UPDATED REPORT ON THE SOUTHERN MARSUPIAL MOLE, MULGA ROCK URANIUM PROJECT, GREAT VICTORIA DESERT, WESTERN AUSTRALIA

Prepared for: Vimy Resources Limited
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October 2015

Mulga Rock Uranium Project - Public Environmental Review - December 2015
Appendix B - Terrestrial Fauna

B5

Table of Contents

Page

1 PROJECT DESCRIPTION ... 1

2 INTRODUCTION ... 4

3 SOUTHERN MARSUPIAL MOLE (*NOTORYCTES TYPHLOPS*) ... 4

3.1 LEGAL STATUS ... 4
3.2 DISTRIBUTION ... 5
3.3 HABITAT PREFERENCES ... 5
3.4 DESCRIPTION ... 5
3.5 ECOLOGY ... 6

4 MRUP STUDY OBJECTIVES ... 6

5 METHODS ... 7

5.1 MRUP METHODOLOGY ... 8

6 RESULTS ... 11

6.1 MULGA ROCK URANIUM PROJECT AREA ... 11
6.2 TROPICANA PROJECT AREA ... 25
6.2.1 Operational Area ... 25
6.2.2 Infrastructure Areas ... 26
6.3 SIMPSON DESERT ... 26

7 DISCUSSION ... 26

8 RISK ASSESSMENT ... 29

8.1 HABITAT LOSS ... 29
8.2 HABITAT FRAGMENTATION ... 32
8.3 FIRE ... 33
8.4 PREDATION ... 33

9 REFERENCES ... 33

LIST OF FIGURES

Figure 1 Mulga Rock Uranium Project: regional location. ... 2
Figure 2 Mulga Rock Uranium Project: project tenure and development envelope. ... 3
Figure 3 Southern Marsupial Mole survey trench and molehole locations within MRUP area ... 10
Figure 4 Southern Marsupial Mole survey trench and molehole locations shown with vegetation mapping (Legend on following page.) ... 18
Figure 5 MRUP Area within the PEC - "Yellow sandplain communities in the Great Victoria Desert" ... 31

LIST OF TABLES

Table 1 List of trenches in which moleholes were defined as present (information as provided by Vimy). ... 11
Table 2 Comparison of the molehole density results from regional surveys for SMM (some data not available). ... 28
Table 3 Connectivity Index ... 30
Table 4 Impact assessment on dune buffers and connectivity of dunes. ... 30

LIST OF PLATES

Plate 1 Marsupial Mole on the surface showing tracks with tail drag 6
Plate 2 Excavation of trench in progress. 9
Plate 3 Completed trench. 9
Plate 4 Molehole in trench T_NNA5517 12
Plate 5 Molehole (1 of doublet) in trench T_096 12
Plate 6 Molehole (2 of doublet) in trench T_096 13
Plate 7 Molehole in trench T_049 13
Plate 8 Molehole in trench T_089 14
Plate 9 Molehole in trench T_092 14
Plate 10 Molehole in trench T_074 15
Plate 11 Molehole 1 in trench T_075 15
Plate 12 Molehole 2 in trench T_075 16
Plate 13 Molehole in trench T_095 16
Plate 14 Molehole in trench T_100 17
Plate 15 Vegetation surrounding trench T_028 (south view). 21
Plate 16 Vegetation surrounding trench T_096 (south view). 22
Plate 17 Vegetation surrounding trench T_049 (north view). 22
Plate 18 Vegetation surrounding trench T_089 (north view). 23
Plate 19 Vegetation surrounding trench T_092 (south view). 23
Plate 20 Vegetation surrounding trench T_074 (south view). 24
Plate 21 Vegetation surrounding trench T_075 (south view). 24
Plate 22 Vegetation surrounding trench T_095 (north view). 25

SUMMARY

This report has been prepared for Vimy Resources Limited (Vimy) and documents the results of a survey to ascertain the presence of the Southern Marsupial Mole (*Notoryctes typhlops*) in the Mulga Rock Uranium Project area (MRUP). The study area lies approximately 240km east-north-east of Kalgoorlie on the western sector of the Great Victoria Desert (GVD). It is situated 55 km north-east of Queen Victoria Spring, a Nature Reserve within the GVD.

The Southern Marsupial Mole (SMM) is a conservation significant species at both State and Federal level and is known to occur in the sand dune deserts within Western Australia, South Australia and the Northern Territory; this includes the Great Victoria Desert in which the MRUP is located.

SMM are superbly adapted to a subterranean life; they are blind, the snout is heavily keratinized and they have short, powerful limbs with large digging claws. Females have a backward opening pouch and the males have no visible scrotum as the testes lie between the skin and the abdominal wall. SMM may be the most fossorial mammals in the world.

It appears that sand dune crests and slopes are favoured by SMM as suitable ótunnellingô sand is usually present; some evidence suggests that SMM can also be found in sandy plains. They 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 ótunnellingô. The preferred dunes are generally vegetated with *Acacia* species and other shrubs, often with a ground cover of spinifex.

Based on the available information to date, what has been assessed as the most suitable sand dune habitat within the Vimy development envelope is described by Mattiske Consulting Pty Ltd (MCPL) as:

> Vegetation Community 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.

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. MCPL have calculated that 7.36% of the mapped S6 community lies within the MRUP development envelope. While vegetation community S6 probably represents the optimal SMM habitat, it is possible that other sandy vegetation communities could also support this subterranean marsupial.

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 moleholes. This method has been used in order to establish whether SMM have been present in various sandy habitats throughout the MRUP area. Between January 2013 and March 2014, 122 trenches were excavated within the MRUP area. Nine of these trenches were noted as having soil disturbance identified as resulting from SMM tunneling. Photographs of these moleholes and the habitat surrounding each successful trench (except for one) are provided in the report.

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 molehole/m^2, compared to Tropicana which has approximately 1.99 molehole/m^2. In addition, the density of moleholes 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 molehole/m^2. What the majority of studies have shown is 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 moleholes; vegetation structure and fire history may have less influence but this is yet to be determined.

In any mine development there is inevitable loss of habitat for all resident and non-resident fauna. The level of impact of this loss is mostly determined by the availability of similar habitat in surrounding areas and the mobility of the species being displaced. Given the lack of knowledge of the ecology and behavior of the SMM, much of the discussion of the potential impact of mine development on this species is speculative. MCPL considers that only 7.36% (70.98ha) of MCPL mapped extent of the S6 community occurs within the development footprint, with the largest proportion of this community located in the ñmine pitò areas. However, this community extends well beyond the development footprint, with approximately 199.49ha occurring within the development envelope. It appears that there is a strong positive correlation between SMM presence and dune connectivity and this is relatively low within the MRUP area. While the loss of a small proportion of optimal habitat and potential loss of individual SMM will be unavoidable should the project proceed, the impact on the species as a whole will be negligible given that the SMM 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.

It is unknown whether the small population of SMM within the MRUP area is connected to that within the Tropicana Project area and associated infrastructure corridors, and whether there is likely to be any cumulative impact following development of both Tropicana (existing) and the Mulga Rock projects (developing). In addition, further surveys based on trenching in suitable habitat between the MRUP area and the SMM molehole records from the Tropicana Pinjin Road infrastructure corridor approximately 41km NW of MRUP camp and 55km NE of MRUP camp, would potentially confirm that the MRUP population is not isolated from other SMM populations. This trenching survey could be extended to include the area between the MRUP area and the alternative infrastructure route between the Tropicana Operational Area and the Transline where 26 moleholes were discerned in three trenches approximately 75km east of the MRUP camp.

Other potential impacts on SMM such as fire and predation are discussed in this report but are not considered to be having a major influence on SMM within the MRUP area.

1 PROJECT DESCRIPTION

The Mulga Rock Uranium Project (MRUP) lies approximately 240km east-north-east of Kalgoorlie-Boulder in the Shire of Menzies (Figure 1). The area is remote, located on the western flank of the Great Victoria Desert, and is comprised of a series of large, generally parallel sand dunes, with inter-dunal swales and broad flat plains.

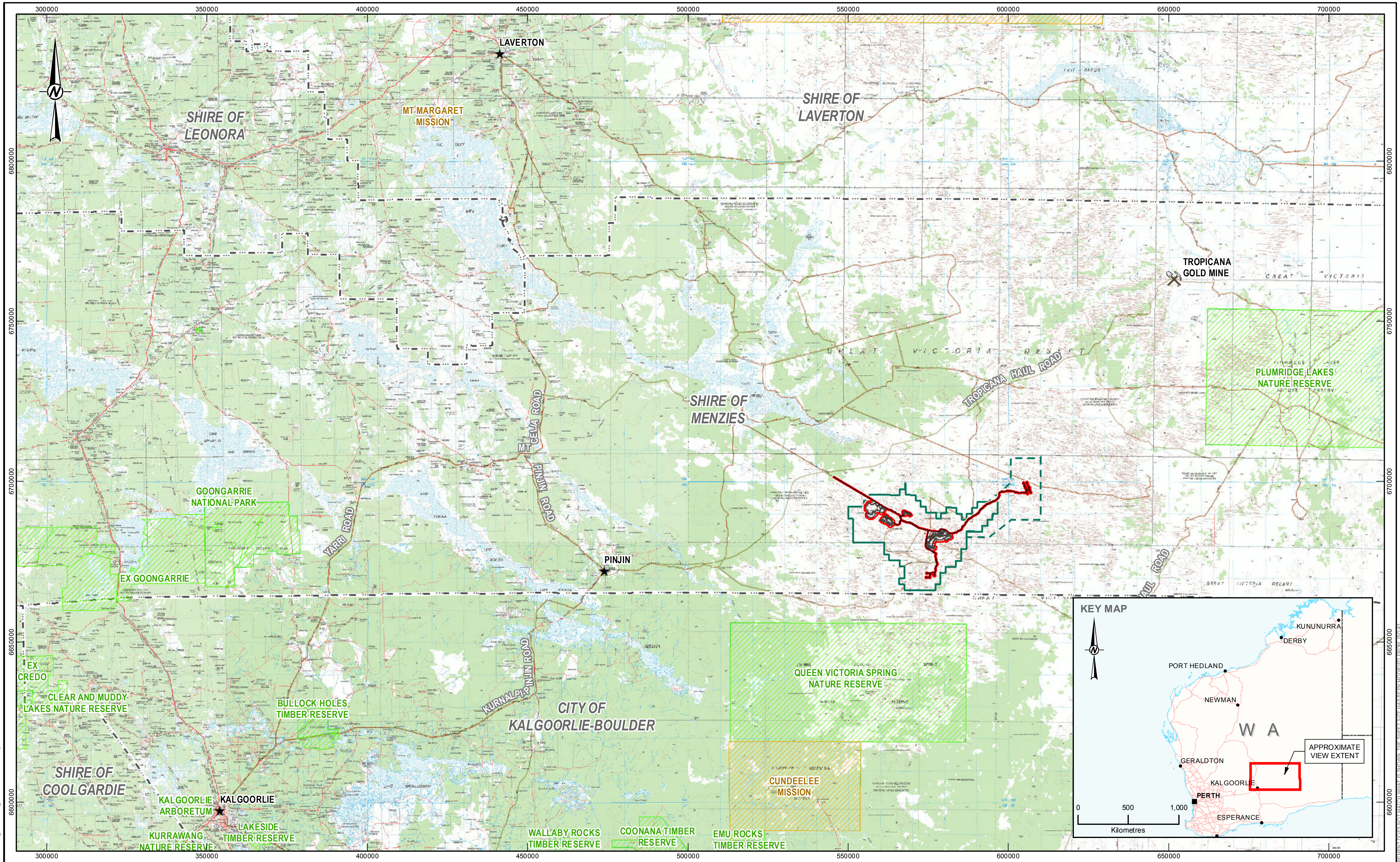
Access to the Project area is limited and is only possible using four-wheel-drive vehicles. The nearest residential town to the Project is Laverton which lies approximately 200km to the north-west. Other regional residential communities include Pinjin Station homestead located approximately 100km to the west, Coonana Aboriginal community situated approximately 130km to the south-south-west, Kanandah Station homestead positioned approximately 150km to the south-east, and the Tropicana Gold Mine lying approximately 110km to the north-east of the Project.

The MRUP covers approximately 102,000 hectares on granted mining tenure (primarily M39/1080 and M39/1081) within Unallocated Crown Land (UCL). It includes two distinct mining centres, Mulga Rock East (MRE) comprising the Princess and Ambassador resources, and Mulga Rock West (MRW) comprising the Emperor and Shogun resources; MRE and MRW are approximately 20km apart. MRE contains over 65% of the total recoverable uranium and is of a higher grade than MRW. Mining will commence at MRE which will include the location of the processing plant. 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 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.

Other metal concentrates will be extracted using sulphide precipitation after the uranium has been removed and sold separately. These metal concentrates will not be classified as radioactive. The UOC product will be sealed in drums and transported by road from the mine site in sealed sea-containers to a suitable port (expected to be Port Adelaide) which is approved to receive and ship Class 7 materials for export.

The MRUP will require the clearing of vegetation, borefield abstraction, mine dewatering and reinjection, the creation of above-ground and in-pit overburden (non-mineralised) and tailings landforms, and the construction of on-site processing facilities and associated infrastructure. Key Project infrastructure will include mine administration and workshop facilities, fuel and chemical storage depots, a diesel-fired power plant of up to 20 megawatt (MW) capacity and distribution network, a saline abstraction borefield and a saline mine water reinjection borefield with associated pipelines and power supply units, an accommodation village servicing a fly-in / fly-out workforce, an airstrip, laydown areas and other supporting ancillary infrastructure including communications systems, roads, a 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, branching off the Tropicana Gold Mine access road. Figure 2 shows the project tenure and development envelope.

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



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

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-20
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
REGIONAL LOCATION

PROJECT NO.	CONTROL	REV.	FIGURE
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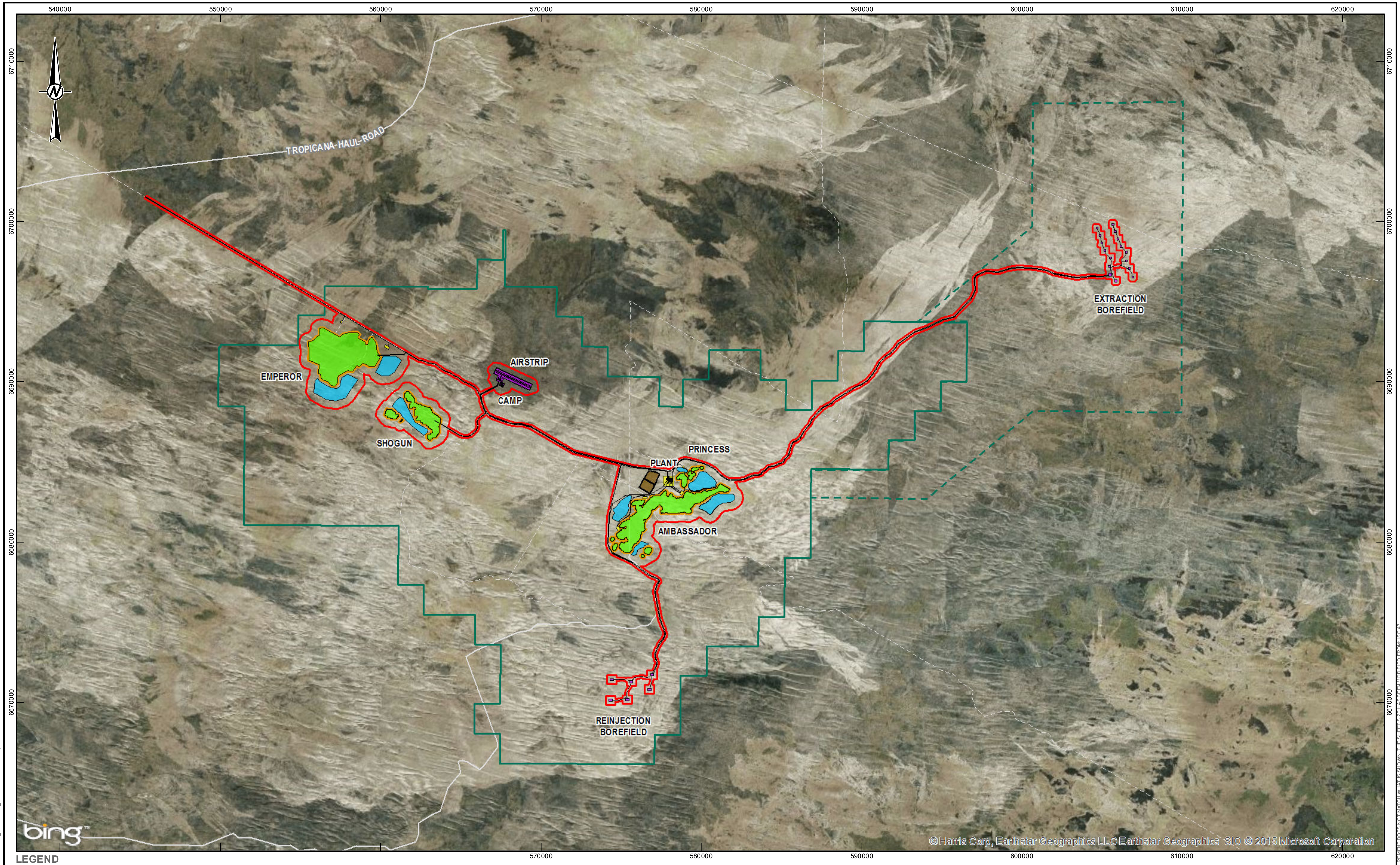


LEGEND

MINOR ROAD/TRACK	PIT
ROAD	OVERBURDEN LANDFORM
MRUP DEVELOPMENT ENVELOPE	PROCESSING INFRASTRUCTURE
PROJECT BOUNDARY (MINING TENURE)	ABOVE GROUND TSF
PROJECT BOUNDARY (MISCELLANEOUS TENURE)	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

0 5 10
1:220,000 KILOMETRES

CLIENT
VIMY RESOURCES LIMITED

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-16
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
PROJECT TENURE AND DEVELOPMENT ENVELOPE

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	B5	0	2

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

2 INTRODUCTION

This report has been prepared for Vimy Resources Limited (Vimy), previously known as Energy and Minerals Australia (EAMA), and documents a review of the Southern Marsupial Mole (*Notoryctes typhlops*) including data from the Mulga Rock Uranium Project, hereafter called MRUP. The Southern Marsupial Mole (SMM) is a conservation significant species at both State and Federal level.

The MRUP area lies approximately 240km east-north-east of Kalgoorlie in dune fields on the western flank of the Great Victoria Desert (GVD). The MRUP is situated 55 km north-east of Queen Victoria Spring, a Nature Reserve within the GVD. Development of the mine will involve open pit mining, with life of mine (LOM) clearing estimated at 3,787ha within an envelope of 9,998.17ha of sand dune and sand sheet; this includes habitats in which the SMM may be present.

The GVD is the largest dune desert in Australia, covering 424,400km^2. It straddles the South Australia/Western Australia border, stretching more than 700 kilometres from west to east. It experiences low rainfall, averaging around 200mm to 250mm per year, but this varies greatly from year to year. The desert is surrounded by arid areas - the Gibson Desert to the north, the Tirari and Sturt's Stony Desert to the east, the Nullarbor Plain to the south and Western Australian mallee scrub to the west (Friends of the Great Victoria Desert). The GVD straddles the Western Australian (WA) and South Australian (SA) border and is the largest sand dune desert in Australia (Benshemesh and Schulz 2008). Half of the 40 million hectares occupied by this desert occur on the WA side of the border.

3 SOUTHERN MARSUPIAL MOLE (*NOTORYCTES TYPHLOPS*)

The information given in the following sections has mainly been paraphrased from several scientific papers and journal articles by J. Benshemesh, the acknowledged authority on SMM. Each article is referenced in text and listed in References (Section 9). Information extracted from other sources is noted in text and authors are listed in References.

Currently, there appears to be some doubt as to the taxonomic status of *N. typhlops* and whether or not there are two species: a northern form and a southern form. This is yet to be clarified (Benshemesh 2004) but the populations in the south and south-western portion of the GVD are most likely to form part of the southern form. Neither form should be confused with the Northern Marsupial Mole (*Notoryctes caurinus*).

3.1 Legal Status

The SMM (whether one species or two) is currently listed as Endangered under the Federal Environmental Protection and Biodiversity Conservation Act 1999 (EPBC), administered by the Department of the Environment (DotE), and also the Western Australian Wildlife Conservation Act 1950 (WC) administered by the Department of Parks and Wildlife (DPaW). Both *N. typhlops* and *N. caurinus* are listed as ódata deficientô by the International Union for Conservation of Nature (IUCN).

However, the listing eligibility of *N. typhlops* is currently under review by DotE (undated), with the proviso that additional information is required to more fully understand the conservation status of the species. Current information indicates that:

- there is no evidence of a continuing decline in population size;
- their geographic distribution is not precarious for either extent of occurrence and/or occupancy;

- their population size is unknown but evidence of the species has been found in most areas of suitable habitat within their distribution (Woinarski *et al*. 2014;
- Woinarski *et al*. (2014) considers that the population size is likely to be in excess of 10,000 mature individuals; and
- no population viability analysis has been undertaken.

These points have been paraphrased from the DotE (undated) document and will require updating when new information has been fully reviewed by DotE.

3.2 Distribution

The SMM is known to occur in the sand dune deserts of central Australia, within Western Australia, South Australia and the Northern Territory. The deserts in which the SMM have been found include the Great Sandy, Little Sandy, Gibson, Tanami, western Simpson Desert and the GVD (Benshemesh 2004). The extent of occurrence is estimated to be 620 000km^2. The area of occupancy is unknown but is likely to be > 20 000km^2. Both are considered to be stable (Woinarski *et al*. 2014).

Benshemesh (2004) states that, in general, the paucity of records and changed nature of opportunities for observations by aboriginal people was such that the available data were inadequate to determine whether there has been a change in the area of occupancy by marsupial moles at the time of preparation of the Recovery Plan. In addition, Benshemesh (2004) stated that more recent records have shown an increase in known range of the SMM by 500km to the south-west, 200km to the north and 100km to the west. Targeted searches by various mining companies, in particular the Tropicana Gold Project and the MRUP, have increased the level of knowledge of the distribution of the SMM within the GVD1 Shield sub-region as a result of surveying by excavation of trenches to uncover the distinctive ómoleholesô created by the tunneling of SMM through the sand (see Section 2.5).

3.3 Habitat Preferences

Benshemesh (2004) states that, in general, it appears that sand dune crests and slopes are favoured by SMM as suitable ótunnellingô sand is usually present; some evidence suggests that SMM can also be found in sandy plains. Benshemesh and Schulz (2008) also state that SMM 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 ótunnellingö. The preferred dunes are generally vegetated with *Acacia* species and other shrubs, often with a ground cover of spinifex.

In their report on the operational area of Tropicana *ecologia* (2009a) found that signs of SMM were more frequently encountered in trenches in yellow and yellow-red sands than in red sands. This correlated with sand softness, with yellow sand dunes generally made up of softer, deeper sands, often connected by softer inter-dunal areas which provided more potential habitat and linkages between dunes (*ecologia* 2009a).

3.4 Description

Benshemesh (2008) describes the SMM as blind, with shovels for hands and a subterranean lifestyle. It lacks external ears and the eyes are reduced to non-functional buds beneath the skin. They have dense, silky, golden fur, and the snout is heavily keratinized. The front limbs are short and powerful, with large digging claws. The short tail is very strong and appears to be used as a holdfast when tunneling. They have fused neck bones to make their bodies more rigid. They may be up to 16cm long and weigh between 40 and 70gm. Although the SMM appears to come to the surface rarely, when it does, this short tail leaves a sinuous drag mark (see Plate 1).

Plate 1 Marsupial Mole on the surface showing tracks with tail drag (Credit: Uluru-KataTjuta National Park).

Females have a backward-opening pouch with two teats; males have no visible scrotum as the testes lie between the skin and the abdominal wall. Marsupial moles are superbly adapted to an underground lifestyle, and may be the most fossorial mammals in the world (Benshemesh 2008).

3.5 Ecology

Benshemesh (2008) describes the SMM as extremely elusive in their habits making them particularly difficult to study and to define their ecological profile. However, what is known is that the SMM is superbly adapted to underground life. They tunnel through lightly cemented sand, backfilling as they go, leaving oval-shaped changes in sand texture and colour; these backfilled tunnels are referred to as ómoleholesô (Pavey *et al*. 2012). There is no evidence that these moleholes are re-used (Benshemesh 2008), and they persist in the soil profile for many years. As such, these moleholes provide evidence of SMM presence at some time in the past. They come to the surface occasionally but this surfacing behaviour appears to be extremely variable, both temporally and spatially, within the Uluru-Kata Tjuta National Park and Ayers Rock Resort (Bennison *et al.* 2014), and it is likely that this variability occurs wherever the SMM is present. Bennison *et al*. (2014) also found that there was a significant relationship between surfacing behaviour and environmental variables such as fire age, timing of significant rainfall events, presence of infrastructure and the cumulative rainfall received in the preceding three months.

It is assumed that SMM lead solitary lives, feeding on a range of invertebrate prey and their larvae; in captivity they also feed on geckos, spiders and centipedes. Little else is known about these elusive and difficult to find marsupials.

4 MRUP STUDY OBJECTIVES

The main study objectives for this report are to:

1. review information from a range of sources describing the SMM and the trenching methods by which they are mainly recorded;

2. 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;
3. compare the results of these data with the results from the Tropicana Gold Project;
4. produce a stand-alone document on the results of SMM assessments within the MRUP; and
5. include in the document a risk assessment of long-term changes to SMM habitat within the MRUP project area.

5 METHODS

Benshemesh (2005) produced a monitoring manual for marsupial moles which describes in detail the survey and monitoring methods for these enigmatic marsupials; much of the information presented in this section has been extracted from this manual. Survey methods are the same for both species of marsupial mole (*N. caurinus* and *N. typhlops*); therefore, this section of the report does not distinguish between them.

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 (Benshemesh 2005). The most efficient of these methods to date has been the excavation of trenches in suitable habitat to count visible moleholes.

Benshemesh (2005) recommends that for general 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.

Detailed descriptions and diagrams of trenches have been provided in Benshemesh (2005) and a brief summary is provided below:

- Length - 120 cm;
- Depth - 80 cm;
- Width - 40 cm.

The objective is to expose a north facing wall, relatively undisturbed by shovel marks, to be inspected for moleholes. Benshemesh (2005) recommends excavating a 30 cm step into the south wall of the trench to increase sun exposure on the north wall. The north wall should be as smooth and flat as possible to facilitate molehole identification. It is essential that an escape route for other animals that may fall into the trench is constructed. As trenches are generally left for several days, they should be inspected on a daily basis for other entrapped fauna that have not been able to use the escape route.

Detection of moleholes can be assisted by preparation of the trench wall as described in Benshemesh (2005); to be counted as a molehole, the following criteria must be met:

- the structure is filled with sand, with little if any airspace;
- at least two thirds of the molehole's circumference is discernible;
- the structure is symmetrical;
- the structure is rounded;
- the structure is continuous and does not disappear or reduce in minimum dimension when rubbed.

Benshemesh (2005) also provides a guide for aging moleholes, given that this is a subjective evaluation of their general appearance.

When trench inspection is completed, and all moleholes have been documented, trenches should be filled in and their location noted by GPS. If required, photographs should be taken of the trench, surrounding habitat and the north face showing any moleholes detected.

5.1 MRUP Methodology

It was noted during the 2009 survey (Ninox 2010) that the SMM was to be targeted later in the process of environmental assessment for the MRUP; however, the Ninox team took advantage of the presence of several costeans within the survey area to inspect the vertical walls for the soil disturbance associated with the movement of this cryptic animal.

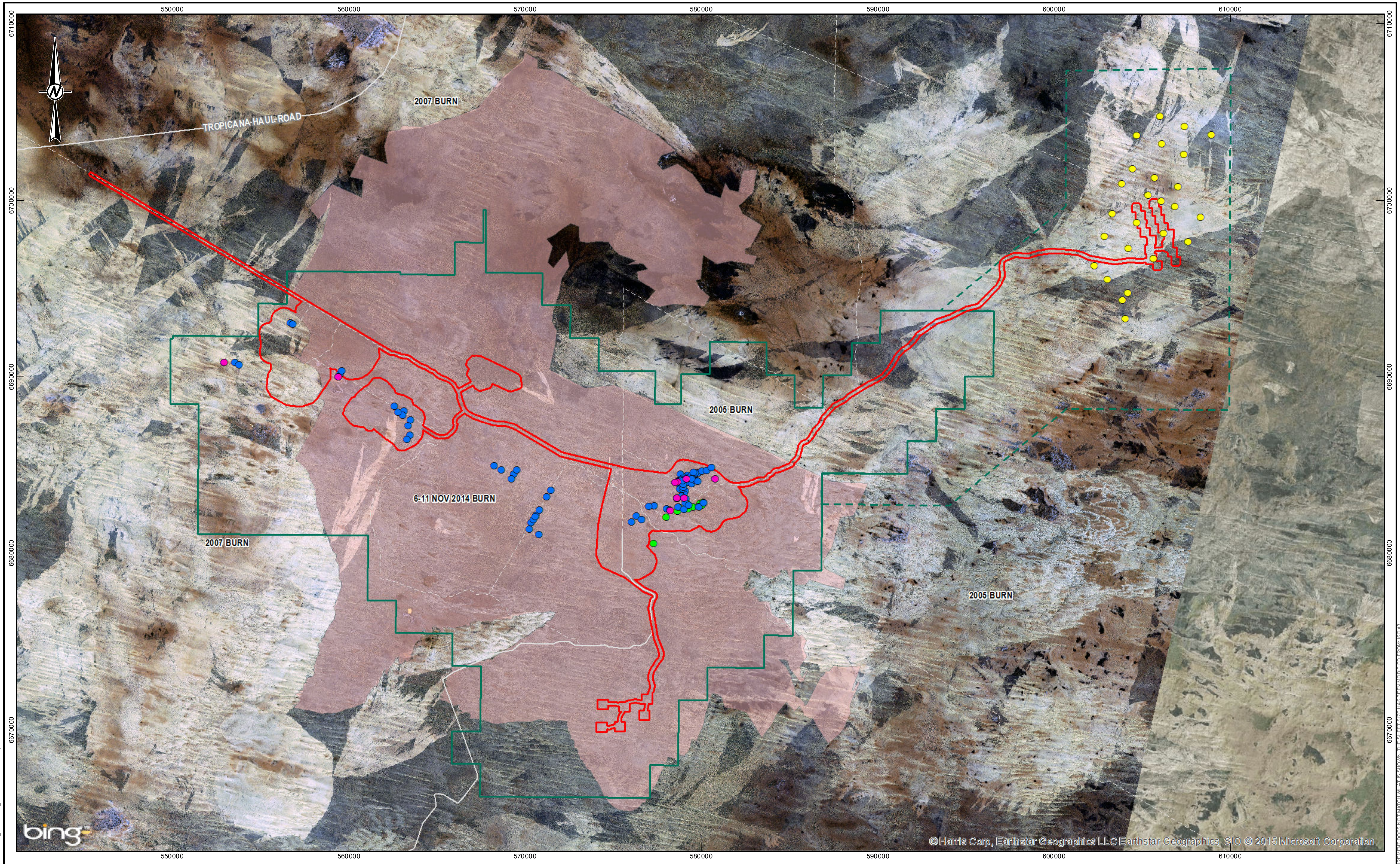
In September 2013, EAMA produced a document that detailed the procedures to be followed during surveying and monitoring of potential marsupial mole holes in trenches (EAMA 2013). EAMA elected to integrate SMM surveys into their routine rehabilitation activities associated with mineral exploration in the MRUP area. The methods described in EAMA (2013) have been summarised below.

Site selection was based on the existing drilling pattern and included dune and swale area. Trenches covered the crest, mid-slope and base of dunes, within the previously mapped vegetation domains. They were to avoid, as far as possible, digging under the canopy of mature plants to minimise disturbance to the root network. Trenches were dug mechanically with a 55cm bucket on the three point linkage backhoe. The trench dimensions were to be a minimum of 300 x 100 x 55cm. Trenches were ramped to allow other animals to escape from the trench. Prior to digging, the soil colour was defined using a MUNSELL chart, and vegetation cover was recorded using a chart provided to staff showing the structural forms of Australian vegetation. Any ground cover of spinifex was recorded and stage of growth was judged against sketches provided by V. Reynolds. Trenches were dug to approximately 1m over a 3m length with the 55cm bucket. The trench was excavated on an east-west plane in order to show the north-facing wall in sunlight. Photographs taken to the east, west, north and south were taken to show surrounding vegetation. Once excavated, soil tests included penetrometer and shear vane meter tests. EAMA (2013) provides detailed instructions for action should any moleholes be identified in any of the trenches; these instructions have not been reproduced in this current document.

Between January 2013 and March 2014, Vimy staff excavated 122 trenches within the MRUP area by the methods described in Vimy 2013. Plate 2 shows a typical trench excavated by mechanical means within the MRUP area.

Plate 2 Excavation of trench in progress.

Plate 3 Completed trench.



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
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	2015-10-28
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SOUTHERN MARSUPIAL MOLE SURVEY TRENCH AND MOLEHOLE LOCATIONS WITHIN MRUP AREA

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	B5	0	3

6 RESULTS

6.1 Mulga Rock Uranium Project Area

No evidence of the presence of SMM was detected in the costeans inspected by Ninox personnel in 2009 (Ninox 2010). Subsequently, Vimy provided Ninox with an Excel spreadsheet showing the data collected during the targeted sampling within the MRUP area between September 2012 and March 2014. These data have been discussed below.

From the information provided to Ninox by Vimy, nine of the 122 trenches were noted as having soil disturbance present that was identified as moleholes, with trench T_075 and T_096 having two moleholes identified in each.

Table 1 List of trenches in which moleholes were defined as present (information as provided by Vimy).

Trench ID	NNA #	Plate Nos.	Easting	Northing	Molehole Diameter (Max)	Molehole Diameter (Min)
T_028	**NNA5517**	4 & 15	579,132	6,684,221	45	42
T_096	**NNA5753**	5 & 16	578,490	6,684,005	47	40
T_096	**NNA5753**	6 &16	578,490	6,684,005	45	35
T_049	**NNA5598**	7 & 17	578,633	6,684,042	42	34
T_089	**NNA5735**	8 & 18	579,008	6,683,126	49	47
T_092	**NNA5738**	9 & 19	578,209	6,682,413	45	39
T_074	**NNA5703**	10 & 20	559,389	6,690,003	45	30
T_075	**NNA5705**	11 & 21	552,908	6,690,824	45	35
T_075	**NNA5705**	12 & 21	552,908	6,690,824	50	45
T_095	**NNA5751**	13 & 22	580,769	6,684,210	52	40
T_100	**Disposal pit # 3**	14	578,589	6,683,114	45	30

The following photographs (Plates 4 to 14) show the moleholes in the trenches listed above and Plates 15 to 22 show the surrounding vegetation to eight of the nine successful trenches.

Plate 4 Molehole in trench T_NNA5517

Plate 5 Molehole (1 of doublet) in trench T_096

Plate 6 Molehole (2 of doublet) in trench T_096

Plate 7 Molehole in trench T_049

Plate 8 Molehole in trench T_089

Plate 9 Molehole in trench T_092

Plate 10 Molehole in trench T_074

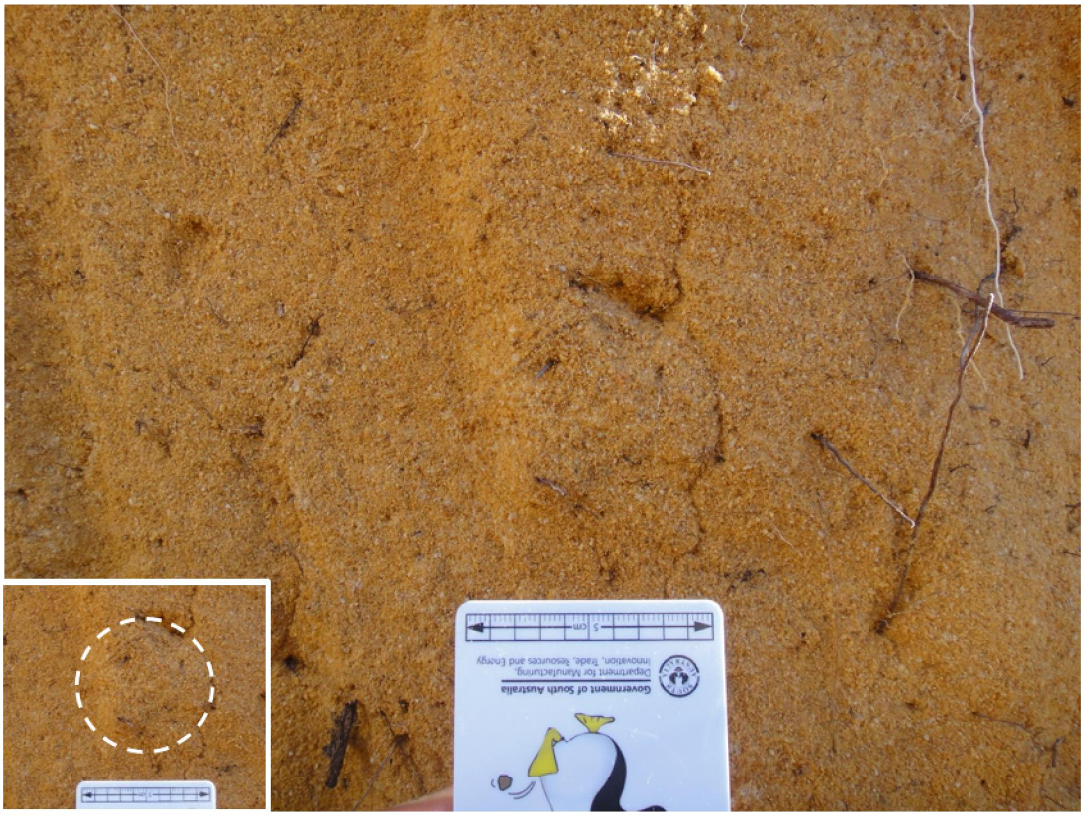


Plate 11 Molehole 1 in trench T_075

Plate 12 Molehole 2 in trench T_075

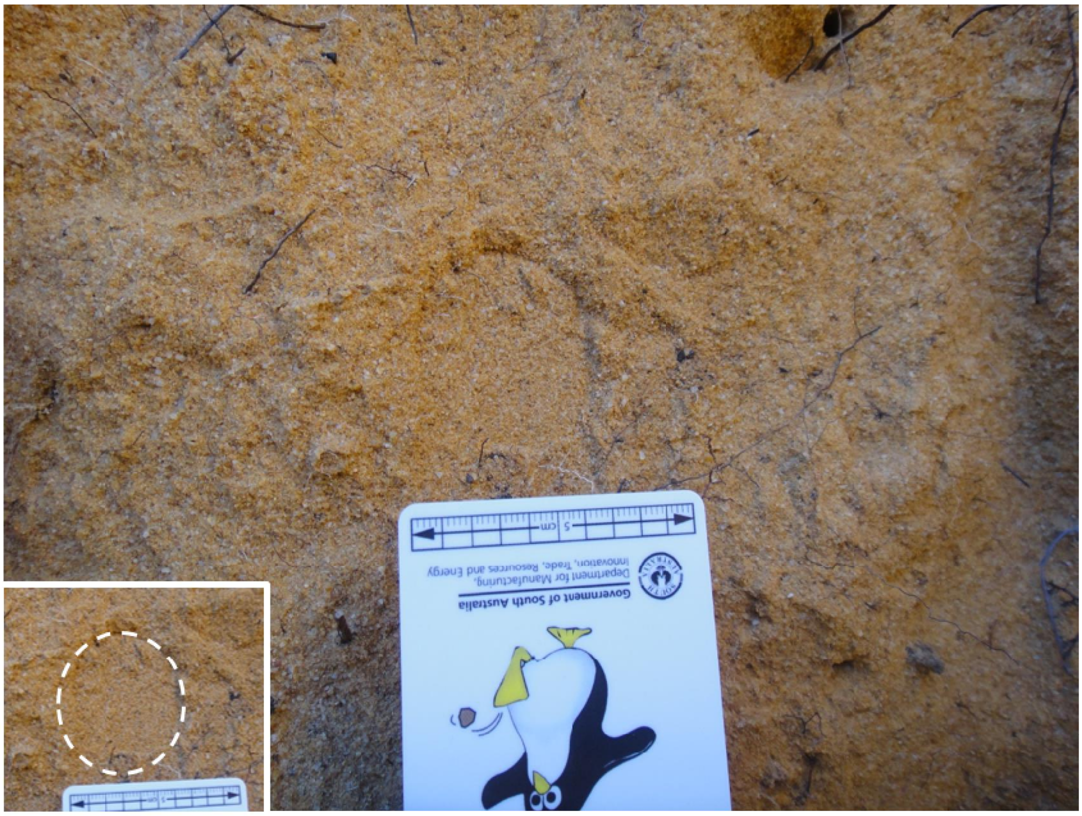
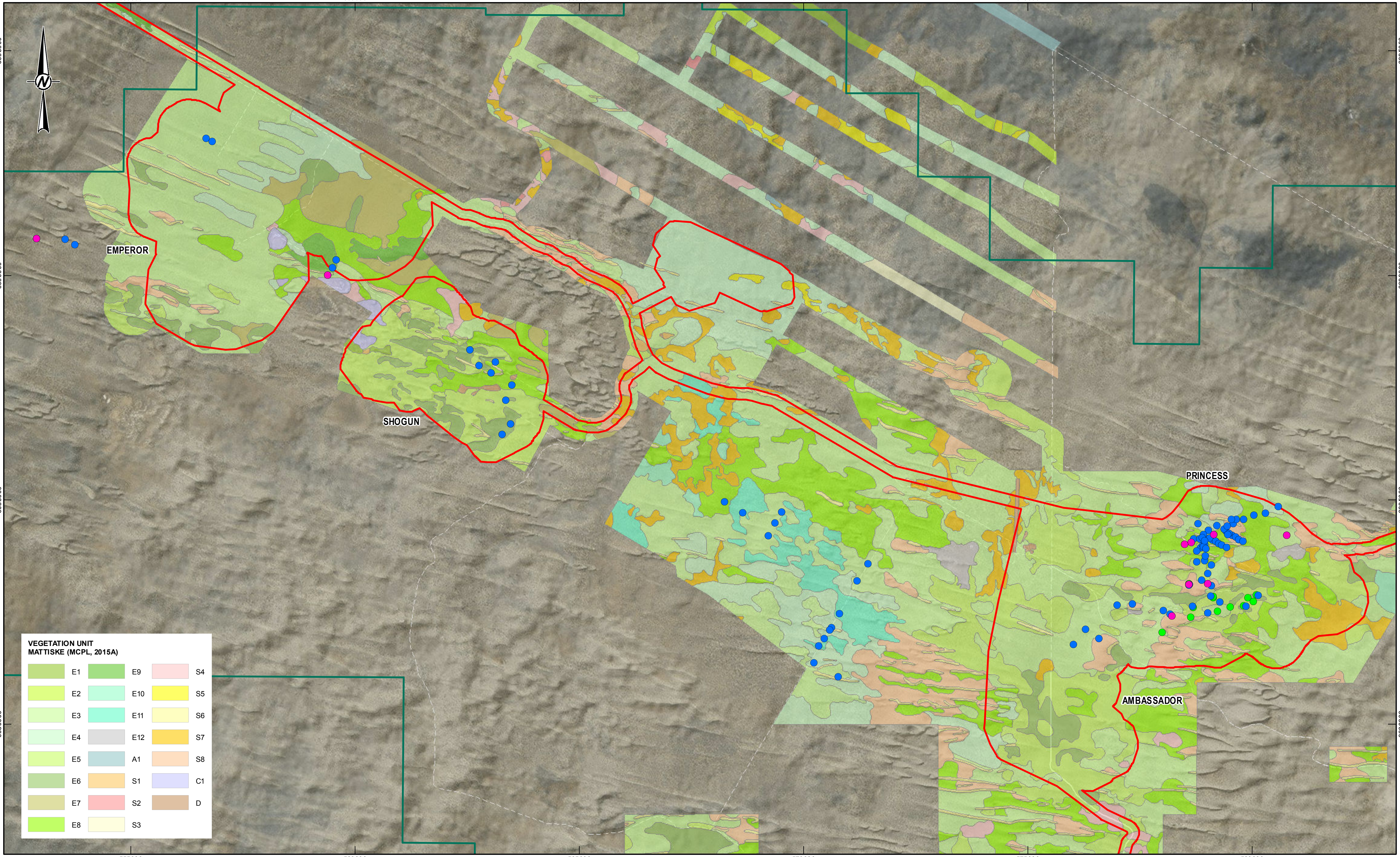


Plate 13 Molehole in trench T_095

Plate 14 Molehole in trench T_100

Figure 4 (a) shows the trench locations relative to the MCPL vegetation mapping; the year of trenching is colour coded and the location of successful trenches is also shown.



LEGEND

- MOLEHOLE LOCATION
- 2010 TRENCH SURVEY
- 2012 TRENCH SURVEY
- 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

VIMY RESOURCES

CONSULTANT

Golder Associates

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

PROJECT
MULGA ROCK URANIUM PROJECT

TITLE
SOUTHERN MARSUPIAL MOLE SURVEY TRENCH AND MOLEHOLE LOCATIONS SHOWN WITH VEGETATION MAPPING (LEGEND ON FOLLOWING PAGE.)

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	B5	0	4A

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* 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.

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 gongylocarpa* over *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* sp. 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	2015-10-23
DESIGNED	MS
PREPARED	MS
REVIEWED	GB
APPROVED	GB

TITLE
VEGETATION UNIT DISTRIBUTION – LEGEND

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	B5	0	4B

25mm

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

Path: G:\Spatial_Information_Group\GIS_WORKSPACE_AUSTRALIA\01_WA\SH5107_MINIGWAL\1540340\Projects\APPENDIX\Rev0\1540340-B5-F004B-Rev0.mxd

Based on the available information to date, what has been assessed as the most suitable sand dune habitat within the Vimy development envelope is described by Mattiske Consulting Pty Ltd (MCPL 2015) as:

> Vegetation Community 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.

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 (MCPL 2015). MCPL (2015) have calculated that 7.36% of the mapped S6 community lies within the development envelope.

While vegetation community S6 probably represents the optimal SMM habitat, it is possible that other sandy vegetation communities could also support this subterranean marsupial. Examples include, in order of potential habitat preferences, (descriptions from MCPL 2015; percentage of each mapped vegetation community within the disturbance footprint are also given):

> Vegetation Community 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%.
>
> Vegetation Community 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; 0.82%.
>
> Vegetation Community 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; 1.86%.
>
> Vegetation Community 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%.
>
> Vegetation Community 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%.
>
> Vegetation Community 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%.

Vegetation Community 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%.

Vegetation Community 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%.

Vegetation Community 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%.

While it is not possible to state with any certainty the vegetation community in which the successful molehole trenches were located, the following photographs show the surrounding vegetation to eight of the nine trenches.

Plate 15 Vegetation surrounding trench T_028 (south view).

Plate 16 Vegetation surrounding trench T_096 (south view).

Plate 17 Vegetation surrounding trench T_049 (north view).

Plate 18 Vegetation surrounding trench T_089 (north view).

Plate 19 Vegetation surrounding trench T_092 (south view).

Plate 20 Vegetation surrounding trench T_074 (south view).

Plate 21 Vegetation surrounding trench T_075 (south view).

Plate 22 Vegetation surrounding trench T_095 (north view).

6.2 Tropicana Project Area

The Tropicana project consists of an operational area approximately 330km east-north-east of Kalgoorlie, and 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. The results of these searches are described in the following sections.

6.2.1 Operational Area

The Tropicana operational area lies approximately 110km north-east of the MRUP camp. This operational area was surveyed for the presence of SMM by *ecologia* environmental (2009a). *Ecologia* (2009a) state in their methodology that their survey for the presence of marsupial moles was to consist of 75 sites, with 225 trenches being excavated within the operational area. For regional comparisons, 41 sites and 123 trenches were established to the east of the operational area. The trenches were all excavated and sampled following consultation with Dr J. Benshemesh including a review of Benshemesh (2005).

Section 4.4 in *ecologia* (2009a) states that 90 mole survey sites were established with the aim of mapping the distribution of moles throughout areas of greatest potential impact. Each site consisted of three trenches, resulting in 270 trenches. Forty-one of these sites were found to have traces of marsupial mole, with the majority in the soft, sandy dune systems on the western side of the operational area. Approximately one third of the moleholes were considered recent or fresh. Five of the 41 regional sites showed evidence of marsupial mole presence. Mole signs were found in five of the 41 regional sites surveyed, with some in habitat not generally associated with preferred mole habitat (*ecologia* 2009a).

Ecologia (2009a) found that signs of moles were significantly more common on dunes than in interdunal habitat but that they appeared to favour yellow and yellow-red sands over red sands. These sands seemed to be the main determining factor in mole presence with neither fire history nor overlying vegetation providing any indication of mole presence.

6.2.2 Infrastructure Areas

During a field assessment of the proposed Pinjin Road infrastructure corridor, 73 trenches were excavated in 25 sites (URS 2009) in accordance with the methods detailed by Benshemesh (2005). Six of these trenches revealed 10 moleholes in total. Of these, two were relatively close to the MRUP area: Pinjin Site 2-11a, at 634 717mE and 6 702 286mN, approximately 41km NW of MRUP camp; Pinjin Site 1-5c, at 602 783mE and 6 731 645mN, approximately 55km NE of MRUP camp. In contrast to the study within the Tropicana operational area, URS (2009) found that vegetation structure appeared to be a significant predictor of suitable marsupial mole habitat. All moleholes were found in trenches located in open scrub, with data showing that reddish yellow surface sand colour was another factor within this survey location.

An alternative infrastructure route between the Tropicana Operational Area and the Transline was also inspected for suitable SMM habitat and three dunes were investigated with three or four trenches in each (*ecologia* 2009b). Twenty-six moleholes were discerned in three of the four trenches in site 1, 19 in three of the four trenches in site 2, and one in one trench in site 3. The majority of these moleholes were judged to be fresh. These sites lie approximately 75km east of the MRUP camp.

Inclement weather conditions prevented adequate sampling for SMM in the Minigwal Trough water area and pipeline corridor (*ecologia* 2009c) although suitable habitat was present.

6.3 Simpson Desert

Watson (2009a) discusses a survey conducted in 2006 in an area within the Simpson Desert in South Australia which was investigated for the presence of SMM. In total, 19 sites were sampled with three trenches in each site, excavated according to the methods detailed in Benshemesh (2005). Signs of SMM were identified in nine of the 57 trenches with multiple moleholes being distinguished in three trenches.

Following on from the 2006 survey, 25 sites, containing 75 trenches were surveyed in the Simpson Desert in 2007 (Watson 2009b). Moleholes were recorded in seven of the 25 sites, with nine of the 75 trenches containing moleholes.

A comparison of the SMM data between 2006 and 2007 showed that considerably fewer moleholes were observed in 2007 than in 2006; and that more moleholes were recorded in the lower dune trenches which contrasted with the 2006 results (Watson 2009b).

7 DISCUSSION

Marsupial moles represent a unique and ancient lineage, are little known, and are rarely encountered (Benshemesh and Schulz 2008). They inhabit the vast sandy deserts of central Australia, with the GVD being a major stronghold for the Southern Marsupial Mole (Benshemesh and Schulz 2008). Over recent years, targeted searches for this species have been undertaken within the GVD during environmental studies for the development of various mining activities. These studies have provided a significant increase in information regarding the distribution and possible abundance of these enigmatic animals. While the actual abundance of SMM is unknown, evidence of the species has been found in most areas of suitable habitat (stable dunes) within their distribution; Woinarski *et al*. (2014) consider that the population size is likely to be > 10 000 mature individuals.

Most of the studies within the GVD to date have highlighted the difficulties of surveying for these animals, with excavated trenches being the most efficient method of determining whether moles occur, or have occurred, within a given area. While providing invaluable data on the habitat requirements of SMM, little additional information on the ecology, behaviour, breeding and other life history details result from these surveys.

The results from the Tropicana operational area and proposed infrastructure routes, the Simpson Desert and other areas within South Australia 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 molehole/m^2, compared to Tropicana which has approximately 1.99 molehole/m^2. In addition, the density of moleholes 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 molehole/m^2. Table 2 compares several areas that have been surveyed for marsupial moles by means of excavating trenches for moleholes.

What the majority of studies have shown is 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 moleholes; vegetation structure and fire history may have less influence but this is yet to be determined. However, Benshemesh and Schulz (2008) state that their results show that the SMM is more widespread and common in the Western Australian GVD than previous records suggest. Indeed, averages of 20-60 km of recognisable tunnel per hectare are common in central dunefields (Dickman & Woodford Gamf 2008, cited in Benshemesh 2010). Rather than being a rare curiosity, it is possible that marsupial moles might be so abundant that they profoundly affect their environment both by their consumption of prey and by turning the soil as they tunnel. In addition, recent surveys using novel techniques have shown the species to be widespread and relatively common. There is no evidence of a continuing decline (Woinarski *et al*. 2014).

Table 2 Comparison of the molehole density results from regional surveys for SMM (some data not available).

State	Region	Study/report year	Mole holes	Sites	Trenches	Dimensions L x H (m)	Area surveyed m^2	Molehole density Molehole/m^2	Aeolian material	Rainfall	Source
WA	Mulga Rock	2012-14	11	122	122	>1x>0.75	413	**0.03**	Yellow-Orange sands	200-250	
WA	TPG GVD	2008	175	12	89	1x0.7	80.6	**2.17**	Red-Yellow sands	200-250	Benshemesh & Schulz 2008
WA	TPG Operational Area	2009	136		84	Variable	118.41	**1.15**			*ecologia* 2009a
WA	TPG Access Corridor Pinjin Option	2009	10	25	73	1.2x0.8	70.1	**0.14**	Red-Yellow sands	~250	URS 2009
WA	TPG Access Corridor Transline Option	2009	20	4	12	1x0.7	8.4	**2.38**			*ecologia* 2009b
SA	West Simpson Desert	2006	14	19	57	1x0.8	45.6	**0.31**	Red sands	100-150	Watson M. 2006
SA	West Simpson Desert	2007	11	25	75	1x0.8	60	**0.18**	Red sands	100-150	Watson M. 2007
SA	APYL[1]-Maralinga-Ooldea	2000-2005	501	?	?	1x0.8?	?	**?**	Red sands?	~250	
SA	APYL[1] B10	2014	276			1x0.8	85.4	**3.23**		~250	Benshemesh 2014
NT/SA	Finke, West Simpson, East Great Sandy	2011	294	32	94	1x>0.7	90.2	**3.8**			Pavey *et al.* 2012

[1] Anangu-Pitjantjatjara-Yankunytjatjara Lands

8 RISK ASSESSMENT

In any mine development there is inevitable loss of habitat for all resident and non-resident fauna. The level of impact of this loss is mostly determined by the availability of similar habitat in surrounding areas and the mobility of the species being displaced. Given the lack of knowledge of the ecology and behavior of the SMM, much of the discussion of the potential impact of mine development on this species is speculative.

Benshemesh (2009) states that the most detrimental landscape changes associated with the Tropicana Gold Project include the pit, tailings dams and waste landforms. These mining and processing structures are generally large and change the local landscape for a relatively long term. They are also components of any above-ground mining development and, while the location and size of the pit(s) cannot be altered, it is sometimes possible for other infrastructure such as waste dumps, processing plants, roads and camps to be situated away from fauna habitats of significance.

Benshemesh (2009) discusses the potential effects of landscape changes resulting from mine development on SMM and an assumption has been made in this current document that similar potential effects may occur within the MRUP area where suitable SMM habitat is present.

8.1 Habitat Loss

The development envelope for the MRUP is 9,998ha; suitable sand dune habitat for SMM is present within this envelope. As stated earlier, based on the available information to date, what has been assessed as the most suitable sand dune habitat within the Vimy development envelope is described by Mattiske Consulting Pty Ltd (MCPL 2015) as:

> Vegetation Community 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.

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 (MCPL 2015). In total, MCPL (2015) considers that only 7.36% (70.98ha) of MCPL mapped extent of the S6 community occurs within the development footprint, with the largest proportion of this community located in the ñmine pitò areas (MCPL 2015). However, this community extends well beyond the development footprint, with approximately 199.49ha occurring within the development envelope.

MCPL (2015) state that:

> *Based on the polygon (supplied by Tropicana Joint Venture), the broader yellow sandplains are estimated to represent 1,692,000 ha (Figure 11). In comparison, the MCPL mapping extent for the MRUP covers over 29,000 ha within the boundaries of this polygon. Calculations supplied by X. Moreau (General Manager – Geology and Exploration, VMY), indicate that the cumulative yellow sand dune crest area is approximately 12,936 ha (approximately 0.76% of the total polygon area) with approximately 965 ha mapped by MCPL (assumed to be similar to the S6 vegetation community).*

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. Figure 5 shows the extent of Yellow Sand Plain surrounding and within the MRUP development envelope and footprint.

Benshemesh and Schulz (2008) discuss the strong positive correlation between SMM presence and dune connectivity; these authors rated the dune connectivity to surrounding dunefields within the Tropicana Gold Project area, scored on a 1 to 9 scale with 1 being poor dune connectivity and 9 being high connectivity. Vimy have produced a connectivity index as shown below in Table 3 which shows that with a maximum buffer of 100m, there is a low index of connectivity (0.12) within the MRUP footprint.

Table 3 Connectivity Index

Buffer	Total Buffer Area in Yellow Sand Plain (ha)	Area of Sand Dune Buffer Connectivity (ha)	Connectivity Index (=Connected Area/Total Area)
25 m	45,244	846	0.02
50 m	94,608	3,711	0.04
75 m	148,038	10,658	0.07
100 m	205,528	25,563	0.12

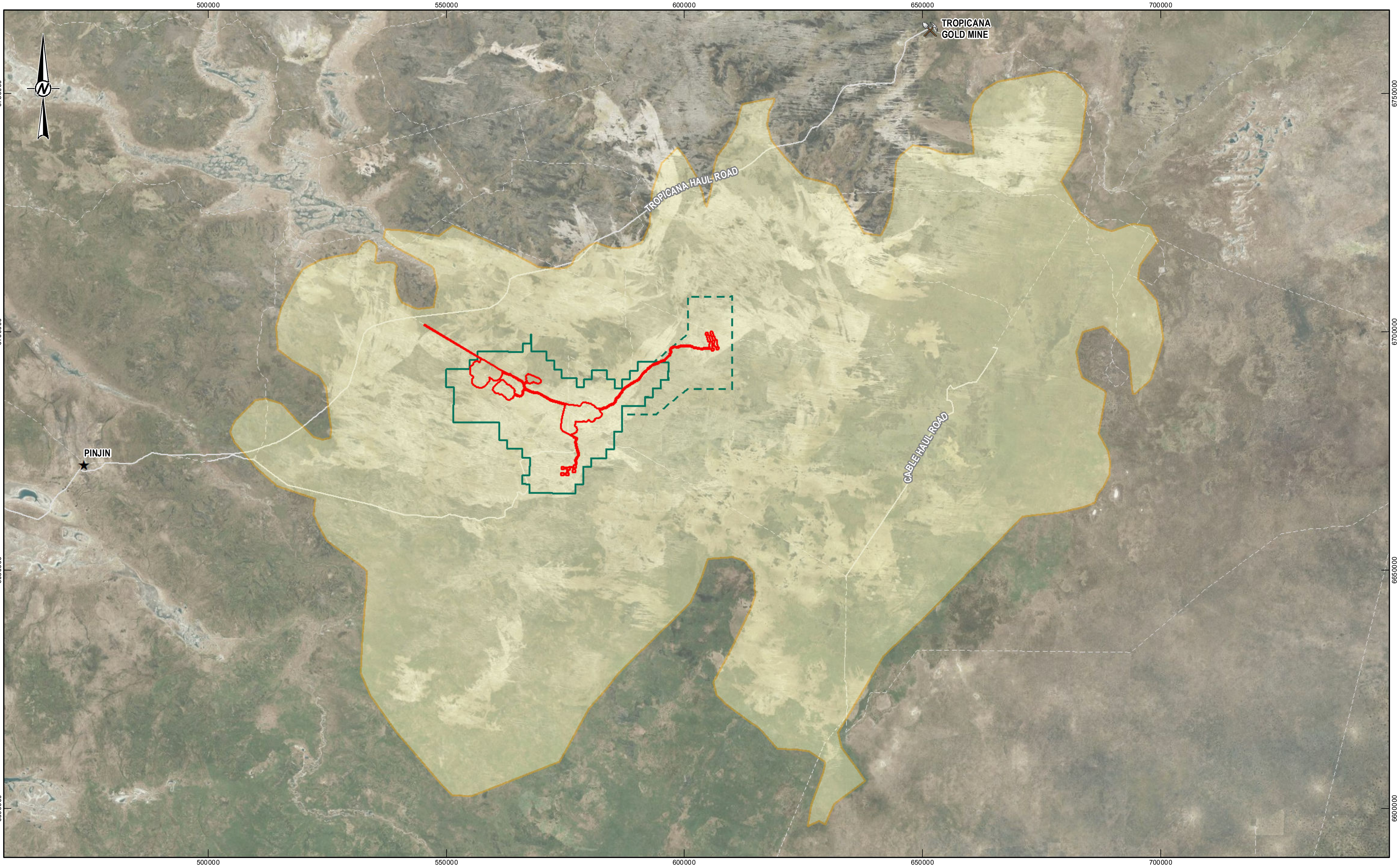
Table 4 shows the potential impact on dune buffers and connectivity of dunes by the site layout. With a maximum 100m buffer, a total of 91.2ha of dune buffer connections are intersected by this site layout; this is estimated at 3.7% of total dune buffer that will be intersected by the site layout.

Table 4 Impact assessment on dune buffers and connectivity of dunes.

Buffer	Area of Total Dune Buffer intercepted by Site Layout (ha)	% of Total Dune Buffer intersected by Site Layout	Area of Dune Buffer Connections intersected by Site Layout (ha)	% of Total Dune Buffer Connections intersected by Site Layout
25m	14.87	0.033	5.79	0.013
50m	59.61	0.063	22.88	0.024
75m	142.64	0.096	56.71	0.038
100m	298.68	0.14	106.35	0.052

While the loss of a small proportion of optimal habitat and potential loss of individual SMM will be unavoidable should the project proceed, the impact on the species as a whole will be negligible given that the SMM 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.

In addition, the results of the trench survey within the project area (122 trenches) and the relatively low positive results (nine trenches with 11 moleholes, Table 1) indicate that the population of SMM is low when compared to the density of moleholes exposed during excavations in other locations where trench surveys have been conducted (Table 2).



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

0 10 20 30 40 50

1:750,000 KILOMETRES

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
1540340	B5	0	5

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

Given the information above, it is very unlikely that the loss of habitat within the MRUP would have any significant impact on the SMM as a whole. However, it is unknown whether the small population within the MRUP area is connected to that within the Tropicana Project area and associated infrastructure corridors, and whether there is likely to be any cumulative impact following development of both Tropicana (existing) and the Mulga Rock projects (developing). In light of this, it was noted in Benshemesh (2009) that the dunefields south of Lake Rason are not obviously connected to the rest of the GVD, and the population of SMM may represent a sub-population. Lake Rason is located approximately 150km north-north-east of the MRUP area. Benshemesh (2009) goes on to state that the available SMM habitat south of Lake Rason is estimated to be approximately 14,000km of dune, which represents a substantial amount of habitat. The loss of a small percentage of this habitat south of Lake Rason is unlikely to represent a threat to the SMM in this western flank of the GVD.

8.2 Habitat Fragmentation

The MRUP area is traversed by major access roads (Nippon Hwy and PNC Baseline Rd), tracks and a network of exploration gridlines. The majority of the roads and tracks have been in place for many decades resulting in a somewhat fragmented landscape. For the purposes of this report it has also not been possible to determine changes to the extent of major and minor roads, tracks and gridlines. The extent to which this has impacted on the local population of SMM is unknown. At the time of the 1985 survey (Martinick & Associates 1986), the trenching technique for revealing the presence of SMM was unknown and, as a result, it is not possible to ascertain whether SMM were present in the 1980s. The distribution of marsupial moles was also somewhat of a mystery at that time, with only nine specimens noted in DPaWộs NatureMap up to 1990; as a result, this animal was not discussed in the 1986 report.

Based on the discussion of the effects of roads and tracks on SMM within the Tropicana Project Area (Benshemesh 2009), there may be some long and short term impact on the local SMM population within the MRUP area, particularly as the development of the project proceeds. However, potential impact on SMM within the MRUP area could be reduced by:

- closure and rehabilitation of tracks and grid lines that are no longer required by:
    1. shallow ripping of compacted surface sands;
    2. placement of vegetation debris on the surface once ripping has been completed to reduce wind erosion and encourage plant growth;
    3. blocking vehicle access to these rehabilitated tracks and grid lines;
    4. education of the workforce explaining the reasons for blocking access to disused tracks and grid lines;
- where possible, careful placement of new infrastructure, particularly tracks and exploration grid lines, to avoid optimal SMM habitat and to reduce potential fragmentation of SMM dune habitat.

These two measures would decrease any potential impact on this localised and small population.

In addition, further surveys based on trenching in suitable habitat between the MRUP area and the SMM molehole records from the Tropicana Pinjin Road infrastructure corridor approximately 41km NW of MRUP camp and 55km NE of MRUP camp, would potentially confirm that the MRUP population is not isolated from other SMM populations. This trenching survey could be extended to include the area between the MRUP area and the alternative infrastructure route between the Tropicana Operational Area and the Transline where 26 moleholes were discerned in three trenches approximately 75km east of the MRUP camp.

However, the apparent low density of SMM, as demonstrated in Table 2, indicates that it is unlikely that development of the MRUP will cause any major disruption to SMM populations on this western flank of the GVD.

8.3 Fire

At Tropicana, moleholes were found in both burnt and unburnt locations during the first survey and there was no difference apparent to field staff (*ecologia* 2009a); therefore, the effect of fire on SMM populations or individuals remains unknown.

Much of the MRUP area and surrounds was burnt during 2014; given the low density of moleholes (Table 2) indicating a low population, it is unlikely that this fire would have had much effect on SMM within the project area.

Long term effects of fire on food availability for SMM is unknown but given that ants and beetle larvae appear to make up a considerable part of their diet (Pavey *et al*. 2012), research into the effects of fire on these two invertebrate groups within the GVD would provide the required information.

8.4 Predation

Native and introduced predators are likely to prey on SMM, particularly when they appear on the surface, although some predatory behaviour may include digging moles out of the ground. Dingoes and feral cats are the most common mammalian predators in the MRUP area, with cat numbers being relatively high (C. Woolard pers. comm.). It is not known how great an impact these predators have on SMM, but within the current study area, the density of SMM appears to be quite low and, as a result, they may not form a major component of introduced or native predator diet.

It is likely that the potential for any impact on SMM by the highly efficient predatory feral cats in the area would be reduced by the continued presence of Dingoes, supported by feral cat control by Vimy as development of the project proceeds.

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