

# **A REPORT OF AN ARCHAEOLOGICAL SURVEY OF THE PROPOSED MULGA ROCK URANIUM PROJECT NORTHEAST OF KALGOORLIE**

**PREPARED FOR VIMY RESOURCES LTD**

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## **EXECUTIVE SUMMARY**

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The archaeological survey of the proposed Mulga Rock Uranium Project (MRUP) located at Narnoo, approximately 250 kilometres northeast of Kalgoorlie, was undertaken between 5 and 13 July 2010. The survey was conducted on behalf of Vimy Resources Limited (then known as Energy and Minerals Australia Limited).

The survey areas are located within tenements E39/876, E39/877, E39/1148, E39/1149, E39/1150, P39/4877, P39/4878, P39/4879, P39/4880, P39/4881, P39/4882, P39/4883 and P39/4884.

Western Heritage Research Pty Ltd archaeologist Wayne Glendenning conducted the archaeological survey and was assisted by Western Heritage Research Pty Ltd field assistant Ashley Blake.

Environmental scientist Colin Woolard, of Woolard Consulting Pty Ltd, and Vimy Resources employees Salim Mamouni, Anthony Sinclair, Morris Wu, Oliver Hirst, Emer O'Connor, Daniel Browne, Dessie O'Brien and Colm O'Reilly also assisted with the survey.

Four archaeological sites are recorded as being located within the MRUP area. These sites will not be disturbed by activities associated with the MRUP.

No new archaeological sites were identified as a result of the archaeological survey.

From the result of the archaeological survey a predictive model has been formulated with regard to the MRUP:

- Sites are more likely to be found around claypans located between dunes;
- Sites are more likely to be found within kopai areas located between dunes;
- Sites are more likely to be found within drainage depressions between dunes;
- Sites are unlikely to be found on dunes;
- Sites are unlikely to be found on sand covered swales; and
- Sites are unlikely to be found on sand plains.

As there are no drainage depressions, kopai areas or claypans in the area of the Mulga Rock Project no archaeological sites will be disturbed by activities associated with the MRUP.

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## 1 INTRODUCTION

Vimy Resources Limited (Vimy, further referred to as the Proponent), formerly known as Energy and Minerals Australia Limited, is proposing to develop a 1,300t/year uranium oxide concentrate project from the Mulga Rock deposits (Ambassador, Princess, Shogun and Emperor), 250km east north-east of Kalgoorlie on the western edge of the Great Victoria Desert. The Project is sited on Unallocated Crown Land, with the nearest inhabited settlement – the Pinjin pastoral lease homestead located approximately 100km to the west (Figure 1 and Figure 2).

The Mulga Rock deposits were discovered and evaluated by PNC Exploration Australia Pty Ltd (PNC) during the period 1978 – 1998. In addition to extensive exploration works, PNC commissioned ethnographic (McKeich 1982a and 1982b) and archaeological (O'Connor 1984) baseline studies covering the proposed development areas. More recently, regional surveys were undertaken in the period 2002-2008 by several heritage consultants commissioned by AngloGold Ashanti Australia for the Tropicana Joint Venture tenure that encloses the Mulga Rock Uranium Project (MRUP) on three sides. The published findings are summarised in Mattner and Bergin (2009) show that no ethnographic or historical sites were identified within the broad project tenure, including access corridors.

The Mulga Rock Uranium Project (MRUP) lies approximately 250km 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, comprising 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 (Figure 2).

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, which are approximately 20km apart (Figure 3). 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.

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

The archaeological survey of 63 one hectare (100 metres by 100 metres) survey areas located in the MRUP area, approximately 250 kilometres northeast of Kalgoorlie, was undertaken between 5 and 13 July 2010 on behalf of Energy and Minerals Australia Limited.

The survey areas are located within tenements E39/876, E39/877, E39/1148, E39/1149, E39/1150, P39/4877, P39/4878, P39/4879, P39/4880, P39/4881, P39/4882, P39/4883 and P39/4884 (Figure 3).

The survey areas are comprised of diverse environmental communities found throughout the Project area and more regionally.

Western Heritage Research Pty Ltd archaeologist Wayne Glendenning conducted the archaeological survey and was assisted by Western Heritage Research Pty Ltd archaeological field assistant Ashley Blake.

Environmental scientist Colin Woolard, of Woolard Consulting Pty Ltd, and Energy and Minerals Australia Limited employees Salim Mamouni, Anthony Sinclair, Morris Wu, Oliver Hirst, Emer O'Connor, Daniel Browne, Dessie O'Brien and Colm O'Reilly also assisted with the survey.

The aim of the survey was to inspect as many of the various topographical units as possible within the MRUP area.

The archaeological survey comprised three components:

- Archival research of the Department of Aboriginal Affairs (DAA) database;
- Archaeological field inspection of the survey areas; and
- Reporting of the survey results.

A handheld *Garmin 76CS* Global Positioning System (GPS) unit using the GDA 94 datum was used during the survey.

## 2 PREVIOUS RESEARCH

Western Heritage Research conducted a search of the DAA and WHR databases in order to identify both relevant reports of surveys undertaken within the survey area and previously recorded Aboriginal heritage sites within the tenements E39/876, E39/877, E39/1148, E39/1149, E39/1150, P39/4877, P39/4878, P39/4879, P39/4880, P39/4881, P39/4882, P39/4883 and P39/4884<sup>1</sup>.

As a result of the search four archaeological sites were identified within the MRUP tenure and there is one report of previous research within the survey area (O'Connor 1984). The four sites are identified in Figure 4, matched to O'Connor's original report (1984), along with their reported location on the DAA database (with corresponding DAA's site search extracts attached in Appendix).

Brief details of the sites are presented in Table 1.

Site ID	Site Name	Legacy ID	Site Type	Easting	Northing	Tenement	Access
1985	Minigwal 2	W01180	Artefact Scatter	557238	6687958	E39/876 E39/1149	Open
1986	Minigwal 3	W01181	Artefact Scatter	555138	6689058	E39/876 E39/1149	Open
1987	Minigwal 4	W01182	Artefact Scatter	552238	6687858	E39/1149	Open
1988	Minigwal 5	W01183	Artefact Scatter	552538	6684158	E39/1149	Open

**Table 1** Previously recorded archaeological sites located within tenements.

All of the sites are artefact scatters located within areas of ephemeral water sources such as kopai and claypans, which are found at low points between dunes.

The report by O'Connor presents the results of an archaeological survey undertaken over a proposed mineral exploration project conducted at the MRUP area by PNC Exploration (Australia) Pty Ltd in 1983. As a result of that survey O'Connor identified six archaeological sites of which four are located within the present tenements of the Proponent (see Table 1).

All of these sites are located near to ephemeral water sources such as claypans and interdunal depression areas.

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<sup>1</sup> The survey was carried prior to M39/1080 and M39/1081 being granted, which were excised from the tenements listed above.

None of these archaeological sites will be impacted upon by the activities associated with the MRUP.



### **3 ARCHAEOLOGICAL SURVEY**

#### **3.1 ENVIRONMENT**

##### **3.1.1 CLIMATE**

The climate of both the survey areas is classified, according to the modified Köppen system of climate classification, as hot, persistently dry desert (Stern, de Hoedt and Ernst 2001). Total average annual rainfall for the region is 232 millimetres, which falls evenly throughout the year with a slight decrease between May and August. Average temperatures range from a January daily maximum and minimum of 33.4°C and 17.4°C respectively, to a June daily maximum and minimum of 17.8°C and 4.7°C respectively (Bureau of Meteorology 2014)<sup>2</sup>.

##### **3.1.2 GEOLOGY**

The Project area is located in the Officer Basin, a geological feature covering approximately 410,000 square kilometres of Western Australia. The surface geology of the Officer Basin is comprised primarily of seif dunes of red and yellow sand. Laterite outcropping occurs in parts of the project area with calcrete deposits associated with major drainage channels and alluvium, colluvium and clay soils in areas between sand dunes and in claypans (Geological Survey of Western Australia).

According to Fullwood and Barwick (1990) the Project area overlies a horseshoe shaped paleochannel of more than 100 metres depth. The paleochannel comprises Tertiary sediments overlying quartz sand sediments, peat and kaolinic clay deposits.

##### **3.1.3 VEGETATION**

The Project area lies within the Helms Botanical district (Beard 1990). Mattiske Consulting Pty Ltd completed a vegetation survey over the MRUP area. They concluded there were four plant communities within the Project area: Eucalyptus Woodlands, Acacia Woodlands, Mixed Shrublands and Chenopod Shrubland.

Each of the vegetation types are associated with various topographical features such as dunes, swales, sand plains and dune slopes.

##### **3.1.4 LAND INTEGRITY**

The MRUP area is characterised by dune systems with dunes up to 20 metres in height.

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<sup>2</sup> Readings taken from the Laverton Meteorological Station.

The land surface shows disturbance from previous mineral exploration activities. Old vehicle tracks, drill holes and cut lines are found throughout the Project area.

## 3.2 REGIONAL BACKGROUND

An awareness of the regional archaeological background of a given survey area is important as it can enable the archaeologist to make predictive statements regarding the expected archaeological characteristics within that region. The regional background can be augmented by the results of previous research undertaken for archaeological surveys within the vicinity of the survey area.

An archaeological predictive model is based on the assumption that the location of archaeological sites is not random, but is associated with specific features of the surrounding environment and factors related to human activity and human behavioural norms in the past (Verhagen 2007).

Identifying those relationships between environmental and geographic (primarily through landforms) characteristics and known archaeological site locations along with knowledge of occupancy of an a region gained from dating techniques, repeating patterns can be identified, creating a statistical model that can be applied to un-surveyed areas in order to identify new locations that may have been the site of similar human activities and occupation.

The survey areas are situated in the semi-arid/arid zone of Australia. Most archaeological research of the arid zone of Australia has focused on the timing of Pleistocene occupation and abandonment during the time of the Last Glacial Maximum (LGM)<sup>3</sup>, and subsequent Holocene re-occupation by Aboriginal people (Smith 1987; Lampert and Hughes 1988; Veth 1989a; Ross, Donnelly and Wasson 1992; Bowdler 1990).

It remains difficult to ascertain the precise nature of arid zone occupation prior to the LGM. According to Ross *et al.* (1992), the arid zone has never been well watered and hyper-arid conditions during the LGM would have made the arid zone unsuitable (Hiscock n.d.). Early occupation was therefore either opportunistic (Veth 1989a; Hiscock n.d.) or required certain behaviour modifications in order for people to live in arid conditions (Ross et al 1992).

Such modifications may have resulted in population adjustments and human groups retreating to areas of greater resources and water (Lampert and Hughes 1980; 1987; Smith 1988; Veth 1989a), which Veth (1989b) terms 'refuges'. These refuges are "...piedmont/montane uplands and riverine/gorge systems, both providing networks

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<sup>3</sup> Between 18,000 Before Present (BP) and 30,000 BP

of permanent water sources capable of withstanding climatic extremes” (Veth 1989b:256).

Gould (1980) has suggested that two types of environmental adaptation were employed by Aboriginal groups in order to survive in the arid zone: ‘adaptive process’ and ‘adaptive behaviour’. Adaptive process is an adaptation involving large-scale responses to the continuing climatic patterns that produce aridity and is characterised by a risk minimisation strategy. In contrast, adaptive behaviour is a response to short-term changes in climatic conditions, for example, periods of extreme drought or high rainfall.

With climate amelioration during the late Pleistocene and early Holocene, at around 12,000 BP, human populations again moved into the marginal areas of the corridors and to a lesser extent, barrier deserts. Most sites have been found within the ‘corridors’ thus possibly reflecting a post LGM re-colonisation (Veth 1989a). According to Smith (1988), there seems to have been neither a sudden increase in population nor new sites within the arid zone in the early Holocene.

In contrast to the occupation patterns of the late Pleistocene and early Holocene, the late Holocene saw a substantial increase in sites within the arid zone and an increased utilisation of those sites, as evidenced at *Mandu Mandu* Creek in North-west Australia (Morse 1988), Colless Creek in Queensland (Hiscock 1988), and *Puritjarra* in Central Australia (Smith 1987, 1988). Data captured from these sites supports Veth’s (1989a: 239) assertion that sites numbers and occupation intensity is a function of the emergence of reciprocity networks and the development of seed grinding technology and not of environmental conditions.

Smith (2013:155-156), in contrast, states that three observations can be made regarding human settlement in the arid zone during the Last Glacial Maximum:

1. The archaeological evidence indicating the presence of small, highly mobile and dispersed populations during the LGM;
2. No archaeological evidence to indicate systematic long distance movement of population with evidence of land use by population limited by access to water resources; and
3. The archaeological evidence points to “cryptic” refugia whereby a group may survive across its former range but at lower densities and scattered occurrences.

The evidence for the antiquity of human occupation of the sandy deserts is scant and within the survey area non-existent. Serpent’s Glen from the northwest of the sandy

deserts in the Carnarvon Ranges indicates occupation from 30,000BP to 28,000BP and then nothing until 4,710+/- 180BP. A date of 2160 +/-105 BP has been obtained from charcoal in deposits at Agnew rockshelter, whilst at two hearth sites at Wiluna, dates of 1040+/-80 BP and 4090+/-100 BP were obtained from charcoal (O'Connor and Veth, 1996).

In order to redress the paucity of archaeological research in the semi-arid/arid zone, O'Connor and Veth (1996) undertook the Arid Zone Project. The aim of the project was to investigate the timing and characteristics of the occupation of the semi-arid/arid zone of southwestern Australia.

The study involved an archaeological survey of the area from the northeastern Goldfields to the Wheatbelt of Western Australia, and included excavations at three rockshelters. One of these rockshelters *Katampul*, which is located mid-way between Leinster and Leonora, indicated evidence of human occupation from the Pleistocene to the present. O'Connor and Veth obtained five radiocarbon dates from charcoal samples within the rockshelter's stratified deposit, ranging from 21,170+/-190 BP to 350+/-350 BP.

As a result of the regional survey and previous work undertaken in the Arid Zone, Veth (1989;1993;1995;1996), made a series of assumptions regarding the general characteristics of archaeological material within the Semi-arid/Arid Zone:

- Most of the archaeologically visible sites that represent the greatest social complexity and longevity are located near permanent water sources;
- The more permanent sites near water sources will reflect greater lithological variability and more intense stone reduction;
- The proportions of retouched and utilised tools will be comparatively high;
- Large quantities of debitage from tool manufacture and rejuvenation should be present;
- Less complex sites will be located near ephemeral water sources; and
- Ubiquitous low-density occurrences of isolated artefacts are the result of numerous task specific events reflecting both resource procurement and maintenance of extractive tools (cf Gould 1980).

In a similar environment to the present project area, at Olympic Dam in South Australia, Hughes, Hiscock, Sullivan and Marwick (2011) conducted an archaeological impact study and tested a predictive model, which predicted the following locations that archaeological sites would be found:

- Sites occur infrequently in tablelands and tablelands with dissection slopes and where they do occur they are mainly knapping floors and quarries where raw materials that are locally available are used for artefact manufacture;
- Large, high density sites with a large diversity of lithologies will be found in drainage depressions between dunes;
- Widely spaced sand dunes will comprise medium to large sized sites with a low to medium sized lithologies with a range of artefact typologies. Most of these sites will be found near raw material outcropping or around interdunal claypans;
- Sites occur less frequently and are less diverse in areas of moderately spaced dunes due to the increased cover of sand and the less presence of claypans; and
- Closely spaced dunes will have virtually no sites due to the almost continuous cover of sand on the sand dunes.

It is expected that the archaeological signature of the survey areas will conform to the archaeological characteristics outlined by Veth (1989;1993;1995;1996) and more specifically Hughes *et al* (2011).

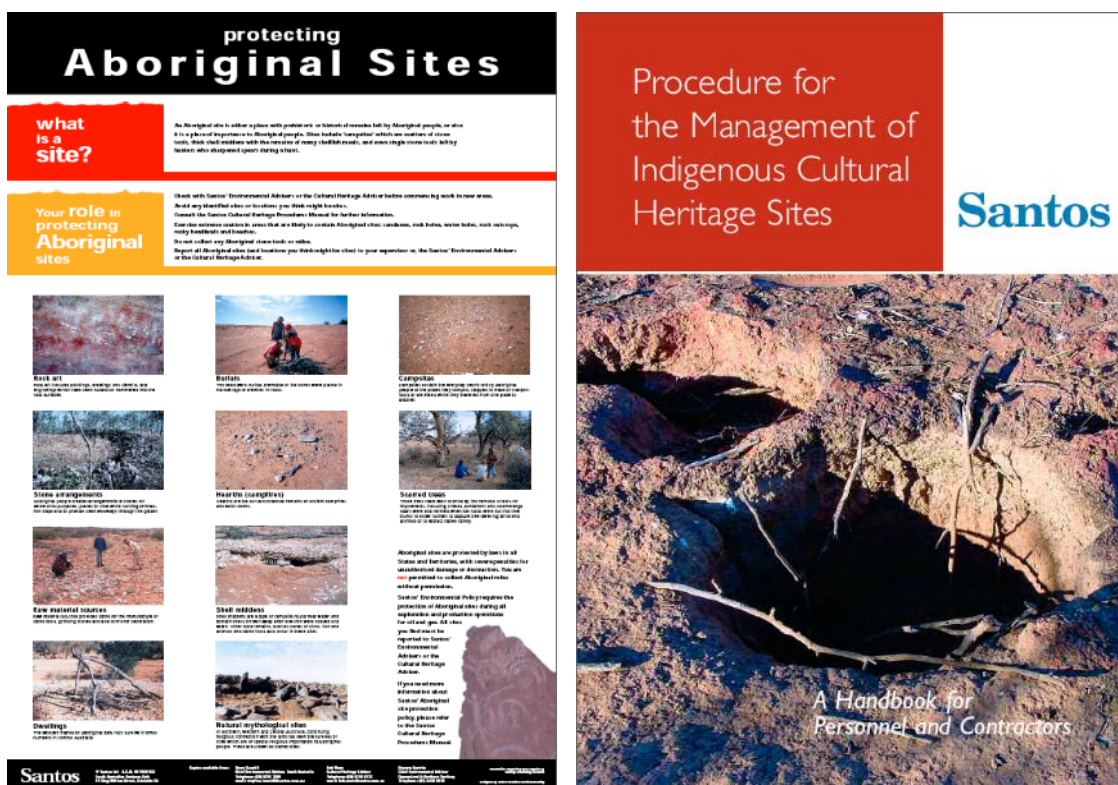
This is also supported by regolith dating in two locations on the project area showing that the bulk of aeolian sand deposition took place between ~93,000 and 7,000 BP, by which time the aeolian landforms would likely have been mostly stabilised through the effect of deep rooted vegetation (Figure 77 and Figure 88).

### 3.3 ARCHAEOLOGICAL FIELDWORK

The archaeological survey was conducted between 5 and 13 July 2010. The archaeological survey areas comprised 63 parcels of land, measuring 100 metres by 100 metres (one hectare), throughout tenements E39/876, E39/877, E39/1148, E39/1149, E39/1150, P39/4877, P39/4878, P39/4879, P39/4880, P39/4881, P39/4882, P39/4883 and P39/4884.

The purpose of inspecting such a large number of squares was to include examples of the various topographical environments within the Project area. A survey methodology was established comprising purposive pedestrian transects spaced 10 metres apart across each survey area while simultaneously the archaeologist and the archaeological assistant walked in a meandering fashion across each survey area.

Prior to fieldwork commencing Wayne Glendenning conducted a tutorial on how to identify artefacts for the survey team, supported with some training material from Santos Limited (2007).



**Photograph 1 Training material used in a tutorial session with all survey participants (Santos Limited, 2007)**

Archaeological visibility within the survey area ranged from less than 5% in areas of thick vegetation and detritus to greater than 90% in cleared areas.

It is estimated that using this methodology, approximately 100% of the survey areas were surveyed.

It is expected a predictive model for the location of archaeological sites based primarily on Hughes *et al.* (2011) can be developed for the MRUP area as a result of this survey.

It is to be noted that the dunes within the MRUP area are situated closer together and therefore have less claypans and kopai areas than the Olympic Dam survey area (Woolard 2014 pers. comm.).



**Photograph 2** Set-up of a pedestrian transect at Square 15, southeast of Emperor



**Square 2 550391E 6698511N**

Environment: Yellow sand plain.

Flora: *Eucalyptus gongylocarpa*/mallee/low shrubs/spinifex.

Archaeological visibility: Burnt 50% to 100%.



**Photograph 3** Square 2 looking east.

**Square 3 554957E 6686957N**

Environment: Red sand flat dune.

Flora: *Eucalyptus gongylocarpa*/spinifex.

Archaeological visibility: 50% to 100%.



**Photograph 4** Square 3 looking east.

**Square 4 555061E 6686922N**

Environment: Red sand overlying kopai.

Flora: Low shrubs/spinifex.

Archaeological visibility: 0% in areas of spinifex to 80% in other areas.



**Photograph 5** Square 4 looking east.



**Square 5 552446E 6697163N**

Environment: Yellow sand plain.

Flora: *Eucalyptus gongylocarpa*/mallee/low shrubs/spinifex.

Archaeological visibility: Burnt 50% to 100%.



**Photograph 6** Square 5 looking south.

**Square 6 554297E 6685059N**

Environment: Red sand plain drainage depression surrounded by yellow dunes.

Flora: Thick mallee woodland.

Archaeological visibility: 10% in areas of spinifex to 50% in other areas.



**Photograph 7** Square 6 looking north.

**Square 7 554327E 6688628N**

Environment: Yellow sand dune slope and drainage.

Flora: Mallee/spinifex.

Archaeological visibility: 80% to 90%.



**Photograph 8** Square 7 looking north.



**Square 8 554734E 6690911N**

Environment: Yellow sand dune and swale.

Flora: Mallee/spinifex.

Archaeological visibility: 90% to 100%.



**Photograph 9** Square 8 looking east.

**Square 9 554322E 6685118N**

Environment: Red sand plain drainage depression surrounded by yellow dunes.

Flora: Thick mallee woodland.

Archaeological visibility: 50% to 100%.



**Photograph 10** Square 9 looking southeast.



**Square 10 555001E 6687082N**

Environment: Red sand kopai.

Flora: Minor *Eucalyptus gongylocarpa*/low shrubs/spinifex.

Archaeological visibility: 50% to 100%.



**Photograph 11** Square 10 looking west.

**Square 11 554649E 6688273N**

Environment: Yellow sand overlying kopai drainage system.

Flora: Mallee/spinifex/wind grass.

Archaeological visibility: 80% to 100%.



**Photograph 12** Square 7 looking north.

**Square 12 555107E 6687014N**

Environment: Red sand kopai.

Flora: Minor *Eucalyptus gongylocarpa*/low shrubs/spinifex.

Archaeological visibility: 20% in areas of spinifex to 100% in other areas.



**Photograph 13** Square 12 looking west.



**Square 13 555615E 6691943N**

Environment: Yellow sand dune slope.

Flora: Mallee/minor shrubs/spinifex.

Archaeological visibility: 10% in areas of spinifex to 80% in other areas.



**Photograph 14** Square 13 looking north.

**Square 14 554325E 6688659N**

Environment: Yellow sand dune slope drainage.

Flora: Mallee/spinifex.

Archaeological visibility: Burnt 80% to 90%.



**Photograph 15** Square 14 looking south.

**Square 15 558243E 6690925N**

Environment: Red clay claypan/Red sand dune.

Flora: Mallee/gimlet/spinifex with saltbush around gypsum (kopai).

Archaeological visibility: 10% in areas of spinifex to 100% on claypan.



**Photograph 16** Square 15 looking east.



**Square 16 557994E 6689012N**

Environment: Yellow sand flat dune.

Flora: Mallee/low shrubs/spinifex.

Archaeological visibility: 80% to 100%.



**Photograph 17** Square 16 looking southwest.

**Square 17 559398E 6689742N**

See Square 20



**Square 18 558996E 6692208N**

Environment: Orange sand flat dune.

Flora: *Cholitr*is mallee/minor shrubs/spinifex.

Archaeological visibility: 20% in spinifex areas to 80% in other areas.



**Photograph 18** Square 18 looking east.

**Square 19 557994E 6687096N**

Environment: Red/yellow sand flat.

Flora: Mallee/cholitrif/spinifex.

Archaeological visibility: 10% in areas of spinifex to 50% in other areas.



**Photograph 19** Square 19 looking south.

**Square 20 559398E 6689842N**

Environment: Red sand/kopai claypan.

Flora: Mallee/gimlett/spinifex.

Archaeological visibility: 20% in areas of spinifex to 100% on kopai.



**Photograph 20** Square 20/17 looking east.



**Square 21 559784E 6693538N**

Environment: Yellow sand swale.

Flora: Minor *Eucalyptus gongylocarpa*/mallee/spinifex.

Archaeological visibility: 0% in detritus areas to between 70% and 90% in other areas.



**Photograph 21** Square 21 looking east.

**Square 22 561236E 6682080N**

Environment: Yellow sand swale.

Flora: *Eucalyptus gongylocarpa*/mallee/spinifex.

Archaeological visibility: 50% to 70% in other areas.



**Photograph 22** Square 22 looking east.

**Square 23 560888E 6687884N**

Environment: Yellow sand Kopai drainage area.

Flora: Area burnt no trees or shrubs.

Archaeological visibility: 50% to 70% in other areas.



**Photograph 23** Square 23 looking north.

**Square 24 563414E 6687560N**

Environment: Yellow sand overlying red clay.

Flora: Mallee/low shrubs/spinifex/grass tree.

Archaeological visibility: 30% in areas of spinifex to 80% in other areas.



**Photograph 24** Square 24 looking east.



**Square 26 563184E 6684529N**

Environment: Yellow sand plain.

Flora: Banksia/low shrubs/spinifex.

Archaeological visibility: 10% in areas of spinifex to 50% in other areas.



**Photograph 25** Square 26 looking west.



**Square 28 564153E 6692632N**

Environment: Yellow sand plain.

Flora: Mulga thicket/low shrubs.

Archaeological visibility: 30% to 50%.



**Photograph 26** Square 28 looking west.

**Square 29 565921E 6684760N**

Environment: Yellow sand Interdunal flat.

Flora: Minor *Eucalyptus gongylocarpa*/mallee/minor shrubs/spinifex.

Archaeological visibility: 50% to 80%.



**Photograph 27** Square 29 looking south.

**Square 30 563137E 6677384N**

Environment: Red sand sand plain.

Flora: *Gracillia* mallee/spinifex.

Archaeological visibility: 30% to 60%.



**Photograph 28** Square 30 looking south.

**Square 31 566077E 6690553N**

Environment: Orange sand three parallel silcrete/calcrete outcrops.

Flora: *Eucalyptus gongylocarpa*/mallee/low shrubs/spinifex.

Archaeological visibility: 50% to 80%.



**Photograph 29** Square 31 looking east.



**Square 32 567620E 6683744N**

Environment: Yellow sand dune.

Flora: Minor *Eucalyptus gongylocarpa*/mallee/cypress/spinifex.

Archaeological visibility: 10% in areas of spinifex to 50% in other areas.



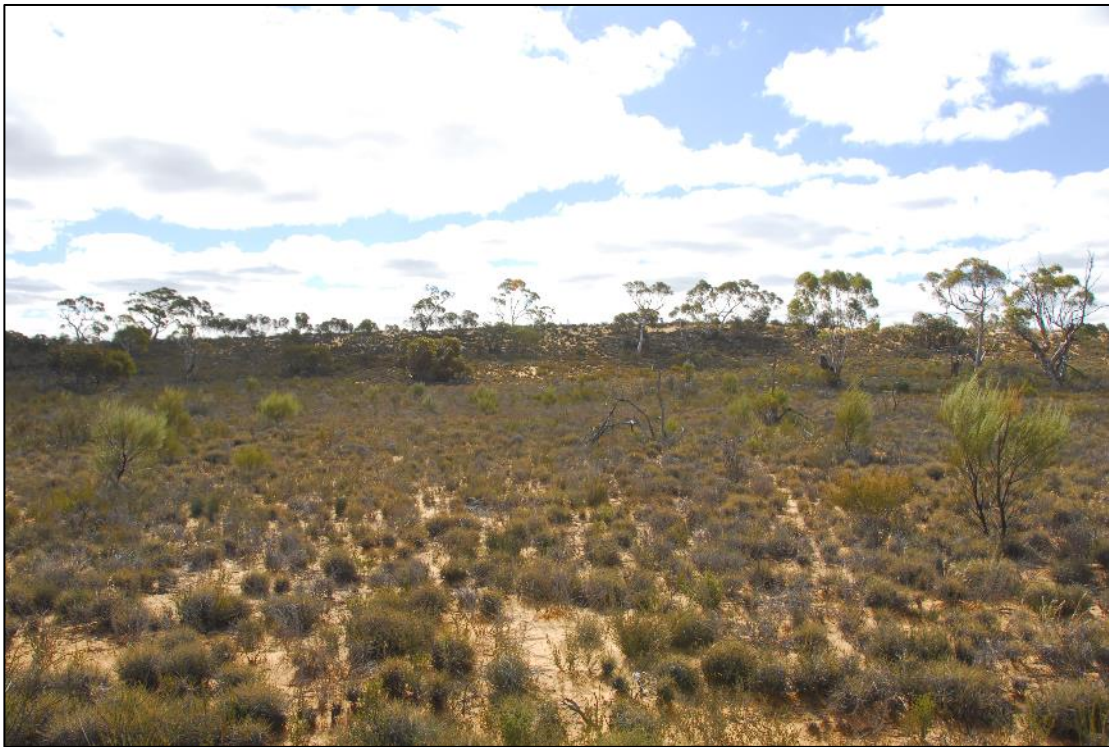
**Photograph 30** Square 32 looking south.

**Square 34 568448E 6687355N**

Environment: Yellow sand dune slope.

Flora: *Eucalyptus gongylocarpa*/mallee/low shrubs/spinifex.

Archaeological visibility: 25% to 50%.



**Photograph 31** Square 34 looking north.

**Square 37 568900E 6684429N**

Environment: Yellow sand low slope/interdune swale.

Flora: Mallee/low shrubs/spinifex.

Archaeological visibility: 30% to 70%.



**Photograph 32** Square 37 looking south.



**Square 38 569207E 6686615N**

Environment: Red/yellow sand sheet.

Flora: Minor *Eucalyptus gongylocarpa*/*Cholitrus* mallee/low shrubs/spinifex.

Archaeological visibility: 50% to 80%.



**Photograph 33** Square 38 looking south.



**Square 39 568920E 6685871N**

Environment: Yellow sand swale.

Flora: Mallee/minor shrubs/spinifex.

Archaeological visibility: 50% to 80%.



**Photograph 34** Square 39 looking south.

**Square 41 569995E 6685105N**

Environment: Yellow sand dune.

Flora: Open *Eucalyptus gongylocarpa*/mallee/spinifex.

Archaeological visibility: 50% to 100%.



**Photograph 35** Square 41 looking south.

**Square 42 569511E 6680005N**

Environment: Orange sand dune.

Flora: Open *Eucalyptus gongylocarpa* woodland/mallee/spinifex

Archaeological visibility: 0% in detritus to 50% elsewhere.



**Photograph 36** Square 42 looking south.



**Square 43 570146E 6681879N**

Environment: Yellow sand

Flora: Cypress woodland/mallee/low shrubs/spinifex

Archaeological visibility: 20% in areas of spinifex to 80% elsewhere.



**Photograph 37** Square 43 looking north.

**Square 45 570798E 6687795N**

Environment: Yellow sand dune crest/slope/swale.

Flora: Minor *Eucalyptus gongylocarpa*/*Cholitriss mallee*/low shrubs/spinifex.

Archaeological visibility: 30% to 70%



**Photograph 38** Square 45 looking northeast.



**Square 46 570921E 6683887N**

Environment: Yellow sand dune.

Flora: Minor *Eucalyptus gongylocarpa*/mallee/minor shrubs/spinifex.

Archaeological visibility: 50% to 80%.



**Photograph 39** Square 46 looking south.

**Square 47 570848E 6684969N**

Environment: Yellow sand dune and flat.

Flora: Open *Eucalyptus gongylocarpa*/spinifex.

Archaeological visibility: 30% to 50% on flat and 70% to 90% on dune.



**Photograph 40** Square 47 looking south.

**Square 49 572180E 6686278N**

Environment: Yellow sand sand plain.

Flora: *Eucalyptus gongylocarpa*/mallee/spinifex

Archaeological visibility: 50% to 80%



**Photograph 41** Square 49 looking north.



**Square 50 568231E 6683383N**

Environment: Yellow sand swale and drainage area with patches of pisolites.

Flora: Mallee/spinifex

Archaeological visibility: 20% in areas of spinifex to 80% elsewhere.



**Photograph 42** Square 50 looking south.

**Square 51 572029E 6697149N**

Environment: Red sandy clay swale.

Flora: Acacia/mulga woodland/shrubs/spinifex.

Archaeological visibility: 20% in areas of spinifex to 50% elsewhere.



**Photograph 43** Square 51 looking south.



**Square 52 572287E 6682751N**

Environment: Yellow sand dune.

Flora: *Eucalyptus gongylocarpa*/light open mallee/spinifex.

Archaeological visibility: 70% to 90%.



**Photograph 44** Square 52 looking south.

**Square 53 572573E 6682647N**

Environment: Yellow sand dune.

Flora: Open *Eucalyptus gongylocarpa* woodland/spinifex.

Archaeological visibility: 50% to 90%.



**Photograph 45** Square 53 looking south.

**Square 54 571522E 6678912N**

Environment: Red sandy clay flat area.

Flora: Acacia woodland/low shrubs/spinifex.

Archaeological visibility: 20% to 50%.



**Photograph 46** Square 54 looking south.



**Square 55 574712E 6676908N**

Environment: Yellow sand plain.

Flora: *Eucalyptus gongylocarpa*/mallee woodland/minor shrubs/spinifex.

Archaeological visibility: 0% in detritus to 20% to 90% elsewhere.



**Photograph 47** Square 55 looking south.

**Square 56 573254E 6687777N**

Environment: Yellow sand flat.

Flora: Minor *Eucalyptus gongylocarpa*/mallee/minor shrubs/spinifex.

Archaeological visibility: 20% in areas of spinifex to 80% elsewhere.



**Photograph 48** Square 57 looking south.



**Square 58 573413E 6682401N**

Environment: Yellow sand dune.

Flora: Open *Eucalyptus gongylocarpa*/mallee/spinifex

Archaeological visibility: 30% to 80%.



**Photograph 49** Square 58 looking southwest.

**Square 59 573584E 6687621N**

Environment: Orange sand flat.

Flora: Minor *Eucalyptus gongylocarpa*/mallee/minor shrubs/spinifex.

Archaeological visibility: 10% in areas of spinifex to 80% in other areas.



**Photograph 50** Square 59 looking south.

**Square 60 572630E 6696797N**

Environment: Red sandplain.

Flora: Mulga woodland/Acacia/Dodonia.

Archaeological visibility: 20% to 70%.



**Photograph 51** Square 60 looking south.



**Square 61 574776E 6695530N**

Environment: Pisolite gibber plain.

Flora: Closed mulga shrubland/spinifex.

Archaeological visibility: 20% in areas of spinifex to 50% in other areas.



**Photograph 52** Square 61 looking south.



**Square 62 575404E 6682366N**

Environment: Yellow sand dune.

Flora: *Eucalyptus gongylocarpa*/open mallee woodland/spinifex.

Archaeological visibility: 30% in areas of spinifex to 100% in other areas.



**Photograph 53** Square 62 looking west.

**Square 63 575393E 6681286N**

Environment: Orange sand flat dune.

Flora: *Eucalyptus gongylocarpa*/open mallee woodland/spinifex.

Archaeological visibility: 10% in areas of spinifex to 50% in other areas.



**Photograph 54** Square 63 looking south.

**Square 64 575952E 6683029N**

Environment: Pale yellow sand flat dune.

Flora: Mallee woodland/spinifex.

Archaeological visibility: 50% to 100%.



**Photograph 55** Square 64 looking north.



**Square 65 575932E 6684740N**

Environment: Red sand flat.

Flora: Minor *Eucalyptus gongylocarpa*/spinifex

Archaeological visibility: 10% in areas of spinifex to 80% in other areas.



**Photograph 56** Square 65 looking north.



**Square 66 577004E 6681675N**

Environment: Red/yellow sand flat dune with small silcrete/calcrete outcrop.

Flora: Open low mallee woodland/minor shrubs.

Archaeological visibility: 10% in areas of spinifex to 50% in other areas.



**Photograph 57** Square 66 looking south.

**Square 67 576992E 6682414N**

Environment: Red sand dune.

Flora: Open low mallee woodland/minor shrubs.

Archaeological visibility: 50% to 100%.



**Photograph 58** Square 67 looking north.

**Square 68 577467E 6682856N**

Environment: Yellow sand saddle.

Flora: *Eucalyptus gongylocarpa*/spinifex.

Archaeological visibility: 30% in areas of spinifex to 100% in other areas.



**Photograph 59** Square 68 looking north.



**Square 69 578730E 6682933N**

Environment: Orange sand flat dune.

Flora: Minor *Eucalyptus gongylocarpa*/minor shrubs/spinifex

Archaeological visibility: 10% in areas of spinifex to 80% in other areas.



**Photograph 60** Square 69 looking south.



**Square 70 580121E 6682240N**

Environment: Red sand flat.

Flora: Minor *Eucalyptus gongylocarpa*/mallee/spinifex spinifex/grass tree

Archaeological visibility: 10% in areas of spinifex to 80% in other areas.



**Photograph 61** Square 70 looking south.

**Square 71 579873E 6682147N**

Environment: Red sand swale.

Flora: *Eucalyptus gongylocarpa*/spinifex.

Archaeological visibility: 10% in areas of spinifex to 80% in other areas.



**Photograph 62** Square 71 looking south.

**Square 72 581496E 6683944N**

Environment: Yellow sand swale.

Flora: *Eucalyptus gongylocarpa*/low shrubs/spinifex.

Archaeological visibility: 10% in areas of spinifex to 50% in other areas.



**Photograph 63** Square 72 looking north.



**Square 74 590528E 6687243N**

Environment: Yellow sand sand plain

Flora: Occasional *Eucalyptus gongylocarpa*/mallee/minor shrubs/spinifex

Archaeological visibility: 10% in areas of spinifex to 90% in other areas.



**Photograph 64** Square 74 looking east.



**Square 75 590000E 6688105N**

Environment: Yellow sand sand plain

Flora: Minor *Eucalyptus gongylocarpa*/mallee/minor shrubs/spinifex

Archaeological visibility: 10% in areas of spinifex to 50% in other areas.



**Photograph 65** Square 75 looking north.

### 3.4 RESULTS OF THE ARCHAEOLOGICAL SURVEY

As a result of the archaeological survey no archaeological sites were identified within the survey areas.

A total of 22 isolated artefacts were located during the survey (see Table 2 in the Appendix).

No artefacts were located where there was any sand cover i.e. sand dunes, sand plains and swales.

All artefacts were derived from locally derived silcrete material and showed limited evidence of reworking.

All of the artefacts were located in areas between dunes in either claypan areas or kopai areas



**Photograph 66** Silcrete core found at 577037E 6681656N.



**Photograph 67** Silcrete flake found at 555091E 6687120N.

## 4 CONCLUSIONS

The archaeological survey of the proposed MRUP, located at Narnoo, within tenements E39/876, E39/877, E39/1148, E39/1149, E39/1150, P39/4877, P39/4878, P39/4879, P39/4880, P39/4881, P39/4882, P39/4883 and P39/4884, was conducted between 5 and 13 July 2010.

A total of 62 one hectare sample areas were inspected during the survey. All of the sample areas coincided with a particular environmental unit such as yellow sand dune, red sand swale and orange sand plain.

The survey methodology comprised pedestrian inspection along transects spaced 10 metres apart across each sample area.

No archaeological sites were identified as a result of the archaeological survey.

The lack of archaeological sites is likely to be a function of the lack of water sources such as rockholes.

However 22 isolated artefacts were identified as a result of the survey. Generally isolated artefacts are non-diagnostic and their presence does little more than indicate the presence of Aboriginal people at some time in the past.

In the MRUP area the isolated artefacts are important in that they give the archaeologist insight into what environmental units that archaeological sites may be found.

From the result of the archaeological survey a predictive model may be formulated based on the Hughes *et al.* (2011) predictive model for the area surrounding Olympic Dam in South Australia and presented in Section 3.2.

With regard to the MRUP area:

- Sites are more likely to be found around claypans located between dunes;
- Sites are more likely to be found within kopai areas located between dunes;
- Sites are more likely to be found within drainage depressions between dunes;
- Sites are unlikely to be found on dunes;
- Sites are unlikely to be found on sand covered swales; and
- Sites are unlikely to be found on sand plains.



As there are no drainage depressions, kopai areas or claypans in the area of the MRUP no archaeological sites will be disturbed by activities associated with the MRUP.

## 5 REFERENCES

- Bates, D. 1985 *The Native Tribes of Western Australia*. I. White (ed) National Library of Australia: Canberra.
- Bowdler, S. 1990 The Silver Dollar site, Shark Bay: an interim report. *Australian Aboriginal Studies* 2:60-63.
- Beard, J.S. 1990 *Plant life of Western Australia*. Kenthurst: Kangaroo Press.
- Bureau of Meteorology 2013 Climate statistics for Australian locations: Laverton [available online]. Bureau of Meteorology. Available from: [http://www.bom.gov.au/climate/averages/tables/cw\\_012045.shtml](http://www.bom.gov.au/climate/averages/tables/cw_012045.shtml) [accessed 20 May 2013].
- Fullwood, K. E. and R. E. Barwick 1990 Mulga Rock Uranium Deposits, Officer Basin. In F. E. Hughes (ed) *Geology of the Mineral Deposits of Australia and Papua New Guinea*. The Australasian Institute of Mining and Metallurgy. Melbourne.
- Geological Survey of Western Australia 1974 Geology of Western Australia: Western Australia Geological Survey, Memoir 2, pp 33-54.
- Gould, R.A. 1980 *Living Archaeology* Cambridge University Press: Cambridge.
- Hiscock, P.D. n.d. Pleistocene abandonment of arid central Australia. Unpublished paper.
- Hiscock, P.D. 1988 Prehistoric settlement patterns and artefact manufacture at Lawn Hill, northwest Queensland. Unpublished Ph.D. thesis, Australian National University.
- Hughes, P. Hiscock, M. Sullivan, B. Marwick 2011 Archaeological investigations at Olympic Dam In arid northeast South Australia. *Journal of the Anthropological Society of South Australia*. Volume 34. Pp 21-37.
- Lampert, R. and P.J. Hughes 1980 Pleistocene archaeology in the Flinders Range: research prospects. *Australian Archaeology* 10:11-20.
- Lampert, R. J. and Hughes, P. J 1987 The Flinders Ranges: A Pleistocene outpost in the arid zone. *Records of the South Australian Museum* 20: 29-34.
- Lampert, R. and P.J. Hughes 1988 Early human occupation of the Flinders Ranges. *Records of the South Australian Museum* 22:139-168.

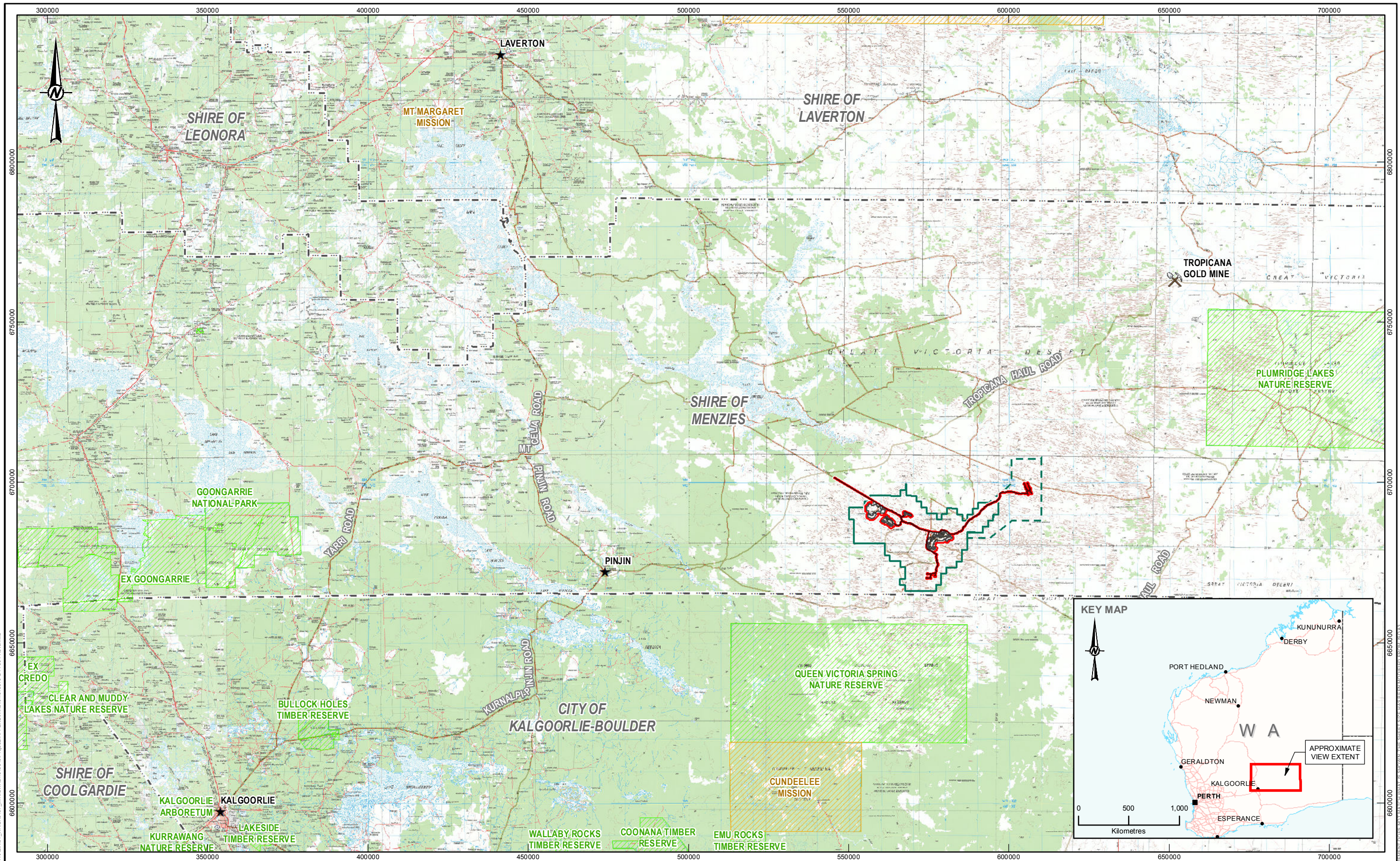
- Mattiske Consulting Pty Ltd 2013 Flora And Vegetation Survey Of The Mulga Rock Project Area. Unpublished report prepared for Energy and Minerals Australia Limited.
- Morse, K. 1988 *Mandu Mandu* Rockshelter: Pleistocene human occupation of North West Cape, Western Australia. *Archaeology in Oceania* 23:81-88.
- O'Connor, S. 1984 An archaeological survey for Aboriginal sites in the P.N.C. exploration lease area, Officer Basin, Great Victoria Desert.
- O'Connor, S. and P. Veth 1996 A preliminary report of recent archaeological research in the semi-arid/arid belt of Western Australia. *Australian Aboriginal Studies* 1996(2): 42-50.
- Ross, A.T. Donnelly and R. Wasson 1992 The peopling of the arid zone: human-environment interactions. In J. Dodson (ed) *The naïve lands: prehistory and environmental change in Australia and the southwest Pacific*. Longmire Cheshire: Melbourne.
- Santos Limited, 2007, Procedure for the management of indigenous cultural heritage sites – A handbook for personnel and contractors, Adelaide South Australia
- Smith, M.A. 1987 Pleistocene occupation in arid central Australia. *Nature* 228:710-711.
- Smith, M.A. 1988 The pattern and timing of prehistoric settlement in central Australia. Unpublished Ph.D. thesis, University of New England
- Smith, M.A. 2013 *The Archaeology of Australia's deserts*, Cambridge University Press
- Stern, H., G. de Hoet and J. Ernst 2001 Objective classification of Australian Climates [online]. Bureau of Meteorology. Available from: [http://www.bom.gov.au/climate/environ/other/koppen\\_explain.shtml](http://www.bom.gov.au/climate/environ/other/koppen_explain.shtml) [accessed 20 May 2013].
- Tindale, N. 1974 *Aboriginal tribes of Australia: their terrain, environmental controls, distribution, limits and proper names*. Australian National University Press: Canberra.
- Verhagen, P. 2007 *Case Studies in Archaeological Predictive Modelling*. Leiden University Press
- Veth, P. 1989a Islands of the interior: a model for the colonisation of Australia's arid zone. *Archaeology in Oceania* Vol 24:81-92.

- Veth, P.M. 1989b The prehistory of the sandy deserts: spatial and temporal variation in settlement and subsistence behaviour within the arid zone of Australia. Unpublished Ph.D. thesis, University of Western Australia: Nedlands.
- Veth, P. 1993 *Islands in the interior: The dynamics of prehistoric adaptations within the arid zone of Australia*. Ann Arbor (MI): University of Michigan.
- Veth, P. 1995 Aridity and settlement in northwest Australia. *Antiquity* 69:733-746.
- Veth, P. 1996 Current archaeological evidence from the Little and Great Sandy Deserts. In Veth, P. and Hiscock, P. (eds). *Archaeology of Northern Australia*. Regional Perspectives. Tempus Vol.4, pp. 50-65. Anthropology Museum, The University of Queensland.



**6 APPENDIX**





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LEGEND	
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	TOWN
	ROAD
	INFRASTRUCTURE
	MRP 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  
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CLIENT  
**VIMY RESOURCES LIMITED**

CONSULTANT

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

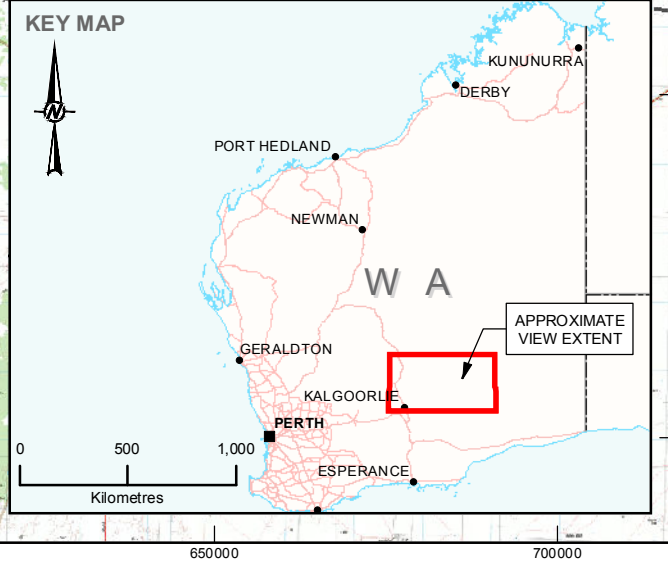
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**MULGA ROCK URANIUM PROJECT**

CONSULTANT

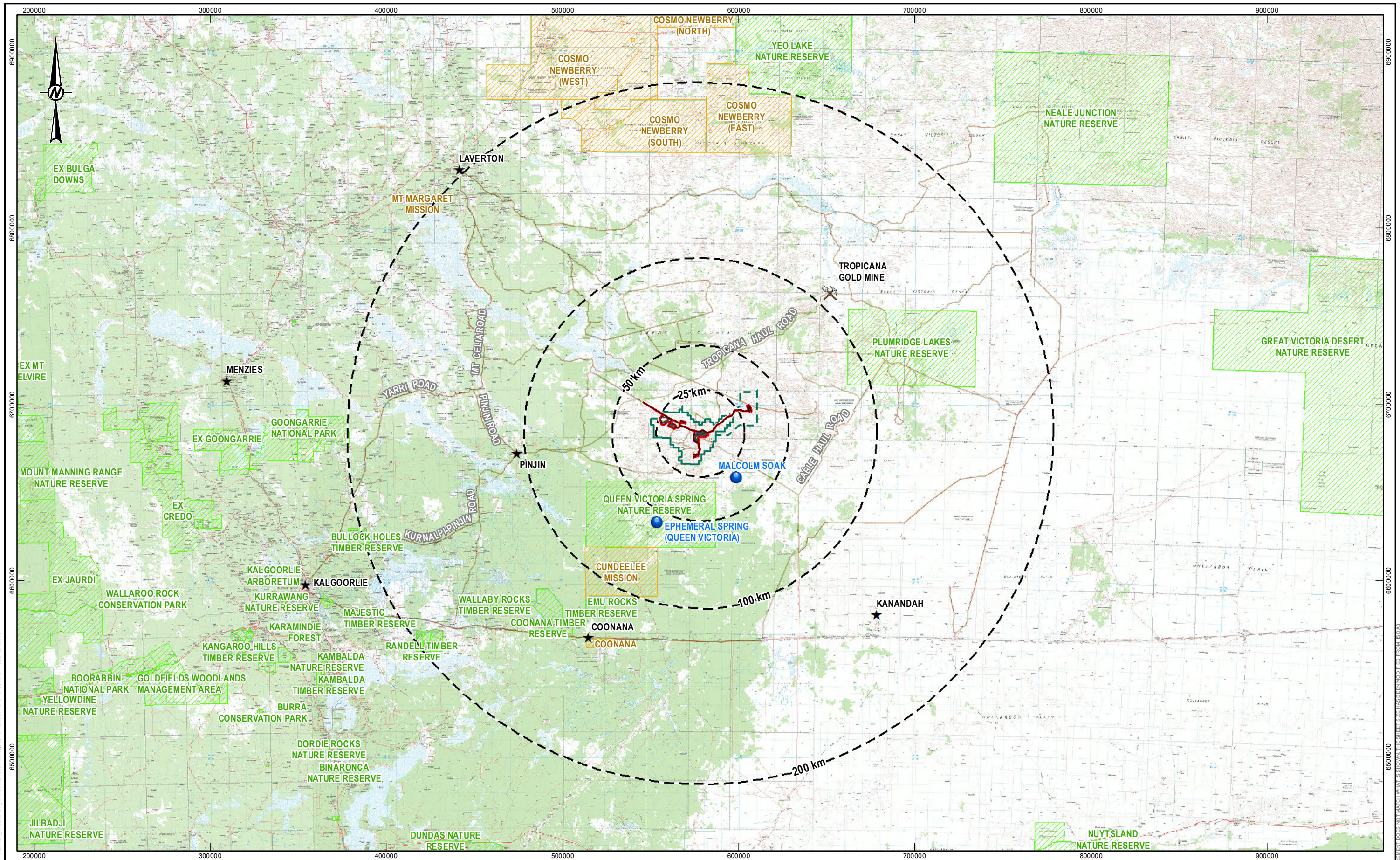
TITLE  
**REGIONAL LOCATION**

PROJECT NO. 1540340 CONTROL G4 REV. 0

FIGURE **1**







**LEGEND**

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

**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)  
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**VIMY RESOURCES LIMITED**

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DESIGNED	MS
PREPARED	MS
REVIEWED	CWC
APPROVED	CWC

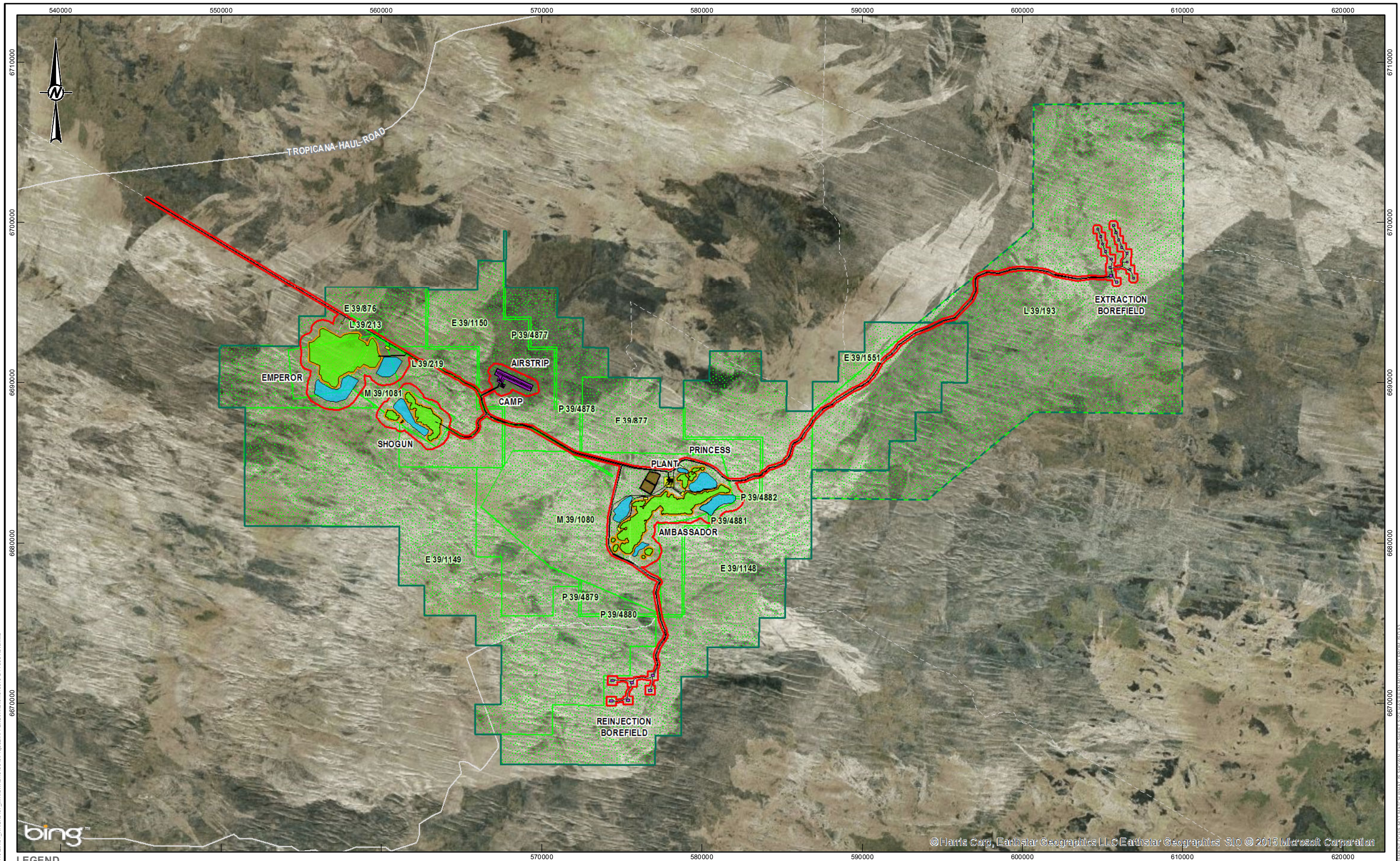
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**MULGA ROCK URANIUM PROJECT**

TITLE  
**NEARBY COMMUNITIES AND KNOWN NEARBY SURFACE WATER RESOURCES**

PROJECT NO. 1540340	CONTROL G4	REV. 0	FIGURE <b>2</b>
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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
	PROJECT TENEMENT		PIT CLEARING (50 m BUFFER)

**NOTES**  
 1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 51

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

PROJECT  
**MULGA ROCK URANIUM PROJECT**

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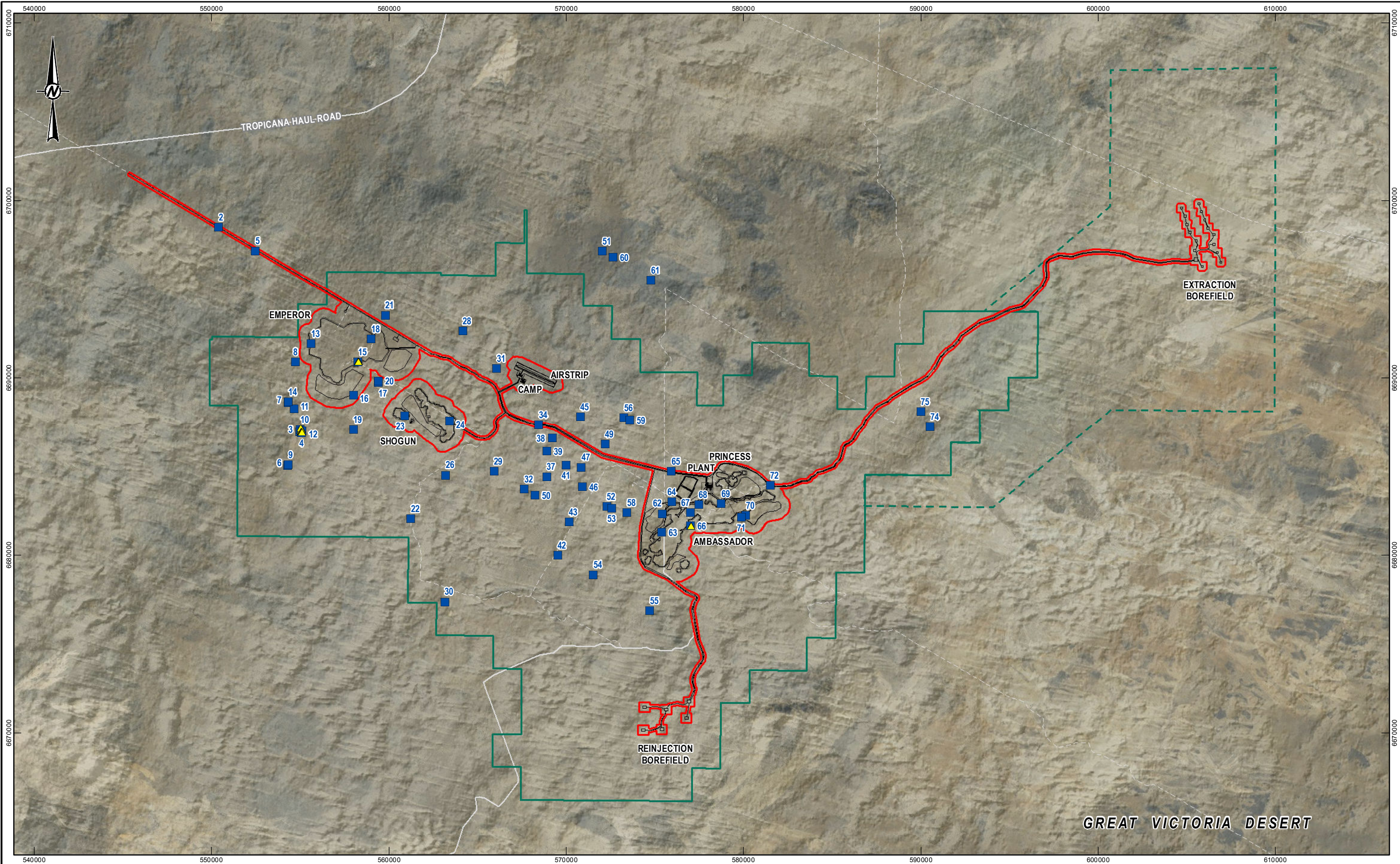
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**LEGEND**

- ISOLATED ARTEFACT LOCATION
- SQUARE SURVEYED
- 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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PROJECT  
 MULGA ROCK URANIUM PROJECT

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

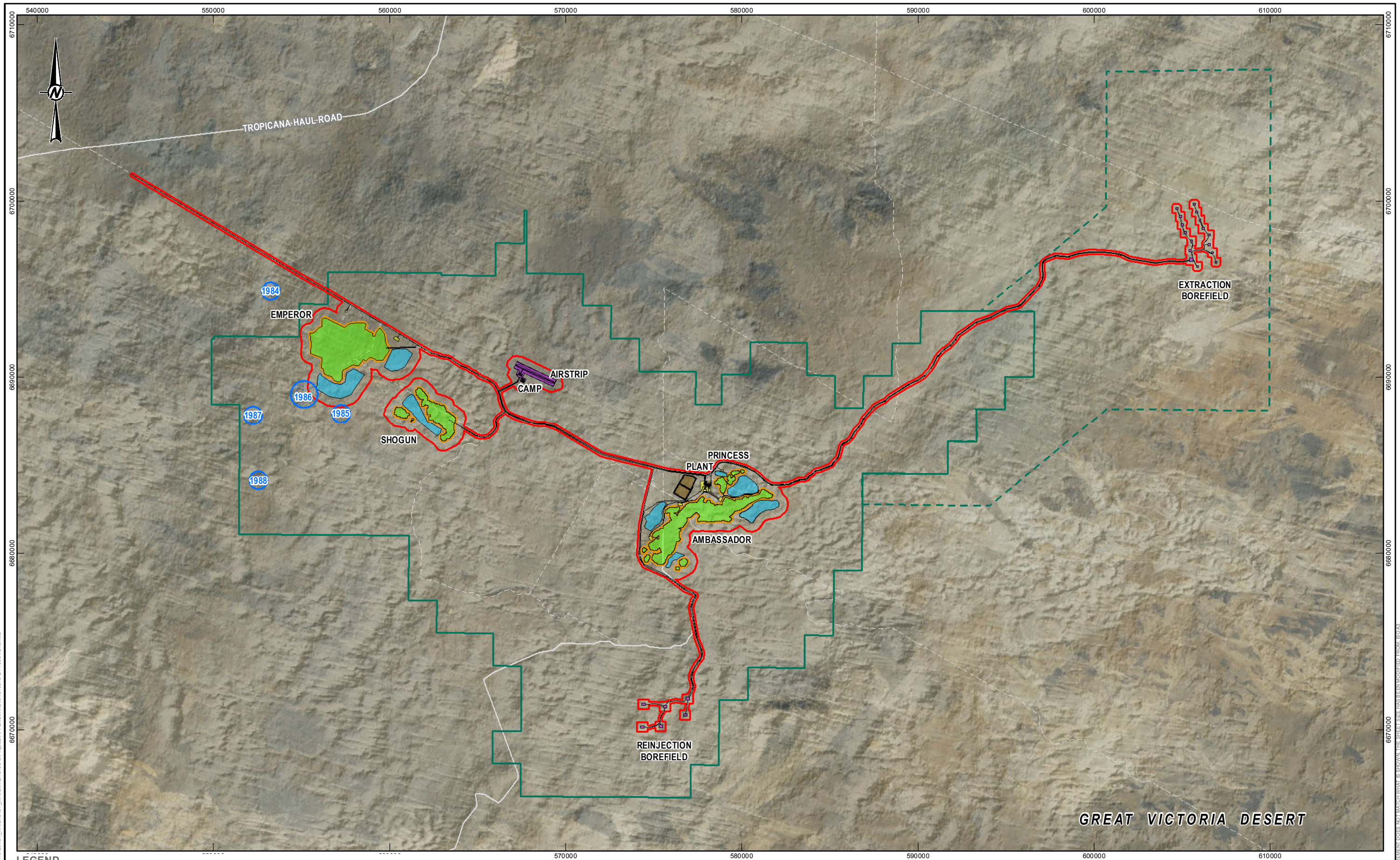
TITLE  
**ARCHAEOLOGICAL SURVEY SQUARES WITH ISOLATED ARTEFACTS LOCATION**

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	G4	0	4

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




If this requirement does not match what is shown, the sheet size has been adopted from ISO A3 25mm





GREAT VICTORIA DESERT

**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



CLIENT  
**VIMY RESOURCES LIMITED**

CONSULTANT



PROJECT  
**MULGA ROCK URANIUM PROJECT**

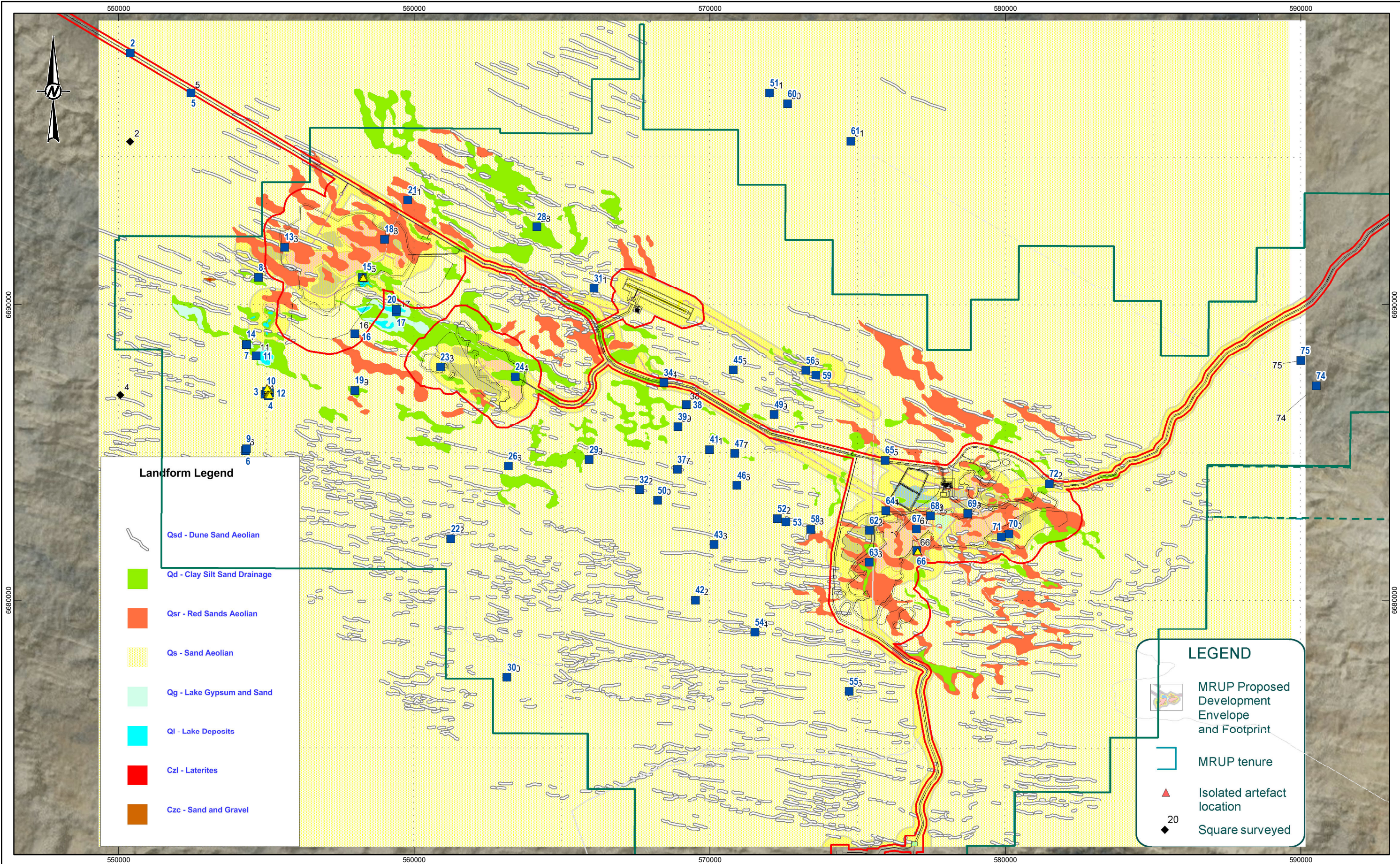
TITLE  
**ABORIGINAL HERITAGE SITES**

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

PROJECT NO.	CONTROL	REV.
1540340	G4	0

FIGURE  
**5**





### Landform Legend

- Qsd - Dune Sand Aeolian
- Qd - Clay Silt Sand Drainage
- Qsr - Red Sands Aeolian
- Qs - Sand Aeolian
- Qg - Lake Gypsum and Sand
- Ql - Lake Deposits
- Cz1 - Laterites
- Czc - Sand and Gravel

### LEGEND

- MRUP Proposed Development Envelope and Footprint
- MRUP tenure
- Isolated artefact location
- Square surveyed

### LEGEND

- ISOLATED ARTEFACT LOCATION
- SQUARE SURVEYED
- 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  
 AERIAL IMAGERY SOURCED FROM ESRI ONLINE  
 TOPOGRAPHY BASED ON NATIONAL DEM 1 S SOURCED FROM GEOSCIENCE AUSTRALIA

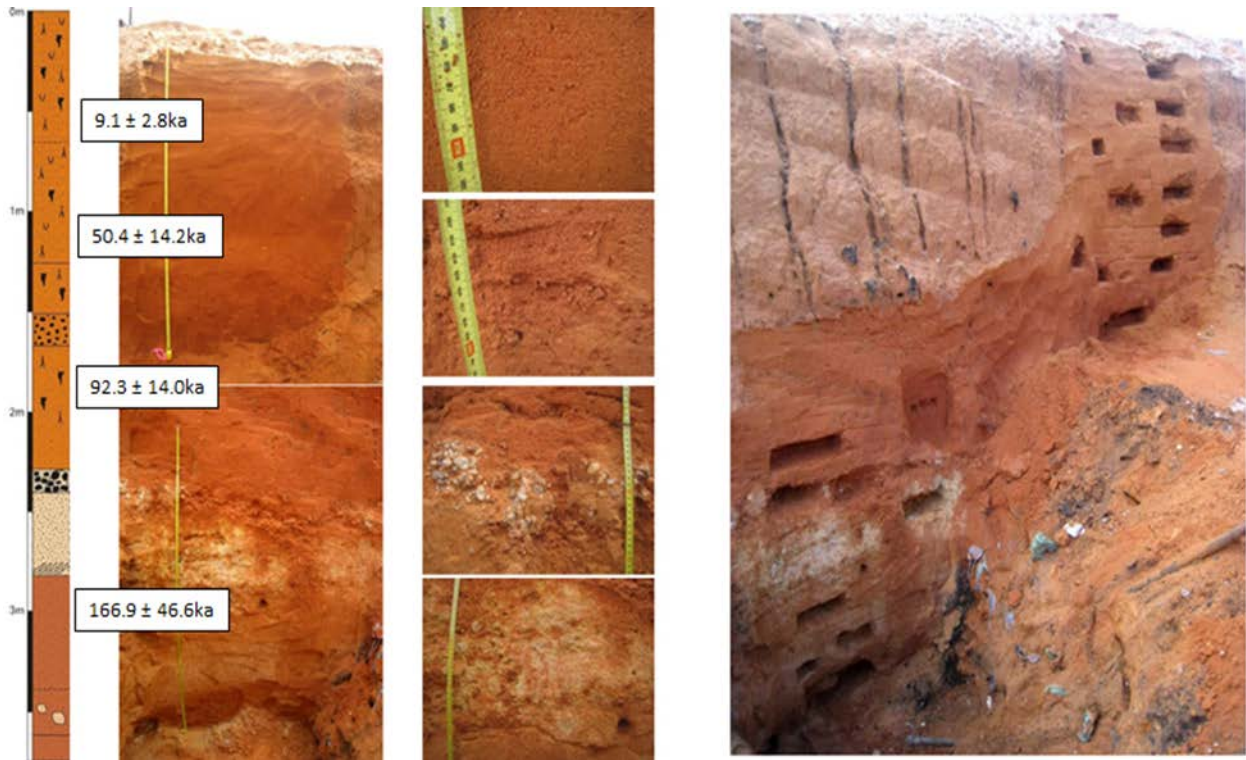
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CLIENT <b>VIMY RESOURCES LIMITED</b>	PROJECT <b>MULGA ROCK URANIUM PROJECT</b>																
CONSULTANT 	TITLE <b>ARCHAEOLOGICAL SURVEY SQUARES WITH ISOLATED ARTEFACT LOCATIONS ON INTERPRETED LANDFORM TYPES</b>																
<table border="0"> <tr><td>YYYY-MM-DD</td><td>2015-10-28</td></tr> <tr><td>DESIGNED</td><td>MS</td></tr> <tr><td>PREPARED</td><td>MS</td></tr> <tr><td>REVIEWED</td><td>CWC</td></tr> <tr><td>APPROVED</td><td>CWC</td></tr> </table>	YYYY-MM-DD	2015-10-28	DESIGNED	MS	PREPARED	MS	REVIEWED	CWC	APPROVED	CWC	<table border="0"> <tr><td>PROJECT NO.</td><td>1540340</td><td>CONTROL</td><td>G4</td><td>REV.</td><td>0</td></tr> </table>	PROJECT NO.	1540340	CONTROL	G4	REV.	0
YYYY-MM-DD	2015-10-28																
DESIGNED	MS																
PREPARED	MS																
REVIEWED	CWC																
APPROVED	CWC																
PROJECT NO.	1540340	CONTROL	G4	REV.	0												
FIGURE <b>6</b>																	

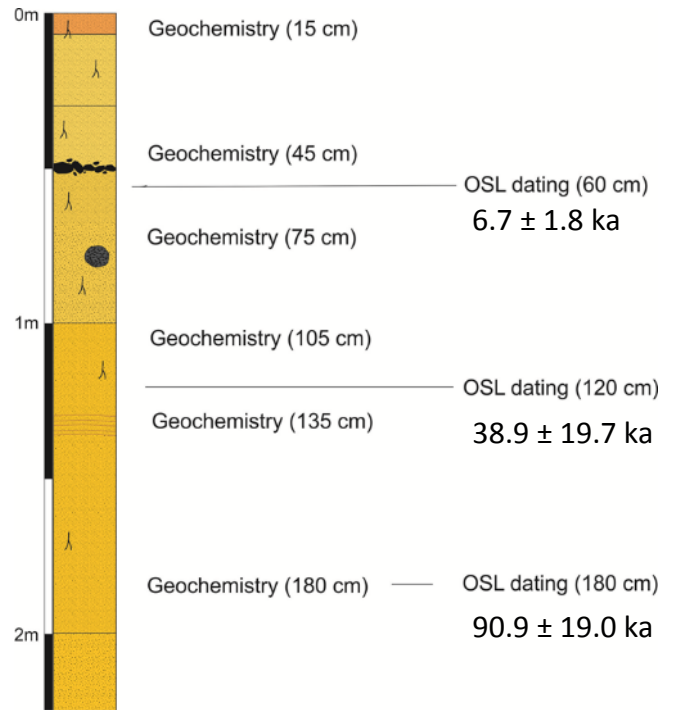
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25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN HOODIFIED FROM ISO A3



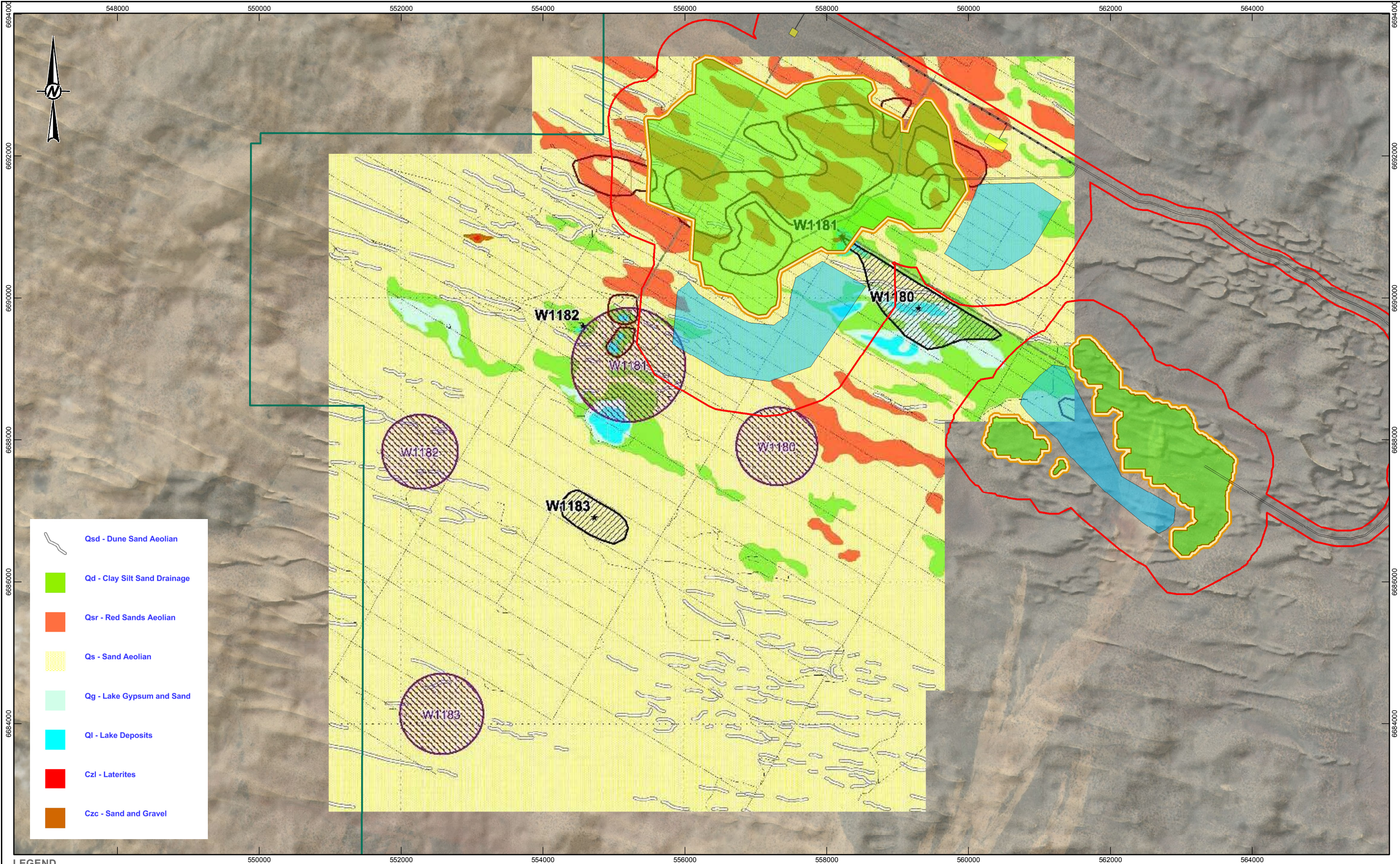


**Figure 7** OS� dating and soil profile from MRUP rubbish tip (573,752mE/6,683,942mN)



**Figure 8** Landscape, soil profile and OS� dating and soil profile from the GSWA sand pit (584,048mE/6,687,580mN)





	Qsd - Dune Sand Aeolian
	Qd - Clay Silt Sand Drainage
	Qsr - Red Sands Aeolian
	Qs - Sand Aeolian
	Qg - Lake Gypsum and Sand
	Ql - Lake Deposits
	Czl - Laterites
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	PIT
	OVERBURDEN LANDFORM
	PROCESSING INFRASTRUCTURE
	PIT CLEARING (50 m BUFFER)
	MRUP DEVELOPMENT ENVELOPE
	PROJECT BOUNDARY (MINING TENURE)

	ESD DISTURBANCE FOOTPRINT
	DAA site record
	Original record (S. O'Connor)
	J. Mattner survey records (Sept. 2010)

**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  
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0 1 2 3  
 1:50,000 KILOMETRES

CLIENT  
**VIMY RESOURCES LIMITED**



PROJECT  
**MULGA ROCK URANIUM PROJECT**

TITLE  
**RECORDED ARCHAEOLOGICAL SITES**

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

PROJECT NO.	CONTROL	REV.	FIGURE
1540340	G4	0	9

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



Isolated Artefact Number	Typology	Lithology	Easting	Northing	Length (mm)	Width	Thickness	Platform Thickness	Platform Width	Square
1	Core	Silcrete	577037E	6681656N	91.5	56.7	35.5	-	-	66
2	Hammerstone	Silcrete	577037E	6681656N	69.9	39.7	36.0	-	-	66
3	Angular fragment	Silcrete	577037E	6681656N	41.4	38.7	19.8	-	-	66
4	Flake	Chert	558313E	6690901N	26.0	15.3	5.0	9.2	5.4	15
5	Flake	Silcrete	558267E	6690931N	37.5	14.9	5.3	9.5	3.2	15
6	Flake	Silcrete	558250E	6690925N	28.7	18.4	5.2	9.3	2.6	15
7	Flake	Silcrete	558275E	6690913N	36.3	26.8	7.2	15.3	6.6	15
8	Adze	Chert	558275E	6690913N	22.5	17.8	5.7	-	-	15
9	Flake	Chert	558275E	6690913N	18.5	13.7	3.1	9.2	3.5	15
10	Flake	Silcrete	555040E	6687059N	45.2	42.7	14.3	19.6	11.4	16
11	Flake	Silcrete	555091E	6687120N	59.5	33.7	10.2	27.3	12.6	16
12	Angular fragment	Silcrete	555074E	6687115N	40.5	42.2	29.3	-	-	12
13	Angular fragment	Opaline Silica	555054E	6687114N	28.4	12.5	29.5	-	-	10
14	Broken Flake Distal	Opaline Silica	555052E	6687113N	28	12.5	9.6	-	-	10
15	Flake	Silcrete	555020E	6687181N	32.5	19.5	7.2	16.3	4.5	10
16	Angular fragment	Silcrete	555028E	6686965N	18.3	13.2	3.1	-	-	10
17	Tula Adze	Brown Chert	555052E	6686984N	36.7	19.4	18.4	-	-	10
18	Angular fragment	Brown Chert	555052E	6686980N	12.2	11.3	1.5	-	-	10
19	Angular fragment	Silcrete	555054E	6686968N	16.3	13.2	3.5	-	-	10
20	Angular fragment	Silcrete	555052E	6686967N	27.4	25.1	8.2	-	-	10
21	Flake	Quartz	555079E	6686940N	18.3	13.5	3.2	11.0	3.1	10
22	Flake	Opaline Silica	555106E	6686944N	18.2	22.1	1.5	11.4	1.8	10

**Table 2 Isolated artefacts identified and recorded during the survey.**