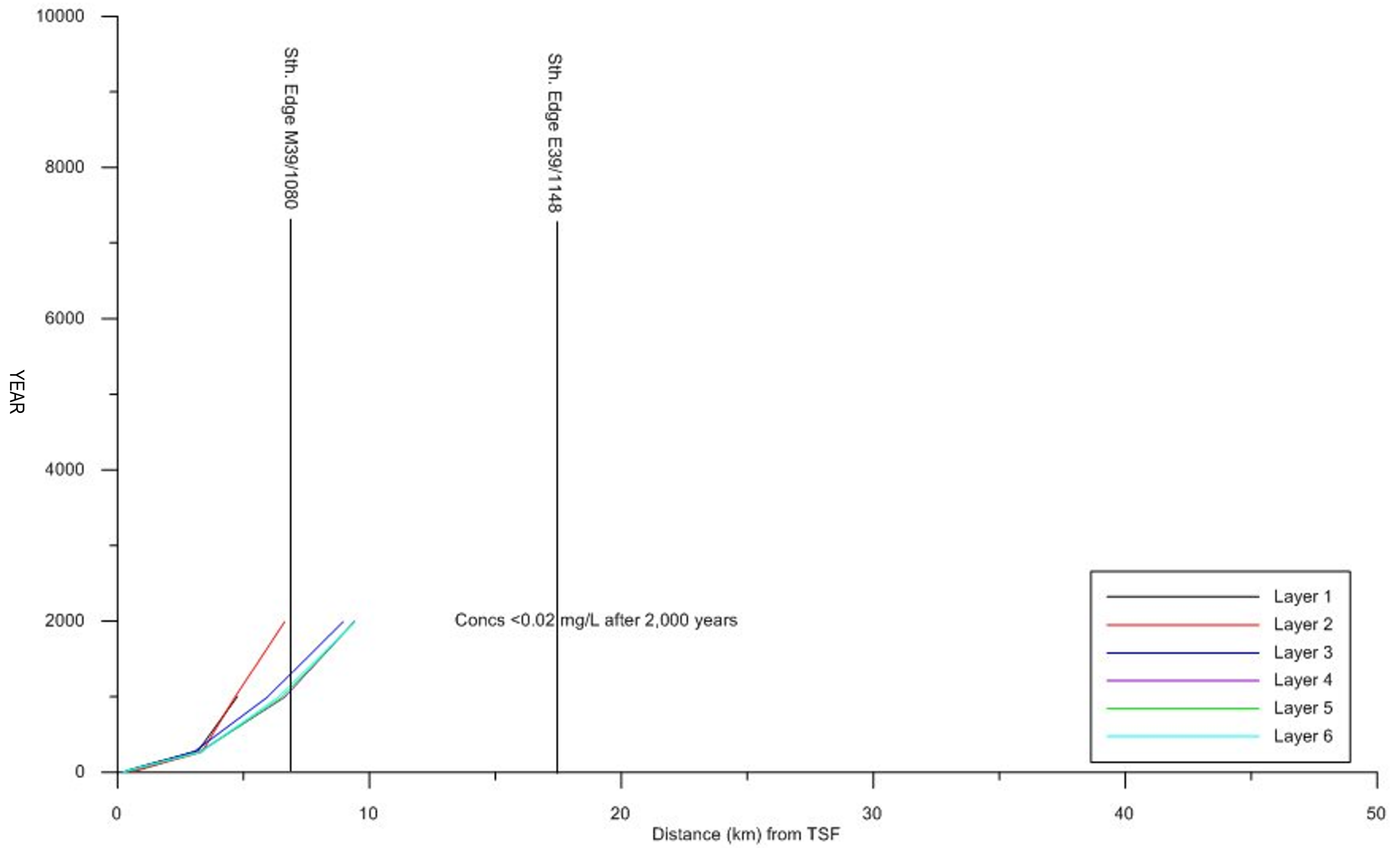

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT	YYYY-MM-DD 2015-11-06	TITLE **MIGRATION OF 0.02 mg/L URANIUM CONCENTRATION WATER ALONG THE PALAEOCHANNEL VERSUS TIME SOURCE: ROCKWATER (2015e)**	
	DESIGNED MS		
	PREPARED MS		
	REVIEWED DCR	PROJECT NO. 1540340	CONTROL PER
	APPROVED DCR	REV. 0	FIGURE **11.9**

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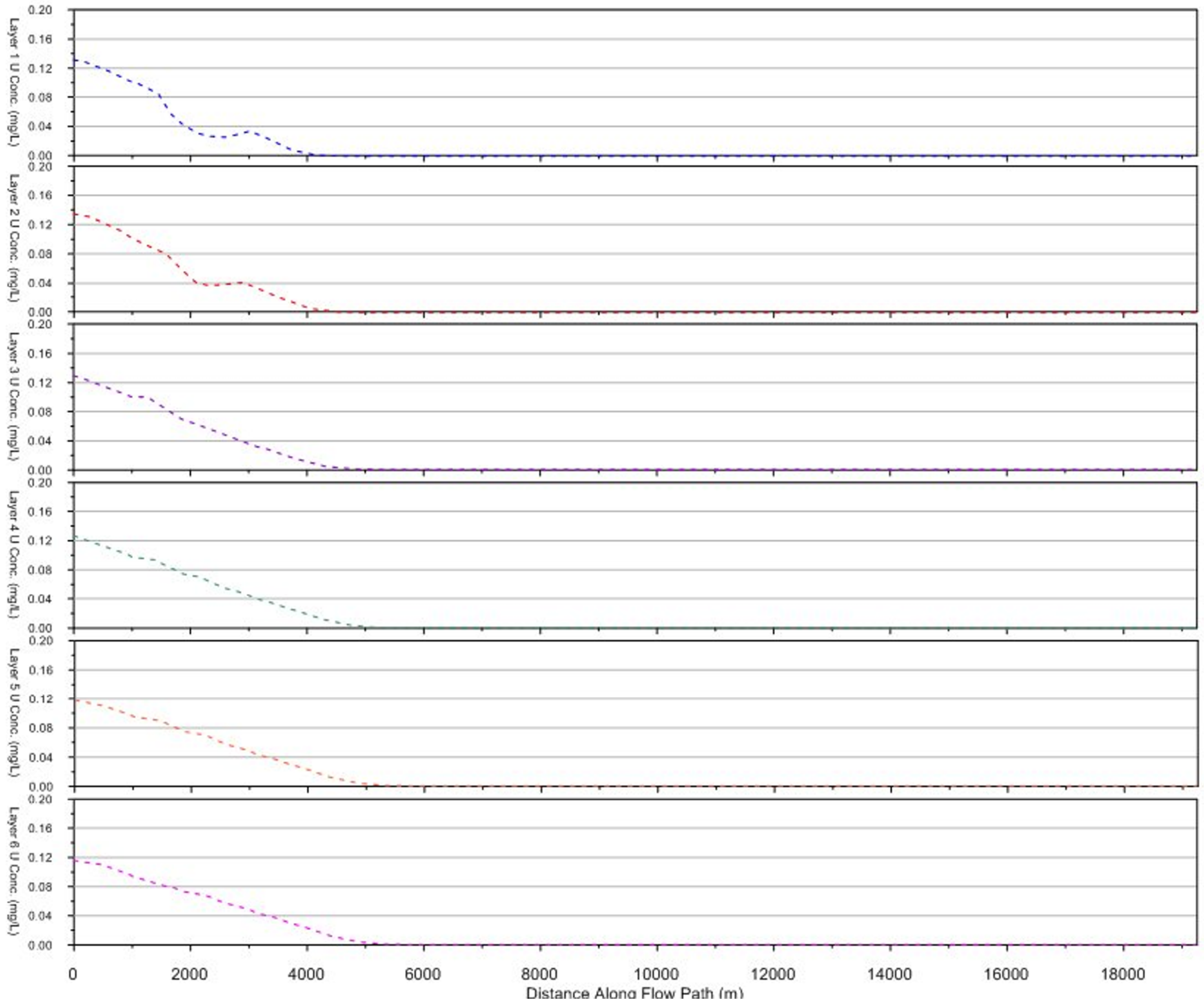

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TITLE
DEVELOPMENT OF URANIUM CONCENTRATION PLUME IN MODEL LAYERS AT 284 YEARS
SOURCE: ROCKWATER (2015e)

PROJECT NO.	CONTROL	REV.	FIGURE
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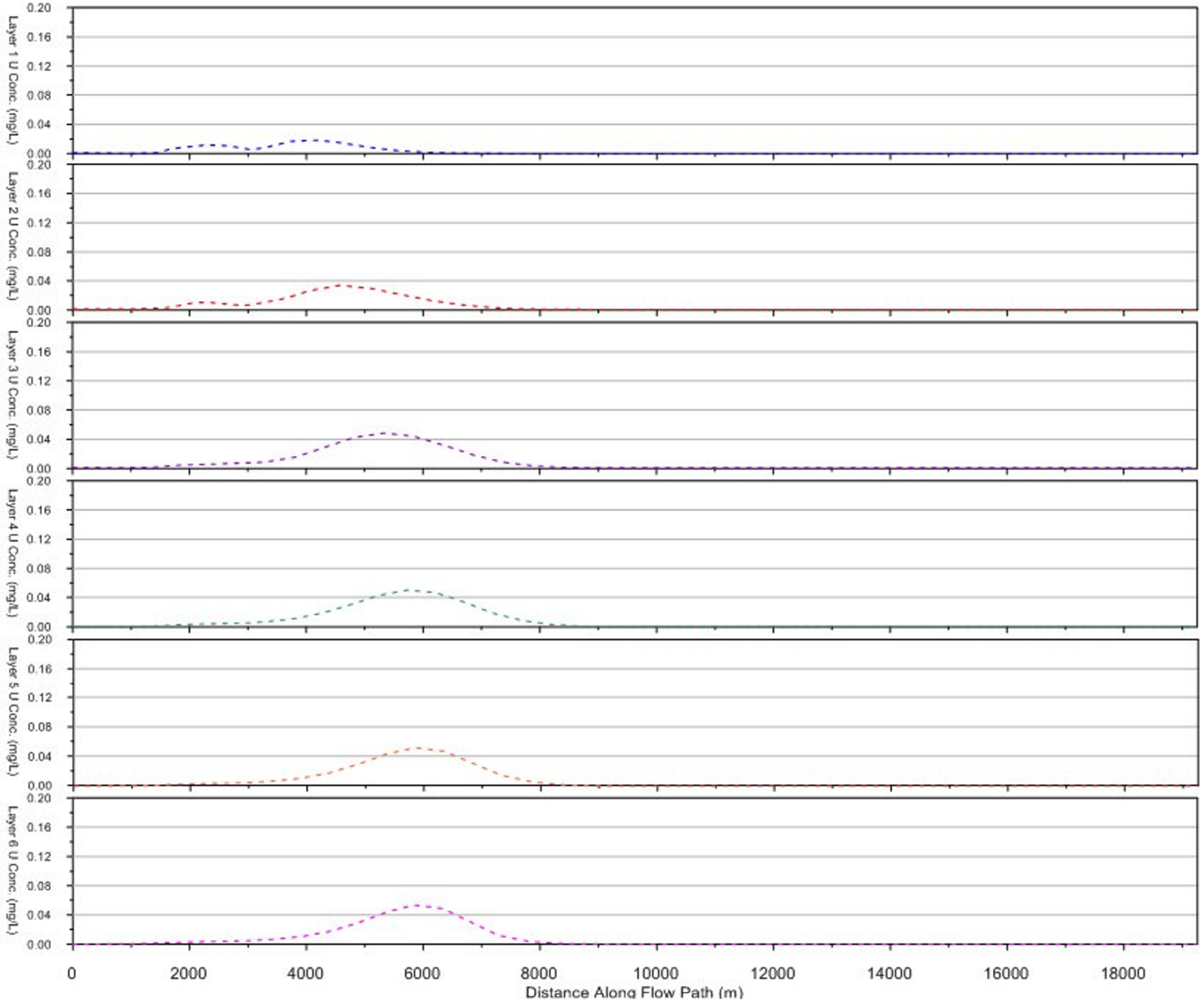

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MULGA ROCK URANIUM PROJECT

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APPROVED	DCR

TITLE
DEVELOPMENT OF URANIUM CONCENTRATION PLUME IN MODEL LAYERS AT 1000 YEARS
SOURCE: ROCKWATER (2015e)

PROJECT NO.	CONTROL	REV.	FIGURE
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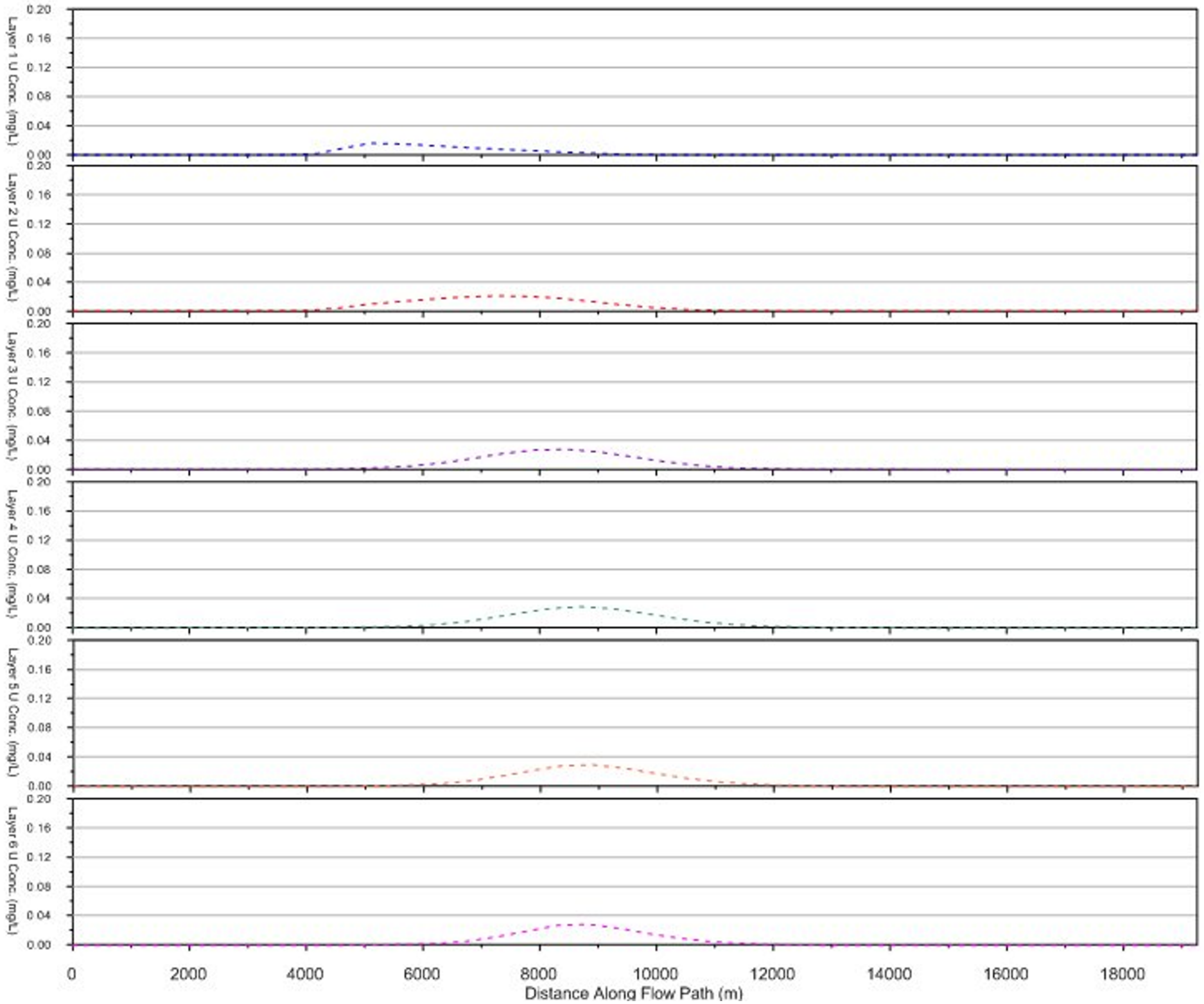

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT Golder Associates	YYYY-MM-DD	2015-11-06	TITLE **DEVELOPMENT OF URANIUM CONCENTRATION PLUME IN MODEL LAYERS AT 2000 YEARS** **SOURCE: ROCKWATER (2015e)**
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	PREPARED	MS	PROJECT NO. 1540340	CONTROL PER	REV. 0	FIGURE **11.12**
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11.9 Best Practice Containment

Waste material and process water will, during an initial period, be directed to an above-ground tailings storage facility (TSF). The sides of this facility will be double-lined to control the potential for lateral seepage. The bottom of this facility will contain an underdrainage system, below which will be a clay liner. It will be lined to a standard consistent with Water Quality Protection Note 27 *Liners for Containing Pollutants, Using Engineered Soils* (DoW 2013). As expected by the saturated permeability of the engineered clay liner (i.e. 10^{-9}m/s; DoW 2013) there will eventually be some seepage through the base of this facility, equivalent to 3.2cm/a. Seepage water will migrate downwards until it reaches the aquifer directly underneath the tailings facility. There are no water flows or perched water tables in the area that could disrupt this downward movement to the underlying aquifer.

Once the seepage reaches the aquifer, the conceptual understanding is that the contaminants will be captured by the carbonaceous material that characterises the area at that level. This is the same mechanism that captured the metals and metalloids from groundwater under naturally occurring conditions. In effect the contaminants are being returned to a similar environment from which they came and which required the application of very strong acid to extract them during the processing phase. In the absence of the strong acid they will be captured once again by the carbonaceous material.

The process of leaching and precipitating through the processing of the material to generate the tailings is expected to remove most metals and metalloids. Moreover, a comparison between expected tailings seepage (without prior base metals extraction) and the composition of the groundwater underlying the facility (Appendix D8) has shown that most contaminants would likely be present at levels that are similar to those that have prevailed naturally within local groundwater.

The above-ground TSF will only be utilised for two to three years, but modelling has been undertaken for a 10 year period. During that 10 year period it was estimated that there would be no more than 27cm of seepage (The above-ground TSF will not be drained during the period when deposition is taking place, indeed since all tailings will be deposited sub-aqueously, it is desirable for it not to be drained. Once the facility is no longer being utilised the facility will be drained to field capacity. This has been estimated to take approximately four years (Appendix D8). After this time, since the facility would have drained to its field capacity, no further significant seepage is expected because the tailings facility would be drained to the limit of what can be achieved by drainage. The quality of this drainage water will be monitored and it will either be recycled through the processing plant or sent to the newly operating in-pit tailings facility for disposal.

Based on a worst case scenario model, the maximum amount of seepage from the above-ground TSF that could reach the aquifer directly below is less than 0.5% of the calculated volume of water located in the aquifer in that area (Appendix D8). Even if the contaminants are not captured by the carbonaceous material, the dilution arising from the existing volume of water would render the effects indistinguishable from the natural variations that exist in the groundwater (Appendix D8). Although drainage into the aquifer is the intended method of management for contaminants that become mobilised, it is clear that there will be some seepage through the in-pit TSF walls. This seepage was modelled and it was shown that under a worst case scenario this seepage could extend for as much as 100m if there were sand layers with high transmissivity. However this seepage will remain isolated from any ecosystems and will ultimately slowly dry *in situ* or migrate down to the aquifer. It was estimated that after 2.5 years (Appendix D8) 40m of tailings would have completely drained. Once complete drainage occurs there will be no further drainage into the aquifer and no lateral seepage.

In essence all drainage from TSFs (both above-ground and in-pit) will ultimately drain into the local aquifer, which is at the same elevation as the base of the proposed in-pit facilities. ASLP test work demonstrated that aluminium, cobalt, copper, manganese, nickel, lead and zinc were likely to be mobilised from these tailings (Appendix H2). Studies of the aquifer to date have reported conditions that are reducing and as most of the elements considered to be likely to be released are redox sensitive, this demonstrates the likelihood of ongoing attenuation of mobile metals and metalloids by organic matter and bio-accumulation (Appendix D8).

Based on a detailed understanding of processes already active on site, and the results of modelling, natural attenuation is considered by Vimy to be the best practice approach.

11.9.1 Effectiveness of Containment

The above-ground TSF is designed to hold the initial tailings generated until such time as the in-pit storage option becomes available (approximately two to three years from the commencement of mining). As described above, the sides of the facility will be double-lined to control lateral seepage and the base of the facility will be clay lined with a drainage facility above it. Upon the in-pit tailings facility becoming available the above-ground facility will cease to be used and it can then be drained and the liquid sent for in-pit storage. Once the above-ground TSF has fully drained to field capacity there is likely to be little if any further seepage through the clay lining. The process of seepage through the clay liner was estimated to take at least ten years and no more than negligible seepage though the clay liner is expected. Such seepage would migrate down to the underlying aquifer.

The primary method of containment of metals and metalloids, including radionuclides, is reliance upon the natural geochemical and biogeochemical attenuation, which occurs within the carbonaceous material that characterises the orebody itself and through which tailings drainage will pass.

There are no stygofauna living within the site groundwater (Appendix C1), which is not surprising given the salinity, acidity, high sulphate concentrations and low ORP, and there have been no troglofauna recorded living in the area immediately above the water table (again this is not surprising considering the complete lack of voids at this depth capable of hosting troglofauna, and the absence of any nutrient flow) (Appendix C2).

11.9.2 Movement of Material

The effectiveness of any containment must consider the protection of environmental receptors. In this case there are no environmental receptors that require discussion with respect to the containment of tailings in order to prevent an impact upon them. Therefore, for the purpose of considering the effectiveness of attenuation, the boundary of the mining lease, a distance of approximately 12km from the Princess in-pit tailings facility was taken as a reference point.

The radionuclide distribution in existing groundwater is discussed in Section 11.5. Around two thirds of the water samples analysed from the MRE area recorded uranium levels that were below detection limits (Appendix D2). This is a testament to the effectiveness of the geochemical sequestration processes at work. The average of those uranium readings that were above detection limits in groundwater at MRE averaged 0.022mg/L with highest level recorded being 0.068mg/L (Appendix D2).

11.9.3 Acid and Metalliferous Drainage Potential of Proposed Pits

Given the presence of sulphide bearing phases within the geological units at the site, there is the potential for acid and metalliferous drainage to occur during mining activities.

The primary management strategy of avoiding these materials during operation cannot apply as the sulphides form the ore.

The potential for AMD to be generated from the proposed pits is limited by the following factors (Appendix H2):

- All voids will be backfilled, either fully or partially to a depth of no less than 10m above the water table, following the cessation of mining, and thus the potential ‘window’ for oxidation is restricted.
- The mine pits will only intersect the water table (redox boundary) in the basal 2–5m, and thus the requirement for dewatering is limited to an extent of around 3–6m.
- Dewatering is only required during the active mining and in-pit processing (i.e. beneficiation) phase; groundwater levels will be restored once the mining front has passed.

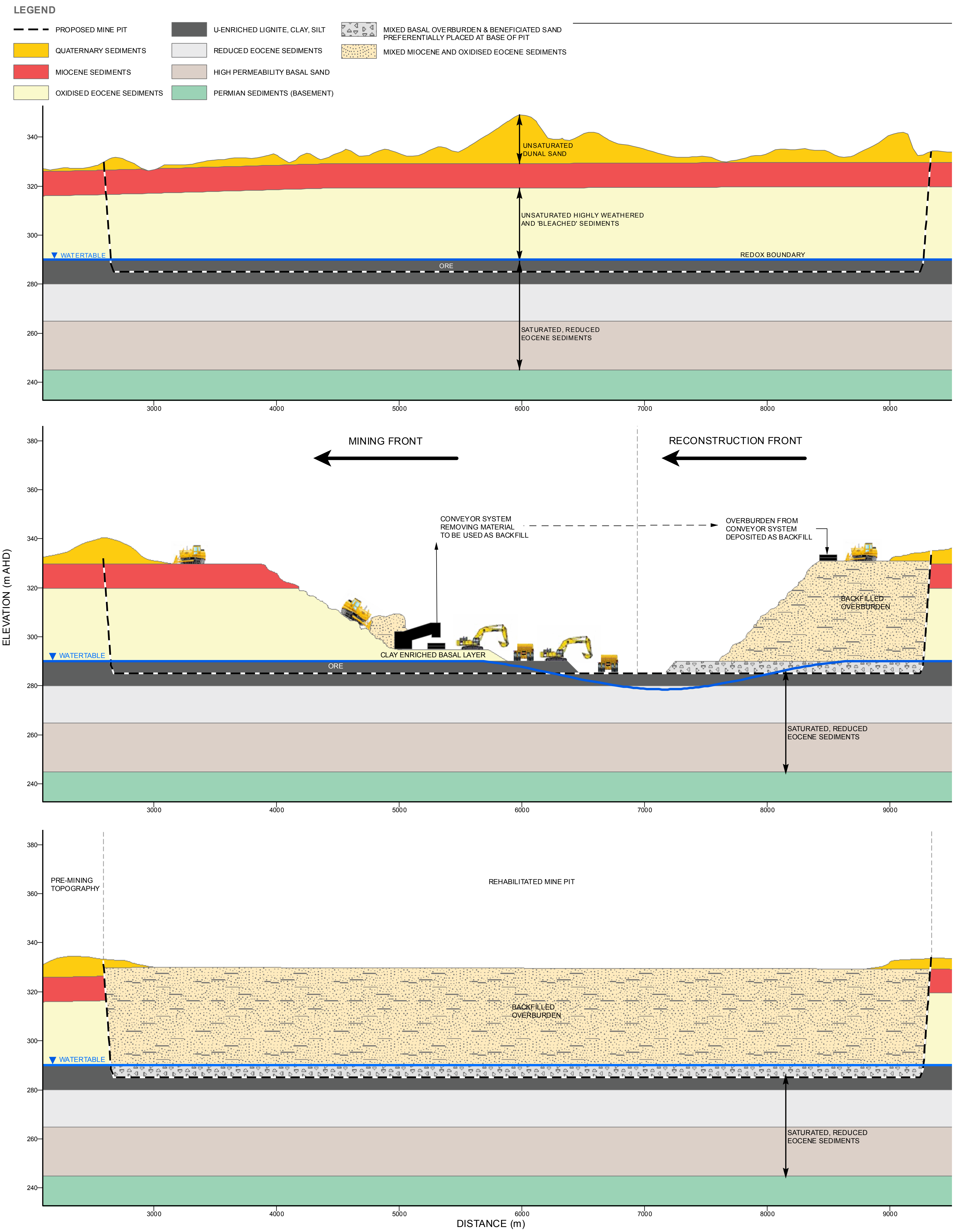
- The top ~40m of the *in situ* profile (i.e. 85-90% of the total material mined) exists in an already oxidised and unsaturated condition, and thus no change in its redox status (variation between reduction and oxidation) will occur during mining operations.

Any potential AMD generated during operations:

- Will be captured during dewatering of the pit.
- The hydrological conditions are such that the seepage will flow downgradient and be naturally attenuated by geochemical and hydrological processes.
- Will preferentially flow through the organic material capable of naturally striping most elements of environmental concern from the water column.

A schematic diagram showing the geological/hydrological environment within the MRUP and the relationship with mining and mining activities (such as dewatering) is presented in Figure 11.13 and Figure 11.14.

Further details of the potential strategies to mitigate and manage AMD are provided in the conceptual Acid and Metalliferous Drainage Management Plan (AMDMP; MRUP-EMP-016).



CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-06
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

V1:1,400 — 0, 50, 100 METRES

H1:28,000 — 0, 1,000, 2,000 METRES

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
IMPACT OF MINING, RECONSTRUCTION WITH OVERBURDEN AND REHABILITATION OF THE MINE VOID ON THE HYDROGEOLOGY OF THE MRUP

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	11.13

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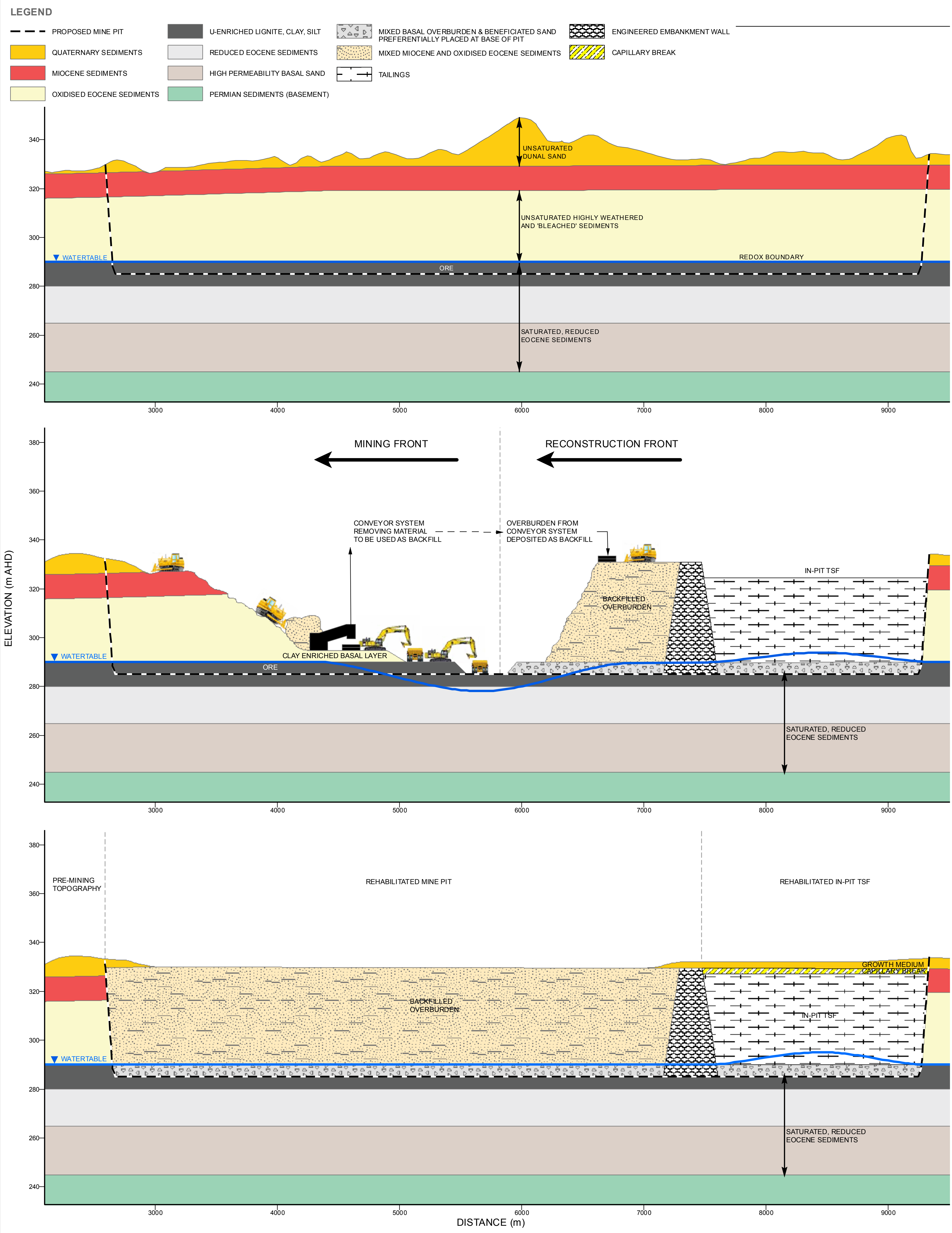

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H1:28,000 METRES

CLIENT
VIMY RESOURCES LIMITED

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-06
DESIGNED	MS
PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

TITLE
IMPACT OF MINING, IN-PIT TSF, RECONSTRUCTION WITH OVERBURDEN AND REHABILITATION OF THE MINE VOID ON THE HYDROGEOLOGY OF THE MRUP

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	11.14

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25mm

11.10 Impact on Receptors

There are no sensitive environmental receptors associated with the local aquifer. For the purposes of assessing impacts, a reference of the boundary of the mining tenure was utilised so that impacts were assessed against existing groundwater quality at that location.

During the first couple of years of mining before the Princess Pit has been mined out and becomes available to serve as an in-pit TSF, tailings will be deposited in an above-ground TSF. Although the above-ground TSF will be clay lined to Department of Water standards (Water Quality Protection Note 27; WQPN 27, DoW 2013), the liquor will eventually penetrate through the liner, at a maximum rate of 1.0×10^{-9}m/s (equivalent to 3.2cm/year) and migrate downwards to the water table directly below the surface TSF (Appendix D8). The content of this liquor is assumed to be the same as the estimated content of seepage from tailings (however in practice the intervening calcrete layer would largely neutralise any such leachates). Once it contacts the water table (which is likely to take more than a century) it will behave in the same manner as seepage from the in-pit storage of tailings – namely the low density will maintain the liquor in the upper layers, where it will be rapidly attenuated by passage through the carbonaceous material that will effectively act as a filter adsorbing the contaminants. It is not expected to have measurable impact upon groundwater at the boundary of the mining tenure.

Once the Princess Pit has been mined of resources, it will be the location for the storage of tailings and waste process water for the majority of the life of the Project. Once its capacity of that facility is reached, a second in-pit tailings storage facility will be established in one of the other pits (within Ambassador), in a similar hydrogeological setting. Tailings will be slurried to the in-pit tailings storage area and deposited in the base of the mined out pit. Deposition will be subaqueous to ensure that no dust is generated. The liquid component will move vertically downwards to the existing water level and then will move horizontally. The extent of horizontal movement will be controlled by the existing hydraulic gradient and, in particular, it will be constrained by the existing paleochannel boundaries. Due to hydraulic gradients, it will move in a south-westerly direction down the local tributary valley and then enter the main paleochannel area where it will generally head south. During this process the lower salinity of the seepage water (which makes it less dense than the local groundwater) combined with horizontal transmission, which is far easier than vertical transmission, will maintain the plume mostly in the upper levels, where overall transmissivity is low and the capacity to adsorb contaminants is at its highest. By the time the plume of seepage water reaches the mining tenement boundary, the level of contaminants will have reduced to the point where the plume would be potentially indistinguishable from the average levels prevailing in the groundwater in the area, and considerably lower than the upper limit of natural variability observed within the existing groundwater.

Given the well constrained vertical extent of the root stock (limited to the top of Ecocene or older sediments), the potential contaminants will not have any opportunity to interact with sensitive terrestrial environmental receptors from the time the tailings and the processing waste water are co-disposed into tailings facilities until the point at which dilution and attenuation has reduced the levels to something indistinguishable from what occurs naturally.

Tailings Storage Facilities (seepage to groundwater system)

It is planned that most if not all tailings will be stored in the Princess and Ambassador pits with an above-ground tailings storage facility (TSF) near the Princess Pit. Any seepage from the tailings will enter the tributary paleochannel aquifer and migrate to the main paleochannel and then move south with the natural groundwater movement (Appendix D10). In the long term, that is centuries to millennia, neither dewatering nor reinjection activities will affect the migration of seepage from the tailings.

It is expected that there will be no environmental impacts, as described elsewhere in this document, given the slow rate of groundwater movement, the high groundwater salinities, the geochemical potential to attenuate any migrating metals or radionuclides and the lack of groundwater dependent ecosystems (Appendix D10).

Once ore is at the processing plant additional water derived from the Kakarook North borefield will be added. Processing water will be held in dams close to the processing plant and recycled from the various stages in the processing plant for reuse where possible. During use in processing, the water will become more saline. When the salinity increases beyond the level where it is suitable for process use, it will be transferred to waste water to be used to pump the tailings to the TSF. The dams used to hold process water will be lined to control seepage. The processing plant area will be bunded and sealed to ensure that any spills will be contained within the bunded area.

The primary additives used during the initial part of metallurgical processing stage will sulphuric acid and ferric sulphate, which will be added during the leaching stage. The acid will subsequently be neutralised and becomes part of the processing waste water that is pumped with tailings to the TSF. Other additives include sodium sulphide and sodium chloride, which are used as part of the process of stripping uranium off the resins and these additives also flow through to the tailings. Sodium hydroxide and hydrogen peroxide are used during the production of uranium concentrate. Sodium sulphide will be used to precipitate out the base metals – zinc, copper, nickel and cobalt. The modelling of tailings liquor and associated seepage was undertaken on the basis that neutralisation had not occurred and the base metals had not been extracted. This therefore represented a worst case outcome. The only process stream that could be considered to have worse characteristics than the tailings liquor would be the liquid containing the extracted uranium, which will remain contained within the process plant area where it is converted through precipitation and drying to yellowcake.

Any spillage of any intermediate processing material will be within the process plant area, which will be bunded and sealed ensuring that spillages would be contained. Spilt material would be unable to escape into the external environment and in any event will be immediately cleaned up. The only material leaving the process plant area will be packaged final product and waste water and tailings, which will be pumped to the appropriate TSF.

In total, approximately 1.8GL/a of brackish water will be extracted from the extraction borefield and an additional 0.8GL/a of mine dewatering water (which is saline to hypersaline) will enter the process plant with the ore as a slurry. No sensitive ecosystems are connected to either of these bodies of water and once extraction ceases the aquifers will gradually return to approximately their pre-existing levels. The material pumped to the TSFs consists of around 2.6GL/a of waste water (comprising a mixture of water from the extraction borefield and some mine dewatering water). The remaining water is lost through evaporation and other processing losses. The waste water is effectively contained by being disposed of into tailings facilities.

There will be a requirement to store fuel at various locations. All fuel storage facilities will be bunded and lined as appropriate to contain any spillage and prevent its release into the environment.

11.11 Management of Water Quality Impacts

The following Management Plans (MPs) have been or will be developed to ensure that the quality of groundwater and surface water is maintained and any impacts upon contained or associated biota, are minimised:

- Surface Water Management Plan (MRUP-EMP-009).
- Groundwater Management Plan (MRUP-EMP-010).
- Groundwater Operating Strategy (MRUP-EMP-011).
- Managed Aquifer Recharge Management Plan (MRUP-EMP-012).
- Tailings Management Plan (MRUP-EMP-013).
- Acid and Metalliferous Drainage Management Plan (MRUP-EMP-016).
- Water Operating Strategy (MRUP-EMP-021).
- Radioactive Waste Management Plan (MRUP-EMP-029).
- Chemical and Hydrocarbon Management Plan (MRUP-EMP-037).

These Management Plans are contained in Appendix K1.

The overall objective of the application of all these Management Plans to the key environmental factor of Inland Waters Environmental Quality is to ensure that the impact on the quality of groundwater and surface water as a result of the development of the MRUP will be minimised and that there will be no adverse impact upon any contained biota. The achievement of the following objectives will assist in delivering such an outcome:

- All tailings facilities will be constructed in compliance with all applicable legislation and other guidelines for the safe design, operation and management of tailings storage facilities.
- The process of transferring tailings to the tailings storage facility will be effective and secure.
- Material that is deposited in tailings facilities will be either contained within those facilities or any seepage will be sequestrated by carbonaceous matter within the local aquifers ensuring containment of all tailings materials.
- Groundwater quality is maintained within acceptable limits compared to baseline values.
- Indirect impacts to existing and potential groundwater users, GDE and subterranean fauna are negligible.
- Monitoring is undertaken to a level that will enable informed decision making with results of monitoring summarised in project annual environmental reporting.

The management of impacts to the existing surface water and groundwater will be predominantly achieved through the use of the:

- Groundwater Management Plan (MRUP-EMP-010), which will ensure that surface water and groundwater quality is continuously assessed and potential adverse impacts upon quality and any associated biota are mitigated by appropriate management actions.
- Tailings Management Plan (MRUP-EMP-013), which will ensure that the risks associated with transfer and storage of tailings are managed to ensure their avoidance or mitigation.
- Acid and Metalliferous Drainage Management Plan (MRUP-EMP-016), which will ensure that that any surface stockpiles will not be able to drain in a manner that could adversely impact upon surface water or groundwater quality.

In relation to the management of tailings in particular the following risks will be managed:

- The risk of failure of tailings embankment walls through ensuring that:
  - The facilities are constructed in accordance with all applicable legislation and other guidelines or codes of practice for the safe design, operation and management of tailings storage facilities
  - An inspection and audit of the facilities is carried out annually by an independent geotechnical or engineering specialist and
  - The freeboard of each TSF is managed appropriately to ensure sufficient factor of safety in accordance with established guidelines and codes of practice.
- The risk of pipeline failure or leaks through ensuring that:
  - The pipelines are constructed in accordance with all applicable legislation and other guidelines or codes of practice for the safe design, operation and management of such pipeline infrastructure
  - Daily inspections of pipelines are carried out and
  - Pipelines are located within earthen bunds to mitigate the impacts from any potential failures.

- The risk of uncontrolled seepage from above-ground tailings storage facilities by ensuring that:
  - Any above-ground TSF is positioned in a geographical and topological location that limits the impacts from seepage
  - The facility is designed and constructed in accordance with all applicable legislation and other guidelines or codes of practice for the safe design, operation and management of tailings storage facilities and
  - A double liner system is installed including a fit-for-purpose leak detection system.
- The risk of overtopping of any tailings storage facility (or being filled above required restrictions) by ensuring that:
  - The deposition of tailings material is continuously monitored using instrumentation and visual inspection in accordance with established guidelines and codes of practice and
  - Adequate freeboard (or the distance between the top of the tailings and any other limit), capable of accommodating a maximum flood event, is monitored as necessary to maintain capacity and remove the risk of overtopping in accordance with established guidelines and codes of practice.
- The risk of seepage from in-pit TSFs impacting on downstream environmental receptors by:
  - Monitoring downstream bores to identify whether a seepage plume is occurring and to quantify any changes in groundwater quality and implementing appropriate remedial measures if it is identified that groundwater quality beyond the tenement boundary is adversely impacted.

11.11.1 Monitoring

The following parameters will be monitored as part of the management of TSFs:

- Water quality parameters in tailings material from active disposal facilities – by collecting samples and sending to the laboratory for analysis on a quarterly basis.
- Flow parameters for all tailings including tailings production, slurry pump operation and outlet deposition will be undertaken continuously and reviewed monthly sufficient to satisfy regulatory requirements and to verify site water balance.
- Pipeline integrity of all tailings pipelines will be confirmed on a daily basis by visual inspections.
- The performance of slurry pumps will be assessed for structural integrity and leaks on a daily bases using visual inspection.
- Freeboard (or any other height limits imposed upon TSFs) will be continuously monitored by both computerised instrumentation and visual inspections of all active facilities.
- Structural integrity of above-ground TSF and the performance of all instrumentation and the underdrainage and leak detection system will be established on a monthly basis by Vimy personnel and confirmed annually by an independent inspection and audit by an engineering specialist.

The following water quality parameters will be monitored:

- Water quality parameters associated with dewatering activity including levels (drawdown), quality (including salinity and pH) and flow rates.
- Water quality parameters in process water streams including quantity, quality and flows.
- Water quality parameters associated with reinjecting activities including levels (mounding), quality (including salinity and pH) and flow rates.
- Water quality parameters associated with tailings material including levels (in tailings facilities), quality (including salinity, pH and contaminants such as metals) and flow rates.

- Groundwater quality in groundwater downstream from any TSF to establish the nature and extent of any contaminant plume.

There will also be additional monitoring activity undertaken under the Environmental Monitoring Management Plan (MRUP-EMP-032) which will be developed to include checks for leaks or other seepage that could enter the environment and ultimately impact existing surface water and groundwater quality.

11.11.2 Management Targets and Contingency Actions

Exceedances of the following management targets would lead to contingency actions:

- **Target** – Monitoring of any parameter associated with the management of TSFs including the structural integrity of the facilities, performance of any equipment or other infrastructure, and the level of the tailings within any facility reveals problems, underperformance or increased risks that would give rise to concern about the potential for failure in relation to containment:
  – **Contingency action** – Investigation into the cause of the problems, underperformance or increased risks and the implementation of appropriate measures to ensure that the associated risks do not materialise and that as a result there is no containment failure and no adverse impact on inland water environmental quality or any associated biota.
- **Target** – Monitoring of any water quality parameters reveals a deviation from expected values that would be sufficient to warrant concern about the associated impact on inland water environmental quality:
  – **Contingency action** – Investigation into the cause of the unexpected deviation and the implementation of appropriate measures to ensure that the impact on inland water environmental quality is minimised and the impact on any associated biota is prevented by measures designed to remediate the problem.

11.12 Mitigation Hierarchy

Implementation of the Groundwater Management Plan (MRUP-EMP-010) and the Tailings Management Plan (MRUP-EMP-013) will ensure that tailings are adequately contained and that groundwater is monitored within the mining areas, within the reinjection borefield and downstream of all TSFs.

Appropriate remedial action will be taken in the event that monitoring reveals readings in groundwater that would suggest that elevated levels of contaminants will enter the groundwater system and will be sufficiently elevated that they represent a threat to any ecosystems, or that they will be still be above the natural variability in the quality of the groundwater by the time the water reaches the tenement boundary (a distance of approximately 12km away), appropriate remedial action will be taken. This will include identifying the cause of the excessive contaminant release and rectifying at source or, for example, extracting and treating or otherwise recycling the groundwater in a manner designed to reduce the contaminant load.

11.13 Residual Impacts after Mitigation Measures

Seepage will drain into, or would migrate down to the existing groundwater where it would effectively be constrained by the confines of the existing aquifer and would be further constrained (by density differentials) to the upper layers of the aquifer where the process of fixation would be most efficient. Therefore, there are not expected to be any significant environment impacts arising from seepage from the tailings facilities.

11.14 Predicted Outcomes

There are no surface water flows in the area. The rates of evaporation are considerably higher than the annual rainfall, including in extremely wet years. This suggests that very little local recharge of the aquifer located below the various mining areas takes place, other than when high rainfall events occur. The aquifers are around 40m below the surface, far beneath any ecosystems and they are sufficiently saline as to be of no use for any purpose other than for use in mining and mining processes. The water table is very flat and the transmissivity at the level of the surface of the water table is low which means that the uppermost groundwater only moves very slowly.

The mine dewatering water is partly used in processing and partly used for other operational purposes. Only in years when the mining takes place in the deepest sections will there be surplus mine dewatering water and this surplus water will be reinjected into the same greater aquifer as it was drawn from. This reinjection will, however, take place downstream, where the water quality will be poorer meaning that the receiving environment will be worse than the liquid being reinjected. All process water that could be contaminated with higher concentrations of radionuclides to those naturally occurring in the local groundwater will be transferred to tailings; process water will not be reinjected directly into the aquifer.

There are no perched water tables or any other higher layers of water in the area. Surface water that doesn't evaporate will travel vertically downwards, essentially without interruption until it meets the water table.

The initial above-ground TSF will be lined with clay at the bottom and double lined at its sides so that seepage will be limited and effectively confined to its base. The seepage liquor to the extent that any penetrates through the drainage system and through the clay liner will eventually move downward to the aquifer below. The main tailings storage facilities will be located within mined out pit areas and will not be filled above the level where seepage could interact laterally with any ecosystems. There will be no local containment associated with these facilities and the seepage will flow directly into the aquifer that will run through their base. Any lateral movement from the upper sides of the in-pit tailings facilities will be into what are effectively clean sands from where the contaminants will eventually migrate down to the aquifer below. Modelling suggests that if there were a more highly transmissive sand lens in the side wall it could penetrate as much as 50m over the life of the mine, but this is still below any biologically active zone and won't impact any environmental receptors regardless of how far it travels laterally (Appendix D8).

The result of modelling seepage from the in-pit TSFs shows that a pulse of higher metal and radionuclide concentrations would pass the southern lease boundary, some 7km south of the TSFs, approximately 1,500 to 2,500 years after mine closure. Even with the conservative approach used, which maximised all relevant aspects to simulate the highest concentration peak, the predicted peak uranium concentration in tailings is lower than the highest natural concentrations measured at the site.

The tailings will have the majority of the contained copper, zinc, nickel and cobalt removed by sulphide precipitation and will be neutralised up to a pH level of around 4-4.5. In this regard the seepage liquor will be significantly less acidic and will contain less of certain base metals (Cu, Zn, Ni, Co) than was modelled. The modelling of the worst case scenario, where there was no neutralisation and no removal of some base metals, and all other assumptions were conservative, suggested that the level of contaminants would be sufficiently attenuated by the time the plume reached the mining lease boundary, a distance of around 12km, for the level of contaminants to be indistinguishable from natural ground water variation in the area. This modelling is entirely consistent with the modelling and subsequent operational monitoring associated with other paleochannel deposits located in South Australia which were hosted in an area with much higher transmissivity and negligible organic material capable of potentially naturally attenuating the seepage.

The reinjection program which will only run in years when there is surplus dewatering water needing to be disposed of will be part of a managed aquifer recharge scheme in accordance with an approved operating strategy.

As much as possible process water will be obtained from mine dewatering water in the first instance. This will be supplemented by brackish borefield water for processing purposes where a lower salinity is required. All process water will be recycled to the fullest extent practicable.

Groundwater downstream from the TSFs will be monitored to ensure that the seepage plume behaves as expected. In the event that contaminant concentrations are above expectations, mitigation measures will be undertaken to the extent necessary to ensure that there will be no adverse impact upon environmental receptors. However in the absence of any sensitive environmental receptors or other uses for the groundwater in this aquifer it is unlikely to be warranted. Furthermore, there are no adverse impacts of the above-ground and in-pit TSFs capable of being offset or requiring any appropriate offset.

12. Air Quality and Atmospheric Gases

12.1 Relevant Environmental Objectives, Legislation, Policies and Guidelines

12.1.1 EPA Objective

The EPA applies the following objective to the assessment of proposals that may affect air quality:

> *To maintain air quality for the protection of the environment and human health and amenity, and to minimise the emissions of greenhouse and other atmospheric gasses through the application of best practice.*

12.1.2 Regulatory Framework

The main air emissions with potential impacts associated with the project are:

- Dust from mining and processing activities, as well as land clearing, haulage and associated infrastructure.
- Sulphur, carbon and nitrogen oxides and particulates from local power generation utilising hydrocarbon based fuel (diesel or gas).

The protection of air quality and atmospheric gasses at the MRUP is assessed using the following legislation, standards and guidance documents:

- Air Quality (particulate matter and other pollutants):
  - *Environmental Protection Act 1986 (WA) (EP Act).*
  - *Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act).*
  - *National Environment Protection (Ambient Air Quality) Measure (2013).*
  - *Victorian Environmental Protection Authority (Vic EPA) Design Criteria.*
  - *WA Environmental Protection Authority (EPA) Guidance Statements.*
- Greenhouse gas:
  - *National Greenhouse and Energy Reporting Act 2007.*
- Radiation:
  - *Mines Safety and Inspection Act 1994, & Mines Safety and Inspection Regulations 1995.*
  - *Radiation Safety Act 1975.*
  - *Radiation Safety (General) Regulations 1983-2003.*
  - *Radiation Safety (Transport of Radioactive Substances) Regulations 2002.*
  - *Managing Naturally-Occurring Radioactive Material (NORM) in Mining and Mineral Processing – Guidelines ('The WA NORM Guidelines').*

Environmental Protection Act 1986

This is an act which is designed to protect the environment of the State which includes limiting any alteration of the environment to the detriment or potential detriment of an environmental value, which includes air quality.

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Australian Government's key piece of environmental legislation which focuses on the protection of MNES – of which there are nine matters with one being nuclear actions (including uranium mining). The Project is a uranium mining project and the environment is considered a protected matter where nuclear actions are involved. Air quality is considered part of the environment.

National Environment Protection Measures

The *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) 2003 was developed to provide benchmark standards for ambient air quality to ensure all Australians have protection from the potential health effects of air pollution.

Air Toxics NEPM

The *National Environment Protection (Air Toxics) Measure* (Air Toxics NEPM 2011) provides a framework for monitoring, assessing and reporting on ambient levels of five air toxics; benzene, formaldehyde, toluene, xylenes and polycyclic aromatic hydrocarbons (PAHs), in order to facilitate the collection of information for the future development of air quality standards for these pollutants (NEPC 2004).

Consistent with the application of environmental quality criteria, Air NEPM standards have not been applied within the Project disturbance area. However, as sensitive receptors are present with this area, such as the accommodation camp, Air NEPM standards have been applied at the location of such sensitive receptors. Assessment of compliance with NEPM standards has been made for the maximum predicted concentration (Appendix E1).

Victorian Environmental Protection Authority Design Criteria

The Victorian Environment Protection Authority (Vic EPA) Design Criteria established under the Victorian *State Environment Protection Policy (Air Quality Management)* (SEPP-AQM) were used during this assessment where NEPM standards were not available.

Similar to Air NEPM, SEPPAQM design criteria have not been applied within the Project disturbance area but have been applied at sensitive receptors located within this area. SEPPAQM design criteria are taken at the 99.9 percentile concentration for averaging times of one hour or less, which corresponds to the 9^{th} highest hourly concentration when using one year of meteorological data (Appendix E1).

WA Environmental Protection Authority Guidance Statements

There are no specific state-wide criteria for TSP. Historically, the EPA has applied the standard and limits for TSP from the *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999* (Kwinana EPP). The Kwinana EPP defines limits (concentrations of atmospheric waste that shall not be exceeded) and standards (concentrations of atmospheric waste that should desirably not be exceeded) for TSP.

There are no specific state-wide criteria for dust deposition. EPA has applied the NSW Department of Environment and Conservation (NSW DEC) dust deposition standard provided in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW. NSW DEC impact assessment goals for dust deposition such that nuisance dust impacts could be avoided are:

- Maximum increase in deposited dust of $2g/m^2$/month.
- Maximum total deposited dust level of $4g/m^2$/month (Appendix E1).

National Greenhouse and Energy Reporting Act 2007

This is an act which introduces a single national reporting framework for the reporting and dissemination of information related to greenhouse gas emissions and the energy production and consumption of corporations.

Radiation Safety Act 1975

This is an act which regulates the keeping and use of all substances, whether natural or artificial, and regardless of form, which consists of or contains more than the maximum prescribed concentration of any radioactive element. There are two key subsidiary pieces of legislation:

- *Radiation Safety (General) Regulations 1983*. These regulations define radioactive substances and cover the licensing of premises.
- *Radiation Safety (Transport of Radioactive Substances) Regulations 2002*. These regulations cover the transport of radioactive materials in Western Australia and the storing, packing and stowing of such materials for transport, including licensing requirements and the development of an approved radiation protection program.

The Radiological Council is an independent statutory authority established under s.13 of *Radiation Safety Act 1975*, which assists the Minister for Health to protect public health; the Radiological Council issues the licence required to mine or mill radioactive substances.

WA NORM Guidelines

This Guideline was developed by the Department of Mines and Petroleum (DMP) to manage naturally-occurring radioactive material (NORM) in Mining and Mineral Processing. The Guidelines deal with pre-operational, operational monitoring and reporting requirements, with a particular emphasis on air monitoring strategies, airborne radioactivity sampling and dust control strategies.

Applicable Guidance and Position Statements

Consideration was also given to the following documents:

- DEC 2011, A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities, Perth, Western Australia.
- Department of Environment (DoE) 2006, Guidance Notes: Air Quality and Air Pollution Modelling, Perth, Western Australia.
- EPA 2002, Guidance Statement No. 12: Minimising Greenhouse Gas Emissions, Perth, Western Australia.

12.2 Project Air Quality Assessment Criteria

Assessment criteria for the Project are summarised in Table 12.1 (Appendix E1).

Table 12.1 Assessment Criteria

Pollutant	Averaging period	Max. / 99.9th %ile	Exceedence goals	Criterion[1]
Mine operations				
Total suspended particles	24-hours	Maximum		90µg/m^3
Particulates as PM_{10}	24-hours	Maximum		50µg/m^3
	1-hour	99.9 %ile		80µg/m^3
	Annual	Maximum		20µg/m^3
Dust deposition	Annual	Maximum		2.0g/m^2/month[2]
Power station (other pollutants)				
Carbon monoxide	8-hours	Maximum	1 day per year	11,254µg/m^3
Nitrogen dioxide	1-hour	Maximum	1 day per year	247µg/m^3
	Annual	Maximum	None	62µg/m^3
Sulphur dioxide	1-hour	Maximum	1 day per year	572µg/m^3
	24-hours	Maximum	1 day per year	229µg/m^3
	Annual	Maximum	None	57µg/m^3
Xylenes	3-minutes	99.9 %ile		350µg/m^3
Formaldehyde	3-minutes	99.9 %ile		40µg/m^3
Acetaldehyde	3-minutes	99.9 %ile		76µg/m^3
Benzene	Annual	Maximum		10.5µg/m^3
Toluene	3-minutes	99.9 %ile		650µg/m^3
	24-hours	Maximum		4,114µg/m^3
	Annual	Maximum		411µg/m^3

Notes 1: Temp 0degC, pressure 101.325 kPa (1 atm).
2: Incremental increase in dust deposition from the Project.

12.3 Existing Environment

12.3.1 Sensitive Receptors

The nearest sensitive receptors to the Project are presented in Table 12.2. The closest historical settlement (located approximately 90km distant) is no longer occupied. The proposed accommodation camp will be located on the site, approximately 6km from the processing plant.

Table 12.2 Sensitive Receptor Locations

Name	Description	Easting, m	Northing, m	Distance from MRUP processing plant (km)
Tropicana Gold Mine	Active mine	651,500	6,763,700	110
Pinjin	Existing pastoral station	473,900	6,672,300	105
Cundeelee	Abandoned Aboriginal settlement	540,500	6,601,000	90
Tenement boundary	MRUP boundary	566,740	6,673,620	15
Tenement boundary 2	MRUP boundary	585,170	6,677,920	9
Access Road	PNC and TPG access road	542,745	6,703,620	40
Accommodation Village	Conceptual village location	573,980	6,687,670	6

12.3.2 Climate

The climate of the MRUP area is classified as desert with hot summers and cool-mild winters. Rainfall throughout the year does not vary considerably with 20-40mm/month falling in the summer months (November-March), often associated with cyclonic events, and 10-30mm/month in winter (April-October), with a total annual average rainfall of approximately 280mm. Daytime temperatures typically reach 30 to 40°C in summer and 18 to 30°C in winter, with lows of 15 to 22°C and 5 to 15°C respectively. Pan evaporation (around 2,650mm/yr) greatly exceeds rainfall throughout the year and thus the environment exists in a water deficit condition. Daily pan evaporation rates vary from 11-12mm/day (330-360mm/month) in summer to 2-3mm/day (75-100mm/month) in winter.

This data was derived from three dedicated meteorological stations located in the proposed MRUP, which have been measuring key parameters from 2009 to present, with the data validated against the BoM Laverton AWS records.

During the summer months wind direction is predominately southeasterly (i.e. to the northwest), while in winter the prevailing wind direction is easterly.

12.3.3 Dust

The MRUP area has an elevated natural background dust concentration that is contributed to by sources such as bush fires or wind erosion. There are limited anthropogenic sources of pollutants in the area (Tropicana Gold Mine approximately 110km to the northeast and the Pinjin settlement approximately 105km to the west). Contributions from anthropogenic sources are unlikely to be of any significance given the lack of development in the vicinity (Appendix E1).

12.3.4 Greenhouse Gases

Existing anthropogenic greenhouse gas emissions within the MRUP are minimal and associated with exploration activities.

12.3.5 Radiation

An assessment of baseline radiation was undertaken by Radiation Advice and Solutions Pty Ltd (Appendix F1) which is summarised in the sections below. The impact of radiation discussion within this section is limited to non-human (flora and fauna) environmental receptors. The potential impacts of radiation on human health are discussed in Section 13.

12.3.5.1 Radionuclides in Soil

Worldwide background level of radionuclides in soils is about 3ppm Uranium (U) (or approximately 40BqU/kg) and about 10ppm Thorium (Th) (or about 40BqTh/kg). In arid (and leached-out) central Australia the figures are expected to be lower. The Kintyre ERMP noted averages of 24 and 21Bq/kg for U and Ra respectively, and 13Bq/kg for Th (Appendix F1).

Monitoring of radionuclides in soils over the MRUP for uranium and thorium indicating averages of about 1.0 and 11.0ppm for uranium and thorium respectively. This is consistent with a surface material dominated by Aeolian sediments. The radionuclide levels are low across the Southwest Great Victoria Desert in comparison to world averages (Appendix F1).

12.3.5.2 Radionuclides in Airborne Dust

Radionuclide concentrations in airborne dust are usually determined through particulate sampling and analysis of the collected particulates. As noted in Section 12.4.1, the amount of airborne dust mass and activity is highly variable, however the concentration ratios conform with direct soil assay results.

12.4 Surveys and Investigations

Several air quality and atmospheric gas surveys have been commissioned by Vimy for the MRUP:

- Dispersion Modelling (Appendix E1). This specifically addressed:
  - Dust concentration and deposition baseline surveys.
  - Development of a dust dispersion and deposition model.
  - Development of a dispersion model for the power station.
  - Development of a greenhouse gas emission estimate.
- Occupational and Environmental Radiation Predictions and Controls (Appendix F1).

12.4.1 Dust Characterisation

Vimy conducted a baseline investigation program for airborne dust (PM_{10}) and dust deposition as follows:

- High volume air sampler (HVAS):
  - 56 samples taken from May 2012 to February 2015.
  - Sample periods range from 1 to 37 days, but are usually one to four weeks long.
- Dust deposition gauge:
  - 9 samples each at up to ten sites taken from July 2013 to February 2015.
  - Sample periods range from 29 to 86 days (one to three months).

Between May 2012 and February 2015 the HVAS indicated the amount of airborne dust recorded was highly variable with the average over each sampling period typically ranging between 2.6μg/m^3 and 35μg/m^3. One high reading of 98.5μg/m^3, recorded over a 10 day sample period, was the result of particulates caused by a local bushfire. The weighted average over the entire period was 13.5μg/m^3.

Dust deposition gauges are located at 10 different sites and recorded the dust deposited over nine different time periods from July 2013 through to February 2015. Seasonal variations in dust deposition were as expected, with higher concentrations being measured during the typical dust season for the area (October through to April). The average rate of dust deposition was 0.6g/m^2/month.

12.4.2 Dust Dispersion Model

Vimy commissioned a consultant to develop a dispersion model (Appendix E1). The purpose of the air quality assessment and modelling was to:

- Characterise pre-operational baseline air quality over the project, and the climate, local meteorology and the existing air environment and particulates within the Project area.
- Model various scenarios representative of various stages of the project, including post-closure.
- Present the cumulative air quality impacts of the proposed project on the air environment.
- Model of potential emissions (including pollutants other than dust) from power generation and impacts upon sensitive receptors.

The air quality model uses estimates of dust emissions from the following processes:

- Mechanical emission dust sources:
  - Loading ore and overburden
  - Hauling ore and overburden
  - Light vehicle traffic (including buses)
  - Grading of haul roads
  - Overburden dumping and dozing
  - Ore dumping and conveying (transfer points) within the processing plant.
- Wind erosion dust sources:
  - Active pit area (worst case, when the pit depth is minimal)
  - Overburden landform
  - Roads (haul and light vehicle roads)
  - Tailings dam (surface storage only)
  - Ore stockpile.

The processes were used to calculate increases in dust concentration at the sensitive receptors in units of $\mu g/m^3$ and project originated dust deposition in units of g/m^2/month.

The modelling was conducted in accordance with the DER's Air Quality and air pollution modelling guidance notes (DEC 2006).

Due to the scale of the domain modelled, air dispersion modelling was carried out using the US EPA approved CALPUFF non steady state air dispersion model. Vimy provided surface meteorological observations for three on-site automatic weather stations to inform CALMET (the 3D meteorological model pre-processor to CALPUFF), and coupled with upper air data synthetised using The Air Pollution Model (TAPM). Model development used weather data for the year 1 June 2012 through 31 May 2013, chosen as the most representative of characteristic local meteorological conditions.

CALPUFF was then used to simulate the dispersion characteristics and concentrations of airborne pollutants generated by the proposed activities.

The resulting dispersion model was used to assess four operational years and one year at closure (Appendix E1):

- Scenario 1, Year 3 – the highest production year during the onset of mining, with a surface tailings dam still in production.
- Scenario 2, Year 10 – the highest predicted production year for the life of mine.
- Scenario 3, Year 11 – high mining rate, also with two active pits.
- Scenario 4, Year 14 – elevated mining rate, two active pits and production of an ore stockpile for processing in later years.
- Scenario 5, closure (first year) – the first year after mine closure, with the largest surface areas with partial rehabilitation.

The closure scenario was included in order to quantify the dust impacts of the site upon the conclusion of mining, but while the rehabilitation process (revegetation) is not fully complete. It is anticipated that rehabilitation will not be complete until full vegetation establishment (closure plus five years). The first closure year was chosen as it has the highest surface area of landforms that have incomplete rehabilitation (Appendix E1).

12.4.3 Power Generation Dispersion Model

The principal pollutants from diesel fired power stations are products of combustion and include:

- Oxides of nitrogen (NO_x).
- Sulphur dioxide (SO_2).
- Particulate matter less than 10 microns in aerodynamic diameter (PM_{10}).
- Volatile organic compounds (VOCs).

These products were modelled using the CALPUFF dispersion model. Worst case emissions were estimated for the site by assuming that the 19 diesel generators (1MW each) at the processing plant and the single 1MW diesel generator at the borefield are operating at maximum capacity for the modelling year (Appendix E1).

12.4.4 Greenhouse Gas Emission Estimate

Greenhouse gases will be produced from a number of sources throughout the minesite and power station. These are:

- Vehicle movements (combustion of diesel).
- Energy production from the power station (combustion of diesel) for operation of minesite and borefield.
- Use of carbonates for production of uranium oxide and other precious metal concentrates.

Other processes considered comparatively small and excluded from the study were (Appendix E1):

- Use of oils, greases and lubricants in workshops.
- Onsite waste management.
- Overall land use change.

The following processes considered to be under the operational control of contractors, were also relatively small and are not included within the assessment (Appendix E1):

- Air transport of personnel to site.
- Delivery of goods to site and removal of wastes.

The total greenhouse footprint is expected to vary by a small amount over the course of the MRUP. Emissions for the worst case scenario year were estimated. This year includes:

- Vehicle transport of ore to the edge of pit.
- Power station running at full capacity.
- Production of uranium oxide and other precious metal concentrates.

This worst case year was used to produce an overall greenhouse emission footprint for the 16-year period. In reality, total carbon emissions are likely to be less than the estimates in this assessment, as this assessment focused on the worst case emissions (Appendix E1).

12.4.5 Radiological Assessment for Non-human Biota

Vimy commissioned JRHC Enterprises Pty Ltd to provide an assessment of the radiation related impacts to non-human biota from the proposed MRUP. This was based on predicted radon concentrations and radionuclide deposition rates.

The impact of radionuclide in dust and associated dispersion modelling has been addressed separately under Section 13.

The calculated radionuclide concentrations in various source materials are shown in Table 12.3 (refer Appendix F1).

Table 12.3 Radionuclide Analysis Mined Materials

Material	Uranium Grade (ppm)	Radionuclide Concentration(Bq/g)[1]					
		U^{238}	U^{234}	Th^{230}	Ra^{226}	Pb^{210}	Po^{210}
Ore	600	7.5	7.5	7.5	5.8	5.8	5.8
Low-grade ore	300	3.75	3.75	3.75	2.75	2.75	2.75
Non-mineralised overburden	20	0.25	0.25	0.25	0.36	0.36	0.36

Note 1: Measurements were available only for U^{238} and Ra^{226}. It has been assumed that the U^{234} and Th^{230} concentrations will be the same as the U^{238} concentrations. It has been assumed that the concentrations of Pb^{210} and Po^{210} will be the same as the Ra^{226} concentration.

The average sources of dust emissions for the modelled scenarios discussed in Section 12.4 are shown in Table 12.4 as proportions of total emitted dust (Appendix F1).

Table 12.4 Average Proportion of Dust Emission for All Years of Operation

Emission Source	Proportion of TSP Emissions (%)
Ore	7.4%
Low-grade ore	20.9%
Overburden landforms	71.5%

The radon emanation rates used in the modelling are provided in Table 12.5.

Table 12.5 Estimated Radon Releases

Source of Radon	Emission Rate (MBq/s)			
	Year 3	Year 10	Year 11	Year 14
Mining	0.26	0.36	0.58	0.66
Low-grade and Overburden Stockpiles	0.60	0.90	1.20	1.50
Tailings	0.30	0.30	0.30	0.30
Processing Plant	0.45	0.45	0.45	0.45
Total	1.61	2.01	2.53	2.91

Due to the lack of data on radon emanation for the non-mineralised (or barren) overburden landforms, extremely conservative emanation rates were assigned to these overburden landforms, consistent with low-grade mineralisation (400ppm U_3O_8). Given the prominence of such landforms in the later years of the Project, the emanation rates modelled are expected to be materially greater than actual rates. Vimy will collect data from actual equivalent landforms during geotechnical investigation trenching at the Ambassador deposit, being conducted from November 2015 onwards. This data will be used to update the emissions model.

The impacts to non-human biota are assessed as a calculated incremental dose rate. The assessment is based on the results of the air quality modelling conducted by GHD (GHD 2015e) which provide a measure of project originated radioactivity in the environment outside the Project area. It then uses recognised standard methods to calculate a radiological impact.

The sensitive receptor locations, as defined by the air quality modelling, are locations where members of the public and workers at the accommodation village might potentially be impacted by project activities and associated air emissions (refer to Table 12.2). The locations on the southeast project boundary (approximately 9km from the proposed processing plant location) and northwestern access road into the operations (approximately 40km from the proposed processing plant location) are not permanently occupied locations, but provide estimates of “worst case” exposure situations (Appendix F1).

The impact to non-human biota is assessed by determining the change in radiation dose rates to standard species of flora and fauna as a result of emissions from the operation. The change in concentration is then used as input data for an ERICA (Environmental Risk Ionising Contaminants: Assessment and Management) assessment which calculates a dose to set of reference species (Appendix F1).

The ERICA Software Tool is a widely used method for assessing radiological impacts to plants and animals. The software uses a collection of impact databases and is based on a three tiered approach to assessing the radiological risk to plants and animals. Tier one is the simplest assessment level, requiring the minimum input data, and if the results of an assessment meet a predefined screening level, then further assessment is not required. If the screening level is exceeded, then more detailed tiered assessments occur. Tier two assessments are also undertaken if further data is available. The idea behind the tiered approach is that assessments are undertaken with an appropriate level of information and effort. The screening level is the radiation dose rate, below which no effects would be observed and the ERICA default level is set at 10µGy/h (Appendix F1).

12.5 Potential Impacts

The construction and operational stages of the Project have the potential to increase dust generation at the site by mechanical sources, such as trucking, and increased erosional sites from land clearance.

12.5.1 Dust Emissions

12.5.1.1 Predicted Dust Concentration

The modelling showed predicted dust concentration impacts are anticipated to be the highest during Scenario 2 (Year 10) which represented the highest mining throughput and therefore the greatest dust emissions. However, predicted impacts at receptors are all lower than assessment criteria. The results indicate that:

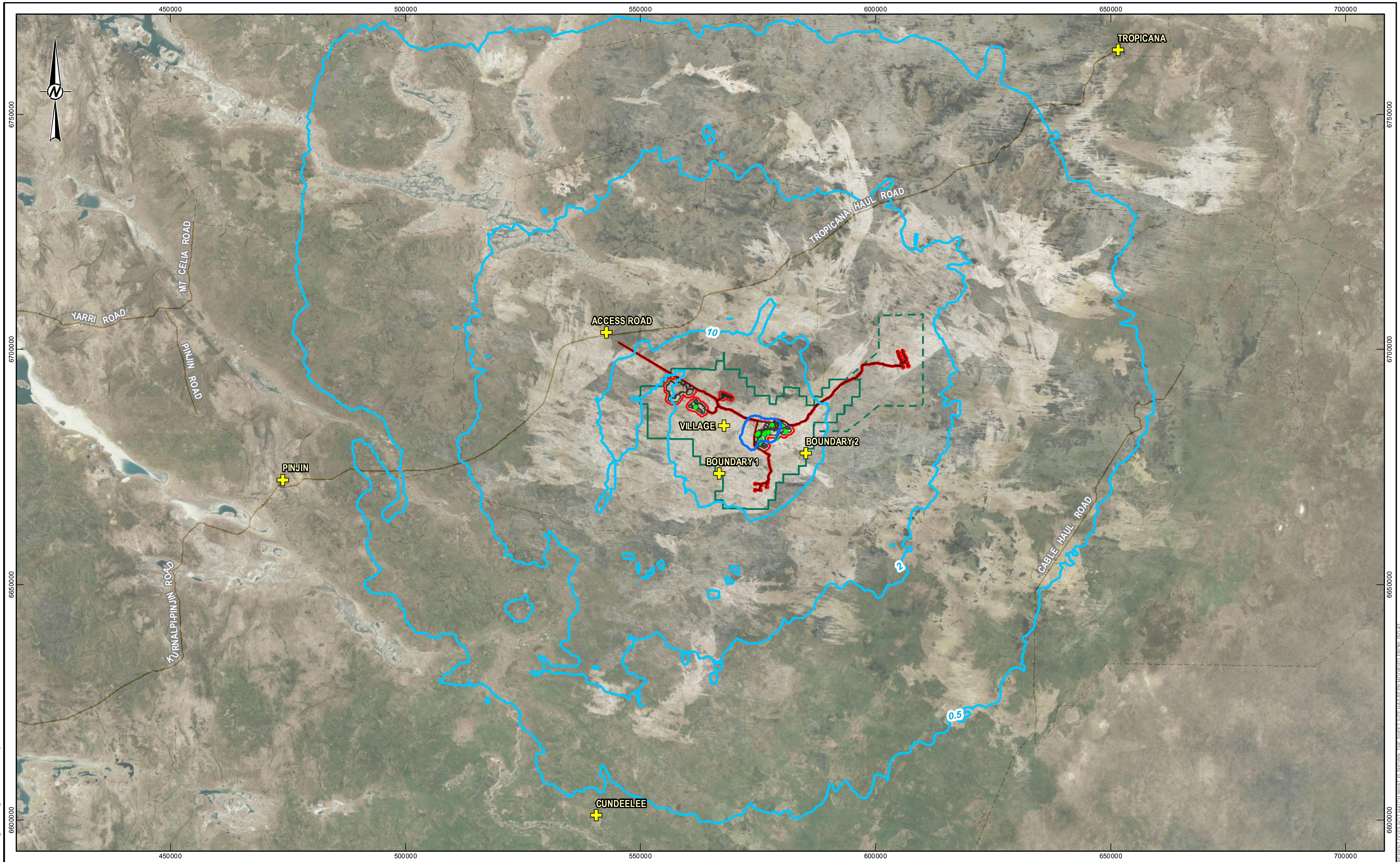
- The highest predicted concentration impacts are at the closest receptor (MRUP accommodation village) and range between 22% and 52% of the various assessment criteria for the four scenarios.
- Predicted concentrations at MRUP site boundaries during mining years range between 5% and 42% of the guidelines for the scenarios.
- When considering the three population receptors surrounding MRUP, as they are a significant distance from the MRUP, the predicted concentrations during mining years range from 0.1% to 0.7% percent of any of the criteria.
- Predicted concentrations at receptors during the closure scenario are lower than those during mining years (Appendix E1).

The percentages presented above are an indication of the approximate proportion of the criterion.

Results for Scenario 2 (the highest prediction production year for the life of mine) are presented in Table 12.6 and Figure 12.1 to Figure 12.5, with ambient levels excluded.

Table 12.6 Scenario 2, Year 10 Predicted Concentrations at Receptors

Receptor	PM_{10}, µg/m^3			TSP, µg/m^3	
Averaging period	Annual	24-hour	1-hour	24-hour	1-hour
Rank	Max	Max	99.9th %ile	Max	99.9 %ile
Guideline	20	50	80	90	- -
1: Tropicana Gold Mine	0.002	0.03	0.11	0.11	0.41
2: Pinjin	0.009	0.01	0.21	0.20	0.76
3: Cundeelee	0.009	0.14	0.57	0.50	2.09
4: Tenement boundary	1.539	9.21	25.84	29.89	84.39
5: PNC X TPG access road	0.964	1.69	6.22	6.11	23.35
6: Accommodation village	3.161	13.64	30.13	42.73	94.87
7: Tenement boundary 2	0.727	8.19	19.42	25.81	60.02



LEGEND

- SENSITIVE RECEPTOR
- PIT AND PROCESSING PLANT SOURCE LOCATION
- PREDICTED 1-hr 99.9 PERCENTILE PM10 CONCENTRATION
- VICTORIAN SEPP-AQM CRITERIA (80 µg/m³)
- INFRASTRUCTURE
- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
CONTOURS GENERATED FROM SC2_PM10_1HR_CONC_99%ILE.GRD PROVIDED BY GHD
AERIAL IMAGERY SOURCED FROM ESRI ONLINE

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1:750,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-03
DESIGNED	MS
PREPARED	MS
REVIEWED	EWC
APPROVED	EWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SCENARIO 2, YEAR 10
PREDICTED 1-HOUR 99.9 PERCENTILE PM10 CONCENTRATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	12.1

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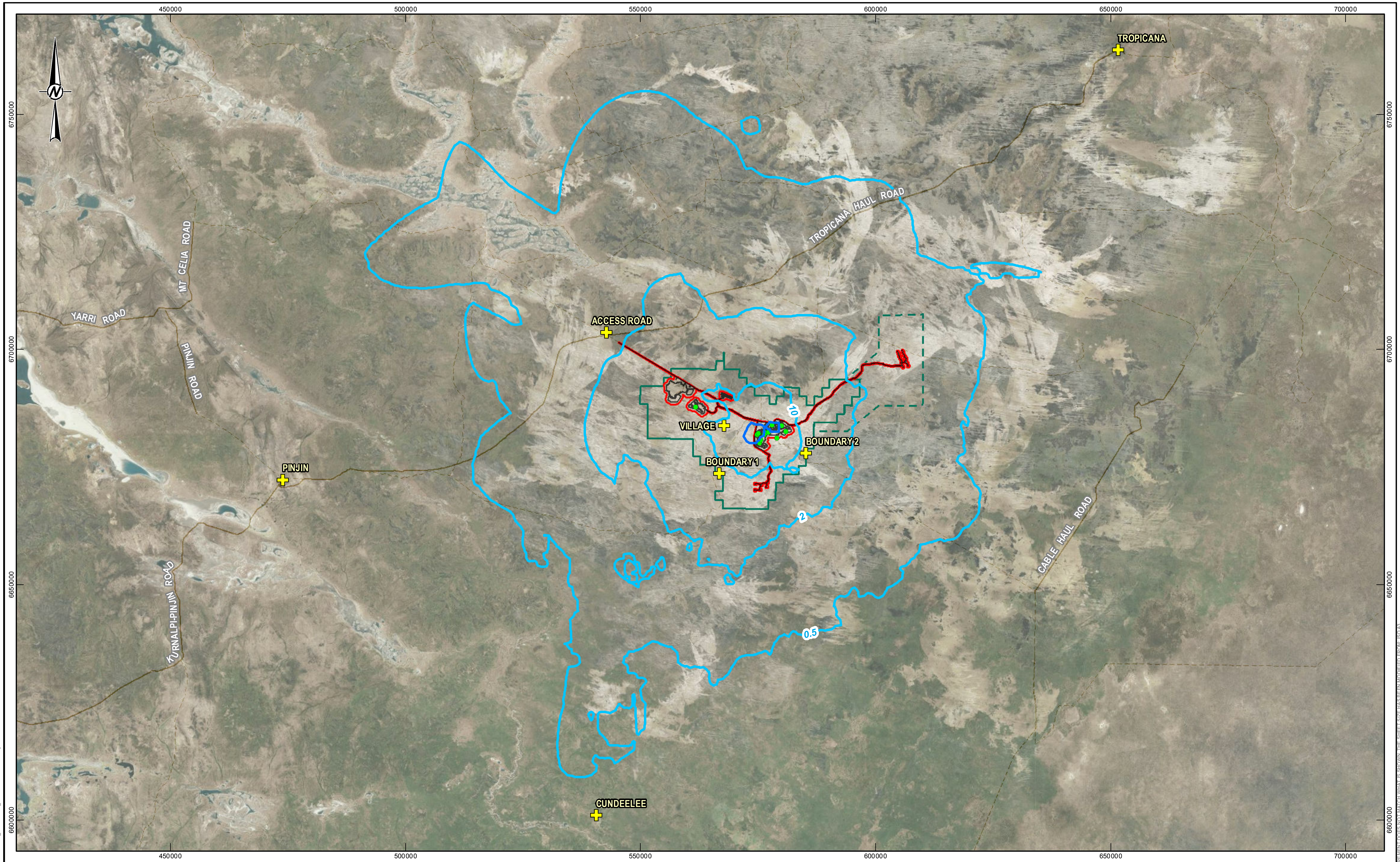

LEGEND

- SENSITIVE RECEPTOR
- PIT AND PROCESSING PLANT SOURCE LOCATION
- PREDICTED 24-hr MAX PM10 CONCENTRATION
- AIR NEPM CRITERIA (50 μg/m³)
- INFRASTRUCTURE
- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
CONTOURS GENERATED FROM SC2_PM10_24HR_CONC_MAX.GRD PROVIDED BY GHD
AERIAL IMAGERY SOURCED FROM ESRI ONLINE

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1:750,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-03
DESIGNED	MS
PREPARED	MS
REVIEWED	EWC
APPROVED	EWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SCENARIO 2, YEAR 10
PREDICTED 24-HOUR MAXIMUM PM10 CONCENTRATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
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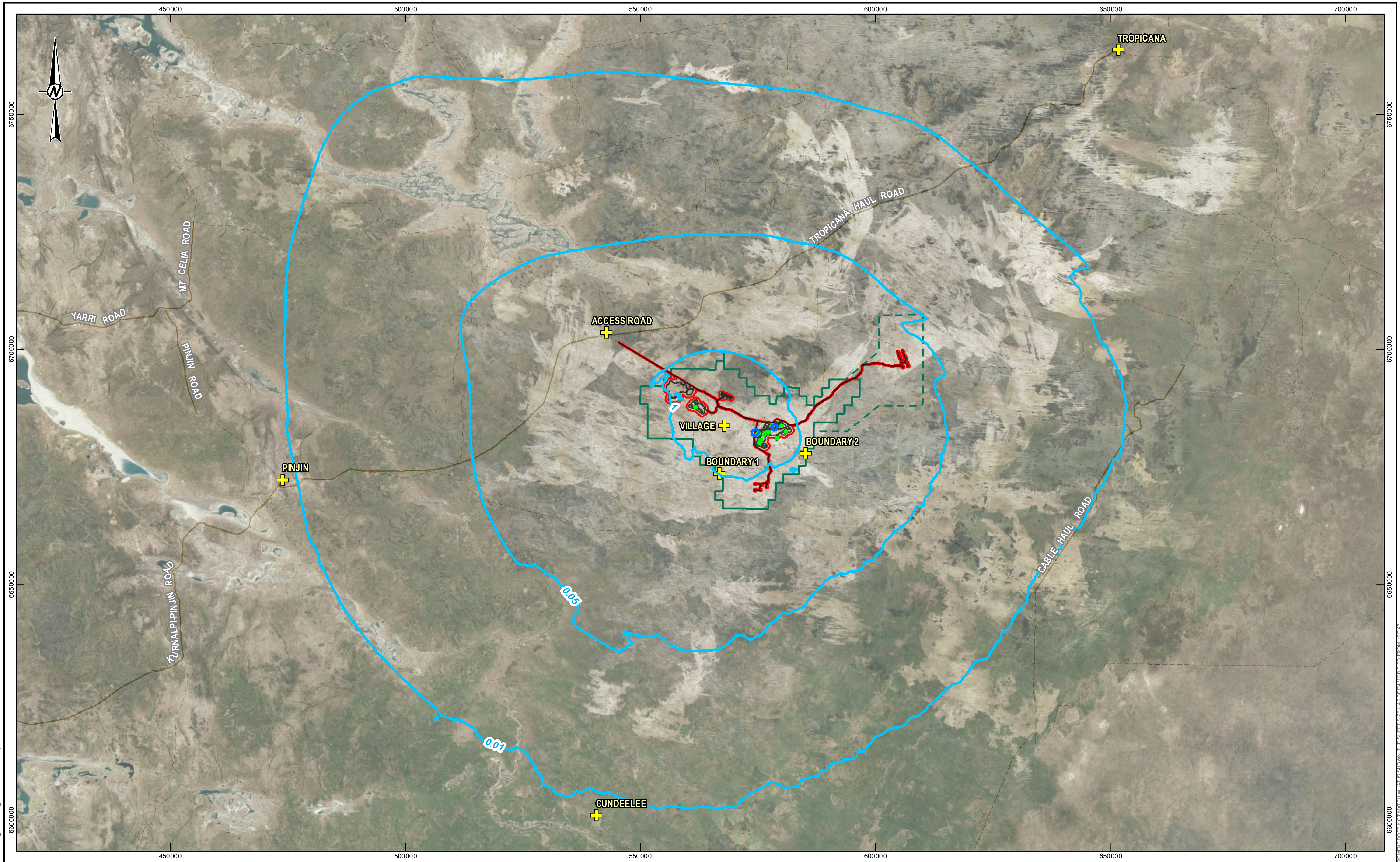

LEGEND

- SENSITIVE RECEPTOR
- PIT AND PROCESSING PLANT SOURCE LOCATION
- PREDICTED ANNUAL MAX PM10 CONCENTRATION
- PROPOSED VARIATION TO AIR NEPM CRITERIA (20 µg/m³)
- INFRASTRUCTURE
- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
CONTOURS GENERATED FROM SC2_PM10_ANNUAL_CONC.GRD PROVIDED BY GHD
AERIAL IMAGERY SOURCED FROM ESRI ONLINE

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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-03
DESIGNED	MS
PREPARED	MS
REVIEWED	EWC
APPROVED	EWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SCENARIO 2, YEAR 10
PREDICTED ANNUAL MAXIMUM PM10 CONCENTRATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	12.3

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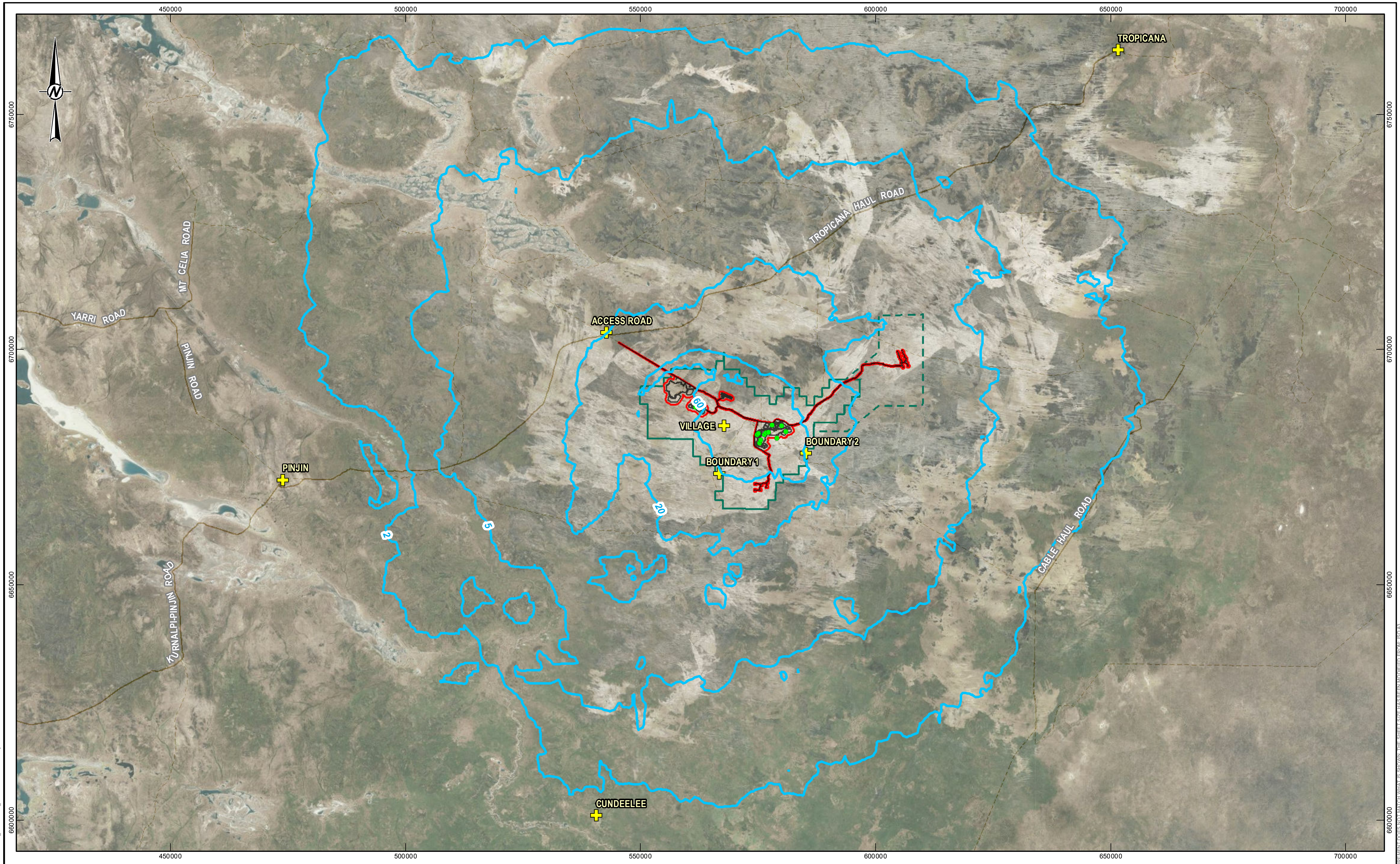

LEGEND

- SENSITIVE RECEPTOR
- PIT AND PROCESSING PLANT SOURCE LOCATION
- PREDICTED 1-hr 99.9 PERCENTILE TSP CONCENTRATION
- INFRASTRUCTURE
- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
CONTOURS GENERATED FROM SC2_TSP_1HR_CONC_99%ILE.GRD
PROVIDED BY GHD
AERIAL IMAGERY SOURCED FROM ESRI ONLINE

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1:750,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-03
DESIGNED	MS
PREPARED	MS
REVIEWED	EWC
APPROVED	EWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SCENARIO 2, YEAR 10
PREDICTED 1-HOUR 99.9 PERCENTILE
TSP CONCENTRATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
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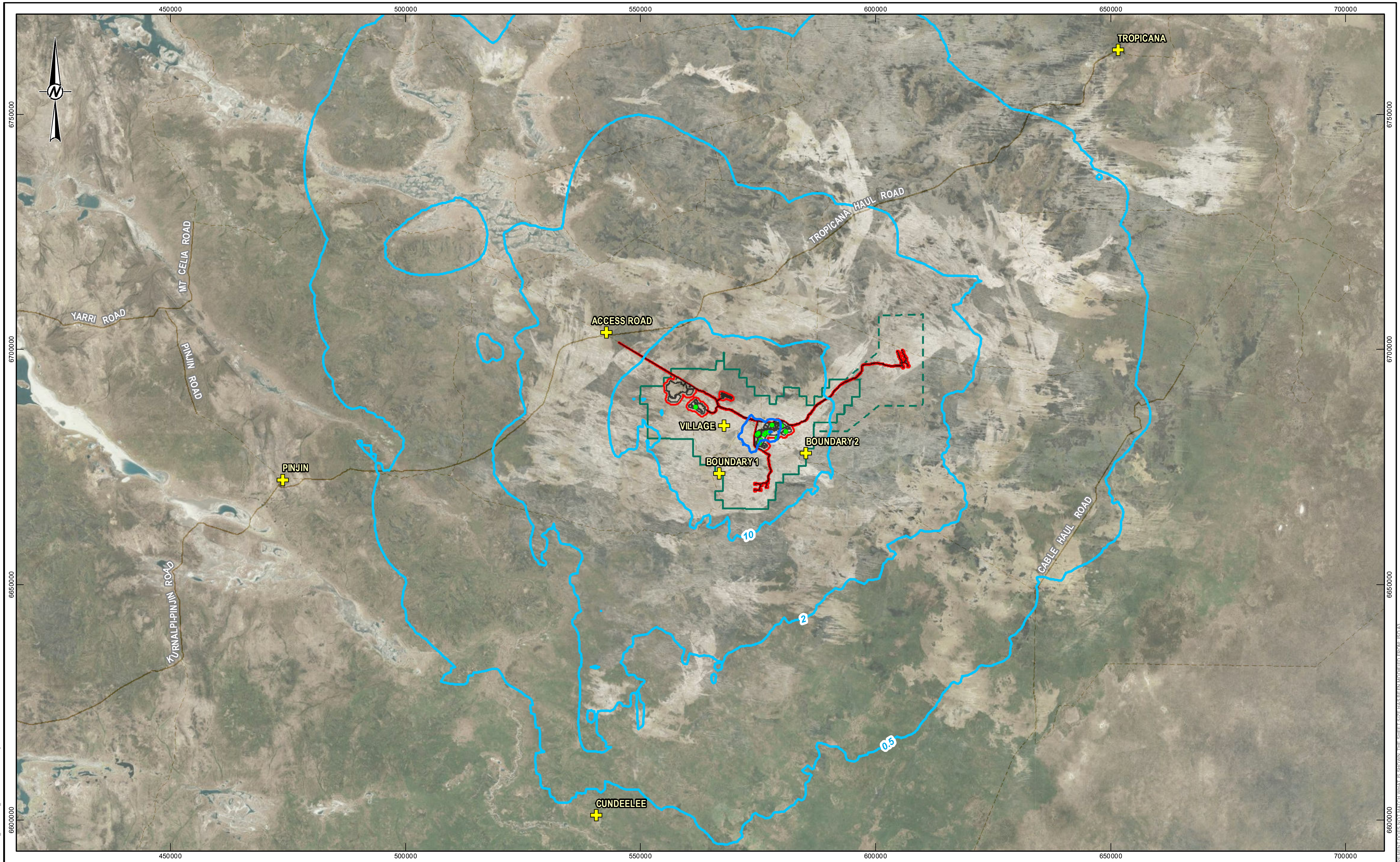

LEGEND

- SENSITIVE RECEPTOR
- PIT AND PROCESSING PLANT SOURCE LOCATION
- PREDICTED 24-hr MAX TSP CONCENTRATION
- KWINANA EPP CRITERIA (90 μg/m³)
- INFRASTRUCTURE
- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
CONTOURS GENERATED FROM SC2_TSP_24HR_CONC_MAX.GRD PROVIDED BY GHD
AERIAL IMAGERY SOURCED FROM ESRI ONLINE

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1:750,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-03
DESIGNED	MS
PREPARED	MS
REVIEWED	EWC
APPROVED	EWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SCENARIO 2, YEAR 10
PREDICTED 24-HOUR MAXIMUM TSP CONCENTRATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	12.5

12.5.1.2 Predicted Dust Deposition

The modelling showed predicted dust deposition is highest at the MRUP accommodation village, though well below the monthly deposition criteria (less than 1%). Deposition at other sites is predicted to be much lower (Appendix E1).

The reason for the predicted low emissions is due to the significant distance between source and receptors. Large particles will be deposited closer to the sources than any of the receptor locations. Smaller particles will remain airborne further from the emission sources, but are less prone to deposition. Results for Scenario 2 are presented in Table 12.7 (Appendix E1).

Table 12.7 Scenario 2, Year 10 Predicted Dust Deposition at Receptors

Receptor	Dry deposition			Wet deposition			Total deposition		
Units	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$
Guideline	- -	- -	- -	- -	- -	- -	- -	2	- -
1: Tropicana Gold Mine	5.4×10^{-13}	1.4×10^{-6}	1.7×10^{-5}	6.3×10^{-12}	1.7×10^{-5}	2.0×10^{-4}	6.8×10^{-12}	1.8×10^{-5}	2.1×10^{-4}
2: Pinjin	3.2×10^{-12}	8.6×10^{-6}	1.0×10^{-4}	1.5×10^{-11}	3.9×10^{-5}	4.6×10^{-4}	1.8×10^{-11}	4.7×10^{-5}	5.6×10^{-4}
3: Cundeelee	2.5×10^{-12}	6.7×10^{-6}	7.9×10^{-5}	5.3×10^{-12}	1.4×10^{-5}	1.7×10^{-4}	7.8×10^{-12}	2.1×10^{-5}	2.5×10^{-4}
4: Tenement boundary	1.3×10^{-8}	3.5×10^{-2}	4.2×10^{-1}	2.0×10^{-10}	5.5×10^{-4}	6.4×10^{-3}	1.3×10^{-08}	3.6×10^{-2}	4.2×10^{-1}
5: PNC X TPG access road	8.8×10^{-11}	2.4×10^{-4}	2.8×10^{-3}	1.4×10^{-10}	3.7×10^{-4}	4.4×10^{-3}	2.3×10^{-10}	6.1×10^{-4}	7.1×10^{-3}
6: Accomm-odation village	7.7×10^{-9}	2.1×10^{-2}	2.4×10^{-1}	5.3×10^{-10}	1.4×10^{-3}	1.7×10^{-2}	8.2×10^{-09}	2.2×10^{-2}	2.6×10^{-1}
7: Tenement boundary 2	5.4×10^{-10}	1.4×10^{-3}	1.7×10^{-2}	1.3×10^{-10}	3.4×10^{-4}	4.0×10^{-3}	6.6×10^{-10}	1.8×10^{-3}	2.1×10^{-2}

12.5.1.3 Cumulative Impacts from Regional Background Dust

As there are limited anthropogenic dust sources in the area, the majority of dust in the area will be through dust emission processes that naturally occur in the environment. Namely, wind erosion from open areas and bushfire smoke. The impact of a nearby bushfire on air quality can be very significant, as measured during the November 2014 fire that burnt the majority of the Project area, and over the following months.

Dust emissions from the MRUP project, regional background sources, or both, have the potential to dominate in the neighbourhood of the minesite (a scale of kilometres from the site); however further afield, where the receptors are located (tens of kilometres), background regional conditions and their own local neighbourhood sources will dominate (Appendix E1).

The highest predicted incremental increase in ground-level concentration from mining activities is approximately 14µg/m^3 (PM_{10}, 24-hr avg) (at the accommodation village). However, times of elevated dust emissions from MRUP will likely correlate with elevated regional dust due to wind erosion in the surrounding environment. Based on the predicted concentrations at the MRUP accommodation camp, the cumulative concentration may on occasion exceed guideline values, but this cannot be quantified without hourly or daily measurements being taken at the MRUP site, though MRUP contribution will likely have only contributed up to 25% of the overall dust concentration (Appendix E1).

Dust deposition monitoring undertaken at the MRUP site ranges from 0.1 to 0.3g/m^2/month for six of nine sample periods. Three sample periods have consistently elevated measurements, ranging from 0.3 to 4.0g/m^2/month. These measured deposition values are three to seven orders of magnitude greater than the predicted mine dust deposition at receptor locations. The predicted deposition is significantly lower due to the separation distances between the sources and the receptor (Appendix E1).

12.5.1.4 Consideration of Cumulative Impacts from Other Sources

The plots show that the range of any measurable dust impact (taken as 10% of the assessment criterion) is approximately 30km. That is, any location outside of a radius of 30km from the minesite is unlikely to distinguish MRUP dust contributions from other regional sources. As the closest major dust source to MRUP is Tropicana (110km from MRUP), cumulative impacts from the two sources are likely to be insignificant (Appendix E1).

12.5.2 Power Generation Emissions

The modelling conducted by GHD (Appendix E1) showed the predicted concentrations at all receptors are below the assessment criteria for all assessed pollutants. Predicted ground level concentrations at the borefield power generation site are also below these assessment criteria (Table 12.8 and Table 12.9).

Table 12.8 Predicted Concentrations at Receptors, µg/m^3

Receptor	CO	NO_2[1]		PM_{10}			SO_2		
Averaging period	8-hour	1-hour	Annual	1-hour	24-hour	Annual	1-hour	24-hour	Annual
Rank	Max	Max	- -	99.9 %ile	Max	- -	Max	Max	- -
Guideline	11,254	247	62	80	50	20	572	229	57
1: Tropicana Gold Mine	0.2	0.4	0.002	0.04	0.010	0.0005	0.014	0.0013	0.000070
2: Pinjin	0.5	0.6	0.012	0.11	0.03	0.003	0.022	0.0038	0.00041
3: Cundeelee	1.2	1.3	0.013	0.3	0.05	0.003	0.046	0.0067	0.00046
4: Tenement boundary	10	14	0.12	3	0.4	0.03	0.48	0.051	0.0042
5: PNC X TPG access road	4	3	0.07	0.6	0.2	0.02	0.11	0.027	0.0023
6: Accommodation village	7	16	0.1	2	0.3	0.03	0.54	0.04	0.0045
7: Tenement boundary 2	11	14	0.1	3	0.4	0.02	0.49	0.06	0.0030
8: Plant power station	3,647	**2,171**	**126**	**480**	**168**	**33**	75	22	4.3
9: Borefield	12	37	0.1	3	0.5	0.04	1.3	0.07	0.0050

1. Taken as 20% of NO_x result

Table 12.9 Predicted Concentrations at Receptors (VOC components), µg/m^3

Receptor	Acetaldehyde	Benzene	Formaldehyde	Toluene			Xylene
Averaging period	3-min	3-min	3-min	3-min	24-hour	annual	3-min
Rank	99.9%ile	99.9%ile	99.9%ile	99.9%ile	max	- -	99.9%ile
Guideline	76	10.5	40	650	4114	411	350
1: Tropicana Gold Mine	6.2×10^{-2}	7.9×10^{-3}	4.2×10^{-4}	1.9×10^{-5}	6.0×10^{-4}	6.2×10^{-5}	2.2×10^{-4}
2: Pinjin	1.7×10^{-1}	2.3×10^{-2}	2.5×10^{-3}	5.0×10^{-5}	1.6×10^{-3}	1.7×10^{-4}	5.8×10^{-4}
3: Cundeelee	3.9×10^{-1}	4.0×10^{-2}	2.8×10^{-3}	1.2×10^{-4}	3.8×10^{-3}	3.9×10^{-4}	1.4×10^{-3}
4: Tenement boundary	3.9×10^{0}	3.1×10^{-1}	2.5×10^{-2}	1.2×10^{-3}	3.7×10^{-2}	3.9×10^{-3}	1.3×10^{-2}
5: PNC X TPG access road	9.3×10^{-1}	1.6×10^{-1}	1.4×10^{-2}	2.8×10^{-4}	9.1×10^{-3}	9.3×10^{-4}	3.3×10^{-3}
6: Accommodation village	2.3×10^{0}	2.6×10^{-1}	2.7×10^{-2}	7.0×10^{-4}	2.2×10^{-2}	2.3×10^{-3}	8.1×10^{-3}
7: Tenement boundary 2	3.8×10^{0}	3.4×10^{-1}	1.8×10^{-2}	1.1×10^{-3}	3.7×10^{-2}	3.8×10^{-3}	1.3×10^{-2}
8: Plant power station	7.0×10^{2}	1.3×10^{2}	2.6×10^{1}	2.1×10^{-1}	6.8×10^{0}	7.0×10^{-1}	2.4×10^{0}
9. Borefield	4.7×10^{0}	5.2×10^{-1}	3.0×10^{-2}	1.4×10^{-3}	4.6×10^{-2}	4.7×10^{-3}	1.7×10^{-2}

12.5.2.2 Consideration of Cumulative Impacts and Background Concentrations

There are limited anthropogenic sources of pollutants other than dust in the area. The Tropicana Gold Mine is the closest major source and this is located more than 110km away. Background anthropogenic levels are unlikely to be significantly different when considered with the MRUP sources. Emissions from power generation were modelled separately from dust emissions from the remainder of the mine. GHD (Appendix E1) noted the predicted dust concentrations due to power generation are only elevated directly at the power station (dust generation point), and this would have occurred during low dispersion events. As such, cumulative impacts at the power station are significant. However, predicted concentrations at the accommodation camp are small, so there is negligible cumulative impact.

12.5.3 Greenhouse Gas Emissions

Total greenhouse gas emissions for the life of mine (construction and operation) are estimated from:

- 16 operational year emissions.
- Construction emissions.

Table 12.10 summarises the total emissions for the MRUP (Appendix E1).

Table 12.10 Summary of Total Greenhouse Gas Emissions

Source	Total Emissions (tonnes CO_2-e)	Percentage of total
Total diesel fleet	543,136	15%
Total electricity	2,609,980	73%
Total production of product	443,520	12%
All emissions	**3,596,635**	**100%**

12.5.4 Radiological Assessment

The modelling of the radon emissions was used to calculate concentrations at sensitive receptor locations. For dust, emission factors outlined in Section 12.4.2 are used to provide dust concentrations at sensitive receptor locations.

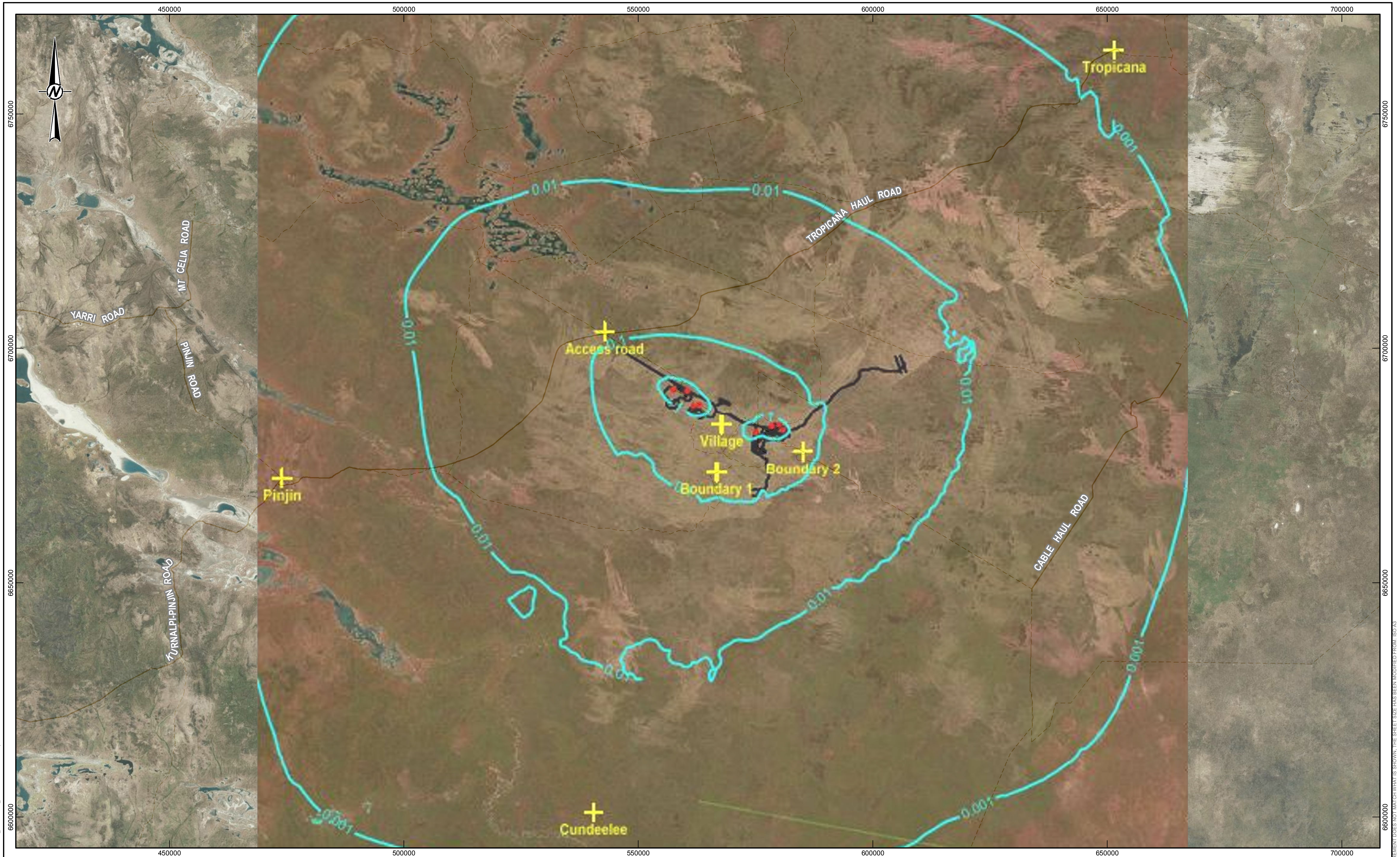
12.5.4.1 Radon

The predicted annual average ground level concentrations at each of the main receptor locations can be seen in Table 12.11. These figures do not include naturally occurring background radon concentrations which are approximately 10 to 20Bq/m^3 (Appendix F1).

Table 12.11 Annual Average Radon Ground Level Concentrations

Location	Ground Level Concentrations Annual Average (Bq/m^3)			
	Year 3	Year 10	Year 11	Year 14
Accommodation Village	0.26	0.37	0.52	0.52
Cundeelee	0.001	0.001	0.002	0.002
Pinjin	0.001	0.001	0.002	0.002
Tropicana Gold Mine	<0.001	<0.001	<0.001	<0.001
Southeastern boundary	0.19	0.20	0.21	0.19
Northwest boundary	0.02	0.03	0.04	0.07

The incremental annual average radon concentration from the air quality modelling at Year 14 of operations, when radon emissions are at their highest rates is presented in Figure 12.6.



LEGEND

MINOR ROAD/TRACK

ROAD

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

AERIAL IMAGERY SOURCED FROM ESRI ONLINE

0 10 20 30 40 50

1:750,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-03
DESIGNED	MS
PREPARED	MS
REVIEWED	EWC
APPROVED	EWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
ANNUAL AVERAGE MODELLED RADON CONCENTRATIONS Bq/m³ FROM THE MRUP

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	12.6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

12.5.4.2 Airborne Dust

Airborne dust has been calculated from the modelled dust concentrations and can be seen in Table 12.12 (Appendix F1).

Table 12.12 Annual Ground Level Concentrations (maximum result for all modelled years)

Location	Ground Level Concentrations PM10 Dust ($\mu g/m^3$)	Assumed Ground Level Concentrations TSP Dust ($\mu g/m^3$)	Equivalent Radionuclide Concentration ($\mu Bq/m^3$)
Accommodation camp	3.16	6.32	9.48
Cundeelee	0.01	0.02	0.03
Pinjin	0.01	0.02	0.03
Tropicana Gold Mine	<0.01	<0.02	<0.03
Southeastern boundary	0.73	1.46	2.19
Northwest boundary	0.96	1.92	2.88

12.5.4.3 Dust Deposition

The radionuclide deposition rates for the life of the project have been calculated from the modelled dust deposition rates and presented in Table 12.13 (Appendix F1).

Table 12.13 Cumulative Dust Deposition (16 years)

Location	Ground Level Concentrations Dust Deposition (g/m^2)	Radionuclide Deposition (Bq/m^2)
Accommodation Village	8.62	12.9
Cundeelee	4.6×10^{-3}	6.9×10^{-3}
Pinjin	1.1×10^{-2}	1.7×10^{-2}
Tropicana Gold Mine	4.3×10^{-3}	6.5×10^{-3}
Southeastern boundary	3.8×10^{-1}	5.7×10^{-1}
Northwest boundary	1.7×10^{-1}	2.6×10^{-1}

12.5.4.4 Non-human Biota Impact

This section provides an assessment of the potential radiological impacts on non-human biota from the operation. The assessment conducted by JHRC (Appendix F1) considers airborne emissions from the project which results in the deposition of radioactive dusts on surrounding soils and is summarised below.

The ERICA assessment was conducted using a soil radionuclide concentration of 0.862Bq/kg (for each long lived uranium-238 series radionuclide). This is the location of the highest radionuclide deposition, being at the proposed accommodation village. The output of the assessment can be seen in Table 12.14 which shows that the 10µGy/h screening level (trigger level) was not exceeded.

Table 12.14 Output of ERICA Assessment

Organism	Concentration Ratio source	Dose Rate (µGy/h)	Screening Level (µGy/h)
Lichen and bryophytes	ERICA default	0.182	10
Arthropod – Detritivorous	ERICA default	0.007	10
Flying insect	ERICA default	0.006	10
Grasses & herbs	ERICA default	0.035	10
Mollusc – Gastropod	ERICA default	0.007	10
Shrub	ERICA default	0.051	10
Bird	ERICA default	0.005	10
Amphibian	ERICA default	0.009	10
Reptile	ERICA default	0.009	10
Kangaroo	ARPANSA 2014	0.020	10
Tree	ERICA default	0.004	10
Mammal (small burrowing)	ERICA default	0.008	10
Mammal (large)	ERICA default	0.008	10

The species with the highest level of exposure is lichen and bryophytes, however the impact level remains well below the trigger level for further assessment.

It can be concluded that the ERICA assessment indicated that there is no radiological risk to reference plants and animals from emissions from the proposed project. For further discussion of this assessment, refer to Section 6 Flora and Vegetation and Section 7 Terrestrial Fauna.

12.6 Management of Impacts

For the identified impacts, Vimy has adopted the following hierarchy of controls to reduce the risk to a level that is as low as reasonably achievable (ALARA):

- Avoid.
- Minimise.
- Mitigate.
- Rehabilitate.
- Offset.

12.6.1 Dust Management

Dust generated during the construction and operational phases of the MRUP, including any potential radionuclides in dust, is not expected to produce any significant residual environmental impacts on air quality or non-human biota.

Operation of the diesel power generators will be monitored continuously and any performance degradation will be identified using built-in board sensors. Diesel power generators installed for the power station will automatically start up and shut down based on the required load, conserving fuel and reducing emissions.

Emissions from the diesel power generators are minimised by ensuring each is well maintained and operated using ultra low sulphur (50ppm) diesel.

Residual impacts will be limited by the application of the following Environmental Management Plans (EMPs):

- Dust Management Plan (MRUP-EMP-024).
- Ground Disturbance Management Plan (MRUP-EMP-019).
- Rehabilitation and Revegetation Management Plan (MRUP-EMP-030).
- Radioactive Waste Management Plan (MRUP-EMP-029).
- Rehabilitation and Revegetation Management Plan (MRUP-EMP-030).
- Mine Closure Plan (MRUP-EMP-031).

The overall air quality objective of these MPs is to ensure that impacts are minimised locally, through dust emissions and pollutants from power generation, and globally from the emission of greenhouse gases.

The Ground Disturbance Management Plan (MRUP-EMP-019), the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030) and Conceptual Mine Closure Plan (MRUP-EMP-030) and will address:

- Minimum necessary clearing of vegetation.
- Rehabilitation of cleared areas as soon as practicable in order to reduce areas likely to generate dust.
- Landforms at closure designed to minimise dust generation.

The Dust Management Plan (MRUP-EMP-024) will address minimisation of dust generation by:

- Applying dust suppression measures such as water spraying to all dust generating activities:
  - material handling activities such as excavation and truck loading
  - around material stockpiles
  - within the primary crushing circuit
  - along all transport corridors as necessary.
- Ensure that tailings deposition is subaqueous and exposed tailings are not allowed to dry.
- Vehicle speed restrictions are applied.
- Off-road travel is restricted.
- Hygiene measures are applied to areas where dust build-up could occur.

The following management plans (yet to be developed) will contribute to air quality and atmospheric gases management for the MRUP:

- Greenhouse Gas Management Plan (MRUP-EMP-017).
- Radiation Management Plan (MRUP-EMP-028).

12.6.1.1 Dust Monitoring

Dust emissions will be monitored at various monitoring locations around the MRUP site as required under the Dust Management Plan (MRUP-EMP-024). The objectives of the monitoring program will be to provide timely dust concentration data (TSP, PM_{10} and $PM_{2.5}$) to assist with the management of environmental objectives for the Project. Data will be compared with preliminary performance indicators to determine compliance and also the effectiveness of the compliance targets. Together, the monitoring data and performance indicator targets will allow for an evaluation of the impact of the Project on ambient air quality and trigger corrective actions if required.

Fuel use related to all fuel consuming activities will be monitored as required under the Greenhouse Gas Management Plan (MRUP-EMP-017) and this information will be subject to analysis to determine fuel use efficiency as related to particular activities.

Other monitoring will be conducted in accordance with the requirements of the specific EMPs.

If monitoring actions indicate that management targets outlined in Table 12.15 have been exceeded then the associated corrective actions outlined below will be implemented.

Table 12.15 Dust Management Corrective Actions

Management target	Action in case of failure
No decline in vegetation health at flora monitoring locations attributed to dust levels	• Conduct investigation to determine specific cause of the impact. • Implement appropriate dust control measures to reduce further impact (e.g. speed reduction in strategic locations).
No exceedance of ambient dust level trigger at monitoring locations	• Raise as environmental incident report. • Conduct investigation to determine specific cause of the impact. • Implement appropriate dust control measures to reduce further impact. • Review Dust MP procedures and update where necessary to reduce further impacts.
No exceedance of ambient dust deposition level trigger at monitoring locations	• Raise as environmental incident report. • Conduct investigation to determine specific cause of the impact. • Implement appropriate dust control measures to reduce further impact. • Review Dust MP procedures and update where necessary to reduce further impacts.
Observation of visible excessive dust at minesite	• Conduct investigation to determine specific cause of the impact. • Implement necessary controls to prevent further impacts (e.g. increase water cart usage and reduce work load in certain wind conditions). • Raise as environmental incident report.

12.6.1.2 Radiation Monitoring

A comprehensive environmental and occupational radiation monitoring program will be developed for operations. The aim of this program is to provide data for the assessment of doses to the public, to measure any radiological impacts on the off-site environment and to ensure that the radiation controls for off-site impacts are effective.

A detailed environmental monitoring program will be developed and an outline of the monitoring program is shown in Table 12.16.

Table 12.16 Outline Environmental Radiation Management Program

Environmental Pathway	Measurement Method	Location and Frequency
Direct (external) gamma	Handheld environmental gamma monitor	Annual survey at perimeter of operational area
Radon Decay Product Concentrations	Real time monitors	Monitors will rotate between off-site locations
Dispersion of dust containing long-lived, alpha-emitting radionuclides	High volume samplers	Monitors will rotate between approved off-site locations
Dispersion of dust containing long-lived, alpha-emitting radionuclides	Dust deposition gauges	Sampling at identified locations. Samples composited for one year then radiometrically analysed
Seepage of contaminated water	Groundwater sampling from monitoring bores	A network of monitoring bores will be sampled quarterly and analysed for radionuclides and other constituents
Run off of contaminated water	Surface water sampling	Opportunistic surface water sampling will occur following significant rainfall events
Radionuclides in potable water supplies	Sampling and radiometric analysis	Annually

Other monitoring will be conducted in accordance with the requirements of the specific EMPs.

12.7 Predicted Outcomes

Taking into account the MRUP design and proposed management measures to be implemented, Vimy believes that the proposal will meet the EPA's objective with regard to air quality and atmospheric gases.

13. Human Health

13.1 Relevant Environmental Objective

13.1.1 EPA Objective

The EPA applies the following objective to the assessment of proposals that may affect human health:

To ensure that human health is not adversely affected.

13.1.2 Regulatory Framework

The protection of human health is covered by the following key statutes:

- *Radiation Safety Act 1975 (WA) (RSA).*
- *Mines Safety and Inspection Act 1994 (WA) (MSIA).*
- *Australian Radiation Protection and Nuclear Safety Act 1998 (Cth) (ARPANS Act).*
- *Environmental Protection Act 1986 (WA) (EP Act).*
- *Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act).*

Radiation Safety Act 1975

This is an act which regulates the keeping and use of all substances, whether natural or artificial, and regardless of form, which consists of or contains more than the maximum prescribed concentration of any radioactive element.

There are two key subsidiary pieces of legislation:

- *Radiation Safety (General) Regulations 1983.* These regulations define radioactive substances and cover the licensing of premises.
- *Radiation Safety (Transport of Radioactive Substances) Regulations 2002.* These regulations cover the transport of radioactive materials in Western Australia and the storing, packing and stowing of such materials for transport; it includes licensing requirements and the development of an approved radiation protection program.

The Radiological Council is an independent statutory authority established under s.13 of RSA, which assists the Minister for Health to protect public health; the Radiological Council issues the licence required to mine or mill radioactive substances. Vimy will be required to prepare a Radiation Management Plan (RMP), a Radioactive Waste Management Plan (RWMP), a Transport Radiation Management Plan (TRMP) and a Mine Closure Plan (MCP) all of which require the approval of the Radiological Council.

Mines Safety and Inspection Act 1994

This act covers the laws relating to the safety of mines and mining operations and the inspection and regulation of mines, mining operations and all equipment and other substances supplied to or used at mines. It is also intended to promote and improve the safety and health of persons at mines. The Mines Safety Inspection Act and subsidiary legislation is administered by the Department of Mines and Petroleum (DMP).

The *Mines Safety and Inspection Regulations 1995*, Part 16 details requirements relating to radiation safety including authorised limits, preparation of a radiation management plan, control of exposure, reporting, stockpile management and disposal of waste material and long term waste management.

The DMP has also published the Managing Naturally Occurring Radioactive Material (NORM) in Mining and Mineral Processing – Guidelines. There are seven guidelines in the series that address a system of radiation protection in mining and provide detailed information on how to manage radiation hazards in mining and processing operations. The NORM guidelines have informed the studies and approach to identification and management of human health. Pertinent guidelines include:

- NORM 2.2 – preparation of radiation management plan – mining and processing.
- NORM 3.1 – pre-operational monitoring requirements.
- NORM 4.2 – controlling NORM – management of radioactive waste.
- NORM 4.3 – controlling NORM – transport of NORM.
- NORM 5 – dose assessment.

Australian Radiation Protection and Nuclear Safety Act 1998

The *Australian Radiation Protection and Nuclear Safety Act* is complementary to the State legislative framework described above. Under this act, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is created and the agency publishes the 'Radiation Protection Series' which is a range of publications (encompassing Fundamentals, Codes and Guides) designed to promote practices which protect human health and the environment from harmful effects of radiation. ARPANSA is recognised as the national authority on radiation protection in Australia and is responsible for the establishment of the National Directory for Radiation Protection (NDRP). The NDRP aims to standardise the requirements for radiation protection across the country.

Key publications that are relevant to the protection of Human Health from the Proposal include:

- RPS C-2 (Code for the Safe Transport of Radioactive Material (2014)).
- RPS No.9 (Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005)) – otherwise known as the 'Mining Code'.
- RPS No. 20 (Safety Guide for Classification of Radioactive Waste (2010)).

Radioactive waste arising from uranium mining is subject to the provisions of the Mining Code (RPS No.9). The Mining Code requires the operator to develop and obtain approval for, prior to the commencement of operations, a Radiation Management Plan (RMP) and Radioactive Waste Management Plan (RWMP).

Environmental Protection Act 1986

This is an act which is designed to protect the environment of the State which includes limiting any alteration of the environment to the detriment or potential detriment of an environmental value, which includes human health.

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Australian Government's key piece of environmental legislation which focuses on the protection of MNES – of which there are nine matters with one being nuclear actions (including uranium mining). Accordingly, the MRUP triggers assessment under the EPBC Act.

Site-specific MRUP Plans

The following Management Plans (MPs) have been or will be prepared to ensure that the impact upon human health from the development of the MRUP is minimised:

- Tailings Management Plan (MRUP-EMP-013).
- Acid and Metalliferous Drainage Management Plan (MRUP-EMP-016).

- Greenhouse Gas Management Plan (MRUP-EMP-017).
- Transport Radiation Management Plan (MRUP-EMP-022).
- Emergency Response Management Plan (MRUP-EMP-023).
- Dust Management Plan (MRUP-EMP-024).
- Fire Management Plan (MRUP-EMP-025).
- Waste Management Plan (MRUP-EMP-026).
- Spill Response Management Plan (MRUP-EMP-027).
- Radiation Management Plan (MRUP-EMP-028).
- Radioactive Waste Management Plan (MRUP-EMP-029).
- Mine Closure Plan (MRUP-EMP-031).
- Chemical and Hydrocarbon Management Plan (MRUP-EMP-037).

13.2 Existing Environment – Background Radiation

13.2.1 Natural Background Radiation

Radiation is a natural phenomenon, it is present everywhere; worldwide natural radiation doses to populations arise from exposure to cosmic rays, gamma radiation from uranium and thorium naturally present in soil and rock, from inhalation of radon in air which has passed over continental landmass, and from radionuclides ingested in food and water.

Natural background radiation is highly variable; worldwide annual average dose to the human population is quoted by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) to be about 2.4mSv/year (UNSCEAR 2008). However, some locations incur doses which are more than tenfold higher. The general Australian background dose is 1.5mSv/year which compares favourably with Cornwall (UK) where the equivalent figure is 7.8mSv/year (ANSTO 2015a).

This proposal relates to uranium, which is an element found everywhere on earth in trace quantities and was first discovered in the 18th Century. Uranium is a naturally occurring metal with an atomic number of 92 and is represented by the letter U. Everything around us, including uranium, is made up of atoms. Atoms can be simplistically, but reasonably considered to consist of a nucleus made up of protons and neutrons, and electrons which orbit around the nucleus.

The number of protons in the nucleus, also known as the atomic number, determines the element to which the atom belongs. Each element has its own atomic number. If the number of protons in the nucleus is changed, then the element to which the atom belongs is changed. If an atom has 92 protons, the atom is a uranium atom.

The number of neutrons in an atom is also important and may vary, but does not change the element to which the atom belongs. Atoms of an element with different numbers of neutrons are called “isotopes”. Uranium 238 is an example of an isotope, where the number 238 refers to the number of protons and neutrons in the nucleus (92 protons + 146 neutrons = 238). Uranium 235 is another uranium isotope with a nucleus made up of 92 protons + 143 neutrons.

Some isotopes of some elements are unstable and will spontaneously emit radiation in the form of sub-atomic particles, or “electro-magnetic energy”. This process is called “radioactivity” or “radioactive decay”, and the atoms that undergo this process are called “radioactive”. The radiation produced from this decay is known as “ionising radiation”. Radioactive atoms do not all decay at the same time, or at the same rate. The scientifically accepted way of describing the decay process is by using the term “half-life”. The half-life of a radioactive atom can vary from a fraction of a second to billions of years.

The isotopes of the elements formed by the radioactive decay of uranium 238 are themselves radioactive and as they in turn decay, they form a “decay series”. When uranium ore is processed, the uranium is extracted by chemical and physical processes with the aim of removing only the uranium isotopes to produce the ‘yellow cake’ product (uranium peroxide). This leaves the other isotopes in the process wastes (tailings), which need to be appropriately managed as they will continue their radioactive decay. The uranium 238 decay series is presented below in Table 13.1 with Uranium 238 as the start of the decay chain and Lead 206 is the final stable isotope.

Table 13.1 Uranium 238 Decay Series

	Isotope	Type of Decay	Half-life*
Uranium 238 Decay Series	Uranium-238	Alpha	4.5×10^{9} years
	Thorium-234	Beta	24.1 days
	Protactinium-234	Beta	1.17 minutes
	Uranium-234	Alpha	2.4×10^{5} years
	Thorium-230	Alpha	7.7×10^{4} years
	Radium-226	Alpha	1.6×10^{3} years
	Radon-222	Alpha	3.8 days
	Polonium-218	Alpha	3.05 minutes
	Lead-214	Beta	26.8 minutes
	Bismuth-214	Beta	19.9 minutes
	Polonium-214	Alpha	1.64×10^{-4} seconds
	Lead-210	Beta	22 years
	Bismuth-210	Beta	5 days
	Polonium-210	Alpha	138 days
	Lead-206	---	Stable

A resource for further background information and a general introduction to radiation protection in mining and processing of radioactive ores is the Radiation Workers Handbook which is available from the Minerals Council of Australia (http://www.minerals.org.au/resources/uranium/radiation).

13.2.2 Surveys and Investigations of Background Radiation (Pre-operational)

Radiation monitoring has taken place at the Project area in various forms since 2007 (Appendix F1):

- Passive Radon Monitors (PRMs) were first set up in 4th Quarter of 2007 and then continuously for 9 months from October 2012.
- Environmental Thermoluminescent Dosimeters (TLDs) as issued by ARPANSA have been used to monitor average gamma dose rates at 10 different locations over a three year period.
- A High Volume Sampler has been used since May 2012 to collect airborne dust and that dust has then been analysed for radionuclide concentrations.
- Continuous monitoring of radon daughter products (using an Environmental Radon Daughter Monitor (ERDM)) has taken place since May 2012.
- Continuous environmental monitoring of radon-222 gas was undertaken over the period December 2014-January 2015 (using Durridge RAD7 units).
- Soil samples were obtained in various locations and analysed for radioactivity reported in Appendix F1 and reproduced in Table 13.2.

- Groundwater samples were obtained from various locations and analysed for radioactivity SGS (Australian Radiation Services) Laboratory.

The locations of the PRMs, the TLDs and the ERDM used during monitoring are shown in Figure 13.1. The location of the dust monitors is shown in Figure 13.2. The findings from these environmental radiation studies are that the MRUP area has radiation levels similar to the rest of inland Australia, with gamma, airborne radon and radon decay products, and soil radionuclide measurements all within the normal range (Appendix F1). This is not surprising given the uranium orebody does not outcrop to surface and is covered by at least 35m of overburden.

In addition to the investigations of the pre-mining environment, tests were undertaken of the ore to determine the radon emanation rates. Both dry and water saturated ore samples were tested using:

- The Countess Method using Charcoal canisters.
- Continuous radon monitors (Durridge Rad7 units).

The results for the broken dry ore showed Rn-222 emission rates of 0.5Bq/m^2/s for 315ppm U_3O_8 ore and 2.24Bq/m^2/s for 830ppm U_3O_8 ore (Appendix F1).

13.2.3 Existing Radiological Environment at MRUP

Gamma Radiation

The levels of background radiation depend primarily on the concentrations of natural radionuclides in soil, namely Uranium 238 and Thorium 232 and their daughters and K-40. Typical gamma background levels across Australia range from below 0.1 to above 0.25µSv/h. The background gamma radiation for the MRUP (0.06µSv/h) is similar to the Kintyre Project in WA (0.09µSv/h) and the Australian average (0.07µSv/h) (Appendix F1) based on environmental TLD surveys. This result is consistent with naturally occurring gamma radiation dose rates observed elsewhere in inland Australia.

MRUP background radiation has been assessed using surface and aerial surveys. The background radiation is characterised by low levels of gamma radiation consistent with Aeolian sediment landforms covering the deposits that are at depth. A ground spectrometer survey recorded equivalent uranium and thorium grades ranging from 0.4 to 4ppm and 3 to 25ppm respectively.

Environmental background gamma dose rates were also assessed using TLDs placed in 10 locations across the site over four years. The MRUP average from the TLDs is approximately 0.06µGy/h, with some variability by location and time (Appendix F1). The measured gamma dose rates are attributed to the gamma radiation naturally emanating from the surface and from cosmic radiation primarily originating from the sun.

Radionuclides in Soil

Assessment of radionuclides in soils over the MRUP has been carried out through two conventional soil sampling programs where the first 10-20cm of the soil profile was sampled. The laboratory analysis of the surface soils at the MRUP site has yielded the results provided in Table 13.2.

Table 13.2 Surface Soil Analysis

Sources of soil	Value	Radionuclide concentration				Number of Samples
		Uranium		Thorium		
		ppm	Bq/kg[1]	ppm	Bq/kg	
MRUP 1996 (<180µm fraction)	Range	0.06-0.85		0.02-2.4		214
	Average	0.18	4.6	0.43[2]	1.4	
MRUP 2014 (<180µm fraction)	Range	0.06-0.71		0.21-8.82		102
	Average	0.31	7.8	2.59	20.7	

1. Assuming a specific activity of 2528kBq/g for U and 8kBq/g for Th, and assuming secular equilibrium in both cases.
2. Partial leaches via cold dilute HCl.

As shown in Table 13.2 there is little evidence of significant mineralisation in the surface soils in the area. This is consistent with regional geochemical surveys in similar environmental settings in Australia. Generally speaking, the radionuclide levels are low across the Southwest Great Victoria Desert (where the MRUP is located) in comparison to world averages (UNSCEAR 2008), as shown by a regional geochemical soil survey carried out by the GSWA in 2010 (Morris 2013), and both regional and project-scale detailed airborne radiometric surveys.

Radionuclides in Groundwater

The water quality for the MRUP is hypersaline as detailed in Section 11 and accordingly is not fit for human consumption or livestock purposes. Notwithstanding, samples of groundwater were taken and the laboratory analysis of the groundwater sample taken at the MRUP site has yielded the results provided in Table 13.3.

Table 13.3 Groundwater Radionuclide Analysis

Sample Ref	Radionuclide concentration				
	Naturally Occurring U238 Series (Bq/L)				
	Uranium-238	Radium-226	Lead-210	Polonium-210	Thorium-230
RC1279	<0.02	2.01 ± 0.19	<0.19	0.025 ± 0.013	0.021 ± 0.014
NND5030	0.22 ± 0.02	1520 ± 110	<6.1	0.014 ± 0.010	0.277 ± 0.049
NND5036	1.5 ± 0.1	77.3 ± 5.5	1.06 ± 0.23	0.036 ± 0.016	2.56 ± 0.24
NND5040	0.30 ± 0.02	13.9 ± 1.0	0.34 ± 0.10	0.0105 ± 0.0089	0.271 ± 0.071
Bore #1	<0.07	0.178 ± 0.022	<0.15	0.0038 ± 0.0051	0.065 ± 0.031
Bore #2	<0.13	1.28 ± 0.16	<0.63	0.0090 ± 0.0071	0.0133 ± 0.0085
Bore #3	<0.13	1.27 ± 0.12	<0.54	0.0114 ± 0.0076	0.31 ± 0.11

Airborne Dusts

Radionuclide concentrations in airborne dust are usually assessed by air particulate sampling and analysis of the collected particulates. Sampling for the MRUP involved high volume samplers to collect TSP and dust deposition gauges. The high volume samples via assay of the collected dust provide the concentrations of radionuclides in air and the dust deposition gauges measure the rate at which airborne dust deposits on the ground. The location of the sampling equipment is provided in Figure 13.2.

Very low concentrations of alpha-emitting radionuclides were recorded (0-0.002Bq/m^3) which is consistent with low levels of uranium observed in surface soils in the area. Results from stationary dust deposition gauges located over the Project area for the period from August 2013 – October 2014 found that the dust deposition varied between 0.1 to 3g/m^2/month. For comparison, an average dust deposition value of 1.5g/m^2/month was reported for the Kintyre Uranium Project ERMP document (2013). The MRUP is located in a similar arid environment and the recorded figures are consistent with other arid inland projects in Australia.

Radon and Radon Decay Products

Radon 222 is a naturally occurring gas that is present in the atmosphere generated by the radioactive decay of parent radium in soil and rock. Radon 222 has a half-life of 3.8 days.

PRMs were placed in 10 locations across the project (refer to Figure 13.1). The average radon concentration based on 10 locations and 4 different quarters of monitoring was approximately 25Bq Rn/m^3 with the results showing a noticeable temporal and locational variability. December 2014-January 2015 monitoring using Durridge RAD7 units showed results consistent with the results from the passive monitors. Table 13.4 shows a comparison of measured radon concentrations at MRUP with reported radon concentrations at other uranium project and mining areas.

Table 13.4 Comparison Radon Concentrations

Location	Airborne Radon Concentration Bq/m^3
Lake Way, WA	27
Beverley, SA	36
Honeymoon, SA	28
Olympic Dam, SA	20
Kintyre, WA	16
Mulga Rock, WA	25

The radon decay products being measured are, like radon itself, highly variable dependent on weather and atmospheric stability. A series of radon progeny spot measurements were undertaken between 2012 and 2014. The measured potential alpha energy concentration (PAEC) varied between of 0.01-0.2µJ/m^3 with most of the measured radon progeny readings less than 0.04µJ/m^3. These measured radon progeny levels are consistent with the mean radon gas levels observed and demonstrate some for the short term variability to be expected in radon gas concentration due to short term variations in the weather (Appendix F1).

13.2.4 Background Radiation Summary

The measured radioactivity levels in environmental media (water, soils and air) in the vicinity of the MRUP is lower than in the wider region. The orebody is overlain by a substantial layer of non-mineralised soils which limit the surface radioactivity observed at the site.

13.3 Mining and Processing

13.3.1 Mining

The mining process is detailed in Section 5, with the following pertinent aspects from a radiological perspective. The project comprises two distinct mining centres Mulga Rock East (MRE) and Mulga Rock West (MRW), which are approximately 20km apart. Mining will commence at MRE which will include the location of the plant. The MRUP will be mined using open cut mining techniques.

Open cut mining techniques include excavation using truck and shovel for initial slot and smaller pits. After mining the ore exposed by the first slot, a pit void is created approximately 200-300m in length. At this point a dozer trap and conveyor waste handling system is installed to progress the mining front and convey the overburden to backfill the mined out section of the pit (initial slot).

13.3.2 Processing

Beneficiation Plant

Run of mine (ROM) ore feed is initially crushed and then conveyed from the pit to a semi-mobile beneficiation plant. At the beneficiation plant, the crushed ore will be pulped in a log washer to fully liberate the fine carbonaceous clay material from the coarse sands. The resulting slurry is screened at 2mm and the coarse oversized material stacked in a stockpile to be trucked to the main process plant where it will be fed to a semi-autogenous grinding mill.

The <2mm slurry is then deslimed at 0.045mm and the resulting fines, which are high in uranium are sent to the main process plant. The mid-size fraction (<2mm >0.045mm) representing approximately 75% of the initial ROM feed, is then beneficiated using a two-stage spiral gravity circuit. The final beneficiated slurry is then pumped to the mill at the main process plant.

Main Process Plant

The main process plant will receive beneficiated ore from the mine and then grind this feed to 80% passing a size of 150µm using a mill circuit. The milled ore is then leached for 4 hours at 40ºC using sulphuric acid. The leach discharge is then pumped to a resin-in-pulp (RIP) circuit where the slurry is contacted with an ion-exchange resin to recover the uranium present in solution. The RIP circuit has eight contact stages and is analogous to a gold carbon-in-pulp circuit except resin is used instead of activated carbon.

Uranium-loaded resin is then recovered and uranium stripped from the resin using a sodium chloride solution. The strip solution, which now contains the uranium, is further concentrated and then precipitated using concentrated caustic to generate a sodium diuranate (SDU) precipitate. The SDU precipitate is then re-dissolved using sulphuric acid and precipitated from solution using hydrogen peroxide to generate a final uranyl peroxide or “yellowcake” product. The final uranium product is washed, filtered, dried and packaged in steel drums ready for transport.

The slurry from the uranium RIP circuit has no recoverable uranium remaining but is further processed to recover the base metals still in solution. The uranium-barren leach solution is recovered using a counter current decantation circuit.

13.3.3 Risks from Methane in Lignite Ores

Hazard Overview

The uranium ore is associated with lignite and the mining and/or processing of lignite presents a hazard. There is a potential for lignite to release methane or for spontaneous combustion of the lignite to occur particularly when dewatering of the lignitic ore has allowed the ingress of oxygen.

Methane is a colourless odourless gas at room temperature and standard pressure and is the main component of natural gas. Under hazardous material classification, methane is classified as an extremely flammable gas. Methane is lighter than air and will, if not contained, dissipate quickly. The risk is that methane may accumulate in sufficient concentrations to present a flammable or explosive atmosphere. The minimum concentration of a particular combustible gas or vapour necessary to support its combustion in air is defined as the Lower Explosive Limit (LEL) for that gas. Below this level, the mixture is too “lean” to burn. The maximum concentration of a gas or vapour that will burn in air is defined as the Upper Explosive Limit (UEL). Above this level, the mixture is too “rich” to burn. The range between the LEL and UEL is known as the flammable range for that gas or vapour. The LEL for methane is 5% and UEL is 15% by volume.

Mining Risk from Methane

The ore being mined within the MRUP can be characterised as carbonaceous material which also contains considerable quantities of sand and silts within or just above the water table. The overburden material is unconsolidated sands that is highly porous and therefore provides a permeable layer above the carbonaceous material preventing build-up of methane gases. The strip mining method will provide a wide shallow mining face that provides natural ventilation that will prevent build-up of methane to LEL levels.

The mining method will involve dewatering and is expected to involve draining the ore such that the water table is reduced to around 1m below the base of the pits being mined. The dewatering will reduce the amount of water in the ore to field capacity which is the amount of water held in material once excess water has drained away and downward movement of water ceases. The ore is expected to retain at least 30% water and therefore minimise the risk of oxidation of the carbonaceous material. In addition methane that may be produced through this process would dissipate quickly preventing build-up of methane to LEL levels. Once mining has been completed the dewatering in that area will cease and the water table is predicted to return to pre-mining levels. Accordingly the risk of methane generation through oxidation is limited to active mining.

Processing Risk from Methane

Once the ore has been mined it will be screened and separated into different size fractions through a beneficiation plant located near to the mining pit. The sandy material will be deposited back in the pit into previously mined areas to the depth of the ore.

The beneficiated material and fine material fraction will then be made into slurry and pumped to the main processing plant. The processing method is a wet process outlined as outlined above. The wet process controls the spontaneous combustion of the material and the design of the facility will address the potential for methane build up. The ventilation controls necessary to address radon gas hazards will also address methane hazards.

13.3.4 Workforce

The operating MRUP is anticipated to employ a peak work force of 315 personnel at full production capacity. The operation will be staffed by fly-in-fly-out (FIFO) workforce. The workforce can be grouped based on their likely exposure and the similar exposure groups for the MRUP with respect to radiation are:

- Mine workers (e.g. geologist, pit technical, equipment operator).
- Process workers (e.g. operators, maintenance personnel).
- Administration and Support Personnel (e.g. catering, managers, cleaners).
- Transport (of U_3O_8 off-site).

13.4 Radiation Overview of Proposed Project

13.4.1 Overview

The potential radiological impact on workers depends upon the work being undertaken, its location and duration and the measures implemented to reduce exposure. The primary pathways through which workers will be exposed to radiation are:

- Direct external gamma radiation from gamma emitters within the ore, tailings and process streams.
- The inhalation of radon 222 gas and radon progeny.
- The inhalation of long-lived alpha radiation emitting radioactive dust (LLA).

In addition to the three primary radiation exposure pathways listed above there is a potential for workers to receive a radiation exposure from the ingestion of radioactive material. The ingestion pathway is regarded as a less important radiation exposure pathway because it can and will be prevented by the strict industrial hygiene measures in place at the mine. Limited worker radiation exposures from external gamma radiation, the inhalation of radon and radon progeny and to the inhalation of airborne LLA are unavoidable. The ingestion of radioactive materials by workers is avoidable and hence this radiation exposure pathway is of less importance.

13.4.2 External Gamma Radiation

The orebody contains gamma emitting material which is currently shielded by the covering overburden. Once the ore is mined there will be gamma radiation emitted by:

- Exposed ore in the open pit.
- Stockpiling of ore prior to processing.
- Ore being processed during the initial stages of processing.
- The waste stream in the process plant.
- Exposed tailings in the repository.
- Exposure to final product including during transport to port.

MRUP workers who work adjacent to the ore and mineralised waste rock will receive gamma radiation exposures from the ore. For workers within mobile equipment about half the gamma radiation will be stopped by the steel surrounding the operator's compartment.

The MRUP mill will separate the radioactive components of the ore into various process streams. Each of the mill process circuits will exhibit a characteristic gamma radiation field dependant on the specific process and on the ore grade being processed. The non-uranium radionuclides will report to tailings.

The product processing circuits will produce low levels of gamma radiation from the build-up of yellowcake within the circuits. Since most of the gamma radiation in the ore and waste streams originates from Ra-226 and its immediate progeny, the process waste streams and the TSFs are considered the important sources of gamma radiation during operations and during early stages of closure.

Drying and packaging will be undertaken within an autonomous and enclosed facility. The product will be packaged into 205 litre heavy gauge plastic lined steel drums and sealed. Aged U product emits gamma radiation but the handling of the drums will not contribute significantly to the gamma radiation exposures of workers at MRUP. The truck drivers hauling loads of uranium product from the mine to the port will receive low levels of gamma radiation from the load.

13.4.3 Radon 222 Gas and the Short Half-life Progeny

Radon 222 is a noble gas that is produced by the radioactive decay of Ra-226. It has a half-life of 3.8 days. That is long enough for the radon gas to diffuse through the exposed ore or tailings to the surface where it will be released into the atmosphere. Although it is chemically inert, radon can move with the groundwater and again be released into the atmosphere when this water daylights in the pit.

Because the Rn-222 is a noble gas it is not readily absorbed into the lungs of workers when inhaled. The important part of the worker dose is from the inhalation of the short-lived radon progeny that follows immediately after the radioactive decay of Rn-222.

The subsequent sections will discuss Rn-222 emanating from various parts of the mine and convert the projected level of Rn-222 to a dose rate from the inhalation of the short-lived radon progeny. The primary sources of radon gas will be from:

- Rn-222 emanating from the ore surface and ore stockpiles.
- Rn-222 emanating from exposed tailings.
- Gases released from the ore during processing (the grinding and primary leach circuits).
- Rn-222 released from the ground water during mining and dewatering.

13.4.4 Long Lived Radioactive Airborne Dust (LLA)

The LLA can be separated into three categories:

- Ore dust from the pit, ore stockpiles, haulage systems and initial part of the process plant (grinding and leach). The ore dust contains all 14 radionuclides in the U-238 decay chain (Table 13.1).
- Dust from the waste stream including the tails. The process waste stream contains primarily the radionuclides from Th-230 onwards as listed in Table 13.1.
- Concentrated uranium from the late stages of the mill including packing and drying. The concentrated uranium contains U-238 and the subsequent three radionuclides listed in Table 13.1.

While Rn-222 will emanate naturally from the orebody when it is exposed, the suspension of radioactive LLA generally follows from work activities such as:

- Haulage.
- The wind blowing over dry stockpiles and tailings.
- Dried spills of ore and process materials. That includes spills when process systems are opened for maintenance.
- Emissions from the process tanks and grinding circuits.

13.4.5 Ingestion of Radioactive Material

By the nature of uranium mining, there will be large quantities of radioactive material within the mining areas, the ore stockpiles and within the mill circuits. Hence, it will be important that the mining operations make adequate provision to control the spread of this radioactive material and to maintain clean areas where workers can eat and perform other non-radioactive work. Examples of such clean areas would include:

- Lunch rooms.
- Office areas.
- Accommodation.

Other radioactive work areas will require periodic assessment and cleaning to ensure that the levels of radioactive contamination are maintained at acceptable levels. Examples of such areas would include:

- The cabs of mobile equipment.
- Any equipment that requires maintenance work in a shop.
- Maintenance shops generally.
- General areas in the processing facility that are prone to radioactive spills.

13.5 MRUP Radiation Assessment

13.5.1 Gamma Radiation Levels

A worker standing on a large orebody or near a large ore stockpile will effectively be subject to gamma radiation from a semi-infinite plane source. There are a number of theoretical calculations and practical measurements available in the literature which allow for the calculation of the gamma dose rates to be expected from the 600ppm U_3O_8 MRUP ore.

In-pit gamma dose rate assessments were carried out using, as guidance from the literature, a figure of 3.5µSv/hr per 1000ppm U_3O_8, applicable over an extensive flat slab, such as an extended ore bench or large stockpile (Appendix F1). This number is also supported by professional experience including direct readings on other ore bodies, and by recent ore drum readings onsite, recently reported in the literature (Appendix F3). Since the average ore grade at MRUP is approximately 600ppm U3O8, the expected dose rate over bare ore, without shielding, using this guidance is 2.1µSv/hr.

Workers seated in the cabs of mobile equipment would be partially shielded by the steel around them. This would reduce the gamma dose rate in the cab by a factor of about 50%. The mineralised waste rock would produce lower gamma radiation levels depending on the degree of mineralisation.

Other sources of gamma radiation include:

- The grinding circuit and the leach tanks. The front end of the mill will contain the complete suite of radionuclides in the U-238 decay chain and hence the gamma radiation from the grinding mill and leach tanks will be comparable to that directly off the orebody although the steel walls of the grinding mill and leach tanks will provide shielding. Allowing for shielding the gamma dose rates directly adjacent to the grinding mill and the primary leach tanks are calculated to be:

  3.5µSv/hr (1000ppm ore) × 50% = 1.8µSv/hr
- The mill waste stream will carry the Ra-226 and its progeny to the tailings storage facility. Since the bulk of the gamma emitting radionuclides follow directly after the decay of Ra-226, these circuits will emit gamma radiation at a rate similar to that of the ore. Hence the gamma dose rate directly adjacent to the tailings is calculated to be 3.5µSv/hr.
- Allowing for the shielding provided by the walls of the tanks and pipes the calculated gamma dose rate adjacent to a large tank is:

  3.5µSv/hr × 50% = 1.8µSv/hr. This conservative dose rate calculation ignores the internal shielding within the tanks and pipes provided by the liquids within containment.
- The tailings storage facility will contain the gamma emitting radionuclides which will build back up after the processing. The gamma radiation levels directly above unshielded tailings will be comparable to the gamma levels above the orebody (3.5µSv/hr).

The gamma dose rate calculations above are predicated on the workers being close to a large quantity of the radioactive material. When workers are located at a distance away from these sources of gamma radiation, the gamma dose rates will decrease with distance until the dose rates reach normal background levels.

13.5.2 Radon and Radon Progeny

As noted in Section 13.2.1 Rn-222 follows in the U-238 decay chain from the radioactive decay of Ra-226. Consequently it is to be expected that Rn-222 will be present in any location where material containing Ra-226 is exposed to the atmosphere. The projected radon gas releases by Sonter (Appendix F1) from parts of the mining process at MRUP are listed in Table 13.5.

Table 13.5 Radon Emanation Rates

Project Element	Radon Release
Open pit areas (20ha at any one time, using an emanation rate = 2BqRn/m^2/sec)	0.4MBq/s
Tailings (60ha exposed at any one time, using emanation rate = 0.5BqRn/m^2/sec)	0.3MBq/s
Radon from Plant: assume complete release during grinding and leaching	0.45MBq/s
Pit dewatering	0.2MBq/s

13.5.3 In-Pit Radon Levels

The open pit will be mined in 20ha blocks with the extended open mined out pit extending 500m by 1200m at a depth of 50m. The radon gas generated within the ore will diffuse up to the surface of the orebody through the pore spaces. It can also be carried by groundwater. While the mechanisms by which radon gas reaches the air within the pit are complex, the calculations by Sonter (Appendix F1) found that the projected flux rate of Rn-222 from the MRUP pit floor was 2Bq/m^2/s.

The Rn-222 released from the floor of the pit will move with the wind currents and dissipate in the atmosphere. The experience elsewhere is that for most weather conditions the radon concentrations encountered during open pit mining are low, simply because of the rapid dispersion of the radon gas into the atmosphere. During calm periods and during weather inversions the dissipation of the radon will decrease and the corresponding levels within the pit will increase. As an example of the radon levels that may be encountered the following calculation assumes that the pit is at maximum depth and that the winds are blowing over the pit at 1m/s.

Modelling of radon concentrations in-pit that was carried out assumed the following:

- Dimensions of exposed ore of 20ha.
- 2Bq/m^2/s radon emanation.
- Overall pit dimensions of 500m by up to 1,200m, depth 50m.
- Corresponding volume of air capped by atmospheric inversion at surface.
- Low airspeeds, of 1m/s (3.6km/hr); giving air transit times of 500 seconds in contact with ore, and total in-pit air age up to 1200 seconds.

Calculating for instantaneous radon injection rate into ‘pit box’ then (2Bq/m^2/s × 20ha) = 4 × 10^{5}Bq/s.

Volume into which Rn is injected = (20ha × 50m) = 1 × 10^{7}m^3.

So concentration increase rate $\Delta C/\Delta t$ = 0.04Bq/m^3/s.

Maximum concentration occurs at maximum air transit time across ore, which is 500 seconds, which equates to 20Bq/m^3.

These are conservative assumptions. During hot windy conditions the radon in the pit will disperse rapidly. The Rn-222 moving up from the pit will spread out over the minesite, giving rise on average to slightly elevated radon gas levels within a distance of 1km from the pit. As an example, the measurements of Rn-222 found at and around Key Lake found that the mean ambient radon concentrations reached natural background levels at about 5km from the minesite (Cameco 2005).

Once in the atmosphere the Rn-222 will decay to the short lived radon progeny, which when inhaled can deliver a radiation dose to workers.

The assumed age of the air in the open pit is 20 minutes, which leads to a PAEC of in-growth radon decay products of 0.05 to 0.1µJ/m^3 for the conservative assumptions listed above, and in the worst case of wind along a pit long axis (Appendix F1).

13.5.4 Process Plant Radon Levels

The main processing facility will be located near Ambassador and Princess Pits with the above-ground tailings storage facility to the west. Experience at other mines is that radon is largely released through the crushing and grinding circuits and the initial leaching where radon is released from the pore space in the material and also from within the grains of ore particles.

The Rn-222 release at the process plant (Table 13.8) was calculated by neglecting any release of radon during the initial crushing of the ore at the pit and assuming all the radon was released during grinding and the initial leach at the mill. This conservative calculation yielded a radon release of 0.45MBq/s within the plant. Unlike the case for the open pit, releases of radon at the process plant will be generally at elevation from the upper ends of grinding screens or process tanks and not from the floor as is the case for the open pit.

The calculation of potential radon levels within the process plant assumed an open box of 500m × 500m × 10m high. Note that there will be no physical walls around the process plant but the plant will contain tanks and equipment which will somewhat inhibit the flow of air through the plant. Assuming this is released into a box of 500 × 500 ×10m with a volume of $2.5 \times 10^6 m^3$ we obtain a radon concentration increase of:

$$\Delta C/\Delta t = 0.45\text{MBq/s}/2.5 \times 10^6\text{m}^3 = 0.18\text{Bq/m}^3\text{/s}.$$

Assuming a wind speed of 1m/s we obtain a transit time across the process plant of 500s.

Hence the maximum predicted radon gas concentration is:

$$\Delta C/\Delta t \times 500\text{s} = 90\text{Bq/m}^3.$$

The effective dose rate to workers will depend on the age of the Rn-222. A simple conversion to effective dose rate yielded a dose rate to workers of 0.7µSv/h.

This calculation neglects the effect of heating of the plant by the sun and the heat of the process equipment which will cause the contaminated air to rise instead of flowing through the “box”. Hence this calculation of the effective radon dose rate in the plant is very conservative.

BHP (BHP 2011) reported that radon decay products contribute 5% of the average annual total dose and that the annual dose from this pathway was 0.1–0.2mSv due to the small sources of radon in the plant compared to the mine and the generally good natural ventilation. That would imply a mean effective dose from the inhalation of radon progeny of 0.1µSv/h as compared to the conservative calculation of dose from the inhalation of radon progeny presented above.

13.5.5 In-Pit Airborne Long Lived Dust (LLA)

The mining operations at MRUP will give rise to the suspension of radioactive dust in the air. The concentrations of airborne dust will be quite variable both temporally and spatially depending on the work taking place, on the wind conditions and on the moisture content of the radioactive materials. The actual radiation dose received by workers will also be dependent on the Radiation Management Program provided to ensure that the doses received from the inhalation of radioactive dust are minimised.

The assumed mean level of inhalable dust within and around the pit is 2.5mg/m^3 (Appendix F1).

Assuming an ore grade of 600ppm U_3O_8 the uranium content within 2.5mg is 1.6×10^{-2}Bq/m^3.

There are eight alpha radiation emitters in the U-238 decay chain.

Assuming that the constituents of the U-238 decay chain are in secular equilibrium we obtain an alpha radiation airborne activity of 1.6×10^{-2}Bq/m^3 × 8 alpha emitters = 0.125αdps/m^3 or 0.125Bq$_\alpha$ /m^3.

For a worker inhaling this air at the standard rate of 1.2m^3/h, this translates to an inhalation intake of 0.15Bq$_\alpha$/h.

As per Appendix C.9 of the WA NORM-5 Guide the conversion between inhaled activity and effective dose for 5µm AMAD particles containing uranium ore is given by:

Effective Dose 0.0035mSv/Bq$_\alpha$

Hence a worker breathing this air with no respiratory protection is subject to an inhalation dose rate of

0.15Bq$_\alpha$/h × 0.0035mSv/Bq$_\alpha$ = 0.525µSv/h

13.5.6 Process Plant Long Lived Dust (LLA)

A significant proportion of dust emissions are typically generated by crushing areas of the processing circuit. The MRUP process plant receives slurry feed that is ground to 150µm in a mill circuit, then leached, and then pumped to a resin-in-pulp (RIP) circuit, then onto a stripping circuit and finally precipitated, and packaged. The handling of the final product is handled in a sealed autonomous facility with dust extraction and scrubbing equipment. Accordingly, the process itself is not predicted to generate measurable emissions of dust. Infrequent, low level dust emissions will arise from periodic maintenance, sampling and larger spillages from process systems.

The processing plant is not predicted to provide a significant source of dust contributing to processing workers exposure. The plant is located within 1km of the mining pits and above-ground tailings facilities and to provide a conservative estimate of dust exposure the dust levels from the processing plant have been assumed to be the same as the mining areas, namely a ambient mean airborne dust level of 2.5mg/m^3 (Sonter Appendix F1). This corresponds to an effective dose rate of 0.53µSv/h for someone inhaling the dust.

In practice the levels will be lower due to distance from the source and because of the controls that will be implemented within the process plant.

13.6 Projected MRUP Worker Doses

The previous sections have provided the dose rate calculations for the MRUP site. These dose rate calculations did not take into account the reduction in worker radiation exposures resulting from the implementation of a stringent radiation management program as specified in the WA NORM-2.2 Guide. The effects of a comprehensive radiation management program, including the ALARA provision, are discussed in a separate section.

This section will continue with the annual worker dose estimates using the conservative dose rate projections provided above and are more conservative than the estimates presented in Appendix F1.

13.6.1 Total Annual Dose Miners

The mining areas will comprise the following facilities which present sources of radiation exposure:

- Mining pit.
- Above-ground TSF.
- In-pit TSF.

Gamma

Gamma dose is reflective of the time spent by the worker in proximity to the source. Table 13.6 presents a summary of dose predictions based on the following assumptions:

- The geologist spends 30% of their working time in the pit (i.e. 750h).
- The pit technicians spend 50% of their working time in the pit (i.e. 1250h).
- The heavy equipment operators spend 100% of their time in the pit but their gamma dose rates are attenuated by 50% from the shielding provided by their equipment (i.e. 1.05µSv/h × 2500h/year)

Table 13.6 Representative Mine Worker Gamma Dose Predictions

Worker Type	Estimated annual gamma dose
Geologists	1.6mSv
Pit Technicians	2.6mSv
Mine heavy equipment operators	2.6mSv

Radon Progeny

The mean radon progeny levels in the pit were calculated at 0.03µJ/m^3. For a worker in the open pit with no respiratory protection for 2500 h/year this would correspond to an annual radon progeny exposure of:

$$0.03\mu J/m^3 \times 2500h/year = 25\mu J\ h/m^3 = 0.08mSv$$

Many workers will spend only a limited time in the open pits. The heavy equipment operators who will spend most of their time in the open pits will have the radon progeny in the cabs reduced by the ventilation systems of the cabs in mobile equipment.

Airborne Dust

As stated previously the projected dust levels in the pit will give rise to an effective dose rate of 0.525µSv/h for someone breathing the air with no respiratory protection. That corresponds to annual effective dose of 1.31mSv for a worker breathing the air for 2500h/year. The doses presented in Table 13.7 are based on same exposure times assumed for external gamma radiation and assume that the filtration systems for the cabs of mobile equipment remove all the airborne dust.

Summary of Mine Worker Doses

Table 13.7 Mine Worker Total Dose Prediction

Worker category	Radiation pathway				Limit/Standard
	Gamma	Dust (LLa)	RnDP	Total (mSv/y)	mSv/y
Geologist	1.6	0.4	0.1	2.1	20
Pit Technician	2.6	0.6	0.1	3.3	20
Mine heavy equipment	2.6	0.1[1]	0.2	2.9[2]	20

Note 1: Assumes protection factor of 10 for standard cabin air conditioning re removal of airborne dust.

Note 2: Experience at other mines indicates there is some attenuation of radon progeny by vehicle ventilation systems but this has not been included here.

13.6.2 Total Dose Process Plant Workers

The processing facility will consist of three main areas and doses were estimated for workers in these areas as follows:

- Beneficiation plant.
- Concentrator section which consists of ore handling, ore crushing and grinding areas.
- Hydrometallurgical section, which consists of acid leach circuits and precipitation of final product uranium.
- Final product handling.

Gamma

The annual gamma dose for process plant workers will depend on the gamma dose rates and the time workers spend adjacent to sources of gamma radiation. As discussed in Section 13.5.1 the maximum projected gamma dose rates in the process plants are 1.8μSv/h. If a worker spent the entire working year adjacent to such a gamma radiation source, his annual gamma radiation dose would be 4.5mSv. However, process workers will spend significant time in the control room and in parts of the plant that do not exhibit significant external gamma radiation. The experience at other mines indicates the average annual gamma contribution to overall dose of process operators and maintenance workers is about 1mSv/y (Appendix F). This is supported by dose information at Olympic Dam (BHP 2011). In other words, process workers can be expected to spend about 25% of their working time adjacent to gamma emitting process equipment with the remainder of their time spent elsewhere.

Similarly, maintenance workers will work on non-radioactive as well as radioactive equipment.

The annual external gamma dose to process workers and maintenance workers presented in Table 13.8 assumes that these workers spend about 25% of their working hours adjacent to gamma emitting equipment.

Table 13.8 Representative Process Worker Gamma Dose

Worker Type	Estimated annual gamma dose
Process Operator	1.3mSv
Maintenance Worker	1.3mSv

Radon

Section 13.5.4 presented a conservative calculation of the effective dose rate from the inhalation of radon progeny of 0.7μSv/h and the operating experience at the Olympic Dam process plant which found that process workers were subject to a mean radon progeny effective dose rate of 0.1μSv/h.

In light of the conservative nature of the radon concentration calculation, this document has elected to project a mean annual effective dose rate from the inhalation of radon progeny of 0.1μSv/h.

A worker subjected to this effective dose rate would receive an annual radon progeny effective dose of 0.25mSv.

Airborne Dust

In Section 13.5.6, the projected effective dose rate from the inhalation of radioactive dust for the site generally was projected to be 0.525μSv/h. This projection is predicated on the assumption that the airborne dust directly associated with the process plant will be primarily from the re-suspension of spills and from the maintenance of radioactive equipment and that the radiation exposure from such spills will be minimised by operational controls.

Accordingly, exposure for a full year (2500h) at this rate will deliver an effective annual dose of 1.31mSv.

For comparison, the Olympic Dam EIS (BHP 2009) reported average effective doses to workers in the hydrometallurgical plant from the inhalation of dust of 0.75mSv/year.

The calculated dust exposures and the measured operational dust exposures at Olympic Dam can be considered equivalent and within the uncertainty of the dose estimates. For the purposes of this document the projected annual effective doses from the inhalation of dust for MRUP process workers have been set at 1.3mSv/year.

Summary of Process Worker Doses

The conservative predicted total dose for metallurgical plant workers and maintenance workers (rounded to 0.1mSv) is presented in Table 13.9.

Table 13.9 Representative Process Worker Total Annual Dose Projection

Worker category	Radiation pathway				Limit/Standard
	Gamma	Dust (LLa)	RnDP	Total (mSv/y)	mSv/y
Process Operator	1.3	1.3	0.2	2.8	20
Maintenance Worker	1.3	1.3	0.2	2.8	20

The conservative dose projections in Table 13.9 can be compared to the actual operating exposures at Olympic Dam (Olympic Dam EIS (2009)) which reported the average total doses to workers in the hydrometallurgical plant of 1.5mSv/yr.

13.6.3 Other Workgroups

MRUP Support Personnel and Camp

MRUP support personnel based remotely from the mine and processing facility will be based near the camp. The camp is located approximately 10km to the west of the processing plant, TSF, Princess and Ambassador pits; and approximately 4km to the northeast of Shogun and Emperor Pits. Given the distance from the operational areas these group of employees have been considered under the public exposure assessment refer to Section 13.7.8.

Construction Workers

A construction workforce of up to 1,200 workers would be employed to build the accommodation village, processing plant and associated infrastructure. While some mine pre-stripping and mining will occur during construction, it will be away from the construction activities and therefore doses to construction workers are expected to be at natural background levels. Any construction work that occurs within the designated radiation areas after mine operations commence will be managed and monitored in a similar manner as the production workforce.

Regular area monitoring would be conducted during construction to ensure that construction worker doses remain well below the public limit of 1mSv/y.

Transport Workers

The uranium product is to be transported via truck to port facilities in South Australia for export. The product is to be contained within sealed drums and then within secured sea containers, accordingly, gamma radiation is the relevant exposure pathway. Drivers can be exposed to gamma radiation when checking and securing their load and then in the truck cabin for the duration of their shipment.

Vimy intends to use two drivers per truck enable continuous movement of product to the port, approximately 2,450km from the mine which equates to approximately 30 hours exposure per driver per shipment with the drivers sleeping in the cabs to facilitate continuous transport.

Gamma dose rates in truck cabins have been measured to be approximately 1μSv/h (BHP 2009). The dose prediction is based on the 1μSv/h external gamma dose rate, an exposure time of 30h per shipment and 48 shipments per year for each driver. This corresponds to an approximate annual dose rate of 1.4mSv. Doses to the public from the transport of product are dealt with in Section 13.7.9.

Management of the transport of the uranium concentrate from the minesite to the port facilities and the issue of driver radiation exposure will be as part of the Radiation Management Plan (MRUP-EMP-028) and Transport Radiation Management Plan (MRUP-EMP-022).

13.6.4 Predicted Worker Dose Summary

Table 13.10 provides a summary of the predicted worker exposures for the MRUP without the controls provided in the following section with comparison to the applicable exposure standard. Notwithstanding that predicted levels are below exposure standards, Vimy is committed to controlling radiation exposure and the management measures to be applied are outlined in Section 13.8.

Table 13.10 Predicted Dose Summary

Worker Type	Predicted Value	Limit/Standard
Geologist	2.1mSv/y	20mSv/y
Pit technician	3.3mSv/y	20mSv/y
Equipment Operator	2.9mSv/y	20mSv/y
Metallurgical Plant	2.8mSv/y	20mSv/y
Maintenance Workers	2.8mSv/y	20mSv/y
Transport	1.4mSv/y	20mSv/y

The conservative predicted dose for personnel working on the MRUP are well below the applicable exposure limit, however Vimy is committed to minimising radiation exposure and will apply the management principles and measures outlined in Section 13.8.

13.7 Public and Environmental Radiation Assessment

13.7.1 Sensitive Receptors

Impacts are assessed as projected radiation doses to members of the public and as a calculated dose rate for non-human biota. The assessments are based on the results of air quality modelling which provide a measure of project originated radioactivity in the environment outside the mine tenement area and uses recognised standard methods to calculate the radiological impact (Appendix B of Appendix F1).

The sensitive receptors locations, as defined by the air quality modelling, are locations where people may be located and where the non-human biota impact assessments are necessary. These are as follows:

- Tropicana Gold Mine, an active mining operation, located approximately 110km northeast of the operation.
- Pinjin, an existing pastoral station located approximately 105km west of the operation.

- Cundeelee, an abandoned Aboriginal community, located approximately 90km NW of the operation, (note that this location has been included on the basis that it may be used by an Aboriginal community in the future).
- The proposed location of the mining accommodation village, located within the mining lease area and approximately 10km from the processing plant.

An additional two locations were selected for public and environmental radiological assessment. One of these locations is on the south east project boundary (approximately 9km from the processing plant location) and one is located on the north western access road into the operations (approximately 40km from the processing plant location). These are not permanently occupied locations, but are intended to provide estimates of "worst case" exposure situations.

13.7.2 Impact Assessment Approach

For members of the public the potential exposure pathways were identified and the predicted dose estimated. Table 13.11 provides a summary of the approach to dose estimation.

Table 13.11 Dose Estimation Methods

Dose Pathway	Member of Public
Gamma Radiation	Modelled
Inhalation of radionuclides in dust	Estimation based on air quality modelling results
Inhalation of RnDP	Estimation based on air quality modelling results
Ingestion of radionuclides	Estimation based on modelled dust deposition and transfer factors

The impact to non-human biota (flora and fauna) is assessed by determining the change in radiation doses to standard species of flora and fauna as a result of emissions from the operation. The change in concentration is then used as input data for an ERICA assessment which calculates a dose to a set of reference species. The method for determining the change in media concentration is via modelled dust deposition results.

In addition to the production and ore grading information provided previously the assessment of public exposure takes into account a number of other factors. The values and assumptions used in the assessment are summarised in Table 13.12. The assumptions presented below are generally more conservative than those presented for the occupational exposure section.

Table 13.12 Public Assessment Criteria

Criteria	Value/Assumption
Exposure hours	8760/y
Breathing rate	$1.0m^3/h$
Ore grade and radioactivity relationship	1ppm U = $12.3mBq(U^{238})/g$
Tailings radionuclide concentration	equal to ore (excluding U)
Deposited dust mixing depth (Kaste 2007)	10mm
Density of soil in environment ($1m^3$)	1.5 tonnes
Radon emanation rate from ore	$50Bq/m^2/s$ per percent of U
Radon emanation rate from tailings	Same as ore
Dose conversion factor for Rn and RnDP in equilibrium (ICRP 1993)	$1.1\mu Sv/(\mu Jh/m^3)$
Dust inhalation dose conversion factor (ARPANSA 2005)	$7.2\mu Sv/\alpha dps$
TSP (Total Suspended Solids)	Doubled PM_{10} Results

13.7.3 Radionuclide Analysis

Previous work (ANSTO 1989) has indicated that radionuclides in the ore and the waste material are not in secular equilibrium. The calculated radionuclide concentrations are shown in Table 13.13.

Table 13.13 Radionuclide Analysis of Ore

Material	Uranium Grade (ppm)	Radionuclide Concentration(Bq/g)[1]					
		U238	U234	Th230	Ra226	Pb210	Po210
Ore	600	7.5	7.5	7.5	5.8	5.8	5.8
Low-grade ore	300	3.75	3.75	3.75	2.75	2.75	2.75
Waste Rock	20	0.25	0.25	0.25	0.36	0.36	0.36

Note 1: Measurements were available only for U^{238} and Ra^{226}. It has been assumed that the U^{234} and Th^{230} concentrations will be the same as the U^{238} concentrations. It has been assumed that the concentrations of Pb^{210} and Po^{210} will be the same as the Ra^{226} concentration.

13.7.4 Gamma

Gamma radiation exposure to members of the public from sources within the Project area is considered to be negligible due to the distance between the sources and the public during operations. The sources of gamma radiation (for example ore stockpiles) are well within the project boundary and at least 5km from the closest publicly accessible area (the northwest corner of the project by the site access road).

Gamma radiation intensity reduces significantly with distance (as one divides by the distance squared when the source is at a distance). The gamma shine at the closest accessible area would not be discernible from natural background levels.

13.7.5 Dust Emission Factor

The dust sources for the air quality assessment are based on standard emission factors for equipment and processes (Appendix E1). The air quality modelling uses estimates of dust emissions from various processes and calculates increases in dust concentration at the sensitive receptors in units of $\mu g/m^3$. The modelling was conducted for a number of scenarios to reflect changing operation status and location of the source terms. The maximum modelled annual average dust concentration at each receptor has been used for the dose assessment.

The outcome from the modelling was averaged for the all years of the operation to assess source term contribution and then a weighted average technique was used to calculate the radionuclides. Assuming secular equilibrium, which provides a more conservative estimate, and using the radionuclide composition shown in Table 13.13, the average specific activity of the suspended dust from the mine for use in the assessment is calculated to be 1.5Bq/g. Potential higher emissions from the processing plant have not been included in the long term modelling due to the wet processing method (slurry), the enclosed final packing area and the ventilation exhaust scrubbing systems at emission points from the plant.

Figure 2, Appendix B of Appendix F1, shows the incremental annual average PM_{10} dust concentrations for a typical modelled year (Year 10 of operations). The maximum modelled annual average dust concentrations at each receptor location are presented in Table 13.14. The dust concentration was multiplied by the weighted specific activity to provide an activity concentration.

Table 13.14 Annual Ground Level Concentrations (Maximum Result for All Modelled Years)

Location	Ground Level Concentrations PM_{10} Dust (µg/m^3)	Assumed Ground Level Concentrations TSP Dust (µg/m^3)	Equivalent Radionuclide Concentration[1] (µBq/m^3)
Accommodation Village	3.16	6.32	9.48
Cundeelee	0.01	0.02	0.03
Pinjin	0.01	0.02	0.03
Tropicana Gold Mine	<0.01	<0.02	<0.03
Southeastern boundary	0.73	1.46	2.19
Northwest boundary	0.96	1.92	2.88

Note 1: For each member of the U-238 decay chain

The air quality modelling has calculated the cumulative dust deposition for the life of the project. Table 13.15 presents the radionuclide activity deposition rate.

Table 13.15 Cumulative Dust Deposition (16 years)

Location	Ground Level Concentrations Dust Deposition (g/m^2)	Radionuclide Deposition[1] (Bq/m^2)
Accommodation Village	8.62	12.9
Cundeelee	4.6×10^{-3}	6.9×10^{-3}
Pinjin	1.1×10^{-2}	1.7×10^{-2}
Tropicana Gold Mine	4.3×10^{-3}	6.5×10^{-3}
Southeastern boundary	3.8×10^{-1}	5.7×10^{-1}
Northwest boundary	1.7×10^{-1}	2.6×10^{-1}

Note 1: for each member of the Decay Chain

13.7.6 Radon Emissions

The air quality assessment (Appendix B of Appendix F1) describes four scenarios for radon emission based on various stages of the project. The emission rates modelled indicate that Year 14 of the project has the highest annual average radon emissions. Figure 1, Appendix B of Appendix F1, shows the incremental annual average radon concentration as per the air quality modelling at Year 14 of operations, when radon emissions are at their highest rates. The plots of incremental radon concentrations for other modelled years can be found in the air quality reports (Appendix B of Appendix F1).

The predicted annual average ground level concentrations at each of the main receptor locations is presented in Table 13.16 excluding natural background radon concentrations (which are 10 to 20Bq/m^3).

Table 13.16 Annual Average Radon Ground Level Concentrations

Location	Ground Level Concentrations Annual Average (Bq/m^3)			
	Year 3	Year 10	Year 11	Year 14
Accommodation Village	0.26	0.37	0.52	0.52
Cundeelee	0.001	0.001	0.002	0.02
Pinjin	0.001	0.001	0.002	0.02
Tropicana Gold Mine	<0.001	<0.001	<0.001	<0.001
Southeastern boundary	0.19	0.20	0.21	0.19
Northwest boundary[1]	0.02	0.03	0.04	0.07

Note 1: Modelled location is on access road.

13.7.7 Bush Tucker

The MRUP area is sparse with minimal plants and animals in the region, mainly because of the lack of surface water. Accordingly, the ingestion of bush tucker is not considered to present a significant contribution to overall doses to the public. However, bush tucker is a potential pathway and a conservative assessment was undertaken to evaluate dose contribution.

Given the remote location of the operation and the distance to sensitive receptors a hypothetical model has been used. To assess the potential doses from the consumption of bush foods, an estimate of the amount of food consumed was made. AAEC (AAEC 1985) assumed an intake of 155kg/y of plant material and 125kg/y of animal material for traditional owners of the Maralinga lands and these estimates have been used in this assessment. The model assumes that the people are permanently located at the site (i.e. 8,760h/y) and only consume locally sourced food.

To assess the contribution of the project to increased doses the change in soil radionuclide concentration from dust deposition was calculated. This was used to calculate concentration of radionuclides in plants and animals from the soil using published concentration ratios. The dose was estimated by applying the ingestion dose factors to the human intake of the plants and animals. Table 13.17 presents the calculated ingestion dose.

Table 13.17 Data for Ingestion Dose Assessment

Location	Dose (mSv/y)		
	Vegetation Ingestion	Meat Ingestion	Total Ingestion
Accommodation Village	0.144	0.085	0.229
Cundeelee	<0.001	<0.001	0.001
Pinjin	<0.001	<0.001	0.001
Tropicana Gold Mine	<0.001	<0.001	0.001
Southeastern boundary	0.006	0.004	0.010
Northwest boundary	0.003	0.002	0.005

The ingestion doses presented are highly conservative as the local environment is unlikely to support this level of food supply being an arid inland area with minimal water supply. Further settlements such as the Accommodation Village or the Tropicana Gold Mine would not consume any local food at all. In practice, it is expected that actual ingestion doses will be below any measurable level.

13.7.8 Public Dose Prediction

An estimate of the potential annual dose from the ingestion exposure pathway as a result of emissions from the project has been made for people living at the sensitive receptor locations and consuming food from that location. Note that the Mulga Rock area is sparse with minimal plants and animals in the region, mainly because of the lack of surface water. Therefore, permanently consuming locally grown food is unlikely to occur in practice, however the assessment is provided to show the most conservative assessment of ingestion doses. Also, due to the distance of the receptors, the gamma contribution to overall dose will be negligible.

Table 13.18 summarises the total annual radiation exposure project for members of the public at the locations specified.

Table 13.18 Public Total Dose Estimates

Location	Exposure Pathway Dose (mSv/y)[1]				
	Gamma	Dust	RnDP	Ingestion[2]	Total Dose
Accommodation Village	<0.001	0.004	0.073	0.229	0.306
Cundeelee	<0.001	<0.001	0.003	0.001	0.005
Pinjin	<0.001	<0.001	0.003	0.001	0.005
Tropicana Gold Mine	<0.001	<0.001	<0.001	0.001	0.003
Southeastern boundary	<0.001	0.001	0.030	0.010	0.041
Northwest boundary	<0.001	0.001	0.010	0.005	0.016

13.7.9 Product Transportation

During the routine trucking of final uranium product to Port Adelaide, there is the potential for members of the public to be exposed to gamma radiation. The exposure is limited due to relatively low gamma dose rates and the limited exposure times.

Since the uranium product will be contained within sealed containers the only radiation exposure pathway considered was external gamma radiation emanating from the load. The external gamma dose rates from a container have been measured to be 5µSv/h at 1m from a container of uranium oxide, and 1µSv/h and 0.2µSv/h at a distance of 5m and 10m respectively (BHP Billiton 2009). Two scenarios were considered:

- **Scenario 1**: Assume a member of the public is travelling behind a product container on a truck for six hours at a distance of 5m. The external gamma radiation dose received will be 1µSv/h × 6h = 0.006mSv.
- **Scenario 2**: Assume someone stands permanently on the side of a road and that 50 loaded trucks pass this member of the public at a distance of 1m during the course of one year. The external gamma radiation exposure of this member of the public will be 5µSv/h × 1/60h per truck × 50 trucks/year = 0.004mSv/year.

In the event of an incident during transit, the emergency response plan would be initiated. The priorities of the response are first aid and containment of product. The area would be segregated and spilt product covered and removed.

13.8 Proposed Management

MRUP will develop and implement a corporate Radiation Protection Program which will be equivalent to that implemented at other Australian uranium mines.

As part of the approval and authorisation process, a draft Radiation Management Plan (RMP) will be developed for the Project and provided to the DMP and Radiological Council prior to construction. The RMP would include details of radiation protection and radioactive waste management specific to the plant and address the requirements of the Western Australian NORM Guidelines (DMP 2010) and the ARPANSA Mining Code (ARPANSA 2005).

A Transport Radiation Management Plan (TRMP) will be developed which will include an Emergency Response Assistance Plan (ERAP). The transport carrier will be required to develop a plan consistent with the MRUP ERAP.

This section sets out the principles that will be applied in managing worker radiation exposures and radioactive waste. It outlines the way these principles will be applied to the Project, including an outline of the radiation control methods and an overview of the proposed monitoring.

13.8.1 Principles for the Management of Radiation

The basic international standard for radiation protection is produced by the International Commission on Radiological Protection (ICRP). It was the ICRP that first formulated the concept that worker radiation doses should be maintained As Low As Reasonably Achievable (ALARA), social and economic factors taken into account (ICRP 26).

The ICRP has maintained this position since that time so that the requirements of any radiation protection program are:

- Worker dose limits must not be exceeded.
- Worker doses should be maintained ALARA.

The requirements of the MRUP Radiation Management Plan are specified in detail in the WA NORM 2.2 Guide. The basic elements in the Radiation Protection Plan that MRUP will provide include:

8. Management control over work practices.
9. Personnel qualification and training.
10. Control of occupational and public exposure to radiation.
11. Planning for unusual situations.

These broad goals will be achieved through:

- Worker notification of radiation sources.
- Work procedures and protective clothing to limit worker dose.
- Incorporating radiological controls into the design of the plant and mine.
- Application of engineering controls where appropriate.
- Worker training to control and reduce worker dose.
- A worker dosimetry program to measure the workers doses received.
- Reporting of worker doses to the regulatory authorities.

These measures have been showed to be effective at other uranium mines and will used at the proposed MRUP.

13.8.2 Radiation Control in Design

Hazards and risks, including radiation, are most effectively controlled through good design decisions at an early stage. MRUP will review:

- The mine plan including the location of ore, mineralised rock stockpiles and radioactive wastes with a view to minimising the site radiation levels and with a particular emphasis on the control of LLA.
- The design of the process equipment with an intent to minimise the radiation levels within the plant, providing for the clean-up of spills and facilitating the maintenance of radioactive systems.
- The provision of controlled entry points to radioactive areas to ensure stringent contamination control and to limit the spread of radioactive contamination to non-radioactive areas.

13.8.3 Radiation Control in the Mine

Access to the main mining areas will be restricted to ensure that only appropriately trained and qualified personnel enter the main mine work area.

Gamma radiation levels will be relatively low in the mine, but the gamma radiation levels are sufficient to generate gamma radiation exposures of up to 5mSv per year for workers spending all of their working hours for a full year on ore. Such gamma radiation exposures are unlikely to occur in practice due to shielding from equipment and work areas and because mine workers do not spend their full shift in locations where they are exposed to ore. While the addition of additional gamma radiation shielding within equipment cabs may be considered, it is unlikely to be required.

For production drill operators and charge up crews who may be required to spend extended time directly on the ore, a workplace exposure plan will be developed based on actual dose rate measurements. The plan would estimate doses (based on exposure time and dose rate) and if necessary provide a pad of inert material placed on the ore to provide shielding during drilling and charging activities.

Workers will be monitored with TLD gamma monitors and direct-reading personal electronic dosimeters will be issued to workers who may be in higher exposure situations, allowing real time readout and dose assessment. The results of this monitoring will be regularly reviewed and individuals whose doses may be approaching the target levels may be assigned to other duties.

Results of the gamma radiation dose monitoring will be used to improve the radiation management measures where appropriate.

Active radon (and therefore RnDP) control in the mining areas is unlikely to be necessary during mining operations. However, during stable atmospheric conditions (night time in winter months), RnDP concentrations may increase due to natural processes (e.g. formation of temperature inversions) and these are not directly amenable to control. However, measures will be taken to limit the exposures arising from such situations which may include the use of respiratory protective equipment, task rotation or scheduling. Examples of scheduling controls include delaying work in-pit by pedestrians until atmospheric inversion conditions break up, which would be expected to occur by about 7am.

All heavy equipment operating in the pit will have air-conditioned cabs equipped with HEPA filters which will reduce the dust levels in the cabins and also reduce radon progeny levels to some extent.

Continuous radon progeny monitors will be installed in the pit at times when stable atmospheric conditions are likely to occur to provide a warning of abnormally elevated radon progeny levels. Should essential work be required when high concentrations exist, then respiratory protection will be utilised.

Routine mine dust suppression measures will minimise doses from inhalation of radioactive dust as will the maintenance of high standards of cleanliness inside the cabs of mobile equipment and all equipment used in the pit generally. Dust suppression measures will primarily involve the use of water during ore handling or haulage.

13.8.4 Radiation Control in the Processing Facility

The plant will be designed for ease of access so that spills can be effectively cleaned up before they become dust sources. Ample wash-down water points, hoses and sumps will be supplied for spillage clean-up.

The material being supplied to the beneficiation plant located adjacent to the pit will retain some moisture following the dewatering process providing some natural attenuation of the dust. The plant may generate some LLA and release of radon gas embedded in the ore. The plant will separate the ore and send a slurry to the process plant for further treatment. Dust suppression controls applied to mining areas will also be applied to this area. Radon levels will be monitored and controls such as vent points from the crusher will be implemented as necessary.

Given the wet processing method, spillage control becomes important and all areas will be bunded. Spilled material will be collected and pumped back to vessels or to the tailings management system as required. Tanks containing radioactive process slurries will be suitably bunded to capture at least the volume of the tank in the event of a catastrophic failure. The tailings pipeline corridor will be bunded, and designed to contain spillage from tailings pipeline failures. Pressure sensors will be installed on pipelines to give early warning of failure and facilitate prompt response to spillages that may occur.

The uranium precipitation, drying and packing section of the plant handles a product of up to 85% uranium concentration, requiring specific radiation protection measures, particularly dust control. The technology for the safe and secure packing of uranium concentrate into drums has been used for many years at uranium production facilities in Australia. It consists of a totally enclosed packing booth with an automated drum filling process operating under negative pressure to prevent releases of dust. The negative pressure is maintained by an extraction ventilation system, and air is scrubbed prior to release. Typically, uranium product packing scrubbers remove more than 99% of exhausted dusts and particulates.

The standard operating practice requires all product packing workers to change into dedicated overalls prior to entry to the area, and then change when leaving the area. Access to the product drying and packing area will be by ‘swipe-card’, with only authorised personnel allowed access. The swipe-card system will also log entry and exit and will record names of personnel and the total amount of time each person spends in this controlled area.

During operations, the emission of dust and radon from tailings cells will be controlled by the inherent moisture levels within the tailings. Elevated moisture levels reduce the amount of radon that is emitted because the radon is unable to escape from the water saturated pore spaces of around the tailings particles.

The moisture also prevents dusting. As the tailings material dries and becomes competent and safe to drive on, it will be progressively covered.

13.8.5 Construction and Commissioning

During construction and commissioning, the area will be subject to dust monitoring, to establish exposure levels and to identify dust sources. Based on the results of monitoring, additional dust control measures may be implemented. In situations where engineering solutions cannot be found, procedures will be used (such as work permits) and as a final measure, respiratory protection will be utilised.

13.8.6 General Management Measures

Access Control

Access to operating areas will be controlled to ensure that only those who have been properly trained in specific radiological protection measures can be admitted. As part of this process, controlled and supervised areas will be established for radiation control purposes.

A ***supervised area*** is one in which working conditions are kept under review but in which special procedures to control exposure to radiation are not normally necessary.

A ***controlled area*** is one in which employees are required to follow specific procedures aimed at controlling exposure to radiation. Controlled areas are likely to include the mine (both mining areas and tailings management areas), ore handling, beneficiation plant and product precipitation drying and packing areas.

To facilitate the control of people, vehicles and contamination, the operations area will be divided by fencing into ‘clean’ and ‘potentially-contaminated’ areas. Access to the potentially-contaminated area will be via a security gate.

Change-room facilities will be established which will have a clean side and a dirty side. Workers will come to work through the clean side and change into work clothes and exit through the dirty side into the “potentially-contaminated’ areas. At the end of shift workers will enter the dirty side, remove their work clothes and shower, then proceed to the clean side where they will change back into clean clothes before returning to camp. All work clothes will be laundered on site.

Egress from the potentially contaminated area by vehicle will be via a wheel-wash to prevent contaminated material being transported off-site by vehicles. In general, vehicles that are likely to be regularly in contact with higher grade uranium mineralisation (for example mine vehicles) will be kept within the contaminated area. Equipment that must be taken off-site (for example for specialist servicing or repair) will be required to be cleaned and then checked for contamination by suitably trained staff.

Radiation Safety Expertise

MRUP will provide suitably qualified and experienced radiation safety professionals to assist it during the design, construction and operational phases of the Project. Qualified radiation protection personnel would be employed to implement and direct the RMP.

Induction and Training

All employees will receive an induction informing them of the hazards associated with the workplace, of which radiation is one hazard. Area inductions will provide further information on the radiation risks associated with the particular work area. For example, workers who will work in the mine will receive more detailed information on radon, radon decay products and controls.

Specific training will be provided to personnel involved in the handling of uranium concentrates. Managers and supervisors will receive additional training in the recognition and management of situations that have the potential to increase a person’s exposure to radiation. This is similar to the Hazard Observation (HAZOB) reporting system, and will also contribute to the annual review of performance of the plans.

A specific radiation safety work permit system will be implemented for use before any non-routine work in a potentially high exposure situation is undertaken. This includes work such as maintenance in the product packing area, where the work permit would list all controls and instructions with respect to radiation protection.

Record Keeping

A computer-based data management system will be used to store and manage all information relating to radiation management and monitoring. The system will allow the recording of 'raw' and processed data and all relevant supplementary information such as calibration records, dose conversion factors, formulae used to estimate doses and employee occupation, work area, and time spent in various exposure situations.

Information that can be used to identify a person is considered confidential, and only authorised personnel will be able to access such data (including the relevant authorities). Periodic and statutory reports will be prepared from information stored in the electronic database. Periodic dose reports would be provided to individuals.

Worker radiation monitoring records would be made available to the CEO of ARPANSA via the Australian National Radiation Dose Register (ANRDR), in accordance with confidentiality requirements.

Incident Response

It is not expected that radiological emergencies would arise. However, plans for incidents or accidents that may result in exposure radiation or loss of containment of radioactive material will be prepared as part of the overall site emergency response plan and include:

- Immediate response to medical conditions.
- Evacuation of non-essential personnel.
- Stabilisation of the source(s) of radiation.
- Assessment of the likely source(s) of radiation exposure and the types of radiation.
- Contamination of the person(s) and the area.

The plan will also include requirements for post-incident response, including counselling of all people involved or affected by the incident, detailed investigation of the incident, including root cause analysis to prevent recurrence, and procedures for estimating any radiation doses that may have arisen. Appropriate external experts will be used to assist as required.

Review of Performance

Radiation monitoring results will be reviewed on an ongoing basis to determine the adequacy and effectiveness of engineering and management controls to reduce radiation exposures of people and the environment. Targets for the following year will be set and progress towards these targets will be monitored (at quarterly intervals). This is considered as an important aspect of the ALARA process for the MRUP.

Monitoring

An occupational and environmental radiation monitoring program would be developed and implemented. The final programs will form part of the RMP and would be submitted to the appropriate authorities for approval prior to operations. The plans would include support systems such as servicing and calibration of monitoring instruments.

Occupational Monitoring Program

Table 13.19 provides an outline of a conceptual occupational monitoring program and the monitoring will be conducted to fulfil two major aims:

- To provide data to assess the doses received by workers.
- To determine the effectiveness of radiation protection controls.

Table 13.19 Conceptual Occupational Monitoring Program

Radiation type	Measurement Method	Application
Direct External Gamma Radiation	Thermoluminescent dosimeter (TLD) badges	All plant and pit personnel
	Electronic Personal Dosimeters (EPDs)	Specific maintenance tasks/purpose
	Gamma survey meters	Routine surveys, pit and plant
Inhalation LLA dust	Personal Air Samplers (PAS) plus drawer assembly alpha detector	Issue to personnel in each Work Group; plus investigative
	Locational	For investigative purposes
Inhalation RnDPs	Grab samples (Borak, Rolle)	For investigative purposes
	Continuous Rn and RnDP monitors	Continuous in-pit, in-plant, for control; investigation
Surface alpha/beta contamination	Alpha/beta probe, survey	Workplace and crib-room checks
		Equipment and outgoing checks

As part of the operational ALARA program, a series of action levels would be established to ensure that exposures remain controlled. These will be defined in consultation with the DMP and radiation health regulators during the development of the RMP and subject to adjustment as MRUP gains experience with site operations.

A preliminary indication of action levels together with response is presented in Table 13.20. Trigger levels are a management tool for reducing exposures, and are not a regulated limit. An action level system requires that personnel take specified remedial action when monitoring results exceed the specified level. In some cases, the action would include a formal reporting and investigation procedure.

The development of site specific Action Levels will form part of the Radiation Management Plan and will be subject to adjustment as MRUP gains experience with site operations. Table 13.20 provides a preliminary indication of action levels that may be set, and the remedial actions that may be required.

Table 13.20 Proposed Occupational Action Levels

Radiation	Trigger Level	Actions
Gamma Dose Rates	5µSv/h	Limit exposure time, relocate activity or introduce additional shielding if practicable
Loose Surface Contamination in radioactive areas	4000Bq/m^3	Immediate clean up
Airborne dust concentrations	5mg/m^3	Identify cause and employ appropriate mitigation measures such as dust suppression, housekeeping or ventilation
Electronic personal dosimeters	100µSv in one week	Identify cause and introduce appropriate mitigation such as changes in work practices, relocation or additional shielding.
Thermoluminescent dosimeter (quarterly Result)	1mSv	Identify cause and employ appropriate mitigation such as changes in work practices or additional shielding
Radon Progeny Levels	5µJ/m^3	Restrict access to areas, introduce additional ventilation or require personal protection equipment

13.8.7 Radioactive Waste Management

A Radioactive Waste Management Plan (RWMP) has been developed for MRUP that details the waste streams and management of radioactive wastes. This Plan together with the Mine Closure Plan provides the framework for identify, managing and disposing of radioactive waste streams generated by the project. The RWMP is provided in Appendix H3.

The RWMP is structured in accordance with the specific requirements outlined in document 4.2 of the NORM Guidelines. Radioactive waste is generally defined as material for which there is no further use, and which contains an average radionuclide concentration that exceeds 1Bq/g or is contaminated with radioactive material. The MRUP will adapt and implement the waste classification methodology outlined in ARPANSA RPS 20.

RPS 20 notes that facilities for disposal of very low level waste (Very LLW) or low level waste (LLW) should:

- Have sufficient capacity so that the radioactive waste only occupies a small percentage of the total volume.
- Have 2m or so of soil or clean fill cover of the radioactive waste.
- Have leachate control.
- Be suitable for any other of the waste characteristics – e.g. non-radioactive hazardous constituents.
- Take into account land use restrictions post-closure.

Contaminated waste will include tyres, process plant equipment, vehicles and general wastes such as personal protective equipment. This will be disposed of at the site waste disposal area in constructed trenches that will be progressively covered by local inert overburden material reclaimed from mining operation and covered by Quaternary sediments and growth medium.

Process material wastes, such as collected spillage or slimes from the sedimentation dams will be reprocessed or disposed of with the tailings. The MRUP will have surface tailings disposal facilities and in-pit tailings disposal facilities and the operation of these facilities is addressed in Section 11.

13.8.8 Post-closure

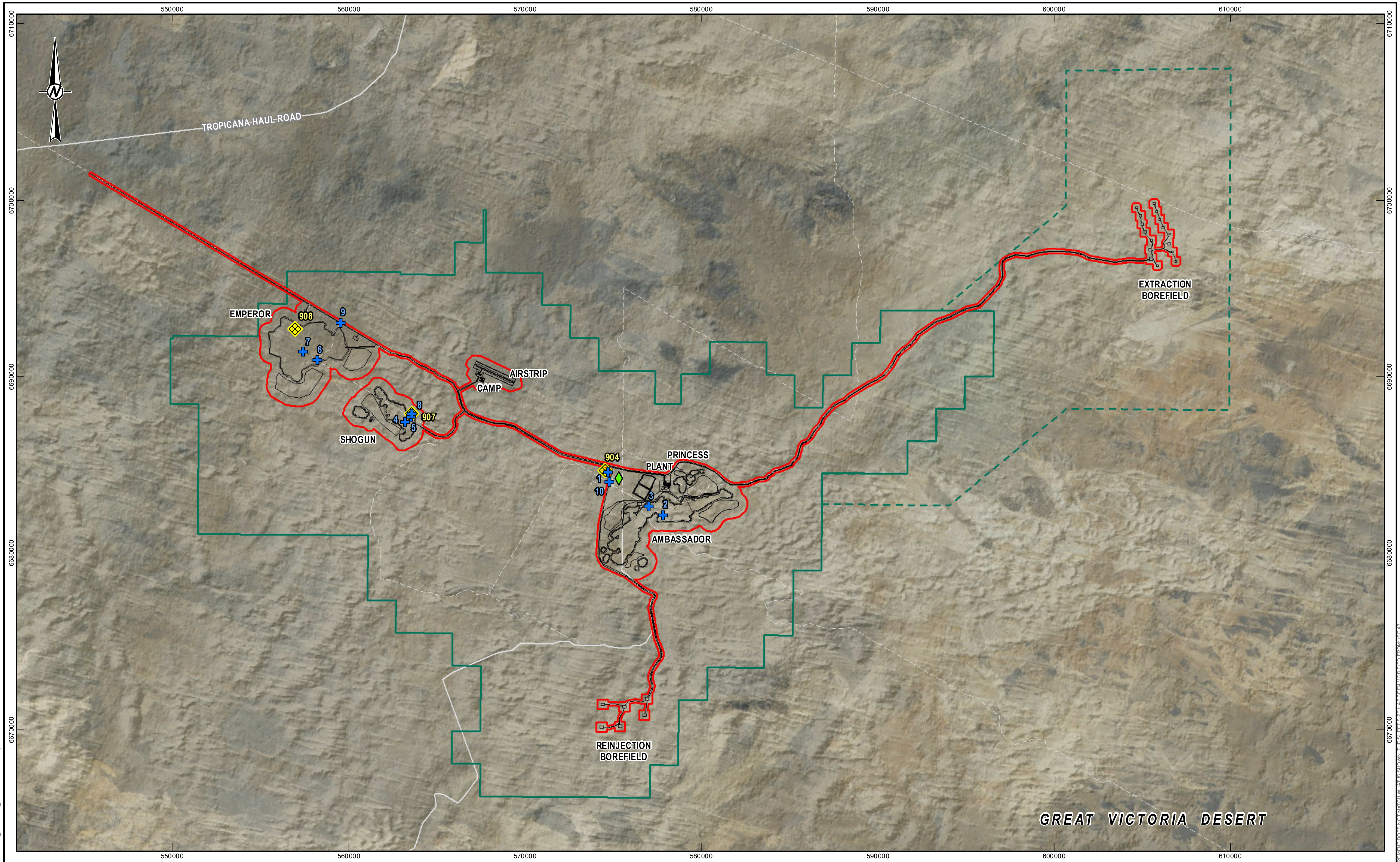
The closure and rehabilitation of the mine will be subject to compliance with an agreed Mine Closure Plan (Appendix H1). The above-ground tailings facility will be capped, covered and rehabilitated in a manner that prevents radon emanation. The majority of the tailings will be deposited back in-pit and covered with sufficient overburden to control radon emanation.

Plant and equipment will be cleaned and any radioactive material captured and disposed of in a suitable manner. Once rehabilitation has been fully implemented there will be no alpha-emitting dust or radioactive gas emanations at above natural background levels.

There will be no further transport of uranium concentrate and therefore no further gamma emissions from transport. The radiological dose assessment on all workers and all members of the public post closure, once rehabilitation has been completed, will return to natural background levels.

13.8.9 Human Health Summary

The radiation assessment completed for the MRUP demonstrates that the project is being designed with recognition of radiation hazards, processes and tasks to enable effective control of worker and public doses as a result of the project. The predicted dose assessment for both workers and member of the public without the controls detailed are a fraction of the regulatory limit. Exposure trigger levels together with response actions will be defined within the yet to be approved RMP to ensure worker and public impacts are not greater than predicted in this document.



LEGEND

- WEATHER STATION
- PRM AND ENVIRONMENTAL TLD
- ERDM
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
LOCATION OF TLD AND PRM MONITORING SITES (SONTER 2015A)
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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CLIENT
VIMY RESOURCES LIMITED

PROJECT
MULGA ROCK URANIUM PROJECT

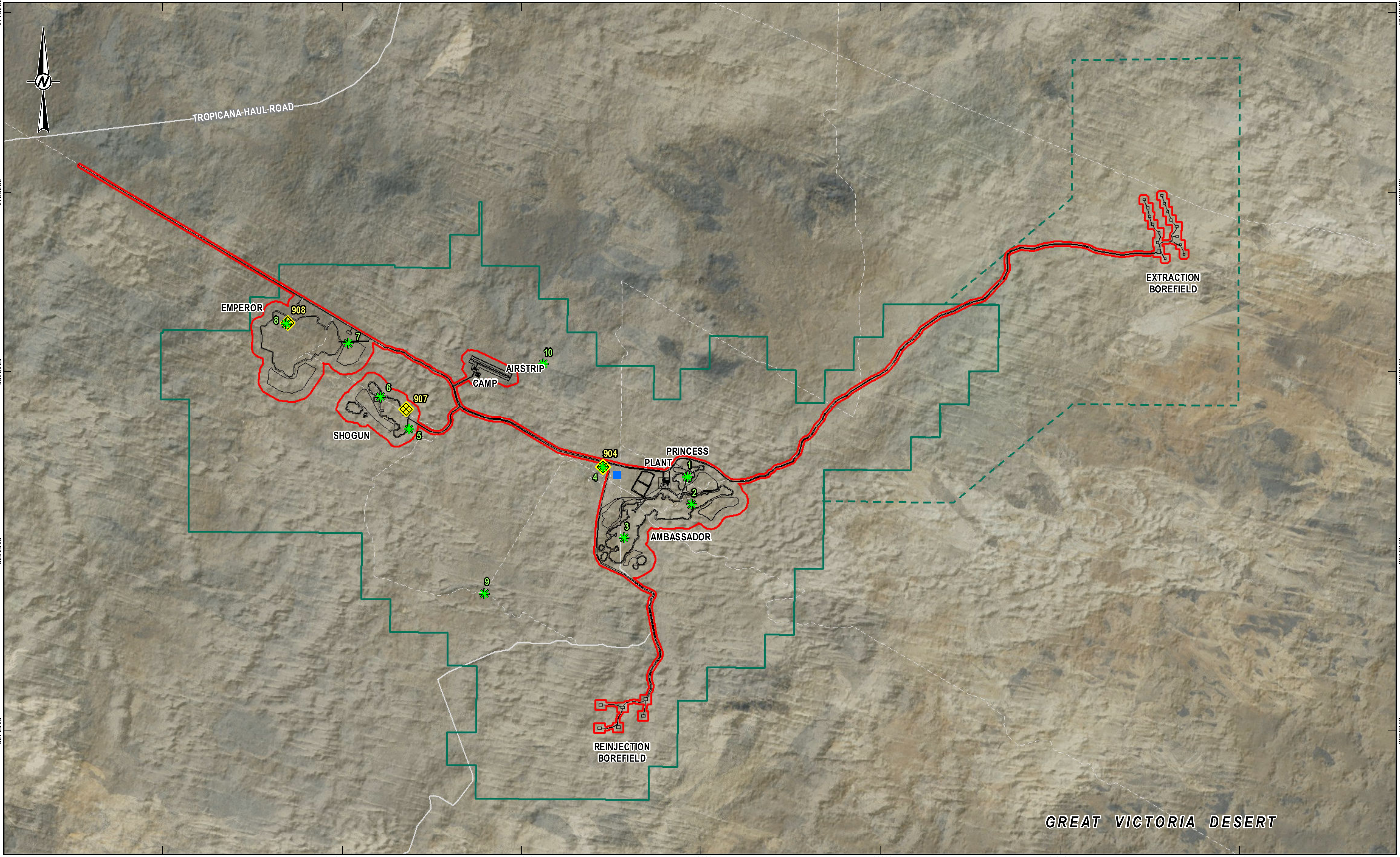
CONSULTANT

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	CWC
APPROVED	CWC

TITLE
LOCATION OF TLD AND PRM MONITORING SITES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	13.1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3



LEGEND

- WEATHER STATION
- DUST DEPOSITION GAUGE
- HIGH VOLUME SAMPLER
- MINOR ROAD/TRACK
- ROAD
- INFRASTRUCTURE
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
LOCATION OF TLD AND PRM MONITORING SITES (SONTER 2015A)
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

0 5 10
1:200,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	CWC
APPROVED	CWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
LOCATION OF HIGH VOLUME SAMPLER AND DUST DEPOSITION GAUGES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	13.2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

14. Heritage

14.1 Relevant Environmental Objectives, Legislation, Policies and Guidelines

14.1.1 EPA Objective

The EPA applies the following objectives to the assessment of proposals that may affect heritage:

To ensure that historical and cultural associations, and natural heritage, are not adversely affected.

14.1.2 Regulatory Framework

The protection of heritage is covered by the following statutes:

- *Aboriginal Heritage Act 1972* (WA) (AHA).
- *Environmental Protection Act 1986* (WA) (EP Act).
- *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).
- *Native Title Act 1993* (Cth).

Aboriginal Heritage Act 1972

This is an Act which requires the preservation of places and objects customarily used by, or traditional to, the original inhabitants of Australia or their descendants or anything associated with or incidental to such matters.

Environmental Protection Act 1986

This is an act which is designed to protect the environment of the State which includes limiting any alteration of the environment to the detriment or potential detriment of an environmental value, which includes heritage values, whilst having regard to its various principles.

Environment Protection and Biodiversity Conservation Act 1999

This act is designed to enhance the management and protection of Australia's heritage places, including World Heritage properties. It provides for the listing of historic or Indigenous places that are of outstanding national heritage value to the Australian nation.

Native Title Act 1993

This act provides a system for the management and protection of native title rights and interests in land, as well as the co-existence of other valid land uses. It provides a process for traditional owners to lodge a claim for recognition of their native title rights and interests. While claims are being considered, the registered native title claimants maintain a right to negotiate over proposed developments within their claim boundaries.

Guidance and Position Statements

The following EPA position and guidance statements set the framework for identification and assessment of impacts to heritage:

- EPA April 2004, EPA Guidance Statement No. 41 – Assessment of Aboriginal Heritage; provides guidance where Aboriginal heritage is linked directly to the physical and biological attributes of the environment, thereby making 'Aboriginal heritage' a relevant environmental factor, in cases where the protection and management of those attributes are potentially threatened as a result of any proposal.

- Department of Aboriginal Affairs and Department of Premier and Cabinet (DAA & DPC) April 2013, Aboriginal Heritage Due Diligence Guidelines; provides guidance including an Aboriginal Heritage Risk Matrix for the general assistance of those undertaking the development of a proposal where there is the potential to impact Aboriginal heritage.

14.2 Historical Context

There is abundant evidence from archeological records that Aboriginal people occupied and passed through traditional lands (which include the Great Victoria Desert) for more than 20,000 years following inland colonisation from coastal areas of Australia which occurred much earlier (~60,000-40,000 years). While no dating is available for archeological sites in the southwestern Great Victoria Desert, the artefacts recorded in various archeological surveys, coupled with landscape dating, provide an insight into likely minimum ages for the colonisation of the south-western portion of the region. The presence of tula adzes and other backed artefacts and microliths across the region is consistent with a regional distribution showing settlement 3,500-2,500 years ago (Smith 2013). This is also supported by regolith dating at the MRUP showing that the dunes of the southwest portion of the Great Victoria Desert had likely stabilised (other than through minor localised Aeolian redistribution following bushfires) by around 6,700 years ago (Morris 2013).

By contrast to the more temperate coastal regions, contact with Europeans in the desert region came late due to the inhospitable nature of the country and the lack of rock exposure that was driving early prospectors to discover mineral resources.

Three of the early explorers' records are most relevant to the MRUP, being:

- Giles (1876).
- Carnegie (1896).
- Lindsay (Elder, 1891-1892).

All three passed through, or close to, the MRUP area and provided detailed first insight into Aboriginal populations in that region. The records report very small population groups sparsely distributed, with no evidence of permanent site occupation away from very rare water or gnamma holes (a minimum of 25km away from the MRUP), other than signs of survival-style subsistence such as the digging of mallee tree roots to draw water.

Further archeological research suggests occupation of this semi-arid/arid zone would have been opportunistic and required environmental adaptation to survive (either behavioural change or climactic change). In general terms, occupation by Aboriginal people was more likely to occur close to water and food sources. In dunal areas where the dunes are close together there is less likelihood occupation could occur due to the increased cover of sand (Appendix G4).

From the turn of the twentieth century, the desert people began to migrate out of their traditional lands, moving west towards the townships of the Kalgoorlie-Boulder and Leonora Goldfields, Mount Margaret and Laverton. Their movement was accelerated by various droughts and the establishment of missions, most notably the Mount Margaret Aboriginal Mission in 1921 (and later the Cundeelee mission), about 200km to the north-northwest of the MRUP. A number of the participants in ethnographic surveys for MRUP in 2010 were born at the Mount Margaret Mission.

The closest Aboriginal communities to MRUP were the Cundeelee and Coonana sites. Cundeelee was a ration depot and then a mission (est. 1950). It was chosen to relocate Spinifex people (or Anangu Pitjantjatjara, whose country straddles the West Australian and South Australian border) who were removed from their land during the time of the Maralinga atomic tests. In the 1980s, recurring problems with access to water and other resources led to the closure of Cundeelee and the majority of residents moved to Coonana, about 170km east of Kalgoorlie-Boulder, along the Trans-Access Road. Coonana saw a steady decline in population from around 300 people living there in the mid-1980s to only a handful of people in 2010. In 2014, it is understood only one resident remains. Most original residents of the Cundeelee or Coonana communities have now resettled in Tjuntjuntjara, in the southwest corner of the Spinifex country, a territory clearly identified in the November 2000 determination by the National Native Title Tribunal (Cane 1998).

14.3 Existing Environment

In 2015, there are no current native title claims over the MRUP area. A pre-existing claim was in place by the Wongatha people – this covered an area to the north of the proposed mining area and included the area where the MRUP extraction borefield will be located. This claim was subsequently rejected by the Federal Court in February 2007 (*Harrington-Smith v Western Australia (No 9) ([2007] FCA 31)*). Since that time, the Wongatha people have asserted 'traditional rights' over the area and are recognised as the appropriate traditional owner group for the MRUP area.

A search of the DAA's Aboriginal Heritage Inquiry System shows there is one Registered Site (ID 1986; Minigwal 3) located at the edge of the proposed overburden landform for the Emperor pit (Figure 14.1). It is described on the register as an artefact/scatter site and, as such, is an archeological site (containing physical evidence of past activity). A further four registered sites, which are also artefact scatters, are in the same vicinity of the Project area. One sits 370m from the Emperor OL and three are further away – between 2-6km from any planned disturbance. There are no registered ethnographic sites (significant due to spiritual, social, aesthetic or historical reasons).

14.4 Surveys and Investigations

There has been a total of five surveys commissioned by Vimy (and preceding entities involved in developing the MRUP):

- An ethnographic survey of the region around the MRUP was undertaken by McKeich in 1982 on behalf of PNC Exploration (Australia) Pty Ltd. McKeich interviewed twelve Aboriginal elders from Cundeelee who then discussed the issues concerning their relationship to the land in question more widely within their community, and provided feedback (Appendix G2). McKeich also interviewed Aboriginal people from Mt Margaret and had a meeting with seven elders from that community (Appendix G3). The findings derived from Cundeelee and Mt Margaret people were the same, namely that the area had no present significance and that within the Project area there were no specific mythological, sacred or camping sites of which they were aware. McKeich specifically reported in August 1982 that *"No extant Aboriginal groups have any economic, political, or religious claims upon the specified area although the people from Mt Margaret or some others may have an interest in the north-west section."*
- An archeological survey for Aboriginal sites was undertaken in 1983 by O'Connor on behalf of PNC Exploration (Australia) Pty Ltd. The survey located six sites containing surface scatters of stone artefacts (Appendix G5). Only one site, at a granite outcrop known as Malcolm Soak, was deemed to be archeologically significant. The site is outside the MRUP disturbance footprint (about 25km to the southeast). Artefact scatters found at the other sites suggest that occupation of those sites was very short term and opportunistic in nature, probably linked to the very ephemeral nature of available water (Appendix G5).
- Two ethnographic surveys were undertaken on behalf of Energy and Minerals Australia Ltd (EAMA; since renamed Vimy Resources Ltd) in July 2010 (a men's survey) and October 2010 (a women's survey). The surveys engaged senior Wongatha people as nominated by the North East Independent Body (NEIB), the Wongatha's consultative body for heritage matters in the region at the time of the survey. Consistent with the findings of the previous survey, neither of these surveys identified any ethnographic sites (Appendix G1).
- A further archeological survey was undertaken by Warranup Pty Ltd on behalf of EAMA in July 2010. It consisted of archeological surveys of one hectare quadrants surveyed along 10m spaced pedestrian transects designed to represent a variety of different environments within the Project area. No

archeological sites were identified within the survey areas, and no artefacts were identified in any of the areas with sand cover, such as dunes (Appendix G4). A total of 22 isolated artefacts were located in flat areas of depression where water drains to between the dunes, such as claypans (Appendix G4).

More information is provided in Sections 14.4.1 and 14.4.2 on the two most recent studies for ethnography and archeology.

Regionally, since around 2005, the Tropicana Joint Venture (AngloGold Ashanti Australia and Independence Group) has developed the Tropicana Gold Project (a large gold deposit located 110km northeast of Mulga Rock), with first production achieved in late 2013. Project heritage documentation released as part the Environmental Impact Assessment (EIA) process, which included proposals for infrastructure adjacent to the Mulga Rock Project area, provides details of eight ethnographic surveys conducted over JV tenure over a period from 2002 to 2008 (Mattner and Bergin 2009).

This tenure included the Mulga Rock Project's proposed extraction borefield and the western access corridor.

Details from these ethnographic surveys for Tropicana are described in:

- Machin B 2004, *Heritage surveys over a selection of AngloGold Ashanti tenements including EMA's proposed water supply area.*
- Mathieu C and Glendenning W 2008, *East and west access corridors.*

Mattner and Bergin (2009), in a summary report for AngloGold Ashanti reported no ethnographic sites were identified for surveys in development areas, nominated tenure or infrastructure corridors.

In assessing potential infrastructure corridors during the Tropicana Gold Mine EIA, Anglogold Ashanti Australia also carried out a survey of European heritage around the former Pinjin town site (Hocking 2007). That survey identified that the former Pinjin town site and associated area (including the Old Pinjin Homestead, part of the current Pinjin pastoral lease) weren't included on any heritage listing, nor included in or near the Goldfields Esperance heritage rail network. It documented likely first gold production at Pinjin in 1897, followed by mining tenements applications in 1903 and declaration of a public reserve for the Pinjin cemetery in 1908. In the 1960s, the Pinjin homestead was moved to its current location, and the Pinjin pastoral Lease transferred to its current owners (Tisala Pty Ltd).

14.4.1 Ethnography Surveys

A men's survey was undertaken in July 2010 with a group of six Wongatha men, a heritage specialist and representatives of EAMA. The group were taken to the proposed development area and shown the location of the proposed pits. They traversed the tenement areas and made various stops to review maps and walk sections of the MRUP area. At the conclusion of the survey, the men confirmed that they knew of no significant sites in the area and that they had not identified any new sites (Appendix G1). In 2014, when it was apparent the Project description had changed to include additional mining areas within the previously surveyed area, the survey participants were contacted to confirm their advice in the context of the Project changes. Affidavits were supplied to support this.

A women's survey was undertaken in October 2010 with a group of six Wongatha women, a heritage specialist and representatives of EAMA. The group undertook the survey of the MRUP tenements in a similar fashion to the men's group and provided advice to say they knew of no sites of cultural significance in the area. They had not identified any new sites. The group were also consulted again in 2014 regarding Project changes and confirmed their earlier advice.

Recent changes in the Project description – increasing the size of the disturbance footprint and life of the mine to 16 years – have been communicated to senior Wongatha representatives through direct consultation and will be included in future project updates. A plan to consult with the broader traditional owner group is included as part of the Project Stakeholder Consultation Management Plan (MRUP-EMP-036). The Project changes do not change the results of the survey as both groups provided advice for the entire MRUP area, inclusive of the revised disturbance footprint.

14.4.2 Archeological Surveys

The comprehensive archeological survey conducted in 2010 was designed to underpin an environmentally-based predictive model for ongoing management of potential heritage sites across the MRUP area, similar to the model developed for the Olympic Dam Operation in a similar environment (Hughes *et al.* 2011).

Warranup Pty Ltd conducted the survey on foot across 63 one hectare transects. Twenty-two isolated artefacts were identified, generally silcrete flakes or core with little evidence of reworking. Glendenning (Appendix G4) advised the discoveries were non-diagnostic and did little more than provide evidence that Aboriginal people had passed through the area at some time. 22 isolated artefacts were identified and recorded and provided guidance for the development of a predictive model – with sites more likely to be found in and around claypans, kopi and drainage depressions between dunes than on dunes, sand covered swales or sand sheets/plains (Appendix G4).

As identified earlier by O'Connor (Appendix G5), few assemblages contain retouched implements, being primarily flakes or pieces with a single retouched edge. Those flake assemblages suggest opportunistic flake production for maintenance/sustenance rather than for extractive tasks, also consistent with the general lack of quarries or grinding stones. Whilst this might reflect a sampling bias rather than an intrinsic feature of archeological sites, it is consistent with other observations made in the region that suggest low density and transient site occupancy, reliant on rapidly shifting resources (rather than seed exploitation), primarily in the form of surface water and bush tucker.

14.5 Potential Impacts on Heritage Sites

The potential impacts to Aboriginal heritage from development of the MRUP relate to the interference or damage to any sites in the disturbance footprint. The results of surveys conducted for the Project suggest the activities of the MRUP will not impact on any known sites and are unlikely to impact on any unknown sites.

The location of unknown sites is likely to be in locations defined by Glendenning's predictive model. The model showed the MRUP activities were unlikely to disturb sites on top of dunes, sand covered swales or sandplains but claypans, drainage depressions and kopai areas were more likely to contain archeological artefacts or evidence or prior activities (Appendix G4). While the MRUP topography has a general lack of such features, the predictive model will assist to highlight the location of potential sites. The potential risk of disturbing unknown Aboriginal heritage sites is considered to be low. The risk will be mitigated through the implementation of appropriate management plans as outlined in Section 14.6.

14.6 Management of Impacts to Heritage

The overall objective for Aboriginal heritage is to avoid or minimise disturbance to any heritage sites during the course of the development and operation of the MRUP. This will be achieved through the preparation and implementation of various management plans (MPs). The following MPs have been or will be prepared:

- Ground Disturbance Management Plan (MRUP-EMP-019).
- Heritage Management Plan (MRUP-EMP-034).
- Document and Data Control Management Plan (MRUP-EMP-038).
- Environmental Induction and Training Management Plan (MRUP-EMP-039).

The Ground Disturbance and Heritage Management Plans are contained in Appendix K1.

The achievement of the following objectives will assist in delivering such an outcome:

- No unauthorised disturbances to heritage artefacts or sites.
- No adverse impacts upon historical and cultural values within and surrounding the MRUP area.
- Ensure awareness of heritage values amongst operating workforce.

The management of impacts to Aboriginal heritage will be predominantly achieved through the Heritage Management Plan (MRUP-EMP-034) and the use of a Ground Disturbance Permit (GDAP) (MRUP-POL-001). This will ensure that prior to any ground disturbing activities being undertaken, the proposed area of disturbance is cross checked against a database maintained under the Document and Data Control Management Plan (MRUP-EMP-036) containing the spatial location of all known heritage site locations and all areas where there is a risk that heritage sites might be present (using the predictive model). If the checks reveal any risk of disturbance, the areas proposed to be cleared will be surveyed to identify the exact location of the site or the particular areas where there is risk of such disturbance, and any sites will be delineated and restrictions established so that the heritage values are not impacted; or they are not impacted until suitable clearance authorisation has been given under the *Aboriginal Heritage Act 1972*.

In addition to this the Heritage Management Plan (MRUP-EMP-034) will ensure that if any sites are found during clearing activity the work will immediately be stopped so that an appropriate assessment of the potential artefacts can be undertaken. DAA will be notified and appropriate consultation undertaken.

As part of their induction under the Environmental Induction and Training Management Plan (MRUP-EMP-039) all of the site based workforce will be:

- Educated about Aboriginal cultural and heritage matters.
- Trained to identify sites that should not be disturbed.
- Educated as to the importance avoiding disturbance to such sites.

The Heritage Management Plan (MRUP-EMP-034) will also ensure that all vehicle movements will be confined to existing roads (unless off-road travel is authorised) so as to minimise the risk of disturbing heritage sites.

In the unlikely event that an Aboriginal site is identified and cannot be avoided, permission to disturb the site will be sought through the appropriate DAA approvals processes and in consultation with traditional owners. No historical or cultural associations are expected to be adversely affected by the development of the Project.

14.7 Monitoring

The monitoring of potential disturbance to areas that contain known heritage sites, or are in close proximity to known heritage sites, or are believed to be at risk of containing potential heritage sites will be undertaken using the protocols established under the Ground Disturbance Management Plan (MRUP-EMP-019). This Plan requires a comparison between the areas proposed for disturbance and a central database containing the location of known heritage risk sites prior to the issue of a GDAP (MRUP-POL-001) authorising such disturbance. This database will be regularly updated to reflect the latest information under the Document and Data Control Management Plan (MRUP-EMP-038).

Information being entered into the database will include any relevant observations made by operators undertaking clearing or other activities in the field or as a result of further survey work if deemed required.

14.7.1 Trigger and Contingency Actions

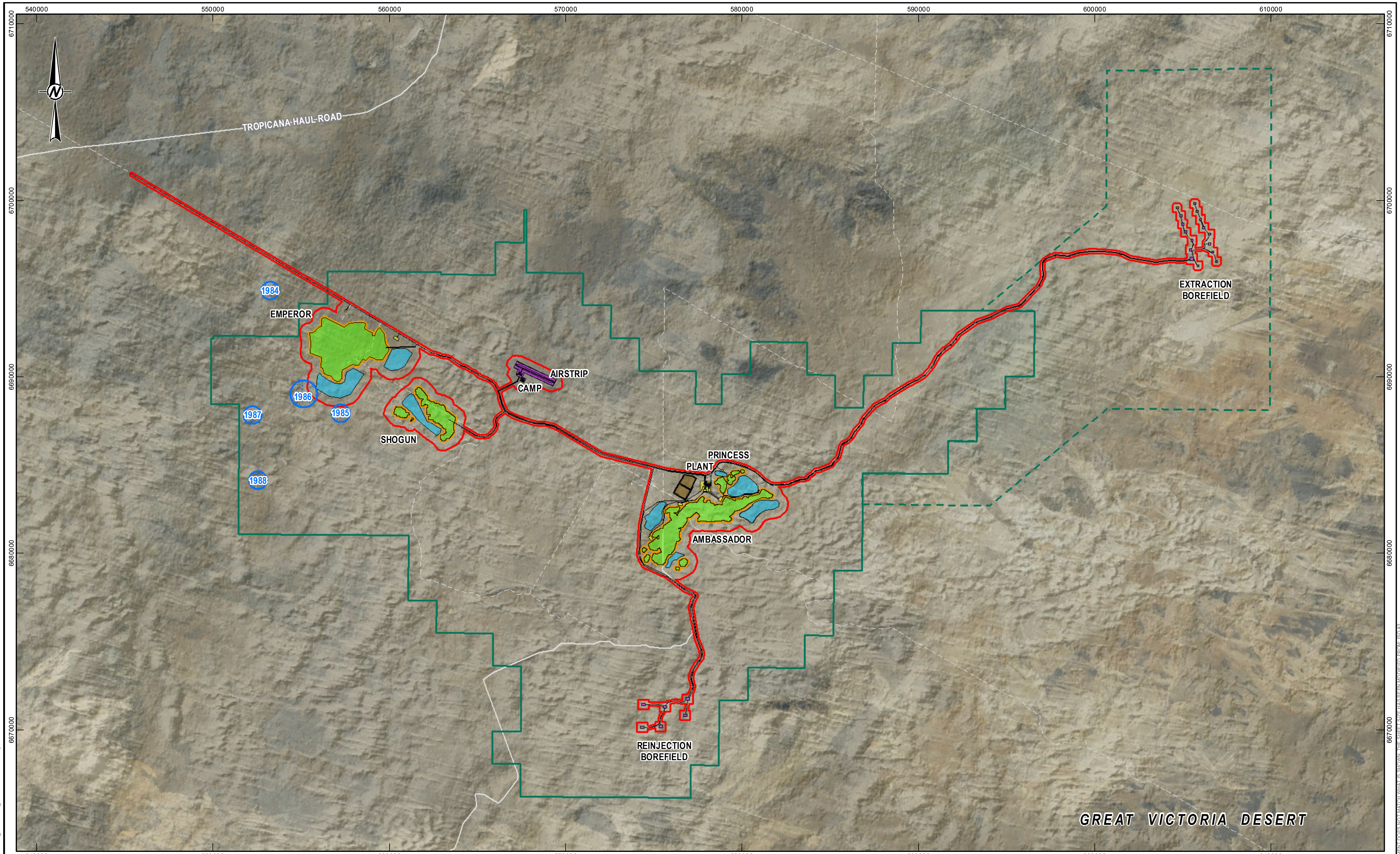
The following triggers would lead to contingency actions:

- **Trigger** – Identification of a heritage site in a location being cleared, or proposed to be cleared:
  - **Contingency action** – Isolation of the site to prevent disturbance; investigation to determine exact spatial location and heritage significance; application for authorisation to disturb under s.18 *Aboriginal Heritage Act 1972*, if it is a site and disturbance cannot be avoided.

14.8 Predicted Outcomes

The survey work undertaken suggests that no known Aboriginal sites (whether ethnographically or archeologically determined) will be impacted as a result of the development of the MRUP. Based on survey results and archeological modelling, any undiscovered Aboriginal heritage sites are more likely to be located in topographic depressions, including claypans and kopai areas, where drainage water would have temporarily collected. This likelihood will be considered ahead of all actions in such areas.

Through the implementation of the MPs and the management strategies outlined in Section 14.6, Vimy is confident that the EPA's objective with respect to heritage can be met. It is Vimy's expectation that the Project will not disturb Aboriginal sites or Aboriginal objects as defined under ss.5&6 of the AHA. The level of impact to Aboriginal heritage is considered to be low and therefore does not require consideration of an offset.



LEGEND

- MINOR ROAD/TRACK
- ROAD
- MRUP DEVELOPMENT ENVELOPE
- PROJECT BOUNDARY (MINING TENURE)
- PROJECT BOUNDARY (MISCELLANEOUS TENURE)
- ABORIGINAL HERITAGE SITE
- PIT
- OVERBURDEN LANDFORM
- PROCESSING INFRASTRUCTURE
- ABOVE GROUND TSF
- SUPPORTING INFRASTRUCTURE
- PIT CLEARING (50 m BUFFER)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

REFERENCE

INFRASTRUCTURE DATA PROVIDED BY CLIENT
ABORIGINAL HERITAGE SITES © DEPARTMENT OF INDIGENOUS AFFAIRS
AERIAL IMAGERY SOURCED FROM ESRI ONLINE
TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

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1:200,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-31
DESIGNED	MS
PREPARED	MS
REVIEWED	CWC
APPROVED	CWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
ABORIGINAL HERITAGE SITES

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	14.1

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15. Rehabilitation and Closure

15.1 Relevant Environmental Objectives, Legislation, Policies and Guidelines

15.1.1 EPA Objective

The EPA applies the following rehabilitation and closure objectives to the assessment of proposals:

> *To ensure that premises are closed, decommissioned and rehabilitated in an ecologically sustainable manner.*

15.1.2 Regulatory Framework

In addition to the EPBC Act and the EP Act, rehabilitation and closure is covered by the following relevant policy guidance statements and legislation:

- ANCOLD 2012, Guidelines on Tailings Dams- Planning, Design*, Construction, Operation and Closure* May 2012. This is a list of guidelines that Tailings Dams should comply with.
- ANZECC/ARMCANZ 2000, Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4. Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra. 1,500pp. These guidelines aim to achieve the sustainable use of Australia's and New Zealand's water resources by protecting and enhancing their quality while maintaining economic and social development.
- ANZMEC & MCA 2000, Strategic Framework on Mine Closure – Discussion Paper. Proponents are expected to follow the principles and objectives identified in this document.
- ARPANSA 2005, Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing. This is a Code of Practice and Safety Guide intended to foster uniform high standards of radiation protection and radioactive waste management in mining and mineral processing throughout Australia. Also known as the Mining Code (2005).
- ARPANSA Technical Report 167 – A review of existing Australian radionuclide activity concentration data in non-human biota inhabiting uranium mining environments. This report provides a summary and evaluation of existing radionuclide concentration data in non-human biota common to Australian uranium mining environments.
- ARPANSA 2011, Joint convention on the safety of spent fuel management and on the safety of radioactive waste management, Australian National Report. Wastes from the mining and processing of uranium ores are subject to this legally binding international treaty on radioactive waste safety.
- *Contaminated Sites Act (2003)* (WA) Perth. An Act providing for the identification, recording, management and remediation of contaminated sites – where contaminated refers to substances having the potential to harm human health, the environment or any environmental value.
- Department of Industry, Tourism and Resources (DTIR) 2006, Mine Closure and Completion, Leading Practice Sustainable Development Program for the Mining Industry. Dept. of Industry Tourism and Resources, Canberra, ACT. A handbook that addresses mine rehabilitation through the identification of key issues affecting sustainable development in the mining industry.
- DITR 2015, Leading Practice Sustainable Development Program for the Mining Industry – Risk Assessment and Management. Department of Industry, Tourism and Resources, Canberra, Australia.
- DMP & EPA 2015, Guidelines for Preparing Mine Closure Plans, Perth, Western Australia. These guidelines aim to ensure that, for every mine, a planning process is in place so that mines can be closed, decommissioned and rehabilitated in a manner that meets DMP and EPA objectives for

rehabilitation and closure. The guidelines recognise that closure planning is a progressive process and has been designed to ensure that a planning process results in closure, decommissioning and rehabilitation that is ecologically sustainable, consistent with agreed post-miming outcomes and land uses, and without unacceptable liability to the State.

- DMP 2013, Code of Practice – Tailings Storage Facilities in Western Australia. Perth, Western Australia. A Code designed to assist those involved with tailings storage facilities to meet their legislative obligations for work health and safety under the *Mines Safety and Inspection Act 1994* and environmental matters under the *Mining Act 1978.*
- DMP 2015, *Guide to Departmental requirements for the management and closure of tailings storage facilities (TSFs).* Perth, Western Australia. A guide provided to assist tailings storage facilities (TSFs) designers and operators by describing the reports that should be submitted to the DMP in accordance with section 4 of the Mining Proposal guidelines as required by the *Mining Act 1978* and the *Tailings storage facilities in Western Australia – code of practice*.
- DMP 2015, *Guide to the preparation of a design report for tailings storage facilities (TSFs)*. Perth, Western Australia. A guide provided to assist TSF designers with preparing the design report for a TSF to be submitted to the DMP in accordance with section 4 of the Mining Proposal guidelines as required by the *Mining Act 1978* and the *Tailings storage facilities in Western Australia – code of practice.*
- EPA 2006, Guideline for the Assessment of Environmental Factors: *Guidance Statement No. 6. Rehabilitation of Terrestrial Ecosystems*. Environmental Protection Authority, Perth, Western Australia. This guidance applies to terrestrial habitats where natural ecosystems will be reinstated in land that has previously been cleared, it only addresses general principles and focuses on effective use of completion criteria to measure biodiversity in rehabilitation projects.
- IAEA 2009, *Establishment of Uranium Mining and Processing Operations in the Context of Sustainable Development*: Nuclear Energy Series- NF-T-1.1. A Report providing stakeholders with practical information and historical examples of experience gained from the introduction of uranium mining and processing operations in specific areas and the subsequent effects of mine closures; it focuses on the criteria necessary for the sustainable development of uranium mining and processing operations in the context of the four cornerstones (environment; social issues; economics; and governance) of sustainable development.
- IAEA 2010, *Best Practice in Environmental Management of Uranium Mining:* Nuclear Energy Series No NF-T-1.2. This is an overall guide to what is best practice in modern uranium mining and provides operators with guidelines and examples of the implementation of the principles of best practice operating in the uranium mining and processing industry with respect to the extraction and processing of uranium ores.
- *Mining Act 1978*. The *Mining Act 1978* (the Mining Act) outlines the law as it relates to mining. The Mining Act as it relates to closure requires an operation to make safe all holes, pits, trenches and other disturbances on the surface of the land which are likely to endanger the safety of any person or animal. Take all necessary steps to prevent fire and damage to trees or other property. A Mine Closure Plan is required to be approved by the Department and reviewed every 3 years, or as specified by the Department.
- *Radiation Safety Act 1975.* This is an act which regulates the keeping and use of all substances, whether natural or artificial, and regardless of form, which consists of or contains more than the maximum prescribed concentration of any radioactive element. There are two key subsidiary pieces of legislation:
- *Radiation Safety (General) Regulations 1983.* These regulations define radioactive substances and cover the licensing of premises.

- *Radiation Safety (Transport of Radioactive Substances) Regulations 2002.* These regulations cover the transport of radioactive materials in Western Australia and the storing, packing and stowing of such materials for transport; it includes licensing requirements and the development of an approved radiation protection program.

15.2 Conceptual Characterisation of MRUP at Closure

The overall objective of closure is to construct safe, stable, non-polluting landforms that demonstrate sustainable closure land uses. In order to achieve this closure objective Vimy will:

- Ensure the interests of relevant stakeholders are considered during all stages of closure planning.
- Establish and refine rehabilitation objectives and completion criteria, based on the findings of monitoring and research, that are appropriate to the agreed post-mine land use.
- Construct safe, stable, non-polluting landforms that are geomorphologically and functionally consistent with the surrounding landscape and capable of sustaining agreed post-mine land use, and do not impact on surrounding environmental values or uses.
- Rehabilitate disturbed areas to meet agreed post-mine land use objectives and completion criteria.
- Develop indicators to demonstrate (through monitoring) when rehabilitation activities meet the established objectives and completion criteria.

Through the implementation of the above closure objective, it is anticipated that:

- No significant long term physical offsite impacts will occur as a result of operations.
- No significant long term impact on baseline surface or groundwater flow patterns and quality will occur as a result of operations.
- No unsafe areas will remain after closure whereby members of the general public and animals could be harmed.
- Rehabilitated and closed operational areas will be aesthetically consistent with the surrounding landform and consider stakeholder expectations.

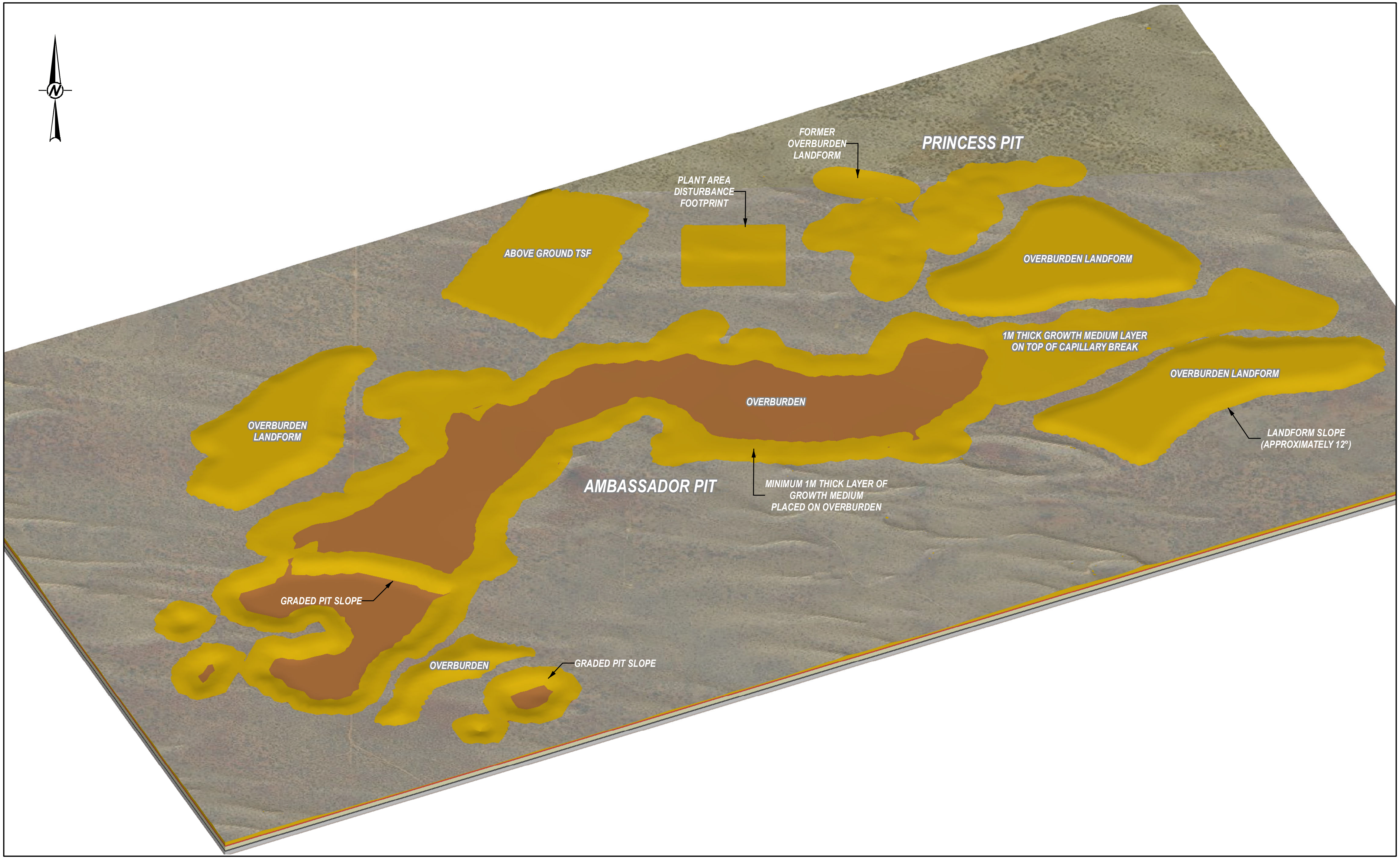
Following cessation of mining, and subsequent rehabilitation and closure of post-mine landforms, the land use of the area will be self-sustaining native ecosystems of regional relevance.

Vimy has committed to backfilling and rehabilitating the mine voids to reduce the residual environmental impacts of the operation. At closure, and following decommissioning of infrastructure, and rehabilitation of disturbed areas to agreed post-mine land use, the post-mine landform at the MRUP will consist of:

- One above-ground, single-lift (maximum height 10m) TSF; 106ha in area.
- Several (nominally seven) overburden landforms (OL), to store the overburden material that is not placed back within the mine void.
- Backfilled mine voids (either backfilled to surface or to not less than 10m from the water table).
- Two in-pit TSFs (approximately 237ha).
- Various rehabilitated surface disturbance areas (including offices, plant, roads and tracks).

The post-mine landforms will not exceed the height of the regional dunal system, nominally up to 358-360m AHD, and therefore the post-mine landforms will ‘fit’ into the landscape and thus will not impede or adversely impact on the surrounding environment. All other disturbance areas will be rehabilitated to the agreed post-mine land use.

The expected post-mine landforms of the MRUP are illustrated in Figure 15.1 to Figure 15.3. Revegetated post-mine landforms of the MRUP are illustrated in Figure 15.4 to Figure 15.6.



LEGEND

QUATERNARY SEDIMENTS	REDUCED EOCENE SEDIMENTS
MIOCENE SEDIMENTS	HIGH PERMEABILITY BASAL SAND
OXIDISED EOCENE SEDIMENTS	PERMIAN SEDIMENTS (BASEMENT)
OREBODY	

NOTES

SURFACE TOPOGRAPHY SHOWN WITH NO VERTICAL EXAGGERATION.
MODEL FOR DISPLAY ONLY (NOT TO BE SCALED OFF).

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

PROJECT
MULGA ROCK URANIUM PROJECT

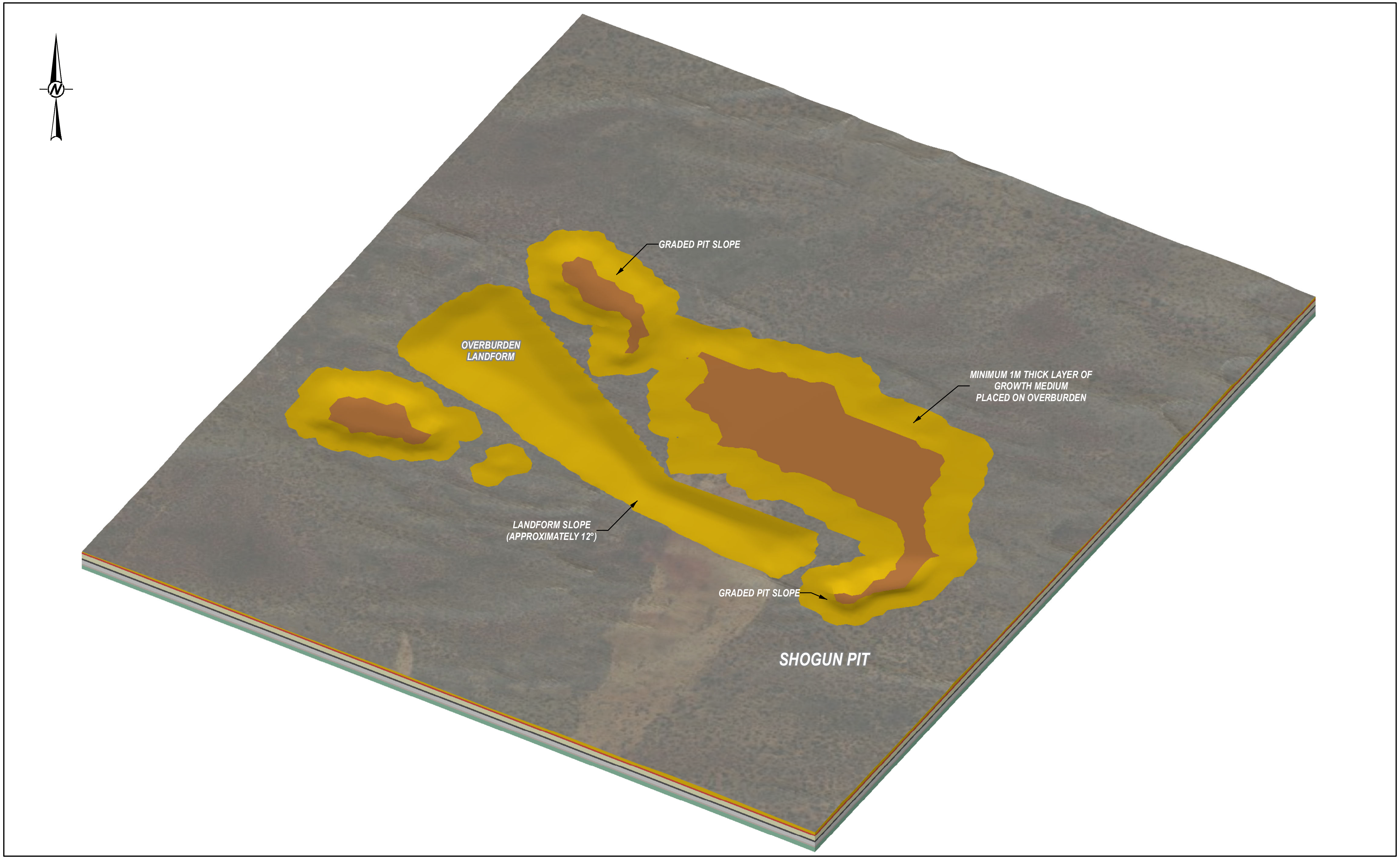
CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-29
DESIGNED	SAR
PREPARED	SAR
REVIEWED	EWC
APPROVED	EWC

TITLE
3D IMAGE OF THE MULGA ROCK EAST – CLOSURE

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	15.1



LEGEND

QUATERNARY SEDIMENTS	REDUCED EOCENE SEDIMENTS
MIOCENE SEDIMENTS	HIGH PERMEABILITY BASAL SAND
OXIDISED EOCENE SEDIMENTS	PERMIAN SEDIMENTS (BASEMENT)
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VIMY RESOURCES

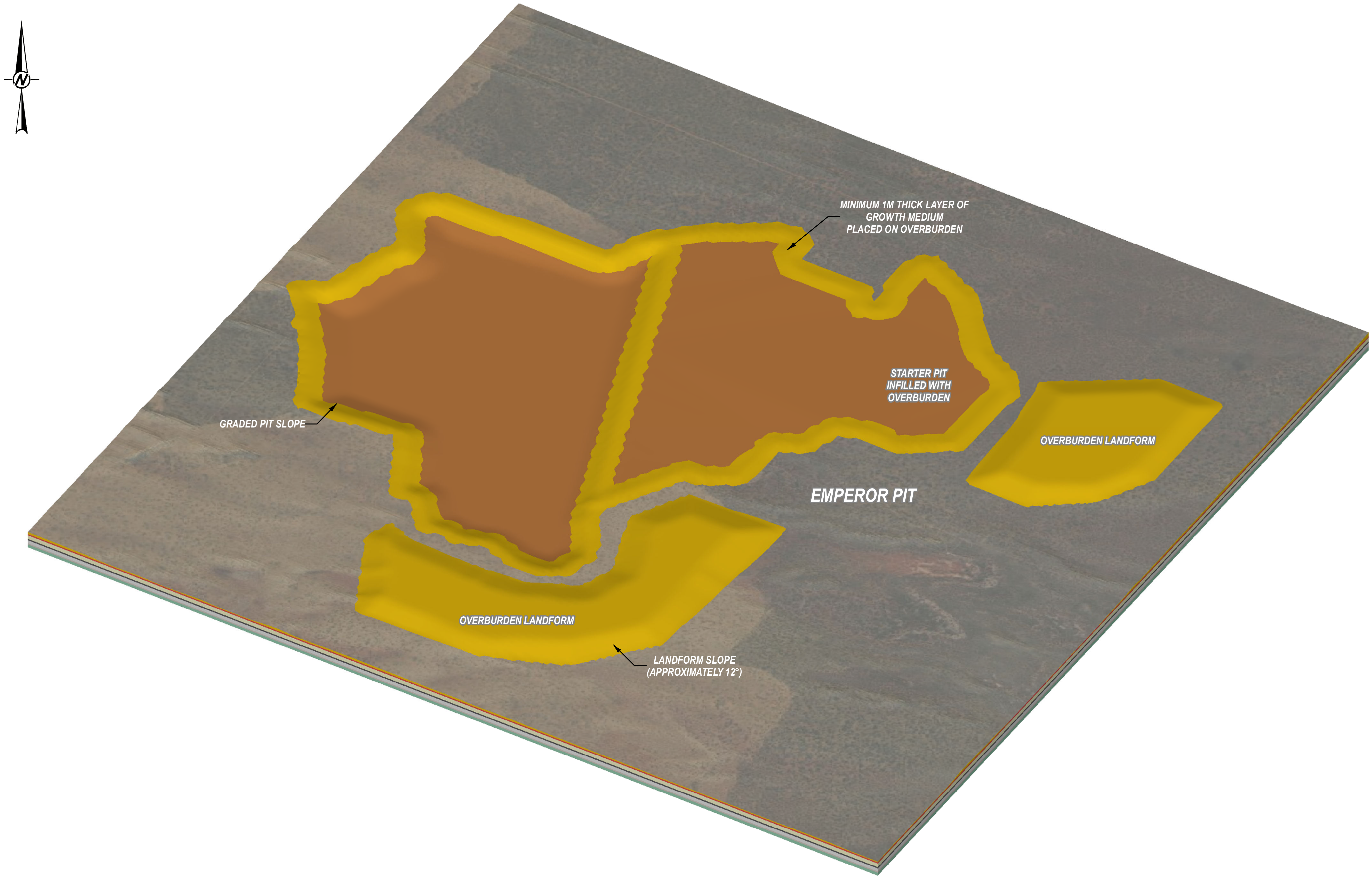
PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-29
DESIGNED	SAR
PREPARED	SAR
REVIEWED	EWC
APPROVED	EWC

TITLE
3D IMAGE OF THE MULGA ROCK WEST – SHOUGUN CLOSURE

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**15.2**



LEGEND

QUATERNARY SEDIMENTS	REDUCED EOCENE SEDIMENTS
MIOCENE SEDIMENTS	HIGH PERMEABILITY BASAL SAND
OXIDISED EOCENE SEDIMENTS	PERMIAN SEDIMENTS (BASEMENT)
OREBODY	

NOTES

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Golder Associates

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DESIGNED	SAR
PREPARED	SAR
REVIEWED	EWC
APPROVED	EWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
3D IMAGE OF THE MULGA ROCK WEST – EMPEROR CLOSURE

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	15.3

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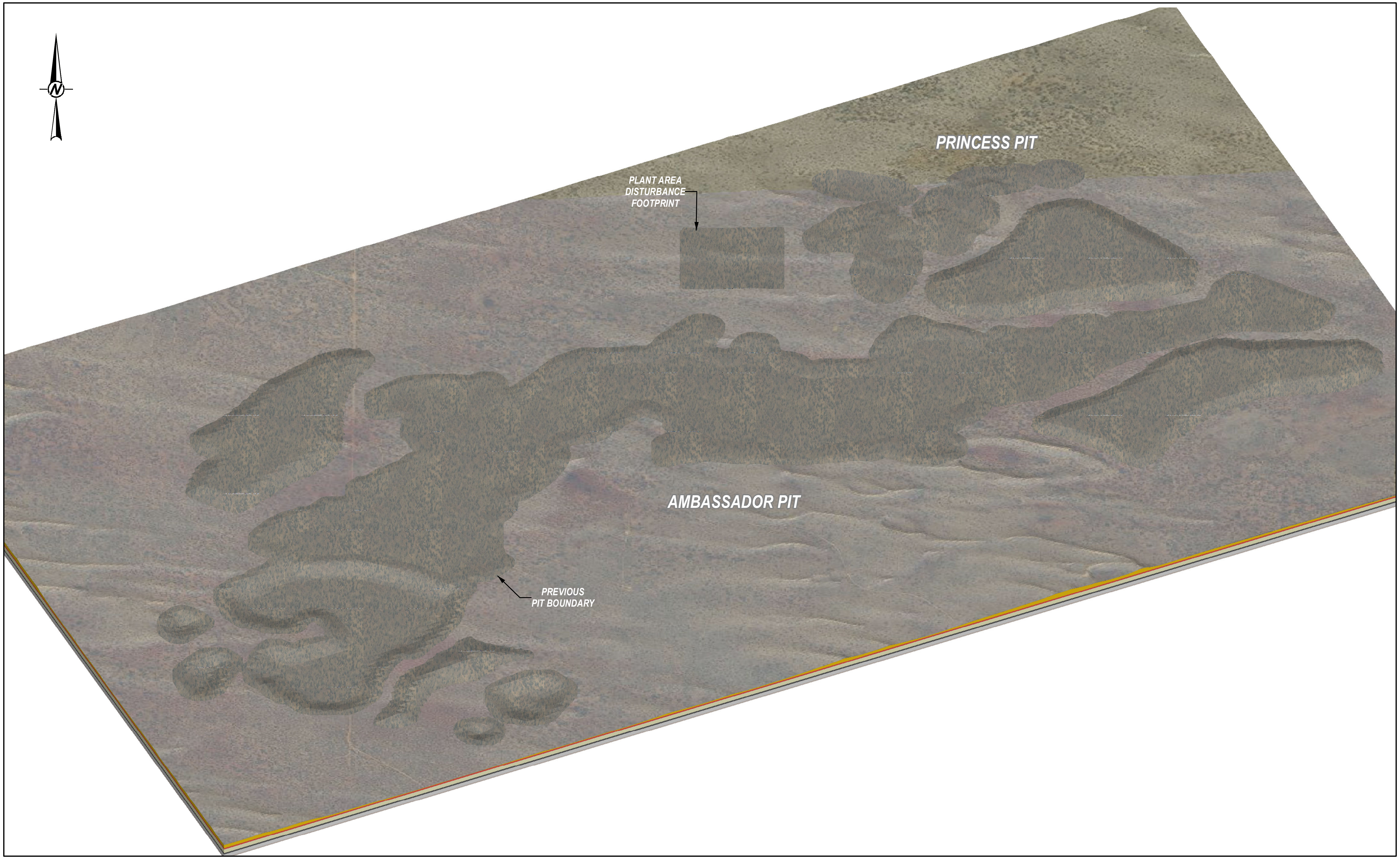

LEGEND

QUATERNARY SEDIMENTS	REDUCED EOCENE SEDIMENTS
MIOCENE SEDIMENTS	HIGH PERMEABILITY BASAL SAND
OXIDISED EOCENE SEDIMENTS	PERMIAN SEDIMENTS (BASEMENT)
OREBODY	

NOTES

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CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

CONSULTANT

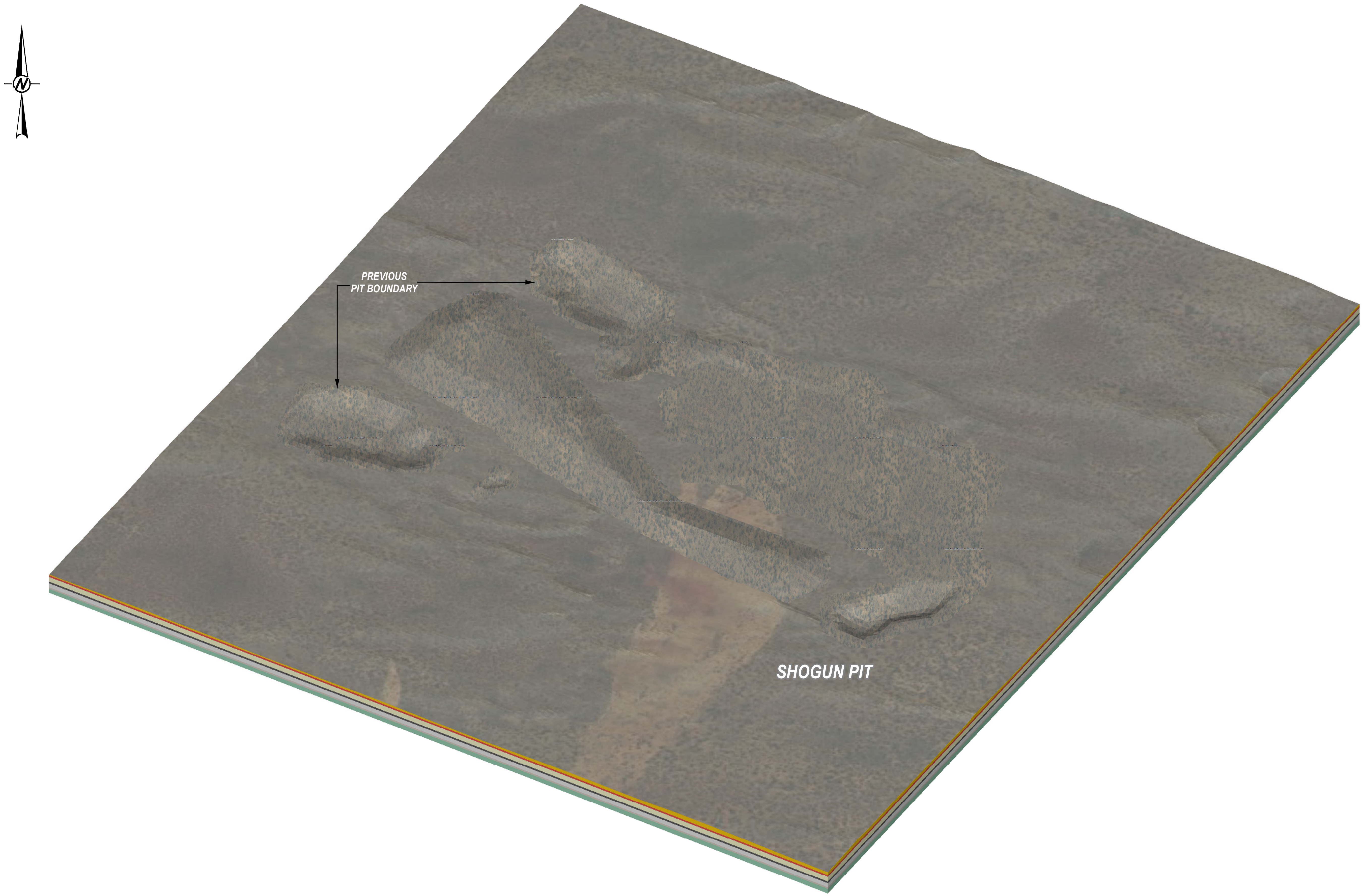
Golder Associates

YYYY-MM-DD	2015-10-29
DESIGNED	SAR
PREPARED	SAR
REVIEWED	EWC
APPROVED	EWC

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
3D IMAGE OF THE MULGA ROCK EAST – CLOSURE (REVEGETATED)

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	15.4



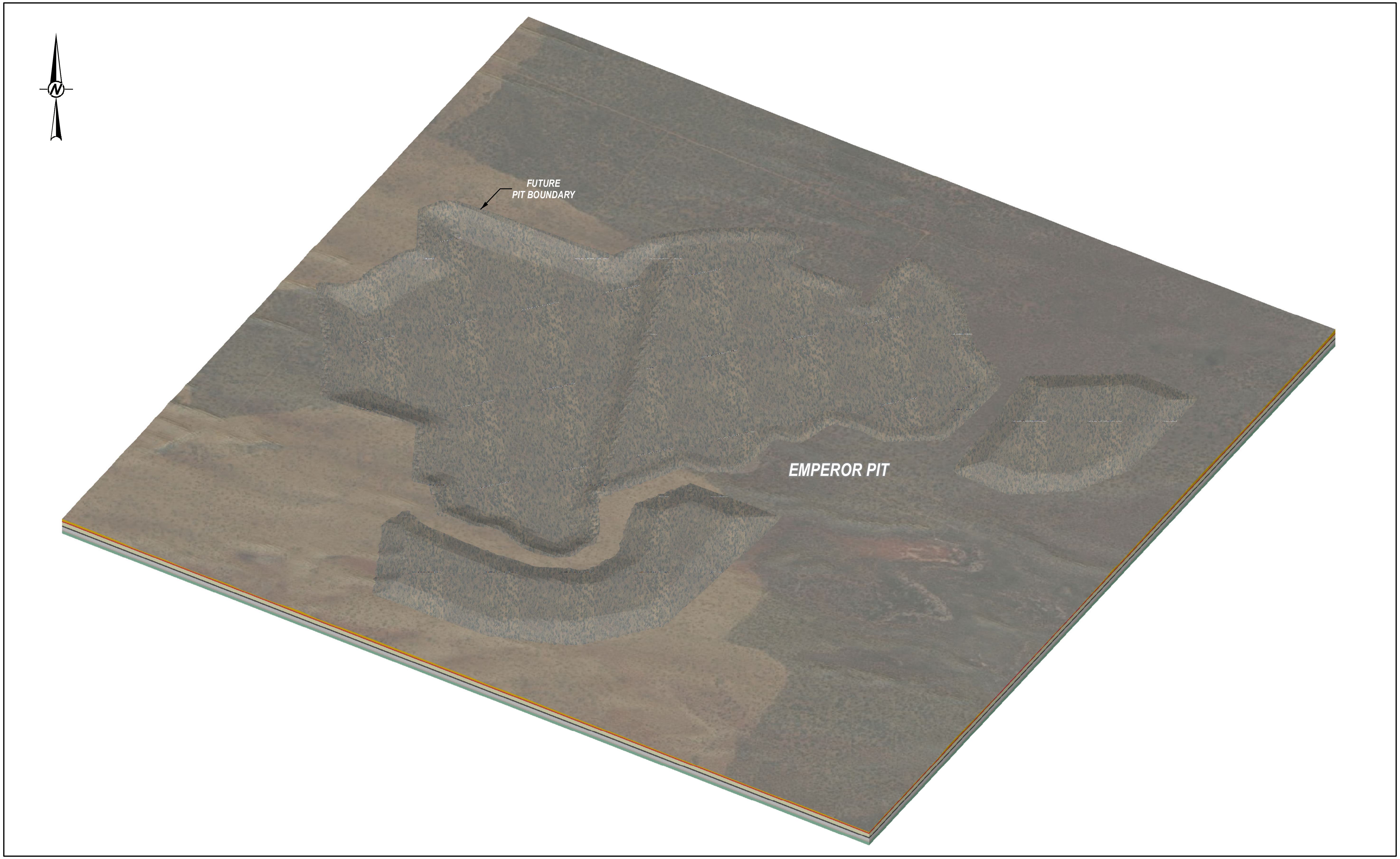
LEGEND

- QUATERNARY SEDIMENTS
- MIOCENE SEDIMENTS
- OXIDISED EOCENE SEDIMENTS
- OREBODY
- REDUCED EOCENE SEDIMENTS
- HIGH PERMEABILITY BASAL SAND
- PERMIAN SEDIMENTS (BASEMENT)

NOTES

SURFACE TOPOGRAPHY SHOWN WITH NO VERTICAL EXAGGERATION.
MODEL FOR DISPLAY ONLY (NOT TO BE SCALED OFF).

CLIENT	VIMY RESOURCES LIMITED	PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT	Golder Associates	TITLE	3D IMAGE OF THE MULGA ROCK WEST – SHOGUN CLOSURE (REVEGETATED)
YYYY-MM-DD	2015-10-29	PROJECT NO.	1540340
DESIGNED	SAR	CONTROL	PER
PREPARED	SAR	REV.	0
REVIEWED	EWC	FIGURE	15.5
APPROVED	EWC		



LEGEND

- QUATERNARY SEDIMENTS
- MIOCENE SEDIMENTS
- OXIDISED EOCENE SEDIMENTS
- OREBODY
- REDUCED EOCENE SEDIMENTS
- HIGH PERMEABILITY BASAL SAND
- PERMIAN SEDIMENTS (BASEMENT)

NOTES

SURFACE TOPOGRAPHY SHOWN WITH NO VERTICAL EXAGGERATION.
MODEL FOR DISPLAY ONLY (NOT TO BE SCALED OFF).

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT	YYYY-MM-DD	2015-10-29	TITLE 3D IMAGE OF THE MULGA ROCK WEST – EMPEROR CLOSURE (REVEGETATED)
	DESIGNED	SAR	
	PREPARED	SAR	
	REVIEWED	EWC	PROJECT NO. 1540340 · CONTROL PER · REV. 0 · FIGURE 15.6
	APPROVED	EWC	

The MRUP is designed to have a low residual impact. The post-mine landforms will be generally congruent with the surrounding land surface, consisting of an undulating surface of large Aeolian dunes separated by localised topographic depressions and flat plains. This incorporation of the post-mine land surface into the surrounding environment will ensure that the broad surface hydrological and pedogenic processes of the region are maintained. All disturbance surfaces will be rehabilitated and revegetated as required under the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030) and the Mine Closure Plan (MRUP-EMP-031) to achieve safe, stable, non-polluting landforms capable of sustaining the post-mine land use and not adversely impacting surrounding environmental values. The Mine Closure Plan (MRUP-EMP-031) is provided as Appendix H1.

Rehabilitation and closure of the MRUP will involve the following broad stages:

- Backfilling of mine voids with either overburden, beneficiation rejects or tailings.
- Reconstruction of the surficial soil and overburden profile (i.e. cover system) to support the desired post-mine land use.
- Revegetation of the backfilled and reconstructed mine voids with suitable native species to achieve the agreed post-mine land use.
- Rehabilitation of the above-ground TSF and OL and revegetation with suitable native species to achieve a sustainable ecosystem.
- Decommissioning and removal of above-ground infrastructure.
- Disposal of and appropriate treatment of all contaminated soil material.
- Rehabilitation of above-ground disturbance areas.

15.3 Pre- and Post-Mine Condition: Residual Impacts

Stakeholder expectations will be considered in all rehabilitation activities necessary to meet the desired closure objective. Backfilling of the mine voids and reconstruction of the soil profile, as outlined in the conceptual Mine Closure Plan (Appendix H1), will likely restore the pre-mine hydrology (encompassing both surface hydrology and groundwater hydrogeology) and pedogenic function (the function performed by soil) of the landform, such that negligible residual impacts are expected. Localised changes to surface hydrology will be evident where pits have been partially backfilled creating depressions. Re-establishment of these key ecosystem processes will facilitate the return of the biotic component of the environment leading to a stable and sustainable post-mine landform that will be congruent with the pre-mine ecosystem.

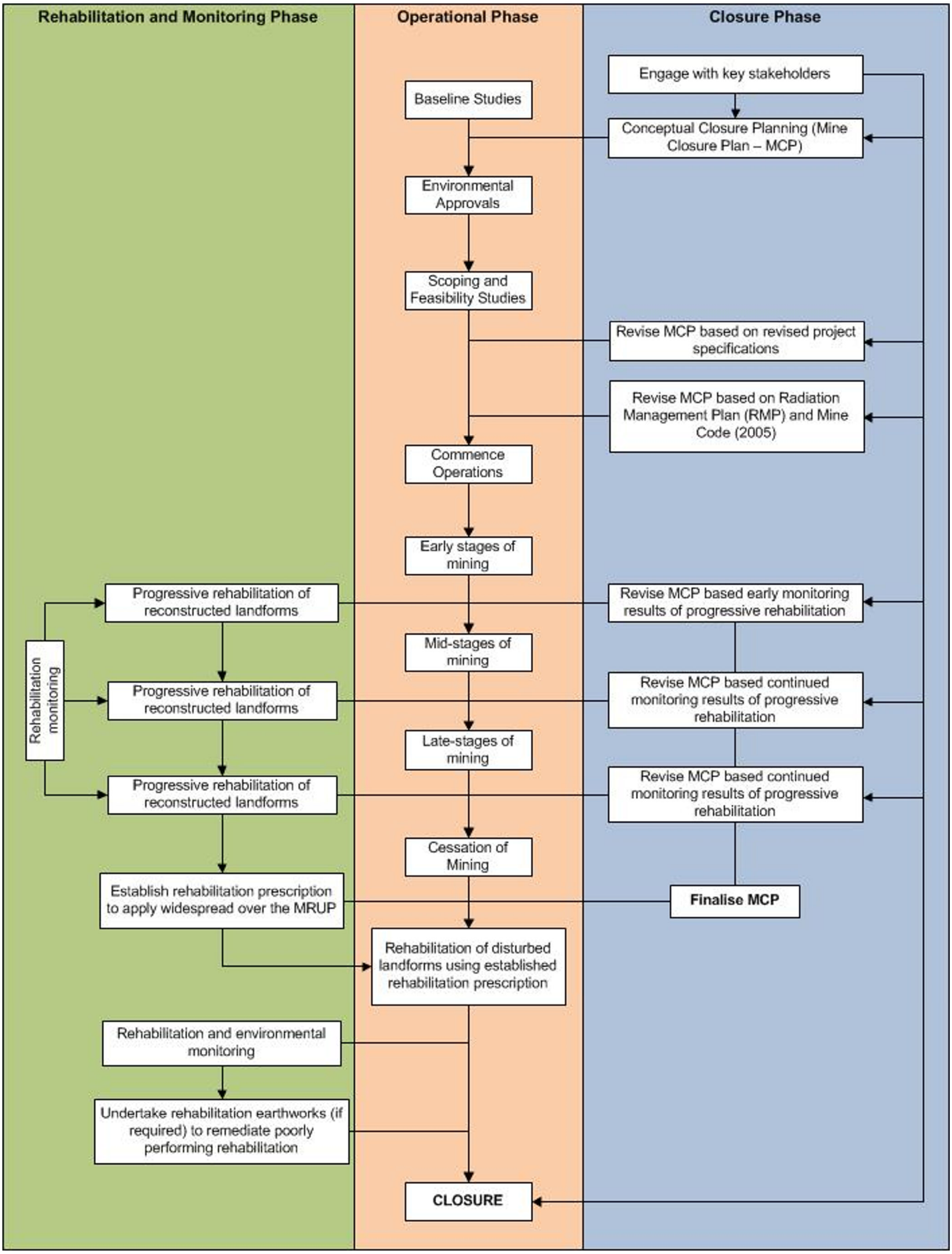
Residual impacts are expected only where infrastructure is left in place, as per stakeholder requirements. This is likely to be restricted to roads and tracks, airstrip, and possibly the bore extraction and reinjection infrastructure that will allow future users to access groundwater sources. Given the post-mine landforms will be broadly congruent with the pre-existing environment, and that the revegetation to be re-established will be aligned to the capability of the reconstructed profile to sustainably support their growth requirements, all disturbance areas are expected to be successfully rehabilitated resulting in no residual impact on the area.

Although an above-ground TSF and a number of OLs will be constructed and remain as permanent land forms, they have been designed so that they are height limited to the regional dunal landforms. The post-closure landforms will therefore blend into the landscape, and be protected from excessive wind erosion by shadowing from the higher dunes (i.e. boundary layer effect). The surfaces of these post-mine landforms have been designed to be stable and resistant to both wind and water erosion, while the surficial soil profile has been designed to ensure that a sustainable revegetation is achieved. The above-ground TSF and the OLs are therefore not expected to impact on the surroundings and will likely produce a sustainable ecosystem that is congruent with the surrounding environment and aligned with stakeholder expectations; hence they are not deemed residual impacts.

15.4 Closure Planning Life Cycle

Closure planning is considered an iterative process, whereby it is continually updated and revised following results of rehabilitation trials, monitoring, identification and implementation of new techniques and technologies, modifications to mining schedules, and changes in stakeholder and regulatory expectations. As such closure planning is initially conceptual, addressing broad closure objectives, and progressively becomes more detailed as the operation progresses. The closure planning life cycle to be applied at the MRUP is shown in Figure 15.7.

Vimy is committed to achieving the best environmental outcome for this project, and consequently a mining schedule has been proposed that will involve the continuous backfilling of the mine void behind the mining front, to facilitate progressive rehabilitation throughout the operation. This allows rehabilitation concepts and theories to be tested relatively early in the mine life, and for this understanding to continually develop over time, until a defined rehabilitation prescription, that achieves the desired closure goal, is established.



CLIENT VIMY RESOURCES LIMITED			PROJECT MULGA ROCK URANIUM PROJECT
CONSULTANT Golder Associates	YYYY-MM-DD	2015-11-16	TITLE **MINE CLOSURE PLAN DEVELOPMENT**
	DESIGNED	MS	
	PREPARED	MS	
	REVIEWED	EWC	PROJECT NO. 1540340 / CONTROL PER / REV. 0 / FIGURE **15.7**
	APPROVED	EWC	

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15.5 Radioactive Waste Management Plan

Radioactive waste is generally defined as material for which there is no further use, and which contains an average radionuclide concentration that exceeds 1Bq/g or is contaminated with radioactive material.

A preliminary Radioactive Waste Management Plan (RWMP; MRUP-EMP-029) has been prepared for the MRUP and is reproduced as Appendix H3. The RWMP outlines the radioactive waste streams and the approach to managing residual radioactive materials to ensure that the post closure radiation levels at the site are not perceptibly different from the measured pre-development radiation levels.

The key features of the plan are to:

- The identification and characterisation of all waste streams.
- All radioactive waste from mining and processing will be contained or otherwise encapsulated.
- Processing waste (tailings) will be disposed of into an above-ground TSF initially, but once mining voids become available all subsequent processing waste will be disposed of into in-pit TSFs where the material will be covered and permanently isolated from sensitive receptors.
- Waste water that may contain entrained radioactive dusts and sediments will be disposed of into one of the TSFs, similar to the processing waste.
- Any other potentially radioactive waste, such as collected spillage, slimes from sedimentation dams or water from wash-down facilities or site runoff will be disposed of into one of the TSFs, similar to the processing waste.
- Other contaminated waste (such as used PPE) will be recycled if decontamination is possible or will otherwise be disposed of into locally constructed appropriate disposal facilities.
- All facilities will be consistent with the requirement of the Conceptual Mine Closure Plan (MRUP-EMP-031), the Tailings Management Plan (MRUP-EMP-013) and the Groundwater Management Plan (MRUP-EMP-010).

The Preliminary RWMP aims to:

- Consider the Project Key Environmental Factors (PKEFs) and demonstrate how the environmental objectives of the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Radiation Protection Series (RPS 6, RPS 9, RPS 15) and the International Atomic Energy Agency Safety Standard SSR-5 'Disposal of Radioactive Waste' (IAEA 2011) are to be achieved.
- Identify and characterise the waste streams associated with the operation of the Project, in accordance with RPS 20 (ARPANSA 2010).
- Identify preliminary controls and risk categories for the management of tailings, process and surface waters based on Australian National Committee on Large Dams guidelines (ANCOLD 2012).
- Consider International Atomic Energy Agency Nuclear Energy Series publications

A description of how potential impacts on the environmental factors are managed are discussed throughout this PER and summarised in Table E4 (Summary of Impacts and Proposed Management Measures). The RWMP notes that good design in conjunction with effective management systems based on appropriate standards, will ensure that the PKEFs will be protected.

The main waste streams that are generated from operations that require management are:

- Approximately 30 to 50Mtpa of non-radioactive inert overburden and surficial soil materials will be mined.

- Approximately 1.2-1.5Mtpa of non-radioactive course silica sands which will be separated via in-pit beneficiation process and mixed with the basal portion (2-5m) of the oxidised Eocene sediments (overburden) and preferentially placed at the base of the mined pit.
- Approximately 1.2-1.3Mtpa of processing plant tailings will be produced and disposed in the TSFs. Three TSFs are proposed for the MRUP, one above-ground TSF and two in-pit TSFs (Princess Pit and the Ambassador In-pit TSFs). The tailings are the processing residue that has passed through the processing plant and had uranium extracted, leaving the remaining radionuclides in the uranium decay series.
- Water that may have come into contact with radioactive materials from areas which may contain uranium bearing materials, including surface run off, and leachate that has infiltrated materials such as tailings.
- Miscellaneous wastes that may have become contaminated through contact with ores and process residues (referred to as contaminated waste), including discarded conveyor belts, rubber lining material, pipes, filter media and used personal protective equipment.

The RWMP has adapted the classification methodology from ARPANSA RPS 20. Initial waste classifications indicate that radioactive waste for the Project are likely to be classified as very low level waste (Very LLW) or low level waste (LLW). ARPANSA RPS 20 notes that facilities for disposal of Very LLW or LLW should:

- Have sufficient capacity so that the radioactive waste only occupies a small percentage of the total volume.
- Have 2m or so of soil or clean fill cover over the radioactive waste.
- Have leachate control.
- Be suitable for any other of the waste characteristics e.g. it will need to be able to cater for clinical waste or radioactive waste containing non-radioactive hazardous constituents, if applicable.
- Take into account land use restrictions post-closure.

Project tailings would be classified as low level waste (LLW), thereby allowing disposal in engineered surface landfill type facilities. The relatively low radionuclide activity from the waste streams identified for the MRUP, along with their ease of classification, segregation and disposal and encapsulation options identified combined with the discharge environment and natural processes controlling solids and liquid transfers support the classification of the tailings as being a low level NORM waste.

Contaminated waste will include tyres, process plant equipment, vehicles and general wastes such as personal protective equipment. This will be disposed of at the site waste disposal area in constructed trenches that will be progressively covered by inert overburden material reclaimed from mining operation and covered by Quaternary sediments and growth medium.

Process material wastes, such as collected spillage or slimes from the sedimentation dams will be disposed of with the tailings.

Upon completion of the detailed design of the MRUP, the Conceptual RWMP will be revised to include detailed waste registers and classifications for all radioactive waste streams for the Project (including intermediate processing waste). The revision will detail controls and determine risk categories for the management of tailings, process and surface waters based on the ANCOLD (May 2012) guidelines.

15.6 Conceptual Mine Closure Plan

A Conceptual Mine Closure Plan (CMCP; MRUP-EMP-031) has been prepared for the MRUP and is provided in Appendix H1. This CMCP has been completed in accordance with the EPA/DMP Guidelines for Preparing Mine Closure Plans (2015) and will be regularly updated in accordance with Figure 15.7.

The CMCP Plan together with RWMP, provide the framework to identify, manage and dispose of radioactive waste streams generated by the project.

The overall mining plan for the MRUP will see the landforms progressively close and rehabilitate mined pit during the mining operations.

15.6.1 Closure Objectives

The overall objective of closure as stated in the CMCP, is to construct safe, stable, non-polluting landforms that demonstrate sustainable closure land uses. In order to achieve this objective Vimy will:

- Ensure the interests of relevant stakeholders are considered during all stages of closure planning.
- Establish and refine rehabilitation objectives and completion criteria, based on the findings of monitoring and research, that are appropriate to the agreed post-mine land use.
- Construct safe, stable, non-polluting landforms that are geomorphologically and functionally consistent with the surrounding landscape and capable of sustaining agreed post-operational land use, and do not impact on surrounding environmental values or uses.
- Rehabilitate disturbed areas to meet agreed post-operational land use objectives and completion criteria.
- Develop indicators to demonstrate (through monitoring) when rehabilitation activities meet the established objectives and completion criteria.

Through the implementation of the above closure objectives, it is anticipated that:

- No significant long term physical offsite impacts will occur as a result of operations.
- No significant long term impact on baseline surface or groundwater flow patterns and quality will occur as a result of operations.
- No unsafe areas will remain after closure whereby members of the general public and animals could be harmed.
- Rehabilitated and closed operational areas will be aesthetically consistent with the surrounding landform and consider stakeholder expectations.

Following cessation of mining, and subsequent rehabilitation and closure of post-mine landforms, the land use of the area will be self-sustaining native ecosystems of regional relevance.

15.6.2 Decommissioning Plan

Decommissioning will need to consider radiation and this will be managed through the development of an inventory of all materials and equipment at the site, nominating final disposal location for each item on the inventory. The plan will also have a schedule to assist the operation to be carried out in an efficient manner.

A strict protocol will be developed to segregate equipment that has been potentially exposed to radioactive contamination from other equipment.

The decommissioning and deconstruction of the infrastructure facilities may result in three main types of materials, namely:

- Materials that can be sold or otherwise passed on to third parties.
- Other materials not contaminated by uranium.
- Materials that have been contaminated by uranium that exhibit a surface radioactivity above a trigger level.

Material that cannot be re-used or is uneconomic to re-use shall be disposed of as waste in accordance with the Preliminary RWMP and other legislative requirements. This includes but is not limited to:

- The use of appropriate radiometric and other testing, removal and sorting procedures.
- The use of registered, licensed contractors.
- The selection of appropriate disposal techniques.
- Tracking of volumes and materials.

All materials not removed from site will be buried in designated areas, one accommodating all the uncontaminated materials and the other all materials contaminated by uranium.

15.6.3 Post-closure

The closure and rehabilitation of the mine will be subject to compliance with an agreed CMCP (Appendix H1). The above-ground tailings facility will be capped, covered and rehabilitated in a manner that prevents radon emanation. The majority of the tailings (over 90%) will be deposited back in-pit and covered with sufficient overburden to control radon emanation.

Plant and equipment will be cleaned and any radioactive material captured and disposed of in a suitable manner. Once rehabilitation has been fully implemented there will be no alpha-emitting dust or radioactive gas emanations that are predicted to be above background levels.

There will be no further transport of uranium concentrate and therefore no further gamma emissions from transport. The radiological dose assessment on all members of the public and the environment post closure, once rehabilitation has been completed, is predicted to return to background levels.

15.7 Potential Impacts of Radiation on Non-human Biota

The potential impact to non-human biota is assessed by determining the change in radiation dose rates to standard species of flora and fauna as a result of emissions from the operation. The change in concentration is then used as input data for an ERICA (Environmental Risk Ionising Contaminants: Assessment and Management) assessment which calculates a dose to set of reference species (Appendix B in Appendix F1).

The ERICA Software Tool is a widely used method for assessing radiological impacts to plants and animals. The screening level is the radiation dose rate, below which no effects would be observed and the ERICA default level is set at 10µGy/h (Appendix B in Appendix F1). The output of the assessment can be seen in Table 15.1 which shows that the 10µGy/h screening level (trigger level) was not exceeded.

Table 15.1 Output of ERICA Assessment

Organism	Concentration Ratio source	Dose Rate (µGy/h)	Screening Level (µGy/h)
Lichen and bryophytes	ERICA default	0.182	10
Arthropod – Detritivorous	ERICA default	0.007	10
Flying insect	ERICA default	0.006	10
Grasses & herbs	ERICA default	0.035	10
Mollusc – Gastropod	ERICA default	0.007	10
Shrub	ERICA default	0.051	10
Bird	ERICA default	0.005	10
Amphibian	ERICA default	0.009	10
Reptile	ERICA default	0.009	10
Kangaroo	ARPANSA 2014	0.020	10
Tree	ERICA default	0.004	10
Mammal (small burrowing)	ERICA default	0.008	10
Mammal (large)	ERICA default	0.008	10

The species with the highest level of exposure is lichen and bryophytes, however the impact level remains well below the trigger level for further assessment. It can be concluded that the ERICA assessment indicated that there is no radiological risk to reference plants and animals from emissions from the proposed project.

The potential impacts of radiation on non-human biota are expanded within Section 12 and summarised below.

15.8 Material Physical and Geochemical Characterisation

15.8.1 Soil and Overburden Materials

Physical and geochemical characterisation of the soil and overburden materials likely to be disturbed during mining has been investigated and reported by Soilwater Consultants (SWC) (Appendix H2). A summary of the beneficial and limiting properties exhibited by these materials is presented in Table 15.2.

All surficial sands, comprising the Quaternary Dunal Sands, exhibit optimal physical and chemical properties for material handling (i.e. excavation and trucking) and vegetation growth. They are non-saline, non-dispersive, non-sodic, and have very low erosion and hard-setting potentials, primarily due to the dominance of sand-sized particles, and corresponding absence of a finer fraction (i.e. silt + clay). Laboratory scale rainfall simulation test work undertaken on these sandy materials identified that no runoff will be generated at any slope angle due to their very high permeability (typically > 5m/day). Although this is the case, geotechnically sands on steep slopes are typically not stable, and consequently a slope design criteria of 10-12° was identified as optimal to produce a safe and stable post-mine land surface.

The Quaternary sands play an important role as an evaporative buffer, to prevent underlying (slightly) more clayey subsoils from hard-setting, and in facilitating lateral root exploration to maximise the volume of soil profile accessed by the vegetation (i.e. the surface soils are friable, with low coherence, and thus roots are able to easily penetrate through the sandy matrix).

All Quaternary sands are chemically infertile, containing negligible nutrient content, and have very low water holding capacities. Consequently, roots of the native vegetation must access a large volume of the soil profile to obtain sufficient plant available water (PAW) to meet their transpiration requirements.

Underlying the surficial sand, and covering the entire MRUP, exists a thin reddish brown sandy loam material. This material was deposited, most likely under alluvial conditions, prior to the change to more Aeolian deposition that has formed the surface materials. This material has good water holding capacity, and it is circum-neutral, non-saline and non-sodic. This material does however, exhibit some dispersive and hard-setting properties, primarily in response to its very low salinity; hence there are effectively no salts or electrolytes in the soil solution to flocculate the soil and thus it disperses and the mobile clay fraction facilitates the hard-setting of this material. In response to these observations and results of laboratory testing, it was recommended by SWC (Appendix H2) that if these materials are to be used in rehabilitation, then they will need to be covered by at least 50cm of Quaternary sand to prevent them from structurally degrading.

The reddish brown sandy loam was deposited onto a pre-existing calcrete surface, which in most cases represented the upper portion of the Miocene sediments. This material is physically stable and non-dispersive, non-erodible and 'non hard-setting' due to the dominance of Ca^{2+}, both on the exchange sites as well as in the soil solution. It also has a high acid neutralising capacity (ANC; up to 100kg H_2SO_4/t) and thus can be used to effectively treat any potential acid rock drainage.

The calcrete material is classified as strongly alkaline (i.e. pH up to 9) and is typically saline with elevated electrical conductivity (EC) values approaching 100 milliSiemens per metre (mS/m). These properties are in contrast to all of the overlying soils which are slightly acidic and non-saline; hence their use in rehabilitation may impact plant growth of those species more susceptible to acidity and salinity.

Table 15.2 Key Properties and Behaviour of the Soil and Overburden Materials at the MRUP

Material	Material Class	Beneficial properties	Limiting properties
Quaternary sand (including yellow and red Sands)	Soil	• Non-dispersive and erosion-resistant. • Negligible surface water flow with vertical infiltration dominating. • Friable, low soil strength and not hardsetting. • Optimal soil chemical properties (i.e. slightly acidic to neutral pH).	• Negligible water holding or PAW content. • High permeability that may exacerbate ponding and subsurface lateral flow at a texture contrast boundary.
Red loam or sandy clay	Soil	• Good water holding and PAW capacity. • Optimal soil chemical properties (i.e. non-saline and neutral – alkaline pH).	• Although non-sodic, the low salinity results in this material being dispersive and highly erodible. • Hardsetting.
Calcrete	Overburden	• Physically stable and non-dispersive, non-erodible and non-hardsetting. • High to very neutralising capacity.	• Strongly alkaline and often high salinity that may impact some susceptible species.
Miocene/ oxidised Eocene	Overburden	• Sandy regions are physical stable, have low salinity and are slightly acidic in pH. • Clayey regions have optimal water holding and PAW content to support native plant species, although considerable heterogeneity in its spatial distribution exists.	• Sandy regions have low water holding and PAW contents. • Clayey regions are dispersive, erodible, and hardsetting and have a low permeability and relatively high salinity that may impact on revegetation growth.

15.8.2 Ore and Tailings Materials

The physical and geochemical properties of the ore and tailings materials have been characterised by ANSTO (ANSTO 2015) and summarised by SWC (Appendix F1). This information was used as the source terms for the solute fate and transport modelling undertaken by GHD (Appendix D8) to assess the long term impacts that tailings seepage may have on groundwater quality (Section 11).

Ore

The orebody represents a thin organic rich layer at and directly below the redox boundary (i.e. at and directly below the groundwater level). The orebody only has a thickness of 2-5m, with the uranium and base metals Co, Cu, Ni and Zn) accumulated at the redox interface and strongly bound to the organic matter surfaces, either by ion exchange or complexation with functional groups (i.e. carboxylate anion – $RCOO^-$; where R represents the 'rest of the molecule'; C is a carbon atom; and OO represents two oxygen atoms). It comprises up to 40% organic matter and varies from lignite to organic rich (approximately 3% organic matter) sandstone. In addition to organic matter, the orebody is composed of quartz (35–88%) and kaolinite (6-15%), with minor feldspars and sulphides.

Particle size distribution data shows that the ore is composed of around 6-15% clay (< 2µm fraction; corresponding to the kaolinite mineralogy) and 6-50% silt (< 20µm fraction), with the remainder of the material comprised of well-graded sand. The permeability of the ore material is governed by the silt and clay content, and varies from 0.02 to 0.7m/day (Appendix D2). The cation exchange capacity (CEC) of the material is appreciable, reflecting the presence of organic matter and is typically greater than 20 milliequivalent of hydrogen per 100g of soil (meq/100g), with CEC values over 60mq/100g not uncommon. The exchange complex is dominated by sodium (Na), and thus the material is considered sodic, with Exchangeable Sodium Percentage (ESP) values > 6% and likely to be around 20-30%. The ore material is therefore expected to be dispersive and erodible if stockpiled.

The Total Sulphur (Total S) content of the ore material has been assessed during extensive geological drilling, and varies from < 0.1% to a maximum of 13.4%. Following block model optimisation of the orebody, the average Total S content of the ore to be mined is 1.64%. Test work undertaken by ANSTO (ANSTO 2015) identified that the majority (80-90%) of the Total S is composed of the sulphide form (sulphide-S), and thus it can be assumed that ore material below the redox boundary contains on average 1.3-1.5% sulphide-S. Based on this sulphide content, the maximum potential acidity (MPA) of the orebody will likely be around 43 kg H_2SO_4/t. The Eocene sediments below the redox boundary have an inherent acidic pH (typically < 5; Appendix H2), likely due to previous and potentially contemporaneous sulphide oxidation (e.g. Cl/SO4 ratio of groundwater within the MRUP varies from 3.3 to 9.5, with an average of 5.1), and thus they contain no readily available acid neutralising capacity (ANC). Consequently, the MPA value of 43kg H_2SO_4/t effectively equates to the net acid producing potential (NAPP) of the material. Measured (net acid generation (NAG) values of equivalent materials (ANSTO 2015) vary from 15 to 57kg H_2SO_4/t.

The above results indicate that the ore material to be mined at the MRUP is classified as potentially acid forming (PAF) and may release acidity under appropriate conditions. Although this is the case, the surrounding receiving environment, is already acidic (prior to disturbance), and thus the likely additional inputs of acidity into the already strongly acidic groundwater system is not likely to cause adverse environmental impact.

The potential for the ore material, including the clay enriched lignite and lignite to release metals and metalloids during leaching has been tested using the Australian Standard Leach Procedure (Appendix H2). The results show that only Cd, Co, Fe, Se and Zn are expected to leach from the ore (lignite) materials, with all other elements strongly retained in the solid phase (i.e. through strong organic-metal complexes); hence not mobile to leaching solutions.

Tailings

The tailings to be generated from the processing of the orebody will have a target particle size of P_{80} at 150µm. Detailed hydrometer test work shows that after beneficiation of the sand fraction the tailings will contain 50-60% silt + clay (i.e. < 20µm) and clay (< 2µm) contents of 25%. It will therefore behave like a silty clay, with low permeability and appreciable water holding capacity at field state. The Atterberg Limits (a basic measure of the critical water contents of fine-grained soils) obtained for the tailings reflect their fine texture with liquid limits (LL; % water content at which behaviour changes from liquid to plastic) and plastic limits (PL; % water content at which behaviour ceases to be plastic and instead break apart) of around 53% (LL) and 45% (PL). The plasticity index (PI; ~ 8) and Activity (A; ~ 0.32) indicate that the tailings is slightly-plastic and non-reactive or inactive.

Geochemically the tailings material closely resembles the ore material, albeit with significantly lower U and base metal contents. There is generally no alteration or loss of sulphides within the leach and base metals plant, and thus the tailings are considered PAF with Total S grade approximating the ore material (i.e. 1.6%) and corresponding average sulphide-S levels in the range of 1.3–1.5%. Based on these sulphur levels, the tailings will have a MPA and NAPP of around 40-45kg H_2SO_4/t.

Following processing the tailings materials are expected to contain elevated Ba, Cr and V, as the majority of the Co, Cu, Ni and Zn, including U, is removed during processing. The potential for the tailings to generate metalliferous drainage was tested by ANSTO (Appendix H2) using the Australian Standard Leach Procedure. This testing, using actual site water, identified that Mn and Pb were the only metals showing enhanced mobility, when the extraction of Co, Cu, Ni and Zn are considered. Given the organic carbon in the orebody is preserved during processing, and the majority of the elements of environmental concern are strongly complexed to this material, the potential for the tailings to generate metalliferous drainage is considered low.

With the TSF the following controls limit the potential of the tailings to generate acid metalliferous drainage (AMD):

- The high carbon content of the generated tailings expected to contain around 40% Total Carbon, with the majority of this, given the pH of the tailings, to be organic carbon. This means that microbial decomposition of the organic material will result in a continual consumption of available oxygen favouring reducing (Eh) conditions below the approximate ~600-700mV (SHE) needed to oxidise Ferrous (Fe^{2+}) to Ferric (Fe^{3+}), which has the potential to oxidise sulphides.
- The inherent buffering capacity – although the pH of the tailings would suggest no readily available acid neutralisation capacity (ANC) is present (i.e. no carbonates present), microbial decomposition of the organic matter, under depleted oxygen and sulphur reducing conditions, will produce biogenic alkalinity which will assist in neutralising the released acidity.
- Limited oxygen diffusion into clayey tailings at field capacity. The tailings are relatively clayey and, based on their particle size distribution, are expected to have a high field capacity of around 30% (v/v); and a corresponding air-filled porosity of only 10% (v/v). Under these conditions the oxygen diffusion rate is expected to be low ($< 8.0 \times 10^{-7}$m/s) and limiting to sulphide oxidation (i.e. to completely oxidise the 1.64% Total S, assuming it is all sulphidic, approximately 30g of oxygen/kg of soil is needed). Based on the very low oxygen diffusion rates at field capacity in the clayey tailings, insufficient oxygen will be available to fully oxidise the sulphides.
- Low permeability of the tailings following draining. The permeability of the tailings is expected to decrease sharply as the tailings consolidate and drain. At field capacity the permeability of the tailings is expected to be around 1.0×10^{-1}cm/d (equivalent to 1.1×10^{-8}m/s). Consequently, the transport and seepage of any oxidation reaction products (i.e. AMD) from the base of the TSF, once it is at field capacity, will be limited.

15.9 Radon Exhalation Performance of Cover Systems

Radon emanation rates were measured from dry samples for two different ore types (lignitic and sandy) using charcoal canisters backed by continuous radon and thoron emanation rates measured using a Durridge RAD 7 unit (Appendix F3). Tests were also carried out with samples saturated with site water and capped with Eocene clay material to assess their respective emanation attenuation potential. Results were as follows:

- Radon emanation rates from saturated vs. dry ore decreased by greater than 95% to less than 0.1Bq/m^2/s. This is due to the diffusion coefficient of radon being much lower in water than in air. That attenuation factor achieved in a submerged configuration is likely to be greater than that achieved through what will merely be a saturated medium.
- A 35cm Eocene sand clay cap achieved greater than 99% attenuation of the radon emanation rate. The proposed 2m thick capping structure for the surface and in-pit tailings (1m capillary break and 1m growth medium) is expected to result in similar radon attenuation factors following drainage of the tailings leachate.

Following the completion of two geotechnical investigation trenches at the Ambassador deposit in late 2015-early 2016, Vimy intends on conducting further radon and thoron emanation test-work on loose bulk mineralised samples excavated from the base of the trench to confirm the previous radon emanation test work using small-scale canisters. These ore samples will undergo processing in a pilot plant, and similar radon emanation measurements will be taken over the tailings generated and rate assumptions for various landforms updated accordingly.

This supports the concept of benign radon emanation rates associated with the final MRUP tailings reconstructed landforms, decreasing in a logarithmic manner over time with the decay of radium left in those tailings. The proposed cover systems for the various post-mine landforms (including the backfilled pits, TSF and OLs) will be sufficient to reduce radon exhalation to below background levels.

Given the very short half-life of thoron (55.6 seconds), it wasn’t considered relevant for the scope of closure.

15.10 Landscape Evolution Modelling of Post-mine Landforms

To establish the long term evolution of the post-mine landforms, erosion modelling on actual site materials was undertaken using a laboratory scale rainfall simulator, with the results entered into WEPP (Watershed Erosion Prediction Project) to determine the optimal post-mine landform configuration based on the material properties (Appendix H2). During the rainfall simulator test work, intense rainfall events (including 1:100 year 72 hr event) were incorporated to get accurate measurements of predicted sediment loss and surface runoff.

The WEPP model results showed that the proposed reconstructed soil profiles for the various post-mine landforms were stable at all slope angles, and negligible runoff occurred due to the sandy nature of the surface cover (i.e. the majority of the rainfall infiltrated the surface sands, with sediment losses typically less than DMP stability criteria of 5t/ha/yr).

To establish the long term stability of the post-mine landforms, SIBERIA Landscape Evolution Modelling (a complex topographic evolution model capable of assessing gully development and incision and landform containment design) was undertaken over a 10,000 year period. Both the above-ground TSF and an OL from Ambassador (AWOL) were modelled. The OL was modelled with 1m of permeable growth medium (nominally Quaternary sands), overlying the sandy Miocene and Eocene sediments. In contrast, the above-ground TSF is comprised of a shallow sandy growth medium overlying the clayey embankment walls and tailings.

A 3D image of the AWOL landform (to the left of the image) and the above-ground TSF (behind AWOL) is illustrated in

Figure 15.8. The results of the SIBERIA modelling over 10,000 years for the AWOL and above-ground TSF landforms are presented in Figure 15.9 and Figure 15.10 respectively.

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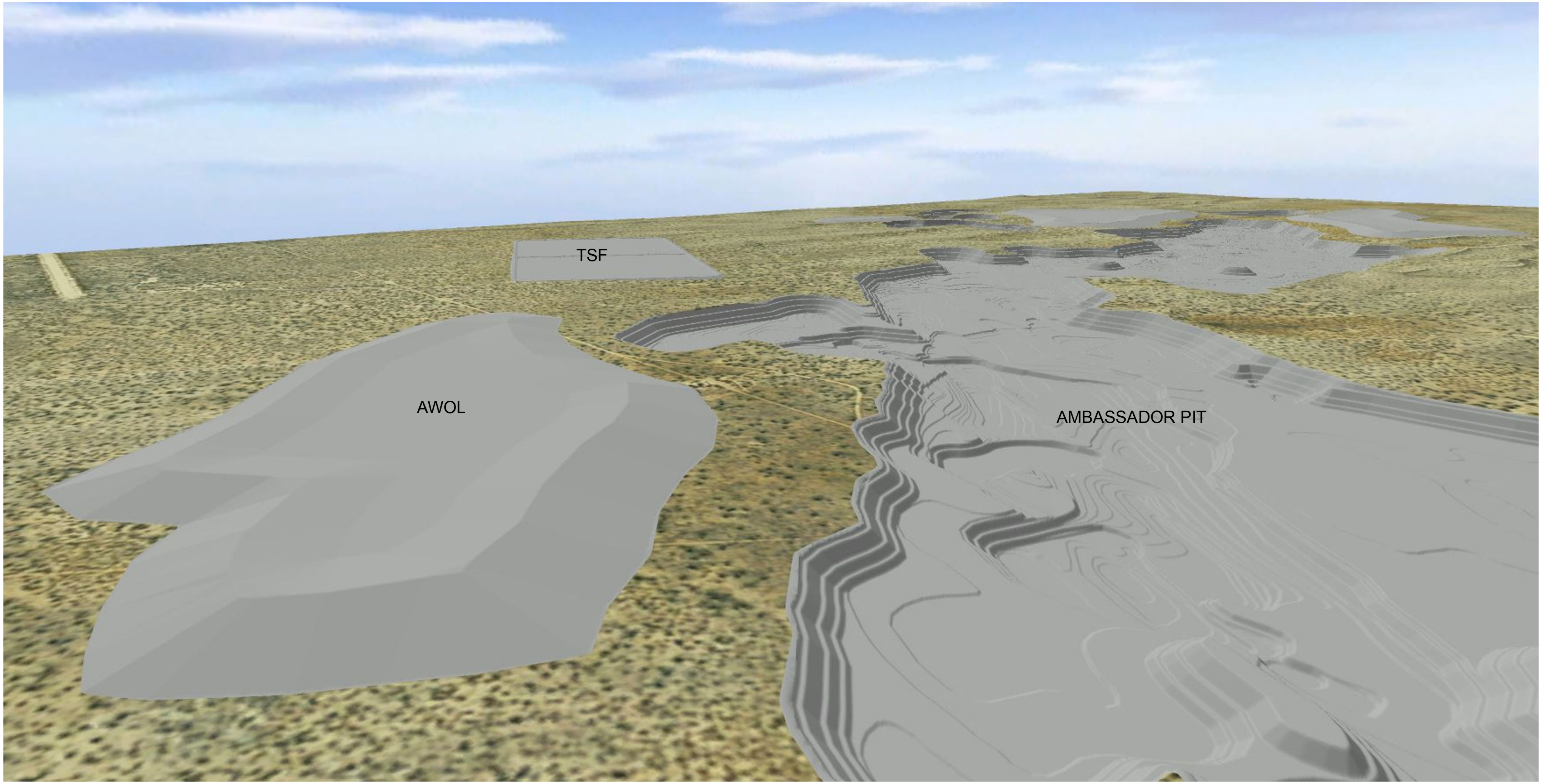

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT	YYYY-MM-DD	2015-11-04	TITLE **3D REPRESENTATION OF AMBASSADOR PIT LOOKING TOWARDS THE NORTHEAST DURING OPERATIONS**
	DESIGNED	MS	
	PREPARED	MS	
	REVIEWED	DCR	PROJECT NO. 1540340 · CONTROL PER · REV. 0 · FIGURE **15.8**
	APPROVED	DCR	

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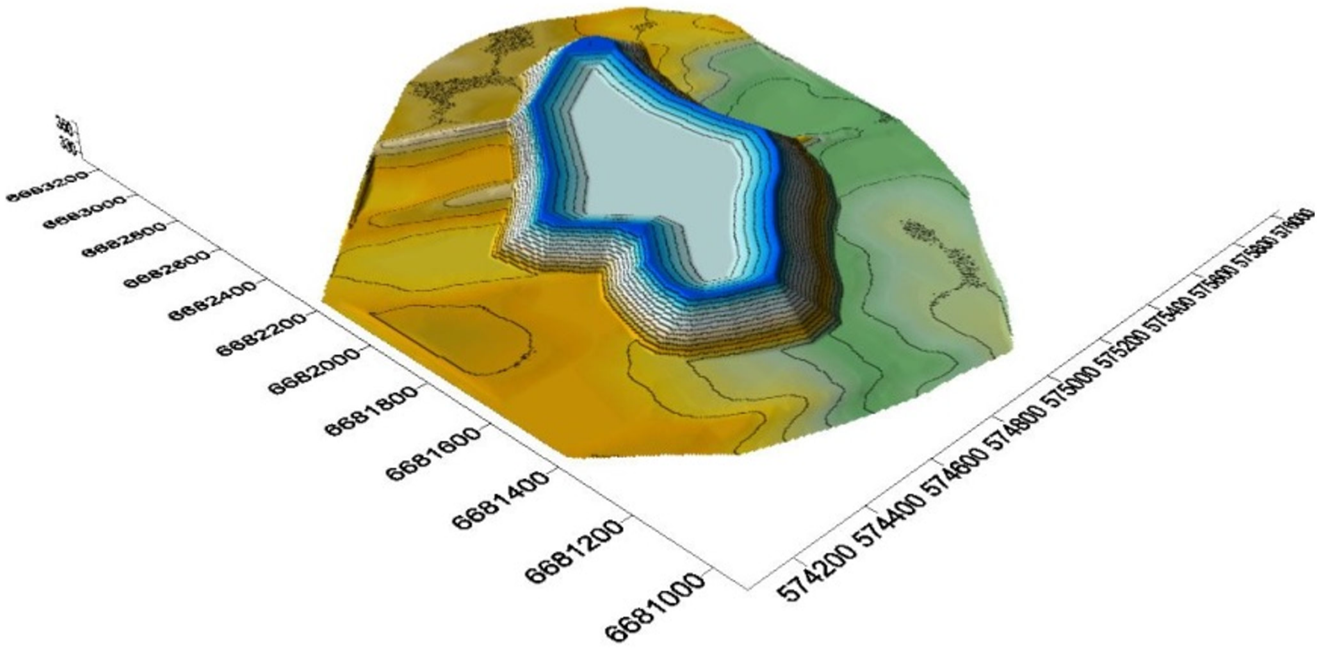

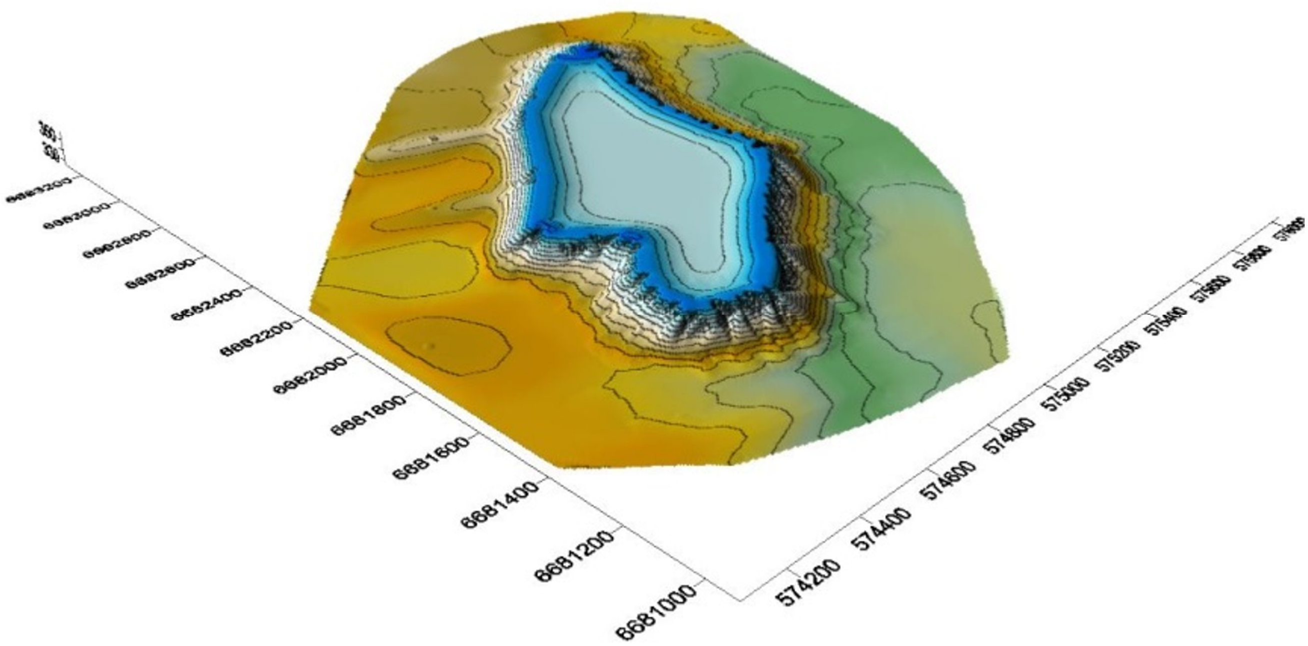

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-04
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PREPARED	MS
REVIEWED	DCR
APPROVED	DCR

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SIBERIA MODELLING RESULTS FOR THE AMBASSADOR OL AT END OF CONSTRUCTION (ABOVE) AND FOLLOWING 10,000 Y OF WEATHERING (BELOW)

PROJECT NO.	CONTROL	REV.	FIGURE
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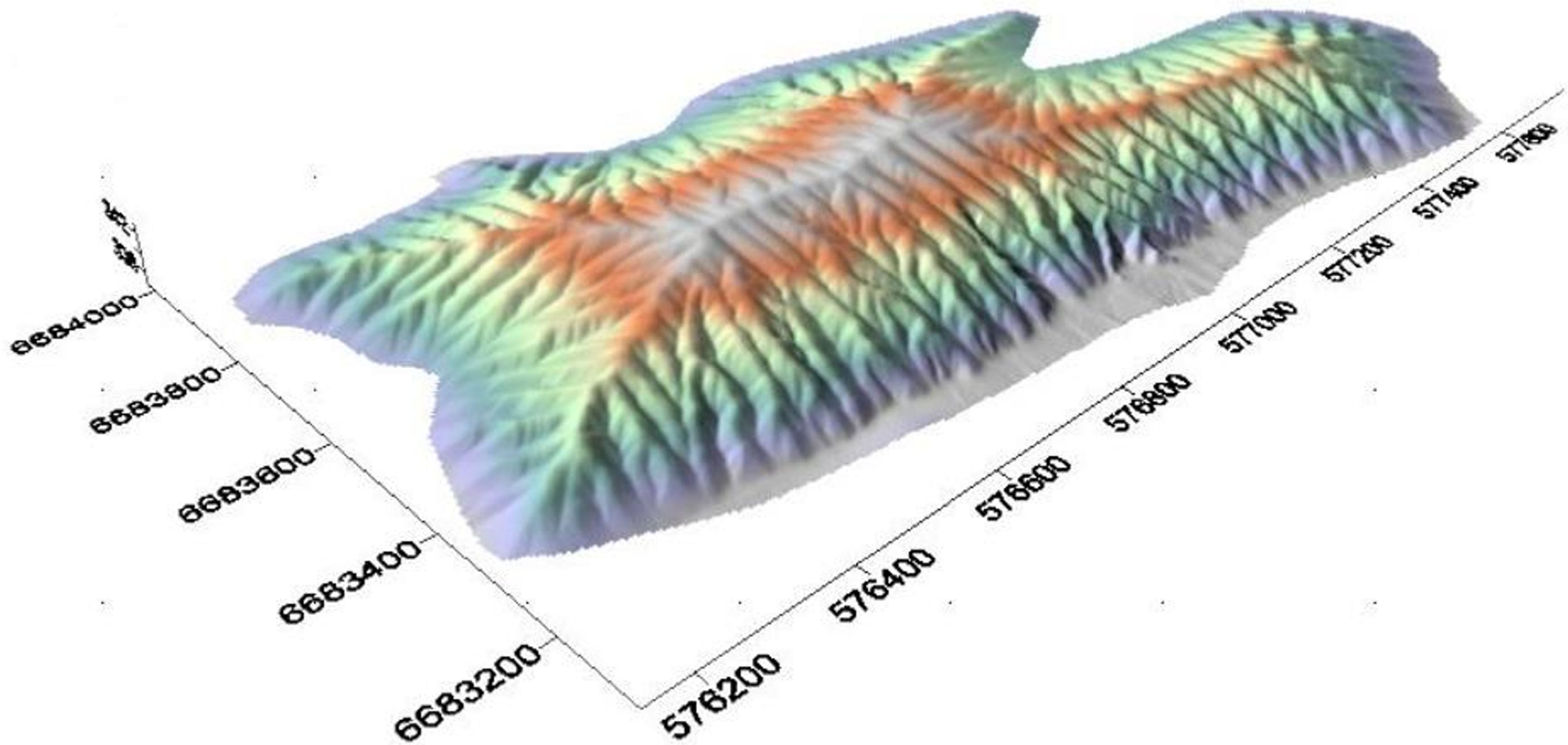

CLIENT VIMY RESOURCES LIMITED		PROJECT MULGA ROCK URANIUM PROJECT	
CONSULTANT Golder Associates	YYYY-MM-DD: 2015-11-04	TITLE **SIBERIA MODELLING RESULTS FOR THE ABOVE-GROUND TSF FOLLOWING 10,000 YR OF WEATHERING**	
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	PREPARED: MS		
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The SIBERIA model results demonstrate that in the absence of vegetation cover:

- The OL landform was more stable than the above-ground TSF due to the high infiltration rates of the OL materials which limited surface runoff reducing the erosion potential.
- The above-ground TSF has a limited depth of highly permeable sands covering an engineered wall (high clay content). The contact between the highly permeable sand and low permeable clay engineered wall on the TSF concentrates water during high rainfall events and increases the potential for erosion. Although there is the potential for some of the underlying substrate to become exposed in some of the deeper gullies, in practice surface sealing following infilling and natural dust deposition will limit this.
- In the above-ground TSF scenario the magnitude of erosion and sediment loss is substantial, but it is considering a theoretical 10,000 year period (without dust deposition or vegetation cover) and peneplanation (a geomorphological process describing the reduction of hills into plains) of any landform would occur over this period.

The shape of the planned above-ground TSF is different to the one modelled, however the internal structure, composition, and design prescription, which influenced the erodibility of the landform, remain the same.

Vegetation establishment and growth was not considered in the SIBERIA model, and thus the results represent worst case. The positive results obtained from the WEPP modelling (Appendix H2), which considers a 100 year period, for the yellow dunal sand cover indicates that over this period, which is sufficient to establish a functioning and sustainable ecosystem on the post-mine landforms, the proposed post-mine landforms will be stable.

15.11 Materials Balance and Scheduling

This project is still in the initial stages of mine planning, with a Definitive Feasibility Study (DFS) yet to be completed. Detailed material movements and mine scheduling will be undertaken as part of the DFS and the information obtained from this work incorporated into the existing conceptual MCP. Preliminary growth medium balances and waste volumes are presented in the CMCP and reproduced as Table 15.3 and Table 15.4. Table 15.3 indicates that there is significantly more growth medium available through the pre-mining stripping process than is required for rehabilitation.

Table 15.3 Estimated Growth Medium and Overburden Volumes to be Managed for Each Mine Pit

Deposit	Potential salvaged growth medium (m^3)		Used growth medium (m^3)	
	Stripped from pits	Stripped from OL footprints	Required for pits (including in-pit TSFs)	Required for OL (including TSF)
Princess	1,490,000	1,470,000	990,000	1,740,000
Ambassador	4,700,000	2,800,000	2,880,000	1,380,000
Shogun	2,300,000	1,400,000	920,000	710,000
Emperor	8,950,000	3,720,000	1,280,000	1,860,000
Subtotal	**17,440,000**	**7,920,000**	**5,080,000**	**4,950,000**
Total volume	**25,360,000**		**9,030,000**	

Table 15.4 indicates that landforms will be reduced in size or removed as part of the closure planning process.

Table 15.4 OL During Operations and Closure

OL	Surface Area (footprint) (ha)	Maximum height (m)	Maximum Volume (m3)	Changes at closure
PNOL (Princess North OL)	16.3	30	2,266,800	Landform removed at closure. Used for construction and rehabilitation of the above-ground TSF and rehabilitation of the Princess In-pit TSF cover.
PEOL (Princess East OL)	130.7	30	25,214,000	Landform size reduced at closure. Used for the rehabilitation of the Princess In-pit TSF cover.
AEOL (Ambassador East OL)	136.0	30	23,715,000	
ASOL (Ambassador South OL)	32.9	30	4,675,600	
AWOL (Ambassador West OL)	106.5	30	19,947,000	Used for TSF cover. Final size reduced.
SOL (Shogun OL)	141.9	30	34,800,000	
EEOL (Emperor East OL)	135.2	30	35,577,000	
ESOL (Emperor South OL)	237.0	30	68,329,000	
Total	**936.5**	**30**	**214,524,400**	

Due to the large lateral extent and horizontal geometry, the deposit lends itself to strip mining techniques using truck and excavator, and dozer trap mining techniques similar to those used in thermal coal, and mineral sands mining.

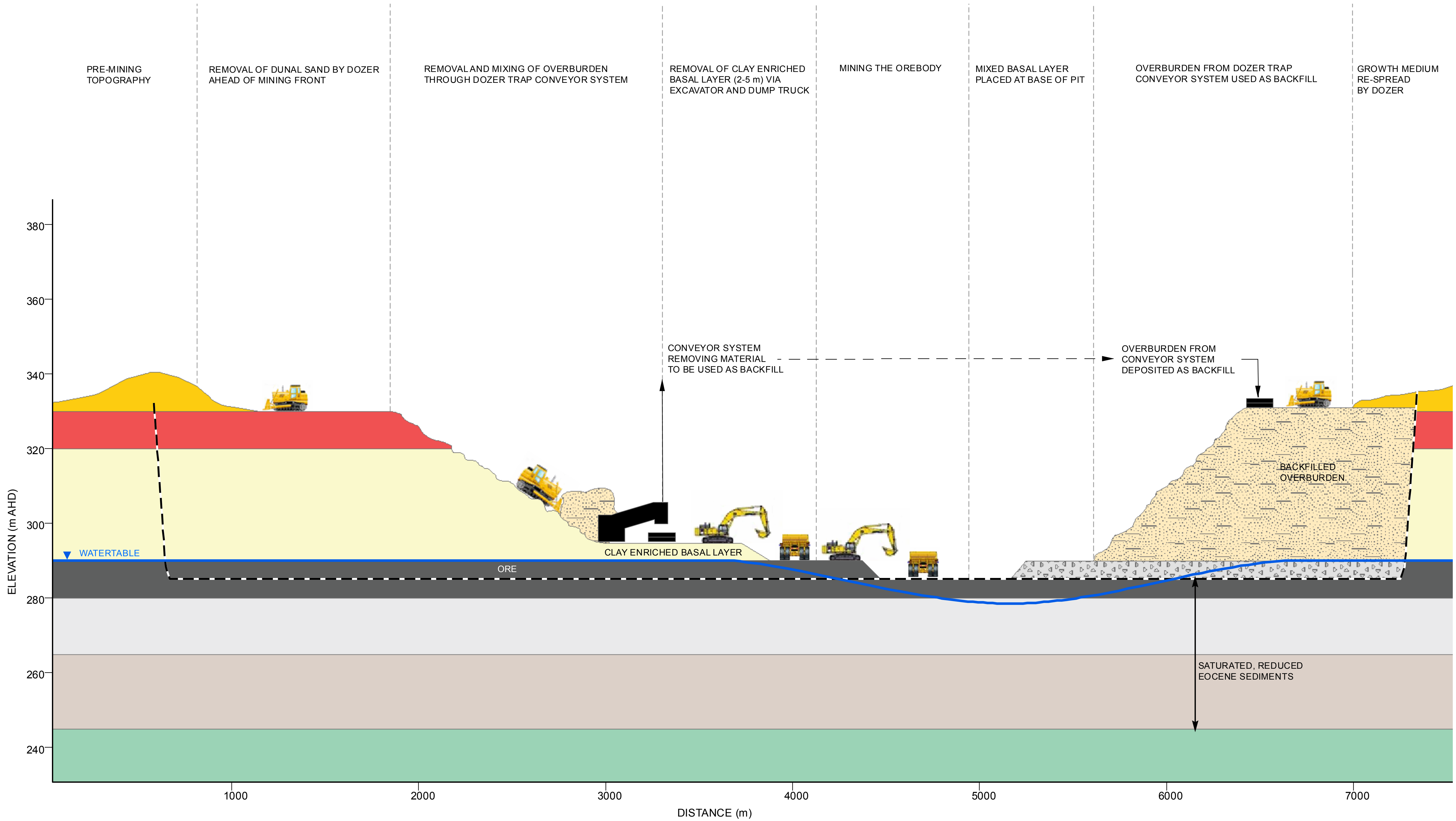
The upper portion of the growth medium will be progressively stripped from the surface of pits (ahead of the mining front) using both truck and shovel and dozer methods. This material will either be stockpiled around the edge of pits to later be reinstated on top of backfilled mining voids, or be used for capping OLs.

Pits will be initiated with the excavation (truck and shovel) of an initial slot to expose the ore, with the overburden placed in an OL adjacent to the initial slot. This OL will remain as it is not economically feasible to return it to the pit for backfilling. After mining the ore exposed by the first slot, a pit void is created approximately 200-300m in length. At this point a dozer trap and conveyor waste handling system is installed to progress the mining front and convey the overburden to backfill the mined out section of the pit (initial slot).

Mineralised ore at the bottom of the pit will be mined by a small truck and shovel conventional fleet.

The backfilling of the pit progresses along the strike length at a similar rate as the mining front (dozer trap) progresses. In some cases, smaller satellite pits which are not large enough for a dozer trap system will be mined with conventional truck and shovel (AMEC Foster Wheeler 2015). The proposed mining sequence is illustrated in Figure 15.11 and Figure 15.12 to Figure 15.15.

This mining method will result in a relatively small environmental footprint at any given time and significant benefits from progressive rehabilitation. Owing to the nature of the material hosting the ore and overburden, mining is expected to be free digging where drilling and blasting will not be required. This expectation may change following continued geotechnical and strength test work of defined silicrete lenses located at the Miocene/Eocene contact



LEGEND

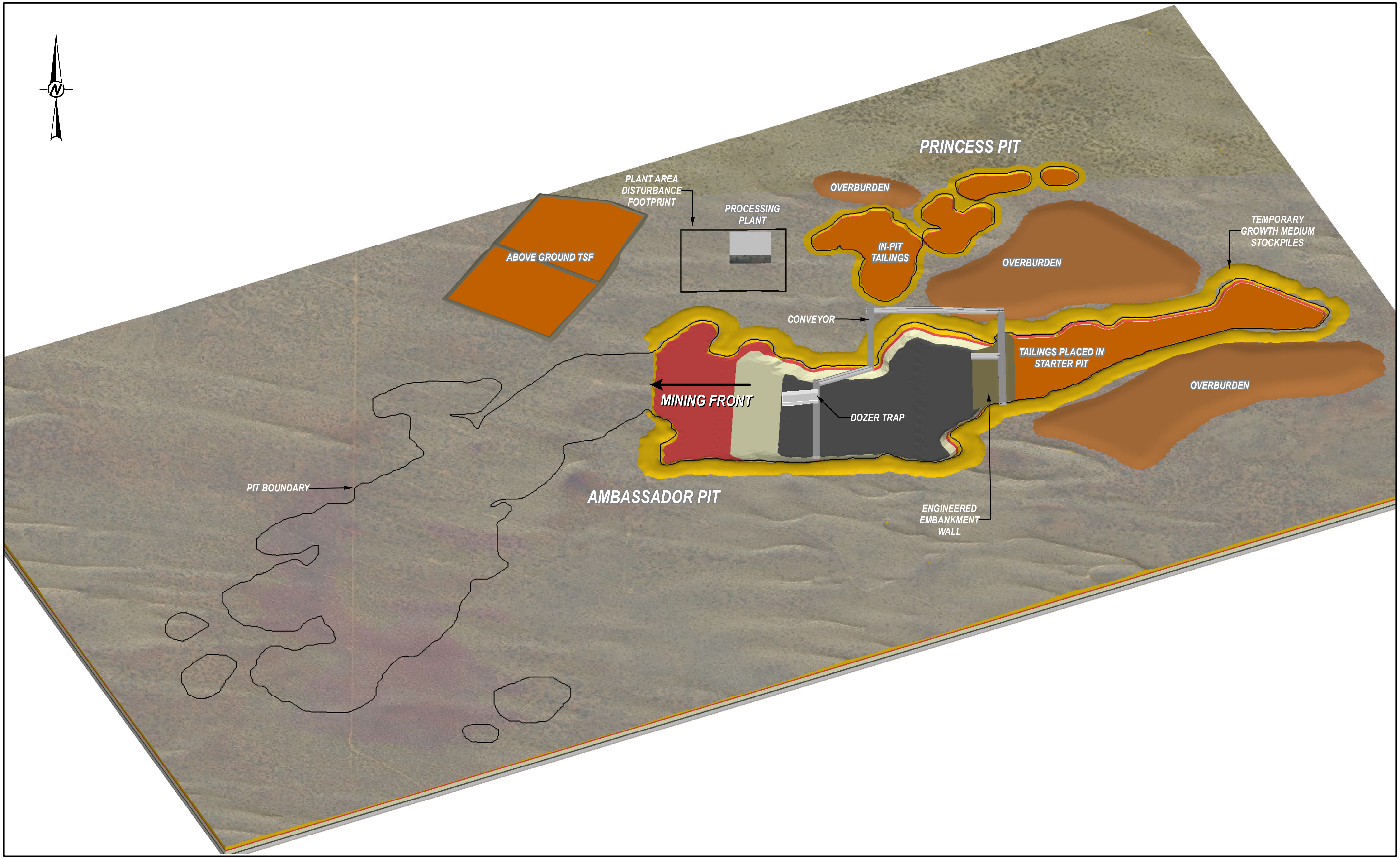
- PROPOSED MINE PIT
- QUATERNARY SEDIMENTS
- MIOCENE SEDIMENTS
- OXIDISED EOCENE SEDIMENTS
- U-ENRICHED LIGNITE, CLAY, SILT
- REDUCED EOCENE SEDIMENTS
- HIGH PERMEABILITY BASAL SAND
- PERMIAN SEDIMENTS (BASEMENT)
- MIXED BASAL OVERBURDEN & BENEFICIATED SAND PREFERENTIALLY PLACED AT BASE OF PIT
- MIXED MIOCENE AND OXIDISED EOCENE SEDIMENTS

0 10 20 30 40 50
V 1:1,000 METRES

0 200 400 600 800 1,000
H 1:20,000 METRES

CLIENT	VIMY RESOURCES LIMITED	PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT		TITLE	**PROPOSED MINING OF THE MINE PITS AND INTERNAL MANAGEMENT OF SOIL AND OVERBURDEN MATERIALS**
YYYY-MM-DD	2015-10-29		
DESIGNED	MS		
PREPARED	MS		
REVIEWED	EWC		
APPROVED	EWC		

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	15.11



LEGEND

- QUATERNARY SEDIMENTS
- MIOCENE SEDIMENTS
- OXIDISED EOCENE SEDIMENTS
- OREBODY
- REDUCED EOCENE SEDIMENTS
- HIGH PERMEABILITY BASAL SAND
- PERMIAN SEDIMENTS (BASEMENT)

NOTES

SURFACE TOPOGRAPHY SHOWN WITH NO VERTICAL EXAGGERATION.
MODEL FOR DISPLAY ONLY (NOT TO BE SCALED OFF).

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-29
DESIGNED	SAR
PREPARED	SAR
REVIEWED	EWC
APPROVED	EWC

TITLE
3D IMAGE OF THE MULGA ROCK EAST – OPERATION STAGE 1

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**15.12**

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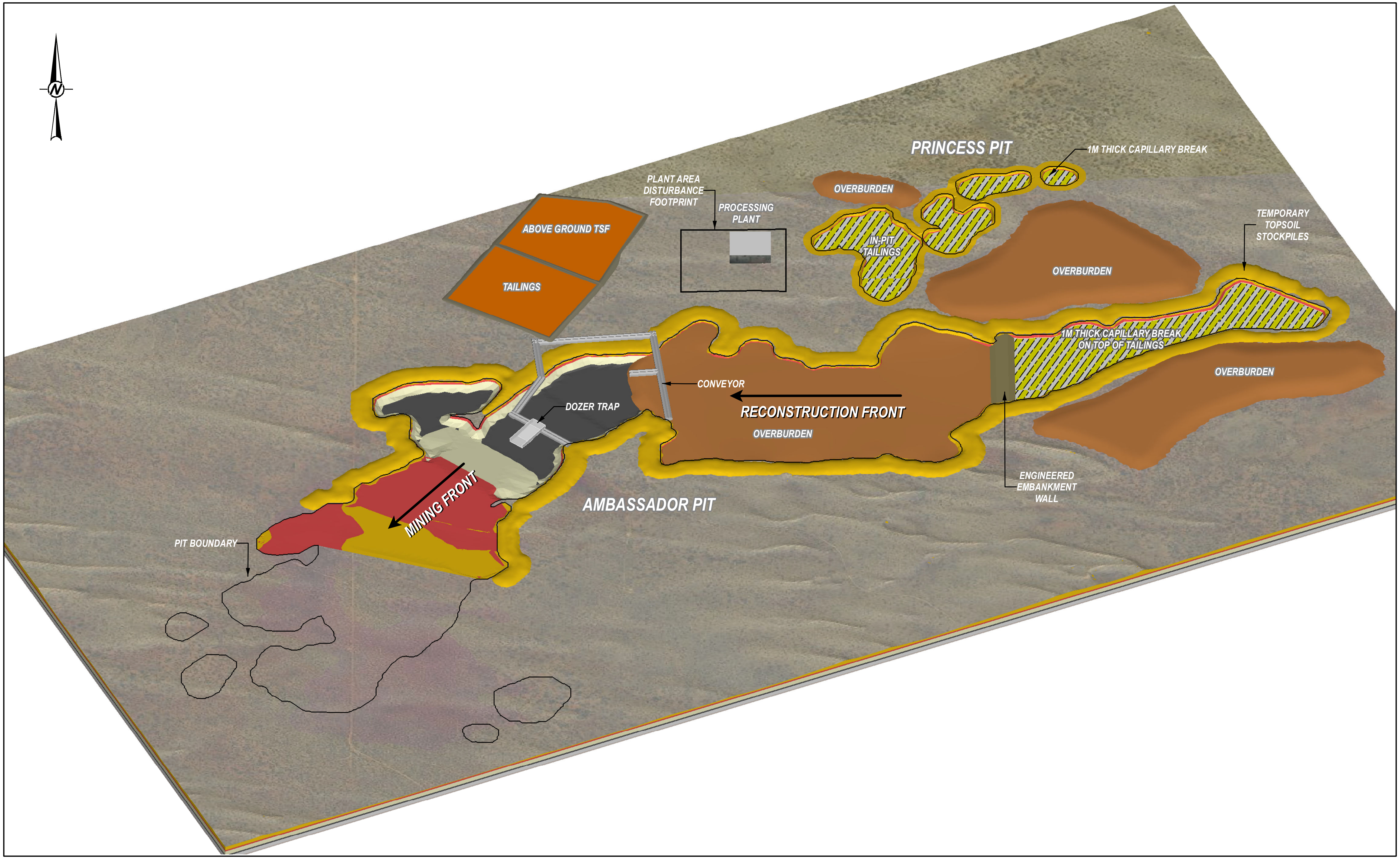
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

0



LEGEND

QUATERNARY SEDIMENTS	REDUCED EOCENE SEDIMENTS
MIOCENE SEDIMENTS	HIGH PERMEABILITY BASAL SAND
OXIDISED EOCENE SEDIMENTS	PERMIAN SEDIMENTS (BASEMENT)
OREBODY	

NOTES

SURFACE TOPOGRAPHY SHOWN WITH NO VERTICAL EXAGGERATION.
MODEL FOR DISPLAY ONLY (NOT TO BE SCALED OFF).

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

PROJECT
MULGA ROCK URANIUM PROJECT

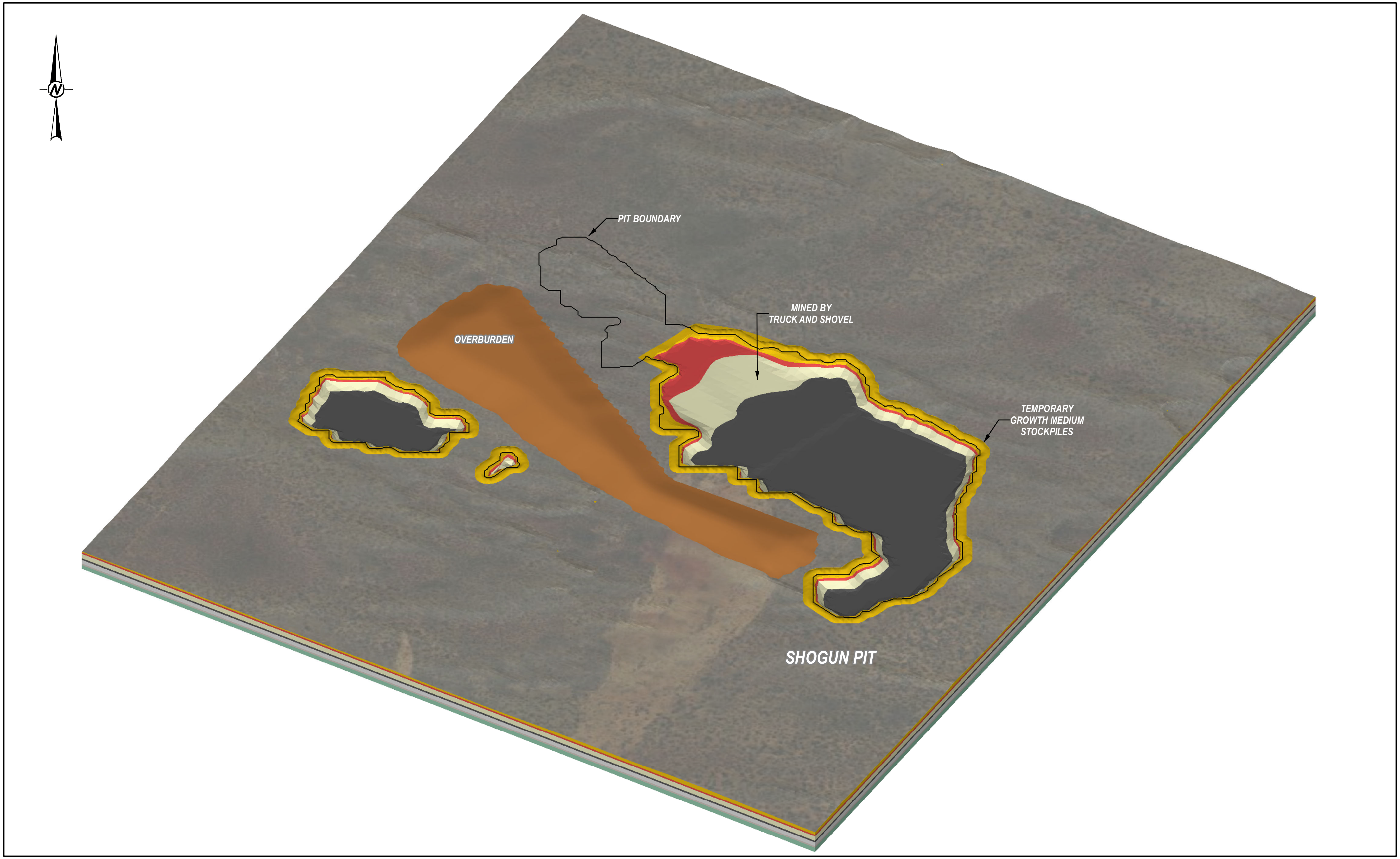
CONSULTANT

Golder Associates

YYYY-MM-DD	2015-10-29
DESIGNED	SAR
PREPARED	SAR
REVIEWED	EWC
APPROVED	EWC

TITLE
3D IMAGE OF THE MULGA ROCK EAST – OPERATION STAGE 2

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	H1	0	15.13



LEGEND

- QUATERNARY SEDIMENTS
- MIOCENE SEDIMENTS
- OXIDISED EOCENE SEDIMENTS
- OREBODY
- REDUCED EOCENE SEDIMENTS
- HIGH PERMEABILITY BASAL SAND
- PERMIAN SEDIMENTS (BASEMENT)

NOTES

SURFACE TOPOGRAPHY SHOWN WITH NO VERTICAL EXAGGERATION.
MODEL FOR DISPLAY ONLY (NOT TO BE SCALED OFF).

CLIENT
VIMY RESOURCES LIMITED

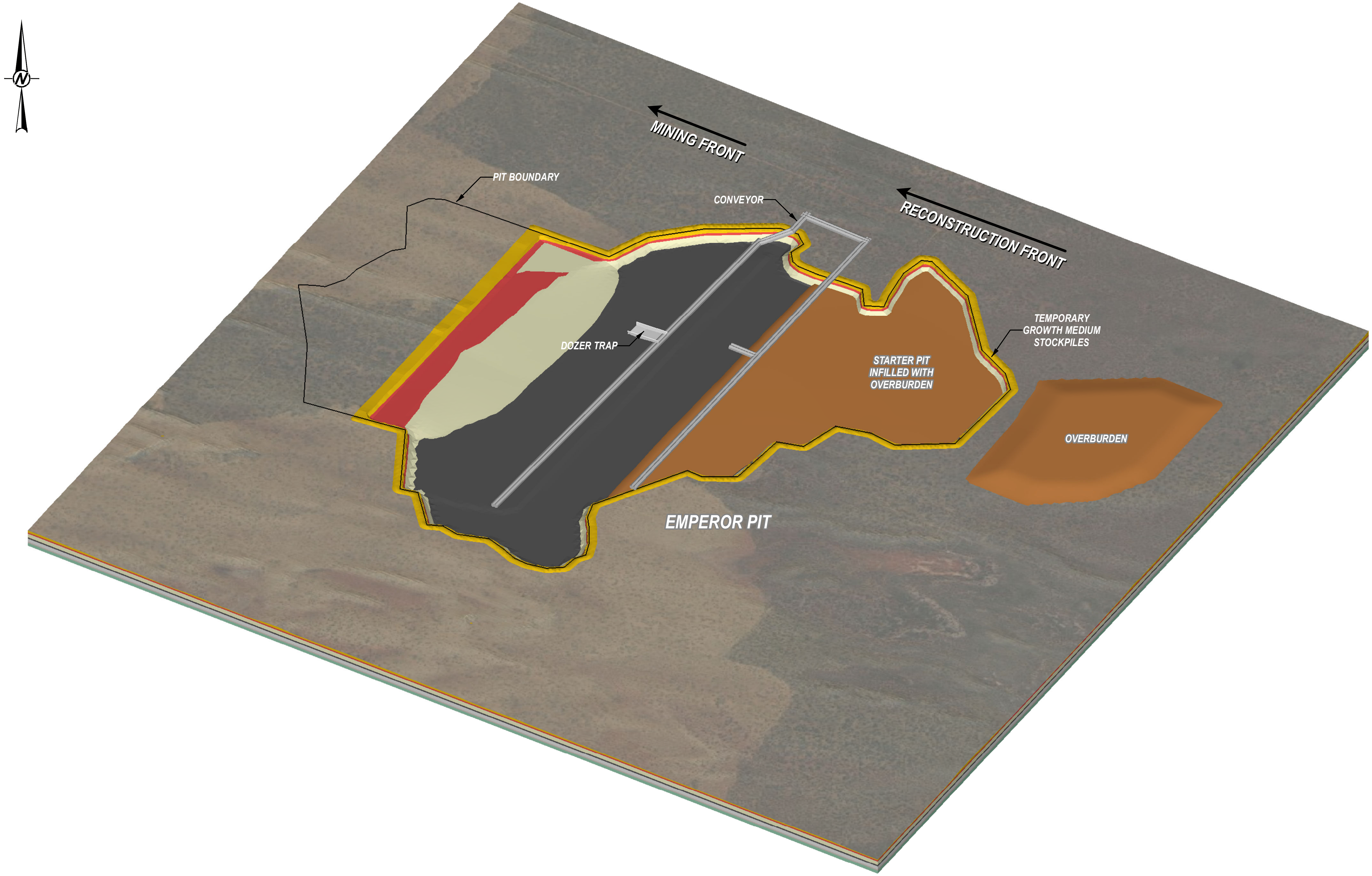
PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-29
DESIGNED	SAR
PREPARED	SAR
REVIEWED	EWC
APPROVED	EWC

TITLE
3D IMAGE OF THE MULGA ROCK WEST – SHOGUN OPERATION

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	15.14



LEGEND

- QUATERNARY SEDIMENTS
- MIOCENE SEDIMENTS
- OXIDISED EOCENE SEDIMENTS
- OREBODY
- REDUCED EOCENE SEDIMENTS
- HIGH PERMEABILITY BASAL SAND
- PERMIAN SEDIMENTS (BASEMENT)

NOTES

SURFACE TOPOGRAPHY SHOWN WITH NO VERTICAL EXAGGERATION.
MODEL FOR DISPLAY ONLY (NOT TO BE SCALED OFF).

CLIENT
VIMY RESOURCES LIMITED

VIMY RESOURCES

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-29
DESIGNED	SAR
PREPARED	SAR
REVIEWED	EWC
APPROVED	EWC

TITLE
3D IMAGE OF THE MULGA ROCK WEST – EMPEROR OPERATION

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	15.15

Mining will initially commence at Princess (Year 0), for about 12-18 months. The Princess Pit will be pre-stripped during the construction phase with a portion of the overburden material used to construct the above-ground TSF. Once the process plant is operational the tailings will be stored in the above-ground TSF until the Princess Pit has been sterilised. After approximately 18 months the tailings will then be diverted to the Princess in-pit TSF (Year 2).

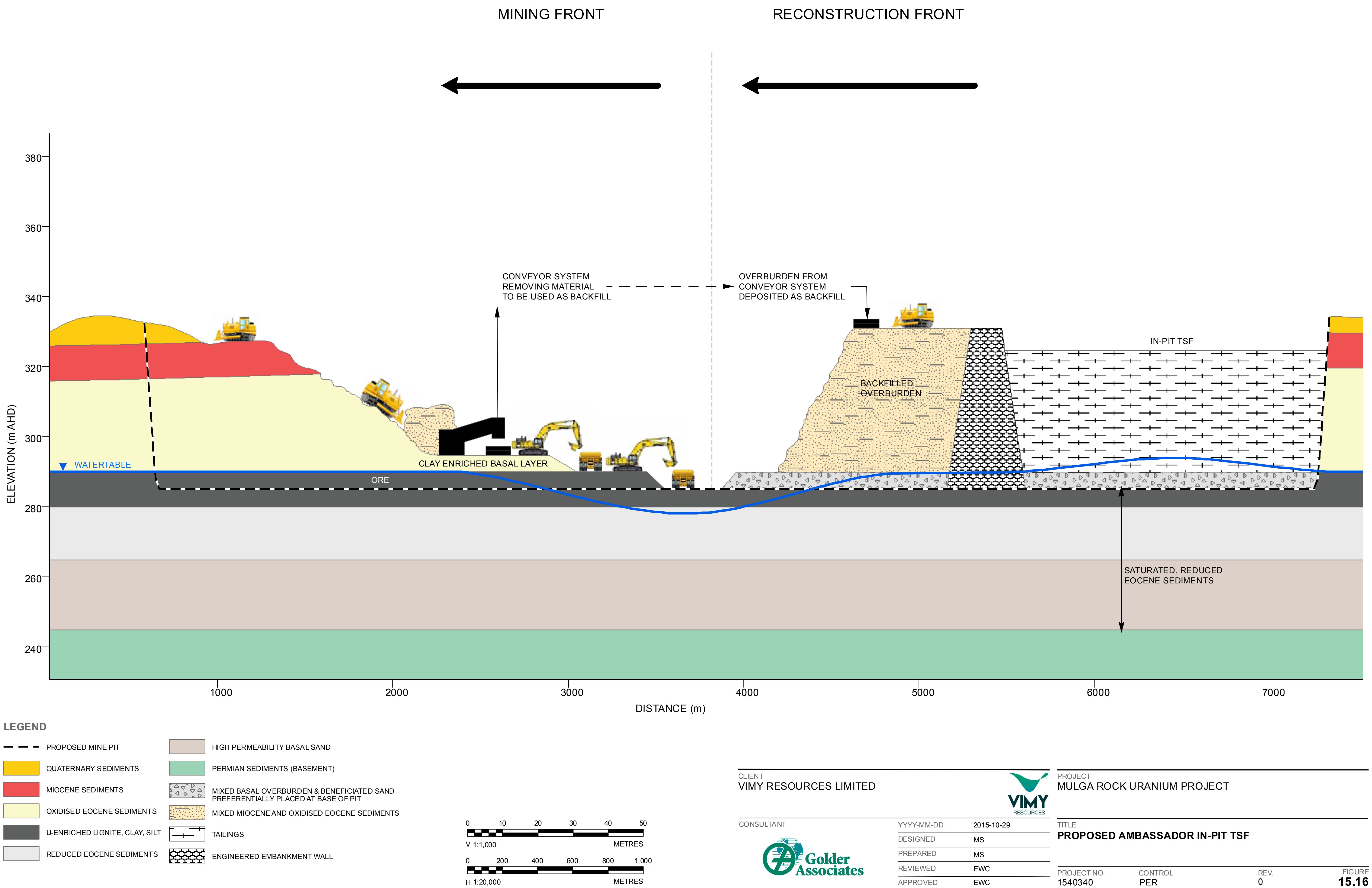
Mining operations will commence at Ambassador in Year 1 and will continue until Year 14. An initial slot will be developed using a conventional truck and shovel fleet. Initial overburden material from this slot will be deposited to the side of the pit as a permanent OL. A void will be left at the beginning of the Ambassador pit to form the second in-pit TSF, which will be required from about year eight onwards (Figure 15.16).

During the same period as mining is occurring at Ambassador, the above-ground TSF will be partially rehabilitated. Once the tailings have dried sufficiently to allow machinery on to its surface a sand layer will be placed over the tailings to prevent dusting. The proposed rehabilitated above-ground TSF is shown in Figure 15.17.

Mining at Shogun commences one year after Ambassador (Year 2) and continues for seven years. At Year 8 mining commences at Emperor and continues for nine years (Year 16).

At the completion of the Project, the overburden waste piles adjacent to the Princess and Ambassador in-pit TSFs will be used to rehabilitate and close the tailings facilities. The above-ground TSF will also be capped and domed over. The final rehabilitation profiles over the Princess and Ambassador in-pit TSFs are shown in Figure 15.18 and Figure 15.19.

The remaining overburden waste landforms located at Ambassador, Shogun and Emperor will be re-contoured and revegetated. There will be voids remaining at the completion of mining operations at Ambassador, Shogun and Emperor. These will be partially filled to a level of not less than 10m from the water table and the sides and base of the pit reshaped. Any contaminated plant equipment, concrete footings and foundations will be placed in the bottom of the remaining mining void before backfilling. Remaining equipment which can be decontaminated will be scrapped and sold.



CLIENT
VIMY RESOURCES LIMITED

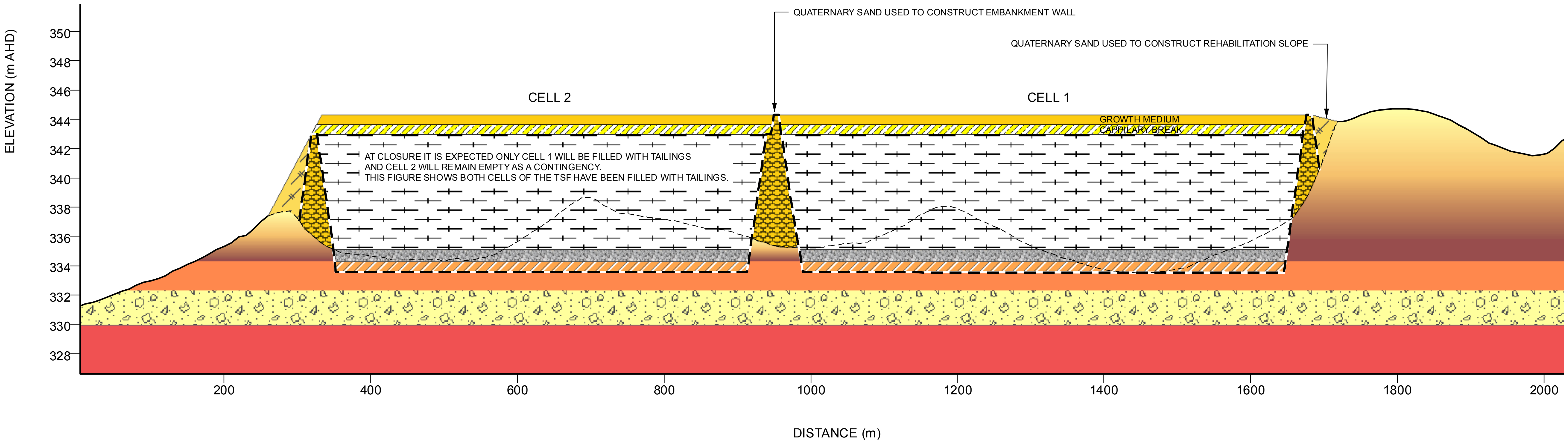
PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-29
DESIGNED	MS
PREPARED	MS
REVIEWED	EWC
APPROVED	EWC

TITLE
PROPOSED AMBASSADOR IN-PIT TSF

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**15.16**



LEGEND

- PROPOSED ABOVE GROUND TSF (AS-BUILT)
- QUATERNARY SEDIMENTS
- MIOCENE SEDIMENTS
- TAILINGS
- CAPILLARY BREAK
- DUNAL SAND
- REDDISH BROWN SANDY LOAM
- CLAY LINER
- CALCRETE
- REHABILITATION SLOPE
- EMBANKMENT WALL
- UNDERDRAINAGE SYSTEM

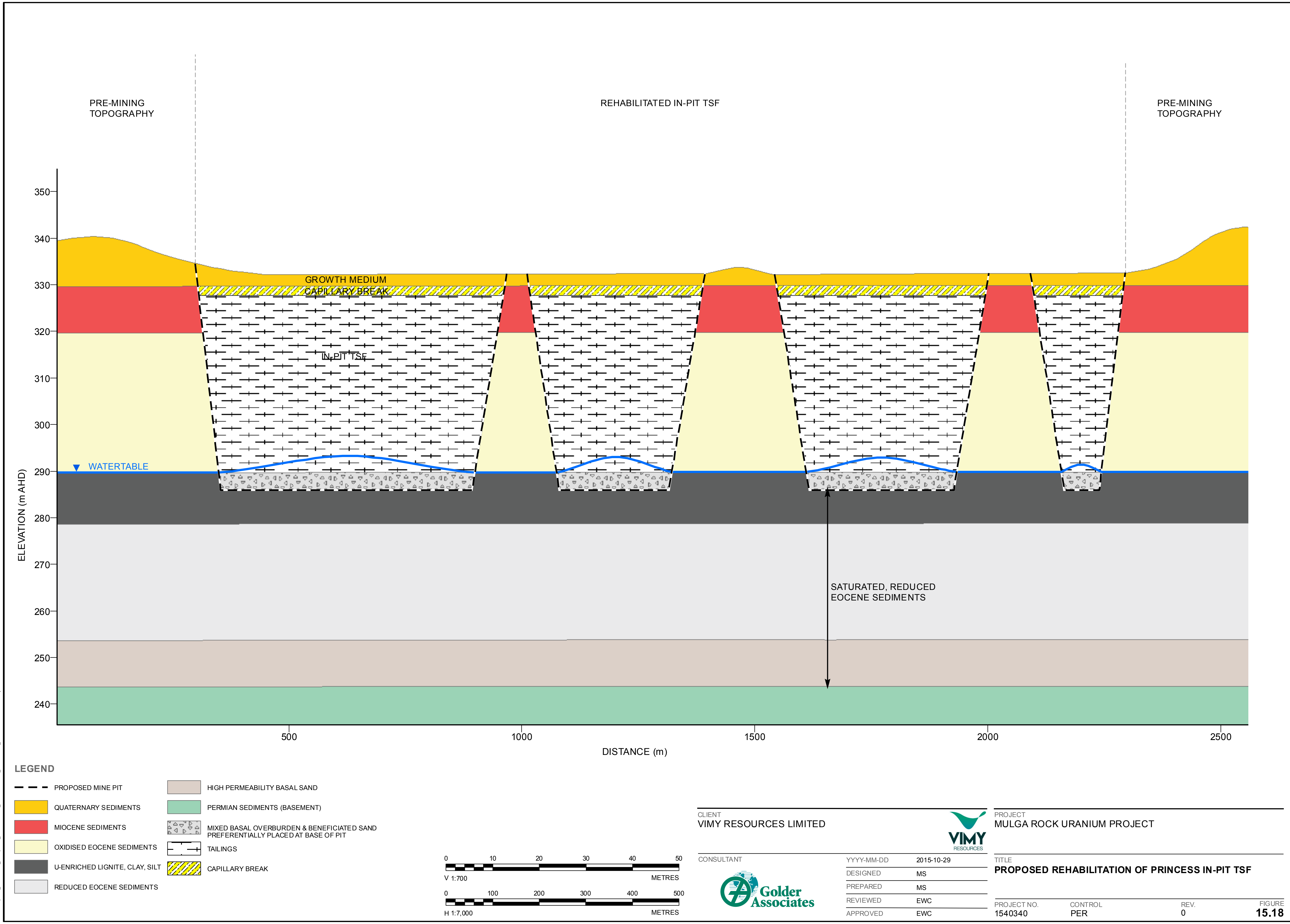
0 5 10 15 20 25
V 1:300 METRES

0 100 200 300 400 500
H 1:6,000 METRES

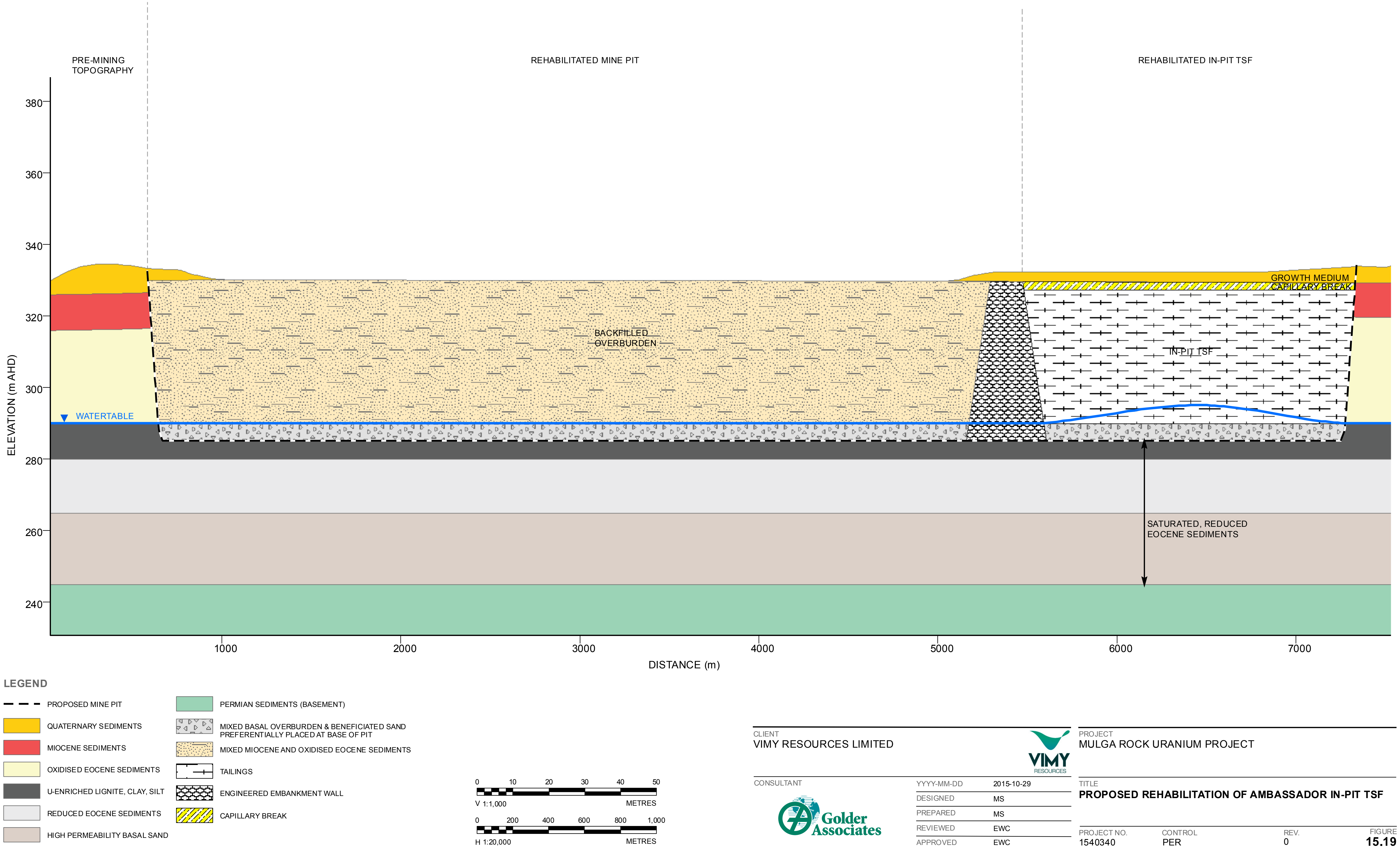
CLIENT	VIMY RESOURCES LIMITED	PROJECT	MULGA ROCK URANIUM PROJECT
CONSULTANT	YYYY-MM-DD: 2015-10-31	TITLE	PROPOSED REHABILITATION OF ABOVE GROUND TSF
	DESIGNED: MS		
	PREPARED: MS		
	REVIEWED: EWC	PROJECT NO. 1540340	CONTROL PER
	APPROVED: EWC	REV. 0	FIGURE 15.17

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm



PRE-MINING TOPOGRAPHY
REHABILITATED IN-PIT TSF
PRE-MINING TOPOGRAPHY
GROWTH MEDIUM
CAPILLARY BREAK
IN-PIT TSF
WATERTABLE
SATURATED, REDUCED EOCENE SEDIMENTS
ELEVATION (m AHD)
350
340
330
320
310
300
290
280
270
260
250
240
500
1000
1500
2000
2500
DISTANCE (m)
LEGEND
PROPOSED MINE PIT
QUATERNARY SEDIMENTS
MIOCENE SEDIMENTS
OXIDISED EOCENE SEDIMENTS
U-ENRICHED LIGNITE, CLAY, SILT
REDUCED EOCENE SEDIMENTS
HIGH PERMEABILITY BASAL SAND
PERMIAN SEDIMENTS (BASEMENT)
MIXED BASAL OVERBURDEN & BENEFICIATED SAND PREFERENTIALLY PLACED AT BASE OF PIT
TAILINGS
CAPILLARY BREAK
0 10 20 30 40 50
V 1:700 METRES
0 100 200 300 400 500
H 1:7,000 METRES
CLIENT
VIMY RESOURCES LIMITED
VIMY RESOURCES
CONSULTANT
Golder Associates
YYYY-MM-DD 2015-10-29
DESIGNED MS
PREPARED MS
REVIEWED EWC
APPROVED EWC
PROJECT
MULGA ROCK URANIUM PROJECT
TITLE
PROPOSED REHABILITATION OF PRINCESS IN-PIT TSF
PROJECT NO. 1540340
CONTROL PER
REV. 0
FIGURE 15.18



CLIENT
VIMY RESOURCES LIMITED

PROJECT
MULGA ROCK URANIUM PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-29
DESIGNED	MS
PREPARED	MS
REVIEWED	EWC
APPROVED	EWC

TITLE
PROPOSED REHABILITATION OF AMBASSADOR IN-PIT TSF

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	**15.19**

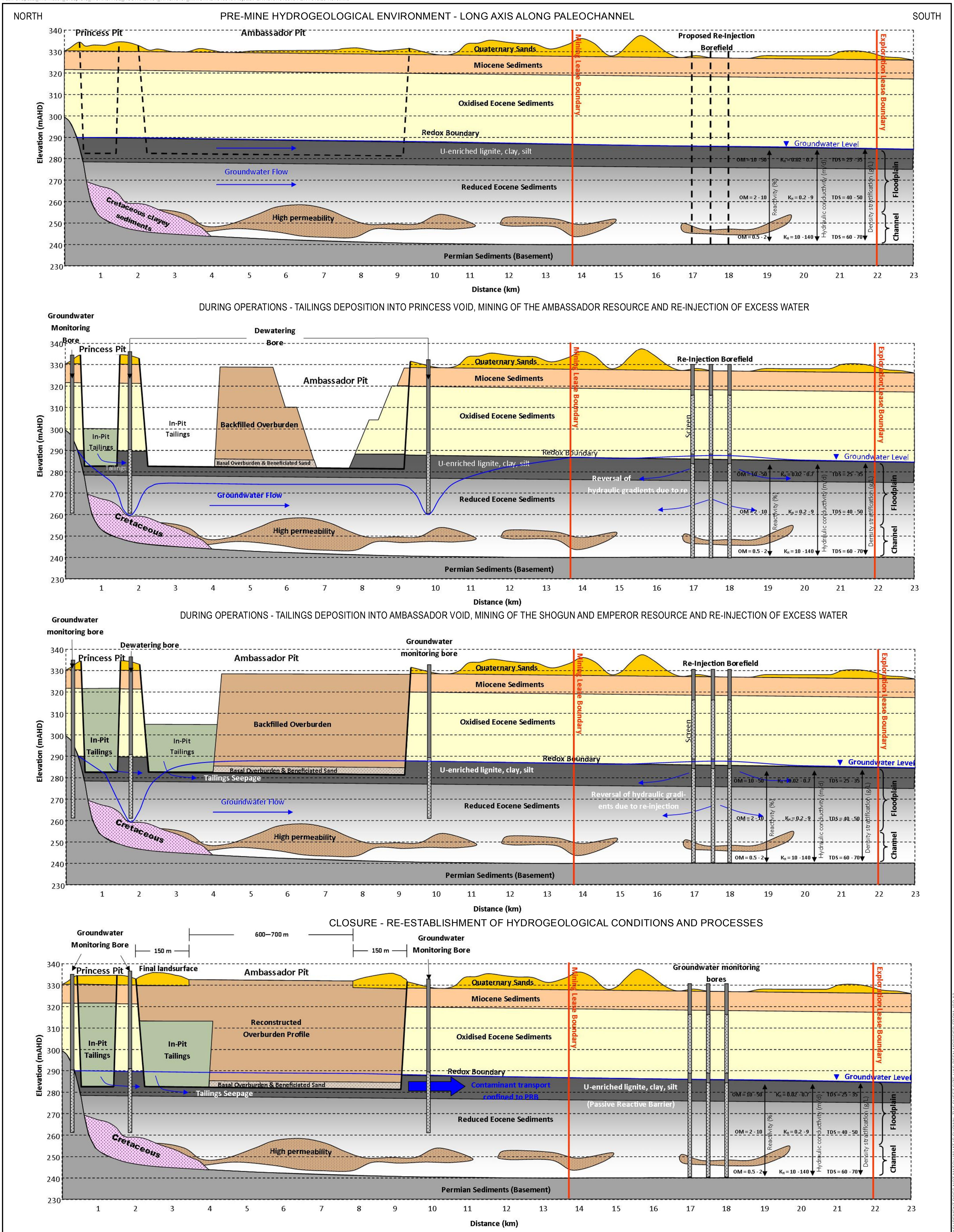
15.12 Progressive Rehabilitation

The mining schedule has been designed so as to facilitate the backfilling of the void, behind the mining front, and subsequent progressive rehabilitation of the reconstructed soil profile. This is also the most cost-effective approach given the large overburden to ore strip ratios (averaging 13:1), and thus there is a financial driver for progressive rehabilitation to occur.

During the DFS, detailed mine schedules will be prepared, which will include the backfilling of the void with overburden (i.e. overburden management) and rehabilitation of the re-established land surface. Proposed areas of progressive rehabilitation and open and closed areas will be determined on an annual basis to facilitate rehabilitation and mine closure planning and works, and in setting financial provisioning targets.

15.13 Characteristics and Function of Post-Mine Landforms

A conceptual hydro-geochemical site model has been developed to assess how the post-mine landforms will interact with the surrounding environment. The conceptual model is provided in Figure 15.20. Technical studies have been undertaken by GHD (Appendix D8) and SWC (Appendix D9) to establish the potential impacts of the proposed operation, in particular the TSFs, on the surrounding environment. This work demonstrates that negligible impact on the quality of the surrounding environment is expected to occur, with no sensitive environmental receptors being adversely impacted.



CLIENT VIMY RESOURCES LIMITED	PROJECT MULGA ROCK URANIUM PROJECT
CONSULTANT Golder Associates	TITLE CONCEPTUAL HYDROGEOCHEMICAL MODEL

YYYY-MM-DD	2015-10-29
DESIGNED	MS
PREPARED	MS
REVIEWED	EWC
APPROVED	EWC

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	PER	0	15.20

15.14 Rehabilitation and Closure Monitoring

The rehabilitation and closure monitoring program for MRUP will be developed to comply with the requirements of the Department of Mines and Petroleum's Guidelines for Preparing Mine Closure Plans (DMP 2015) and the Environmental Protection Agency's Guidance Statement No. 6 for the Rehabilitation of Terrestrial Ecosystems (EPA 2006).

The proposed monitoring program will be designed to achieve the required stakeholder agreed post-mine land use and will include the following components:

- Selection of appropriate analogue sites with justification of their selection.
- Description of field monitoring procedures.
- Description of floristic data provided by the monitoring method.
- Procedures for assessment of rehabilitation success.
- Provision of closure criteria in accordance with DMP and EPA guidelines.
- Procedures to evaluate the success of rehabilitation processes.
- Time-line of rehabilitation monitoring (i.e. frequency and period of monitoring) based on the outcomes and recommendations from successive assessments.

Monitoring will include historic rehabilitation already existing at MRUP as this information is critical to determine the continued establishment of rehabilitation over the longer term.

15.15 Predicted Outcomes

The Proposal is not likely to result in significant environmental impact following closure when management measures are considered. Ongoing investigations and monitoring undertaken during the life of mine will refine the management measures required to achieve the long term objectives of mine closure and in accordance with EPA's closure objective. This will include implementation and continual revision of the MCP to achieve documented objectives and monitoring to check implementation and measure outcomes.

Through the implementation of the closure objectives outlined in this Section and the CMCP, it is anticipated that:

- No significant long term physical offsite impacts will occur as a result of operations.
- No significant long term impact on baseline surface or groundwater flow patterns and quality will occur as a result of operations.
- No unsafe areas will remain after closure whereby members of the general public and animals could be harmed.
- Rehabilitated and closed operational areas will be aesthetically consistent with the surrounding landform and consider stakeholder expectations.

The management measures to appropriately decommission, decontaminate and rehabilitate disturbed areas are in place to mitigate the potential risks to final mine closure. During life of mine operations, investigations and the adaptive management approach will ensure that risks to closure are detected early and are addressed so as to meet the EPA's closure objective.

16. Offsets

16.1 Relevant Environmental Objectives, Legislation, Policies and Guidelines

16.1.1 EPA Objective

The EPA applies the following objective to the assessment of proposals that may require environmental offsets:

> *To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.*

16.1.2 Regulatory Framework

Guidance

- *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy, October 2012, Canberra, Australian Capital Territory. This policy outlines the Australian Government's approach to the use of environmental offsets under the EPBC Act. It is designed to ensure that:
  - The use of offsets under the EPBC Act is efficient, effective, timely, transparent, proportionate, scientifically robust and reasonable.
  - All stakeholders with an interest in a proposal are given guidance and increased certainty concerning when offsets should be considered, and how they should be determined including their nature and scale, and what are acceptable delivery mechanisms.
  - Consistent application of the policy will deliver improved environmental outcomes.
- Government of Western Australia, 2011, WA Environmental Offsets Policy, September 2011, Perth, Western Australia. This policy provides a framework for consistent application of environmental offsets to protect and conserve environmental and biodiversity values for present and future generations, ensuring that economic and social development may occur whilst supporting long term environmental and conservation values.
- Government of Western Australia 2014, WA Environmental Offsets Guidelines, August 2014, Perth, Western Australia. These guidelines are designed to clarify the determination and application of environmental offsets in Western Australia and to ensure the decisions made on such offsets are consistent and accountable.

16.2 Background

The Proposal involves the clearing of up to 3787 hectares of land which will impact the associated flora and fauna. However the extent this impact upon associated flora and fauna will be considerably lessened as a result of recent bushfire activity which resulted in extensive burning of around 78% of the Disturbance Footprint in November 2014.

Flora and Vegetation

Surveys of the flora and vegetation communities located within the Disturbance Footprint have demonstrated that:

- No local vegetation communities are threatened by the proposed clearance.
- No conservation significant species of flora are threatened by the proposed clearance.

There are no known indirect impacts that could threaten conservation significant flora or local vegetation communities located in the Development Envelope.

Fauna and SREs

Surveys of the fauna likely to exist within the MRUP area or likely to inhabit the Disturbance Footprint have demonstrated that it is highly unlikely that any conservation significant fauna will be impacted by the Proposal. In particular:

- To date there have been no observations suggesting that a significant number of Sandhill Dunnarts reside within the Development Envelope. An extensive bushfire in November 2014 destroyed large areas of suitable habitat for the Sandhill Dunnart. Only around 24 hectares of prime habitat for the Sandhill Dunnart (defined as unburnt E3/S6) remains un-impacted within the Disturbance Footprint.
- Although Southern Marsupial Mole (SMM) activity has been detected as having occurred in the area, the density of recorded moleholes is far lower (by a factor of around 100) than has been recorded by any other surveys. The moles require unconsolidated sands to be able to move through whilst underground and are believed to prefer a habitat of interlinked dunes. Approximately 11 hectares of land deemed suitable for SMMs to inhabit (being the vegetation communities S6/S8 found within dunes that are interlinked) will be disturbed.
- Less than 2ha of suitable habitat for Malleefowl exists within the Disturbance Footprint and there have been no observations of either Malleefowl or their presence around the MRUP area.
- No conservation significant invertebrates are likely to occur within the MRUP area.

Subterranean Fauna

No stygofauna were detected in the water within the area where it is proposed to mine. Stygofauna were detected in a few locations (2 out of 12 sampled sites) within the borefield area, but since the annual extraction rate is expected to be ~ 1% of the volume of water located in the borefield and involves taking less than 20% of the volume of water over the life of the mine it doesn't represent a threat to the stygofauna.

Troglofauna were detected in the Disturbance Footprint area but are believed to be widespread within the region and so the clearance doesn't represent a threat.

Hydrological Processes

A borefield will extract around 1.8GL/a (average) from an aquifer approximately 20m below the surface level estimated to contain more than 167GL in total. This aquifer is not connected with any groundwater dependent ecosystems. There will be drawdown within the borefield area, but it will not extend to the limits of the borefield and the only stygofauna located during sampling were in areas away from the proposed borefield location. Once the need for processing water ceases the water levels will return to roughly their pre-existing levels.

The water located beneath the mining areas is saline to hypersaline and any surplus water not used in mining and processing activities will be reinjected into the same aquifer downstream. Since the quality of the water in the aquifer deteriorates as it moves downstream the reinjection water will be of equal or better quality than the water in the receiving area. Any mounding associated with reinjection will be will not be sufficient to be able to reach any biologically active areas above. There are no connected ecosystems and the water levels will gradually return to pre-existing levels once mining activity ceases.

In short no associated groundwater dependent ecosystems will be impacted as a result of the development of the Proposal.

Inland Waters Environmental Quality

Tailings and waste process water will be deposited in a surface tailings facility for the first couple of years and will then be disposed of within pit areas that have been previously mined.

The surface tailings facility will be fully lined and modelling shows that any seepage will simply move vertically down to the aquifer below, where any contaminants will be filtered out from the groundwater by the action of the organic matter. The in-pit tailings facilities will not be lined and will drain into the aquifer running through the base of the tailings facility. Modelling work shows that contaminants are quickly filtered out by the organic material in the layers through which the seepage will pass and that any plume of contaminants will become indistinguishable from background levels by the time the plume reaches the mining boundary approximately 12 kilometres away. Any seepage through the side walls of the in-pit tailings facility will not move laterally by more than around 5m and therefore will not be able to interact with the environment.

Containment of contaminants (both metals/metalloids and radionuclides) essentially relies on the confines of paleochannels, gravity and the very same processes that caused the accumulation of the uranium and base metals in the first place, namely their capture by the carbonaceous material that exists at the surface of and below the water table. Its effectiveness means that there will be no adverse impacts.

Air Quality and Atmospheric Gases

The area naturally has occasionally high levels of dust emissions and the dust produced as a result of the development of the Proposal will be within the range of what occurs naturally. The extent of dust generation will be limited by the implementation of dust management measures.

Of particular concern is dust containing radioactive material, but this will be managed by ensuring that actual ore is kept wet enough to minimise dust generation and is contained throughout the processing stages until it is either packaged in sealed containers or deposited sub-aqueously into tailings storage facilities.

Operations will likely be fuelled by the use of diesel both for mining and for the power required to processes the material and operate other facilities (the use of gas as a fuel for generating electricity is being considered). Total carbon dioxide equivalent emissions were estimated at around 225,000 tonnes per year. Climate change is a global issue and needs to be considered in a global context. The uranium produced as a result of the development of the Proposal will generate electricity with less carbon emissions (measured on a life cycle basis) than any alternate fossil fuels and will effectively displace the equivalent around 50 million tonnes of carbon dioxide that would have been created had coal been burned to create the same amount of electricity. In greenhouse gas emission terms the net effect of the development of the Proposal is beneficial.

Human Health

The risk to human health is not something that can be dealt with via offsets. The risk will be managed down to a level where any residual risk is below the level where it gives any cause for concern.

Heritage

The development of the Proposal will have no known impacts on Aboriginal sites of an ethnographic nature (culturally significant) and no known impacts on sites of an archeological nature.

Rehabilitation and Decommissioning

Decommissioning and rehabilitation will be undertaken to a standard that ensures that the residual impacts will be sufficiently small that no further remediation is required and offsets would not be appropriate.

16.3 Mitigation Hierarchy

Avoidance

In the first instance the application of the mitigation hierarchy requires avoidance of impacts where possible.

Vimy will run an internal control procedure requiring any ground disturbing activity to receive an authority to proceed before clearance can commence; this will be achieved through the issuing of Ground Disturbance Activity Permits (GDAPs). It will require the exact co-ordinates of the area proposed to be cleared to be established and a justification for the extent of the clearance. The proposed area will be compared against known locations of areas that would be better avoided, such as locations of conservation significant flora or interlinked dune complexes, and where practicable disturbance to such area will be avoided.

Minimisation

The same GDAP system will be used to ensure that the areas being cleared are minimised as far as is practicable, and are rehabilitated as soon as possible once there is no longer a requirement for the area to be cleared. Timely rehabilitation will also help to control dust and to reduce the length of time when cleared land is not suitable as an environment for supporting local fauna.

There are a number of indirect impacts associated primarily with operations where minimisation of those impacts will be achieved by the implementation of management plans (MPs):

- The risk to flora and fauna associated with the increased risk of fire that comes with human activities in the area will be managed through a Fire MP (MRUP-EMP-025). Although ostensibly designed to control the risks fire poses to Vimy's operations it will also have the effect of decreasing the risk that Vimy's activities will engender a fire and ensure that any fires in the region, regardless of source, are controlled, supressed or otherwise managed in a manner designed to reduce their spread and lessen their impact as much as can practically be achieved.
- In what is a very arid environment almost all activity has the potential to create some dust and this dust may have an adverse impact on local flora and fauna. All of Vimy's activities will be subject to a Dust MP (MRUP-EMP-024) which will aim to minimise the creation of dust associated with such activities.
- The Project involves mining of ore which contains uranium and other radionuclides that are associated with its presence. Radioactivity has the potential to adversely impact flora, fauna and human health. The issue of radioactivity and its potential to create adverse impacts will be managed through:
  - Radiation MP (MRUP-EMP-028)
  - Radioactive Waste MP (MRUP-EMP-029)
  - Transport Radiation MP (MRUP-EMP-022) and
  - Mine Closure Plan (MRUP-EMP-031).
- Changed environmental conditions as a result of Vimy's activities in the region may encourage the presence of, and an increase in the numbers of feral animals that could present a threat to native flora and fauna. Vimy will monitor the presence of such feral animals as part of its Feral Animal MP (MRUP-EMP-006) and will take appropriate action as a result.
- Vimy's activities could result in the introduction of weeds into the area – this issue will be managed by applying appropriate hygiene measures as part of the Weed MP (MRUP-EMP-003)
- All water used will be extracted under RIWI Act licences and will be subject to Department of Water conditions including, if appropriate, a Groundwater Operating Strategy (MRUP-EMP-011) and the associated Water Conservation and Efficiency Plan which will ensure water use is minimised. Any surplus ware that is reinjected back into the aquifer will be done as part of a Managed Aquifer Recharge MP (MRUP-EMP-012).

- The mine plan and mining method will result in approximately 50-75% of the waste overburden and over 90% of the tailings being placed back within mined out pits which minimises the need to develop significant number of additional waste landforms and resultant impacts.

The selected mining method (dozer trap system and waste conveyance) used to backfill pits will minimise the overburden haulage using conventional mining fleets minimising the potential for vehicle generated dust and greenhouse gas emissions.

Rehabilitation

Aside from mining areas that will be subsequently used for the in-pit disposal of tailings, all other areas mined will be progressively backfilled and rehabilitated once an appropriate topographic profile has been achieved. This progressive backfill means that rehabilitation will also be a progressive activity. A Rehabilitation and Revegetation MP (MRUP-EMP-030) will be implemented under which each phase of rehabilitation will be monitored for effectiveness and adjustments made as appropriate to future phases.

The areas used for the disposal of tailings will also be rehabilitated once they are either full or no longer required for further use. They will be rehabilitated to a standard that negates the need to undertake offsets.

16.4 Impact on Receptors

As a result of the implementation of avoidance and minimisation measures and progressive rehabilitation where appropriate, there are not expected to be any significant lasting residual impacts on any environmental receptors.

16.5 Discussion

Table 16.1 below summarises the environmental offsets for each environmental factor identifying impacts, avoidance measures, minimisation measures, and mitigation and rehabilitation measures. It also covers the likelihood of rehabilitation success and an estimation of the extent of any residual impacts.

It is a requirement that a mitigation hierarchy is applied under which avoidance is preferred to minimisation; minimisation is preferred to rehabilitation; and offsets is regarded as the lowest preference option to be considered only if rehabilitation cannot achieve a reduction in residual impacts to a point where they are considered insignificant. Once operations at the MRUP have ceased and full rehabilitation has been implemented there will be no lasting significant residual environmental impact that would warrants offsets.

There is also a requirement to counterbalance any uncertainty concerning potential environmental impacts through the application of offsets. There will undoubtedly be people genuinely concerned about any number of issues associated with the production of a product containing uranium and associated uncertainty about its future use and associated impacts.

Australia has in place legislation that ensures that it meets its obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons* (NPT) and the *Zangger Committee* (which determines what material and equipment needs to be covered under the NPT) and that it exercises its commitment to the Nuclear Suppliers Group export control guidelines. In particular:

- *Nuclear Non-Proliferation (Safeguards) Act 1987* – regulates nuclear material in Australia and is administered by the Australian Safeguards and Non-Proliferation Office (ASNO)
- *Customs Act 1901 (Prohibited Exports) Regulations* – prescribes prohibited exports and is administered by the Australian Customs and Border Protection Service; and
- *Weapons of Mass Destruction (Prevention and Proliferation) Act 1995* – covers exports not controlled under the Customs Act which may contribute to weapons of mass destruction programs and is administered by the Department of Defence.

There is therefore no risk, above a level of complete insignificance, associated with whether uranium exported from Australia can find its way into any use other than for the peaceful purposes. Those peaceful purposes are predominantly the generation of low carbon emission electricity.

There will be people who are concerned that even if uranium is only used for peaceful purposes there is some uncertainty associated with the effects of exposure to the radiation associated with nuclear power; in particular there are risks associated with the disposal of the waste fuel from nuclear reactors and there are risks associated with the possibility of a nuclear accident leading to Australian uranium contributing to a nuclear disaster.

High level nuclear waste can be safely disposed of, on a permanent basis, in deep geologic deposits. There is no uncertainty about whether they work, merely the lack of a social licence and/or the political will to implement them as a solution for most countries which operate nuclear reactors and therefore need such depositories. Finland is currently in the process of building such depository and Sweden is expected to follow suit.

The latest generation of nuclear reactors is inherently safer than previous generations. The previous generation technology was itself very safe when properly managed. Although the Fukushima nuclear accident was rightly regarded as a catastrophic incident, no person has actually died yet as a direct result of exposure to radiation from the event; and it is entirely possible that no-one will.

The export of uranium is sufficiently well controlled and the risks associated with the operation of nuclear reactors are sufficiently well understood and controlled that the act of mining uranium for subsequent export should not be regarded as having an associated risk in relation to nuclear weapons, nuclear waste or nuclear accidents.

There is also substantial uncertainty about the extent of the risks associated with climate change. In the context of the MRUP there is a risk that extreme weather events associated with climate change could be far worse than those currently expected (as a result of modelling work) and that very high rainfall events could lead to flooding and a consequent adverse impact upon the containment of tailings. However the capacity of the local sand dunes to absorb rainfall is very high (>5m/day) and will prevent widespread flooding; water will accumulate in local depressions, where overlying sand dunes are not present and then gradually evaporate or infiltrate. Moreover the use of in-pit tailings disposal where drainage is directly into the underlying aquifer means that in the event of a very high rainfall event the volume of water in the aquifer would increase leading to an overall dilution of the plume of contaminants seeping from the base of the TSF.

Overall there are no significant residual environmental impacts and no uncertainty that would require offsets to counterbalance it.

It is acknowledged that there is a time lag between the loss of a vegetation community or any conservation significant flora and when appropriate self-sustaining vegetation communities can be properly re-established (including any conservation significant flora) and that this temporary loss may be regarded as an adverse impact. Further consultation with the Commonwealth's Department of Environment will be undertaken to establish the extent to which such a temporary loss might be regarded as a residual impact and might be regarded as significant thereby necessitating an offset requirement.

It is also acknowledged that there is a time lag between the loss of potential fauna habitat as a result of clearing and its restoration as part of rehabilitation to a habitat capable of supporting fauna, and that this temporary loss may be regarded as an adverse impact. Further consultation with the Commonwealth's Department of Environment will be undertaken to establish the extent to which such a temporary loss might be regarded as a residual impact and might be regarded as significant thereby necessitating an offset requirement.

Table 16.1 Environmental Offsets Table

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Flora and Vegetation											
Clearing of 3,787ha of native vegetation (worst case scenario as ~78% of Disturbance Footprint was extensively burnt in November 2014).	The potential to avoid clearing is limited by the location of the mineralised orebodies and the required infrastructure to mine and process this deposit.	Clearing of native vegetation will be minimised through the application of the GDAP system.	Ground disturbance during the construction and operational phases of the Project will be managed through the application of a Ground Disturbing Activity Permit (GDAP; MRUP-POL-001) via the Ground Disturbance MP (MRUP-EMP-019). This will control all clearing of native vegetation to ensure that it is kept to a minimum and approved 3,787ha of clearing is not exceeded over the life of the Project.	All mine voids will be backfilled to a topographic surface that resembles the pre-mine land surface where practicable. There will be depressions where insufficient material is available, and in these cases mine voids will be backfilled with a minimum of 10m above the water table. All post-mine landforms, including backfilled mine voids, Overburden Landforms (OLs), Tailings Storage Facilities (TSFs) and infrastructure disturbance areas, will be rehabilitated with native vegetation similar to pre-mine native vegetation.	**Can the environmental values be rehabilitated / evidence?** Key drivers influencing the functioning of the pre-mine environment and distribution of native vegetation have been identified. The mining schedule has been developed to facilitate the capturing of sufficient required rehabilitation materials to enable re-establishment of the pre-mine ecosystem functioning. Given the Aeolian, sedimentary and highly weathered nature of the soil and overburden materials, their properties are unlikely to restrict revegetation growth and establishment. Previous rehabilitation of an old trial mine area in the Shogun Deposit shows that rehabilitation of provenance Eucalypt species is achievable with minimal management of soils, overburden materials and suitable reconstruction of the backfilled soil profile. Consequently, it is considered rehabilitation utilising a defined prescription that aims to re-establish a functioning ecosystem that will facilitate successful rehabilitation of disturbance areas. Progressive rehabilitation will be undertaken throughout the operational LOM which will enable adaptive management of rehabilitation practices to ensure that they are continually optimised to achieve the desired stakeholder agreed closure goal/s. **How will rehabilitation practices be managed onsite?** All rehabilitation activities will be managed through the implementation of a Rehabilitation and Revegetation MP (RRMP) (MRUP-EMP-030). The RRMP outlines the rehabilitation methodology and schedule aimed to return a functioning ecosystem to the area post-mining operations. This MP also outlines monitoring requirements to ensure that the correct information is collected to enable adaptive management of rehabilitation and revegetation practices. An Environmental Induction and Training MP (MRUP-EMP-039) will also be developed to provide specific information to rehabilitation operators regarding how to undertake rehabilitation activities and the key outcomes required during the process (i.e. to get their buy-in). **What is the type of vegetation being rehabilitated?** Detailed soil and terrain analysis work undertaken for the Project has identified that the thickness of the surficial Quaternary Dunal Sand governs the distribution of the native vegetation, and overall functioning of the ecosystem across the MRUP. It is therefore possible to manipulate this sand thickness in rehabilitation to achieve the most economically feasible and environmentally sound outcome that meets the stakeholder agreed criteria. The soil profile underlying the E3 vegetation type represents best balance between rehabilitation costs (i.e. volume of material to move), environmental function (i.e. allowing for infiltration and recharge of the rainfall) and rehabilitation risks (i.e. the role of the sand cover prevents the problematic properties of the underlying clayey soils from being expressed at the rehabilitation surface). In areas where the depth of sand cover will be minimised, only on flat surfaces (i.e. top of the TSFs, OLs) the revegetation type will be trending towards an E6 community for the OL, whilst the TSF will likely represent a small shrubland community, as there will be a need to ensure roots of the native vegetation do not interact with the tailings material.	The proposed area to be cleared for the construction of the MRUP (3,787ha) is classified under the Interim Biogeographical Regionalisation for Australia (IBRA) as occurring within the Shield subregion (GVD1) of the Great Victoria Desert bioregion (Barton and Cowan 2001). MCPL vegetation community S6 has affinities with the "Yellow Sand Plain Communities of the Great Victoria Desert" Priority 3 (ii) ecological community estimated to be 1,692,000ha in total in the broader region. Area of disturbance to this vegetation community is estimated to be <0.33% for the Disturbance Footprint and <0.66% for the entire MRUP Development Envelope. The native vegetation within the MRUP is not considered a specific habitat supporting a particular fauna assemblage (i.e. foraging habitat) or ecosystem function. It is broadly representative of the wider Yellow Sand Plain Community (YSC) and thus its disturbance and subsequent rehabilitation in response to the MRUP is not expected to have a significant impact on either the fauna of the area, or the function of the system. Based on the above information, the clearing of a maximum 3,787ha for the MRUP is not considered a 'significant residual impact" and thus meets the EPA's Objective for flora and vegetation, in accordance with EAG 9 (EPA 2013). No offset is therefore required. It is acknowledged that there is a time lag between the loss of a vegetation community or any conservation significant flora and when appropriate self-sustaining vegetation communities can be properly re-established (including any conservation significant flora) and that this temporary loss may be regarded as an adverse impact. Further consultation with the Commonwealth's Department of Environment will be undertaken to establish the extent to which such a temporary loss might be regarded as a residual impact and might be regarded as significant thereby necessitating an offset requirement. It is also acknowledged that there is a time lag between the loss of potential fauna habitat as a result of clearing and its restoration as part of rehabilitation to a habitat capable of supporting fauna, and that this temporary loss may be regarded as an adverse impact. Further consultation with the Commonwealth's Department of Environment will be undertaken to establish the extent to which such a temporary loss might be regarded as a residual impact and might be regarded as significant thereby necessitating an offset requirement.	Not expected to be required as there will be no significant residual impact. Discussions will be undertaken with the Commonwealth's Department of Environment to determine if the time lags between clearance and full rehabilitation constitute a significant impact that might warrant offsets.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
					What is the time lag for rehabilitation activities to commence and for a sustainable rehabilitation to be developed? Based on the current mine schedule, significant rehabilitation works cannot commence until Year 6, after commencement of the Project. However a small amount will be possible where clearance required for construction purposes is no longer required for operations. The first significant landform to be rehabilitated will be the above-ground TSF, followed by the backfilled mine void sections in the Ambassador Deposit in Year 7. Monitoring of progressive rehabilitation will commence in Year 6 and will likely continue until 5 years after mining ceases. Annual monitoring of analogue sites (both burnt and unburnt) and historic rehabilitation onsite will add to the existing baseline database. Monitoring results will guide the development of the rehabilitation prescription through adaptive management. Provided that suitable growing seasons prevail after the rehabilitation of disturbed sites, it is envisaged that within 5 years KPIs will indicate completion criteria for closure will be met for this site.						
Direct impacts on Conservation Significant Flora Species (CSFS).	Although the potential to avoid CSFS is restricted, as the location of the minesite is dictated by the location of the mineralised orebody, efforts will be made to avoid any CSFS during siting and construction of infrastructure.	Clearing of areas that are potential habitat for CSFS will be minimised through the application of the GDAP system.	The protection and management of CSFS within the MRUP will be controlled by the Threatened and Conservation Significant Flora and Vegetation MP (MRUP-EMP-002). Ground disturbance during the construction and operational phases of the Project will be managed through the application of a Ground Disturbing Activity Permit (GDAP; MRUP-POL-001) via the Ground Disturbance MP (MRUP-EMP-019). This will control all clearing of native vegetation to ensure any disturbance of CSFS is kept to a minimum and that the number of plants impacted is accurately captured. Revegetation will predominantly occur through the collection and subsequent application of seeds and other plant material (including the lignotubers) harvested during the initial clearing process. To the extent that CSFS are affected by clearing activities, their seeds and potentially other plant material capable of regrowth will be part of the material harvested and subsequently used for rehabilitation purposes.	Given that there will be limited impact on CSFS, no specific rehabilitation or restoration of these species will be included in rehabilitation works for the site. All rehabilitation will be progressively implemented and will be monitored for effectiveness, including the ability or otherwise of vulnerable species to regrow from seed or plant material harvested. In the event it becomes apparent that when an area containing CSFS has been cleared there is no regrowth in the area where the material has subsequently been applied, further investigation will be undertaken to establish the reason why there was no regrowth and whether alternative measures could be implemented to ensure that there is representation in rehabilitated area of CSFS that have been previously growing in cleared areas.	Rehabilitation measures will be monitored for effectiveness including in relation to CSFS. In the event that rehabilitation of CSFS is proving ineffective, an investigation will be undertaken and adjustments made as appropriate until acceptable outcomes are achieved.	Negligible potential direct impact on CSFS will occur due to their limited distribution within the proposed Disturbance Footprint. In total only the following will potentially be disturbed by the MRUP Disturbance Footprint: 38 *Hibbertia crispula* plants (P1-vulnerable); 0.27% of regional total 8 *Dampiera eriantha* plants (P1); 0.43% of regional total 128 *Isotropis canescens* (P2); 4.25% of regional total 2 *Styphelia* sp. Great Victoria Desert plants (P2); 1.84% of regional total 63 *Comesperma viscidulum* plants (P4); 3.32% of regional total 3,941 *Conospermum toddii* plants (P4); 8.62% of regional total 945 *Grevillea secunda* plants (P4); 7.40% of regional total 22 *Dicrastylis cundeeleensis* plants (P4); 0.31% of regional total and 56 *Olearia arida* plants (P4); 1.83% of regional total. No change in the conservation status of conservation significant flora species is therefore expected. Based on the above information, the MRUP will not have a significant residual impact and will not jeopardise the EPA's objective for flora and vegetation, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Indirect impacts on native vegetation and Conservation Significant Flora Species (CSFS).	Where possible, activities that generate adverse products (i.e. dust, radiation) or processes (i.e. groundwater dewatering) that may impact on native vegetation and CSFS will be avoided.	If activities resulting in indirect impacts to native vegetation and CSFS cannot be avoided, then measures will be implemented to modify causal activities and minimise these impacts.	Indirect impacts associated with dust, weeds, radiation, fire, feral animals, and groundwater abstraction, reinjection and quality will be managed according to the following management plans (MPs): Dust MP (MRUP-EMP-024) Weed MP (MRUP-EMP-003) Radiation MP (MRUP-EMP-028) Radioactive Waste MP (MRUP-EMP-029) Fire MP (MRUP-EMP-025) Feral Animal MP (MRUP-EMP-006) Groundwater MP (MRUP-EMP-010) Groundwater Operating Strategy (MRUP-EMP-011) Managed Aquifer Recharge MP (MRUP-EMP-012).	All areas that have been disturbed will ultimately be rehabilitated under the Rehabilitation and Revegetation Management Plan (MRUP-EMP-030). Any areas cleared for construction purposes that are not subsequently required during operations will be progressively rehabilitated. The progressive rehabilitation of any available disturbed sites will be monitored and information on rehabilitation success will be reviewed and fed back into continual improvement of rehabilitation protocols.	**Can the environmental values be rehabilitated / evidence?** Key drivers influencing the functioning of the pre-mine environment and distribution of native vegetation have been identified. The soil profile underlying vegetation that is indirectly impacted remains intact and therefore pedogenic processes that facilitate the germination and establishment of the native vegetation remain intact, even though the above-ground portion of the vegetation has been impacted. The ability to rehabilitate these areas is therefore appreciably easier than having to rehabilitate a completely reconstructed soil profile. Previous rehabilitation of an old trial mine area in the Shogun Deposit shows that rehabilitation of provenance Eucalypt species is achievable with minimal management of soils, overburden materials and suitable reconstruction of the backfilled soil profile. Consequently, it is considered rehabilitation utilising a defined prescription that aims to re-establish a functioning ecosystem that will facilitate successful rehabilitation of disturbance areas. There are numerous examples of successful rehabilitation of drill pads, borrow pits and other surface disturbances where rehabilitation of *in situ* soil profiles with native vegetation is considered achievable. **How will rehabilitation practices be managed onsite?** Native vegetation that is indirectly impacted by the MRUP operations will be rehabilitated in accordance with the Rehabilitation and Revegetation MP (MRUP-EMP-030). The RRMP outlines the rehabilitation methodology and schedule aimed to return a functioning ecosystem to the area post-mining operations. This MP also outlines monitoring requirements to ensure that the correct information is collected to enable adaptive management of rehabilitation and revegetation practices. An Environmental Induction and Training MP (MRUP-EMP-039) will also be developed to provide specific information to rehabilitation operators regarding how to undertake rehabilitation activities and the key outcomes required during the process (i.e. to get their buy-in). **What is the type of vegetation being rehabilitated?** Where practicable, areas that have been indirectly impacted by MRUP operations will be restored to a vegetation community similar to its original state. It is however acknowledged that information on the seed ecology of every species in the MRUP is not available or known and that there is a potential that some indirectly impacted recalcitrant species may not be re-established. Although this is the case the overall description of the vegetation community is unlikely to vary, unless the keystone species are recalcitrant. **What is the time lag for rehabilitation activities to commence and for a sustainable rehabilitation to be developed?** All identified indirectly impacted vegetation will be rehabilitated as soon as it practicable. Provided that suitable growing seasons prevail after revegetation of the rehabilitated areas, it is envisaged that an established revegetation system will be restored within 5 years after rehabilitation. Given the limited presence and distribution of CSFS within the overarching Development Envelope, the potential risks for indirect impact on these species/plants are considered small. As a result no rehabilitation of indirectly impacted CSFS is expected to be required.	The risk of indirect impacts on CSFS is low given their limited distribution within the Development Envelope and the restricted nature of development surrounding proposed infrastructure. Based on the above information, the indirect impacts will not have a significant residual impact and will not jeopardise the EPA's objective for flora and vegetation, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Terrestrial Fauna											
Direct impacts on native vertebrate fauna species. (Clearing of vegetation may result in death or injury of individual fauna, loss or fragmentation of fauna habitat and consequential displacement of populations or subpopulations.) Individual animals may die or be wounded due to such incidents as vehicular strike.	The potential to avoid clearing is limited by the location of the mineralised orebodies and the required infrastructure to mine and process this deposit.	Clearing of native vegetation will be minimised through the application of the GDAP system. This system: Minimises ground disturbance as far as practicable Avoids clearing habitat suitable for MNES listed species where practicable Avoids or minimise the introduction and spread of feral competitors (such as rabbits) Avoids or minimise the introduction and spread of feral predators. Measures will be introduced to minimise vehicle strikes, such as speed limits or avoiding key times if vehicle strike records show that such minimisation measures are warranted.	Ground disturbance during the construction and operational phases of the Project will be managed through the application of a Ground Disturbing Activity Permit (GDAP; MRUP-POL-001) via the Ground Disturbance MP (MRUP-EMP-019). This will ensure that any key locations regarded as environmentally sensitive (such as interlinked sand dunes or refuge unburnt areas) are avoided where practicable. The extent of all disturbance will be minimised to limit habitat loss. A record of all vehicle strikes will be kept. If significant strikes are recorded in a particular location an investigation will be undertaken to determine the cause; if practicable remedial measures will be implemented to avoid further strikes in that location.	The GDAP system will monitor disturbance and ensure that progressive rehabilitation takes place as soon as is practicable.	Progressive rehabilitation will be undertaken throughout the Project life which will enable adaptive management of rehabilitation practices to ensure that they are continually optimised to achieve the agreed closure criteria.	There will inevitably be some impact upon terrestrial fauna as a result of vehicle strikes. The numbers will be monitored and further mitigation measures will be introduced in the event that trigger levels for fauna strikes are exceeded. Whilst there will be a loss of some general habitat and the potential loss of individual animals, there will be no significant residual impact and therefore no offsets will be required.	Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Conservation Significant Fauna Species (CSFS) **Sandhill Dunnart** – No evidence of a significant presence in area and given the recent bushfire only around 24ha of prime habitat (defined as unburnt S6/E3) remains within the Disturbance Footprint. **Southern Marsupial Moles** – Evidence of past existence in area but molehole density is far lower (by a factor of 100) than all other locations. Project area is at the edge of known distribution range. Suitable habitat within Disturbance Footprint (defined as S6/S8 situated within interlinked dunes) is only ~11ha. **Malleefowl** – Less than 2ha of suitable habitat found to exist in Disturbance Footprint and no signs of presence in the area by individuals. Recent fire has burnt ~78% of the proposed Disturbance Footprint resulting in an environment that will not support Sandhill Dunnarts or Malleefowl until suitable regrowth has occurred.	Avoidance measures, in addition to those applied in relation to all vertebrate fauna, are not required for the CSFS as: Despite recent intensive site surveys no significant Sandhill Dunnart presence has been located in the immediate vicinity of MRUP area. As the Disturbance Footprint has been extensively burnt, there will be few, if any, individuals within that area. The Project lies at the SW edge of very wide distribution within the sandy deserts of central Australia and that surveys to date of the **Southern Marsupial Mole** indicate that the population is of a low density. All recent surveys revealed an absence of any signs of **Malleefowl** thus it is considered highly unlikely that a Malleefowl population is present in the Project area.	Clearing of native vegetation will be minimised through the application of the GDAP system. This system: Minimises ground disturbance as far as practicable Avoids clearing habitat suitable for MNES listed species where practicable Avoids or minimise the introduction and spread of feral competitors (such as rabbits) Avoids or minimise the introduction and spread of feral predators.	Ground disturbance during the construction and operational phases of the Project will be managed through the application of a Ground Disturbing Activity Permit (GDAP) via the Ground Disturbance MP (MRUP-EMP-019). This will ensure that any key locations regarded as environmentally sensitive (such as interlinked sand dunes or refuge unburnt areas) are avoided where practicable. The extent of all disturbances will be minimised to limit habitat loss. All site based workers will be educated as part of the Environmental Induction and Training MP (MRUP-EMP-039) to recognise conservation significant fauna (such as the Sandhill Dunnart, the Southern Marsupial Mole, the Woma Python and the Malleefowl) that may potentially inhabit the area. This will also include training to recognise any evidence of fauna existence (such as the presence of Malleefowl mounds or moleholes). All site based workers will be encouraged to report observations or evidence of the presence of such conservation significant fauna. All observations of conservation significant fauna will be entered into the central database according to the Document and Data Control MP (MRUP-EMP-038) protocols. If appropriate (i.e. the observation is not believed to be transient), areas where conservation significant fauna are thought to be present will either be avoided, where practicable, or subject to appropriate measures to reduce the likelihood of adverse impacts.	The GDAP system will monitor disturbance and ensure that progressive rehabilitation takes place as soon as is practicable.	Progressive rehabilitation will be undertaken throughout the Project life. This will enable adaptive management of rehabilitation practices to ensure that they are continually optimised to achieve the agreed closure criteria.	Whilst there will be a loss of some general habitat and the potential loss of individual animals, there will be no significant residual impact and therefore no offsets will be required.	Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Indirect environmental effects upon fauna by the proposed Project may include: altered fire regimes, increases in feral animal numbers, noise and light spill and any changes in air quality (especially dust).	The potential to avoid indirect environmental effects upon fauna is limited by the location of the mineralised orebodies and the required infrastructure to mine and process this deposit. Avoidance of such direct impacts will be managed through the application of appropriate MPs as listed in the section dealing with mitigation.	Clearing of native vegetation will be minimised through the application of the GDAP system. Mechanical works and operational activities (i.e. vehicle activity) will also be minimised to reduce the indirect environmental effects where practicable.	Indirect impacts will be limited by the application of the following Vimy MPs: Dust MP (MRUP-EMP-024) Fire MP (MRUP-EMP-025) Feral Animal MP (MRUP-EMP-006) Radiation MP (MRUP-EMP-028) Radioactive Waste MP (MRUP-EMP-029) Rehabilitation and Revegetation MP (MRUP-EMP-030). Site-wide management practices will be enforced to ensure no unnecessary disturbance occurs to fauna, and will include: Restricted off-road driving Enforced vehicle speed limits An ongoing program of fauna monitoring will be undertaken to ensure feral animal numbers are not increasing or no fauna are encouraged to site by attraction to any facilities.	The GDAP system will ensure that habitat for conservation significant fauna is avoided as far as is practicable. Management measures will also ensure that any indirect impacts upon terrestrial fauna are quickly identified and remedied and that any lasting impact can be prevented. The progressive rehabilitation of disturbed sites will be monitored and information on rehabilitation success will be reviewed and feedback into continual improvement of rehabilitation protocols. This aims to ensure that established KPIs on functioning and stable ecosystems to closely resemble analogue sites will be met.	All identified indirectly impacted, fauna and vegetation habitats will be rehabilitated as soon as it practicable. Progressive rehabilitation will be undertaken throughout the life of the Project. This which will enable adaptive management of rehabilitation practices to ensure that they are continually optimised to achieve the agreed closure criteria. Whilst there will be an alteration of some general habitat and the potential loss of individual animals (i.e. as a result of vehicle strikes), monitoring and further mitigation measures will be introduced in the event that trigger levels for fauna strikes are exceeded. Hence there will be no significant residual impact and therefore no offsets will be required.	Following the cessation of mining, Vimy will decommission the mine in accordance with the Mine Closure Plan (MRUP-EMP-031) and any remaining disturbed areas will be rehabilitated in accordance with the Rehabilitation and Revegetation MP (MRUP-EMP-030). It is expected that over time the revegetated areas will become established and provide suitable fauna habitat resulting in minimal residual impacts. Taking into account the recent fire which reduced the health of the vegetation to Degraded, the minimisation of ground disturbance/clearance areas through the application of the GDAP system, the progressive nature of the proposed rehabilitation that will be undertaken and control measures designed to minimise the effect of with fire and feral predators, the residual impact on terrestrial fauna as a result of the development of the Project is not expected to be significant and therefore will not to warrant any offset. On this basis, Vimy is confident that the EPA's objective with respect to terrestrial fauna can be met.	Not required as no significant residual impact.				
Subterranean Fauna											
Species of stygofauna may be directly impacted by planned open cut mining, and the dewatering to precede it. The aquifer underlying the mining area and the reinjection area is saline to hypersaline (up to 139,700mg/L TDS – Rockwater 2015a) and no stygofauna were detected during surveys (Rockwater 2015c). No stygofauna believed to be present in mining areas.	The potential to avoid dewatering is limited by the need to dewater prior to mining.	There is no need for minimisation as the stygofauna do not exist in the areas proposed for mining due to the salinity of the groundwater.	Management and monitoring of groundwater will be undertaken as part of the Groundwater Operating Strategy (MRUP-EMP-011), Managed Aquifer Recharge MP (MRUP-EMP-012) and the Environmental Monitoring MP (MRUP-EMP-032).	Recovery of water levels immediately following the cessation of mining will be rapid through natural recharge from meteorological waters.	Due to the nature of the aquifer and the minimal dewatering occurring during mine operations, the likelihood of groundwater levels returning to background levels is high.	No significant residual impact and therefore no offsets required.	Not required as no significant residual impact.				
Species of stygofauna may be impacted by the extraction of groundwater as two aquatic worm species were sampled in low densities from the proposed borefield site – the Kakarook North aquifer.	Two species, although in low densities, cannot be avoided although their presence was outside area where bores will be located.	The annual rate of water extraction from the Kakarook North aquifer will represent ~1% of the volume of water conservatively modelled to be present (Rockwater 2015a).	Management and monitoring of groundwater will be undertaken as part of the Groundwater Operating Strategy (MRUP-EMP-011) and utilising protocols within the Environmental Monitoring MP (MRUP-EMP-032).	Recovery of water levels immediately following the cessation of mining will be rapid through natural recharge from meteorological waters.	Due to the recharge capacity and sand nature of the aquifer, the likelihood of species rehabilitation is high.	No significant residual impact and therefore no offsets required.	Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Species of stygofauna may be impacted by the reinjection of saline water. No stygofauna detected in reinjection area and believed not to be present due to high salinity.	Levels of salinity at the site of reinjection are the same as or higher than that of the groundwater at the proposed pits at the level from which extraction will take place. The level of salinity recorded during pump testing 58,000 to 66,000mg/L (Rockwater 2015a) and therefore the area is unlikely to support stygofauna as maximum salinities for prospective stygofauna are 50,000mg/L (EPA 2003).	There is no need for minimisation as the stygofauna do not exist in the areas proposed for mining due to the salinity of the groundwater.	Management and monitoring of reinjection into the groundwater will be undertaken following protocols defined within Groundwater Operating Strategy (MRUP-EMP-011), Managed Aquifer Recharge MP (MRUP-EMP-012) and the Environmental Monitoring MP (MRUP-EMP-032).	The rehabilitation of the effects of water recharge on stygofauna is not applicable as stygofauna are not located in such high salinities.	The rehabilitation of the effects of water recharge on stygofauna is not applicable as stygofauna are not located in such high salinities.	There are not expected to be any long term significant residual environmental impacts in relation to subterranean fauna.	Not required as no significant residual impact.				
Species of troglofauna may be directly impacted by the MRUP 3,787ha Disturbance Footprint. Only 3 species of troglofauna were detected during site sampling.	The potential to avoid disturbance is limited by the location of the mineralised orebodies and the required infrastructure to mine and process this deposit.	Areas disturbed will be minimised through the application of the Ground Disturbance Activity Permit (GDAP) system.	Protocols within the Ground Disturbance MP (MRUP-EMP-019) will activity manage all ground disturbance activities within the Disturbance Footprint.	Protocols within the Vimy Rehabilitation and Revegetation MP (MRUP-EMP-030) will reconstruct the profile comprised of the Miocene and Oxidised Eocene sediment layers, and return a soil profile to the top 1m similar to the original profile.	The return of troglofauna to rehabilitated disturbance sites is likely.	Evidence indicated that the troglofauna habitat is potentially widespread over a distance of at least 50km in the broader region. It also appears unlikely that the abundance, diversity and geographic distribution of the troglofauna community or the conservation status of any individual troglofauna species at MRUP would be impacted by the Project (Rockwater 2015c). Therefore there will be no significant residual impact from the proposed Project on troglofauna, and therefore no offsets are required.	Not required as no significant residual impact.				
Species of subterranean troglofauna may be indirectly impacted by the operations of the proposed project with habitat impacted via accidental spills of hydrocarbons or toxic chemicals.		Hydrocarbons, chemicals and any toxic materials will be appropriately stored and bunded to minimise the potential for spillage according to protocols detailed within the Chemical and Hydrocarbon MP (MRUP-EMP-037).	The Spill Response MP (MRUP-EMP-027) will detail the protocols for immediate reporting and management of hydrocarbon or chemical spills occurring onsite.	The Spill Response MP (MRUP-EMP-027) will detail the protocols for the immediate removal of any contaminated soil caused by an uncontained spill, to be disposed of according to specified procedures within the MP. The affected site will then be included in the progressive rehabilitation program when available.	Once any contaminated soil has been removed, the likely rehabilitation success for the site, utilising protocols within the Rehabilitation and Revegetation MP (MRUP-EMP-030), is high.		Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Hydrological Processes – Groundwater											
Abstraction from Kakarook North Borefield (up to 3.0GL/a; expected average per year over Life of Mine 1.8GL/a).	Required to satisfy water demand for processing plant at around 1.8GL/a – therefore cannot be avoided.	Principle of Water Conservation to be applied at all levels of the MRUP to reduce demand on groundwater. Groundwater supplemented with dewatering water to reduce demand on 'fresher' groundwater from the borefield, but use of dewatering water constrained by Cl^- levels.	Groundwater abstraction managed through the implementation of a Groundwater MP (MRUP-EMP-010). Groundwater abstraction will be managed by a 5C licence to take groundwater. Conditions imposed on this licence will be captured by a Groundwater Operating Strategy (MRUP-EMP-011). Overall principles of Water Conservation and Efficiency documented in the Groundwater Operating Strategy (MRUP-EMP-011).	No rehabilitation required as groundwater levels will rebound back to baseline levels following completion of the Project. No impact on terrestrial ecosystems is expected as groundwater levels occur at ~20m bgl and there is no surface expression in the region.	Likelihood of groundwater levels returning to background levels, within a reasonable timeframe, is high due to high rainfall event recharge of the overlying sediments.	Given groundwater levels will rebound after cessation of the MRUP and that there are no groundwater dependent ecosystems (GDEs) reliant on the aquifer, no significant residual impact will occur and the abstraction of groundwater from the Kakarook North Borefield will not jeopardise the EPA's objective for Hydrological Processes, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				
Abstraction of groundwater by dewatering (up to 2.5GL/a) – this will occur in advance of mining in areas proposed to be mined.	Required to ensure that water level is below the level at which mining is occurring and therefore cannot be avoided. Also required to satisfy water demand for dust suppression and beneficiation of ore at around 0.85GL/a.	Principle of Water Conservation and Efficiency to be applied at all levels of the MRUP to reduce demand on groundwater.	Groundwater abstraction managed through the implementation of a Groundwater MP (MRUP-EMP-010). Groundwater abstraction will be managed by a 5C licence to take groundwater. Conditions imposed on this licence will be captured by a Groundwater Operating Strategy (MRUP-EMP-011). Overall principles of Water Conservation and Efficiency documented in the Water Operating Strategy (MRUP-EMP-021).	No rehabilitation required as groundwater levels will rebound back to baseline levels following completion of the Project. No impact on terrestrial ecosystems is expected as groundwater levels occur at ~40m bgl and there is no surface expression in the region.	Likelihood of groundwater levels returning to background levels, within a reasonable timeframe, is high due to the pits being backfilled (i.e. prevents evaporative loss of water) and the shallow intercept of the mine pits below the water table; hence minimal dewatering required for mining of the deposit.	Given the extent of dewatering required for this Project is minimal, groundwater levels will rebound soon after cessation of mining. There are no groundwater dependent ecosystems (GDEs) reliant on the aquifer and therefore no significant residual impact will occur. Dewatering of the paleodrainage channel aquifer will therefore not jeopardise the EPA's objective for Hydrological Processes, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				
Recharge of groundwater at Reinjection Borefield reinjection of up to 1.5GL/a of excess water not suitable for reuse	Excess groundwater (from dewatering activities) needs to be discharged in an environmentally sound manner – therefore cannot be avoided.	Principle of Water Conservation and Efficiency will result in preferential use of this water minimising the surplus requiring reinjection.	Reinjection of excess water will be managed by the Managed Aquifer Recharge (MAR) MP (MRUP-EMP-012) whose primary objective is to ensure that no adverse impacts on the groundwater system occurs in response to reinjection.	No rehabilitation required as groundwater levels will rebound back to baseline levels following cessation of the reinjection. No impact on terrestrial ecosystems is expected as groundwater levels occur at ~40m bgl and there is no surface expression in the region.	Likelihood of groundwater levels returning to background levels, within a reasonable timeframe, is high due to the small quantity of water being reinjected into the aquifer system (i.e. 1.5GL/a). Given the high transmissivity of the aquifer, there is almost no possibility that mounding will come close to the biologically active zone above (and monitoring would prevent such an outcome), and it will rapidly dissipate following cessation of recharge.	Given the extent of recharge of excess water into the paleodrainage channel aquifer is minimal, groundwater mounding will return to background levels soon after cessation of reinjection. There are no groundwater dependent ecosystems (GDEs) reliant on this aquifer and therefore no significant residual impact will occur. Proposed recharge of the excess water into the paleodrainage channel aquifer will therefore not jeopardise the EPA's objective for Hydrological Processes, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Recharge of excess water at Reinjection Borefield impacts on water quality.	Excess groundwater needs to be discharged in an environmentally sound manner – therefore cannot be avoided.	Principle of Water Conservation and Efficiency will result in preferential use of this water minimising the surplus requiring reinjection.	Principles of Water Protection (as outlined in the Water Operating Strategy: MRUP-EMP-021) will be applied for recharge operations to ensure minimal impact on groundwater quality and reduce long-lasting impacts which may occur at the tenement boundary. The groundwater recharge process and operation of the Reinjection Borefield will be managed primarily by the Managed Aquifer Recharge MP (MRUP-EMP-012,), the corresponding Groundwater MP (MRUP-EMP-010) and Groundwater Operating Strategy (MRUP-EMP-011).	Constraints on the quality of water to be recharged will be set based on the quality of the receiving aquifer system. Exceedances will likely result in cessation of recharge activities until groundwater water quality returns to background ranges. No impact on terrestrial ecosystems is expected as groundwater levels occur at ~40m bgl and there is no surface expression in the region.	As the quality of the groundwater within the proposed Reinjection Borefield is of 'worse' quality than that extracted from the mining areas (i.e. during dewatering operations) no restriction on recharge of excess groundwater water is expected for the majority of the operation. No long term impact on background groundwater quality is expected as a result of the recharge. Strategies are in placed minimise the risk of reinjecting with water with poorer quality than existing and to detect if this occurs. Strategies are also in place to mitigate any exceedance of quality parameters.	Given no adverse impact on groundwater quality is expected and that no GDEs are reliant on this aquifer, no significant residual impact will occur. Proposed reinjection operations will therefore not jeopardise the EPA's objective for Hydrological Processes, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				
Hydrological Processes – Surface Water											
Direct impact of operations on surface water flows.	No connected surface water flows thus no surface water dependent ecosystems are present so no operational areas avoid impacts.	No connected surface water flows thus no surface water dependent ecosystems are present so no operational areas minimise impacts.	Surface water flows restricted to minor sheet flows and captured in localised topographic depressions – the entire region functions as a playa system. Sandy nature of the surface soils result in high infiltration rates that typically exceed rainfall rates of all durations. Location of operational infrastructure will consider the topography and the potential impacts of filling or dissecting the topographic depressions on future surface water flow patterns. This process will be managed according to the Surface Water MP (MRUP-EMP-009). Management and operation of all surface water features associated with the MRUP will be managed by the Water Operating Strategy (MRUP-EMP-021).	Any adverse impacts on identified surface water flow systems or caused by operational infrastructure will be rehabilitated so as to restore the original function.	Any potential impacts that may occur in response to the MRUP on surface water systems will be localised and capable of being rectified and rehabilitated so that their original functioning is re-established.	Given no adverse impact on surface water flow processes is expected and that no surface water dependent ecosystems are present, no significant residual impact will occur. The MRUP will therefore not jeopardise the EPA's objective for Hydrological Processes, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				

<table>
<tr><th rowspan="2">Existing Environment / Impact</th><th colspan="6">Mitigation Hierarchy</th><th rowspan="2">Significant residual impact</th><th colspan="5">Offset methodology calculate</th></tr>
<tr><th>Avoid</th><th>Minimise</th><th>Mitigate</th><th>Rehabilitation</th><th>Likely rehabilitation success</th><th>Type</th><th>Risk</th><th>Likely offset success</th><th>Time lag</th><th>Offset quantification</th></tr>
<tr><td colspan="13">Inland Waters Environmental Quality</td></tr>
<tr><td>Operational activities directly impacting surface water quality.</td><td>Any surface water that is present within the MRUP is restricted to the clayey topographic depressions that partially fill during heavy rainfall events. These areas should be avoided when locating solution ponds/dams and fuel/reagent facilities.</td><td>Potential pathways between operational storage facilities and topographic depressions will be identified and minimised.
Minimise interaction between solution/liquid transfer systems (i.e. pipelines) and sensitive or conservational significant environmental receptors, if identified.</td><td>The management all operational storage facilities, including solution and process water ponds/dams, reagent tanks and TSFs, will be managed according to the Principles of Water Protection (as outlined in the Water Operating Strategy for the site: MRUP-EMP-021).
Management strategies will involve ensuring sufficient freeboard on all ponds/dams to accommodate a 1:100 year 72 hour storm event and bunding around solution/fuel/reagent tanks to accommodate 110% of the maximum storage volume.
All hydrocarbon and other combustible liquids will be stored and handled according to legislative requirements and codes of practice, as documented in the Chemical & Hydrocarbon MP (MRUP-EMP-037).
All spills will be managed in accordance with the Spill Response MP (MRUP-EMP-027) and the Emergency Response MP (MRUP-EMP-023).</td><td>Rehabilitation of spills or uncontrolled releases of solutions/slurries will involve:
Restrict the spread of the spill or release.
Remove or stopping the cause.
Remediate the impact.
Rehabilitate the area
Review (monitor) the progress of rehabilitation.
Relinquish (signoff) from regulators.</td><td>The potential for spills or released solutions to spread widely into the surrounding environment is limited by the topography, sandy nature of the surface soils and absence of surface water flows. Consequently, any spills or uncontrolled releases will be restricted in spatial extent, making clean-up achievable.</td><td>Given the limited extent of surface water across the MRUP and the management systems in place, no significant residual impact on surface water quality or value is expected.
The MRUP will therefore not jeopardise the EPA's objective for Inland Waters Environmental Quality, in accordance with EAG 9 (EPA 2013).
No offset is therefore required.</td><td colspan="5">Not required as no significant residual impact.</td></tr>
<tr><td>Operational activities directly impacting groundwater quality.</td><td>The storage of processing solutions, reagents or hydrocarbons will be avoided within the mine pits.</td><td>Mechanical works and refuelling activities will be minimised in the mine pits to prevent potential contamination with the groundwater.</td><td>The management all operational storage facilities, including solution and process water ponds/dams, reagent tanks and TSFs, will be managed according to the Principles of Water Protection (as outlined in the Water Operating Strategy for the site: MRUP-EMP-021).
All hydrocarbon and other combustible liquids will be stored and handled according to legislative requirements and codes of practice, as documented in the Chemical and Hydrocarbon MP (MRUP-EMP-037).
All spills will be managed in accordance with the Spill Response MP (MRUP-EMP-027) and the Emergency Response MP (MRUP-EMP-023).</td><td>Rehabilitation of spills or uncontrolled releases of solutions/slurries will involve:
Restrict the spread of the spill or release.
Remove or stopping the cause.
Remediate the impact.
Rehabilitate the area
Review (monitor) the progress of rehabilitation.
Relinquish (signoff) from regulators.</td><td>Within the mine pit there is a direct connection with the groundwater aquifer and therefore the risk of contamination is increased. However, through the implementation of the various management plans, and restricting the storage (either temporary or permanent) within the mine pits, will significantly reduce this risk, such that the greatest risk of contamination will come from refuelling operations of some of the larger fleet and breakdowns of equipment.
All spills greater than 250L will be remediated and reported to the Department of Environment Regulation.</td><td>With no storage of large volumes of solutions, reagents or fuels within the mine pit, and the implementation of the various management plans governing operations, the risk of impact on groundwater quality is considered low, and no significant residual impact will likely occur.
The MRUP will therefore not jeopardise the EPA's objective for Inland Waters Environmental Quality, in accordance with EAG 9 (EPA 2013).
No offset is therefore required.</td><td colspan="5">Not required as no significant residual impact.</td></tr>
</table>

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Runoff from operational areas and material stockpiles.	Operational areas and mineralised ore stockpiles will not be located in areas that have the potential for inundation (i.e. in topographic depressions).	Minimise (and consider) the potential connection between operational catchment areas and natural surface flows lines (if present).	Aspects governing surface water flows within and runoff from operational areas are covered in the Construction and Operational Environmental MPs (MRUP-EMP-018 and MRUP-EMP-020, respectively) and the Surface Water MP (MRUP-EMP-009). Surface water drainage management structures will be implemented (where required) in all operational areas, including ore stockpiles, to prevent the uncontrolled release of surface runoff into the surrounding environment.	If areas are impacted from runoff then: **Restrict** the spread or generation of runoff. **Remove** or stopping the cause. **Remediate** the impact. **Rehabilitate** the area **Review** (monitor) the progress of rehabilitation. **Relinquish** (signoff) from regulators.	The potential for runoff from operational areas to spread widely into the surrounding environment is limited by the topography, sandy nature of the surface soils and absence of surface water flows. Consequently, any uncontrolled releases will be restricted in spatial extent, making clean-up achievable.	Given the limited extent of surface water across the MRUP and the management systems in place, no significant residual impact on surface water quality or value is expected. The MRUP will therefore not jeopardise the EPA's objective for Inland Waters Environmental Quality, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Runoff from post-mine landforms.	Avoid the opportunity for exposed landform surfaces to generate runoff.	Minimise the surface area of exposed overburden (Miocene and Eocene sediments) on slopes.	The design, construction and rehabilitation of all post-mine landforms will be undertaken in accordance with the Overburden Landform MP (MRUP-EMP-015), Tailings MP (MRUP-EMP-015) and the overarching Rehabilitation and Revegetation MP (MRUP-EMP-030). Across all post-mine landforms the potential for runoff will be mitigated by: Understanding the nature of the materials and designing and constructing landforms accordingly. Keying-in the all rehabilitated surfaces with the surrounding land surfaces. Utilising contour ripping or equivalent to create an undulating land surface to prevent surface runoff and maximise infiltration. Utilising the Quaternary sands as a cover. Sloping of flat surfaces towards the landform to prevent runoff from the landform.	If excessive runoff from post-mine land surfaces is identified, potentially leading to excessive erosion, then cause of runoff will be identified, mitigated and rehabilitated.	Given sandy nature of surface soils and proposed rehabilitation prescription, outlined in the Mine Closure Plan (MRUP-EMP-031), the potential for surface runoff to occur, and for this runoff to cause significant environment is consider low. Mitigation measures will adequately deal with these impacts and their rehabilitation.	The proposed rehabilitation prescription to be adopted for all post-mine land surfaces has been developed so that negligible surface water occurs and the majority of rainfall infiltrates the surface (i.e. store-release cover). Given this, no significant residual impact on surface water quality is expected to occur The MRUP will therefore not jeopardise the EPA's objective for Inland Waters Environmental Quality, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				
Tailings seepage from in-pit TSFs impacts on water quality.	In-pit TSFs are required (and preferred to above-ground TSFs) to store the tailings generated by the processing of the ore – therefore cannot be avoided.	Principle of Water Conservation and Efficiency to be applied at all levels of the MRUP to optimise water use efficiency during ore processing.	Principles of Water Protection, as outlined in the Water Operating Strategy (MRUP-EMP-021) will be applied for all tailings deposition into the in-pit TSFs. This aims to ensure minimal impact on groundwater quality and reduce long-lasting impacts which may occur at the tenement boundary. The tailings deposition process and operation of the TSF will be managed by the Tailings MP (MRUP-EMP-013) and Tailings Operating Strategy (MRUP-EMP-014).	No rehabilitation or restriction of tailings seepage from the in-pit TSFs is required as seepage water quality is similar to that of the receiving groundwater system. Modelling shows no long term impact on background groundwater quality at the tenement boundary. No impact on terrestrial ecosystems is expected as groundwater levels occur at ~40m bgl and there is no surface expression in the region.	As the tailings seepage has a similar composition to the receiving groundwater system no adverse impact on background groundwater quality is expected.	Given no adverse impact on groundwater quality is expected and that no GDEs are reliant on this aquifer, no significant residual impact will occur. Tailings deposition into the in-pit TSFs will therefore not jeopardise the EPA's objective for Hydrological Processes, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Air Quality and Atmospheric Gases											
Dust impacts on human health. (Note: this section does not consider the radiological impacts from dust inhalation – this is covered in the human health section below). The MRUP is an area that experiences high background dust levels due to the sandy, friable nature of the surface soils, dunal topography (i.e. high surface area), predominance of large-scale fires, and low vegetation density.	Avoid activities that generate excessive dust, particularly during high wind conditions. The selected mining method (dozer trap system and waste conveyance) used to backfill pits will minimise the overburden haulage using conventional mining fleets minimising the potential for vehicle generated dust and greenhouse gas emissions.	Dust exposure will be minimised by reducing time outdoors under high dust conditions, wearing applicable PPE, use of water spray to keep dust levels down, and minimising the areas cleared prior to disturbance.	The levels of dust to be generated during the operation of the MRUP will be controlled by the Dust MP (MRUP-EMP-024). Where practicable all activities that may generate excess dust will be minimised during high wind conditions. Good house-keeping will be applied within the processing plant to prevent excess dust generation. During ground disturbance activities, the area cleared will be kept to a practicable minimum to reduce the potential for dust generation. All ground disturbance activities will be controlled by a GDAP system, in accordance with the Ground Disturbance MP (MRUP-EMP-019).	All post-mine landforms will be rehabilitated such that they are safe, stable, non-polluting and sustainable; thus maximising the potential for rehabilitation growth to occur rapidly. Consideration will be given in the design to the maximum height, direction and overall slope angles of the landforms to minimise the potential for dust generation. All rehabilitation and revegetation will be governed by the Rehabilitation and Revegetation MP (MRUP-EMP-030).	All rehabilitation materials likely to be used in the construction of the outer surfaces of the various post-mine landforms exhibit properties for revegetation growth. Their structural arrangement will be designed to ensure that the reconstructed soil profile meets the transpiration requirements for revegetation (i.e. ensuring its sustainability). In addition, species and revegetation communities will be selected to best match with the reconstructed soil profile. Successful rehabilitation is therefore expected, which will maximise vegetative growth and minimise dust generation potential on the post-mine landforms. Strategic use of cleared vegetation debris will also be considered on rehabilitation surfaces to further promote revegetation growth and minimise dust potential.	Given that successful rehabilitation is expected, and that the dust generation potential of landforms will be considered during the design and construction phases, the likelihood of levels of dust generated beyond background levels being is considered small. The MRUP will therefore not jeopardise the EPA's objective for Air Quality and Atmospheric Gases, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				
Emissions from power generation, including Carbon Monoxide (CO), Nitrous Dioxides (NO_2), Particulate Matter (PM_{10}), Sulphur Dioxide (SO_2) and Volatile Organic Compounds (VOCs).	Avoid equipment that cannot meet efficiency requirements for the site.	Where practicable minimise the generation of gas emissions during power generation activities and ensure best practice utilisation of equipment and activities.	To reduce the level of emissions produced as a result of power generation, efficiency considerations will be made in the procurement of: Mining equipment and generators so as to minimise fuel use. Processing plant equipment so as to minimise power requirement. Accommodation and administration facilities so as to minimise power requirement.	To ensure power efficiencies are being applied, fuel use will be monitored to detect deterioration in efficiency. Equipment will be well maintained and replaced (if replaced) to ensure best practice power generation activities are being adhered to.	Through the application of the various mitigation (management) strategies and plans, and ensuring the Principles of Power Efficiency are adhere to, gas emissions are expected to remain below the various NEPM guidelines.	The MRUP will therefore not jeopardise the EPA's objective for Air Quality and Atmospheric Gases, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				
Greenhouse Gas (GHG) emissions from power generation.	Avoid redundant use of equipment that may result in excessive emission of GHG.	Where practicable minimise the generation of GHG emissions during power generation activities and ensure best practice utilisation of equipment and activities	The generation of GHG emissions during the MRUP will be managed using the Greenhouse Gas MP (MRUP-EMP-017). Management will primarily involve the application of best practice to power generation and the procurement of power efficient equipment.	To ensure power efficiencies are being applied, fuel use will be monitored to detect deterioration in efficiency. Equipment will be well maintained and replaced (if replaced) to ensure best practice power generation activities are being adhered to.	Through the application of the various mitigation (management) strategies and plans, and ensuring the Principles of Power Efficiency are adhere to, GHG emissions will be minimised to as low as practicable levels.	The MRUP will therefore not jeopardise the EPA's objective for Air Quality and Atmospheric Gases, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Human Health											
Radiological impacts on human health. On average the level of radioactivity likely to be generated during the operation of the MRUP is expected to be low and below typical guideline levels for human health.	Avoid all work which may result in unacceptable exposure to radiation or radioactive material.	Minimise contact or exposure to radiation or radioactive material to ensure occupational limits (20Ms/yr.) are not exceeded.	The human health aspects of the MRUP operations are controlled under the Radiation MP (MRUP-EMP-028), Radioactive Waste MP (MRUP-EMP-029), Tailings MP (MRUP-EMP-013) and the Transport Radiation MP (MRUP-EMP-022). Mitigation measures include minimising time on foot in the pit, shielding inside equipment, cover material below soil or water and wearing applicable PPE. Based on legislative requirements, the processing plant is deemed a 'Control Area' requiring wash-in and wash-out. This will reduce the spread of radioactive material and the risk of exposure, through inhalation and digestion.	Rehabilitation of the MRUP will involve: Backfilling of the mine pits to cover the orebody Constructing a store-release cover over the TSF surfaces. Removal of all stockpiled radioactive material from the land surface and any underlying contaminated soil. This materials will be deposited at the base of a mine pit prior to backfilling All rehabilitation works will be in accordance with the Rehabilitation and Revegetation MP (MRUP-EMP-030).	Covering all radioactive ore, tailings and contaminated material with a suitably thick soil cover will effectively prevent radon emanation. Consequently, at closure no alpha-emitting dust or radioactive gas emissions above background levels are expected.	Given the proposed rehabilitation strategy will involve backfilling of the mine voids, with a suitably thick cover to support a sustainable rehabilitation and to prevent surficial radon exposure. The MRUP will therefore not jeopardise the EPA's objective for human health, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				
Dust impacts on human health. The MRUP occurs in an area with naturally high background levels of dust. Given the surface sands are deficit in alpha-emitting radionuclides, captured dust generally contained very low levels of radiation.	Avoid activities that generate excessive dust, particularly from exposed ore surfaces.	Dust exposure will be minimised by reducing time outdoors under high dust conditions, use of water spray to keep dust levels down and wearing applicable PPE.	The levels of dust to be generated during the operation of the MRUP will be controlled by the Dust MP (MRUP-EMP-024). Where possible all activities that may generate excess dust will be minimised during high wind conditions, and good house-keeping will be applied within the processing plant. During ground disturbance activities, the area cleared will be kept to a practicable minimum to reduce the potential for dust generation. All ground disturbance activities will be controlled by a GDAP system, in accordance with the Ground Disturbance MP (MRUP-EMP-019). Based on legislative requirements, the processing plant is deemed a 'Control Area' requiring wash-in and wash-out. This will reduce the spread of radioactive material and the risk of exposure, through inhalation and digestion.	All post-mine landforms will be rehabilitated such that they are safe, stable, non-polluting and sustainable; thus maximising the potential for rehabilitation growth to occur rapidly. Consideration will be given in the design to the maximum height, direction and overall slope angles of the landforms to minimise the potential for dust generation. All rehabilitation and revegetation will be governed by the Rehabilitation and Revegetation MP (MRUP-EMP-030).	All rehabilitation materials likely to be used in the construction of the outer surfaces of the various post-mine landforms exhibit optimal properties for revegetation. Their structural arrangement will be designed to ensure that the reconstructed soil profile meets the transpiration requirements of the revegetation (i.e. ensuring its sustainability). In addition, species and revegetation communities will be selected to best match with the reconstructed soil profile. Successful rehabilitation is therefore expected, which will maximise vegetative growth and minimise dust generation potential on the post-mine landforms. Strategic use of cleared vegetation debris will also be considered on rehabilitation surfaces to further promote revegetation growth and minimise dust potential.	Given that successful rehabilitation is expected, and that the dust generation potential of landforms will be considered during the design and construction phases, the likelihood of excessive levels of dust, beyond background levels, being generated is considered small. The MRUP will therefore not jeopardise the EPA's objective for human health, in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Heritage											
Direct disturbance on identified heritage sites/values. There is currently no Native Title Claim over the MRUP and to date only one Registered Site located on the edge of the Development Envelope.	Although no heritage sites or values have been identified to date within the Disturbance Footprint, if any sites are identified in the future they will be avoided, where required.	Any disturbance on future identified sites within the Disturbance Footprint will be minimised, where required.	Management of all heritage sites identified within the current or future Disturbance Footprint will be in accordance with the Heritage MP (MRUP-EMP-034). The use of the proposed GDAP system will ensure that any future potential heritage sites are identified and managed accordingly.	In the event that an identified heritage site is disturbed without authorisation then it will be rehabilitated as far as practicable back to the existing quality or value, in consultation with the relevant group.	Any rehabilitation will be done in accordance with requirements as determined by stakeholder consultation.	Given the nature of the landscape and the general lack of permanent surface water bodies, and subsequent scarcity of native fauna, it is considered that the likelihood of heritage sites being present within the current or future Disturbance Footprint is low. No significant residual impact is therefore likely to occur and will not jeopardise the EPA's objective for Heritage in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				
Rehabilitation and Closure											
Inappropriate utilisation of problematic materials. Although the soil and overburden materials to be used in rehabilitation exhibit optimal chemical properties, their clayey nature and low salinity levels result in them being dispersive and highly erodible.	Selectively place problematic materials in the base of the backfilled pit. This will avoid the presence of problematic materials within surface overburden landforms.	Approximately 50-75% of waste overburden will be backfilled and not used to form overburden landforms	The handling and utilisation of all soil and overburden materials for rehabilitation purposes, and the construction design of the post-mine landforms, is addressed in : Soil MP (MRUP-EMP-008) Overburden Landform MP (MRUP-EMP-015) Rehabilitation and Revegetation MP (MRUP-EMP-030) Mine Closure Plan (MRUP-EMP-031).	All overburden materials will be covered by a minimum layer of Quaternary Aeolian sand as follows: 0.5m for backfilled pits and OLs 1.0m for in-pit and above-ground TSFs This will act as an evaporative buffer to prevent hard-setting and reduce the flow velocity of infiltrating rainfall so that slaking, dispersion and erosion is negated. This rehabilitated profile has equivalent analogue systems in the MRUP, and where practicable the revegetation community to be re-established will be matched with the reconstructed profile to ensure that the sustainability of the revegetation is met.	The reconstructed rehabilitation soil profiles on the various post-mine landforms will resemble those of the pre-mine environment (i.e. Quaternary sand of variable thickness over a more clayey overburden material). The thickness of the surficial sand has been shown to govern the distribution of vegetation across the MRUP, and thus revegetation systems will be matched with the corresponded soil profile to ensure rehabilitation success. There is a good understanding of how the various materials will behave during mining and rehabilitation, and consequently this information will be used to manipulate the reconstructed soil profile to achieve agreed completion criteria.	Given the nature of the materials available, in sufficient quantities, for rehabilitation, and the current understanding of ecosystem function in the MRUP region, there is a high likelihood that a safe, stable, non-polluting and sustainable post-mine landform will be achieved. No significant residual impact is therefore likely to occur and will not jeopardise the EPA's objective for Rehabilitation and Decommissioning in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				
Planned landforms may not be safe at closure: Unconsolidated backfill may result in subsidence. OLs may be unstable. Inadvertent access and harm to the public and fauna	All above-ground inert infrastructure materials that may be considered hazardous to people and fauna will be removed and disposed of appropriately	Approximately 50-75% of waste overburden will be backfilled and not used to form overburden landforms	Landform safety will be managed through the: Soil MP (MRUP-EMP-008) Overburden Landform MP (MRUP-EMP-015) Rehabilitation and Revegetation MP (MRUP-EMP-030) Mine Closure Plan (MRUP-EMP-031). Backfilled Miocene and Eocene materials will be compacted by heavy machinery during construction to avoid the occurrence of large macro-pores that may collapse over time under overburden pressures. Geotechnical material characterisation (much already undertaken) will be used to further refine stable long term slope angles suitable for rehabilitation. Tailings Operating Strategy (MRUP-EMP-014) and Tailings Management Plan (MRUP-EMP-013) will facilitate efficient and safe operation of the facilities.	The landforms have equivalent analogue systems in the MRUP, and where practicable the revegetation community to be re-established will be matched with the reconstructed profile to ensure that the sustainability of the revegetation is met.	There is a good understanding of how the various materials will behave during mining and rehabilitation, and consequently this information will be used to manipulate the reconstructed soil profile to achieve agreed completion criteria.	Given the nature of the materials available, in sufficient quantities, for rehabilitation, and the current understanding of ecosystem function in the MRUP region, there is a high likelihood that a safe, stable, non-polluting and sustainable post-mine landform will be achieved. No significant residual impact is therefore likely to occur and will not jeopardise the EPA's objective for Rehabilitation and Decommissioning in accordance with EAG 9 (EPA 2013). No offset is therefore required.					

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
Planned landforms may not be stable at closure: Excessive wind and water erosion Pit edges may be unstable and erosion-prone. Above-ground TSFs may be unstable. Below-ground TSFs may be unstable. Increased water and wind erosion.		Approximately 50-75% of waste overburden will be backfilled and not used to form overburden landforms All disturbed infrastructure areas will be reshaped to approximate baseline hydrological function and/or the original surface topography. As there is no change in surface shape, wind erosion should be kept to a minimum.	Landform stability will be managed through the Soil MP (MRUP-EMP-008) Overburden Landform MP (MRUP-EMP-015) Rehabilitation and Revegetation MP (MRUP-EMP-030) Mine Closure Plan (MRUP-EMP-031). Geotechnical material characterisation (much already undertaken) will be used to advise stable long term slope angles suitable for rehabilitation. The landforms have has been designed to be no higher than the sand dunes, which effectively create a protective boundary layer for surfaces at lower elevations. The low batter slope angles will also minimise wind speed acceleration across the surface, which is the driving factor of sediment loss due to wind erosion.	The landforms have equivalent analogue systems in the MRUP, and where practicable the revegetation community to be re-established will be matched with the reconstructed profile to ensure that the sustainability of the revegetation is met.	The reconstructed rehabilitation soil profiles on the various post-mine landforms will resemble those of the pre-mine environment (i.e. Quaternary sand of variable thickness over a more clayey overburden material). The thickness of the surficial sand has been shown to govern the distribution of vegetation across the MRUP, and thus revegetation systems will be matched with the corresponded soil profile to ensure rehabilitation success. There is a good understanding of how the various materials will behave during mining and rehabilitation, and consequently this information will be used to manipulate the reconstructed soil profile to achieve agreed completion criteria.	Given the nature of the materials available, in sufficient quantities, for rehabilitation, and the current understanding of ecosystem function in the MRUP region, there is a high likelihood that a safe, stable, non-polluting and sustainable post-mine landform will be achieved. tailed dust modelling indicates that under the current prevailing wind conditions, negligible sediment yield will occur. No significant residual impact is therefore likely to occur and will not jeopardise the EPA's objective for Rehabilitation and Decommissioning in accordance with EAG 9 (EPA 2013). No offset is therefore required.					
Planned landforms may not be non-polluting at closure: Geochemistry of the overburden and other materials are well characterised and the risk of AMD is considered low.		Approximately 50-75% of waste overburden will be backfilled and not used to form overburden landforms Geochemical characterisation and leach testing on overburden materials will further confirm the low risk.	Chemical stability will be managed through the Overburden Landform MP (MRUP-EMP-015) Mine Closure Plan (MRUP-EMP-031). Tailings Operating Strategy (MRUP-EMP-014) Tailings Management Plan (MRUP-EMP-013) will facilitate efficient and safe operation of the facilities. AMD Management Plan (MRUP-EMP-016)	All material identified as contaminated will either be remediated to DER guidelines or will be removed to storage in an appropriate non-polluting facility such as a TSF.	The reconstructed rehabilitation soil profiles on the various post-mine landforms will resemble those of the pre-mine environment (i.e. Quaternary sand of variable thickness over a more clayey overburden material). The thickness of the surficial sand has been shown to govern the distribution of vegetation across the MRUP, and thus revegetation systems will be matched with the corresponded soil profile to ensure rehabilitation success. There is a good understanding of how the various materials will behave during mining and rehabilitation, and consequently this information will be used to manipulate the reconstructed soil profile to achieve agreed completion criteria.	Given the nature of the materials available, in sufficient quantities, for rehabilitation, and the current understanding of ecosystem function in the MRUP region, there is a high likelihood that a safe, stable, non-polluting and sustainable post-mine landform will be achieved. No significant residual impact is therefore likely to occur and will not jeopardise the EPA's objective for Rehabilitation and Decommissioning in accordance with EAG 9 (EPA 2013). No offset is therefore required.					
Planned landform revegetation may not be sustainable at closure: Reconstructed soil profiles may not sustainably support revegetation Seed ecology of the revegetation species is generally unknown. Uncertainty regarding the response of the revegetation species to fire. Reconstructed soil profiles may		There is a good understanding of the limitations of the various soil and overburden materials to revegetation growth, and the capacity of these materials to support the native vegetation species. The reconstructed soil profiles have, therefore, been designed to ensure that they meet the growth requirements of the proposed revegetation.	Sustainability will be managed through the Soil MP (MRUP-EMP-008) Overburden Landform MP (MRUP-EMP-015) Rehabilitation and Revegetation MP (MRUP-EMP-030) Mine Closure Plan (MRUP-EMP-031). Rehabilitation trials will be undertaken during operations to establish the germination rates of the various revegetation species to be used. The incorporation of progressive rehabilitation into mine planning will enable rehabilitation trials and monitoring to provide valuable information as to	The landforms have equivalent analogue systems in the MRUP, and where practicable the revegetation community to be re-established will be matched with the reconstructed profile to ensure that the sustainability of the revegetation is met.	The reconstructed rehabilitation soil profiles on the various post-mine landforms will resemble those of the pre-mine environment (i.e. Quaternary sand of variable thickness over a more clayey overburden material). The thickness of the surficial sand has been shown to govern the distribution of vegetation across the MRUP, and thus revegetation systems will be matched with the corresponded soil profile to ensure rehabilitation success. There is a good understanding of how the various materials will behave during mining and rehabilitation, and consequently this information will be used to manipulate the reconstructed soil profile to achieve agreed completion criteria.	Given the nature of the materials available, in sufficient quantities, for rehabilitation, and the current understanding of ecosystem function in the MRUP region, there is a high likelihood that a safe, stable, non-polluting and sustainable post-mine landform will be achieved. No significant residual impact is therefore likely to occur and will not jeopardise the EPA's objective for Rehabilitation and Decommissioning in accordance with EAG 9 (EPA 2013). No offset is therefore required.					

Existing Environment / Impact	Mitigation Hierarchy					Significant residual impact	Offset methodology calculate				
	Avoid	Minimise	Mitigate	Rehabilitation	Likely rehabilitation success		Type	Risk	Likely offset success	Time lag	Offset quantification
not sustainably support revegetation Poor rehabilitation growth and/or sustainability due to physical or chemical limitations			what species germinate from seed and what specific seed treatments may be required to stimulate germination.								
Inadequate soil profile reconstruction to re-establish a sustainable, stakeholder agreed end-land use.	Unplanned and unscheduled rehabilitation works will be avoided. The vegetation within the MRUP has specific water use requirements and not matching these to the reconstructed soil profile will likely result in an unacceptable rehabilitation outcome.	Minimise the utilisation of soil and selected overburden materials in non-rehabilitation related activities so that the quantity of rehabilitation material is not diminished.	The handling and utilisation of all soil and overburden materials for rehabilitation purposes, and the construction design of the post-mine landforms, is addressed in: Soil MP (MRUP-EMP-008) Overburden Landform MP (MRUP-EMP-015) Rehabilitation and Revegetation MP (MRUP-EMP-030) Mine Closure Plan (MRUP-EMP-031).	The rehabilitation of all post-mine landforms will be undertaken in accordance with the various management plans. A specific rehabilitation soil profile has been developed for each of the post-mine landforms that takes into account: The risks of the landform impacting on the surrounding environment and future rehabilitation The available of rehabilitation materials per area Inherent constraints and requirements of the landform (i.e. TSF store-release cover system) The ecosystem requirements for sustainable development of the rehabilitation.	The reconstructed rehabilitation soil profiles on the various post-mine landforms will resemble those of the pre-mine environment (i.e. Quaternary sand of variable thickness over a more clayey overburden material). The thickness of the surficial sand has been shown to govern the distribution of vegetation across the MRUP, and thus revegetation systems will be matched with the corresponded soil profile to ensure rehabilitation success. There is a good understanding of how the various materials will behave during mining and rehabilitation. Consequently this information will be used to manipulate the reconstructed soil profile to achieve the desired, stakeholder agreed, land use.	Given the nature of the materials available, in sufficient quantities, for rehabilitation, and the current understanding of ecosystem function in the MRUP region, there is a high likelihood that a safe, stable, non-polluting and sustainable post-mine landform will be achieved. No significant residual impact is therefore likely to occur and will not jeopardise the EPA's objective for Rehabilitation and Decommissioning in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact				
Inability to achieve the completion criteria (i.e. safe, stable, non-polluting and sustainable).	Unplanned and unscheduled rehabilitation works will be avoided. The vegetation within the MRUP has specific water use requirements and not matching these to the reconstructed soil profile will likely result in an unacceptable rehabilitation outcome.	Minimise the utilisation of soil and selected overburden materials in non-rehabilitation related activities so that the quantity of rehabilitation material is not diminished.	The handling and utilisation of all soil and overburden materials for rehabilitation purposes, and the construction design of the post-mine landforms, is addressed in: Soil MP (MRUP-EMP-008) Overburden Landform MP (MRUP-EMP-015) Rehabilitation and Revegetation MP (MRUP-EMP-030) Mine Closure Plan (MRUP-EMP-031).	Although the various soil and overburden materials do not exhibit adverse chemical properties to restrict revegetation growth, their sandy nature does have a significant impact on the water storage and Plant Available Water capacity. The native vegetation have therefore developed specific adaptations to survive extended periods of drought. It is therefore critical that the reconstructed soil profiles match the transpiration requirements of the vegetation, as if this does not occur then poor rehabilitation success is likely.	Through the implementation of the various material and soil profile reconstruction management plans, and the current understanding of the limitations and functioning of the ecosystem, the potential to achieve all four closure tenets (safe, stabile, non-polluting and sustainable) is considered high.	No significant residual impact is therefore likely to occur and will not jeopardise the EPA's objective for Rehabilitation and Decommissioning in accordance with EAG 9 (EPA 2013). No offset is therefore required.	Not required as no significant residual impact.				

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18. Abbreviations

AAEC	Australian Atomic Energy Commission
ACMC	Aboriginal Cultural Material Committee
ACT	Australian Capital Territory
AFP	Albany-Fraser Province
AH Act	*Aboriginal Heritage Act 1972*
AHD	Australian Height Datum; effectively the amount above sea level
ALARA	as low as reasonably achievable
AMD	Acid and Metalliferous Drainage
AMIRA	Australian Mineral Industries Research Association (now known as AMIRA International)
ANC	Acid Neutralising Capacity
ANCOLD	Australian National Committee on Large Dams
ANRDR	Australian National Radiation Dose Register
ANSTO	Australian Nuclear Science and Technology Organisation
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZMEC	Australian and New Zealand Minerals and Energy Council
ARD	Acid Rock Drainage
ARI	Average Recurrence Interval
ARMCANZ	Agriculture and Resources Management Council of Australia and New Zealand
ARPANS Act	*Australian Radiation Protection and Nuclear Safety Act 1998 (Cth)*
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
ASLP	Australian Standard Leaching Procedure
ASRIS	Australian Soil Resources Information System
ASX	Australian Securities Exchange
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BM	Base metal
BOM	Bureau of Meteorology
Bq	Becquerel
CALM Act	*Conservation and Land Management Act 1984*
CALMET	3D meteorological model pre-processor to CALPUFF
CALPUFF	Model that simulates dispersion of air pollutants
CAMBA	China-Australia Migratory Bird Agreement

CAMDMP	Conceptual Acid and Metalliferous Drainage Management Plan
CEC	cation exchange capacity
CMCP	Conceptual Mine Closure Plan
CO	Carbon Monoxide
CO_2-e	Carbon dioxide equivalent
CR	Critically Endangered
CSFS	Conservation Significant Flora Species
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTP	Camera Trapping Protocol
DAA	Department of Aboriginal Affairs
DE	Development Envelope
DEC	Department of Environment and Conservation
DER	Department of Environment Regulation
DEWHA	Department of the Environment, Water, Heritage and the Arts
DFS	Definitive Feasibility Study
DITR	Department of Industry, Tourism and Resources
DMA	Decision Making Authorities
DMP	Department of Mines and Petroleum
DoE	Department of the Environment
DoW	Department of Water
DPaW	Department of Parks and Wildlife
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EAMA	Energy and Minerals Australia
EC	Electrical Conductivity
EIA	Environmental impact assessments
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMS	Environmental Management System
EN	Endangered
EP	Environmental Protection
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority

EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999 (Cth)*
EPDs	Electronic Personal Dosimeters
EPP	Environmental Protection Policy
ERAP	Emergency Response Assistance Plan
ERDM	Environmental Radon Daughter Monitor
ERICA	Environmental Risk from Ionising Contaminants: Assessment and Management
ESD	Environmental Scoping Document
ESP	Exchangeable Sodium Percentage
EX	Extinct
FAQ	Frequently asked questions
FIFO	Fly-in fly-out
GDAP	Ground Disturbance Activity Permit
GDE	Groundwater dependent ecosystems
GHD	GHD Pty Ltd
GPS	Global Positioning System
GVD	Great Victoria Desert
HAZOB	Hazard Observation
HEPA	High-efficiency particulate arrestance
HVAS	High Volume Air Sampler
IAEA	International Atomic Energy Agency
IBRA	Interim Biogeographic Regionalisation for Australia
ICRP	International Commission on Radiological Protection
IFD	Intensity-Frequency-Duration
ISO	International Organization for Standardization
IUCN	International Union for the Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
JORC	Joint Ore Reserves Committee
KBCCI	Kalgoorlie-Boulder Chamber of Commerce and Industry
KF	Kimberley Flora
KPI	Key performance indicator
LEL	Lower Explosive Limit
LGA	Local government area

LL	Liquid Limit
LLA	Long Lived Radioactive Airborne Dust
LLW	Low level waste
LNG	Liquefied Natural Gas
LOM	Life of Mine
MAR	Managed Aquifer Recharge
MCA	Minerals Council of Australia
MCP	Mine Closure Plan
MCPL	Mattiske Consulting Pty Ltd
MNES	Matters of National Environmental Significance
MP	Management Plan
MPA	Maximum Potential Acidity
MPG	Malleefowl Preservation Group
MRE	Mulga Rock East
MRUP	Mulga Rock Uranium Project
MRW	Mulga Rock West
MSIA	*Mines Safety and Inspection Act 1994 (WA)*
Mtpa	Million tonnes per annum
MW	Megawatt
NAF	Non-Acid Forming
NAG	Net Acid Generation
NAPP	Net Acid Producing Potential
NDRP	National Directory for Radiation Protection
NEIB	North East Independent Body
NEPC	National Environment Protection Council
NEPM	National Environmental Protection Measure
NGOs	Non-government organisations
NORM	Naturally Occurring Radioactive Material
NO_x	oxides of nitrogen
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NSW	New South Wales
NSW DEC	New South Wales Department of Environment and Conservation

NW	northwest
NWQMS	National Water Quality Management Strategy
OEPA	Office of the Environmental Protection Authority
OL	Overburden landform
ORP	Oxygen Reduction Potential
PAEC	Potential Alpha Energy Concentration
PAF	Potentially Acid Forming
PAH	Polycyclic Aromatic Hydrocarbons
PAS	Personal Air Samplers
PAW	Plant Available Water
PEC	Priority Ecological Community
PER	Public Environmental Review
PETM	Paleocene–Eocene Thermal Maximum
PKEF	Project Key Environmental Factors
PL	Plastic Limit
PM_{10}	particulate matter of less than 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter of less than 2.5 microns in aerodynamic diameter
PNC	PNC Exploration (Australia) Pty Ltd
PPE	Personal Protective Equipment
ppm	parts per million
PRB	Permeable Reactive Barrier
PRMs	Passive Radon Monitors
RIP	Resin-in-pulp
RIWI Act	*Rights in Water and Irrigation Act 1914*
RMP	Radiation Management Plan
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
ROM	Run of Mine
RPS	Radiation Protection Series
RSA Act	*Radiation Safety Act 1975 (WA)*
RWMP	Radioactive Waste Management Plan
SA	South Australia
SCMP	Stakeholder Consultation Management Plan

SDU	Sodium diuranate
SEAWAT	Computer Program for Simulation of Three-Dimensional Variable-Density Ground-Water Flow and Transport
SEPPAQM	*State Environment Protection Policy (Air Quality Management)*
SHD	Sandhill Dunnart
SIBERIA	Model that simulates the evolution of landscapes under the action of runoff and erosion over long times scales
SLU	Soil Landscape Unit
SMM	Southern Marsupial Mole
SMU	Soil mapping units
SO_2	sulphur dioxide
SRE	Short Range Endemic
SW	southwest
SWC	Soilwater Consultants
SWQMS	State Water Quality Management Strategy
TAPM	The Air Pollution Model
TDS	Total dissolved solids
TEC	Threatened Ecological Communities
TLD	Thermoluminescent Dosimeters
TRMP	Transport Radiation Management Plan
TSF	Tailings Storage Facility
TSP	Total Suspended Particulates
UCL	Unallocated Crown Land
UEL	Upper Explosive Limit
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
UOC	Uranium oxide concentrate
Vimy	Vimy Resources Limited
VOC	volatile organic compounds
VU	Vulnerable
WA	Western Australia
WAH	Western Australian Herbarium
WC Act	*Wildlife Conservation Act 1950 (WA)*

WCEP	Water conservation/efficiency plan
WEPP	Watershed Erosion Prediction Project
WoNS	Weeds of National Significance
YSP	Yellow Sand Plain
YSC	Yellow Sand Plain Community

Appendix A1

Assessment of Flora and Vegetation Surveys conducted for the Mulga Rock Uranium Project, Great Victoria Desert, WA

Mattiske Consulting Pty Ltd for Vimy Resources, October 2015

Appendix A2

Regional *Hibbertia crispula* (P1 & Vulnerable) Survey, Great Victoria Desert, WA

Mattiske Consulting Pty Ltd for Vimy Resources, October 2015

Appendix B1

Mulga Rock – Flora, Fauna and Radioecology Survey

W.G Martinick and Associates Pty Ltd for PNC Exploration (Australia) Pty Ltd, January 1986

Appendix B2

A Fauna Survey of the Proposed Mulga Rock Project Area, Great Victoria Desert, Western Australia

Ninox Wildlife Consulting for Energy and Minerals Australia, January 2010

Appendix B3

Camera Trapping Protocol – Sandhill Dunnart (Sminthopsis psammophila) – Mulga Rock Uranium Project Area

Vimy Resources, October 2015

Appendix B4

Sandhill Dunnart Camera Trap Monitoring: Motion Camera Small Mammal Identification

GHD for Vimy Resources Limited, October 2015

Appendix B5

Updated Report on the Southern Marsupial Mole, Mulga Rock Uranium Project, Great Victoria Desert

Ninox Wildlife Consulting for Vimy Resources, October 2015

Appendix B6

Fauna Assessment for the Malleefowl *(Leipoa ocellata)* – Mulga Rock Uranium Project Area

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Appendix B7

A Revised and Updated Report on the Herpetofauna of the Proposed Mulga Rock Project Area, Great Victoria Desert, Western Australia

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Appendix B8

Short-range Endemic Fauna at the Mulga Rock Uranium Project

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Appendix C1

Mulga Rock Uranium Project: Stygofauna Pilot Assessment

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Appendix C2

Mulga Rock Project: Subterranean Fauna Pilot Study

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Appendix D1

Results of Hydrogeological Investigations and Numerical Modelling, Planned Kakarook North Borefield

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Appendix D2

Results of Hydrogeological Investigations and Numerical Modelling, Mulga Rock Uranium Project

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Appendix D3

Groundwater Study: Lake Minigwal Uranium Prospect

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Appendix D4

Mulga Rock Prospect: Stage 2 Hydrogeological Investigation

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Physicochemical Characterisation of Tailings from the Mulga Rock Uranium Project

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Appendix D8

Mulga Rock Uranium Project Tailings Storage Facility Seepage Analysis

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Appendix D9

Mulga Rock Uranium Project: Surface Water Assessment and Management Plan

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Appendix D10

Results of Solute Transport Modelling for In-pit Tailings Storage

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Appendix E1

Mulga Rock Uranium Project: Dispersion Modelling

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Appendix F1

Occupational and Environmental Radiation Predictions and Controls, Mulga Rock Uranium Project – Radiation Report

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Appendix F2

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Appendix F3

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Appendix G1

Report of an Ethnographic survey: Mulga Rock Uranium Project Area, Great Victoria Desert

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Appendix G2

A Survey for Aboriginal Sites in the Cundeelee Minigwal Area – Interim Report

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A Survey for Aboriginal Sites in the Cundeelee Minigwal Area

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Appendix G4

A report of an Archeological Survey of the Proposed Mulga Rock Project Northeast of Kalgoorlie

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Appendix G5

An Archeological Survey for Aboriginal Sites in the PNC Exploration Lease Area, Officer Basin, Great Victoria Desert

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Appendix H1

Mulga Rock Uranium Project Conceptual Mine Closure Plan

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Appendix H2

Terrain Analysis and Materials Characterisation for the Mulga Rock Uranium Project

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Appendix H3

Mulga Rock Uranium Project Preliminary Radioactive Waste Management Plan

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Appendix I1

EPBC Act – Protected Matters Report, October 2015

Appendix J1

Vimy Resources Limited – Stakeholder Consultation 2008 – October 2015

Appendix K1

Mulga Rock Uranium Project Environmental Management Plans

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Appendix L1

Environmental Scoping Document

Appendix L2

EIA Checklist