



# Taroborah Coal Project

## Appendix 20 – Stygofauna Survey





# **Taroborah Coal Project**

## **Stygofauna Survey – Pilot Study**

Prepared for:  
**Shenhua International Group Pty Ltd**

October 2013



## Document History and Status

Issue	Rev.	Issued To	Qty	Date	Reviewed	Approved
Draft	1	Shenhua Group	1	19.12.11	AGP	ABP
Final	2	Shenhua Group	1	21.02.12	PPJ	ABP
Final Rev1	3	Shenhua Group	1	03.10.13	PPJ	ABP

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<b>Name of Client :</b>	Shenhua International Group Pty Ltd
<b>Name of Project:</b>	Taroborah Coal Project
<b>Title of Document:</b>	Stygofauna Survey
<b>Document Version:</b>	Final Rev1

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## LIST OF ABBREVIATIONS

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%	-	Percent
AARC	-	AustralAsian Resource Consultants
ALS	-	Australian Laboratory Services
bgl	-	Below Ground Level
°C	-	Degrees Centigrade
CHPP	-	Coal Handling and Preparation Plant
DO	-	Dissolved oxygen
EC	-	Electrical Conductivity
EHP	-	Department of the Environment and Heritage Protection
EIS	-	Environmental Impact Statement
EPA	-	Environmental Protection Authority
EPC	-	Exploration Permit of Coal
GDA94	-	Geocentric Datum of Australia 1994
km	-	Kilometre
m	-	Metre
µm	-	Micrometre
µS/cm	-	Micro Siemens per Centimetre
MDL	-	Mineral Development License
Mtpa	-	Million Tonnes per Annum
ORP	-	Oxygen Reduction Potential
ppt	-	parts per thousand
ToR	-	Terms of Reference
WA	-	Western Australia

## EXECUTIVE SUMMARY

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The Australian Laboratory Services Water Sciences Group was commissioned by AustralAsian Resource Consultants Pty Ltd to assess the presence, abundance and community composition of Stygofauna in groundwater at the Taroborah Project site (The Project). This work constitutes one of the baseline studies required for the Project's Environmental Impact Statement.

This study was conducted in accordance with the *Western Australia Environmental Protection Authority Guidance Statement 54 and 54a*. This is a requirement of the Department of Environment and Resource Management, as there are no Queensland-specific stygofauna sampling guidelines.

It should be noted that the sampling locations for the Pilot study were determined in accordance with Section 3.12 of the *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia* (EPA, 2007), which states a low sampling effort can be used to determine whether a project has significant subterranean faunal values. If this study reveals significant subterranean fauna a more intensive investigation is likely to be required.

Seven groundwater samples were collected from bores located on the Project site as part of a pilot survey that was conducted in September 2011. The purpose of the pilot study is to determine whether a more detailed survey is required to sample all stygofauna on the Project site and in the surrounding area. During the pilot study no stygofauna were identified in the groundwater samples from the sampled bores on the Project site.

Therefore, no further stygofauna sampling has been planned due to the lack of any significant subterranean fauna populations being sampled during the Pilot study.



## **1.0 INTRODUCTION**

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The Australian Laboratory Services (ALS) Water Sciences Group was commissioned by AustralAsian Resource Consultants Pty Ltd (AARC) to assess the presence, abundance and community composition of stygofauna in groundwater at the Taraborah Coal Project site (the Project). This work constitutes one of the baseline studies required for the Project's Environmental Impact Statement (EIS).

This study provides an assessment for the presence of stygofauna both on and off the Project site and whether or not the proposed mining activities (construction, operation and decommissioning) could have an impact upon the local stygofauna community (if present).

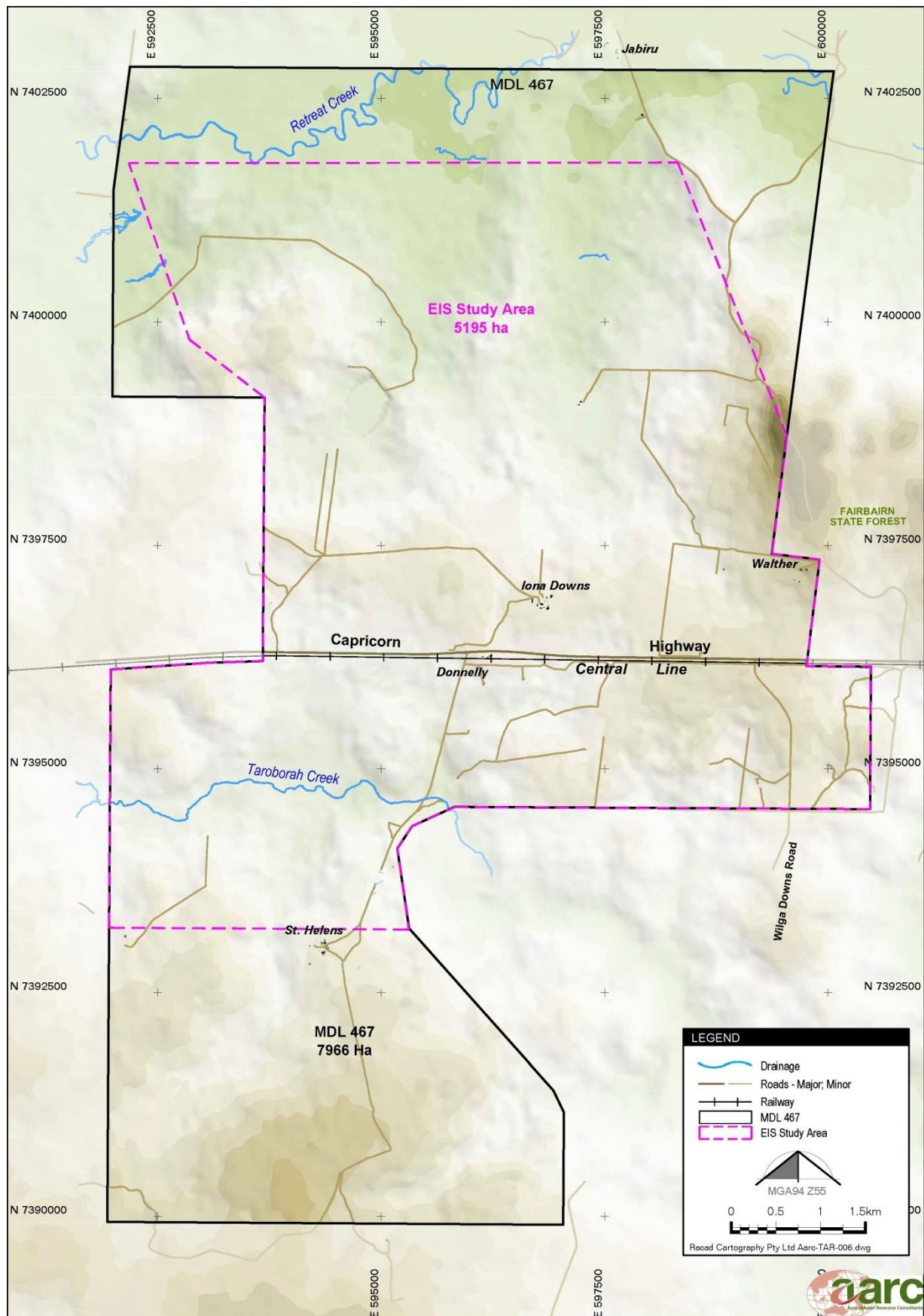
### **1.1 PROJECT DESCRIPTION**

Shenhua has proposed a new coal mining operation in Central Queensland. The Project site is located in the Central Highlands District of Central Queensland (within Queensland's Bowen Basin) approximately 258 kilometres (km) east of Rockhampton and 286 km south-west of Mackay. The closest residential area to the Project is the township of Emerald, located approximately 18 km east of the Project site.

The Project is focused on mining thermal coal deposits, by way of open-cut and underground mining, for which an EIS is being prepared. Shenhua currently holds a Mineral Development License (MDL) – MDL467 which covers the Project site, which has been reduced in size from the original Exploration Permit for Coal (EPC) 1011 lease (refer to Figure 1 for Project location details).

The project includes an eventual mining rate of up to approximately 2.28 Million tonnes per annum (Mtpa) for the open-cut operation and up to approximately 5.75 Mtpa for the underground operation, based on extraction techniques utilised. The development of an onsite Coal Handling and Preparation Plant (CHPP) is also proposed.

As with all baseline studies, the stygofauna survey programme was conducted in accordance with the Project's Terms of Reference (ToR).



**Figure 1 Taraborah Project Site**

## 1.2 DEFINITION OF STYGOFAUNA

Stygofauna are microscopic, aquatic animals that live in groundwater. Communities are often dominated by crustacean invertebrates, but also contain oligochaetes, insects, other invertebrate groups and occasionally fish. Stygofauna are known from limestone, calcrete, and fractured rock aquifers, but appear most abundant in alluvial aquifers (Hancock and Boulton, 2008). The main cause of concern for stygofauna in areas where development extends below the water table is that there is a high degree of endemism among species (Western Australia (WA) Environmental Protection Authority (EPA) 2003, 2007). Therefore, with many species restricted to very small geographical areas, development approvals need to be considered carefully to avoid species extinction.

The probability that a site contains a rich subterranean fauna is largely determined by the region in which the site occurs and local geology (WA EPA 2007).

## 1.3 PROJECT GEOLOGY

The Project site is located in the southwest part of the Bowen Basin. During the Permian period, the Bowen Basin was an area of shallow water or terrestrial sedimentation, providing conditions suitable for coal accumulation. The basin is made up of sedimentary troughs, which separate platforms and, on the western side, overlay older metamorphic rocks. The Project is located on the western edge of the Denison Trough and contains a substantial thickness of Permian sediments, overlain by Tertiary sediments.

## 1.4 GROUNDWATER

There are three distinct groundwater aquifers that occur beneath the Project Site:

- Tertiary basalt aquifer;
- Permian Aldebaran Sandstone; and
- Permian coal seams.

Coal bearing sandstone and siltstone within the Bowen Basin carry varied amounts of water through the internal aquifer systems. During exploratory drilling, groundwater was encountered in aquifers within the Tertiary Basalt and Permian Aldebaran. A groundwater flow model was developed to determine inflow rates and found that the Aldebaran Sandstone aquifers units display hydraulic disconnection, aquitards and graben associated faulting.

## 1.5 SCOPE OF WORK

The Scope of Works required for the stygofauna survey is detailed in a Section of the Taraborah Terms of Reference (ToR), which have been summarised below:

- TOR Section 4.8.1 (Description of Environmental Values):
  - *Provide a description to order or family taxonomic rank of the presence and nature of any stygofauna occurring in groundwater likely to be affected by the project; and*
  - *Sampling and survey methods should follow best practice, such as that published by the Western Australian Environmental Protection Authority – Guidance for the Assessment of*



*Environmental Factors no.54 (December 2003) and No. 54a (August 2007), or any more recent publication that supersedes that guideline.*

- ToR Section 4.8.2 (Potential Impacts and Mitigation Measures)
  - *Describe the potential impacts on stygofauna of any changes in the quality, level or quantity of groundwater, and describe any mitigation measures that may be applied.*

As there are no Queensland-specific stygofauna sampling guidelines, the Department of Environment and Heritage Protection (EHP) require proponents to follow the sampling protocols of the WA EPA (EPA 2003, 2007).

Consistent with the current, Taraborah, stygofauna survey strategy, Guidance Statement 54a (EPA 2007) makes allowances for pilot studies that are less intensive as follows:

- *Much less sampling is required to characterize the type of community present than to document all species. If the area supports significant subterranean fauna, the results of the pilot study can be used to focus the more comprehensive survey that will be required to document all species and assess their conservation.*
- *The design of pilot studies is likely to vary according to situation. The aim will usually be to determine whether a project area has significant subterranean faunal values, which can be achieved with low sampling effort (Culver et al., 2004; Eberhard et al., 2009). It is expected that 6-10 stygofaunal samples or 10-15 troglotaunal samples will be collected in pilot studies. If the pilot study reveals the occurrence of significant subterranean fauna, more intensive investigation is likely to be required.*

Previous stygofauna surveys do not appear to have been conducted for the local area and a limited number of surveys have been conducted in Queensland. It should be noted however, that local groundwater quality is considered suitable for supporting stygofaunal populations. This Project has therefore adopted a 'Pilot Study' approach (as outlined in the preceding paragraphs) in response to the apparent absence of any stygofauna data for the Project area.

## 2.0 METHODOLOGY

A total of seven groundwater samples were collected for stygofauna assessment by AARC in September 2011 (within the Taraborah Project site boundary) (refer to Table 1 and Figure 2 for sample location details) as per WA EPA guidelines for pilot-scale studies. It should be noted that most of the bores sampled were EHP-registered bores and the EHP bore number has been used to identify each location where applicable. All samples were sent to the ALS Water Science Group laboratory in Brisbane for processing.

The geographical setting of the stygofauna bores are presented as photographs in Appendix B. Sampling locations for the Pilot study utilized existing bores created during exploratory efforts earlier in the mining operation. Bore locations were selected in accordance with Section 3.12 of the *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia* (WA EPA, 2007), which details the recommended requirements of a Pilot study for subterranean fauna. A total of 7 bore locations were utilized to determine whether the Project site provides habitat for significant subterranean faunal communities and whether a more intensive investigation is required.

**Table 1 Stygofauna Bores Sampled in September 2011.**

Bore Number	Date sampled	Easting	Northing
TAR053	5.9.11	600126	7396060
TAR249_C	6.9.11	598843	7398818
TAR177_C	7.9.11	595298	7400121
TAR176_C	7.9.11	596635	7397010
TAR040_Cr	8.9.11	594819	7395325
TAR16_Cr	9.9.11	594337	7399966
TAR189_C	13.9.11	595504	7395066

Coordinates are in Geocentric Datum of Australia 1994 (GDA94)

Stygofauna samples were collected using a weighted net of 50 micrometre ( $\mu\text{m}$ ) mesh. Stygofauna sampling methods are detailed in Appendix A and are briefly described below. The net was lowered to the bottom of each bore, raised and lowered four times to dislodge any resting animals, then retrieved slowly to the surface. At the top of each haul, the entire contents of the net were emptied into a 50  $\mu\text{m}$  sieve. After six hauls the sample was transferred to a labelled jar, filled with 100 per cent (%) AR grade ethanol. Samples were then sent to the ALS Water Science Group Laboratory in Brisbane for processing and fauna identification.

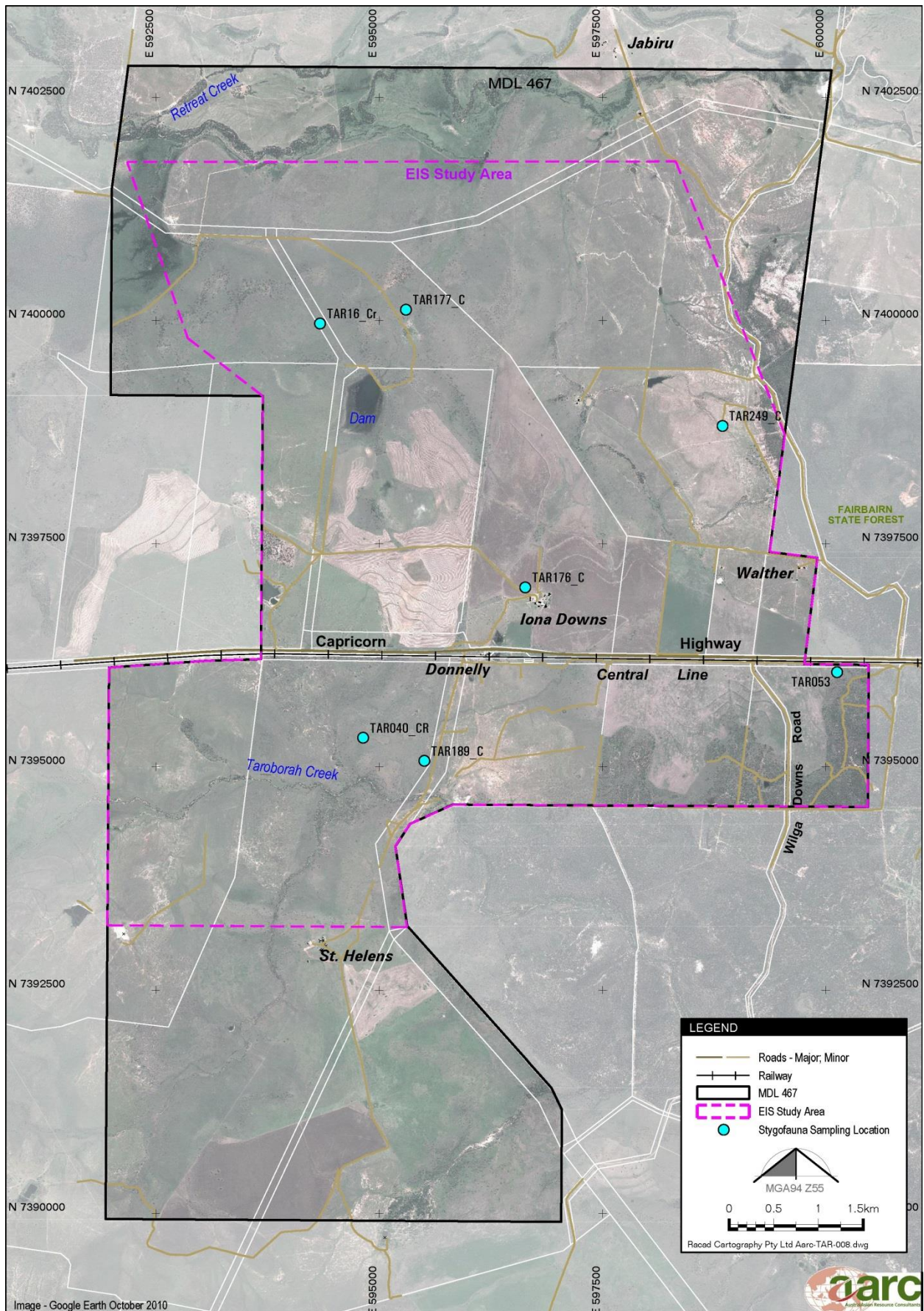
Rose Bengal dye, which stains animal tissue pink, was added to each sample before processing to allow stygofauna to be distinguished from sediments and to reduce sorting time. Samples were elutriated to separate the heavier mineral component from the lighter organic component of the sample, and poured through a 50  $\mu\text{m}$  sieve. The sieve contents, consisting of fine sediments, fauna, and other organic material, were spread thinly over the base of a channelled sorting tray. All fauna were identified to the lowest taxonomic level possible under dissecting microscopes and placed in vials containing 100% ethanol.



Field readings of groundwater quality were also conducted to determine the following parameters: pH; Electrical Conductivity (EC); Temperature; Dissolved Oxygen (DO); Oxygen Reduction Potential (ORP); and Salinity.

Stygofauna were examined using Leica MZ 9.5 stereo-dissection microscopes with planachromat objectives and a zoom capability between 6.3x and 60x magnification. A digital camera was attached which allowed for the production of a photographic reference collection when required. Stygofauna were identified to Order / Family level (where possible) using published taxonomic keys, unpublished working keys, and a specimen reference collection maintained by ALS.





**Figure 2 Stygofauna Sampling Locations**

### 3.0 RESULTS

Within the Taroborah Project site boundary (MDL467) no subterranean fauna were detected from the 7 sample locations. A copy of the stygofauna analysis report from ALS has been provided in Appendix C of this report.

Groundwater quality measurements were recorded during the stygofauna sampling survey. pH, EC, ORP and temperature were measured from all groundwater bores in the pilot study and DO was measured from only 5 of the 7 monitoring bores (refer to Table 2 for groundwater quality details).

The groundwater quality recorded during the Pilot study exhibited EC values ranging from 301 to 1,388 micro Siemens per centimetre ( $\mu\text{S}/\text{cm}$ ), pH ranged from 7.46 to 10.07, whilst groundwater temperatures ranged from 23.1 to 25.8 degrees Celsius ( $^{\circ}\text{C}$ ). Note that depths to groundwater (standing water level) were measured in terms of metres below ground level (m bgl). Off-lease bores were not sampled during the Pilot study.

**Table 2 Groundwater Quality Measurements from Bore Samples**

Bore	Date Sampled	Standing Water Level (m bgl)	Temp ( $^{\circ}\text{C}$ )	pH	EC ( $\mu\text{S} / \text{cm}$ )	Dissolved Oxygen (%)	Salinity (ppt)	ORP (mV)
TAR053	05/9/11	24.91	25.4	7.66	980	N.D.	0.48	-137.6
TAR249_C	06/9/11	48.03	24.8	10.07	576	31.6	0.28	-144
TAR177_C	07/9/11	7.08	25.8	7.46	1,388	25.6	0.69	28
TAR176_C	07/9/11	11.73	24.5	9.57	510	13	0.25	-224.6
TAR040_CR	08/9/11	35.97	25.1	7.57	910	15.6	0.5	-150.7
TAR16_CR	09/9/11	38.65	23.1	7.58	704	16.3	0.34	-116
TAR189_C	13/9/11	44.29	24.6	8.52	301	N.D	1.56	-1.829

N.D – no data due to probe malfunction



## 4.0 DISCUSSION

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No stygofauna were detected during the Pilot study and subsequent analysis. The fact that this pilot study has identified no stygofauna inside the Taraborah MDL does not preclude the possibility of stygofauna from being identified elsewhere on or outside of the Project site if a more intensive investigation were undertaken.

The groundwater quality measurements recorded during the Pilot study (pH of 7.46 to 10.07 and EC of 301 to 1,388  $\mu\text{S}/\text{cm}$ ) are consistent with known tolerance levels of Australian stygofauna Queensland (Hancock and Boulton, 2008). Stygofauna are known to persist in water ranging from fresh to brackish, tolerating salinity up to 35 ppt (Humphreys, 1999) and have been found in dysoxic waters with a DO of below 1%/L (Humphreys, 2006).

However it is understood that the aquifer underneath the MDL is not in hydraulic continuity with local alluvial aquifers and is a confined aquifer. The risk of impactation by the proposed mining activities (such as groundwater abstraction and excavation of the aquifer) upon significant stygofaunal populations is considered to be low due to the isolated nature of the aquifer and the presence of much more suitable habitat being present in relatively close proximity to the site.

As stated previously the Pilot study was undertaken in accordance with the recommendations for Pilot study design as set out by the WA EPA. No stygofauna were found during the study and no further studies are currently planned on the Project site.

## 5.0 REFERENCES

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## Appendix A     Stygofauna Sampling Field Methods

## Stygofauna Sampling Field Methods

The following field methodology for stygofauna sampling has been created and provided by Australian Laboratory Service's Environmental Water Sciences Group.

1. Take photos of bore and surroundings.
2. Record depth to water table and bore depth.
3. Use the larger diameter net where possible, however if bore is uncased use the 50 millimetre diameter net.
4. Collect samples of groundwater for determination of water quality only from bores that are cased, remembering to lower the bailer slowly into the groundwater in order to minimise splashing (for Dissolved Oxygen measurement), several metres below water table.
5. Record temperature, Electrical Conductivity, pH, Dissolved Oxygen (%) and Dissolved Oxygen (mg/L) (if possible).
6. Lower net with collecting vial attached to the bottom of the bore and raise and lower it four times to dislodge resisting fauna.
7. Slowly pull the net to the surface in a steady motion taking care not to create a bow wave.
8. Empty net into a 50 micron mesh sieve and wash net with water from squirt bottle.
9. Repeat steps 6 to 8 five more times, rinsing net into sieve between each haul.
10. After six hauls, empty contents of sieve into labelled jar with 100% ethanol and stain with a small amount of Rose Bengal. Ensure ethanol makes up at least half of the jars contents.
11. Rinse nets thoroughly with tap water after each bore to remove animals that may be stuck to it.
12. Wash nets and sieve in DECON 90 solution to sterilise before using again and allow to dry during travel to next site.

## Appendix B      Photographs of Selected Stygofauna Sampling Bores



**Photo Plate 1      Bore TAR053**

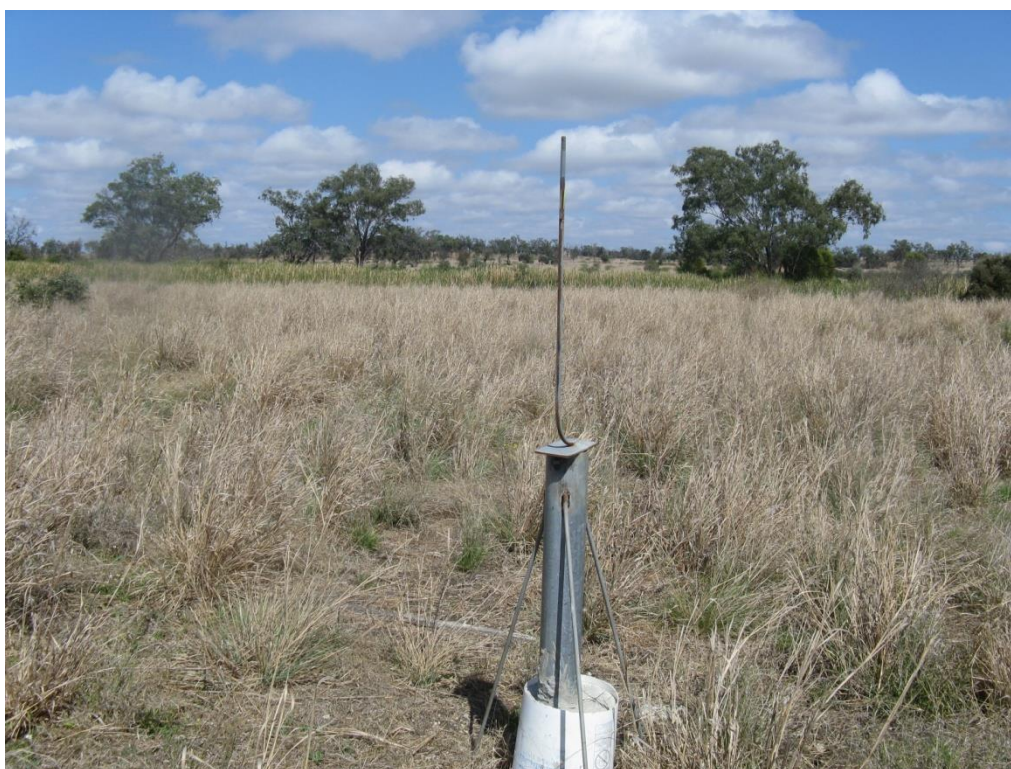


**Photo Plate 2      Bore TAR249\_C**





**Photo Plate 3      Bore TAR177\_C**



**Photo Plate 4      Bore TAR176\_C**





**Photo Plate 5      Bore TAR040\_Cr**



**Photo Plate 6      Bore TAR16\_Cr**





**Photo Plate 7      Bore TAR189\_C**

## Appendix C     ALS Identification of Stygofauna Report



Minerals

Coal

Environmental

Tribology

Food & Pharmaceutical Industrial



# AARC

## IDENTIFICATION OF STYGOFAUNA SAMPLES

September 2011





The ALS Water Sciences Group is part of the Environmental Division of ALS, one of the largest and most geographically diverse environmental testing businesses in the world.

#### CERTIFICATE OF APPROVAL FOR ISSUE OF DOCUMENTS

**Client:** AARC  
**Project Title:** Identification of Stygofauna Samples  
**Report Title:** Identification of Stygofauna Samples  
**Document No:** CQ212363-2011-002  
**Document Status:** Final  
**Date of Issue:** October 2011  
**Comments:**

	Position	Name	Signature	Date
Prepared by:	Lab coordinator - ALS Water Sciences QLD	Gavin Williams		25/10/2011
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#### Document Revision Control

Version	Description of Revision	Person Making Issue	Date	Approval
1	FINAL	Manager - ALS Water Sciences QLD	25/10/2011	

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# **1 Introduction**

AARC (Jane McPhee-Frew) delivered seven (7) stygofauna samples to the ALS Water Sciences Laboratory in Brisbane on 16 September 2011 for processing and identification of stygofauna. ALS is unaware of the location from which these samples were collected nor purpose of sampling.

## **1.1 Background**

The 7 stygofauna samples were collected by AARC project staff. All samples were analysed at the ALS Water Sciences Laboratory in Brisbane on an "as received" basis. Sampling was conducted by AARC between the 5th and 9th September 2011.

## **1.2 Scope of Work**

ALS was requested by AARC to process 7 stygofauna samples and identify any stygofauna found to Family/Order level.



## 2 Methodology

Stygofauna samples were collected in the field by AARC between the 5th and 9th September 2011. Samples arrived at the ALS Laboratory in good condition preserved in 100% AR Grade Ethanol and were appropriately labelled.

ALS is not aware of the sampling equipment and methodology used to collect the stygofauna samples.

### 2.1 Laboratory Processing

In the laboratory, Rose Bengal, which stains animal tissue pink, was added to each sample by ALS before processing to allow stygofauna to be distinguished from sediments and to speed up sorting. Samples were elutriated to separate the heavier mineral component from the lighter organic component, and poured through a 50 µm sieve. The sieve contents, consisting of fine sediments, fauna, and other organic material, were spread thinly over the base of a channelled sorting tray and scanned under dissecting microscopes. Samples were examined using Leica MZ 9.5 stereo-dissection microscopes with planachromat objectives and a zoom capability between 6.3x and 60x.



### 3 Results

Information was not provided by AARC on bore characteristics or groundwater quality. The results from the analysis of the 7 samples are provided in Table 1 below. No stygofauna were recovered from any sample.

**Table 1:** Results from analysis of 7 stygofauna samples collected by AARC between 5th and 9th September 2011

AARC Bore Code	Subphylum	Family	Genus	Stygofauna	No. of Animals
TAR053	-	-	-	NO	0
TAR249	-	-	-	NO	0
TAR177_C	-	-	-	NO	0
TAR176_C	-	-	-	NO	0
TAR040	-	-	-	NO	0
TAR189_C	-	-	-	NO	0
TAR016_CR	-	-	-	No	0





## 4 Discussion

No stygofauna were recovered from the six samples collected by AARC in SEPTEMBER 2011.



## 5 Conclusions

Only 7 groundwater bores were sampled as part of the AARC field program. This is a very small sample size and whilst no stygofauna were recovered from these samples it should be noted that this result does not conclusively indicate that stygofauna are not present in the study area. Further stygofauna sampling is recommended.