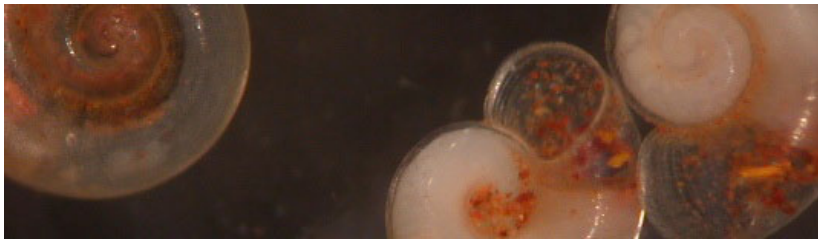
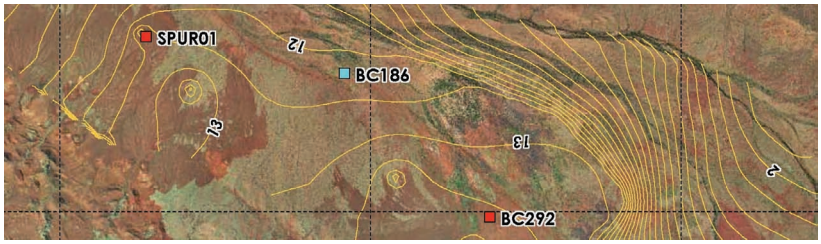
Biota Environmental Sciences

Bungaroo Coastal Waters Project Stygofauna Monitoring Baseline Survey







Prepared for Rio Tinto

September 2013

Biota Environmental Sciences

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Bungaroo Coastal Waters Project Stygofauna Monitoring

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1.0 Introduction

1.1 Project Background

Rio Tinto is undertaking construction and commissioning of a bore field in the Bungaroo Creek area, located approximately 35 km south-southeast of Pannawonica, in the Pilbara region of Western Australia (Figure 1.1). Planned to be operational in the final quarter of 2013, the Coastal Water Project (CWP) will extract up to 10 GL per year from the Bungaroo Creek aquifer to supplement the West Pilbara Supply Scheme (Rio Tinto 2011). CWP developments at Bungaroo include:

- dewatering pumps and associated infrastructure, including the construction of nine production bores and 50 monitoring bores as part of the Pilbara Coastal Water Supply Project;
- transfer pipelines (and associated infrastructure) between production bores and on to Millstream National Park approximately 85 km away; and
- a single 33 kV power line from the existing Mesa J operations to the Bungaroo Valley.

The CWP project was referred to the Environmental Protection Authority (EPA) in May 2010 and determined to be "not assessed" and would be managed under Part V of the *Environmental Protection Act 1986*.

Dewatering and alterations to groundwater systems have the potential to impact stygal species and communities by reducing available habitat and changing hydrology. A Water Resource Management Operating Strategy (Strategen 2012) has been prepared for the CWP to address this, which, in reference to stygofauna, states:

"Monitoring of stygofauna occurrence will occur in areas of interest and control areas to enable impacts associated with groundwater to be evaluated."

and:

"A detailed stygofauna monitoring programme will be developed and forwarded to the Department of Environment and Conservation (DEC) for review and endorsement."

Biota Environmental Sciences (Biota) was commissioned to undertake an initial feasibility assessment and design the monitoring programme required by the operating strategy (Biota 2013b, 2013c). This monitoring programme was subsequently reviewed and endorsed by DEC in 2013.

1.2 Scope of this Study

This report details the results of the first phase of implementation of the required monitoring programme for stygofauna in the Bungaroo CWP study area and nearby Jimawarruda Creek. The sampling design follows the approach set out in Biota (2013c), incorporating an initial set of sites for sampling, and a subset of those sites for water chemistry profiling to characterise stygofauna habitat. It represents a baseline survey phase prior to the commissioning of the bore field, to supplement the data set available from past historical surveys and collect data in a standardised fashion that will be continued for phases after commissioning.

1.3 Previous Surveys

Historic sampling within and around the Bungaroo Valley by Biota has been extensive, with 11 phases completed since 2003 (Biota 2013a). These surveys have demonstrated a diverse stygal community exists within the valley's alluvial aquifer, including a number of species only known from this system (Biota 2010a, 2011a).

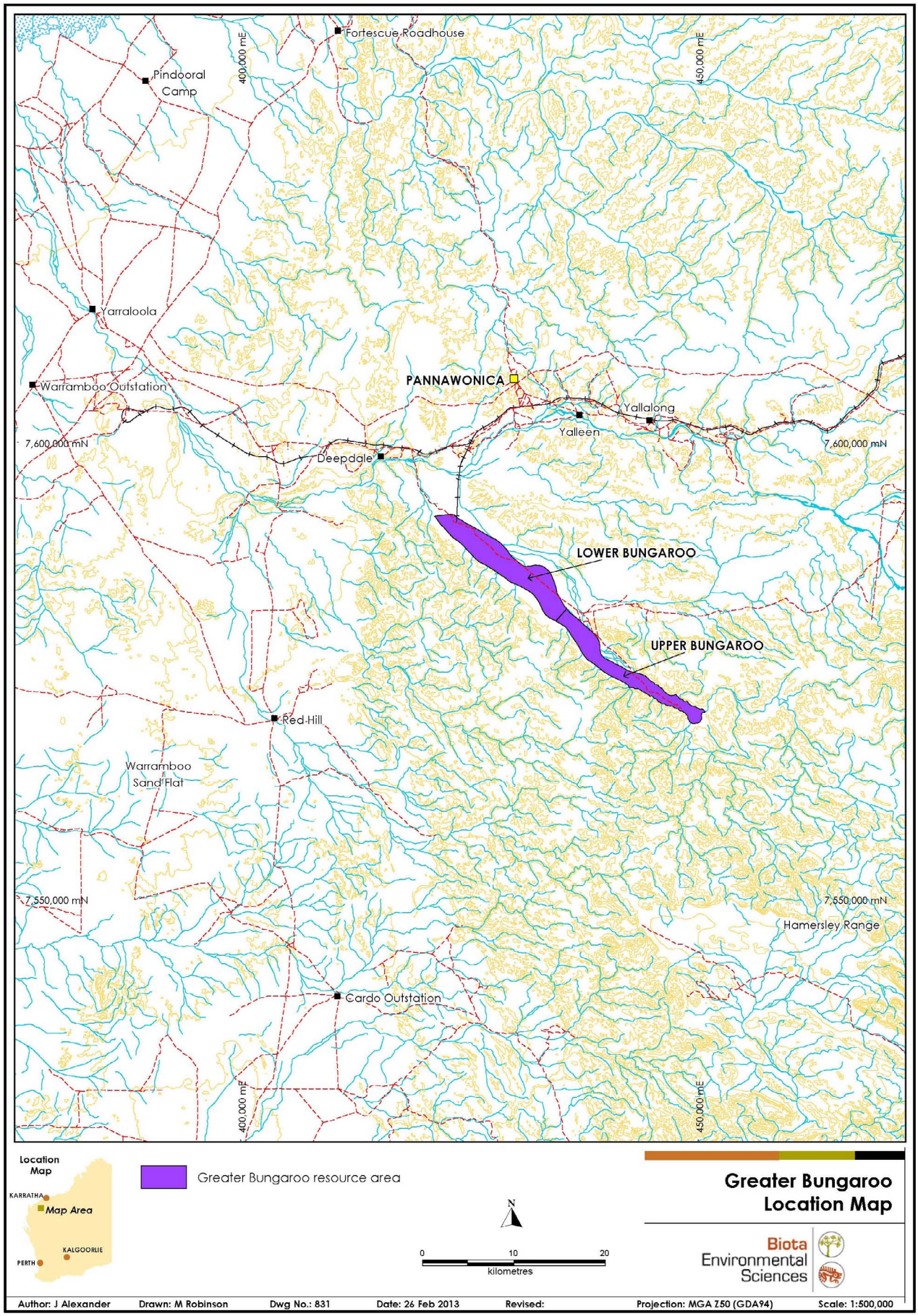


Figure 1.1: Location of the Bungaroo CWP study area (broadly divided into lower and upper Bungaroo Creek).

1.4 Background on Stygobitic Fauna

Stygofauna refer to those fauna that inhabit groundwater, sometimes occurring very close to the surface. They tend to be highly specialised to, and obligate dwellers of, subterranean groundwater habitats. Stygofauna are known to be present in a variety of rock types including karst (limestone), fissured rock (e.g. granite) and porous rock (e.g. alluvium) (Marmonier et al. 1993).

The types of animals that have become stygal (groundwater inhabiting) in Western Australia include platyhelminthes, oligochaetes, crustaceans, water mites and water beetles (Humphreys 1999, Watts and Humphreys 1999). Much attention has been directed to the crustacean fauna, which includes ostracods, copepods, bathynellid syncarids, isopods and amphipods (Humphreys 1999, Watts and Humphreys 1999).

Subterranean food webs are typically almost entirely heterotrophic, with bioproduction primarily dependent on the transport of resources (biomass, detritus) from the surface (allotrophy; Gibert et al. 1994). There are few primary producers (chemolithotrophic bacteria; Danielopol et al. 1994). However, groundwater microbes (i.e. bacteria, fungi and protozoans) are the primary consumers, with generally short direct trophic links to most meiofauna in the system.

The distribution of subterranean fauna species appears to generally be more restricted than that of surface fauna analogues. High levels of endemism are typically characteristic of subterranean taxa and tend to be concentrated in regions that support relatively diverse communities, rather than being distributed randomly (Humphreys 2000).

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2.0 Methodology

2.1 Study Personnel and Survey Timing

This single-phase stygofauna survey was co-ordinated and managed by Jessica Cairnes of Biota. Jessica Cairnes and Nicola Watson of Biota completed the survey work between the 1st and 5th of July, 2013. Melissa Robinson and Ash Brown (Biota) prepared the maps for this report.

2.2 Sampling Methodology

Sampling was completed under Regulation 17 "Licence to Take Fauna for Scientific Purposes" Licence Number SF009207 issued to Jason Alexander (Appendix 1). Sampling techniques were consistent with those outlined in Environmental Protection Authority (EPA) Guidance Statement 54 (EPA 2003) and Draft Guidance Statement 54a (EPA 2007).

Stygofauna was sampled for using modified plankton haul nets. These sampling nets were constructed from 70 μm plankton mesh, with 50 mm and 100 mm apertures attached to a weighted catch jar. Stygofauna sampling nets were lowered to the bottom of water bores and drill holes before being slowly hauled to the surface where the contents of the jar were flushed into a uniquely labelled container. Each monitoring site was sampled in this way a total of five times. On the final haul the net was agitated gently to stir the benthos layer and mobilise any fauna present for more effective specimen collecting. Specimens were stored in a shaded esky in order to preserve the sample prior to sorting and identification.

Following sampling of each monitoring site, the nets were thoroughly rinsed with water, inspected and where possible, left to dry before using on another site. This prevented cross-contamination of specimens between aquifers and sample sites.

Sorting of collected samples was completed in a laboratory on return to Perth, under dissecting microscopes (Olympus SZ40 and SZ61, magnification up to 40x).

2.3 Survey Design and Sampling Effort

A total of 33 sites were originally selected in the monitoring design (13 Impact and 20 Reference) that were accessible and provided a good spatial spread across the study area (Biota 2013c). Field constraints, including bores having been graded over, access tracks closed and blockages, prevented sampling of 12 of the originally selected bores. This was supplemented during the field survey by the addition of a further six opportunistic bores, bringing the total that were able to be sampled during the monitoring phase to 27 bores (nine Impact bores and 18 Reference sites; Table 2.1).

The distribution of the sampling sites is shown in Figure 2.1 and Figure 2.2.

2.4 Water Chemistry Data Collection

Water chemistry data were collected to characterise habitat physical parameters relevant to stygofauna. Parameters measured included dissolved oxygen (μg/l and % saturation), electrical conductivity (μS/cm), temperature (°C) and pH, with data collected using a Troll 9000 in situ water quality meter. Values were logged at approximately 1 m intervals from the top of the water table to the bottom of profiled bores, with depth determined by pressure sensor.

Consistent with the monitoring programme (Biota 2013c), water quality data were collected at a representative subset of 13 of the monitoring bores (Table 2.1).

Table 2.1: **Sampled Impact and Reference area monitoring sites for the Bungaroo CWP** (coordinates in Zone 50, datum GDA94).

Site	Easting	Northing	Modelled Drawdown (m)	Comments
Impact Sites				
BC225	437839	7576280	2.0	Water chemistry profile site
BC292	431917	7584919	13.6	Water chemistry profile site
JW023	426138	7590140	10.5	Previously unsampled
JW024	427126	7590154	11.5	Previously unsampled
BC186	429578	7587212	12.2	Water chemistry profile site
BUNWO1677	436758	7579076	2.9	-
J154	422762	7591412	6.6	-
BUNWP0006	438890	7576460	1.6	Water chemistry profile site
SPUR01	426391	7587798	12.1	-
Reference Sites				
BC156	442019	7573910	0.5	Water chemistry profile site
BC210	443903	7573914	0.6	Water chemistry profile site
BC360	448992	7570740	0	Water chemistry profile site
BC401	443563	7574126	0.6	Water chemistry profile site
BC434	444550	7572686	0.5	-
BC495	448966	7569943	0	Water chemistry profile site
BC667	447880	7570845	0.1	-
BUNWB13	444783	7572485	0.4	-
BUNWO1105	444843	7572206	0.5	Water chemistry profile site
BUNWO1108	445709	7571522	0.5	Water chemistry profile site
JIMWE003	430736	7595444	0	Water chemistry profile site
JIMWE004	430286	7601160	0	-
BC690	448665	7570594	0.1	Water chemistry profile site
PZ11BUN008	469926	7587367	0.0	-
BUNDD2260	443263	7574206	0.7	-
BUNWB09	444380	7572966	0.4	-
PZ11BUN003	470338	7587467	0.0	-
WB11BUN001	502228	7604563	0.0	-

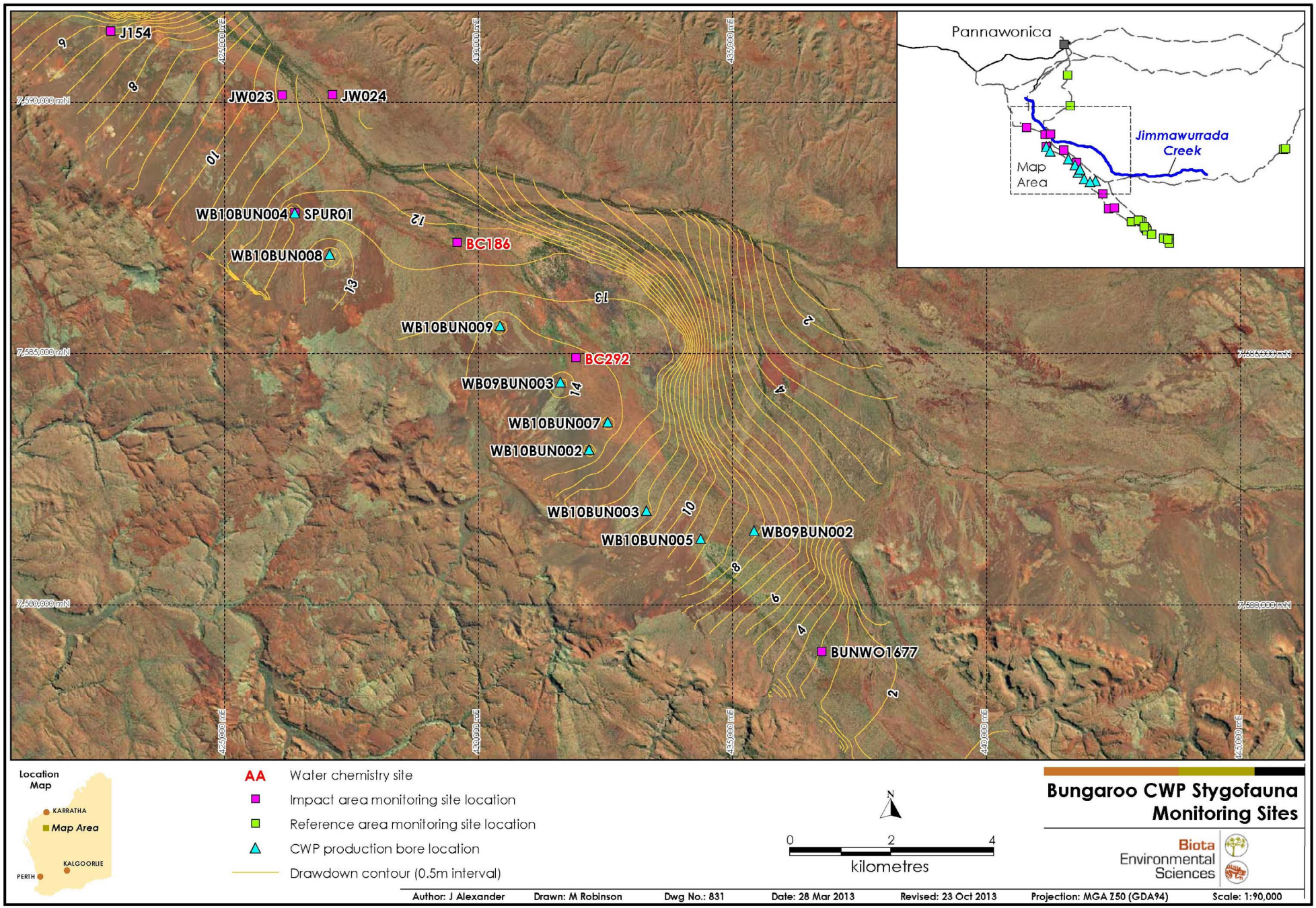


Figure 2.1: Locations of bores sampled successfully in the 2013 baseline CWP monitoring phase (Lower Bungaroo).

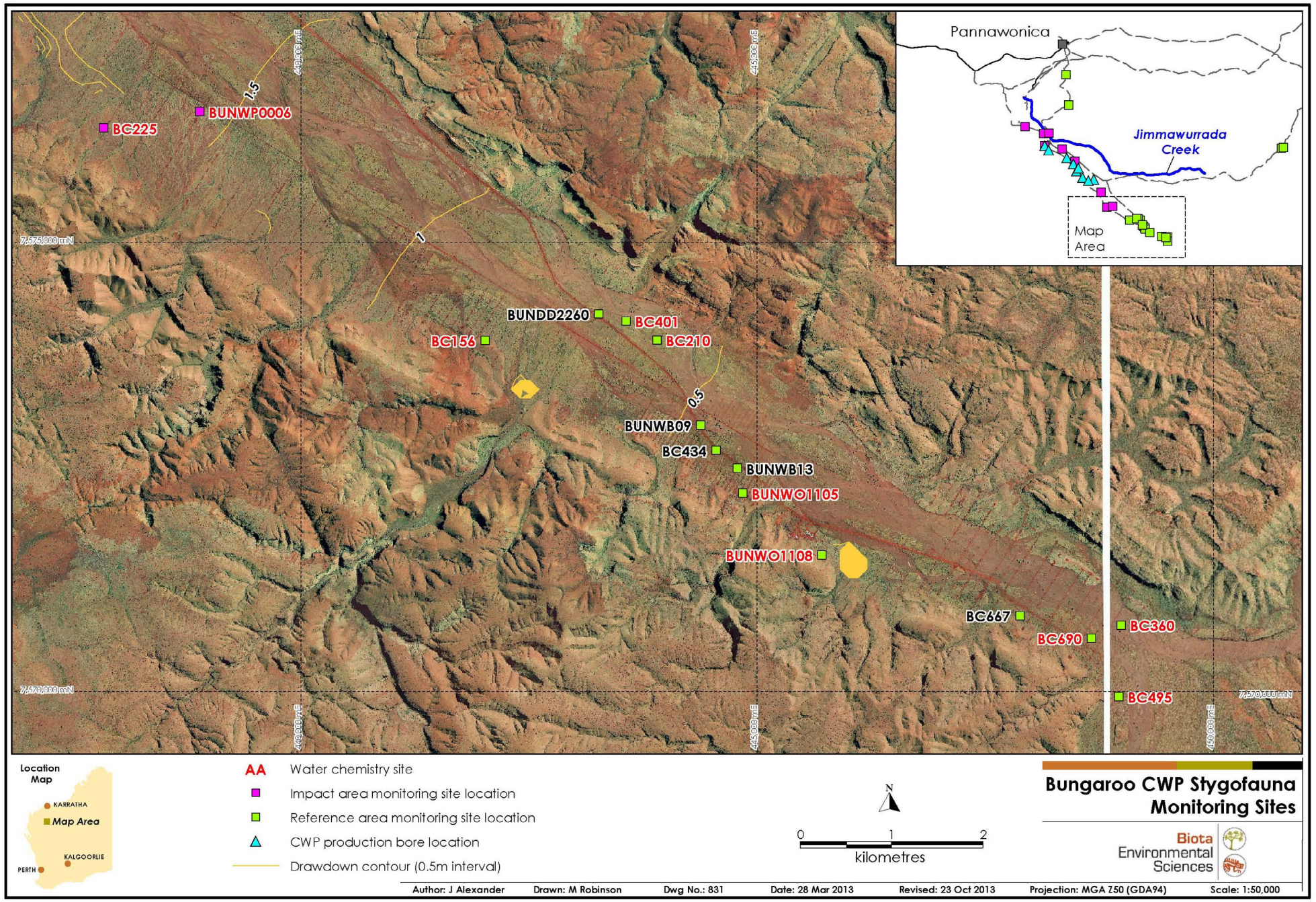


Figure 2.2: Locations of bores sampled successfully in the 2013 baseline CWP monitoring phase (Upper Bungaroo).

3.0 Results

3.1 Stygofauna

3.1.1 Overview of Records

A total of 59 stygobitic fauna specimens were collected during the baseline sampling phase (Table 3.1). The recorded stygobitic fauna represented five orders in five classes (Table 3.1). As is common in stygobitic communities in the Pilbara, the recorded assemblage was dominated by the phylum Crustacea, accounting for more than two-thirds of the fauna.

Table 3.1: Specimens collected and taxonomic summary of stygobitic fauna collected in the baseline sample phase of 2013 (common names from Harvey and Yen 1989).

Taxonomy			Number Collected
Phylum	**Class**	**Order (Common Name)**	
Chelicerata	Arachnida	Hydrachnidia (water mites)	2
Crustacea	Malacostraca	Amphipoda (amphipods)	3
	Copepoda	Cyclopoida (cyclopoid copepods)	32
	Podocopida	Ostracoda (ostracods)	5
Mollusca	Gastropoda	Sorbeoconcha (aquatic snails)	17
		Total	**59**

The water mites were superficially similar but could not be identified below sub-order level. The amphipods recorded were all identified as *Nedsia hurlbertii*; a species recorded routinely during past sampling phases in the Bungaroo valley (Biota 2013a). Four species of cyclopoid copepods and a single harpacticoid copepod species were recorded, all of which have been previously collected at Bungaroo (Biota 2013a), as has the ostracod species collected (*Areacandona triangulum*). The hydrobiid snails collected also appear to be the same taxon previously recorded from the area Hydrobiidae sp. nov. (Biota 2013a).

3.1.2 Distribution of the Fauna in Impact and Reference Areas

Stygofauna were collected from eight of the 27 bores sampled; five from the Reference area and three Impact sites (Table 3.2). A total of eight species were recorded from the five orders represented (Table 3.2). The distribution of the sites yielding stygofauna is shown in Figure 3.1 and Figure 3.2.

Table 3.2: Site by taxon representation of stygofauna in Impact and Reference areas during the 2013 baseline survey phase.

	Reference					Impact		
Taxon	BUNWB13	BUNWO1108	JIMWE003	BC690	BC360	JW024	BC186	BC225
Acariformes (water mite)		1				1		
Nedsia hurlberti (amphipod)			1			2		
Diacyclops cockingi (cyclopoid copepod)		3			6			
Thermocyclops aberrans (cyclopoid copepod)					15			
Diacyclops sp. (juvenile cyclopoid copepod)	1		1					
Elaphoidella humphreysi (harpacticoid copepod)	1						4	
Areacandona triangulum (ostracod)			4					1
Hydrobiidae sp. nov.	17							

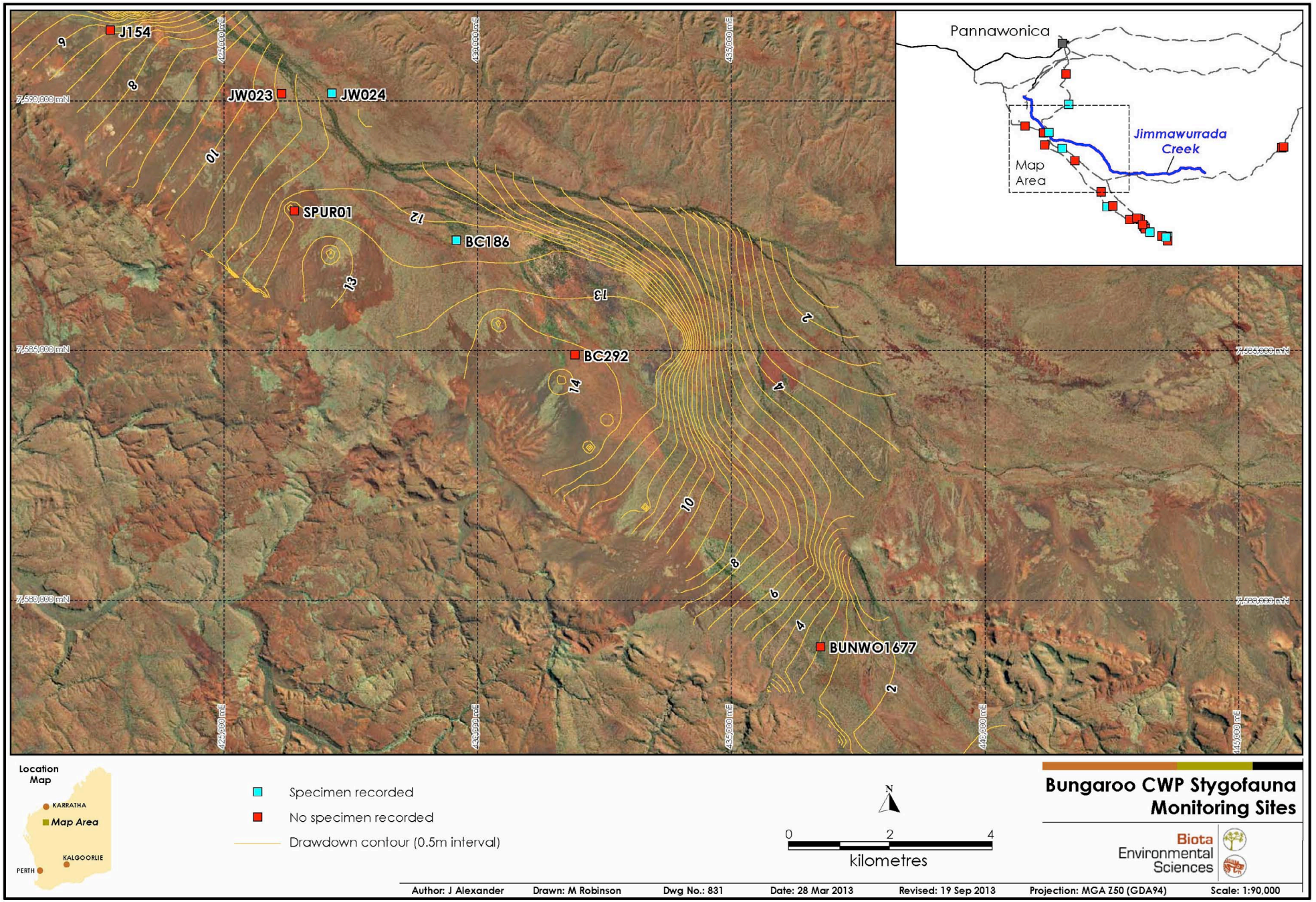


Figure 3.1: Locations of bores yielding stygofauna specimens during the 2013 baseline CWP monitoring phase (Lower Bungaroo).

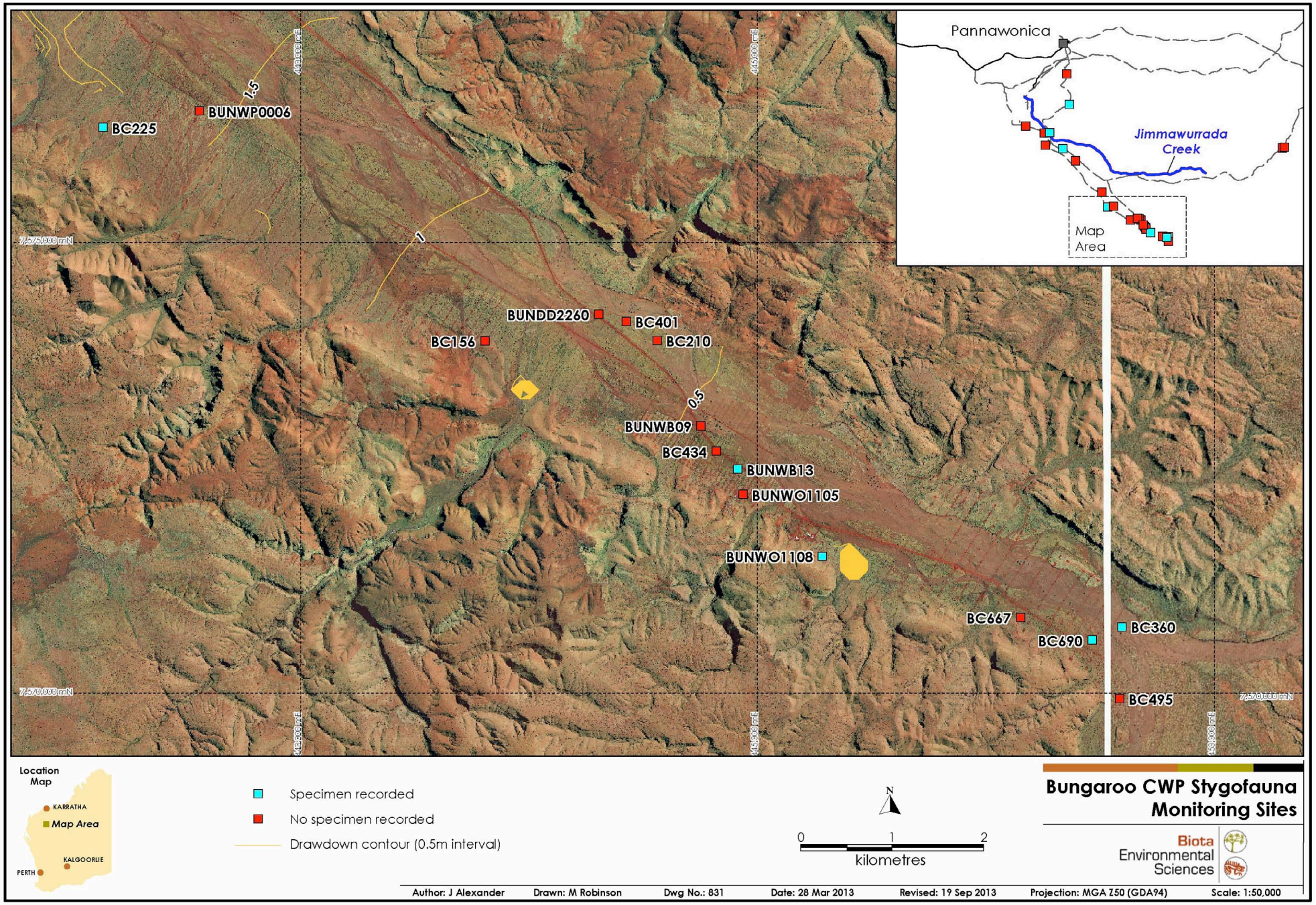


Figure 3.2: Locations of bores yielding stygofauna specimens during the 2013 baseline CWP monitoring phase (Upper Bungaroo).

Four of the five orders were collected from both Reference and Impact areas, with the aquatic snails the only order recorded from Reference areas only (Table 3.2). Four of the eight species were also recorded from both Reference and Impact sites, and all species have previously been recorded at multiple locations within the Bungaroo Valley (Biota 2013a).

In a broader context, six of the eight taxa (*Nedsia hurlberti, Diacyclops cockingi, Thermocyclops aberrans, Diacyclops* sp. (juvenile), *Elaphoidella humphreysi* and *Areacandona triangulum*) have been commonly recorded elsewhere in the Pilbara bioregion and have demonstrated wider distributions (Biota 2009, 2010b, 2011b). The status of the water mite cannot be confirmed as it could not be determined to species level and the Hydrobiidae sp. nov. aquatic snail is currently only known from the Bungaroo Valley (Biota 2013a).

3.1.3 Results in the Context of Past Data

The fauna recorded during the 2013 baseline sampling phase at Bungaroo are a subset of the total fauna previously recorded from the valley (Biota 2013a). The taxa recorded during the baseline phase (Table 3.2) were all represented amongst the known stygal community from the area (Figure 3.3). No new taxa were recorded during the survey phase.

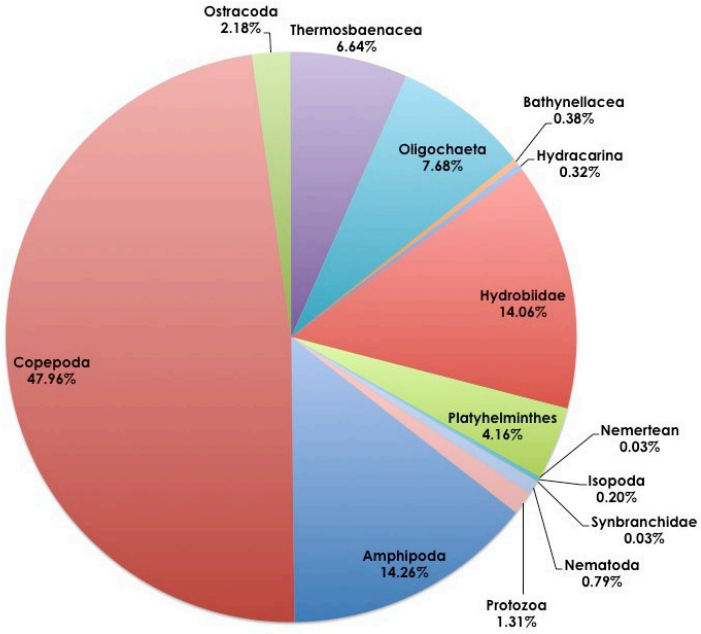


Figure 3.3: Proportional representation of stygofauna recorded from Bungaroo from 11 previous phases of sampling (Biota 2013a).

Hydrobiidae sp. nov. was previously recorded from Reference site BUNWB13, where it was again recorded during the current phase (Table 3.2). The same site has also previously yielded three cyclopoid copepod species (Biota 2013a), also consistent with the current phase (Table 3.2). Reference sites BUNWO1108, JIMWE003 and BC360 all had records of cyclopoid copepods during both the current phase (Table 3.2) and past sampling work (Biota 2013a). Site JIMWE003 has also previously yielded ostracod specimens, again consistent with the results from the current phase (Table 3.2; (Biota 2013a)). In general then, the results from the current phase are in keeping with the results from the 11 previous surveys in the area (Biota 2013a).

3.2 Water Chemistry

Water chemistry data from the study area indicate that the groundwater at Bungaroo is warm, slightly acidic and virtually fresh in nature (Table 3.3). Mean temperature and dissolved oxygen levels were not significantly different between the Impact and Reference sites, whereas Impact sites where on average closer to neutral pH and fresher than Reference areas (Table 3.3).

Table 3.3: Mean values in key groundwater chemistry parameters (± standard error).

Parameter	Reference Sites	Impact Sites
Temperature (°C)	30.25 ± 0.61	30.92 ± 0.92
pH	5.62 ± 0.17	6.70 ± 0.39
Conductivity (µS/cm)	293.88 ± 52.93	622.36 ± 97.39
Dissolved oxygen (µg/l)	17,116.48 ± 4,675.62	17,583.01 ± 5,089.54

Ecological groundwater parameters can vary with depth, which can affect vertical distribution of fauna (Humphreys and Adams 1991). Profiles with depth were therefore constructed of recorded parameters where appropriate: pH did not vary with depth and graphs for this parameter were therefore not compiled. Some monitored holes were very shallow with little data, and graphs were also not compiled for these sites (BC225, BC156, BC401 and BC495), but data from these sites were still used in deriving overall mean values for treatment areas (Table 3.3; Appendix 2).

Dissolved oxygen was variable with depth, but generally decreased with increasing depth through the water table in both Impact and Reference bores (Figure 3.4). Two bores, BUNWP006 and BC360, displayed notable increases in oxygen levels deeper in the profile (Figure 3.4). The latter bore showed the most marked increase at depth, which also had a corresponding minor decrease in salinity (Figure 3.5) and a substantial decrease in temperature (Figure 3.6).

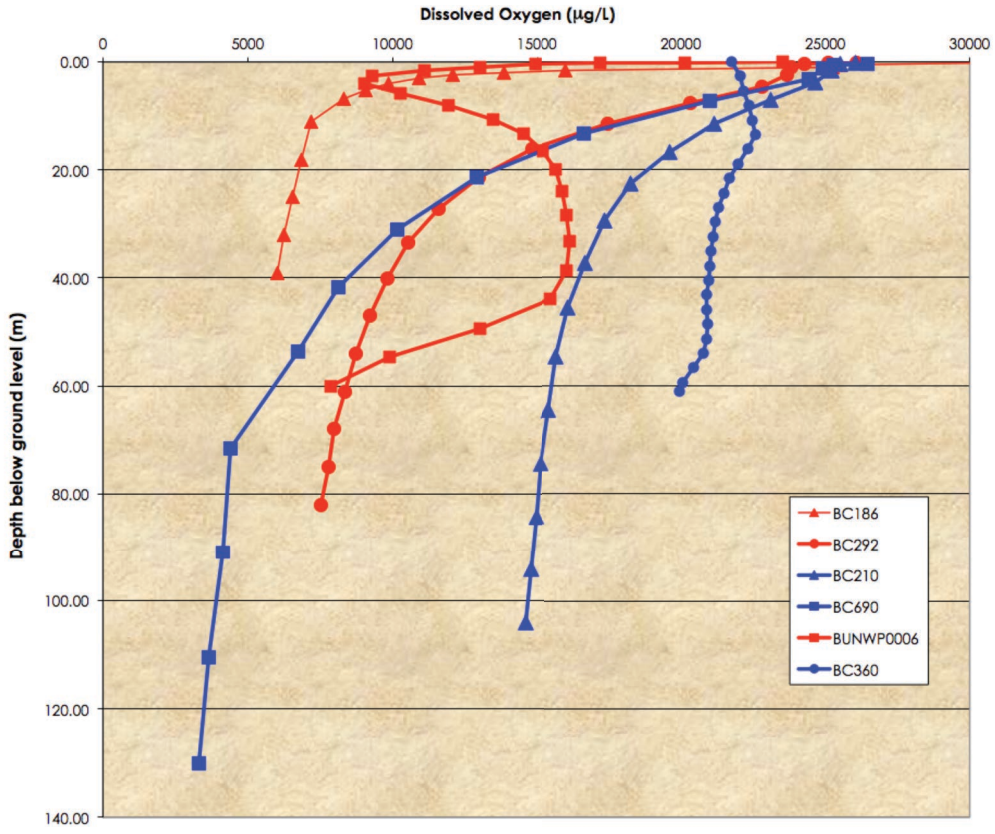


Figure 3.4: Profiles of groundwater dissolved oxygen with depth at Reference (shown in blue) and Impact (red) sites in the study area.

Conductivity showed little variation with depth, with no evidence of a halocline in the aquifer (Figure 3.5), though there was substantial variation amongst bores in conductivity level.

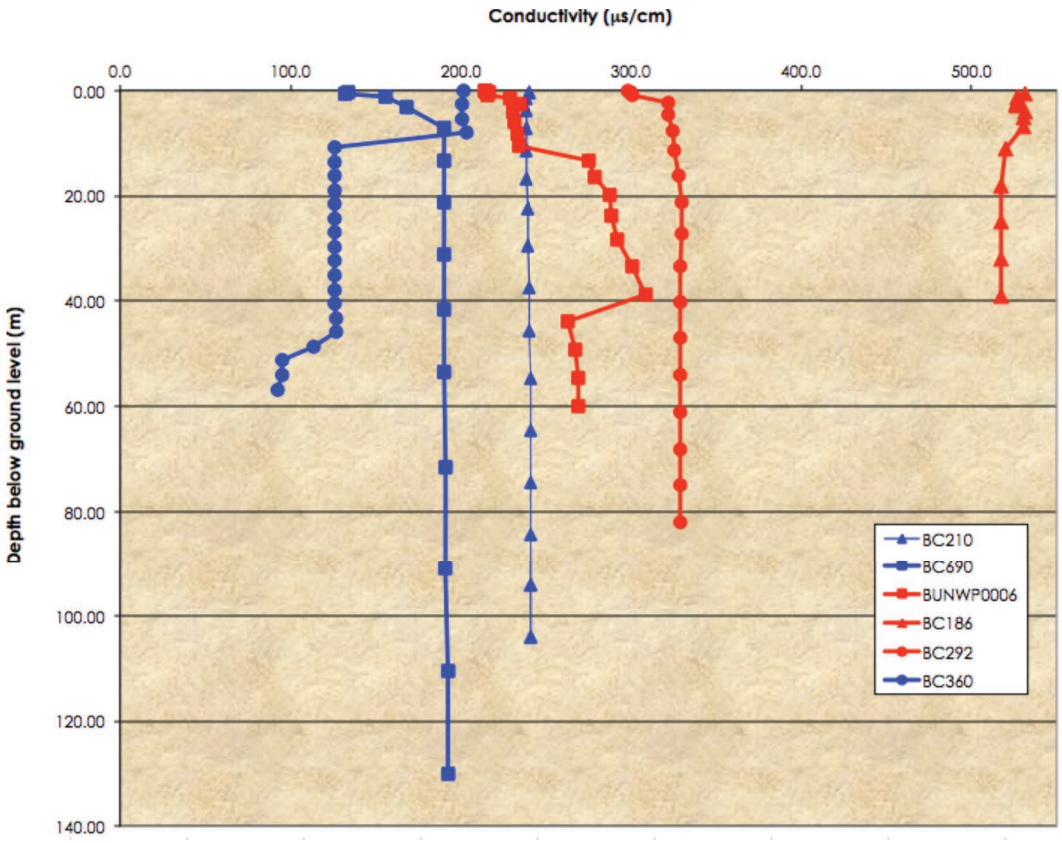


Figure 3.5: Profiles of groundwater conductivity with depth at Reference (shown in blue) and Impact (red) sites in the study area.

Most sites showed little variation in groundwater temperature with depth, though there was often a minor but steady increase in temperature with depth, without any evidence of a strong halocline (Figure 3.6). Bore BC690 showed a small decrease in temperature at depth, corresponding to a slight decrease in conductivity (cf. Figure 3.5).

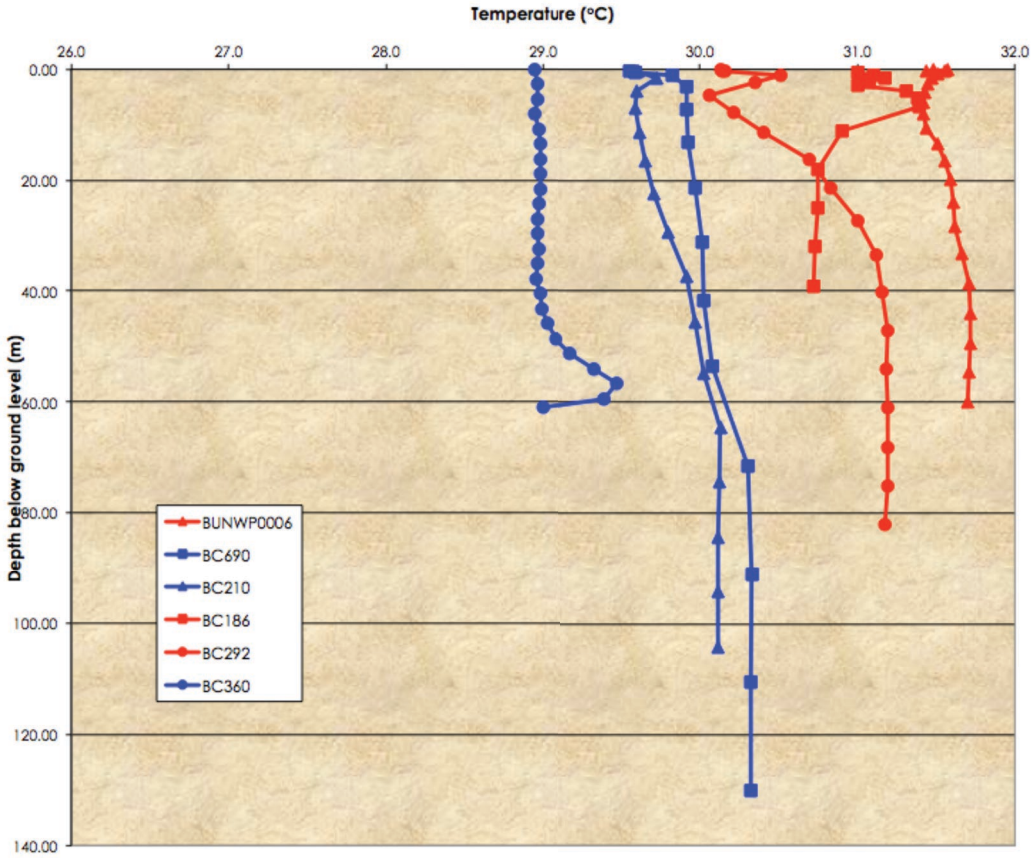


Figure 3.6: Profiles of groundwater temperature with depth at Reference (shown in blue) and Impact (red) sites in the study area.

4.0 Summary and Conclusions

The baseline monitoring phase for the Bungaroo CWP was completed in July 2013 and a total of 27 bores (nine Impact bores and 18 Reference sites) were successfully sampled for stygofauna. Methodology and approach followed the programme prepared by Biota (2013c) as reviewed and endorsed by the DEC.

A total of 59 stygobitic fauna specimens were collected during the baseline sampling, representing five orders in five classes. Stygofauna were collected from eight of the 27 bores sampled; five from the Reference area and three Impact sites. The fauna recorded during the baseline phase are a subset of the total fauna previously recorded from the Bungaroo valley (Biota 2013a). The taxa recorded were all represented amongst the known stygal community from the area (i.e. no new species were found.)

The fauna recorded during this monitoring phase accounts for only a small proportion of the known stygal assemblage of the Bungaroo valley (Biota 2013a). A total of 51 taxa is currently documented for the area therefore many known species were undetected, but probably present during the current phase of work. The issues contributing to this result; single-phase sampling, sampling effects and variability over time, were identified in the monitoring programme design as a limitation inherent to this type of ecological monitoring (Biota 2013c). The inclusion of habitat (groundwater) monitoring data in the programme is a key component intended to address this and provide parallel evidence that the system is still suitable for stygofauna, and that the limited species records are likely to be indicative of the wider community persisting in the area.

Water chemistry data indicate that the groundwater in the study area is warm, slightly acidic and virtually fresh in nature. Mean temperature and dissolved oxygen levels were not significantly different between the Impact and Reference sites, whereas Impact sites where on average closer to neutral pH and fresher than Reference areas. Some bores showed evidence of minor changes in dissolved oxygen and temperature at depth, which has previously been observed in other Pilbara locations (e.g. Biota 2006). It is possible that these habitat changes correspond to areas of increased groundwater flow, cavernous sections in the profile or other changes in stratigraphy.

The data collected during this phase of work provide baseline information for the future monitoring of the Bungaroo CWP. Future analysis of both fauna data and groundwater habitat data over time during the bore field's operation will inform Rio Tinto's management of the facility, and fulfil obligations from both the Water Resource Management Strategy (Strategen 2012) and the stygofauna monitoring programme design (Biota 2013c).

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5.0 Glossary

Aquifer	Body of rock that is varyingly permeable, which contains or transmits groundwater.
EPA	Environmental Protection Authority of Western Australia.
DEC	Department of Environment and Conservation
Halocline	A rapid gradient in salinity level in natural water body.
Meiofauna	Marine and freshwater fauna inhabiting interstitial environments
Stygobite	Obligate groundwater fauna.
Stygofauna	Fauna inhabiting the various types of groundwater.
Taxonomy	Theory and practice of biological classification.
Thermocline	A rapid gradient in temperature in natural water body.

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Appendix 1

License to Take Fauna for Scientific Purposes

Government of **Western Australia**
Department of **Environment and Conservation**

Your ref:
Our ref:
Enquiries:
Phone: Mr D Stefoni
Fax: (08) 9219 9833
Email: (08) 9423 2242
danny.stefoni@dec.wa.gov.au

MR J ALEXANDER
BIOTA ENVIRONMENTAL SCIENCES
PO BOX 155
LEEDERVILLE WA 6903

Re: Licence to Take Fauna for Scientific Purposes.

Dear Sir,

Please find enclosed licence to *COLLECT INVERTEBRATES, TARGETING STYLOBATE EEL AND STYGOBITIC SNAIL, USING STYGOFAUNA HAUL NETS, FOR ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED IRON ORE MINING DEVELOPMENTS AND DEWATERING, BUNGAROO VALLEY, PILBARA.*

Please ensure that all the licence conditions are complied with, including the forwarding of a return at the end of the licence period as advised below:

(1) RETURNS

Reg.17 licence applicants are to note and fulfil the following condition associated with this licence.

'Within one month of the expiration of this licence (or at such other time or times as the Director General may determine) the holder shall furnish to the Director General a return setting out in full detail the number of each species of fauna taken during the currency of the licence, the localities where the species was/were taken and the method of handling of such fauna and disposal of specimens. A copy of any paper or report resulting from this research should be lodged in due course with the Director General. In the case of consultants, a list of the fauna handled, the localities involved and a copy of the interpretive data prepared should be lodged.'

Fauna Survey Returns System

Returns of fauna taken under a Regulation 17 'Licence to Take Fauna' may take several forms such as a written letter, thesis, report, published paper etc. forwarded to the Senior Fauna Licensing Officer (Fauna). In addition to this, in October 2008 DEC introduced a means of collecting, collating and making fauna data available to licence holders online. This is called *Fauna Survey* and it is now compulsory for licence holders to provide information on the species observed and the locations at which they were recorded in the approved .csv file format. DEC provides the server for data storage, a website to make returns online and a return template system which must be used to submit all data. All licence holders must see the following website and use the template provided online to fill in the data using the fields specified.

ALL Regulation 17 licence holders must make returns online, in the fauna survey return data format shown on the website.

www.dec.wa.gov.au/fauna_returns

To enter your returns on line you will require your Licence Number **SF009207** and your Person Number **90684**. These numbers are located on the top right hand corner of the licence, this will allow you to submit your licence returns, query data from a range of sources and download query results in CSV format.

If you have any queries please contact Mr Danny Stefoni on 9219 9833.

Yours sincerely,

.....

for Jim Sharp
ACTING DIRECTOR GENERAL

15 April, 2013

Department of
Environment and
Conservation

Our environment, our future

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9334 0333
Facsimile: 08 9334 0242

Correspondence: **Locked Bag 30**
Bentley Delivery Centre WA 6983

AUTHORISED PERSONS

GARTH HUMPHREYS
ROY TEALE
MICHAEL GREENHAM
DANIEL KAMIEN
TIM SACHSE
JESSICA CAIRNES
PENNY BROOSHOOFT
DAVID KEIRLE
VICKIE CARTLEDGE
CHRIS COLE
NICOLA WATSON
SYLVIE SCHMIDT
STEWART FORD
JACINTA KING
MICHAEL DELANEY
ANDREW SHEPPARD
SCOTT WERNER

DATE OF ISSUE 15/04/2013
VALID FROM 26/04/2013
DATE OF EXPIRY 31/12/2013

LICENSING OFFICER

(JASON)

LICENSEE: MR J ALEXANDER
ADDRESS BIOTA ENVIRONMENTAL SCIENCES
PO BOX 155
LEEDERVILLE
WA 6903

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Department of
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Correspondence: **Locked Bag 30**
Bentley Delivery Centre WA 6983

NO. SF009207
PERSON NO. 90684

RECEIPT NO. **AMOUNT** $0.00

WILDLIFE CONSERVATION ACT 1950
REGULATION 17
LICENCE TO TAKE FAUNA FOR SCIENTIFIC PURPOSES

THE UNDERMENTIONED PERSON MAY TAKE FAUNA FOR RESEARCH OR OTHER SCIENTIFIC PURPOSES AND WHERE AUTHORISED, KEEP IT IN CAPTIVITY, SUBJECT TO THE FOLLOWING AND ATTACHED CONDITIONS, WHICH MAY BE ADDED TO, SUSPENDED OR OTHERWISE VARIED AS CONSIDERED FIT.

DIRECTOR GENERAL

CONDITIONS

1 THE LICENSEE SHALL COMPLY WITH THE PROVISIONS OF THE WILDLIFE CONSERVATION ACT AND REGULATIONS AND ANY NOTICES IN FORCE UNDER THIS ACT AND REGULATIONS.

2 UNLESS SPECIFICALLY AUTHORISED IN THE CONDITIONS OF THIS LICENCE OR OTHERWISE IN WRITING BY THE DIRECTOR GENERAL, SPECIES OF FAUNA DECLARED AS LIKELY TO BECOME EXTINCT, RARE OR OTHERWISE IN NEED OF SPECIAL PROTECTION SHALL NOT BE CAPTURED OR OTHERWISE TAKEN.

3 NO FAUNA SHALL BE TAKEN FROM ANY NATURE RESERVE, WILDLIFE SANCTUARY, NATIONAL PARK, MARINE PARK, TIMBER RESERVE OR STATE FOREST WITHOUT PRIOR WRITTEN APPROVAL OF THE DIRECTOR GENERAL. NO FAUNA SHALL BE TAKEN FROM ANY OTHER PUBLIC LAND WITHOUT THE WRITTEN APPROVAL OF THE GOVERNMENT AUTHORITY MANAGING THAT LAND.

4 NO ENTRY OR COLLECTION OF FAUNA TO BE UNDERTAKEN ON ANY PRIVATE PROPERTY OR PASTORAL LEASE WITHOUT THE CONSENT IN WRITING OF THE OWNER OR OCCUPIER, OR FROM ANY ABORIGINAL RESERVE WITHOUT THE WRITTEN APPROVAL OF THE DEPARTMENT OF INDIGENOUS AFFAIRS.

5 NO FAUNA OR THEIR PROGENY SHALL BE RELEASED IN ANY AREA WHERE IT DOES NOT NATURALLY OCCUR, NOR BE HANDED OVER TO ANY OTHER PERSON OR AUTHORITY UNLESS APPROVED BY THE DIRECTOR GENERAL, NOR SHALL THE REMAINS OF SUCH FAUNA BE DISPOSED OF IN SUCH MANNER AS TO CONFUSE THE NATURAL OR PRESENT DAY DISTRIBUTION OF THE SPECIES.

6 THIS LICENCE AND THE WRITTEN PERMISSION REFERRED TO AT CONDITIONS 3 & 4 MUST BE CARRIED BY THE LICENSEE OR AUTHORISED AGENT AT ALL TIMES FOR THE PURPOSE OF PROVING THEIR AUTHORITY TO TAKE FAUNA WHEN QUESTIONED AS TO THEIR RIGHT TO DO SO BY A WILDLIFE OFFICER, ANY OTHER STATE OR LOCAL GOVERNMENT EMPLOYEE OR ANY MEMBER OF THE PUBLIC.

7 **********ANY INTERACTION INVOLVING GAZETTED THREATENED FAUNA THAT MAY BE HARMFUL AND/OR INVASIVE MAY REQUIRE APPROVAL FROM THE DEPT OF SUSTAINABILITY, ENVIRONMENT, WATER, POPULATION & COMMUNITIES PH 02 6274 1111. INTERACTION WITH SUCH SPECIES IS CONTROLLED BY THE COMMONWEALTH GOVERNMENT'S "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999" & "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION REGULATIONS 2000" AS WELL AS DEC'S WILDLIFE CONSERVATION ACT & REGULATIONS.**********

8 NO BIOPROSPECTING INVOLVING THE REMOVAL OF SAMPLE AQUATIC AND TERRESTRIAL ORGANISMS (BOTH FLORA AND FAUNA) FOR CHEMICAL EXTRACTION AND BIOACTIVITY SCREENING IS PERMITTED TO BE CONDUCTED WITHOUT SPECIFIC WRITTEN APPROVAL BY THE DIRECTOR GENERAL OF DEC.

9 FURTHER CONDITIONS (NUMBERED 1 TO 9) ARE ATTACHED.

PURPOSE COLLECT INVERTEBRATES, TARGETING STYLOBATE EEL AND STYGOBITIC SNAIL, USING STYGOFAUNA HAUL NETS, FOR ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED IRON ORE MINING DEVELOPMENTS AND DEWATERING, BUNGAROO VALLEY, PILBARA.

WILDLIFE CONSERVATION REGULATIONS 1970

Regulation 17:- Licence to Take Fauna for Scientific Purposes

FURTHER CONDITIONS (OF LICENCE NUMBER SF009207)

1. The licensee shall take fauna only in the manner stated on the endorsed Regulation 17 licence application form and endorsed related correspondence.

2. Except in the case of approved lethal traps, the licensee shall ensure that measures are taken in the capture and handling of fauna to prevent injury or mortality resulting from that capture or handling. Where traps or other mechanical means or devices are used to capture fauna these shall be deployed so as to prevent exposure of trapped animals to ants and debilitating weather conditions and inspected at regular intervals throughout each day of their use. At the conclusion of research all markers etc and signs erected by the licensee and all traps shall be removed, all pitfalls shall be refilled or capped and the study area returned to the condition it was in prior to the research/capture program. During any break in research, cage traps should be removed and pitfalls either removed, capped or filled with sand.

3. No collecting is to be undertaken in areas where it would impinge on pre-existing scientific research programs.

4. Any form of colour marking of birds or bats shall only be undertaken in accordance with the requirements of the Australian Bird and Bat Banding Scheme.

5. Any inadvertently captured specimen of fauna which is declared as likely to become extinct, rare or otherwise in need of special protection is to be released immediately at the point of capture. Where such a specimen is injured or deceased, the licensee shall contact Department of Environment and Conservation licensing staff at Kensington (08 9423 2434) for advice on disposal. Records are to be kept of any fauna so captured and details included in the report required under further condition 6 below.

6. Within one month of the expiration of this licence, the holder shall submit an electronic return detailing the locality, site, geocode, date and number of each species captured, sighted or vouchered during the currency of the licence, into the Department of Environment and Conservation Fauna Survey Database (DECFSD). A copy of any paper, report or thesis resulting from the research shall on completion be lodged with the Director General. If a renewal of this licence is required, the licensee shall submit a written progress report for activities undertaken during this licence period prior to the expiry of this licence.

7. Not more than ten specimens of any one protected species shall be taken and removed from any location less than 20km apart. Where exceptional circumstances make it necessary to take large series in order to obtain adequate statistical data the collector will proceed with circumspection and justify their actions to the Director General in advance.

8. All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence shall be donated to the Wes tern Australian Museum. Duplicates (one pair in each case) of any species collected which represents a significant extension of geographic range shall be donated on request to the Western Australian Museum.

9. To prevent any unnecessary collecting in this State, all specimens and material collected under the authority of this license shall, on request, be loaned to the Western Australian Museum. Also, the unused portion or portions of any specimen collected under the authority of this license shall be offered for donation to the Western Australian Museum or made available to other scientific workers if so required.

Appendix 2

Groundwater Data

	BORE	DEPTH	TEMP	PH	Conductivity	DO	DO
		M	C	pH	ms/cm	%sat	mg/L
Impact	BC186	0.03	22.4	5.0	70.1	405.4	34299
Impact	BC186	0.07	23.5	4.7	2.4	390.1	32267
Impact	BC186	0.12	24.3	4.6	2.2	382.5	31230
Impact	BC186	0.16	24.6	4.6	2.1	377.8	30669
Impact	BC186	0.20	24.7	4.6	2.1	374.7	30343
Impact	BC186	0.63	31.0	6.0	531.2	352.8	25507
Impact	BC186	1.05	31.1	6.4	527.3	349.7	25236
Impact	BC186	1.53	31.2	6.6	526.9	221.6	15985
Impact	BC186	2.01	31.0	6.6	527.2	191.5	13849
Impact	BC186	2.48	31.1	6.7	525.9	167.1	12077
Impact	BC186	2.96	31.0	6.7	525.8	150.6	10898
Impact	BC186	3.99	31.3	6.6	531.1	137.0	9864
Impact	BC186	5.17	31.4	6.7	530.9	126.3	9086
Impact	BC186	6.83	31.4	6.7	530.9	115.4	8304
Impact	BC186	11.06	30.9	6.6	519.6	99.2	7201
Impact	BC186	18.05	30.8	6.7	517.1	94.3	6870
Impact	BC186	25.03	30.7	6.7	517.4	89.9	6549
Impact	BC186	32.02	30.7	6.7	517.4	85.9	6259
Impact	BC186	39	30.7	6.7	517.1	82.8	6033
Impact	BC292	0.14	30.1	6.6	298.5	355.7	26065
Impact	BC292	0.28	30.2	6.8	299	342.7	25107
Impact	BC292	0.42	30.1	6.8	299.9	331.1	24268
Impact	BC292	1.01	30.5	6.9	300.6	326.4	23812
Impact	BC292	2.42	30.4	6.8	321.9	323.5	23680
Impact	BC292	4.57	30.1	6.5	322.3	309.7	22810
Impact	BC292	7.70	30.2	6.5	324.3	276.7	20339
Impact	BC292	11.48	30.4	6.5	326.0	238.1	17462
Impact	BC292	16.17	30.7	6.5	328.5	202.9	14817
Impact	BC292	21.33	30.8	6.5	330.0	178.2	12992
Impact	BC292	27.16	31.0	6.5	329.9	159.4	11596
Impact	BC292	33.44	31.1	6.5	329.3	145.2	10551
Impact	BC292	40.07	31.2	6.5	329.1	135.1	9812
Impact	BC292	47.05	31.2	6.5	329.2	126.9	9212
Impact	BC292	54.04	31.2	6.5	329.3	120.4	8748
Impact	BC292	61.03	31.2	6.5	329.4	115.0	8350
Impact	BC292	68.02	31.2	6.6	329.3	109.9	7979
Impact	BC292	75.01	31.2	6.5	329.2	107.3	7786
Impact	BC292	82	31.2	6.5	329.1	103.8	7534
Reference	BC210	0.22	29.6	6.8	240.6	355.3	26051
Reference	BC210	0.43	29.6	6.9	240.3	347.8	25504
Reference	BC210	1.54	29.7	6.8	238.4	343.9	25222
Reference	BC210	3.86	29.6	6.6	238.2	335.4	24657
Reference	BC210	7.12	29.6	6.5	238.4	313.9	23094
Reference	BC210	11.44	29.6	6.5	238.5	287.5	21157
Reference	BC210	16.62	29.7	6.5	238.7	266.3	19595
Reference	BC210	22.50	29.7	6.5	239.0	248.4	18264
Reference	BC210	29.38	29.8	6.5	239.4	236.4	17364
Reference	BC210	37.29	29.9	6.5	240.0	227.0	16656
Reference	BC210	45.61	30.0	6.6	240.2	219.4	16086

Reference	BC210	54.66	30.0	6.5	240.7	213.5	15646
Reference	BC210	64.53	30.1	6.6	241.4	210.2	15381
Reference	BC210	74.40	30.1	6.6	241.4	206.7	15130
Reference	BC210	84.26	30.1	6.6	241.4	204.7	14985
Reference	BC210	94.13	30.1	6.6	241.4	202.3	14807
Reference	BC210	104	30.1	6.6	241.2	199.5	14596
Reference	BC690	0.28	29.6	5.9	133.6	360.1	26461
Reference	BC690	0.57	29.6	6.1	131.7	344.3	25294
Reference	BC690	1.15	29.8	6.0	155.8	340.2	24904
Reference	BC690	3.24	29.9	6.2	168.5	333.4	24414
Reference	BC690	7.14	29.9	6.4	189.9	286.8	21013
Reference	BC690	13.25	29.9	6.4	189.9	226.7	16620
Reference	BC690	21.32	30.0	6.5	189.9	176.0	12905
Reference	BC690	31.08	30.0	6.5	190.0	138.6	10166
Reference	BC690	41.71	30.0	6.5	190.2	111.0	8144
Reference	BC690	53.56	30.1	6.6	190.4	91.7	6726
Reference	BC690	71.50	30.3	6.6	191.3	60.1	4402
Reference	BC690	90.96	30.3	6.5	191.3	56.7	4150
Reference	BC690	110.48	30.3	6.5	192.4	49.7	3642
Reference	BC690	130	30.3	6.5	192.5	45.0	3300
Impact	BUNWP0006	0.07	31.6	7.9	214.6	330.5	23533
Impact	BUNWP0006	0.15	31.5	7.9	213.8	282.1	20121
Impact	BUNWP0006	0.23	31.4	7.9	214.5	240.8	17191
Impact	BUNWP0006	0.43	31.6	7.9	216.4	209.4	14931
Impact	BUNWP0006	0.90	31.5	7.8	215.2	182.3	13026
Impact	BUNWP0006	1.57	31.5	7.4	228.6	155.1	11088
Impact	BUNWP0006	2.64	31.5	6.7	235.1	130.2	9315
Impact	BUNWP0006	4.10	31.4	6.5	230.9	126.4	9052
Impact	BUNWP0006	5.87	31.4	6.4	231.1	143.4	10278
Impact	BUNWP0006	8.11	31.4	6.3	233.0	166.2	11920
Impact	BUNWP0006	10.62	31.4	6.3	234.4	187.8	13477
Impact	BUNWP0006	13.32	31.5	6.5	275.5	202.3	14510
Impact	BUNWP0006	16.42	31.6	6.9	279.1	212.4	15223
Impact	BUNWP0006	19.95	31.6	7.1	287.9	218.3	15650
Impact	BUNWP0006	23.88	31.6	7.2	289.0	221.6	15892
Impact	BUNWP0006	28.31	31.6	7.2	292.5	223.5	16038
Impact	BUNWP0006	33.27	31.7	7.3	300.7	225.2	16158
Impact	BUNWP0006	38.62	31.7	7.4	308.5	223.4	16022
Impact	BUNWP0006	43.96	31.7	7.4	263.0	215.7	15473
Impact	BUNWP0006	49.31	31.7	7.4	267.4	181.3	13005
Impact	BUNWP0006	54.65	31.7	7.5	269.1	138.1	9905
Impact	BUNWP0006	60	31.7	7.5	269.5	109.9	7881