ARCHAEOLOGICAL STUDIES OF

THE TROPICANA GOLD PROJECT AREA
(including the Infrastructure Corridors and Water Supply Area)

GREAT VICTORIA DESERT

March 2006 – December 2008

Prepared for
ANGLOGOLD ASHANTI AUSTRALIA LTD
(as Manager of the Tropicana Joint Venture)

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EXECUTIVE SUMMARY

The Tropicana Joint Venture (JV), between AngloGold Ashanti Australia Limited (manager and 70% stakeholder) and Independence Group NL (30%), is planning to develop the Tropicana Gold Project, which is situated 330km east-northeast of Kalgoorlie, 220km east-southeast of Laverton and 190km north of the Transcontinental Railway in the Great Victoria Desert. This is an arid region of sand plains and sand dune fields with few salient features and no permanent surface water.

The JV has commissioned numerous archaeological site surveys or area inspections of their tenement holdings with a focus on the Tropicana Gold Project (TGP). The TGP consists of 31 mining leases (the Operational Area), together with a series of miscellaneous licences for supporting infrastructure such as access road, communication corridor and a water supply area and water pipeline. Between 2006 and December 2008, Aboriginal archaeological site surveys were conducted on all of these mining tenements and miscellaneous licences. These surveys established a strongly patterned distribution and a very low density of sites in the Tropicana district.

The archaeological studies were commissioned in order to meet the JV's obligations under the WA *Aboriginal Heritage Act* 1972 and in recognition of commitments to the Aboriginal communities. These have been carried out independently of ethnographic site surveys, which commenced earlier (Machin & Glendenning 2002; Machin 2005) and are ongoing. The ethnographic surveys covering the TGP are described in a companion report (Mattner & Bergin 2009).

At the commencement of the archaeological surveys, there were no recorded archaeological sites within 50km of the TGP Operational Area, and only 4 such sites within 100km. This was directly related to the lack of previous archaeological surveys. Research found only 1 such survey which had been carried out in the western half of the Great Victoria Desert.

A total of 11 sites were discovered and recorded within the Operational Area, while more sites were discovered during surveys of the miscellaneous licences. Only 1 site has been found within the 60km^2 of the central mining area, with another 10 sites in the estimated 230km^2 of the remainder of the Operational Area. In addition, 12 sites were found within the 2 infrastructure corridors. Several other sites or potential sites were noted near the corridors and in these instances deviations were selected and surveys that ensured the sites were avoided. No sites were found in the Water Supply Area or in the water pipeline corridor.

The most common archaeological sites are artefact scatters and quarries, with a small number of rockshelter sites. Artefact scatters represent campsites and activity centres where a range of day-to-day tasks were conducted. Two very large scatters (with more than 50 000 artefacts) were found beside gnammas (rockholes). These sites were clearly used on many occasions, probably over centuries or millennia, and served as base camps. Several medium sized scatters (with a few thousand artefacts) were found near ephemeral water sources and indicate repeated visited to these locations. Small and very small scatters are the most common site types and are widely distributed, but in almost all cases were found near a water source, such as a claypan or depression. These may be the remains of camps used by small groups travelling through the district, or may be satellite sites occupied briefly by people staying at the much larger campsites.

The quarry sites range in size from knapping centres used once or twice to small quarries (with hundreds of pieces) visited on a number of occasions. Markedly different is a major quarry ("Blue Robin Quarry 07") which is estimated to contain 100 000 pieces and which was visited many times over centuries or millennia. Most of the quarries are clustered in hills a few kilometres south of the Operational Area where there are outcrops and scree patches of coarse- or medium-grain silcrete. Some quartz outcrops and scree patches were also exploited, but the few quartz quarries are small and consistent with casual exploitation by transient groups.

Several rockshelter sites were found in the few breakaways found in the TGP Operational Area. These typically had only a few associated artefacts, but 2 rockshelters had small artefact scatters below their talus slopes. The largest artefact scatter site ("Blue Robin Mesa 01") also contains 3 rockshelters. All of the rockshelters appear to contain shallow deposit, which would limit their potential for having dateable organic material and their potential for providing a chronology for Aboriginal occupation of the Tropicana district and the Great Victoria Desert.

Some of the smallest artefact scatters and quarries have little if any research potential and may not meet the criteria for registration as sites under the WA *Aboriginal Heritage Act* 1972, even though meeting the definition of an archaeological site adopted for these studies.

Management of the Aboriginal archaeological heritage involves, in the first instance, avoiding any impact to these sites. The current layout and infrastructure planning has taken into account the location of the archaeological sites and been modified as required to achieve site avoidance. In the event that site disturbance is necessary or unavoidable, an application may be made for permission "to use the land" containing a heritage site, in accordance with section 18 of the WA *Aboriginal Heritage Act* 1972.

A Cultural Heritage Management Strategy is being prepared in conjunction with Aboriginal representatives and this will include procedures for protection of sites and appropriate steps which can be taken should new archaeological material be discovered during future operations in the area. Senior representatives from the Wongatha community have been shown some of the archaeological sites, as part of the ongoing development of the management strategy. Their preliminary comments are in accordance with the archaeological assessment of the sites' significance.

From a research perspective, more work is needed before a clear picture of the Aboriginal occupation of the region can be drawn, but the results provide a glimpse of the ways in which the land was occupied and its resources used in the past. It is likely that at least 2 modes of occupation were practiced depending on the availability of water. The few large sites demonstrate that when good conditions prevailed, people travelled to the Tropicana district and stayed to hunt and gather and quarry rock. In drier times, the area was visited only in transit and sites were briefly occupied. In times of drought, which may be decades long, it is likely the Tropicana district was not visited.

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Acknowledgments
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1.0 INTRODUCTION

1.1 Background

The Tropicana Joint Venture (the JV) is planning to develop the Tropicana Gold Project, east-northeast of Kalgoorlie and east-southeast of Laverton. The Tropicana JV, between AngloGold Ashanti Australia Limited (manager and 70% stakeholder) and Independence Group NL (30%), holds mining and exploration tenements that cover approximately 12,500km² over a linear distance of 330km on the eastern margin of the Yilgarn Craton in the Great Victoria Desert. The JV has been undertaking exploration activities in this area since 2002. Exploration has resulted in the identification of a significant gold resource at the Tropicana and Havana prospects and these form the basis of the proposed Tropicana Gold Project (TGP).The TGP is comprised of 3 main components:

- Operational Area - This area contains the mine, processing plant, airstrip, village and other associated infrastructure;
- Water Supply Area - Two basins have been investigated, only the Minigwal Trough is considered to be viable; and
- Infrastructure Corridors - Two options are under consideration (Pinjin and Tropicana-Transline).

The TGP area consists of 31 Mining Leases (covering the Operational Area) and a series of Miscellaneous licences for supporting infrastructure such as access road, communication corridor and water supply area (refer to Table 1).

Early in 2006, the Tropicana JV commissioned archaeological investigations of the proposed Operational Area and surrounding exploration tenements. All of the land within the Operational Area has, as of August 2008, been surveyed for archaeological sites, including the 2 infrastructure corridors and proposed Water Supply Area.

Archaeological investigations commenced in March 2006 with an inspection to determine the likelihood for archaeological sites and identify areas with potential for sites. That has been followed by numerous surveys to systematically search the TGP area and find any such sites, then ensure they are recorded, assessed, delineated and protected. It was envisaged that the information on the presence of sites would be used to influence the final site infrastructure layout, if required.

The archaeological studies were commissioned in order to meet the JV's obligations under the WA *Aboriginal Heritage Act* 1972 and in recognition of commitments to the neighbouring Aboriginal communities. These have been carried out independently of ethnographic site surveys and consultations for the TGP area. Ethnographic surveys of the JV area commenced earlier (Machin & Glendenning 2002; Machin 2005) and are ongoing (Chown & Mattner 2007a, 2007b; Mathieu & Glendenning 2008a, Mathieu & Glendenning 2008b).

In addition to the archaeological work at the TGP, a large amount of work has been commissioned by the JV on other tenements and areas in the tenement block that stretches for over 300km from north of the TGP to south of the Transcontinental Railway (Figure 6). That additional work is detailed in a separate report (Mattner & Sanders *in prep.*) and is not discussed in this report.

All of the archaeological fieldwork has been supervised by Joe Mattner and conducted at various times by the following archaeologists:

- Joe Mattner (MA, BSc Hons: 16 years experience)
- Trudy White (BA Hons: 4 years experience)
- Natasha Sanders (BA Hons: 2 years experience)
- Darren Cooper (BSc Hons: 6 years experience)
- Tom O'Reilly (BA Hons: 10 years experience)
- Esmee Webb (MSc, BA: 20 years experience).

1.2 Location of the Study Area

The TGP Operational Area is located on the southwest edge of the Great Victoria Desert, northwest of the Nullarbor Plain. It is approximately 330km east-northeast of Kalgoorlie, 220km east-southeast of Laverton and approximately 190km directly north of the Kitchener railway siding on the Transcontinental Railway (Figure 1). It is approximately 160km northeast of Queen Victoria Spring Nature Reserve. Lake Rason is located approximately 60km to the north-northwest and Lake Minigwal 125km to the west. Plumridge Lakes Nature Reserve is located to the southeast, with the Salt Creek Junction Airstrip (within the Nature Reserve) approximately 50km southeast of the existing Tropicana exploration camp.

The climate is classified as non-seasonal desert, characterised by low, unreliable rainfall and high evaporation (Beard 1974; 1976). Mean annual rainfall is between 200mm and 250mm, but rainfall is unreliable and unpredictable. Summer storms can bring heavy localised falls, while winter rains are typically lighter but far more widespread. Uncommon but significant are the cyclonic depressions that bring floods to the region on occasion. Also significant and more common are the extended droughts.

The aridity and non-seasonal rainfall will have influenced past Aboriginal occupation of the region, and at times strongly constrained settlement. The scarcity of potable water makes it unlikely that the Aboriginal population was ever numerous. Rather, people probably only ventured into the area after rain when they were sure of water in certain rockholes and 'soaks'. Good rainfall events only happen once or twice a decade, as in other parts of the Australian arid zone (Gentilli 1993), although in the past decade there appears to have been a significant change, with far more summer rainfall than the average.

The Great Victoria Desert is characterised by undulating sand belts rising from the northern edge of the Nullarbor Plain to meet the Gibson Desert. It contains numerous low sandstone breakaways, southern trending valleys and east-west trending seif dunes (Beard 1974:12). In the northwest, there are salt lakes and low-lying sand plains, with valleys filled with sand presumably transported from higher ground. To the west, there is gently undulating terrain of low relief with the few prominent hills being greenstone outcrops (Beard 1974:13).

Generally, the TGP Operational Area is situated on flat sandy plains with east-west elevated dunes in some portions. Sand plains and sand dune fields are the dominant landforms of the surrounding area and there is very little expression of the underlying geology, which is mostly Permian sandstones of the Officer Basin.

There are a few low hills formed by mesas or breakaways, some of which are partially covered by dunes, and there is one prominent rocky ridge in the north of the Operational Area. These hills are typically composed of sedimentary rocks and conglomerates, which have been heavily lateritised. A moderately dense scree or gibber ('float') of rocks and pebbles, many of white

quartz, covers the hills. The gibber extends only a very short distance on to the flanking sand plains, which are typically devoid of stone of any sort.

In this region there are no significant drainage systems. The sands do not hold surface water and even the underlying sandstones and conglomerates are porous, so any rainfall soaks quickly away. A few short creeklines flow from the hills to some of the larger claypans, or else dissipate on the sand plains. All the watercourses are ephemeral and none is a source of permanent water, but the larger creeklines contain long-lasting pools or 'soaks' in their sandy creekbeds, which can be reasonably reliable water sources.

Rainwater collects in claypans, saltpans and depressions, or in rockholes (gnammas) formed in rocky outcrops, but such features are rare. A few of these are named and plotted on existing maps because of their importance. Chains of small saltpans mark the palaeodrainage that links Lake Rason, to the north, with the Plumridge Lakes, to the southeast. These fill irregularly and while they may attract abundant bird life, the water is far too salty to be potable.

The TGP area is located in the Helms Botanical District, bordering the Eucla Botanical District (Beard 1974:50). On the extensive sand plains the vegetation cover can be characterised as spinifex grasslands with sparse trees and few shrubs. The tree component is typically mulga but sometimes is low sparse gums, or a mixture. In pockets, woollybutt grasses dominate and occur with sparse low mulga and only occasional gum trees. Sand dunes have a varied vegetation cover with numerous small and medium shrubs, as well as spinifex. In the interdunal channels there are some stands of mulga trees. On the calcareous soils that are mostly restricted to the northern portion of the tenements, there are Casuarinas with an understorey of shrubs and thin patchy grasses.

Human impact in the vicinity of the TGP area has been very limited and restricted until recently, although introduced animals and pests may have resulted in increased erosion. Lacking water and forage, most of the Great Victoria Desert has proved unsuitable for pastoralism. Hence, the country has probably changed little since present climatic conditions were established about 6000 years ago. Prior to the recent exploration activity, there was a small amount of sandalwood harvesting, or ‘pulling’. Wildfires started by lightning regularly burn areas of spinifex, which is ubiquitous on the sand plains and sand dune fields. As a consequence, loose mobile sands are likely to have covered any artefactual material on the sand plains and dunes.

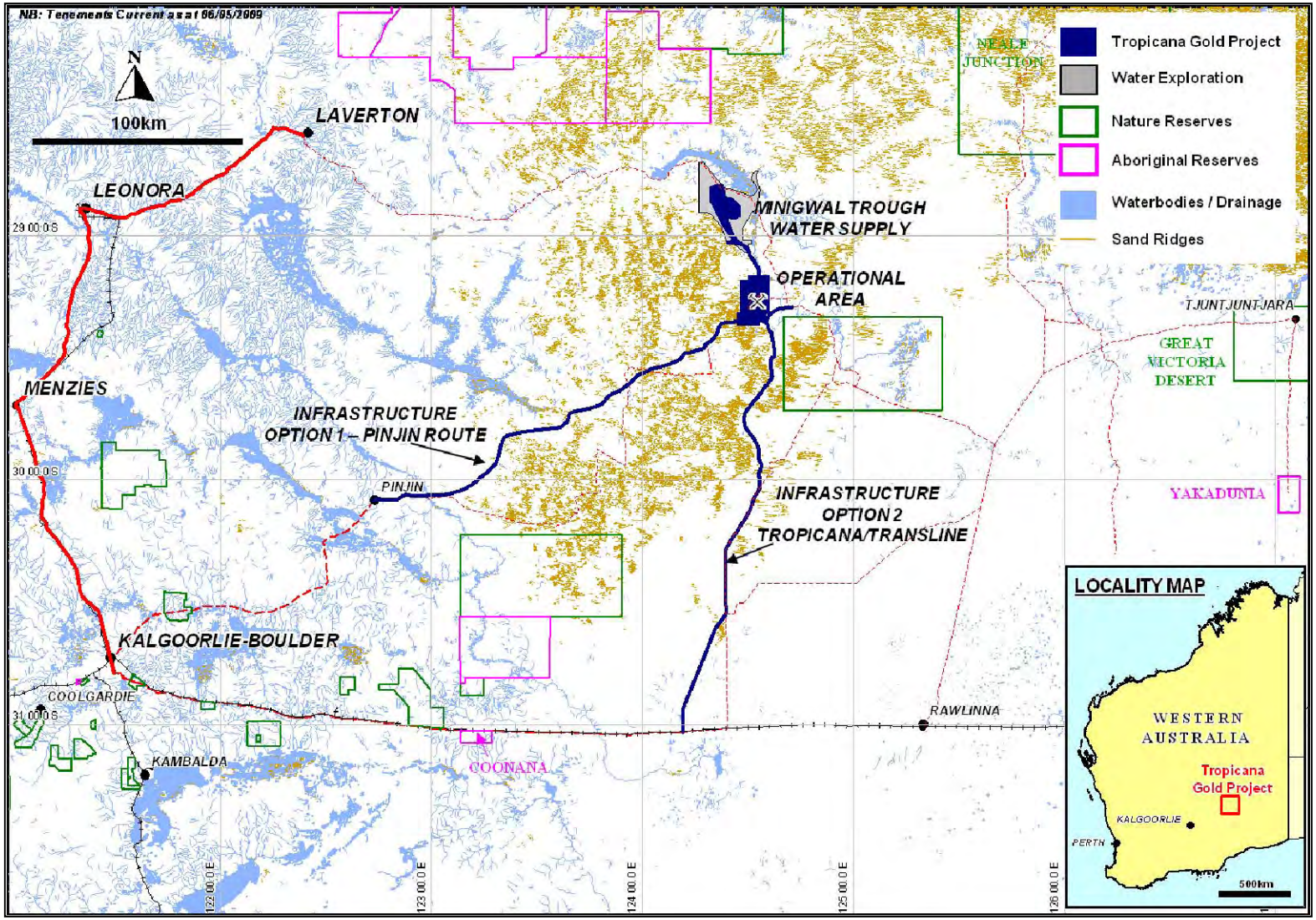

Figure 1 Tropicana Gold Project Location Plan

1.3 Tenements in Study Area

All of the 31 mining tenements in the Operational Area have been surveyed during archaeological investigations. These tenements are listed in Table 1 and illustrated in Figure 2.

The central Operational Area, or mining area, where the open-cut pit and much of the mining activity will be located, is comprised of 8 tenements. Five of these are wholly within the area, together with northern portions of 3 other tenements. The surrounding project area is comprised of 20 entire tenements and the southern portions of 3 tenements. There are also 7 leases covering access road, communication corridor and water borefield associated with the Tropicana Project, all of which are included in this study.

Table 1: Tenements in the Tropicana Gold Project area

Operational Area & surrounding project area (previously within E39/951 & E39/956)	• M39/978	• M39/979	• M39/980	• M39/981
	• M39/982	• M39/983	• M39/984	• M39/985
	• M39/986	• M39/987	• M39/988	• M39/1010
	• M39/1011	• M39/1012	• M39/1013	• M39/1014
	• M39/1015	• M39/1016	• M39/1017	• M39/1018
	• M39/1019	• M39/1020	• M39/1021	• M39/1028
	• M39/1029	• M39/1030	• M39/1048	• M39/1049
	• M39/1050	• M39/1051	• M39/1052	
Infrastructure – Pinjin Road Option	• L31/56	• L31/57	• L39/185	
Infrastructure – Tropicana-Transline Option	• L39/186			
Public Bypass Track & Airstrip and access	• L39/188	• L39/189	• L39/172	
Water Borefield Areas – Minigwal Trough	• L38/150	• L38/113,114,		

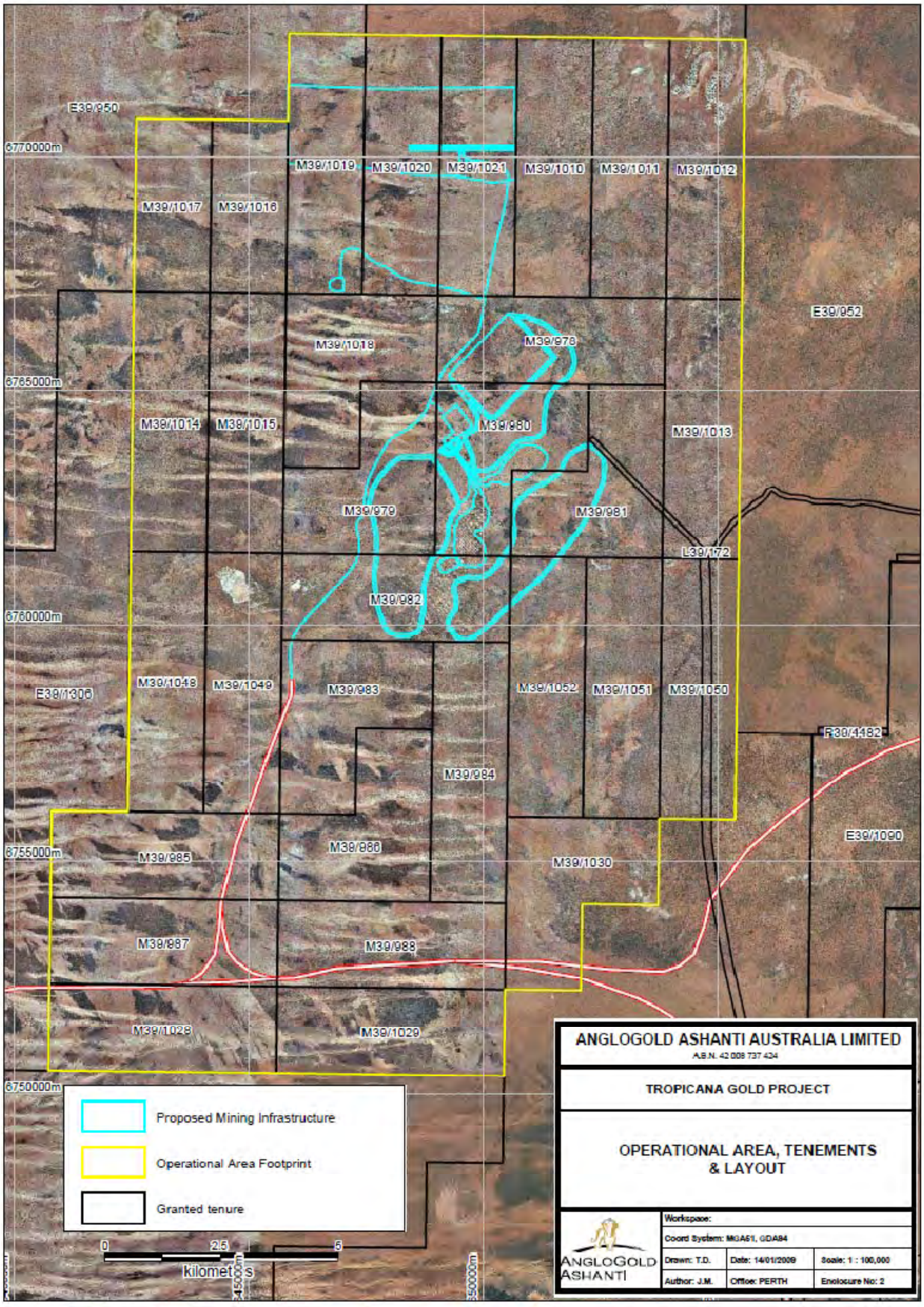

Figure 2: Operational Area tenements and central mining area

2.0 ARCHAEOLOGICAL BACKGROUND

2.1 What is a Site?

The WA *Aboriginal Heritage Act* 1972 makes provision "for the preservation, on behalf of the community, of places and objects customarily used by or traditional to the original inhabitants of Australia". The *Act* applies to both places (Section 5) and objects (Section 6) which are of significance in traditional or contemporary cultural life, including sacred, ritual or ceremonial sites, as well as places of scientific, aesthetic or social significance (Section.39).

For the purposes of this study, an archaeological site is defined as a place where "significant traces of human activity are identified" (Renfrew & Bahn 1991: 42). In other words, a site is a location where there is substantial, in situ evidence of past Aboriginal occupation or activity. This is a scientific definition, not a legal definition. Where a site has archaeological components and also has cultural or historical significance to Aboriginal people, the site can be classified as an ethnoarchaeological site.

A place or feature identified as an archaeological or an ethnoarchaeological site might or might not constitute a "site" under the WA *Aboriginal Heritage Act* 1972. The decision whether a reported site will qualify as a registered "site" under Sections 5 and 39 of the *Act* is made by the Aboriginal Cultural Material Committee at the Department of Indigenous Affairs. That decision is based on a number of factors, of which the viewpoints of Aboriginal spokespersons, anthropologists and archaeologists are only a part.

It is important to note that all Aboriginal sites are protected under the *Act*, whether known or not, and whether reported or not. It is an offence to disturb or conceal a site, or remove artefacts, without appropriate consent. Section 15 of the *Act* requires that newly discovered sites be reported. Excerpts from the *Act* are included in Appendix 2.

The WA *Environmental Protection Act* 1986 also provides for protection of Aboriginal heritage sites, places and locations "in circumstances where the heritage values are linked directly to the physical and biological environment and when the protection and management of those attributes are threatened" (Guidance Statement No.41; 2004). Archaeological sites are discrete places containing the remains of human activities or are specific objects. They are often associated with landscape features (see next section), but are not landscapes or environmental features of themselves. Therefore, they do not fall within the EPA's purview, with rare exceptions. Some ethnographic sites, on the other hand, are directly associated with or linked to landscapes or places, and may be considered for protection under this *Act*.

2.2 Predictive Model of Site Distribution

Correlations between archaeological sites and landscape features make it possible to propose a model of site distribution. This predictive model can only be generalised but it provides a basis when designing surveys and assessing the potential for sites, as well as for understanding the survey results. The model is based on theoretical models and regional research, as outlined in Appendix 3, and empirical data collected from surveys in the semi-arid and arid interior.

The presence of water was a key factor in the occurrence of archaeological sites and particularly artefact scatters representing campsites. Near reliable or long-lasting water sources, very large artefact scatters are common (Appendix 3). Small artefact scatters are likely to occur near ephemeral water sources and generally represent campsites that were seldom occupied or occupied for short periods. Overnight camps, meal-time camps or places where specific tasks

were performed are represented by very small artefact scatters. These sites will not necessarily be associated with water sources and their occurrence is hard to predict.

While water was a key determinant in where sites occur, other aspects influenced the position of sites about water sources. Factors such as shade and wood supply (Mattner 2000a; Tindale 1974), prevailing winds and insect pests (Smith 1988) and slope angle, soils and drainage (Lilley 1985) determined the positioning of campsites.

Some site types will be directly correlated with geological or topographic features. Quarries for stone for tool-making are limited to occurrences of siliceous rock, such as quartz, chalcedony, chert, 'silcrete', etc. Often, quarries will be on hills or ridges, which is where outcrops or subcrops typically are found. Rockshelters or gnammas are typically found in breakaways or at large granitic domes. Rock art is uncommon in this part of the continent.

The distribution of stone arrangements in inland regions is very poorly understood and there is no published literature examining patterns in their occurrence. Observation has shown that stone arrangements are more likely near reliable water sources, including gnammas and claypans. Stone arrangements were functional or esoteric. Single standing or placed stones may signal water while a rock circle may have been the base of a hunting hide. Multiple lines of stones or complex arrangements with hundreds of stones served as ceremonial grounds.

Traditional wooden shelters (called *wiltja*) are occasionally found in these inland regions. These probably have been built in the past 80 years, and frequently occur in small clusters. Generally, *wiltja* are found either near water sources or in the vicinity of non-Aboriginal camps. For example, several examples were observed at sandalwood pullers' camps and were recorded during the ethnographic surveys (see Mattner & Bergin 2009).

Another form of historical site is scarred or marked trees, usually representing places where wood was obtained for boomerangs, shields or bowls. Typically, several scarred trees occur together and a steel axe has been used. Often such sites are near historic campsites. The Tropicana district has a high frequency for fires, so scarred or marked trees may have been burnt and lost.

2.3 Site Recording

Where archaeological material was observed during the surveys and inspections, intensive searches were made to determine the nature and extent of the material. If this was judged on scientific grounds to be an archaeological site (see section 2.1), it was recorded in a preliminary manner according to a standard procedure and format. Notes were made on the local environment and site contents. A sketch of each site was made and photographs taken.

This preliminary recording is sufficient to characterise a site's contents and to assess its scientific significance. Further study of the site, and particularly the assemblage, would be required to fully define the site.

The boundary of a site was marked by flagging tape tied to trees and shrubs. The site boundary, as marked and recorded, is a first approximation of the actual boundary. Coordinates were recorded for points on the perimeter of a site, using a hand-held GPS unit accurate to 5m -10m. From these coordinates a plan showing site locations can be produced.

2.4 Archaeological Significance

The heritage significance of an archaeological site is determined by several factors. Principal among these will be the archaeological or scientific significance and Aboriginal viewpoints. Public, educational or aesthetic values of a site may also be considered. In this report, only the archaeological or scientific significance is considered. This was determined from preliminary site recording and observations, as well as a familiarity with the regional archaeological record.

Assessments of archaeological significance are typically based on two criteria: representativeness and research potential (Raab & Klinger 1977; Bowdler 1981). Representativeness refers to the frequency of occurrence of sites or archaeological material. The more commonplace something is, the less significant it will be, while unique sites will be highly significant. In making this assessment, it is appropriate to consider the known occurrence as well as the likely occurrence of sites.

Research potential refers to the likelihood that study of an archaeological site or material will answer scientific questions or add new or pertinent information to the corpus of archaeological knowledge. A stratified site will have more research potential than a surface site, while a complex assemblage will have more potential than a small or less diverse one. Different archaeologists may ascribe different research potential to the same site, given their own interests and local knowledge.

The degree of site disturbance and the environmental context will also generally influence the assessment of archaeological significance, as will the presence of esoteric components, such as art or rare artefacts (Coutts 1982). Significance is a mutable quality, changing as more sites are recorded, questions are answered or new directions in research arise (Bowdler 1984).

Aboriginal viewpoints on the significance of the archaeological sites discovered to-date are being obtained and documented by AngloGold Ashanti Australia as part of the preparation of a Cultural Heritage Management Plan. This work began with a visit to the Tropicana Project in early 2008 by members of the former Wongatha Native Title Claimant group.

3.0 ARCHIVAL RESEARCH

3.1 Registered Archaeological Sites

At the commencement of the first study in March 2006, a search was made of the on-line Register of Aboriginal Sites, operated by the Department of Indigenous Affairs (DIA), to determine if any Aboriginal sites were known to exist within the TGP area (see Appendix 1). A search was made for a much larger area to establish what types of sites had been recorded in the region.

There were no Aboriginal heritage sites registered within or near the TGP Operational Area at the commencement of the archaeological studies. Indeed, there were very few registered sites in the region. This can largely be attributed to a lack of previous heritage investigations within the Great Victoria Desert region.

There were 2 registered sites within 50km of the TGP area, these being (DIA site id.) #21923 "Claypan Wp 78" and #21924 "Camp Wp 79". Both of these are historic sites recorded in 2001 during an ethnographic survey within the Plumridge Lakes Nature Reserve (Machin 2001). Only 4 other sites were known within 100km (Table 1). Of these, 2 are stone arrangements (#1524 "Jasper Stone Arrangements" and #3050 "Shay Cart Stone Arrangement") and 1 is a standing stone or marker stone (#18196 "Ironstone Rocks"). The remaining site is an artefact scatter and quarry (#1983 "Malcolm Soak").

Table 2: Registered archaeological sites within a 100km radius of the study area (as at 2006)

DIA site id.	Site Name	Site Type
within 50km		
21923	Claypan Wp 78	historical (ethnoarchaeological)
21924	Camp Wp 79	historical (ethnoarchaeological)
within 100km		
1983	Malcolm Soak	quarry / artefact scatter
18196	Ironstone Rocks	marker stone
3050	Shay Cart Stone Arrangement	stone arrangement
1524	Jasper Stone Arrangements	stone arrangement

The nearest registered archaeological sites are all isolated examples and provide an unreliable guide to the archaeological material to be expected in the region. None were discovered during systematic surveys or studies and only one (#1983) was recorded by an archaeologist. This site is more typical of the types of sites which might be expected in the district.

Site #1983 "Malcolm Soak" was recorded by S. O'Connor in 1983. It is situated beside a saltpan between sand dunes. The scatter is concentrated around a 'granite' outcrop, which contains shallow depressions that pool water after rain. The outcrop contains thick quartz seams, which have been quarried. Artefact density varied from 1 artefact/m^2 away from the outcrop to 30 artefacts/m^2 at the base of the quartz seams. Quartz was the dominant raw material for tools, comprising over half of the assemblage, but chalcedony and 'silcrete' artefacts were also present. O'Connor stated that this site was significant because it is extensive (500m x 500m) with a diverse assemblage made of a broad range of raw materials, and because analysis of the site may answer questions on human occupation in the area (O'Connor 1983:27).

3.2 Previous Archaeological Studies

A search was carried out of the DIA's on-line AHIS to determine if any previous archaeological surveys had been conducted over or near the Project Area. The search found no reports of any other heritage work, other than an ethnographic survey to the southeast (Machin 2001), which is discussed above.

Clearly, the absence of registered sites from the district around the Operational Area is related to an absence of site surveys. Aboriginal occupation of the arid zone of Australia has been a focus of academic research for a few decades, however, no research has been conducted in the main portion of the Great Victoria Desert or of inland parts of the Nullarbor region. There is, then, very little material with which to compare the results of the archaeological investigations at Tropicana. A summary of the results of arid zone archaeological research is presented in Appendix 3.

The nearest and most relevant archaeological survey was conducted in 1983 over a large area of sand dune field approximately 130km to the southwest of the Operational Area (O'Connor 1983). The landscape of large sand dunes and broad interdunal swales with spinifex and low shrubs under sparse gums and mulga trees is similar to parts of the TGP area.

Five campsites or artefact scatters were discovered. They generally were situated beside claypans, which occur in deeper than average depressions between the dunes. The claypans are typically small and are ephemeral water sources after good rains. They are also sources of plant and animal foods.

The site assemblages were small to moderately sized, with scores or hundreds of stone artefacts. The artefacts were made of a variety of stone, only some of which was from local outcrops. There were no grinding stones or other evidence of intensive occupation, and the size of the assemblages indicate that the sites were only occupied on a few occasions. The diversity of the stone material indicates that the occupants ranged over a wide area before camping at these claypans, as would be expected in this arid region where high residential mobility was a necessary way of life.

4.0 TROPICANA PROJECT AREA

As noted above, the TGP consists of:

- Operational Area which includes the mining area (e.g., pits, processing plant etc.) and surrounding infrastructure (e.g. airstrip, accommodation village) which are situated within 31 mining tenements (refer Figure 2);
- Infrastructure Corridors – Access Rd and Communication Corridor (refer Figure 4); and
- a Water Supply Area and associated pipeline supply route (refer Figure 5).

The ground disturbance associated with the project could be up to approximately 3500ha (35km^2) if the project reaches it's maximum potential based on current information.

4.1 Mining and Processing Area

4.1.1 Location

At the centre of the Operational Area is the proposed Tropicana mine (Figure 2). This will comprise at least two open-cut pits, which may be up to 5km long and 1km wide, flanked to the west, north and east by larger waste dumps. The processing plant, workshops, mining facilities and tailings dam, which may reach 2km by 1.5km in area, are to be situated north of the pit.

The Operational Area will be situated within a block approximately 9km NS by 6.5km EW, approximately 60km^2 in area. This central area encompasses the 'Tropicana' and 'Havana' Prospects, plus the key mining infrastructure such as the waste dumps and processing plant. It covers all of 5 tenements and the northern portion of another 3 tenements(*). The 8 tenements are:

- M39/978
- M39/979
- M39/980
- M39/981
- M39/982
- M39/983*
- M39/984*
- M39/1052*

All of these tenements have been systematically surveyed for archaeological sites. Prior to the surveys, some parts of this land had been inspected (Mattner 2006).

4.1.2 Environment

The landscape within these tenements can be characterised as extensive sand plain with some portions where sand dunes predominate. There are a few small rocky rises but no hills or breakaways. The vegetation is predominantly spinifex with Marble Gums, Mulga trees and mixed low shrubs, while the dunes support spinifex with sparse eucalyptus trees. The vegetation on the occasional patches of calcareous soils is markedly different, with Casuarina trees and broombush and no spinifex.

There are no sources of surface water in the mining area. There are no creeklines or other drainage features, nor are there any claypans or gilgais. A small gypsiferous depression is located in the western portion, but it is doubtful that this holds water. The small rocky rises do not contain any gnammas. The outcropping stone and scree is heavily weathered and not suitable for making stone tools, with the possible exception of quartz pebbles and rocks eroding from Permian conglomerates. Because of the absence of stone from almost all of the designated land, any artefacts were highly conspicuous.

4.1.3 Survey Methodology

The design of the surveys and sampling strategies took into account the specific conditions and the uniformly low likelihood for archaeological sites within the mining area, which was recognised during inspections (Mattner 2006) and confirmed during initial surveys.

Conditions for the surveys were very good and conducive to site discovery and access was easily achieved to all areas surveyed. Ground surface visibility was moderate to high throughout, on account of the sparse and low vegetation and frequency of past grass fires where spinifex was the dominant groundcover. The sparse shrub and very sparse tree cover meant that any geological or topographic features were easily seen. There is a low diversity in landforms and the scarcity of landscape features meant that all possible areas which might have attracted Aboriginal activity were identified and searched. The almost complete absence of natural stone meant that any stone artefacts were highly conspicuous, even at 10m to 20m. Consequently, in the course of walking each east-west transect a wide corridor was scrutinised.

Archaeological site surveys in the first half of 2007 concentrated on land within and close to the main Tropicana-Havana resource area; that is, the central portion and immediate surrounds of the mining area. These surveys involved systematic searches achieved by walking paired transects spaced 100m apart and aligned east-west. With meandering transects and some overlap in walking to and from features and vehicles, it is estimated the surveys provided a direct sample of more than 20% of the land across the full extent of the Operational Area. Any features likely to be associated with archaeological sites were readily observed because of the open vegetation and homogenous landscape. These features were searched (in addition to the transects) and therefore it is considered there was complete coverage of the designated areas.

With the first few surveys finding no archaeological sites and very little archaeological material on the largely featureless sand plains and sand dunes, subsequent surveys in the mining area were conducted by walking paired transects spaced 200m apart and aligned east-west, with additional searches at all and any features of interest or where it was considered that there was some potential for sites. These wider spaced transects still achieved comprehensive and systematic coverage of the land on account of the open vegetation and homogenous landscape. It is estimated these later surveys provided a direct sample of approximately 10% of the land and comprehensive and thorough coverage of the designated areas.

4.1.4 Results

Very little archaeological evidence has been found in the 60km^2 of the mining area. This result is to be expected given the landforms and the patterning of sites. The surveys established that none of the key features usually associated with sites, such as watercourses, claypans, gnammas, rock outcrops or rockshelters, are present in the designated tenements. Rather, the land is mostly extensive homogenous sand plains with some areas of sand dunes.

After comprehensive and intensive surveys, 1 archaeological site and a few isolated artefacts were discovered in the mining area. The site is small artefact scatter ("Blue Robin Scatter 02") situated close to the southern boundary, within tenement M39/983 (see Figure 3). It is located on a gently sloping portion of an extensive sand plain in thick and recently burnt shrubland.

Table 3: Archaeological site in the mining area

Site name	Site type	Size (no. artefacts)	Extent (EW x NS)	Coordinates (GDA94)	Landform & Tenement
Blue Robin Scatter 02	artefact scatter	100 – 200	35 x 20	647230mE 6758210mN	sand plain M39/M983

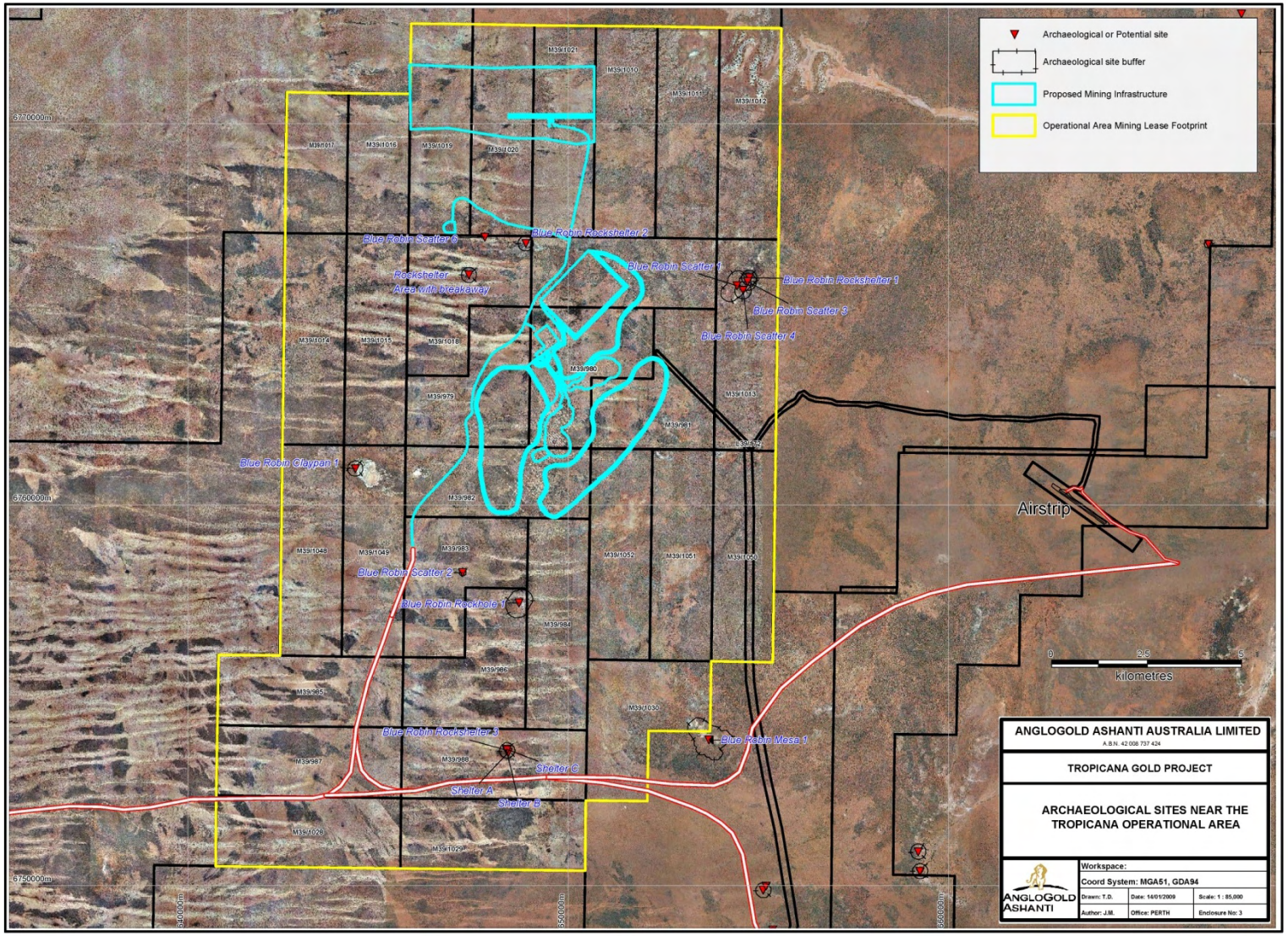

Figure 3: Archaeological sites in the Operational Area

Site “Blue Robin Scatter 02” is a diffuse scatter comprising approximately 150 artefacts. These are almost all mundane pieces, such as unmodified flakes and flaked pieces. There are several cores, most of which have a small number of flake scars and more than one platform. Formal tools and utilised/retouched pieces are uncommon, but 2 eloueras (backed blades) were noted. The great majority of artefacts were made of poor to medium quality quartz, which very likely was obtained locally from pebbles and rocks eroding from the Permian conglomerates.

The assemblage suggests that this was a transient campsite occupied on a few occasions. There are no features nearby to explain its position, but it is approximately mid-way between a gypsiferous depression and a gnamma, and might have been occupied by people who walked the several kilometres to reach either. The site is assessed to be of low significance, as it has very little research potential and similar assemblages are found at other sites in the district.

The site “Blue Robin Scatter 02” is not near any planned mining, infrastructure or development areas and therefore may be easily protected from disturbance in the short term. In the medium to longer term, management of the site will involve either protection by means of signage and/or fencing or else obtaining consent to disturb or destroy the site. This management issue is discussed in the final section below.

There are no management issues or requirements associated with the isolated artefacts. The few examples were widely separated and in almost all cases they were single artefacts. These few included unmodified flakes, large cores and a single chopper. They were made of a range of material, including quartz and silcrete, while the chopper was of a mafic volcanic stone. It should be noted, however, that the loose sands within the surveyed areas may have hidden or covered over some isolated artefacts.

4.2 Surrounding Project Area

4.2.1 Location

Surrounding the mining area, which covers approximately 60km^2, is the remainder of the TGP Operational Area (Figure 2). This extends approximately 22km NS by 12.7km EW, covering an estimated 230km^2 (excluding the central mining area). Subsidiary infrastructure will be situated within the tenements surrounding the central mining area. This includes the new airstrip and accommodation village, as well as roads, powerlines and pipelines as required.

Several prospective exploration areas are also contained in this area, including the 'Hat Trick', 'Salty Dog', 'Northern Extensions', 'Crouching Tiger', 'Zombie', 'Stromboli', 'Rusty Nail' and 'Screaming Lizard' Prospects.

The area contains 26 tenements. Of these, 23 are completely within the area and there are portions of 3 tenements (*) that also cross into the mining area. These 26 tenements are:

- M39/983*
- M39/984*
- M39/985
- M39/986
- M39/987
- M39/988
- M39/1010
- M39/1011
- M39/1012
- M39/1013
- M39/1014
- M39/1015
- M39/1016
- M39/1017
- M39/1018
- M39/1019
- M39/1020
- M39/1021
- M39/1028
- M39/1029
- M39/1030
- M39/1048
- M39/1049
- M39/1050
- M39/1051
- M39/1052*

All of these tenements have been systematically surveyed for archaeological sites. Prior to the surveys, some parts of this land had been inspected (Mattner 2006).

4.2.2 Environment

The landscape within these 26 tenements can be characterised as either wide sand plains with low discontinuous sand dunes or prominent sand dunes with broad swales. The sand dune system is found in the south and northwest, while the sand plains occur in the central, north, east and southeast parts. In the far northeast corner, the sand plains merge into saline flats that border saltpans and pale kopi (gypsiferous) dunes (in tenement M39/1013). The saltpans mark a palaeodrainage line.

Spinifex dominates both the sand plains and the sand dunes; typically with scattered Marble Gums and Mulga and sparse shrubs. There are Mulga and Eucalypt (mallee) thickets in places, particularly between the prominent sand dunes. A diverse range of shrubs and sparse trees grows on the slopes and crests of the dunes. A few patches of calcareous soils support Casuarina trees and broombush. Near the saltpans, low chenopod shrubland is dominant on the saline flats, lower slopes of the kopi dunes and on the fringes of the saltpans.

Small localised breakaways occur to the south of the mining area and a large long ridge is present in the east (on tenement M39/1013). A very large gypsum depression is present in the west (on tenement M39/1049). This may briefly hold water, but more importantly, it is an open grassy areas that attract numerous herbivores.

Very few water sources exist in the tenements. There are no permanent creeklines or other drainage lines, nor are there any claypans or gilgais where water may reliably pond (with the exception of the gypsum depression). Any water that collects in the saltpans and on the saline flats would be unpotable. Small gnammas were noted at several locations on the breakaways south of the mining area, and there is also potential for ephemeral rocky pools on the large ridge near the eastern boundary. Not surprisingly, archaeological sites were found beside these water sources, even though they are ephemeral and unreliable sources.

4.2.3 Survey Methodology

Archaeological site surveys have concentrated on systematically searching the tenements that constitute the project area. The surveys have been achieved by walking transects aligned east-west and spaced either 100m or 200m apart. The closer spaced transects were initially used, but only a small portion of the tenements were sampled at this rate. In areas of homogenous sand plains or sand dunes, which is almost all of the land in the tenements, a sampling design of transects 200m apart has been used for the surveys.

In addition, purposive searches were made of any features that warranted closer scrutiny. Such searches were conducted at the uncommon patches of breakaway or rock outcrop or scree patches, at tree thickets and around the gypsiferous depression. Because of the homogeneity of the landscape, there were few features to scrutinise. At the prominent ridge in the northeast, the survey was achieved by walking transects 50m apart parallel with its long axis. These transects covered land at the edge of the ridge, on its slopes and along its crest.

The survey strategy provided for comprehensive coverage of the designated tenements. As discussed above (in section 4.1.3), conditions for site discovery were very favourable, with open vegetation, good ground surface visibility, high conspicuousness of stone and a scarcity of features. It is considered the surveys provided a direct sample of more than 10% of the land, 100% coverage of the total area and thorough scrutiny of all areas with potential for sites.

4.2.4 Results

A total of 10 archaeological sites have been discovered and recorded in the 26 tenements surrounding the proposed mining area (Table 4 and Figure 3). Four of these sites are clustered on a prominent ridge in the east of the surveyed area, with 3 other sites on high ground in the northwest portion. The other 3 sites are widely separated. The 10 sites include a range of types and some sites have multiple components. Artefact scatters are the most common site type.

All 10 sites are associated with geological or topographic features, such as breakaways, mesas, a large depression, a ridge or rocky outcrops. In other words, the distribution of sites was predictable and fitted with theoretical models of site patterning. No sites were discovered on the sand plains or the sand dunes which are the dominant landforms. The largest of the sites ("Blue Robin Mesa 01") falls on the southeast boundary of the Project Area.

As was the case in the mining area, the site density is very low. The designated area is estimated to be 230km^2, and only 10 sites were found during the comprehensive surveys, giving a density of 1 site per 23km^2. Similarly, the density of isolated artefacts was exceedingly low (except near sites) and the few examples were widely separated. It was noted, however, that the loose sands within the surveyed areas may have hidden or covered over some isolated artefacts.

One major site ("Blue Robin Mesa 01") contains 3 rockshelters, 2 gnammas, 4 grinding grooves, a very extensive artefact scatter estimated to contain more than 50 000 artefacts and a deposit of white ochreous clay that may have been quarried. This was a base camp occupied on many occasions and sometimes for extended periods. It was an order of magnitude larger than any of the other campsites found in the 31 tenements.

Site "Blue Robin Mesa 01" demonstrates that the Tropicana district was used for more than transient hunting and gathering. While that likely was the main pattern of usage, on occasion many people travelled to this site and based themselves there, foraging and hunting in the vicinity. The 2 gnammas at this site are small and would not support many people in dry times, so this site was not used as a refuge in times of drought, as were some base camps. Instead, it was occupied following good rains that allowed people to travel across the desert to this location, to gather together for social purposes and to stay for a time living off the surrounding land.

The relationship between this base camp and other sites in the surrounding area and the district is not yet understood. Further study of the sites' assemblages would be needed to discern the activities conducted at the sites and the patterns in the movement of stone for tools. Only then may it be possible to determine which were satellite sites to the base camp and with sites were unrelated and indicate a different, more transient pattern of occupation.

Although much smaller than the base camp, 2 artefact scatter sites are of moderate size; each containing in the order of 5000 artefacts ("Blue Robin Scatter 01" and "Blue Robin Rockhole 01"). These are sites that were repeatedly occupied, but likely only for short periods. They are beside small ephemeral water sources; rocky pools in a erosion gully and a gnamma, respectively. Both artefact scatters are sparse and extensive, with few formal tools or utilised/retouched artefacts.

Four of the artefact scatter sites are small or very small. The 3 smallest of these sites have less than 50 artefacts and possibly are the remains of one occupation by a small group. The other site contains several hundred artefacts and was likely occupied briefly over a few visits.

Three of the sites, excluding site "Blue Robin Mesa 01", comprise rockshelters with associated artefact scatters. Two of them have very small assemblages and likely result from a few visits. One site ("Blue Robin Shelter 03") contains 3 rockshelters and a moderately sized artefact scatter. This suggests the site was repeatedly visited. This might be explained by its reasonable

proximity to the base camp "Blue Robin Mesa 01", which is 5km to the east. It might also be explained by the potential for very small pools of water to collect on top of the breakaway after rains.

From preliminary observations, it seems that all of the rockshelters at all of the sites have reasonably shallow deposits, with only a low likelihood for stratified deposits. This includes the rockshelters at "Blue Robin Mesa 01". Nonetheless, test-pitting should be considered as a means of checking that observation and searching for deposits that might provide a chronology for the occupation of the district.

Table 4: Archaeological sites in the tenements surrounding the mining area

Site name	Site type	Size (no. artefacts)	Extent (EW x NS)	Coordinates (GDA94 z51)	Landform & Tenement
Blue Robin Mesa 01	multiple components	50 000 – 100 000	900m x 600m	653789mE 6753849mN	mesa crest and flanks M39/M1030
Blue Robin Rockhole 01	artefact scatter & gnamma	~5000	220m x 320m	648770mE 6757380mN	swale between dunes & rocky platform M39/986
Blue Robin Claypan 01	artefact scatter	<50	4m x 16m	644405mE 6760945mN	gypsum depression edge M39/1049
Blue Robin Scatter 01	artefact scatter	~5000	210m x 490m	654430mE 6765710mN	ironstone ridge crest M39/1013
Blue Robin Scatter 03	artefact scatter	<100	50m x 30m	654715mE 6765840mN	ironstone ridge crest M39/1013
Blue Robin Scatter 04	artefact scatter	<50	40m x 30m	654595mE 6765610mN	ironstone ridge crest M39/1013
Blue Robin Scatter 06	artefact scatter	<300	75 x 75	647800mE 6767035mN	above gully in breakaway M39/1015
Blue Robin Shelter 01	artefact scatter & rockshelter	100	36m x 40m	654760mE 6765950mN	ironstone ridge crest M39/1013
Blue Robin Shelter 02	rockshelter & artefact scatter	<50	22m x 25m	648885mE 6766850mN	breakaway at mesa edge M39/1018
Blue Robin Shelter 03	3 rockshelters & artefact scatter	~1000	70m x 140m	648415mE 6753484mN to 648374mE 6753581mN	low breakaway amid sand dunes M39/988

The significance of the 10 sites varies widely. The base camp "Blue Robin Mesa 01" is considered to be of high significance because it is an example of a base camp. Furthermore, it has multiple components which include rockshelters with possible deposits. The very large assemblage has potential for further study that will shed light on settlement patterns in the Tropicana district and the Great Victoria Desert.

An assessment of the significance of the small rockshelter sites "Blue Robin Shelter 01", "Blue Robin Shelter 02" and "Blue Robin Shelter 03" may only be made once it is known what their deposits contain. Although unlikely to be deep or stratified, there may be organic materials in the deposits that can be dated and provide a chronology for settlement. On this account, these sites are conditionally considered to be of moderate significance.

The remainder of sites are open surface artefact scatters that have limited significance because their assemblages have restricted research potential and the sites are likely to be common types. The 2 larger sites "Blue Robin Rockhole 01" and "Blue Robin Scatter 01" have moderately sized assemblages that may provide insights into the movement of people and stone tools in

the district, but will be unable to address other major research questions. Other similar sites may be expected to exist in the region, however these 2 sites are amongst the only known examples at present. For these reasons, they are assessed to be of moderate significance.

The small or very small artefact scatter sites “Blue Robin Claypan 01”, “Blue Robin Scatter 03”, “Blue Robin Scatter 04” and “Blue Robin Scatter 06” are considered to be of very low significance. Their mundane assemblages have little information to provide and other such transient campsites are likely to be common in the wider area.

Management of these 10 archaeological sites starts with their protection from inadvertent disturbance. This may be simple, because all of them are some distance from any proposed mining activities and their location is known. Under these circumstances, there seems no need for active management or protection (e.g. fences) of the sites. Nonetheless, it is important that site “Blue Robin Mesa 01” is not disturbed because any research of the chronology and settlement of this district will likely start with study of this site.

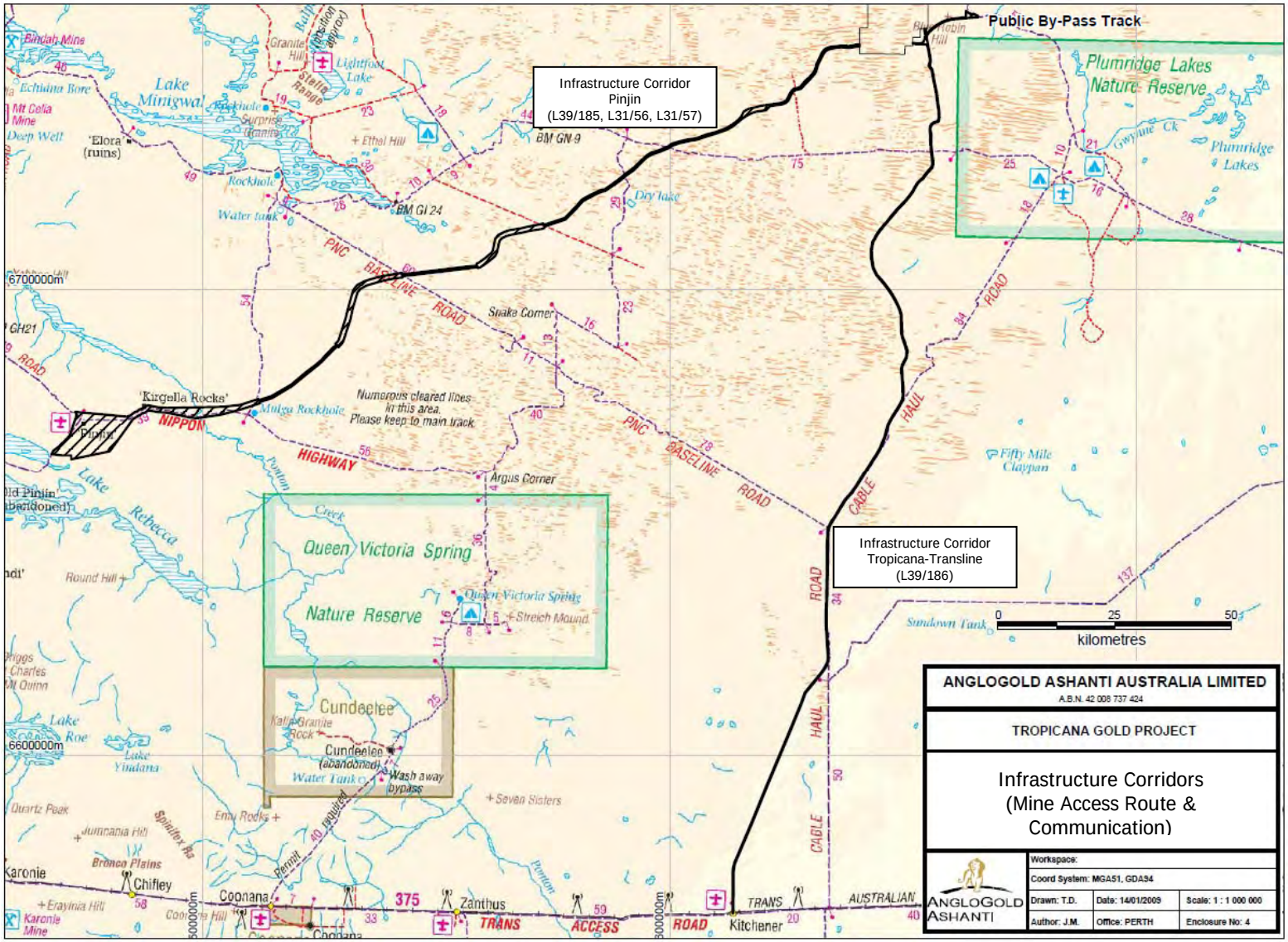

Figure 4: Infrastructure Corridors and Public Bypass Road

5.0 ROADS & INFRASTRUCTURE AREAS

To provide reliable road access from Kalgoorlie to the TGP Operational Area, the Tropicana JV must establish a new gravel access road. Two options are being evaluated. One option is via Pinjin Station and the other via the Transcontinental Railway Road and an old sandalwood pullers' track locally known as the Cable Haul Road (Figure 4).

5.1 Infrastructure Corridor - Pinjin Option

5.1.1 Location

This infrastructure corridor commences at the Kurnalpi-Pinjin Road on Pinjin Station and extends east-northeast for approximately 225km to the Operational Area. It lies within tenements L39/185, L31/56 and L31/57 (Figure 4). It crosses over Ponton Creek, which is a palaeodrainage line extending southeast of Lake Rebecca, and passes southeast of Lake Minigwal. It cuts across several old exploration tracks, including on old track known as the PNC Baseline.

A corridor 200m wide and approximately 210km long was designated for survey; i.e. the route from the Kurnalpi-Pinjin Road on Pinjin Station to the southwest edge of the Operational Area. The portion of the road within the Operational Area is not discussed here as it was covered in the preceding section (4.2).

To avoid heavy traffic near the homestead on Pinjin Station, several alignments were considered as alternatives to link the access road with the Kurnalpi-Pinjin Road. Five possible alignments were surveyed. A small deviation in addition to the 5 options was surveyed after it became apparent that a number of archaeological sites discovered near the Kurnalpi-Pinjin Road caused a 'bottle-neck'. As was the case with the main road option, a 200m wide corridor was searched for each of the alternative alignments.

Subsequently, an inspection was conducted of a sixth possible road alignment around Pinjin Homestead. In this case, a corridor approximately 20km long and between 0.6km and 1.2km wide that extends east-northeast from the Kurnalpi-Pinjin Road was inspected.

5.1.2 Environment

Almost all of the road route from the Operational Area to a point west of Ponton Creek crosses sand plains and through sand dune fields. The road corridor has been selected to avoid cutting through any sand dunes. This landscape is dominated by spinifex grassland with sparse low shrubs and scattered Mulga or Eucalyptus trees. The same vegetation types are found in the Operational Area . Parts of the route have been burnt in recent years and some areas had little vegetation cover.

There is no stone outcropping on the sand plains or in the sand dunes fields and almost no stone in the great majority of the survey corridor. The rare exceptions are a few small patches of heavily lateritised scree or 'float'. Apart from Ponton Creek, which is very saline, there are no drainage lines or water courses in this portion of the road option corridor.

The remaining section west of Ponton Creek passes through the abandoned Kirgella Station and through Pinjin Station. The Pinjin Road Option route lies on or close to a public gravel road for part of this section. Several of the alternative road alignments that bypass Pinjin Homestead in part also lie on or close to gravel roads, but several run cross-country.

In this southwest portion of the route, where it crosses through Pinjin Station and the abandoned Kirgella Station, the landforms and vegetation are far more diverse. This is the

transition from the sand plains and sand dune fields of the Great Victoria Desert to the landforms typical of the greenstone belts of the Eastern Goldfields, such as rocky hills, breakaways, drainage lines and gibber plains, with heavily lateritised mafic and felsic volcanic/igneous rocks and abundant quartz gibber. The vegetation is predominantly open low Mulga woodland with an understorey of mixed shrubs (often Acacia and Eremophila spp). Numerous small drainage lines run out from the hills and across the plains, however, they soon dissipate on the plains or end at small claypans.

Although the landforms on Pinjin Station and the abandoned Kirgella Station are more diverse with more relief than the sand plains and sand dune fields, there are still large areas of flat land with a cover of sand and little or no outcrop or gibber. This is particularly the case for much of the land southeast and south of Pinjin Homestead. This is an area of flat alluvial plains to the northeast of Lake Rebecca. Numerous small claypans, saltpans and deflations are dotted across these sandy plains. Some of the alternative road alignments around Pinjin Homestead pass across these plains.

Particularly noteworthy is a claypan beside the Kurnalpi-Pinjin Road which is reportedly a long-lasting source of fresh water. This claypan is known as Four Mile Dam, after a station dam that was bulldozed into the southern side of it. The claypan is at least a semi-permanent water source and it attracts numerous birds and other wildlife.

5.1.3 Survey Methodology

Two different methods were employed to survey the corridor. This reflects the dichotomy between the southwest portion, where there is a diversity of landforms as well as water sources and stone outcrops, and the remainder of the route which crosses largely featureless and waterless sand plains and sand dune fields. Despite the differences in sampling methods, the sampling rate was constant. Throughout its length, one third of the route (33%) was surveyed.

At the commencement of the survey, the entire route was reviewed using satellite images at a scale of 1:20 000, overlain with the survey corridor. These revealed almost no topographic, geological or water features or places on or within 2km of the corridor, except in the southwest corner on Pinjin Station and the abandoned Kirgella Station.

In the southwest portion, regular searches were made on foot at intervals along the route and along 3 of the options for bypassing Pinjin Homestead (alignments 1–3). Paired pedestrian transects targeted landforms and landscape features where sites were considered likely to exist; such as breakaways, hill crests, lower slopes of hills, drainage lines and land in the vicinity of claypans. Portions of the adjacent plains were also surveyed to ensure scrutiny of these landforms and to achieve coverage of one-third of the proposed road.

For the majority of the route the survey was achieved using an off-road motorcycle to search a pair of transects; one on either side of the centreline. The length of each transect was dictated in part by accessibility, and by safety considerations, but typically was between 15km and 20km long. The placement of transects was primarily decided by an assessment of the landforms, and secondarily by accessibility from existing tracks. One third of this part of the survey corridor was searched by this means. Given the open vegetation, the good ground surface visibility, lack of landscape features and virtual absence of any stone, it is considered the motorcycle transects provided satisfactory coverage.

In all parts of the corridor, purposive searches on foot were made of any features within or close to the survey corridor that warranted further or closer scrutiny. Such searches were conducted at outcrops (including at Kirgella Rocks) and watercourses, at Ponton Creek and any claypans or saltpans.

5.1.4 Results

A search of the Register of Aboriginal Sites, using the AHIS at the DIA, determined that no registered archaeological sites were known within 10km of the route or of the alternative alignments.

No sites were discovered within the road corridor between the Tropicana Gold Project Area and Kirgella Rocks, west of Ponton Creek. Based on the findings of the sample survey, together with the absence of water sources, stone outcrops or other features in this portion of the road corridor, it is considered that no sites are likely to exist.

In contrast, 12 sites were discovered and recorded at a preliminary level on Pinjin Station, or close to its eastern boundary on the abandoned Kirgella Station (Table 5 & Figure 4). One of these is not within the survey corridor, but lies to the south of it on the existing public road (site "Kirgella Rocks Scatter 01"). The other 11 sites are all within (wholly or partly) the 200m wide corridor designated for survey or the inspection corridor.

Table 5: Archaeological sites in and near the Pinjin Infrastructure Corridor

Site name	Site type	Size (no. artefacts)	Extent (EW x NS)	Coordinates (GDA94)	Landform
Kirgella Gnamma Quarry 01	artefact scatter, quarry (qtz), gnamma	estimated 200 000	500m x 800m	482800mE 6671550mN	lateritic outcrop above low breakaway
Kirgella Gnamma Quarry 02	artefact scatter, quarry (qtz), gnamma	<2000	110m x 180m	483180mE 6672230mN	lateritic outcrop on slope
Pinjin Claypan Scatter 01	artefact scatter	~400 + some buried	170m x 100m	469800mE 6667085mN	sand dune near claypan
Pinjin Claypan Scatter 02	artefact scatter	~500 on surface + 1000s buried	435m x 150m	469830mE 6666890mN	sand dune near claypan
Pinjin Claypan Scatter 03	artefact scatter	500 + some buried	150m x 100m	469475mE 6666815mN	sand dune near claypan
Pinjin Claypan Scatter 04	artefact scatter	250 on surface + 100s buried	50m x 100m	468220mE 6665520mN	sand dune near claypan
Pinjin Claypan Scatter 05	artefact scatter	~25	10m x 15m	470220mE 6667220mN	sand dune near claypan
Pinjin Claypan Scatter 06	artefact scatter	~50	40m x 65m	468420mE 6665325mN	sand dune near claypan
Pinjin Claypan Scatter 07	artefact scatter	<50	15m x 35m	468315mE 6665405mN	sand dune near claypan
Pinjin Claypan Scatter 08	artefact scatter	<200 + some buried	50m x 80m	468215mE 6665375mN	sand dune near claypan
Pinjin Claypan Scatter 09	artefact scatter	~30	50m x 60m	468245mE 6665725mN	sand dune near claypan
outside survey corridor					
Kirgella Rocks Scatter 01	artefact scatter, gnamma	<2000	650m x 500m	493950mE 6673700mN	flat rock outcrops

The discovery of numerous sites within the southwest portion of the Pinjin Infrastructure Corridor is partly associated with the transition from the extensive sand plains and sand dune fields of the Great Victoria Desert to the more diverse landforms of the Eastern Goldfields.

An even more important factor is that the western end of the route lies on an aeolian-alluvial plain dotted with claypans and deflations close to Lake Rebecca. Many of these are small and ephemeral water sources after rains, and one of the claypans (Four Mile Dam) is a semi-permanent water source. Three of the 12 recorded sites are situated directly beside that claypan, while 6 other sites are nearby and close to more ephemeral claypans.

Another factor in the number of sites found in this small part of the Pinjin Infrastructure corridor was the numerous alternative alignments; this increased the percentage of this landscape which was surveyed or inspected.

All of the 11 sites within the surveyed or inspected corridors, and the nearby site, are artefact scatters representing campsites. All of these sites are positioned close to water sources; 9 beside or close to claypans and 2 surrounding gnammas. The remaining site surrounds a low granitic dome with small surface depressions that pool rain water and a 'soak' where it is possible to dig to find water or wet sands.

One of the sites is a base camp ("Kirgella Gnamma Quarry 01") and is considered to be of high archaeological significance. It has an estimated 200 000 artefacts spread over a wide area around several small to medium sized gnammas. A small patch of quartz scree occurs at one point within the site and this has been quarried to obtain stone for flaked stone tools. Many of the artefacts were made of local rocks, including this or similar quartz, but there are also many made of stone foreign to this area, indicating that people travelled to this site. While it is not possible to characterise such a large and extensive assemblage on the basis of preliminary recording, it may be noted that very few grindstones and no grinding patches were observed. Nor were any glass, ceramic or historic artefacts noted, despite the proximity of this major site to both Pinjin and Kirgella Homesteads (the boundary fence runs through the site).

It is possible that the presence of this base camp within a few kilometres is the reason for the relatively small assemblage at the other site with a gnamma ("Kirgella Gnamma Quarry 02"). This site contains up to 2000 mostly mundane artefacts and debitage. A large proportion of the assemblage resulted from quarrying and knapping of the cobbles and rocks of coarse-grained silcrete that form a scree over part of the site. This rock is of mediocre quality. There is little evidence of extended visits to the site, which is assessed to be of low to moderate significance.

None of the artefact scatters beside or near claypans in the vicinity of the Kurnalpi-Pinjin Road is large and most are very small. The largest of these are the 3 sites beside the prominent claypan that is a reliable water source (Four Mile Dam). These sites have only a few hundred artefacts visible on their sandy surfaces. One of these sites ("Pinjin Claypan Scatter 02") is on a low broad sand dune and it is likely that several thousand artefacts are buried in the dune. Some of the other sites also are likely to contain buried artefacts.

Even with such a sub-surface component, these sites are only of medium size and do not resemble base camps, despite being at reliable water. Nonetheless, research of these assemblages may indicate their role and relationship to the nearby sites and the base camp "Kirgella Gnamma Quarry 01", which is a day's walk to the east (approximately 15km). On this account, site "Pinjin Claypan Scatter 02" is assessed to be of moderate archaeological significance, while sites "Pinjin Claypan Scatter 01", "Pinjin Claypan Scatter 03", "Pinjin Claypan Scatter 04" and "Pinjin Claypan Scatter 08" are considered to have low to moderate significance.

Most of the other claypan sites have a few score artefacts, or less, on their surfaces. The assemblages are predominantly comprised of mundane and mostly small pieces of limited lithic diversity. The artefacts are exposed on eroding and deflating sands, which suggests both that there is potential for buried artefacts but this potential is low because so few pieces have been unearthed by ongoing erosion. Therefore, sites "Pinjin Claypan Scatter 06" and "Pinjin Claypan

Scatter 07" have low archaeological significance, while the even smaller sites "Pinjin Claypan Scatter 05" and "Pinjin Claypan Scatter 09" have very low significance.

The numerous sites found close to the Kurnalpi-Pinjin Road are evidence of brief transient visits soon after rain to take advantage of the ephemeral pools in the small claypans. Such a patterning of sites might be related to groups visiting the margins and shores of Lake Rebecca when it occasionally filled to exploit the birdlife and game that flourish then.

A similar patterning of sites was demonstrated on the eastern margins of Lake Carey, a few hundred kilometres to the north (Mattner 2000). It was suggested in that study that the primary food resources of the salt lakes and associated claypans were water birds and bird eggs, which can be superabundant after floods. These are foods that do not require implements to harvest and do not require much processing, so there is little need for stone tools. Hence the signature for this activity is numerous very small site assemblages of mostly small artefacts casually made of local stone (Mattner 2000).

A few isolated artefacts were found along the alternative route crossing over Pinjin Station and in the general vicinity of the newly discovered sites. These were either single artefacts or small clusters, and typically were undistinguished unmodified flakes made of local stone. No isolated artefacts were observed on the sand plains or in the sand dune fields that formed the great majority of the survey corridor. While loose sands may have covered single artefacts, and stone artefacts very likely husbanded and not discarded far from sources of replacement stone, it is considered that the absence of any observed archaeological material is direct evidence of a real paucity of Aboriginal activity in these landforms.

Management of the 12 sites discovered in the course of the survey (Table 5) will require some adjustment of plans and road routes, and possibly some protective measures. Seven of the sites are situated close to or directly beside existing public roads; namely the Kurnalpi-Pinjin Road or the road running east through and beyond Pinjin Station (also known as the 'Nippon Highway').

Any work to widen the existing roads is likely to damage these sites, so there are management and site protection issues to consider. By choosing a route that avoids the public roads, the JV will avoid any damage to those sites. The other sites are sufficiently far from public roads that they are not at risk of disturbance, provided that the new road avoids them.

5.2 Infrastructure Corridor - Tropicana / Transline Option Survey

5.2.1 Location

This corridor option was considered for an alternative access route and a communication corridor from Transcontinental Railway and the existing public road that runs beside the railway line to the TGP Operational Area. The corridor would follow an existing public access track known local as the Cable Haul Road. The survey area covered tenement L39/186, which extends from Kitchener Siding northwards for approximately for 160km (Figure 4).

The designated survey area was a 200m wide corridor, and for almost two-thirds of the distance the proposed corridor follows the existing Cable Haul Road track, with some deviations to straighten it. The northern third of the new road option will veer to the west of the existing track and continue northward across country to reach the southeast corner of the Operational Area.

5.2.2 Environment

The landscape within the corridor can be characterised as two distinct landforms, with sand dunes and swales in the northern third of the survey area and an extensive sand plains and claypan system in the southern two-thirds. The vegetation of the sand plains is similar to the open swales between the dunes, and is similar to that described for the Operational Area.

Spinifex is the dominant understorey plant, with some woody forbs and woollybutt grasses. Scattered throughout are widely spaced trees (mostly Mulga or Marble Gum), with some thickets of Mulga or Eucalypts (mallee). The dunes have a more diverse understorey of low shrubs and a thin and patchy overstorey of Eucalypts, Acacias, Casuarinas and Native Pine. Parts of the route have been burnt in recent years and some areas had little vegetation cover. In the more clay soils associated with the claypans, the vegetation is dominated by large Eucalypts (e.g. Salmon Gums), as well as supporting Gimlet and Casuarina trees and Acacia shrubs. Bluebush species dominate the understory, with less salt-tolerant grasses and forbs restricted to the sand plains.

The only hills on the road option are situated between 4km and 7km south of the Operational Area. These low rounded hills have a dense scree of coarse-grained silcrete and small patches of outcrop. Small patches of scree and subcrop also occur sparsely on the flanks and around the base of these hills. Some of this stone is very siliceous and was knapped to make tools and cores; that is, there are quarry sites in these hills. Small deviations of the proposed road route were surveyed to avoid these quarry sites. Approximately 20km to the south of the hills, there are also small patches of scree and subcrop of coarse-grained silcrete. This is less siliceous. No breakaways occur on or near the route.

No rocky material is present on the sand dunes and swales, or on the majority of the sand plains. In the southern section, where there are claypans on the sand plain, quartz and calcrete gibber occurs. This quartz gibber is small to very small and typically not suited for making or knapping stone tools. To the far south, near the railway line, there are subcrops of poor quality ‘silcrete’, which typically is unsuitable for knapping.

There are no creeklines or drainage lines crossing the route, and the only possible water sources are the small claypans in the southern section, and a small gnamma found in the northern section, close to the Plumridge West Road. These are all ephemeral water sources, and with the exception of the gnamma, were not associated with sites.

5.2.3 Survey Methodology

At the commencement of the survey, the entire route was reviewed using satellite images at a scale of 1:20 000, overlain with the survey corridor. These revealed almost no topographic or geological features and no water courses on or within 2km of the corridor.

The survey design was a systematic sample of a third of the designated corridor. It was conducted by walking paired pedestrian transects on either side of the existing road or the approximate road centreline to ensure coverage of the 200m wide corridor. Every third kilometre was searched in this manner. The remaining two-thirds of the corridor was inspected in the course of driving along the existing tracks or centreline.

Although the landscapes crossed by the route were largely devoid of features, any places where sites were considered likely to exist were purposively searched by paired pedestrian transects. These landscape features included hill crests, lower slopes of hills and land in the vicinity of claypans. As mentioned, additional searches were made for small deviations around the silcrete strewn hills near the northern end of the road option route.

5.2.4 Results

Only 1 site is within the final alignment of the Tropicana-Transline Infrastructure Corridor (Table 6). This single site ("Plumridge Road Quarry 02") is a very small quarry or knapping centre where a patch of coarse-grained silcrete was knapped; probably on one occasion. For these reasons, this site is assessed to be of very low significance. It is situated south of the Plumridge West Road, on a low rocky ridge amid an area of sand dunes and small exposures of silcrete. The site is near a very large campsite ("Plumridge Road Rockhole 01") and can be considered a satellite to that site (see below).

While only 1 site is within the final road corridor, this is because deviations were made in the final route selection which kept the route away from other sites discovered during the surveys (see below). A search of the Register of Aboriginal Sites found no registered sites within 10km of the survey corridor.

In addition to site "Plumridge Road Quarry 02", 1 large campsite with a gnamma and 9 quarries (or potential quarries) were discovered during surveys of the Tropicana-Transline Corridor (Table 6). Eight of them are within 7km of the Operational Area and the others are clustered 45km south of the Operational Area. No sites were discovered on or near the existing Cable Haul Road section; that is, in the southern or central sections. All of the sites and potential sites were discovered in the section running north from the existing tracks to the Operational Area.

Table 6: Archaeological sites in and near the Tropicana-Transline Infrastructure Corridor

Site name	Site type	Size (no. artefacts)	Extent (EW x NS)	Coordinates (GDA94)	Landform
within corridor (final alignment)					
Plumridge Road Quarry 02	quarry (knapping)	~20	5m x 5m	655180mE 6724985mN	crest of rocky ridge
outside corridor					
Plumridge Road Rockhole 01	artefact scatter, gnamma	50 000	*250m x 500m*	655490mE 6724810mN	rocky plain with central outcrop
Plumridge Road Quarry 01	quarry	>100	50m x 50m	656520mE 6725350mN	subcrop on plain
Blue Robin Quarry 02	potential quarry	-	-	655205mE 6749920	rocky ridge with outcrop and scree
Blue Robin Quarry 03	potential quarry	-	-	655150mE 6749865mN	rocky ridge with outcrop and scree
Blue Robin Quarry 04	potential quarry	-	-	655205mE 6749985mN	rocky ridge with outcrop and scree
Blue Robin Quarry 05	potential quarry	-	-	655375mE 6748850mN	rocky ridge with outcrop and scree
Blue Robin Quarry 06	potential quarry	-	-	655490mE 6748750mN	rocky ridge with outcrop and scree
Blue Robin Quarry 07	quarry	100 000	230m x 470m	6564000mE 6748550mN	rocky ridge/ breakaway with outcrop & scree
Blue Robin Quarry 08	quarry	500	60m x 36m	655820mE 6747945mN	slope below ridge with outcrop and scree
Blue Robin Quarry 09	quarry	<50	45m x 21m	656000mE 6748080mN	rocky ridge with outcrop and scree

Very few isolated artefacts were found during the surveys, and only in the vicinity of the claypans in the southern portion of the route or near the northern silcrete hills. The artefacts near claypans are very widely separated and mostly occur singly. It was noted, however, that sheetwash may have dispersed, hidden or covered over some isolated artefacts on sandy soils.

All the observed artefacts near the claypans were of foreign rock types, including quartz and various silcretes, while near the northern hills, almost all were local silcrete. Most were found amid scree patches, suggesting casual knapping or testing of the stone in the silcrete scree.

Although outside tenement L39/186, a brief description is presented here of the other sites discovered in the surveys of this corridor. All but 2 of the sites (and potential sites) are situated in the hills between 4km and 7km south of the Operational Area. All of these are quarries for coarse- to medium-grained silcrete. Some are little more than knapping centres, with between 20 and 50 pieces, and there are a few with hundreds of artefactual pieces that also are the remains of casual knapping and transient exploitation. These small quarries are collectively considered to be of low or very low archaeological significance.

In sharp contrast, site “Blue Robin Quarry 07” is estimated to contain at least 100 000 pieces of debris from intensive stone tool manufacture. The quarry surrounds a breakaway or minor cliff where high quality silcrete outcrops and occurs as a dense scree. As well as in situ knapping to make tools, it is very likely this quarry was used to manufacture cores for transport away from the site for later tool production. This quarry was a major source of stone in an area often devoid of stone resources. It is an order of magnitude larger than any other quarries found to-date in the district and has research potential, although limited by a lack of chronological control. It is assessed to be of moderate to high significance. Like “Blue Robin Mesa 01”, this site establishes that people sometimes occupied the Tropicana district for extended periods.

Because deviations were selected to avoid sites, only some of the quarries and potential quarries clustered in the hills a few kilometres south of the Operational Area have been recorded. The status of some as potential quarry sites also reflects the difficulty of distinguishing knapping debris from natural fragments and spalls; a problem exacerbated by fires that regularly burn through this landscape heat-shattering the outcrops and rocks in the scree patches.

Three sites were also recorded close together 45km or so south of the Operational Area and south of the Plumridge West Road. One of these is the site “Plumridge Road Quarry 02” mentioned above. A deviation of the final route ensured that the other 2 sites are outside and several hundred metres to the east of the corridor and therefore not at risk.

One of these is a gnamma and artefact scatter site ("Plumridge Road Rockhole 01"). This extensive low density site contains an estimated 50 000 pieces. Besides the mundane artefacts, the assemblage includes small grinding stones and wood-working implements, which confirm this site was visited on many occasions by people who stayed for extended periods. Like “Blue Robin Mesa 01”, the site may have served as a base camp. It has some research potential, albeit limited, and is considered to be of moderate to high significance. Nearby, there is a small quarry. This site exploited a small subcrop of coarse-grained silcrete of poor quality and is of low significance.

The final alignment of the corridor was selected to avoid almost all of the sites discovered during the surveys, so they are not at risk provided the road and any borrow pits are within the selected corridor. Only 1 site (“Plumridge Road Quarry 02”) is within the corridor and this very small knapping centre can be easily avoided by moving the road slightly from the centre of the corridor. It would be appropriate to erect a temporary fence around the site during clearing and construction of the road to avoid inadvertent disturbance.

Construction material for the corridor may need to be sourced from areas outside of the corridor. Any such areas should be checked for archaeological material beforehand, as a strong correlation between quarries and silcrete outcrops, subcrops and scree patches has been demonstrated.

5.3 Public Bypass Road

5.3.1 Location

This is a short road linking the proposed Mine Access Road with the Lake Rason Road (Figure 4). It is aligned roughly northeast-southwest and runs south and east of site "Blue Robin Mesa 01".

A corridor 200m wide and approximately 15km long was designated for the survey, together with angular areas at each end that were several square kilometres in extent. The northeast end of the bypass road option terminates at the Lake Rason Road beside the existing Tropicana airstrip. The southwest end terminates at the Tropicana-Transline Infrastructure Corridor, close to the southeast corner of the Operational Area. The route is within tenements L39/188 and L39/189.

5.3.2 Environment

The landform and vegetation are similar to that of the sand plains of the Tropicana tenements described above. There are no landscape features; no hills or breakaways, no outcrops, no drainage lines or claypans. Spinifex dominates these plains, with some low shrubs and sparsely scattered trees (mostly Mulga or Marble Gum). There is little rock on the plains and in large sections no rock at all.

5.3.3 Survey Methodology

The route was reviewed using satellite images at a scale of 1:20 000, overlain with the designated corridor, before commencing the survey. Almost no topographic or geological features and no water courses were identified on or within 2km of the corridor. Based on this and the findings of nearby surveys, a systematic sample of a third of the designated corridor was chosen for the survey. It was achieved by walking paired pedestrian transects on either side of the approximate road centreline to ensure coverage of the 200m wide corridor. Every third kilometre was searched in this manner. The remaining two-thirds of the road corridor was inspected in the course of driving along the centreline. Additional searches were made at a few locations considered to have some, albeit low, potential for sites.

5.3.4 Results

No sites and no isolated artefacts were found in the course of the survey. This route is close to the Operational Area and there are no registered sites within 20km of the survey corridor.

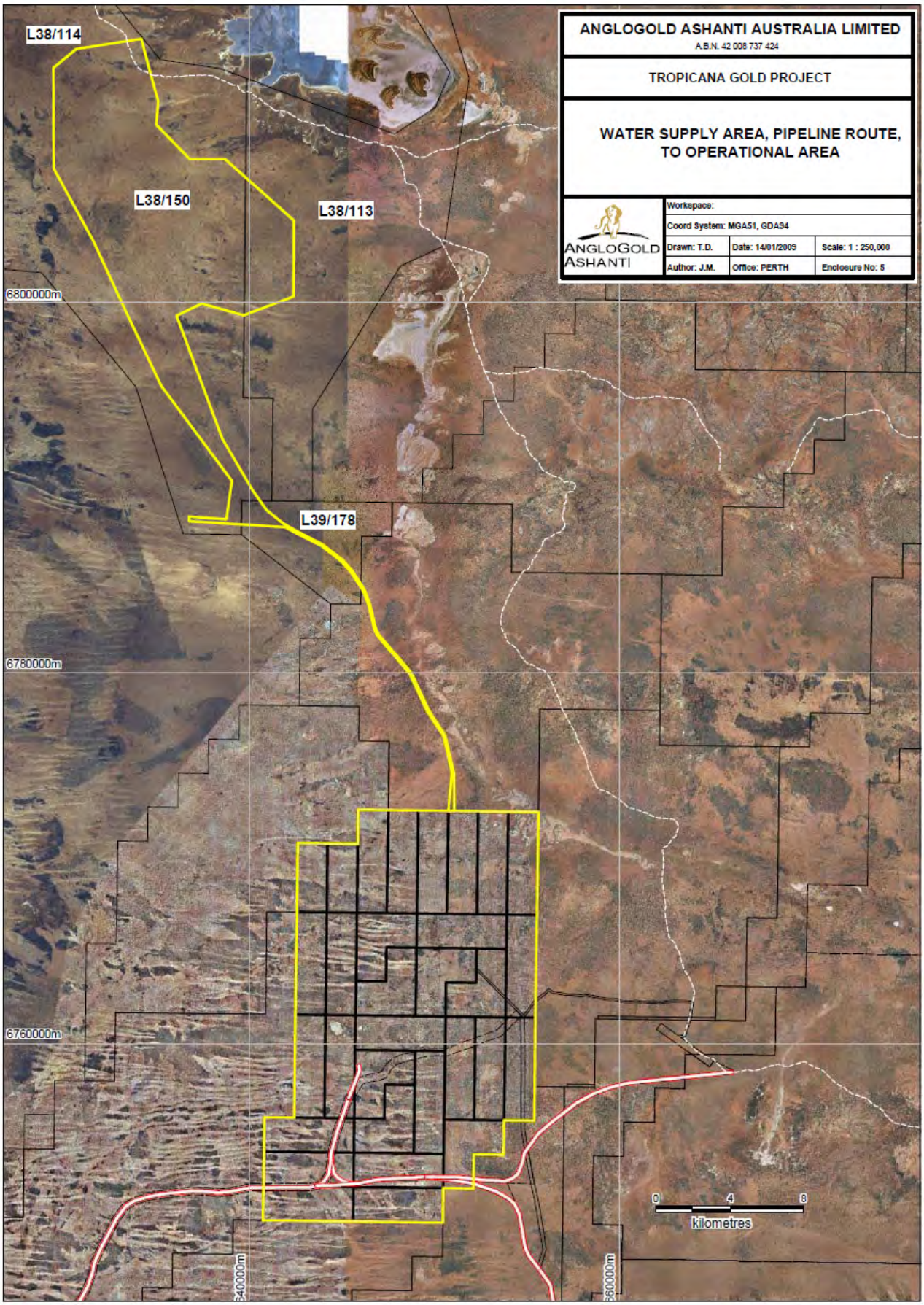

Figure 5: Minigwal Trough Water Supply Area & pipeline to Operational Area

5.4 Minigwal Trough Water Supply Area

5.4.1 Location

Water for the TGP is to be obtained from a new borefield (L38/150), which is situated south of Lake Rason and between 25km and 45km of Tropicana Exploration Camp (Figure 5). The Lake Rason Road cuts across the northeast corner of the borefield. (This existing road extends to Laverton in the west and the Plumridge Lakes Nature Reserve in the southeast.) The Minigwal Trough Water Supply Area has maximum dimensions of approximately 10km EW by 27km NS and a maximum extent of approximately 150km².

Eight proposed bores and associated access tracks were initially surveyed, then the remainder of the borefield area was surveyed at a lower rate of coverage. The 8 bores were TWB008, TWB015, TWB016, TWB017, TWB018, TWB023, TWN028 and TWB029. For all but 2 of these bores, the designated survey area was a square with sides 1km long. At bores TWB015 and TWB023 the surveyed area was larger than 1km². The access track to each exploration bore was included in the survey. These were 200m wide corridors and had a total combined length of approximately 22km.

5.4.2 Environment

The majority of proposed bores are situated on open and mostly flat sand plains. There are no landscape features in this landform, apart from a few low sand dunes and patches of calcrete. There are no hills, outcrops, drainage lines or claypans. In the far northeast corner, the sand plain abruptly end and falls away gently towards Lake Rason. This change occurs where some rocky rises are exposed. These are composed of coarse-grained silcrete and there is a moderately dense scree on and beside these rises. This silcrete is similar to other sources which have been quarried but may not be of the same quality, as no evidence of knapping was noted. This is the only source of stone within or near the Northern Borefield area.

On the sand plains and occasional low dunes, as well as on the silcrete rises, the groundcover is dense spinifex. Over this understory is a scattering of Eucalypts and Mulga trees, as well as occasional shrubs. In a few places there are thickets of mallee or Mulga, and also one extensive thicket of Native Pine.

5.4.3 Survey Methodology

The survey of the Water Supply Area followed 2 methodologies. The initial survey of the proposed water bores and their associated access tracks was achieved by systematic sampling using paired pedestrian transects. At the proposed bores, transects were aligned east-west and spaced 200m apart. They provided a direct sample of 20% of the survey areas, while also comprehensively covering all of the land between the transects because of the very open low vegetation and high conspicuousness of any features or stone material. The access tracks were sampled at a rate of 33% by walking transects on either side of the centreline every third kilometre. The 2km intervals between each systematic transect were inspected by driving along the route.

The remainder of the Minigwal Trough Borefield was searched by vehicle. A portion in the southeast was searched using a 4WD and the remainder was covered using an off-road motorcycle. These vehicular transects were arbitrarily positioned but were arranged in a manner that ensured all sections of the designated land were visited and any landscape features identified on satellite photos or in the course of the survey were visited and searched.

5.4.4 Results

No archaeological sites were found during the survey of the Water Supply Area. Only a very few isolated artefacts were found and all of these pieces were in a small area in the northeast corner, where there are silcrete outcrops on low rises and silcrete scree patches. These isolated artefacts are all of the local rock and indicate a very small amount of casual knapping by transient hunters. It may be noted that the silcrete is of mediocre quality and there are abundant sources of this stone, perhaps of better quality, in the wider area.

The absence of archaeological sites over this large area is easily explained by the complete absence of water sources or water catchments, breakaways, hills or other features typically associated with sites.

5.5 Water Pipeline - Minigwal Trough to Operational Area

5.5.1 Location

It is proposed to build a water pipeline and service road (L38/150) linking the Minigwal Trough Borefield with the mining area. The designated survey corridor was 200m wide and had a length of approximately 29km (Figure 5).

5.5.2 Environment

For almost all its length the water pipeline traverses a low sand dune system which merges with an extensive sand plain to the east. A weathered quartz ridge is situated near the corridor half way along its length. This is the only stone found in the corridor, apart from small patches of calcrete gibber, and the quartz is not suitable for knapping. There are no hills or breakaways on or near the pipeline route, nor are there any drainage lines or claypans. The vegetation cover is consistent with adjacent areas of the Water Supply Area and the Operational Area. It comprises a dense groundcover of spinifex under scattered Mulga and Eucalypt trees and sparse mixed low shrubs.

5.5.3 Survey Methodology

At the commencement of the survey, the entire route was reviewed using satellite images at a scale of 1:20 000, overlain with the survey corridor. These revealed almost no topographic, geological or water features or places on or within 2km of the corridor.

The survey method involved a systematic sample achieved by paired pedestrian transects walked on either side of the centreline of the 200m wide corridor. Every third kilometre was searched in this manner to provide a sample rate of 33%. The remainder of the corridor was inspected in the course of driving along the centreline between transect points.

5.5.4 Results

No archaeological sites and no archaeological material was found during the survey of the water pipeline corridor. There are no features within the corridor that would have attracted Aboriginal occupation or activity, so the absence of sites is to be expected. It is possible that loose sands in the surveyed area may have hidden or covered over some isolated artefacts.

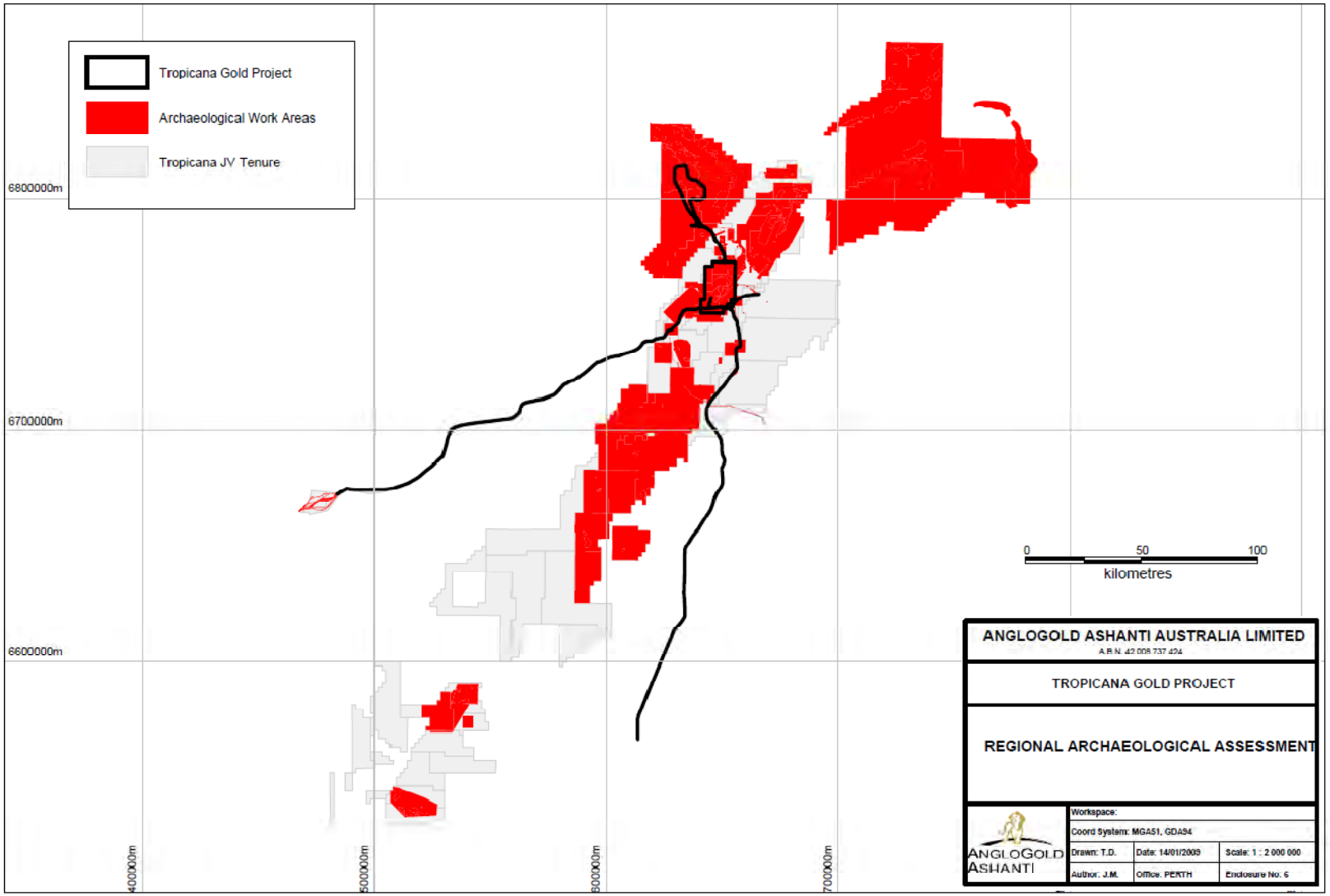

Figure 6: Regional archaeological assessments and studies for the Tropicana Project

6.0 CONCLUSION

6.1 Discussion

Numerous archaeological fieldtrips, either for site surveys or area inspections, have been undertaken in the region over a very large area extending some 200km south and 100km north of the proposed TGP Operational Area (Figure 6). This report summarises some of that work. In particular, this report details the work carried out within the 31 tenements of the Project Area within which mining is proposed and on associated infrastructure corridors such as roads.

This is the first archaeological study in the Tropicana district. It is, apparently, only the second to be reported in the western half of the Great Victoria Desert between the Eastern Goldfields and the border with South Australia. A survey by O'Connor (1983) of an area of sand dune fields is the only other relevant study. Other archaeological research on the edge of the Great Victoria Desert has focussed on excavation of rockshelters in hills and ranges, which are atypical of this desert (e.g. Gould 1968, Webb nd).

The findings from intensive and extensive archaeological surveys in the TGP, and associated areas, have established that there is a strongly patterned distribution of sites in this district which largely mirrors the distribution of temporary water sources (for artefact scatters) and outcrops of medium grained silcrete (for quarries). The size of the artefact scatters is in direct proportion to the apparent reliability of the water source, with the medium and large sites all found beside gnammas. The few rockshelters also are typically associated with an artefact scatter.

Importantly, these results are representative, as they come from the landforms and landscapes which are typical of the Great Victoria Desert; namely, extensive and largely homogenous sand plains and sand dune fields, with small areas of breakaways, hills and occasional depressions.

Only 1 site has been found within the 60km^2 of the mining area, with another 10 sites in the estimated 230km^2 of the remainder of the Operational Area. Another 12 sites were recorded in the proposed road corridors. Some historic material and camps associated with sandalwood pulling were also observed but are not described in this report. They are not archaeological sites and are discussed in the account of ethnographic work for the TGP (Mattner & Bergin 2009).

Table 7: Types of archaeological of sites in the study areas

Project / Study area	Artefact scatter	Quarry	Gnamma + Artefact scatter	Rockshelter + Artefact scatter	Multiple comp-onents	Sub-totals
Mining Area	1	-	-	-	-	1
Surrounding Project Area	5	-	2	3	-	10
Infrastructure Corridor – Pinjin	9	-	-	-	2	11
Infrastructure Corridor – Tropicana/Transline	-	1	-	-	-	1
Public Bypass Road	-	-	-	-	-	0
Water Supply Area (Northern Borefield)	-	-	-	-	-	0
Water Pipeline Corridor	-	-	-	-	-	0
sub-totals	15	1	2	3	2	23

The most common archaeological sites are artefact scatters and quarries, and these are typically small. There are notable exceptions, with large artefact scatters found in association with gnammas (rockholes) and a major quarry found at a particularly good source of stone. Rockshelter sites are also reasonably common, although all are small with only a few artefacts.

The occurrence of sites fitted the theoretical models, with all but one found at or near particular topographic or geological features (Tables 8 and 9).

Table 8: Types of sites and their distribution across landforms

Landform	Base camp Artefact scatter	Artefact scatter	Quarry	Gnamma + Artefact scatter	Rockshelter + Artefact scatter	Sub-totals
sand plain	-	1	-	-	-	1
sand dune fields	-	-	-	1	-	1
breakaways / mesa	2	1	-	-	2	5
rocky hills / domes	-	4	1	1	-	6
claypans	-	11	-	-	-	10
sub-totals	2	17	1	2	2	23

Artefact scatters represent campsites and activity centres where a range of day-to-day tasks were conducted. As predicted by the models, the large and moderately sized scatters are situated beside gnammas (rockholes) where water reliably collects after rains. These sites were clearly used on many occasions probably over centuries or millennia. Curiously, no archaeological sites have been found at the largest gnamma in the region; which is, however, an ethnographic site. This reminds us that the detail of Aboriginal settlement was more complex than our current archaeological models allow for.

Small and very small scatters are widely distributed, but in almost all cases are found near a water source, such as a claypan, depression or drainage line which would occasionally hold ephemeral pools. A corollary of this pattern is that artefact scatters were not discovered in the waterless sand plains or sand dune fields, with only 1 exception (which can be explained as the result of a transient group camping midway between water sources).

Table 9: Size & distribution across landforms of sites containing artefact scatters

Landform	Base camp <50 000	10 001 – 50 000	501 – 5000	50 – 500	<50	Sub-totals
sand plain	-	-	-	1	-	1
sand dune fields	-	-	1	-	-	1
breakaways / mesa	2	-	-	1	1	4
rocky hills / domes	-	-	2	3	-	5
claypans	-	-	1	5	5	11
sub-totals	2	0	4	10	6	22

* these 2 sites are situated at rocky pavements within sand dunes

The quarry sites range in size from knapping centres used once or twice to a major quarry exploited many times over centuries or millennia. All of these exploit a type of coarse- or medium-grain silcrete that ranges in colour from silver to tan. Outcrops of this stone are widely dispersed, but the quarries are typically clustered where the stone is more siliceous and hence more suitable for knapping and stone tool production. It is estimated that half of the stone artefacts found on campsites were made of this local stone. The other artefacts were made of a small range of stone, such as fine-grain siliceous sediment, chalcedony or quartz, from external or foreign sources. When these other quarries are found, it will be possible to trace the directions of movement of people in the wider region.

Several rockshelter sites were found in the few breakaways of the TGP Operational Area. These typically had only a few associated artefacts, but 2 rockshelters had small artefact scatters

below their talus slopes. The largest artefact scatter site ("Blue Robin Mesa 01") also contained 3 rockshelters. All of the rockshelters appear to contain shallow deposits, which may limit their potential for including dateable organic material, and hence for research.

The results provide a glimpse of the ways in which the land was occupied and its resources used in the past. Only a few really large sites have been discovered, but these demonstrate that people were staying in the area to hunt and gather and quarry rock. In other words, this was not empty land visited only in the course of travelling to other more suitable locations. When good conditions prevailed, people travelled to the Tropicana district, brought in stone material from further north, and stayed to harvest and exploit the resources of the district. They stayed in base camps, such as "Blue Robin Mesa 1", worked at quarries such as "Blue Robin Quarry 7" and made foraging trips out from these sites, staying at the many small satellite sites. At other times, when rain was scarce, it is likely they did not visit. Absences might have been decades long, but with major rainfall events, people returned to the waterholes, gnammas and sites they knew.

More work is needed before a clear picture of the Aboriginal occupation of the region can be drawn. None of the sites discovered during these surveys and inspections have been recorded in detail and no sites have been excavated to provide a chronology for occupation. More importantly, a larger range of sites needs to be recorded. Any groups visiting the Tropicana district would have ranged far and wide in the course of the year and in response to the seasons and irregular rainfall events.

6.2 Significance of Sites

The archaeological, or scientific, significance of the sites is determined by their representativeness and research potential (see section 2.5 above). By these measures, only a few of the archaeological sites are considered to be significant, and the remainder are of little significance. Such assessments are made with the caveat that there are exceedingly few archaeological sites known in the wider region and so any assessment is made with only a limited amount of comparative information or material. Nonetheless, the discovery of numerous sites of various types within the Tropicana district demonstrates that many other sites are likely to exist in areas not yet searched. This is supported by findings from surveys and inspections conducted for the JV in regional exploration tenements where other sites continue to be discovered as that work progresses (Mattner & Sanders *in prep.*).

All of the artefact scatters and quarries in the Tropicana Gold Project Area and the associated infrastructure areas are surface sites without stratified deposit. On this account, the research potential of any of the sites is limited. Furthermore, the sites have been subject to some degree of post-depositional disturbance from erosion and bioturbation, which is pronounced in this area because of the loose sandy soils.

Similar sites are likely to occur in the wider region, particularly small artefact scatters representing transient camping and small opportunistic quarries exploited a few times. Even the large base camps and large quarries are likely to be replicated in other areas where there are similar geological and geomorphological conditions.

Site "Blue Robin Mesa 1" is significant because of its very large and complex assemblage, and because it included 3 small rockshelters. The deposit in these rockshelters may contain dateable material which will shed light on the timeframes for occupation of the region. The artefact assemblage also has potential to answer specific questions of site usage, spatial patterning and regional movement of people and stone resources. This may also be the case for the large artefact scatter " 01".

The moderately sized campsites, “Blue Robin Scatter 01” and “Blue Robin Rockhole 01”, have much smaller and less complex assemblages, but may also address the same questions.

The small rockshelters within sites "Blue Robin Shelter 02" and "Blue Robin Shelter 03" apparently contain shallow deposit, yet the deposit may be stratified and contain dateable organic material. On this basis, these 2 sites are tentatively considered to be of moderate archaeological significance. The rockshelter at site "Blue Robin Shelter 01" does not have deposit and that site is of low significance.

The small artefact scatter sites "Blue Robin Scatter 03" and "Blue Robin Scatter 06", together with the small quarries "Blue Robin Quarry 2", "Blue Robin Quarry 3", "Blue Robin Quarry 4", "Blue Robin Quarry 5" and "Blue Robin Quarry 8" and "Plumridge Road Quarry 02" are considered to be of low significance. There are reasonably common site types, judging by their relative abundance in the area surveyed to-date, and have little research potential.

The quarry site "Blue Robin Quarry 07" is very large and an order of magnitude larger than any other known quarry in the region. It contains evidence of stone extraction and tool manufacture spanning centuries or millennia and on a scale suggesting that the stone material and artefacts from the quarry were transported far and wide from this quarry. Unfortunately, there is no possibility for dating use of the site. It is of moderate to high significance.

Table 10: Significance of 23 sites within the Operational Area & associated infrastructure areas

Site name	Components	Size (no. artefacts)	Significance
mining area			
Blue Robin Scatter 02	AS	100 – 200	low
Surrounding Project Area			
Blue Robin Mesa 01	AS, Gn, RS, GP	50 000 – 100 000	high
Blue Robin Rockhole 01	AS, Gn	~5000	moderate
Blue Robin Claypan 01	AS	<50	very low
Blue Robin Scatter 01	AS	~5000	moderate
Blue Robin Scatter 03	AS	<100	low
Blue Robin Scatter 04	AS	<50	very low
Blue Robin Scatter 06	AS	~300	low
Blue Robin Shelter 01	AS, RS	100	moderate
Blue Robin Shelter 02	AS, RS	<50	moderate
Blue Robin Shelter 03	RS, AS	~1000	moderate
Infrastructure Corridor - Pinjin			
Kirgella Gnamma Quarry 01	AS, Gn, Q	200 000	high
Kirgella Gnamma Quarry 02	AS, Gn, Q	<2000	low – moderate
Pinjin Claypan Scatter 01	AS	~400 + buried pcs	low – moderate
Pinjin Claypan Scatter 02	AS	~500 + buried pcs	low – moderate
Pinjin Claypan Scatter 03	AS	500 + buried pcs	low – moderate
Pinjin Claypan Scatter 04	AS	250 + buried pcs	low – moderate
Pinjin Claypan Scatter 05	AS	~25	very low
Pinjin Claypan Scatter 06	AS	~50	low
Pinjin Claypan Scatter 07	AS	<50	low
Pinjin Claypan Scatter 08	AS	<200 + buried pcs	low – moderate
Pinjin Claypan Scatter 09	AS	~30	very low
Infrastructure Corridor – Tropicana/Transline			
Plumridge Road Quarry 02	Q	~20	very low

Key: AS=artefact scatter; Gn=gnamma; RS=rockshelter; GP=grinding patch; Q=quarry

Some of the smallest artefact scatters and quarries are of very low significance because they are commonly occurring site types, have little if any research potential and will not contribute to an understanding of past Aboriginal occupation of the region. It is likely these will not meet the criteria for registration as protected sites under the WA *Aboriginal Heritage Act* 1972, even though meeting the definition of an archaeological site. Such a decision is made by the Aboriginal Cultural Material Committee (see section 2.1 above) and will take into consideration their very low significance and importance.

Those locations with archaeological material which may not meet the criteria for protection as sites under the WA *Aboriginal Heritage Act* 1972 include "Blue Robin Scatter 03", "Blue Robin Scatter 04", "Blue Robin Claypan 01", "Blue Robin Quarry 9", "Blue Robin Quarry 10", "Plumridge Road Quarry 02", "Pinjin Claypan Scatter 05", "Pinjin Claypan Scatter 08", as well as some of the potential quarries noted in the hills south of the Tropicana Project Area. Until such time as the status of these very small archaeological sites is decided by the Aboriginal Cultural Material Committee, they are to be protected from damage.

Senior representatives from the Wongatha community have been shown some of the newly discovered archaeological sites, as part of the ongoing development of a Cultural Heritage Management Plan. Their preliminary comments are in accordance with the archaeological assessment of the sites' significance.

6.3 Recommendations

Management of Aboriginal archaeological heritage involves, in the first instance, determining the whereabouts and nature of this material. In effect, this means identifying sites or places that contain sites and recording some or all of these. Once the position and distribution of sites is known then they may be avoided. Alternatively, decisions on the preservation, or not, of sites can be made on an informed basis and with due consideration of their significance.

The survey determined that 11 sites exist in the Tropicana Gold Project Area. A further 12 sites were discovered in the associated infrastructure corridors and areas, with some additional sites or potential sites also noted outside of the infrastructure corridors. The location of these 23 sites must be taken into account during any activities.

It is understood that the current layout and infrastructure planning has taken into account the location of the archaeological sites and been modified as required to achieve site avoidance. A Cultural Heritage Management Plan is being prepared in conjunction with Aboriginal representatives and this will include procedures for protection of sites and appropriate steps which can be taken should new archaeological material be discovered during future operations in the area.

In the event that site disturbance is necessary or unavoidable, an application may be made for permission “to use the land” containing a heritage site, in accordance with section 18 of the WA *Aboriginal Heritage Act* 1972. Such an application is made to the Registrar of Aboriginal Sites at the Department of Indigenous Affairs on the appropriate forms. The Minister for Indigenous Affairs may grant or decline consent, or grant conditional consent. Any section 18 application will require consultations specific to the selected site(s) with the Aboriginal communities and senior custodians. It would be appropriate for any Ministerial consent “to use the land” containing a site to include a requirement for further detailed site recording, because all sites have only been recorded at a preliminary level so far.

In the central mining area, it is recommended that the location of site “Blue Robin Scatter 02” be taken into account and no disturbance occurs in its’ vicinity. The site is not close to any planned mining or infrastructure and this distance may well be sufficient to protect the site in

the short term. In the medium to longer term, management of the site will involve either protection by means of signage and/or fencing. Alternatively, an application may be made "to use the land" containing the site if there is a risk it might be disturbed.

In the Surrounding Project Area, where there are 10 sites but no planned infrastructure except for roads and pipelines, management may simply require that the location of the sites is taken into account and no exploration activities occur in their vicinity. There seems no need for active protection of the sites, unless there is pressure from people visiting the hills or ridges where some of the sites are situated. In that case, signage and blocking any access tracks may be sufficient measures to protect the sites.

On the Infrastructure Corridors, the numerous sites can be (or have been) avoided by moving the route. Even where sites occur within the 200m wide corridors, it will be possible to position the proposed infrastructure around sites and erect some protective measures to avoid disturbance during construction. Sites that lie directly beside the Kurnalpi-Pinjin Road and the road east of Pinjin Station ('Nippon Highway') are best avoided by selecting a suitable deviation or deviations. Any widening of those public roads will threaten some sites and is to be avoided. If that alternative is not feasible, then an application must be made "to use the land" containing the sites before any widening of the road(s) may occur. Because of the potential for sub-surface artefacts on some sites beside the Kurnalpi-Pinjin Road, it is recommended that salvage test-pitting or excavations be a condition of any consent to a Section 18 application.

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APPENDICES

Appendix 1: Results of a search of the Register of Aboriginal Sites

Appendix 2: Extracts from the WA *Aboriginal Heritage Act* 1972

Appendix 3: Summary of research into Aboriginal occupation of the Arid Zone

Appendix 1

Results of a search of the Register of Aboriginal Sites

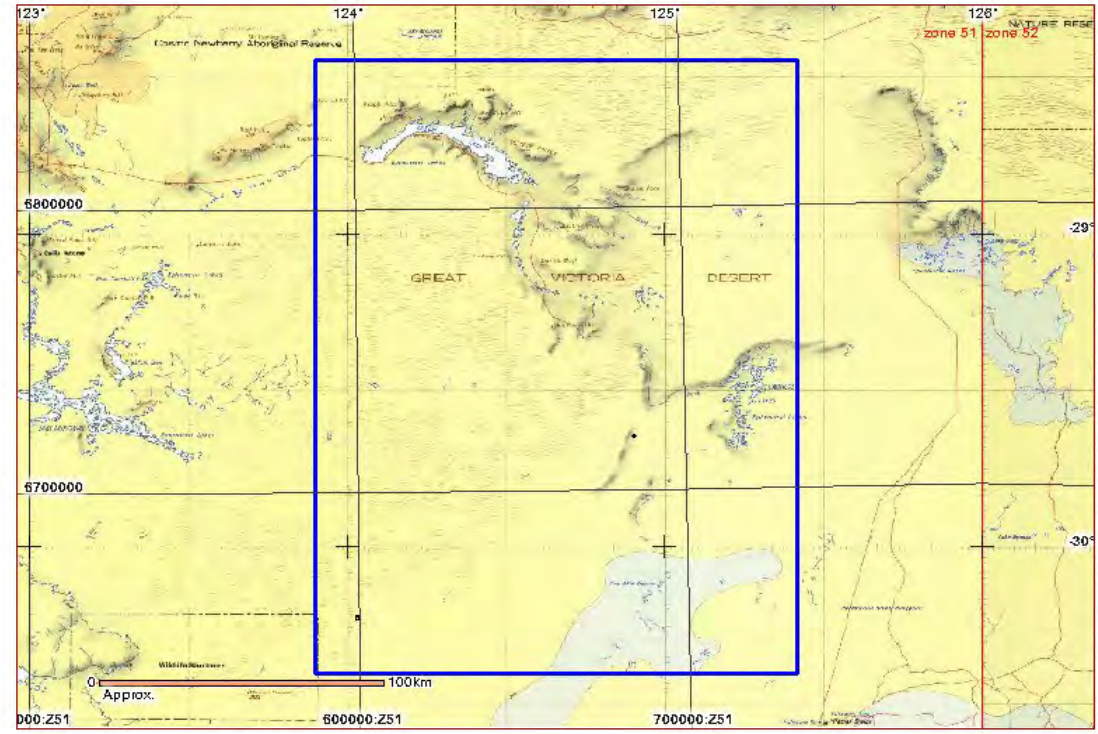
Department of Indigenous Affairs
Government of Western Australia

Aboriginal Heritage Inquiry System
Register of Aboriginal Sites

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
21924	I	O	N	Camp Wp 79		Camp	*Registered Informant names available from DIA.	683934mE 6719278mN Zone 51 [Reliable]	
21923	I	O	N	Claypan Wp 78		[Other: Claypan]	*Registered Informant names available from DIA.	684168mE 6718948mN Zone 51 [Reliable]	
1983	P	O	N	Malcolm Soak	Quarry, Artefacts / Scatter			599338mE 6655658mN Zone 51 [Unreliable]	W01178

Department of Indigenous Affairs
Government of Western Australia

Aboriginal Heritage Inquiry System
Register of Aboriginal Sites



Appendix 2

Obligations relating to Aboriginal Sites

Extracts from the WA *Aboriginal Heritage Act* 1972

Report Of Findings

"15. Any person who has knowledge of the existence of anything in the nature of Aboriginal burial grounds, symbols or objects of sacred, ritual of ceremonial significance, cave or rock paintings or engravings, stone structures or arranged stones, carved trees, rock of any other place or thing to which this Act applies or to which this Act might reasonably be suspected to apply shall report its existence to the Registrar, or to a police officer, unless he has reasonable cause to believe the existence of the thing or place in question to be already known to the Registrar."

Excavation Of Aboriginal Sites

"16. (1) Subject to Section 18, the right to excavate or to remove any thing from an Aboriginal site is reserved to the Registrar.

(2) The Registrar, on the advice of the Committee, may authorise the entry upon and excavating of an Aboriginal site and the examination or removal of any thing on or under excavating of an Aboriginal site and the examination or removal of any thing on or under the site in such manner and subject to such conditions as the Committee may direct."

Offences Relating To Aboriginal Sites

"17. A person who –

(a) Excavates, destroys, damaged, conceals or in any way alters any Aboriginal site; or

(b) In any way alters, damages, removes, destroys, conceals, or who deals within a manner not sanctioned by relevant custom, or assumes the possession, custody or control of, any object on to under an Aboriginal site, commits an offence unless he is acting with the authorisation of the Trustees under Section 16 or the consent of the Minister under Section 18."

Consent To Certain Uses

"18. (1) For the purposes of this section, the expression "the owner of any land" includes a lessee from the Crown, and the holder of any mining tenement or mining privilege, or of any right or privilege under the Petroleum Act, 1967, in relation to the land.

(2) Where the owner of any land gives to the Committee notice in writing that he requires to use the land for a purpose which, unless the Minister gives his consent in this Section, would be likely to result in a breach of Section 17 in respect of any Aboriginal site that might be on the land, the Committee shall, as soon as they are reasonably able, form an opinion as to whether there is any Aboriginal site on the land evaluate the importance and significance of any such site, and submit the notice to the Minister together with their recommendations in writing as to whether or not the Minister should consent to the use of the land for that purpose, and, where applicable, the extent to which and the conditions upon which his consent should be given

(3) When the committee submit a notice to the Minister under subsection (2) of this section he shall consider their recommendation and having regard to the general interest of the community shall either –

(a) Consent to the use of the land the subject of the notice, or a specified part of the land, for the purpose required, subject to such conditions, if any, as he may specify; or

(b) Wholly decline to consent to the use of the land the subject of the notice for the purpose required, and shall forthwith inform the owner in writing of his decision.

(4) Where the owner of any land has given to the Committee notice pursuant to the subsection (2) of this section and the Committee have not submitted it with their recommendation to the Minister in accordance with that subsection the Minister may require the Committee to do so within a specified time, or may require the Committee to take such other action as the Minister considers necessary in order to expedite the matter, and the Committee shall comply with any such requirement.

(5) Where the owner of any land has given to the Committee notice pursuant to the subsection (3) of this section he may, within the time and in the manner prescribed by the rules of court,

appeal from the decision of the Minister to the Supreme Court which may hear and determine an appeal.

(6) In determining an appeal under subsection (5) of this section the Jude hearing the appeal may confirm or may the decision of the Minister against which the appeal has been made or quash the decision of the Minister, and may make such order as to the costs of the appeal as he sees fit.

(7) Where the owner of the any land gives notice to the Committee under subsection (2) of this section, the Committee may if they are satisfied that it is practicable to do so, direct the removal of any object to which this Act applies from the land to a place of safe custody.

(8) Where consent has been given under this section to a person to use any land for a particular purpose nothing done by or on behalf of that person pursuant to, the consent constitute an offence against the Act."

Appendix 3

Summary of research into Aboriginal occupation of the Arid Zone

Research in the Western Desert

Modern archaeological research in the Australian arid zone commenced with the work of R. Gould, from the USA. His objectives were to apply new scientific and theoretical approaches in a region where traditional people could provide information to assist in the understanding and interpretation of the archaeological material. Gould's work was seminal and a very brief outline of some of his results is provided in the following sections.

Gould began his investigations in the mid-1960s with a journey eastward from the edge of the Northern Goldfields of Western Australia through Sandstone, Laverton and Warburton to the Warbuton Ranges (mss 1966) Along the way he consulted with local Aboriginals and visited many sites, searching for rockshelters that contained stratified deposits and could provide a chronology for long-term occupation of the desert. For his excavations, he chose 2 shelters in the Warburton Ranges (Puntutjarpa & James Range Rockshelter) northeast of Warburton, approximately 400km northeast of the Tropicana district.

The Warburton Ranges lie at the northern edge of the Great Victoria Desert and have much more in common with the Central Australia Ranges of southern Northern Territory and northern South Australia than with the sand plains and sand dune fields of the Great Victoria Desert. In this respect, Gould's work is typical of most research that followed. Archaeologists have sought rockshelters with deposit to excavate, which has lead to a focus on the archaeology of ranges in central Australia.

Chief amongst these researchers is M. Smith, who has established that occupation of the ranges north of the Great Victoria Desert has spanned more than 30 000 years and predates the most severe phase of the recent Ice Age. Occupation of rockshelter sites near reliable pools of water continued through that hyper-arid period, although changes are apparent in the style of occupation (see below). Smith suggests that the ranges were bases from which people moved into the surrounding sandy areas as climatic conditions permitted. His work has not, however, revealed what was happening in the sand plains and sand dune fields beyond the ranges.

Arid Zone Settlement Patterns

Several researchers have proposed models for the Aboriginal occupation of the arid and semi-arid zones of Australia, but it is the work of Gould near Warburton and Laverton in the Great Victoria Desert that is of most relevance to the Tropicana district.

As identified by Gould, the Aboriginal response to a highly unpredictable rainfall pattern was ‘rain chasing’. This involved people pursuing localised rainfall events. This allowed them to move or disperse across their lands taking advantage of ephemeral pools. Only as the ephemeral waters dried up would people concentrate about the long-lasting or permanent water sources they had conserved (Gould 1968, 1977a, 1977b). Archaeologically, this settlement/mobility pattern would be reflected in numerous small artefact scatters with poor assemblages dispersed across the landscape, together with a few large, diverse and complex artefact scatters, called ‘base camps’, at reliable water sources.

Gould (1977a) also proposed patterns in the distribution of artefacts across the landscape and at sites. He proposed that the majority of artefacts would be discarded off-site and constitute a background scatter of isolated finds. Casually knapped stone would comprise the vast majority of the background scatter, whereas stone from quarries would comprise the majority of

artefacts at campsites. Wood-working tools and other implements would most commonly be manufactured on quarried stone and will generally be found at campsites. Testing this proposition is difficult because it is generally hard to determine the provenance of stone types.

Cane (1990) proposed a similar settlement/mobility model for peoples in the Great Sandy Desert to the north of the Great Victoria Desert. He considered that movement was more structured and less opportunistic than in Gould's model. This was partly a response to a more seasonal rainfall pattern in his study area (i.e. erratic but heavy summer rains). Cane identified social and religious obligations as primary factors and motivations for movement and site occupation, rather than the economic or subsistence pressures cited by Gould.

In a study of the Rudall River district of the Great Sandy Desert, Veth (1993) followed Gould by emphasising that settlement patterns were dictated by the availability of potable water and staple plant foods. In particular, water was seen as the crucial factor in determining site location, in the length of occupancy and in the complexity and size of the site assemblage.

More recent research into the pattern of Aboriginal sites around Lake Carey also provides some insight into past settlement patterns in the district. Mattner (2000) identified the role Lake Carey played in Aboriginal subsistence on those uncommon occasions that flooding filled or partially filled the lake. Of particular importance were the water sources provided by claypans and saltpans occurring in interdunal swales on the eastern margin of the lake. These freshwater sources allowed people to visit and harvest the occasional abundance of resources at the lakes, particularly water birds and their eggs. People were also able to move along the better watered corridor of the lake margin to reach widely separated parts of their territory.

Occupation of the arid interior relied on staple foods, in particular plant seeds and reptiles. The role of ground flour in the diet can be inferred by the presence and relative abundance of grindstones at sites. At Puritjarra, the first grindstones only appear during the terminal Pleistocene, some 12 000 years after regular occupation of the site (Smith 1986; 2006). Similar patterns are evident at other sites in the Central Ranges, as well as in the Warburton Ranges. At sites excavated by Gould (Puntutjarpa and James Range East), grindstones post-date the first evidence of settlement by several millennia (Smith 1986). This is at odds with the theory that seed grinding technology was necessary to successfully occupy the deserts (cf. Veth 1993).

Smith's research of various sites indicates that occupation predating grinding tools appears to be consistent with brief, frequent visits by mobile groups. The introduction of grinding tools coincides with an increase in material in the archaeological record which can best be interpreted as corresponding to an increase in population densities. In other words, the adoption of seed grinding permitted the intensified use of the land so as to support larger populations, but was not a prerequisite for colonisation of the arid interior. Even further population growth and more intense use of the deserts is shown by the development of complex grindstones in the late Holocene, which were used for processing spinifex seed (Smith 1986; Veth 1995).

Chronology of Occupation

When people first reached Australia, before 60 000 year ago and possibly much earlier, climatic conditions in the interior were more favourable for settlement than at present. Climatic and environmental conditions deteriorated slowly as the last Ice Age gathered momentum. The region became progressively drier and at the height of the Ice Age, between 25 000 to 15 000 years ago, there was a hyper-arid phase. Around this time, there are marked changes in Aboriginal settlement of the Australian deserts, including the apparent abandonment of many regions. Sandy deserts in particular appear to have been abandoned (Veth 1993; Veth et al. 2004).

Gould's excavation of Puntutjarpa rockshelter in the Warburton Ranges yielded a date for initial occupation of arid Australia of approximately 10 000 years ago (Gould 1968). This was the first

evidence of such ancient occupation and showed continued occupation until recent times. More recent excavations in the Central Ranges, particularly by Mike Smith, have provided evidence of much longer occupation of the arid centre and of changes over time, which reflect changes in environments, climates and culture.

Excavations at Puritjarra rockshelter (Smith 1989; 2006) on the eastern edge of the Cleland Hills near a reportedly permanent water source, have revealed evidence of initial settlement about 32 000 years ago, with inconclusive evidence of fleeting visits as early as 42 000 years ago. Visitors to the site during this period were moving over a wide territory and brought red ochre from 125km north and fine-grained silcrete artefacts from the western end of the range. The paucity of broken tools or cores and the absence of evidence for clearing debris from occupation surfaces suggest that use of the rockshelter was transitory in this period. This period is defined by settlement by small, highly mobile groups with high residential mobility and generalised foraging.

During the maximum of the last Ice Age, when conditions in central Australia were exceptionally cold and dry, there is a peak in the number of artefacts at the site. There was a greater reliance on local silicified sandstone for tools, but ochre from 125km away was still found in these levels, suggesting people were still using a wide territory but were now staying for extended periods at sites near reliable water sources, such as Puritjarra. Smith also argues there is no strong indication for a hiatus in occupation of the site during the period when the environment was at its most arid, although he accepts the data is not totally clear. This pattern is replicated at other Central Australian sites and numerous sites elsewhere in inland Australia for this period (Hiscock & Wallis 2005).

In contrast, sites that were not near reliable water and districts without permanent water were very likely abandoned at this time. Abandonment may have been complete, or there may have been transient visits when conditions permitted, but for many millennia parts of the arid zone were unoccupied. These are the so-called 'high risk zones' where water was unavailable (Hiscock & Wallis 2005: 48).

This is supported by excavations at other sites in the arid interior, including Serpent's Glen rockshelter in the Carnarvon Ranges, north of Wiluna (O'Connor et al. 1998). Transient and episodic occupation of that site near a rocky pool in a creekline at the edge of the ranges dates back to 23 500 years ago (O'Connor et al. 1998). Occupation was apparently transient and episodic in that era rather than permanent. It appears there was a long hiatus in occupation soon after that time, followed by resumption of occupation in the mid- to late Holocene, around 4700 years ago. After that time, occupation became progressively more intensive.

At Puritjarra, there are a number of changes in the use of the rockshelter over the period of the Pleistocene-Holocene transition, coinciding with better climatic conditions from 12 000 years ago. There is a change to large core tools and large unmodified flakes, which suggest a greater emphasis on woodworking. The first pits or hearths appear and these levels also include the earliest grindstones. Occupation debris extended across most parts of the shelter floor, suggesting larger camps. The territory available to the occupiers may have decreased, as suggested by a greater use of local ochres and the increase in tools made of local stone.

From 7500 years ago, there is a significant increase in artefact discard rates and both implements and cores were more heavily worked. Larger debris was cleared from the floor of the shelter, reflecting extended episodes of occupation. Grindstones became more common, meaning greater utilisation of seeds for food. There is increased use of locally available ochres and a greater reliance on local material for stone tools. Smith believes that this data points to more local provisioning, visits to the rockshelter that were more sustained, not simply more frequent, and site territories that remained restricted in extent.

In the late Holocene, from 3500 year ago, the people visiting the rockshelter were using a more diverse toolkit, including hafted adzes and scrapers and other composites of wood, resin and

stone. There are specialised grindstones for grinding grass seeds and Acacia seeds. Increasing use of the rockshelter is reflected in discard rate increases, and more pits, hearths, ochre and grindstones. A thousand or so years ago, Puritjarra was a core residential site with extended periods of occupation. This may be related to better climatic conditions and more reliable food sources. The phytolith records show that during the last 1000 – 1500 years grass levels stabilised at their highest values since the last interglacial, indicating increased rainfall.

Late Pleistocene occupation has been established in the Carnarvon Ranges, north of Wiluna, where C-14 dating of charcoal from low levels in the Serpent's Glen rockshelter site returned a date of 23 550 (±140) years ago (O'Connor et al. 1998). Occupation was apparently transient and episodic in that era rather than permanent. It appears there was a long hiatus in occupation soon after that time, followed by resumption of occupation in the mid- to late Holocene, around 4700 years ago. This apparent abandonment of the area occurred during the time of increased aridity during the Glacial Maximum (O'Connor et al. 1998).

Further afield, early Holocene occupation has been documented for several parts of the arid zone of Western Australia. Dates in the order of 10 000 years ago were obtained from excavations at Walga Rock, near Cue (Bordes et al. 1983), and at Puntutjarpa, near Warburton (Gould 1968). Despite these early dates, excavations in semi-arid and arid regions of Western Australia typically return late Holocene dates; in the order of one, two or three millennia ago.

Several artefact scatter sites in sand dunes beside Lake Carey, south of Laverton, were excavated and lens of charcoal discovered in two sites that were interpreted as heaths. These returned dates ranging from 380 years ago to 1530 year ago (Mattner 2000). Excavations in a rockshelter at Mt East, 45km southeast of Laverton, uncovered a shallow deposit with several ash lens as well as dispersed charcoal. Samples have returned dates of 3150 years ago and 4475 years ago; that is, in the mid- to late Holocene.

Research to the south of the Great Victoria Desert, along the coast around Esperance and in Cape Arid National Park, produced a similar picture (Moya Smith 1993). Most of the sites investigated were first occupied in the last few thousand years. Only at Cheetup Cave was there evidence for Pleistocene occupation. This shelter was first occupied about 13 350 years ago, abandoned about 8000 years ago and not reoccupied until 2500 years ago.

People appear to have visited some of the caves beneath the Nullarbor for a very long time. Allen's Cave, just east of the state line, may have been in use 40 000 years ago (Roberts et al. 1996). If so, it yielded the first evidence for Aboriginal occupation of the arid zone. The shelter may have been abandoned during the hyper-arid phase of the last Ice Age, but was certainly visited 20 000 – 10 000 years ago (Mulvaney & Kamminga 1999: 203) and more recently than that as well.

The majority of dated sites recorded throughout the arid region return reasonably recent dates; typically in the late Holocene. This is partly the result of better preservation of organic remains in younger sediments. However, this also probably reflects increased settlement of the non-seasonal desert during the last few thousand years. This is in line with other nation-wide changes suggesting population growth and more intensive use of marginal landscapes at that time. Some of the demographic changes in the arid interior may have been related to developments in seed-grinding technology and the use of spinifex seed (Smith 1989; Veth 1993, 1995), which raised the carrying capacity of these arid landscapes.

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