ANGLOGOLD ASHANTI
AUSTRALIA

TROPICANA GOLD PROJECT

STYGOFAUNA SURVEY REPORT

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TROPICANA GOLD PROJECT

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Tropicana Joint Venture

ANGLOGOLD ASHANTI
AUSTRALIA

INDEPENDENCE GROUP NL

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EXECUTIVE SUMMARY

The Tropicana Joint Venture (TJV) is planning to establish the Tropicana Gold Project (TGP) which will comprise an open-cut mine and associated infrastructure (the operational area), water supply area and infrastructure corridor. The proposed project is located approximately 330 km east north-east of Kalgoorlie, and 15 km west of the Plumridge Lakes Nature Reserve, on the western edge of the Great Victoria Desert (GVD) biogeographic region of Western Australia. The climate is described as arid, with summer and winter rain averaging 150 –180 mm (Barton *et al.* 2001b, a).

Since the discovery of the deposit in 2002, gold mineralisation has been identified over a strike length of approximately four kilometres with two areas of significant mineralisation, termed the Tropicana and Havana deposits (the Resource Area), which form the basis of the proposed TGP. It is currently proposed that the TGP would operate for approximately 10 - 15 years to realize the potential of the resource.

As preparation for the Environmental Impact Assessment, the TJV commissioned *ecologia* Environment (*ecologia*) to conduct a subterranean fauna desktop review of the proposed operational area. Subsequently, *ecologia* recommended that a stygofauna sampling survey be performed, primarily because the geological profile and the quality of the groundwater within the project area suggested that the habitat and its conditions were favourable to stygofauna presence. In addition, stygofauna records existed within ~300 km to the north, east and west of the proposed operational area but there was a lack of knowledge concerning stygofauna distribution within the proposed operational area.

As a result, 47 existing bores were sampled during the survey, of which 40 were located within the operational area and seven in regional areas outside the operational area. Sampling was conducted during September 2007, November 2007, and April-May 2008. Eleven bores were sampled during September 2007, 23 bores were sampled in November 2007, and 30 bores were sampled in May 2008. The sampling involved the following three steps:

- Initial assessment of the bore (size and cap present)
- Water chemistry measurements of water bailed from the bore
- Six trawls of stygofauna nets (three trawls of 50 µm mesh-size net and three trawls of a 150µm mesh-size net)

Sampling in September 2007 yielded no species. Sampling in November 2007 yielded several species, including spiders, mites, collembolans, oligochaetes, a pseudoscorpion and an isopod, however none of these represented stygobitic species. Similarly, sampling in May 2008 yielded mites, collembolans and insects, none of which were stygobitic species.

Slotting size of bore casings presented a limitation to the survey as the majority of bores had casings with slotting size smaller than 3 mm. As stygobitic species range in size (juvenile to adult) from 0.05mm to 2mm (copepods and ostracods), 0.05-5mm (annelids) and 1-25mm (isopods and amphipods), the slotting size may have been accountable for the lack of larger adult stygofauna, however, it does not explain the lack of juveniles and the common microscopic stygofauna (i.e. copepods) for which the slotting size did not present a barrier.

It is highly unlikely that the result of this survey would present a false negative (stygofauna being actually present in the aquifer but not collected during the sampling) because the sample design was extensive (50% larger than required by the EPA guideline 54 and

Appendix 54A) and the age of the bores was sufficient for colonisation by any potential stygofauna in the area.

A valid explanation of the lack of stygofauna within the Tropicana Gold Project Area may come from historical geological events, specifically a marine incursion, which would have altered the aquatic habitat from fresh (or hyposaline) to saline and therefore make it unsuitable for stygofauna. Coupled with a sediment deposition, the marine incursion would gradually decrease the available habitat to the point where relict stygofauna would be either restricted to isolated tributaries north of Tropicana or become extinct. Subsequent re-colonisation would be seriously impeded, both by the distance of the nearest stygofauna refugium as well as by the sedimentary clay barriers deposited around Tropicana. Similar processes are known to have occurred in the Pilbara and the Nullarbor.

The total lack of stygobitic species, large or small, inside and outside the survey area, coupled with the data on the historical marine incursion events suggest that the groundwater habitat within the survey area is devoid of stygofauna.

Monitoring and additional sampling is recommended if the TJV identifies resources outside the proposed TGP footprint containing fresher water. Other risks associated with the potential impact on stygofauna within the operational area have been identified as low and thus do not require any specific controls.

1.0 INTRODUCTION

1.1 Project Background

The Tropicana Joint Venture (TJV) is planning to establish the Tropicana Gold Project (TGP). The proposed TGP is located approximately 330 km east north-east of Kalgoorlie, and 15 km west of the Plumridge Lakes Nature Reserve, on the western edge of the Great Victoria Desert (GVD) biogeographic region of Western Australia (Figure 1). The project is a joint venture between AngloGold Ashanti Australia Limited (70% stakeholder and Manager) and the Independence Group NL (30% stakeholder).

The TGP consists of three main components (Figure 1):

- Operational area - this area contains the mine, processing plant, aerodrome, village and other associated infrastructure;
- Water supply area - two basins have been investigated, the Minigwal Trough and Officer Basin; and
- Infrastructure corridor - two options are under consideration (Tropicana-Transline and Pinjin Road options).

As preparation for the Environmental Impact Assessment, TJV commissioned *ecologia* Environment (*ecologia*) to conduct a subterranean fauna desktop review of the proposed operational area. Subsequently, *ecologia* recommended that a stygofauna sampling survey be performed, primarily because the geological profile and the quality of the groundwater within the project area suggested that the habitat and its conditions were favourable to stygofauna presence. In addition, stygofauna records existed within ~300 km to the north, east and west of the proposed impact area but there was a lack of knowledge concerning stygofauna distribution within the proposed operational area.

Stygofauna are obligate, groundwater dwelling fauna known to be present in a variety of rock types including karst limestone, fissured rock (e.g. granite) and porous rock (e.g. alluvium) (Mamonier *et al.* 1993). They are typically adapted for the subterranean environment, with features such as lack of pigmentation, elongated appendages, worm like body shape and reduced or absent eyes.

Stygofauna seem to have significant roles in the ground water ecosystem. They feed on bacteria and matter percolating down from the ground's surface, presumably maintaining water quality and keeping groundwater flowing as they continually maintain the voids between soil particles.

Due to the connectivity of groundwater habitats with the surface areas, any proposed impact to the environment may have an effect on groundwater fauna. Stygobitic species are particularly vulnerable to impacts that reduce the standing level of the water table or alter groundwater flow. Introduction of foreign pollutants can also have drastic effects on stygofauna as the animals can be very sensitive to water-chemistry changes. Surface impacts, too, can have indirect effects on the subterranean environment as the voids in which stygofauna dwell can be at risk of compaction, which effectively destroys the habitat and reduces water flow from the surface.

Following the recommendations from *ecologia*, the TJV decided to commence a stygofauna sampling survey in accordance with guidance statement 54 to enable the following:

"The EPA is seeking from the proponent sufficient information, through sampling and within the constraints of reasonably available knowledge, to enable the EPA to advise the Minister that, as a consequence of the proposal, there would be a low likelihood that a subterranean fauna would meet the criteria for special legal protection as a threatened species under the *Wildlife Protection Act.*"

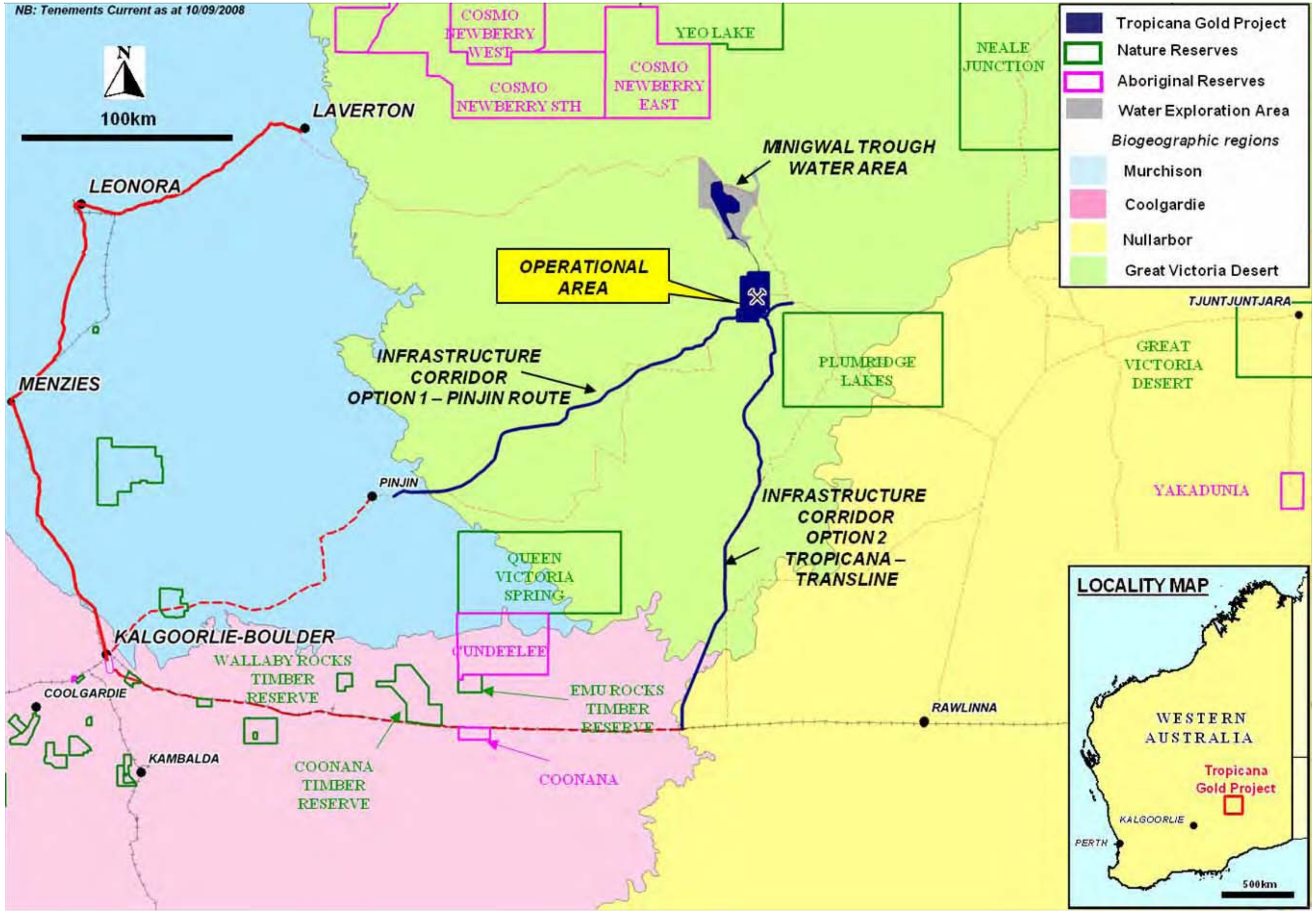


Figure 1 Location Map of The Tropicana Gold Project Area within the IBRA Boundary Map (Info from IBRA V6.1, http://www.naturebase.net/content/view/960/1397/)

1.2 Legislative Framework

The *Environmental Protection Act 1986* is "an Act to provide for an Environmental Protection Authority, for the prevention, control and abatement of environmental pollution, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing." Section 4a of this Act outlines five principles that are required to be addressed to ensure that the objectives of the Act are addressed. Three of these principles are relevant to native fauna:

- *The Precautionary Principle*

  Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

- *The Principles of Intergenerational Equity*

  The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

- *The Principle of the Conservation of Biological Diversity and Ecological Integrity*

  Conservation of biological diversity and ecological integrity should be a fundamental consideration.

Projects undertaken as part of the Environmental Impact Assessment (EIA) process are required to address guidelines produced by the EPA, in this case Guidance Statement 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003), and The Technical Appendix to Guidance Statement No. 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA 2007).

Native fauna in Western Australia are protected at a Federal level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and at a State level under the *Wildlife Conservation Act 1950* (WC Act).

The EPBC Act was developed to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance, to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and to promote the conservation of biodiversity. The EPBC Act includes provisions to protect native species (and in particular prevent the extinction, and promote the recovery, of threatened species) and ensure the conservation of migratory species. In addition to the principles outlined in Section 4a of the EP Act, Section 3a of the EPBC Act includes a principle of ecologically sustainable development dictating that decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.

The *WC Act* was developed to provide for the conservation and protection of wildlife in Western Australia. Under Section 14 of this Act, all fauna and flora within Western Australia is protected; however, the Minister may, via a notice published in the *Government Gazette*, declare a list of fauna taxa identified as likely to become extinct, or is rare, or otherwise in need of special protection. The current listing was gazetted on the 5 August 2008.

1.3 Survey Objectives

ecologia was commissioned to undertake a baseline biological survey of the subterranean invertebrate fauna of the operational area as part of the Environmental Impact Assessment for the TGP.

The EPA's objectives with regards to subterranean fauna management are to:

- maintain the abundance, species diversity and geographical distribution of subterranean terrestrial invertebrate fauna; and
- protect specially protected (threatened) fauna, consistent with the provisions of the *Wildlife Conservation Act 1950.*

Hence, the primary objective of this study was to provide sufficient information to the EPA to assess the impact of disturbance at the operational area on the aquatic subterranean fauna of the area, thereby ensuring that these objectives will be upheld.

Specifically, the objectives of this survey were to undertake a survey that satisfies the requirements documented in EPA's Guidance Statement 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia (EPA 2003), and The Technical Appendix to Guidance Statement No. 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA 2007). The survey involved the following:

- A review of background information (including literature and database searches);
- A development of an inventory of subterranean fauna species occurring in the region, incorporating recent published and unpublished records;
- A development of an inventory of species of biological and conservation significance recorded or likely to occur within the operational area and surrounds;
- A description of the characteristics of the faunal assemblage; and
- An appraisal of the current knowledge base for the area, including a review of previous surveys conducted in the area relevant to the current study.

2.0 BIOPHYSICAL ENVIRONMENT

2.1 Climate

The TGP is located at the junction of the Great Victoria Desert, Nullarbor Plain and the eastern Goldfields. The climate is described as arid, with summer and winter rain averaging 150 –180 mm (Barton *et al.* 2001b, a). Average weather conditions from the study area can be interpreted from weather data from Laverton to the north-west, and Balgair to the south-east. A summary of climatic data for these two locations are provided in Table 1, Figure 2, Figure 3, and Figure 4 below.

Table 1 Summary of Climatic Data for Laverton and Balgair

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Laverton												
Mean max (°C)	35.8	34.8	31.9	27.2	22.1	18.5	17.8	20.0	24.5	28.0	32.1	34.9
Mean min (°C)	20.5	20.0	18.0	13.9	9.5	6.6	5.2	6.4	9.5	12.8	16.6	19.3
Mean rainfall (mm)	24.3	30.1	30.7	22.6	24.1	24.4	16.4	13.7	8.2	8.5	13.6	17.1
Balgair												
Mean max (°C)	32.8	31.9	29.5	26.3	22.3	19.1	18.7	20.6	24.2	26.7	29.2	30.9
Mean min (°C)	16.3	16.7	14.8	11.9	9.0	6.1	5.2	5.9	8.3	10.5	12.8	14.7
Mean rainfall (mm)	21.1	27.7	30.8	21.3	24.0	24.8	17.2	19.1	17.3	15.6	23.6	36.4

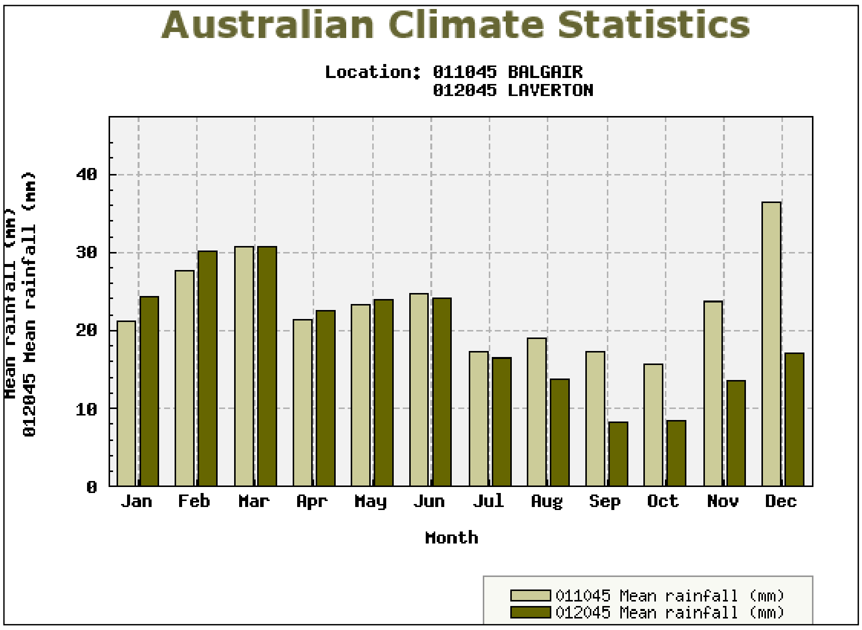


Figure 2 Balgair and Laverton Rainfall (http://www.bom.gov.au)

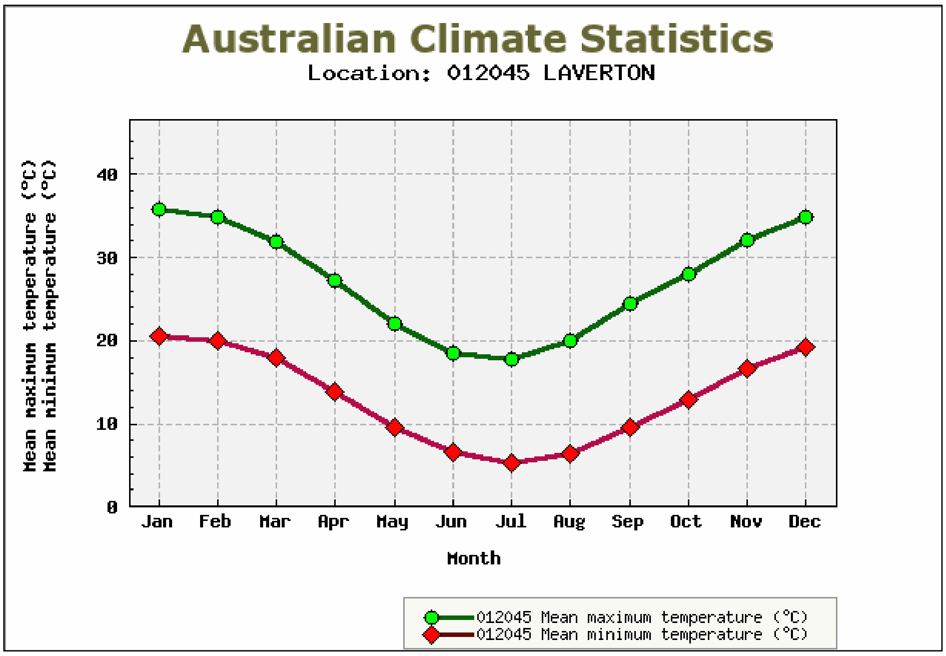


Figure 3 Laverton Mean Maximum and Mean Minimum Temperature (°C) (http://www.bom.gov.au)

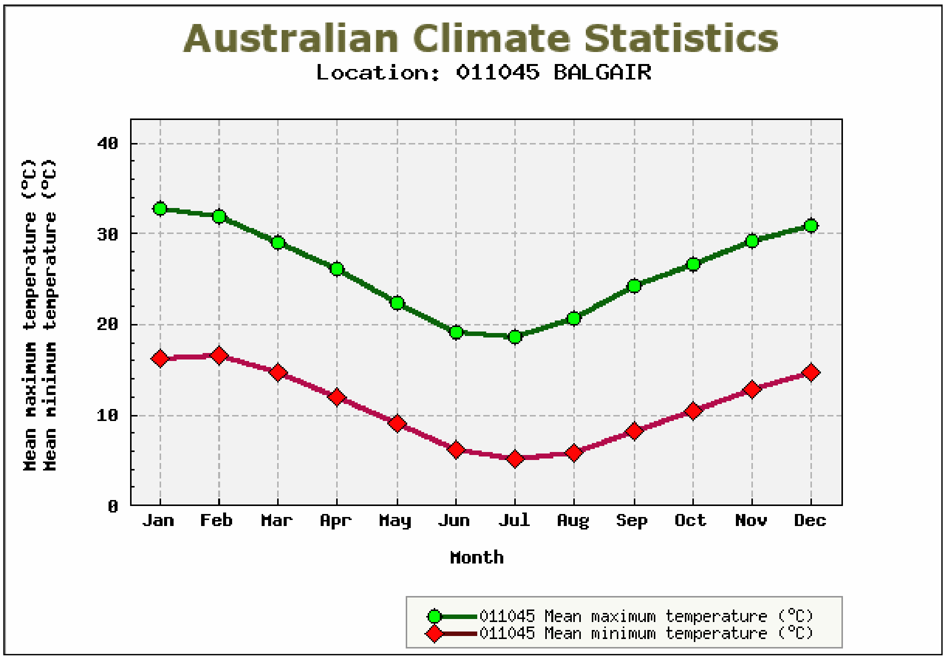


Figure 4 Balgair Mean Maximum and Mean Minimum Temperature (°C) (http://www.bom.gov.au)

2.2 Hydrology

Within the Great Victorian Desert, the Murchison and the Coolgardie regions (particularly in the northern goldfields region), groundwater is contained within unconfined alluvial, calcrete and sedimentary basin aquifers, paleochannels and fractured rock aquifers. Drainage is internal, with flat bottomed paleodrainages discharging into discontinuous chains of salt lakes. Fresh groundwater occurs only in the uppermost tributaries of the paleochannels found in the northern Goldfields. This fresh water becomes more saline (2,000 – 35,000 mg/L TDS) further downstream. There is a sharp interface between the hyposaline (2,000 – 35,000 mg/L TDS) and the hypersaline groundwater (35,000 – 250,000 mg/L TDS) in the trunk of the paleochannels. Salinity levels in the vicinity of salt lakes can exceed 250,000 mg/L TDS (Kalaitzis *et al.* 2002).

Most waterways are very short and all are ephemeral, flowing only after periods of great rainfall. During these periods of great rainfall local basins fill and overflow, flooding surrounding areas. This flushes organic matter from permanent or semi permanent pools to surrounding areas and allows for gene flow among aquatic fauna inhabiting refuge sites.

With respect to stygofauna, records from the Murchison bioregion exist from groundwater of up to 60,000 mg/L (*ecologia* Environment 2006) and therefore stygofauna may be expected to be found anywhere from the headwaters to the middle reaches of palaeochannel systems. In contrast, stygofauna are rarely recorded in the lower reaches where salinity exceeds 250,000 mg/L, except where perched freshwater aquifers (generally associated with calcrete formations) are found. Salinity in the existing groundwater within the operational area does not exceed 60,000 mg/L TDS (Figure 5), suggesting that water-quality conditions are favourable for stygofauna in the area. In addition, the standing water level of 22 - 52.5 mbgl suggests that aquifers contain sufficient levels of water and thus the potential for stygofauna presence within the Tropicana project area is high.

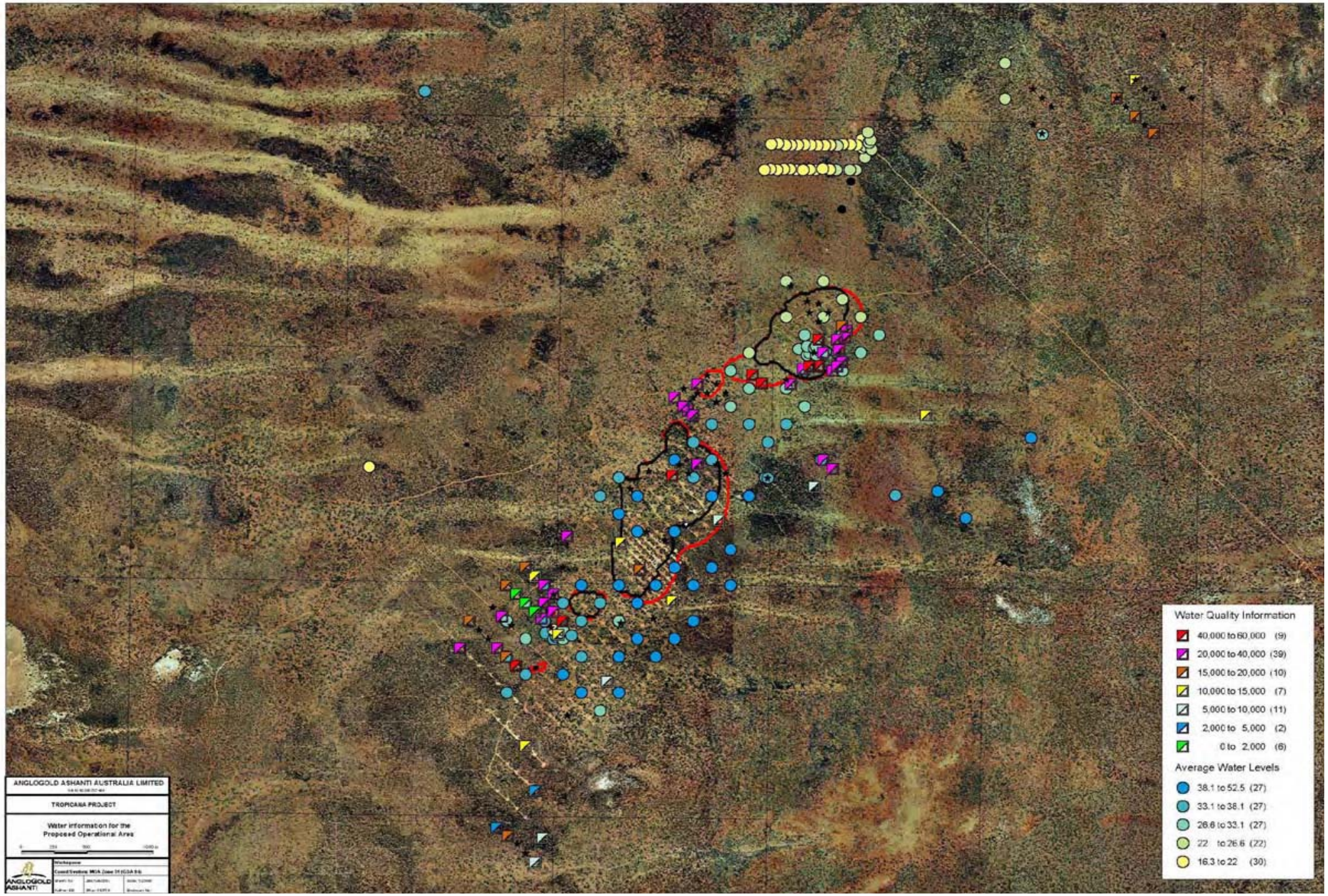


Figure 5 Salinity (TDS mg/L) and Standing Water Level (SWL) of Groundwater for the Proposed Operational Area at TGP

2.3 Biogeography

The Operational Area of the TGP is located in the Great Victoria Desert (GVD) close to the junction of three other biogeographic regions - the Murchison, Coolgardie and Nullarbor Plains biogeographic regions (Figure 1) as defined by Thackway and Cresswell in the Interim Biogeographic Regionalisation of Australia (IBRA) Version 6.1 (Department of Environment and Water Resources, 2007). On a finer scale, it is located on the northern border of the Central and Shield sub-regions of the Great Victoria Desert.

The Central region of the Great Victoria Desert is described as an:

> "*arid active sand-ridge desert with extensive dune fields of deep Quaternary aeolian sands overlying Permian strata of the Gunbarrel Basin. Landforms consist of salt lakes and major valley floors with lake derived dunes. Sand plains with extensive seif dunes running east west, occasional outcropping (breakaways) and quartzite hills provide minor relief* (Barton *et al.* 2001b)."

The subregion covers an area of 14,286,995 ha. Of this total, 9.11% is vested in conservation estate.

2.4 Flora and Vegetation

The operational area is situated in the Helms Botanical District, near the border of the Great Victoria Desert and the Nullarbor Plain, within the Eremaean Botanical Province. At a broad scale, Beard (1975) described three distinct vegetation units within close proximity to and including the TGP:

1. *Acacia aneura* (mulga) low woodland between sand ridges.
2. Tree (*Eucalyptus gongylocarpa, E. youngiana*) and shrub steppe between sand hills with hummock grassland (*Triodia basedowii*).
3. *Acacia aneura / Casuarina cristata* (*C. pauper*) woodland (Mulga and sheoak).

3.0 SURVEY METHODS

3.1 Site selection

Forty existing exploration bores inside the operational area were selected for the survey and sampled in three phases, resulting in a final sample size of 59 (n = 59). This sample size complied with the requirements of the EPA Guidance Statement 54A, which states that a minimum sample size of 40 (n = 40) should be obtained from within the proposed impact area (EPA 2007). In addition, seven bores were chosen as a reference in regional areas outside the TGP operational area, of which five were sampled for stygofauna (two were dry), resulting in a total survey sample size of 64 (n = 64).

The bores sampled are presented in Table 2. Locations of the 38 mm diameter monitoring bores within the mining impact area are shown in Figure 6. The locations of all bores sampled during the survey are shown in Figure 7 and Figure 8.

Table 2 Stygofauna Sampling Bore Locations and Details (regional bores marked as reg.)

BORE ID	Construction Date	Slotting size	GPS coordinates (datum WGS84)				Sampled in 2007	Sampled in 2008	Water Level	Slotting Depth
			zone		Easting	Northing			(mbgl)	from to
TPA2942	25/1/2008	hand slotted < 4mm	51	J	648880	6765046	-	4-May	27.1	0-50m
TPA2952	25/1/2008	hand slotted < 4mm	51	J	649587	6764338	-	4-May	25.6	0-63m
TPA3014	25/1/2008	hand slotted < 4mm	51	J	648101	6760394	-	28-Apr	32	0-47m
TPA3091	25/1/2008	hand slotted < 4mm	51	J	645451	6761146	-	28-Apr	21.3	0-35m
TPA3106	25/1/2008	hand slotted < 4mm	51	J	645631	6761504	-	29-Apr	14.6	0-28m
TPA3124	25/1/2008	hand slotted < 4mm	51	J	645827	6761881	-	29-Apr	16.2	0-21m
TPA3155	25/1/2008	hand slotted < 4mm	51	J	647318	6761055	-	29-Apr	22.8	0-44m
TPMB001	28/11/2006	hand slotted < 4mm	51	J	650809	6763348	23-Nov	30-Apr	28.9	45-57m
TPMB008	28/11/2006	hand slotted < 4mm	51	J	651009	6763328	23-Nov	3-May	28.7	31-43m
TPMB010	28/11/2006	hand slotted < 4mm	51	J	651292	6764941	1-Sep	-	20.2	18-30m
TPMB012	28/11/2006	hand slotted < 4mm	51	J	651287	6765004	1-Sep	-	20.2	25-37m
TPMB013	28/11/2006	hand slotted < 4mm	51	J	651364	6764927	1-Sep	-	22.6	34-46m
TPMB017	3/12/2006	hand slotted < 4mm	51	J	648884	6761103	24-Nov	3-May	34.3	31-49m
TPMB022	28/11/2006	hand slotted < 4mm	51	J	649000	6761108	1-Sep	-	27.7	21-33m
TPMB024	3/12/2006	hand slotted < 4mm	51	J	649084	6761083	24-Nov	3-May	35.1	31-49m
TPMB039	21/2/2007	hand slotted < 4mm	51	J	648734	6760774	21-Nov	3-May	37.2	30-48m
TPMB043	7/12/2006	hand slotted < 4mm	51	J	648875	6760915	24-Nov	-	DRY	18-36m
TPMB045	7/12/2006	hand slotted < 4mm	51	J	649158	6760633	21-Nov	-	46.3	41-59m
TPMB049	21/2/2007	hand slotted < 4mm	51	J	649158	6760915	-	4-May	38.6	32-50m
TPMB050	21/2/2007	hand slotted < 4mm	51	J	648875	6761198	24-Nov	4-May	33.1	27-45m
TPMB053	6/12/2006	hand slotted < 4mm	51	J	649017	6761340	21-Nov	2-May	36	24-42m
TPMB054	6/12/2006	hand slotted < 4mm	51	J	649158	6761198	21-Nov	3-May	36.5	30-48m
TPMB062	21/2/2007	hand slotted < 4mm	51	J	649158	6761481	24-Nov	3-May	38.5	25-43m
TPMB066	5/12/2006	hand slotted < 4mm	51	J	649441	6761481	21-Nov	2-May	44.6	29-47m
TPMB078	6/12/2006	hand slotted < 4mm	51	J	649583	6761905	22-Nov	2-May	44.8	32-50m

TPMB081	6/12/2006	hand slotted < 4mm	51	J	650007	6761481	22-Nov	2-May	50.6	39-57m
TPMB086	22/2/2007	hand slotted < 4mm	51	J	649865	6761905	22-Nov	2-May	49.6	36-54m
TPMB088	22/2/2007	hand slotted < 4mm	51	J	649583	6762188	22-Nov	2-May	40.8	27-45m
TPMB099	22/2/2007	hand slotted < 4mm	51	J	650007	6762330	22-Nov	1-May	38.2	27-45m
TPMB100	22/2/2007	hand slotted < 4mm	51	J	649865	6762471	24-Nov	3-May	48.3	32-50m
TPMB107	4/12/2006	hand slotted < 4mm	51	J	650007	6762612	22-Nov	1-May	34.3	24-36m
TPMB121	4/12/2006	hand slotted < 4mm	51	J	650290	6762895	22-Nov	1-May	31.4	23-41m
TPMB126	23/2/2007	hand slotted < 4mm	51	J	650431	6763037	23-Nov	3-May	31	9-27m
TPMB131	4/12/2006	hand slotted < 4mm	51	J	650431	6763320	23-Nov	1-May	25.9	32-44m
TPMB136	23/2/2007	hand slotted < 4mm	51	J	650855	6763178	23-Nov	30-Apr	29.6	28-46m
TPMB141	28/11/2006	hand slotted < 4mm	51	J	650714	6763602	23-Nov	30-Apr	26.7	30-48m
TPMB142	28/11/2006	hand slotted < 4mm	51	J	650855	6763461	21-Nov	30-Apr	27.5	29-41m
TPMB150	4/12/2006	hand slotted < 4mm	51	J	651138	6763744	23-Nov	29-Apr	26.1	38-56m
TPRC 041	2006	Uncased Drill hole	51	J	651137	6764450	1-Sep	-	26.4	
TPRC 094	2006	Uncased Drill hole	51	J	651206	6764674	1-Sep	-	23.7	
BP bore (reg.)	1984	unknown (probably manual > 4mm)	51	J	594305	6690190	1-Sep	-	2.7	
IB1 (reg.)	Before 2005	unknown (probably manual > 4mm)	51	J	623652	6753325	1-Sep	-	53.8	
IB2a (reg.)	Before 2005	unknown (probably manual > 4mm)	51	J	623899	6753262	1-Sep	-	DRY	
IB2b (reg.)	Before 2005	unknown (probably manual > 4mm)	51	J	623905	6753267	1-Sep	-	DRY	
MB7 100D (reg.)	1984	unknown (probably manual > 4mm)	51	J	575500	6679996	1-Sep	-	33.1	
WB (reg.)	1984	unknown (probably manual > 4mm)	51	J	577307	6676100	1-Sep	-	33.2	
WB#2 (reg.)	1984	unknown (probably manual > 4mm)	51	J	575172	6680822	1-Sep	-	33	

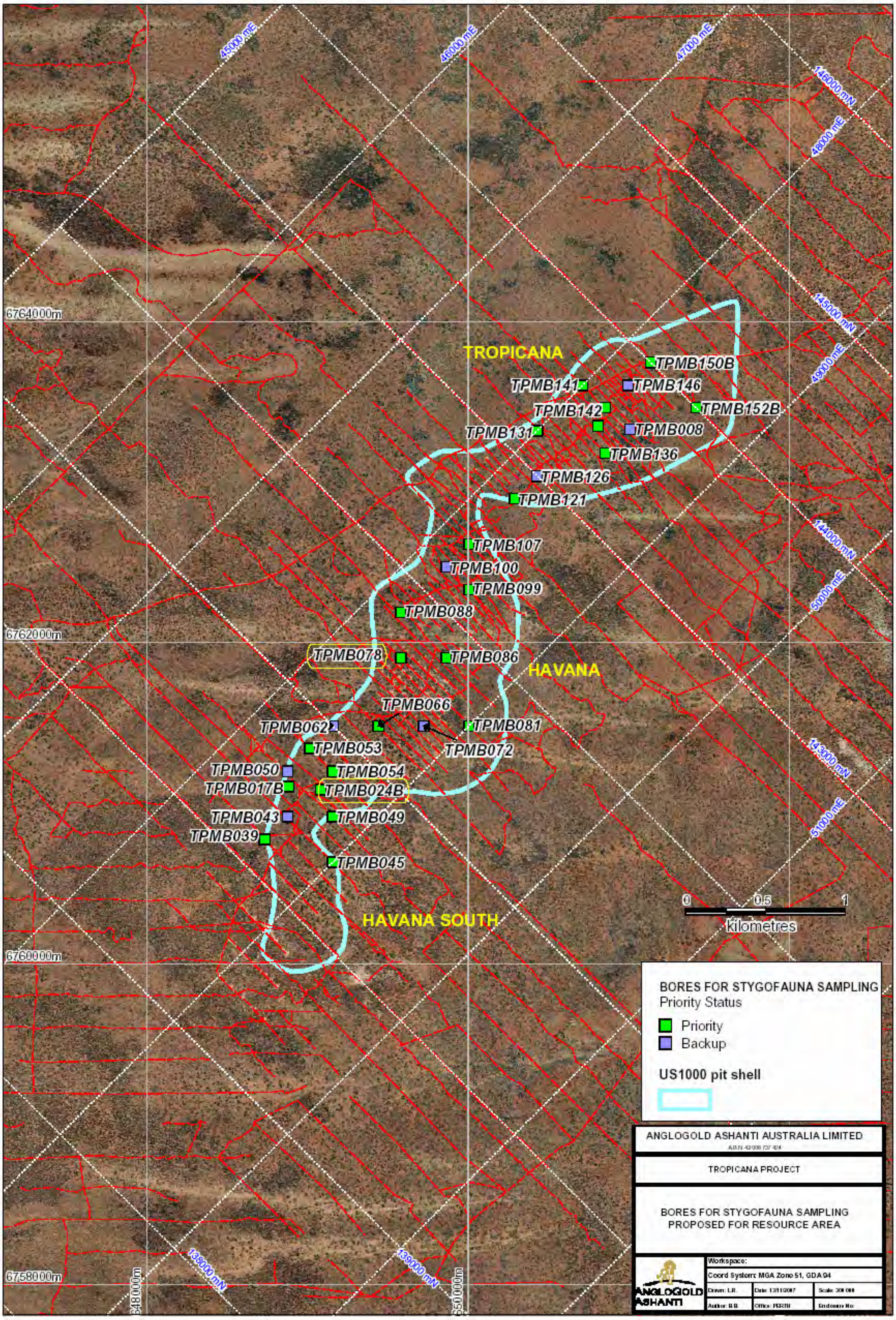
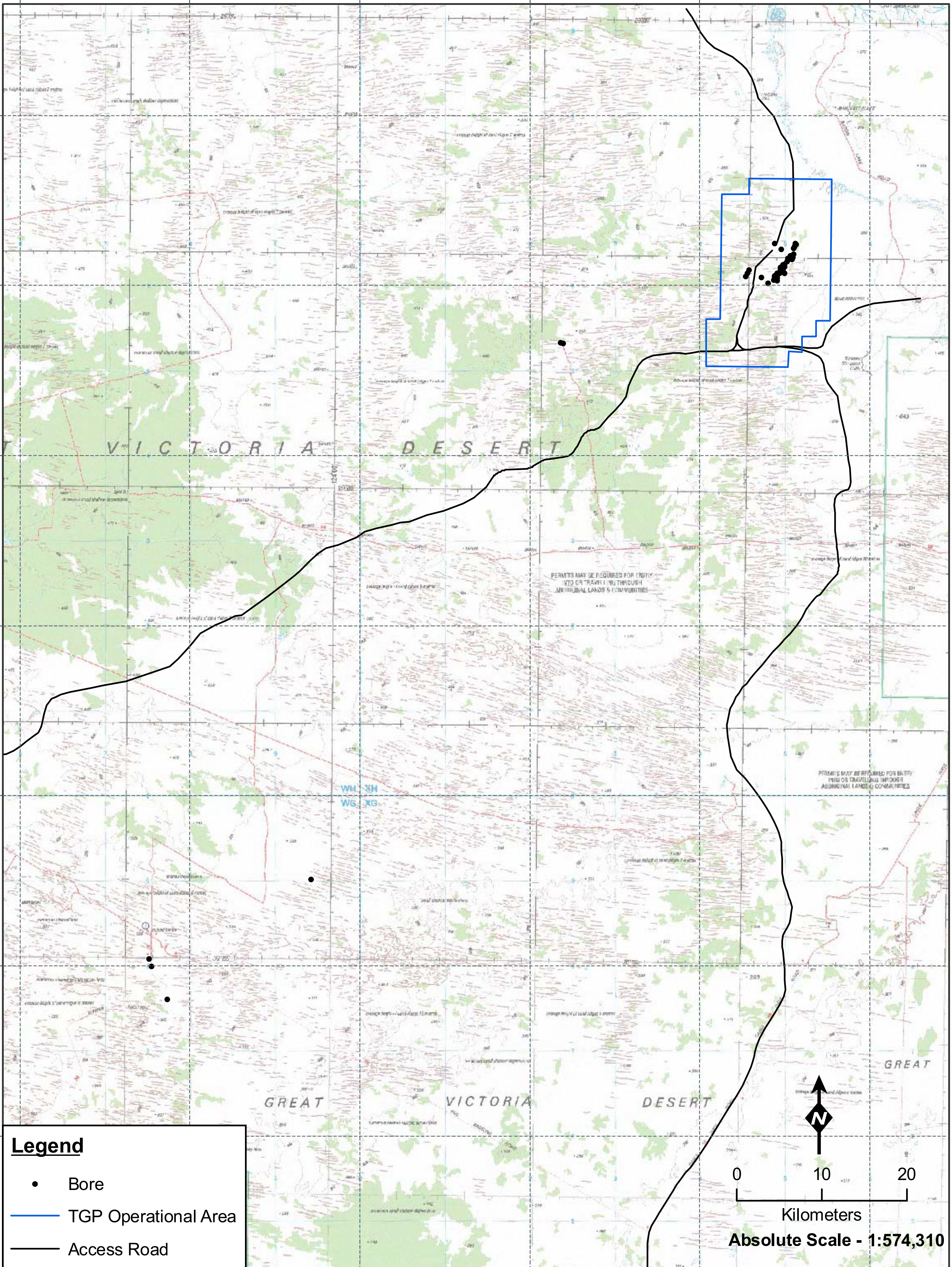


Figure 6 Location of Stygofauna Sampling Points (38 mm casing diameter) within the Resource Area (circled in yellow are bores that were not accessible for sampling at the time of the survey)



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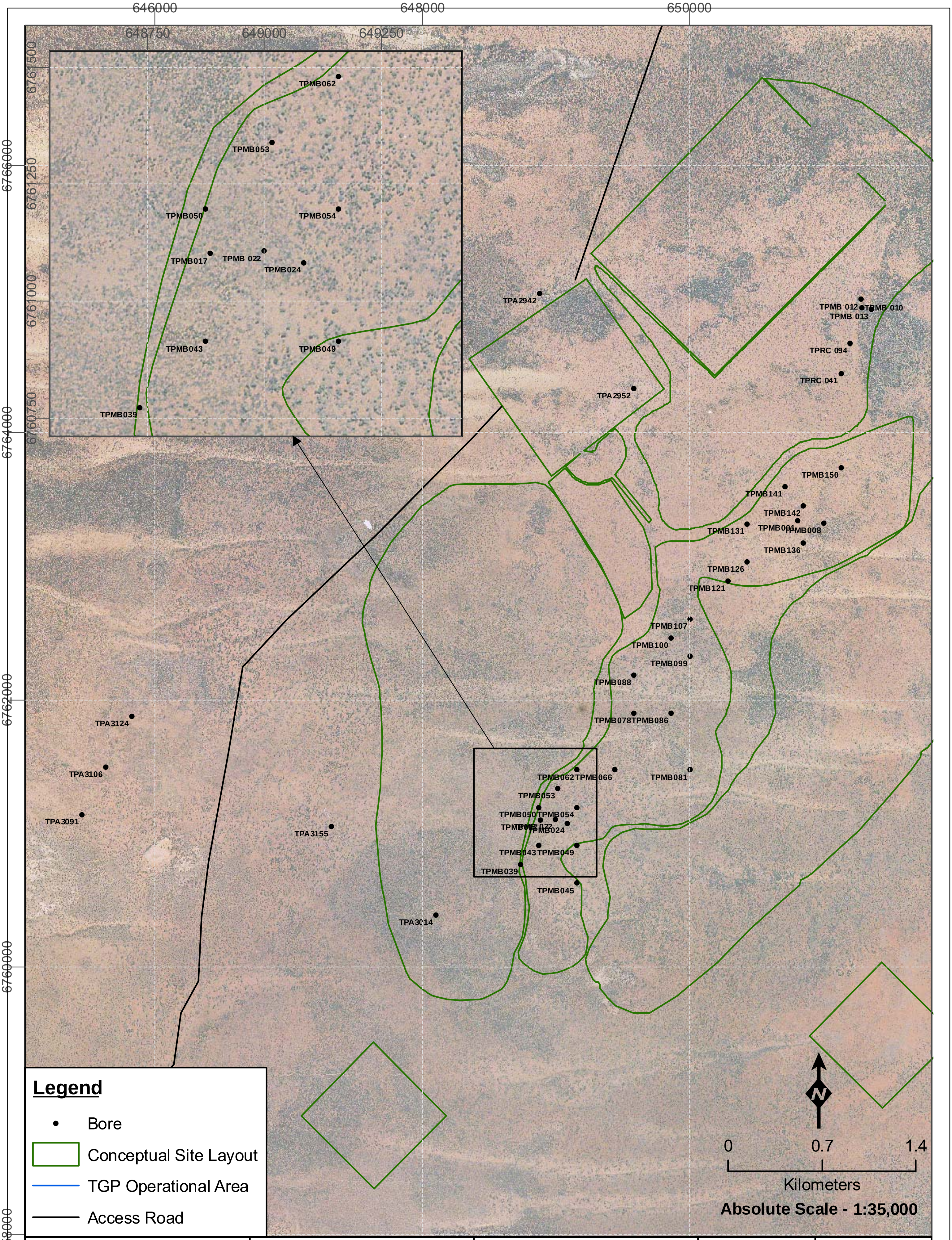
AngloGold Ashanti

Tropicana Sampled Bores

Figure: 7
Project ID: 858
Drawn: SG
Date: 24/02/09

Coordinate System
Name: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

A4



ecologia ENVIRONMENT

ANGLOGOLD ASHANTI

Tropicana Sampled Bores

Figure: 8
Project ID: 858

Drawn: SG
Date: 24/02/09

Coordinate System
Name: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

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3.2 Sampling methods

At each site, physical properties of the bore were recorded, including the size of the casing (mm) and the standing water level (m) using a standing water level meter (dipper). Water samples were drawn using a bailer submerged into the water column. The following physico-chemical parameters were measured from the sample:

- pH
- Temperature (°C)
- Dissolved Oxygen (DO) (ppm, % sat)
- Oxidation Reduction Potential (ORP) (mV)
- Conductivity (µS/cm)
- Total dissolved solids (TDS) (ppm)

Subsequently, each site was sampled by Stygofauna haul nets, following methods in the EPA Guidance Statement 54A (EPA 2007). Specifically, the entire water column was dragged a total of six times, using a 50 µm net three times and a 150 µm net a further three times (Table 3). The specific methods were as follows:

- an appropriate net diameter was chosen (most commonly 47 mm)*;
- the net was slowly lowered into the bore until it hit the bottom. Care was taken not to let the net free fall;
- once the net had reached the bottom of the bore, it was gently raised and lowered approximately 1 m, six times, to stir up the sediments at the bottom;
- the net was then slowly pulled up through the water column (<1 m/sec) in order to reduce the chance of animals avoiding capture by riding the bow wave at the top of the net;
- once the net was at the surface, it was immediately placed in a 50 µm Endicott sieve. The vial was removed from the net and all contents washed into the sieve using deionised water. The net was thoroughly rinsed over the sieve;
- the sieve contents were then washed into one corner and transferred into 120 mL preservation vials using absolute ethanol (100%);
- each vial was labelled with the date and bore name;
- after dragging the water column six times, all equipment was placed into a 25 L tub containing Decon90® for sterilisation to prevent cross-contamination of sites; and
- samples were kept on ice in the field and in a dark location before transportation to Perth; once in Perth, they were stored out of direct sunlight. Sample sorting was completed by scientists at *ecologia's* Perth laboratory. Where difficulties with identification arose, specimens were transferred to the relevant specialists.

*The casing size was found to differ across the sampled bores with the majority having a diameter of 38 mm. The DEC's standard net diameter is 50 mm, therefore smaller nets were designed for sampling of 38 mm diameter bores.

Table 3 Stygofauna Hauls Completed for Each Bore

Stygofauna sampled (no. of hauls and net size)			
Bore ID	**Sep-07**	**Nov-07**	**May-08**
TPA2942	-	-	3 x 3
TPA2952	-	-	3 x 3
TPA3014	-	-	3 x 3
TPA3091	-	-	3 x 3
TPA3106	-	-	3 x 3
TPA3124	-	-	3 x 3
TPA3155		-	3 x 3
TPMB001	-	3 x 3	3 x 3
TPMB008	-	3 x 3	2 (50 µm) x 1 (150 µm)
TPMB010	3 x 3, 50 mm OD	-	-
TPMB012	3 x 3, 50 mm OD	-	-
TPMB013	3 x 3, 50 mm OD	-	-
TPMB017	-	3 x 3	3 x 3
TPMB022	3 x 3, 50 mm OD	-	-
TPMB024	-	Blocked	Equipment stuck
TPMB039	-	3 x 3	3 x 3
TPMB043	-	3 x 3	DRY
TPMB045	-	3 x 3	3 x 3
TPMB049	-	-	3 x 3
TPMB050	-	3 x 3	3 x 3
TPMB053	-	Blocked	3 x 3
TPMB054	-	3 x 3	3 x 3
TPMB062	-	3 x 3	3 x 3
TPMB066	-	3 x 3	3 x 3
TPMB078	-	Blocked	
TPMB081	-	3 x 3	3 x 3
TPMB086	-	3 x 3	3 x 3
TPMB088	-	3 x 3	3 x 3
TPMB099	-	3 x 3	3 x 3
TPMB100	-	3 x 3	3 x 3
TPMB107	-	3 x 3	3 x 3
TPMB121	-	3 x 3	3 x 3
TPMB126	-	3 x 3	3 x 3
TPMB131	-	3 x 3	Equipment stuck
TPMB136	-	3 x 3	3 x 3
TPMB141	-	3 x 3	3 x 3
TPMB142	-	3 x 3	3 x 3
TPMB150	-	3 x 3	3 x 3
TPRC 041	3 x 3, 100 mm OD	-	-
TPRC 094	3 x 3, 100 mm OD	-	-
BP bore (reg.)	3 x 3, 50 mm OD	-	-
IB1 (reg.)	3 x 3, 50 mm OD	-	-
IB2a (reg.)	DRY	-	-
IB2b (reg.)	DRY	-	-
MB7 100D (reg.)	3 x 3, 100 mm OD	-	-
WB (reg.)	3 x 3, 100 mm OD	-	-
WB#2 (reg.)	3 x 3, 100 mm OD, hydrocarbon pollution	-	-
Sample size	**11**	**23**	**30**

3.3 Survey timing

The subterranean environment is generally stable throughout the year. Temperature and humidity is regulated by the depths of rock and soil. Although stygofauna rely on the level of the water table and continual water quality therein, annual changes in rainfall can have an effect on the subterranean environment by contributing to aquifers, possibly increasing the areas which can sustain stygofauna. Times of increased flow can alter water chemistry and may also cause detritus and organic matter to be flushed out removing valuable sources of nutrients.

In order to balance this effect, sample phases were performed during September 2007, November 2007 and May 2008. Based on available data from nearby locations, these periods are subject to different average rainfall.

3.4 Curation and Species Identification

Samples retrieved from bores were rinsed into a 50 µm sieve and transferred to vials containing 100% ethanol. These vials were packed securely to avoid damage upon return to the laboratory.

Where potential stygobitic species were collected and vouchered to be retained for reference, analysis was conducted by *ecologia* scientists. . Where identifications were beyond *ecologia's* available expertise, specimens were sent to taxonomic experts (see section 3.6 Stakeholder consultation).

3.5 Impact Risk Assessment

A risk assessment was undertaken to determine potential impacts arising from the development on stygofauna and the residual impacts following the implementation of management strategies identified in this document. Significance of the risks is classified as either "High" (site/issue specific management programmes required, advice/approval from regulators required), "Medium" (specific management and procedures must be specified) or "Low" (managed by routine procedures).

3.6 Stakeholder consultation

The terrestrial isopod expert, Dr Simon Judd (Edith Cowan University), has been consulted about the troglobitic isopod collected in bore TPMB100.

3.7 Survey Team

The *ecologia* staff involved in planning, coordination and execution of the TGP Stygofauna Survey are listed below.

Name	Qualifications	Position
Jarrad Clark	BSc.(Environmental Management)	Project Manager 1/ Senior Invertebrate Zoologist
Magdalena Davis (Zofkova)	PhD (Zoology)	Project Manager 2 / Manager Invertebrate Sciences
Melissa White	BSc. (Mar. Biol/Zool) Hons	Invertebrate Zoologist
Nicki Thompson	BSc. Zool. (Marine & fish. Biol.)	Invertebrate Zoologist

4.0 RESULTS

4.1 Biological

Sampling was conducted within and outside the operational area during September 2007, November 2007 and May 2008 (Table 3, Figure 6, Figure 7 and Figure 8).

During September 2007 samples were collected from 11 bores (Table 3, Figure 7). No stygobitic species or species of conservation concern were yielded from this survey.

During November 2007, stygofauna samples were taken from 23 bores (Table 3, Figure 6 and Figure 8). Processing of samples in the lab yielded mites, collembolans, oligochaetes, a pseudoscorpion and an isopod, representing a by-catch of troglobitic or deep-litter-dwelling organisms that fell into the bore. No stygobitic species were found.

In May 2008, stygofauna sampling was conducted in 30 bores located across the resources areas (Table 3, Figure 6 and Figure 8). Processing in the lab yielded mites, collembolans and insects, identified as a by-catch of troglofilic or deep-litter-dwelling organisms that fell into the bore. No stygobitic species were found.

In summary, no stygofauna was found within or outside the TGP operational area during the survey.

4.2 Water Chemistry

Six physico-chemical parameters (Temperature, pH, Conductivity, Total Dissolved Solids, Oxidation Reduction Potential and Dissolved Oxygen) were measured in the field from water collected in each of the bores. The average data for each survey are presented in Table 4 for comparison among the different phases, whereas individual bore data for each survey are presented in Table 5, Table 6 and Table 7.

The depth to water from surface ranged from 27.02 m in September 2007 to 36.15 m in November 2007. However, different sets of bores were sampled during these phases, therefore comparison between November 2007 and May 2008 showing a fluctuation from 36.15 m to 31.78 m was more appropriate as there was an overlap in sampling sites.

The water temperature recorded in the bores ranged from a mean of 26.95°C during November to a mean of 23.0°C during May 2008.

The Dissolved Oxygen concentration ranged from 2.07 ppm and 23.93 % sat. to 3.94 ppm and 36.91% sat.

The pH of the water sampled during this survey ranged between 6 and 7.

The Conductivity and TDS ranged from 7.26 mV and 3.33 g/L in November 07 to 23.52 mV and 16.50 g/L in September 2007. However, different sets of bores were sampled during these phases, therefore comparison between November 2007 and May 2008 showing a fluctuation from 7.26 mV and 3.33 g/L to 18.64 mV and 12.04 g/L was more appropriate as there was an overlap in sampling sites.

Table 4 A Comparison of Water Chemistry Data Averaged for Each Survey Phase

Date	DTW (m)	Total Depth (m)	pH	Temp	D.O. (ppm)	D.O. (%sat.)	ORP (mV)	Cond (mS/cm)	TDS (g/L)
Sep-07	27.02	-	6.79	23.59	3.39	-	51.91	23.52	16.50
Nov-07	36.15	47.12	6.71	26.95	2.07	23.93	39.29	7.26	3.33
May-08	31.78	44.84	6.69	23.00	3.94	36.91	40.93	18.64	12.04

Table 5 Water Chemistry Data Taken at Each Bore During September 2007

Bore ID	DTW [mbgl]	pH	Temp. [◦C]	Oxygen [ppM]	ORP [mV]	Conduct. [mS]	TDS [g/L]
TPMB 010	20.23	6.82	21.1	5.5	205	22.1	14.02
TPMB 012	20.21	6.6	24.2	1.34	-69	32.4	21.4
TPMB 013	22.61	6.8	25.3	1.57	-140	39.9	27.7
TPMB 022	27.66	6.7	20.6	4.15	144	20.55	13.1
TPRC 094	23.7	6.3	27	2.22	150	51.1	35.1
TPRC 041	26.40 on angle	6.7	26.4	5.3	155	38	26.4
WB#2	33	6.7	22.7	2.51	-127	0.31	1.62
MB7 100D	33.14	6.8	23.3	2.81	-22	18.95	19.7
WB	33.22	8.9	22.5	2.33	-31	25.6	16.6
BP bore	2.67	5.5	22.5	4.78	180	2.49	1.43
IB1	53.8	6.9	23.9	4.74	126	7.3	4.4
IB2a	DRY						
IB2b	DRY						
Mean	*27.02*	*6.79*	*23.59*	*3.39*	*51.91*	*23.52*	*16.50*

Table 6 Water Chemistry Data Taken at Each Bore During November 2007

Bore	DTW (m)	Total Depth (m)	pH	Temp	D.Oxygen (ppM)	D.Oxygen (%sat.)	ORP (mV)	Cond (mS/cm)	TDS (g/L)
TPMB053	35.97	47.00	-	-	-	-	-	-	-
TPMB054	36.50	48.00	6.88	26.30	3.41	44.20	70.00	6.14	3.79
TPMB062	38.48	43.00	6.45	30.40	2.54	23.20	158.00	0.51	0.291
TPMB066	44.63	47.00	6.76	26.70	1.37	14.50	-169.00	1.24	0.807
TPMB078	44.80	51.00	6.48	27.50	1.25	14.20	-106.00	1.32	8.51
TPMB081	50.56	57.00	6.84	26.50	1.99	21.20	30.00	1.78	0.166
TPMB086	49.64	54.00	7.19	26.70	1.85	20.50	52.00	0.15	0.108
TPMB088	40.76	45.00	6.75	26.60	1.61	19.20	-28.00	0.27	0.156
TPMB099	38.16	45.00	6.18	26.50	2.77	28.40	246.00	0.00	0.0002
TPMB100	48.25	50.00	7.36	30.40	1.30	15.60	17.00	0.63	0.337
TPMB107	34.34	39.00	6.38	28.50	1.25	16.00	-54.00	19.53	13.78
TPMB017	34.30	51.00	6.50	23.20	1.75	21.50	128.00	0.00	0.0008
TPMB024	35.08	49.00	6.55	25.20	5.05	54.20	136.00	0.05	0.027
TPMB039	37.22	48.00	7.00	28.20	1.15	17.00	76.00	7.96	4.95
TPMB043	DRY	36.00	DRY						
TPMB045	46.27	50.00	6.81	27.20	1.42	15.00	-70.00	41.20	1.99
TPMB050	33.12	45.00	6.77	27.20	1.80	19.10	146.00	0.12	0.0695
TPMB001	28.86	59.00	7.18	29.20	2.20	26.20	-130.00	0.00	0.0013
TPMB008	28.65	43.00	7.01	27.50	1.80	18.70	108.00	0.08	0.0382
TPMB121	31.37	41.00	6.59	28.30	1.63	19.80	50.00	24.47	16.18
TPMB126	31.02	39.00	6.42	23.20	1.35	18.00	-37.00	24.47	16.25
TPMB131	25.92	47.00	6.12	23.00	1.40	12.80	-105.00	0.28	0.201
TPMB136	29.61	46.00	6.41	24.70	3.25	47.70	81.00	18.11	11.91
TPMB141	26.66	48.00	6.60	27.30	3.78	39.50	123.00	1.66	0.0727
TPMB142	27.48	42.00	7.38	27.40	2.61	35.10	114.00	0.29	0.135
TPMB150	26.07	55.00	6.52	29.00	1.17	12.80	107.00	23.90	0.01606
Mean	*36.15*	*47.12*	*6.71*	*26.95*	*2.07*	*23.93*	*39.29*	*7.26*	*3.33*

Table 7 Water Chemistry Data Taken at Each Bore During May 2008

Bore	DTW (m)	Total Depth (m)	pH	Temp	D.Oxygen (ppM)	D.Oxygen (%sat.)	ORP (mV)	Con (mS/cm)	TDS (g/L)
TPMB 001	28.82	55	6.9	24.08	1.28	14.9	-241	42.4	27.1
TPMB 008	29.3	44.39	6.78	25.58	3.39	41.3	31	22.7	14.6
TPMB 121	31.41	41	6.36	23.46	4.78	45.9	2	0-35?	0.4
TPMB 126	31.13	37.32	6.26	25.93	1.5	22.1	-118	44.1	28.2
TPMB 131	26.3	43	6.31	24.95	5.86	35.6	-246	-12.91	8
TPMB 136	29.72	43	6.4	23.21	3.1	44	7.3	32.2	20.6
TPMB 141	25.78	43	6.89	20.9	3.96	37.4	158	0.055	0
TPMB 142	27.52	39.98	7.38	18.89	8.79	66	107	0.01	0
TPMB 150	26.82	57	6.46	23.63	4.48	47.1	179	37.5	24.2
TPMB 053	36.24	43.66	7.01	24.16	12.4	24.3	-133	12.4	7.9
TPMB 054	37.05	45.52	6.81	19.3	4.3	47.7	101	12.53	8
TPMB 062	38.61	41.97	6.44	25.01	1.28	13.6	8.6	22	14.1
TPMB 066	44.77	48.06	6.56	24.58	0.96	12.5	106	25.4	16.5
TPMB 078	45.06	49	6.58	22.76	1.83	21.5	113	19.9	12.7
TPMB 081	51.4	54.6	6.72	23.68	3.21	27.4	100	17.2	11
TPMB 086	49.3	53	missing	22.13	4.36	41	68	11.38	7.3
TPMB 088	6.75	43.77	6.75	17.6	4.34	51.8	102	0.001	0
TPMB 099	38.07	45.59	6.58	22.87	4.1	43	-17	0	0
TPMB 100	38.62	47.4	6.49	26.18	2.02	25	-14	31.7	20.3
TPMB 107	34.45	37	6.95	23.9	3.5	35.8	-281	34.6	22.1
TPMB 017	34.96	49	6.64	22.09	4.26	57.1	124	17.3	10.9
TPMB 024B	35.6	47	7.06	22.4	6.39	71	109	7.92	5.1
TPMB 039	37.34	44.88	6.79	24.13	1.23	14.9	-98	11.93	7.6
TPMB 049	38.56	49	6.64	22.67	4.37	51.9	150	15.7	10.1
TPMB 050	33.71	43.56	6.73	21.65	2.1	26	190	16.9	9.3
TPA 2942	27.09	47.89	6.78	23.93	3.2	38	107	7.61	4.9
TPA 2952	25.56	58.15	6.36	25.34	1.74	23.4	38	49.8	31.9
TPA 3124	16.23	19.58	7.03	21.06	3.53	37.4	144	8.3	5.3
TPA 3014	32.04	57.56	6.76	22.89	5.64	47.61	117	13.13	8.3
TPA 3106	14.63	18.77	6.98	20.74	7.61	41.5	161	12.02	7.7
TPA 3091	21.34	34.6	6.62	22.94	3.4	36.3	117	39.6	25.4
TPA 3155	22.82	51.54	6.52	23.12	3.13	38.1	118	24.6	15.7
Mean	*31.78*	*44.84*	*6.69*	*23*	*3.94*	*36.91*	*40.93*	*18.64*	*12.04*

5.0 DISCUSSION

Some of the physico-chemical parameters measured showed fluctuation, especially depth to water (approx. 5 m), temperature (approx. 4°C) and conductivity / TDS (approx 10mV/ 9 g/L), reflecting the dynamics of the dry and wet cycles. Parameters such as pH and Dissolved Oxygen remained relatively stable, which is typical of ground waters throughout Western Australia and elsewhere, where no photosynthetic plants are available to supply oxygen / carbon dioxide into the system. Nonetheless, even the extreme values of the parameters measured were suitable for stygofauna habitation (*ecologia*, unpublished data).

Slotting size of bore casings presented a moderate limitation to the survey and may have affected the results. The majority of bores inside and outside of the operational area had casings with slotting size smaller than 3 mm and some had slotting sizes of 1 mm only. The small slotting size may have accounted for the lack of larger stygofauna as they would be unable to penetrate the casing. On the other hand, the slotting size does not explain the lack of common microscopic stygofauna (i.e. copepods) for which the slotting size did not present a barrier. Moreover, regional bores sampled outside the operational area were relatively old (10+ years) and thus it was assumed that their casings have been slotted manually (as was the practise at the time), resulting in slots larger than 3 mm and thus allowing potential larger stygofauna inside the bore (B. Bastow, AGA, pers. comm.).

As stygobitic species range in size (juvenile to adult) from 0.05mm to 2mm (copepods and ostracods), 0.05-5mm (annelids) and 1-25mm (isopods and amphipods), juveniles (if not adults or sub-adults) would have been found during the survey should stygofauna be present in the area, regardless of the small slotting size of the casing. However, none were recorded. Although this could in some instances present a false negative (stygofauna being actually present in the aquifer but not collected during the sampling) due to a limited sampling program or colonising conditions, this is highly unlikely in this instance. This is because the sample design was extensive (50% larger than required by the EPA guideline 54 and Appendix 54A) and the age of the bores was sufficient for colonisation by any potential stygofauna in the area (Table 2) - of the total 64 samples, 57 samples were collected from bores that were over 6 months old (10+ years on occasion) and 7 samples from bores 3-6 months old.

A valid explanation of the lack of stygofauna within the Tropicana Gold Project Area may come from historical geological events. Tropicana is located at the edge of the Eucla Basin close to the border of the Officer Basin at the delta of several palaeodrainage systems (Figure 9). The palaeovalley system adjacent to the Eucla basin is estimated to have begun to fill with sediment by the late Middle-Late Eocene as the coastline migrated further inland (Hou *et al.* 2008). This Marine incursion would have altered the aquatic habitat from fresh (or hyposaline) to saline which are conditions unsuitable for many stygofauna. If stygofauna occurred in this area, they may have been initially able to move between tributaries of the higher permeable drainage systems. However, the marine incursion coupled with the sediment deposition would have gradually decreased the available habitat to the point where relict stygofauna would be restricted to isolated tributaries north of Tropicana or become extinct (Figure 10). After the marine incursion receded, subterranean re-colonisation would be seriously impeded, both by the distance of the nearest stygofauna refugium as well as by the sedimentary clay barriers deposited around Tropicana (B. Bastow, AGA, 2009). A hypothetical event of adaptation and colonisation of the newly available subterranean environment from the surface aquatic organisms would be impeded by the fact that no permanent fresh of hyposaline surface water existed in the area (B. Bastow, AGA, 2009). Similar examples exist elsewhere in Australia. In the Pilbara region, closely related amphipod species reflect the historical drainage patterns of the area as tributary boundaries act as barriers that prevent gene flow among populations (Finston *et al.* 2009). Similarly, the karst systems of the Nullarbor plain (the largest karst system in the world), which has been inundated completely by marine incursion, harbours only a single species of a stygobitic amphipod of a marine origin (Notenboom 1991; Bradbury *et al.* 2000; Humphreys 2008)

In summary, the fact that no stygobitic species, large or small, were found inside or outside the survey area, coupled with the historical marine incursion events making the groundwater inhabitable, suggests that the groundwater habitat within the survey area is most likely devoid of stygofauna.

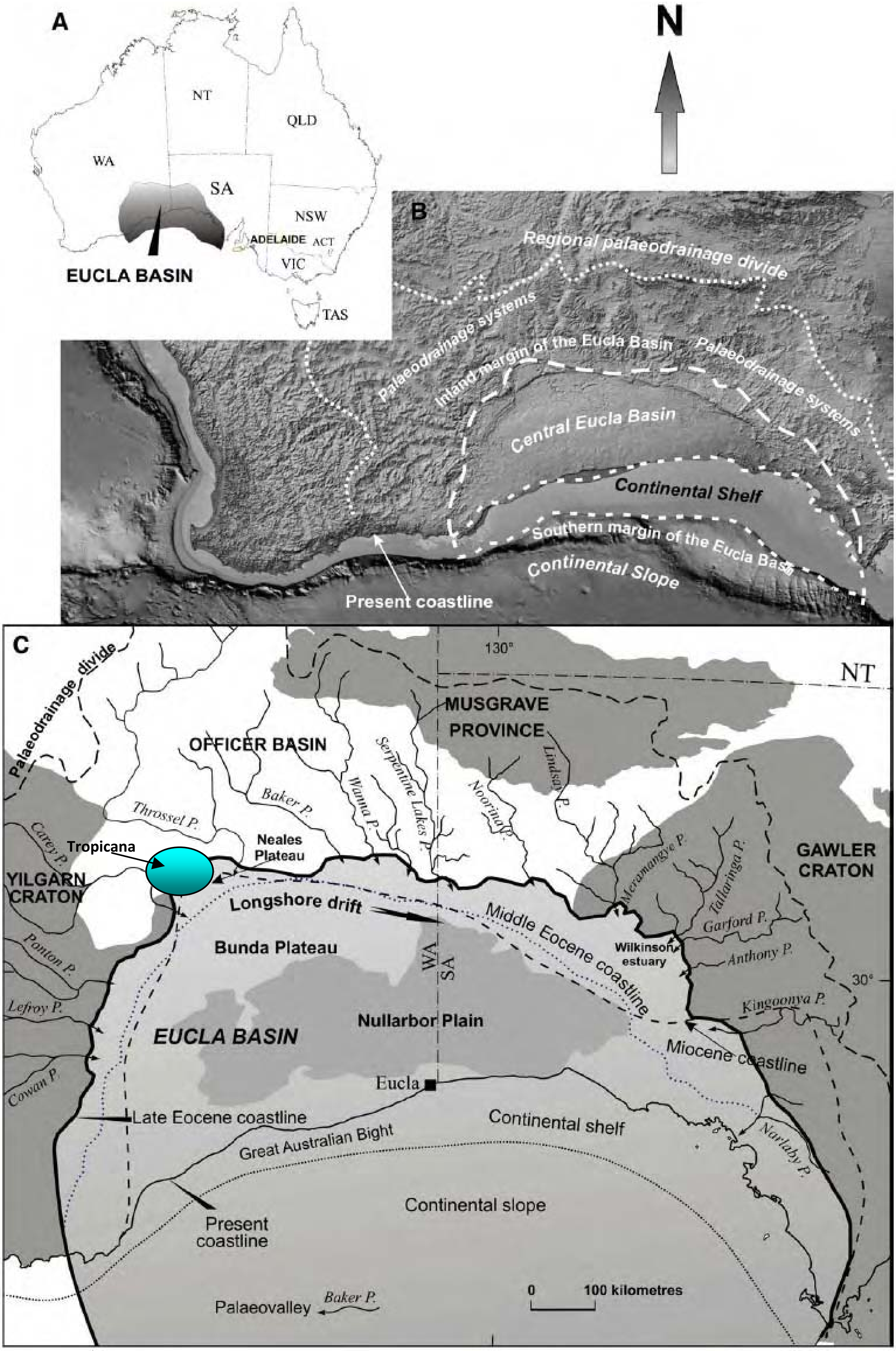

Figure 9 Approximate Location of Tropicana in Relation to the Eucla Basin (Hou *et al.* 2008)

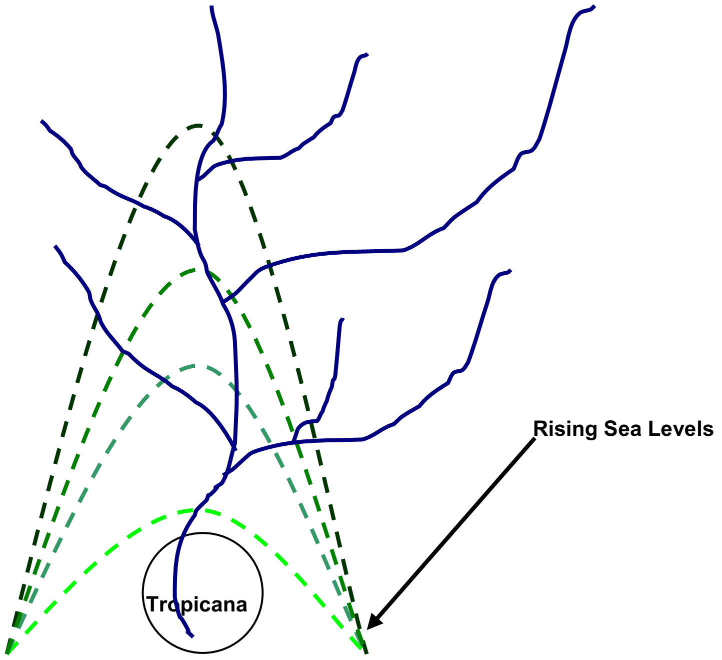

Figure 10 Hypothetical Schematic Diagram of the Process of Isolation / Extinction of Hypothetical Stygofauna Populations by Marine Incursion. As the Sea Levels Rise the Tributaries Become Isolated From Each Other With Saline Water and Sediment Deposition Preventing Movement of Stygofauna Thereby Creating Vastly Isolated Populations or Causing Extinction.

6.0 RISK ASSESSMENT

Three risks have been identified with respect to potential impacts to stygofauna in the operational area, all related to a reduction or a loss of stygobitic habitat (Figure 8). These are:

1. Direct impact on stygofauna habitat from open-pit mining. This risk has been classified as low due to the apparent lack of stygofauna within the project. No specific controls are required.
2. Groundwater draw-down. This risk has been classified as low due to the lack of Stygofauna within the operational area. No specific controls are required.
3. Contamination of aquifers. This risk has been classified as medium due to an unknown number of aquifers that may exist in the areas surrounding the operational area. After applying the specific controls (see Table 8 and Table 9), this risk has been also reduced to low.

Table 8 Stygofauna Impact Risk Assessment

Stygofauna Impact Risk Assessment												
Project: AGAA Tropicana		*Location:* Tropicana, Great Victoria Desert					*Date: 20/10/2008*					
			Inherent Risk					Residual Risk				
Risk Issue	**Aspect (Event)**	**Impact**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**	**Controls**	**Likelihood**	**Consequence**	**Risk Level**	**Significance**
Mine Site											
Direct impact on Stygofauna habitat	Reduction of groundwater habitat due to open-pit excavation	Loss or reduction in stygofauna habitat resulting in a reduction or loss of stygofauna species / communities	1	3	3	**Low**	No controls required as risk is already Low				**Low**
Groundwater draw-down	Reduction of groundwater recharge / inflow resulting in lower groundwater table.	Loss or reduction in stygofauna habitat resulting in a reduction or loss of stygofauna species / communities	1	3	3	**Low**	No controls required as risk is already Low				**Low**
Contamination of Aquifers	Nutrient, Heavy Metals or other pollutants change the chemistry of groundwater and thus of the stygofauna habitat	Loss of stygofauna species / communities beyond the Project footprint area	2	3	6	**Med**	Implementation of a routine monitoring program is recommended to enable early detection of any aquifer pollution and a speedy identification and containment of its source	1	3	3	**Low**

Table 9 Stygofauna Risk Assessment Matrix

Likelihood:		
Value	**Description**	**Criteria**
5	Almost Certain	Environmental issue will occur, is currently a problem or is expected to occur in most circumstances.
4	Likely	Environmental issue has been a common problem in the past and there is a high probability that it will occur in most circumstances.
3	Possible	Environmental issue may have arisen in the past and there is a high probability that it could occur at some time.
2	Unlikely	Environmental issue may have occurred in the past and there is a moderate probability that it could occur at some time but not expected.
1	Rare	Environmental issue has not occurred in the past and there is a very low probability that it may occur in exceptional circumstances.

Consequence:		
Value	**Description**	**Criteria**
5	Catastrophic	Significant impact to fauna species of conservation significance or regional
4	Major	Impact to fauna species of conservation significance in project area.
3	Moderate	Loss of fauna biodiversity in project area.
2	Minor	Short term or localised impact to fauna biodiversity.
1	Insignificant	No impact to fauna of conservation significance or biodiversity.

Table 9 cont.

Risk Matrix:

CONSEQUENCES	Risk Assessment Rating	LIKELIHOOD: 5 ALMOST CERTAIN Is expected to occur in most circumstance	4 LIKELY Will probably occur in most circumstance	3 POSSIBLE Could occur	2 UNLIKELY Could occur but not expected	1 RARE Occurs in exceptional circumstances
	5 - CATASTROPHIC Significant impact to fauna species of conservation significance or regional biodiversity	25	20	15	10	5
	4 - MAJOR Impact to fauna species of conservation significance in project area.	20	16	12	8	4
	3 - MODERATE Loss of fauna biodiversity in project area.	15	12	9	6	3
	2 - MINOR Short term or localised impact to fauna biodiversity.	10	8	6	4	2
	1 - INSIGNIFICANT No impact to fauna of conservation significance or biodiversity.	5	4	3	2	1

12-25	High risk, site/issue specific management programmes required, advice/approval from regulators required.
6 – 10	Medium risk, specific management and procedures must be specified.
1 – 5	Low risk, managed by routine procedures.

7.0 MANAGEMENT RECOMMENDATIONS

Implementing a routine monitoring programme is recommended for the duration of the project in order to detect any potential pollution to the aquifers surrounding the operational area. Other risks associated with the potential impact on stygofauna within the operational area have been identified as low and thus do not require any specific controls.

8.0 REFERENCES

Barton, B., and Cowan, M. 2001a. Great Victoria Desert 1 (GVD1 – Great Victoria Desert Shield subregion). CALM, SEPTEMBER 2001

Barton, B., and Cowan, M. 2001b. Great Victoria Desert 2 (GVD2 – Great Victoria Desert Central subregion). CALM, SEPTEMBER 2001

Beard, J. S. 1975. Pilbara. Explanatory notes to Sheet 4, 1:1,000,000 Series Vegetation Survey of Western Australia. Univ. of W.A. Press.,

Bradbury, J. H., and Eberhard, S. 2000. A new stygobiont melitid amphipod from the Nullarbor Plain. Records of the Western Australian Museum. 20:39-50.

ecologia Environment. 2006. Honeymoon Well Project Stygofauna Survey - Phase 2. Unpublished report to Lionore Australia Pty Ltd., August 2006

EPA. 2003. Guidance for the Assessment of Environmental Factors, Statement No. 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia. EPA, December 2003

EPA. 2007. Guidance for the Assessment of Environmental Factors, Statement No. 54a (Technical Appendix to Guidance Statement no. 54): Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia. Environmental Protection Authority,

Finston, T. L., Francis, C. J., and Johnson, M. S. 2009. Biogeography of the stygobitic isopod *Pygolabis* (Malacostraca: Tainisopidae) in the Pilbara, Western Australia: Evidence for multiple colonisations of the groundwater. Molecular Phylogenetics and Evolution. 52:448-460.

Hou, B., Frakes, L. A., Sandiford, M., Worrall, L., Keeling, J., and Alley, N. F. 2008. Cenozoic Eucla Basin and associated palaeovalleys, southern Australia - Climatic and tectonic influences on landscape evolution, sedimentation and heavy mineral accumulation. Sedimentary Geology. 203:112-130.

Humphreys, W. F. 2008. Rising from Down Under: development in subterranean biodiversity in Australia from a groundwater fauna perspective. Invertebrate Systematics. 22:85.

Kalaitzis, P., Koomberi, H., Commander, P., and Johnson, S. 2002. Managing groundwater abstraction in the palaeochannels of Western Australia: Intergenerational equity and other challenges. Pp. 22-30 *in* Ho, G., and Mathew, K., eds. Sustainability of Water Resources International Conference: Water and Environment Series. IWA Publishing Western Australia.

Mamonier, P., Vervier, P., Gilbert, J., and Dole-Oliver, M. J. 1993. Biodiversity in Groundwaters. Tree. 8:392 - 395.

Notenboom, J. 1991. Marine regressions and the evolution of groundwater dwelling amphipods (Crustacea). Journal of Biogeograpgy. 18:437-454.