



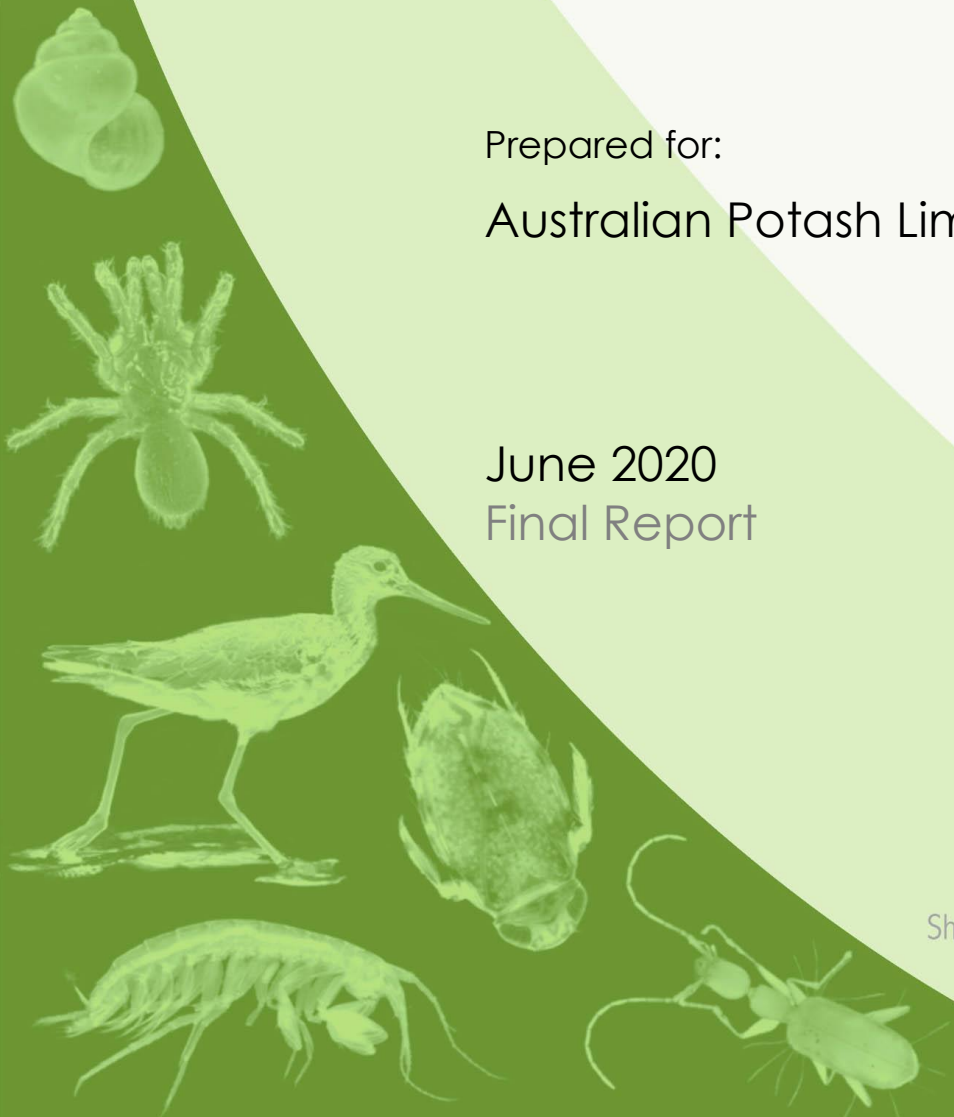
# Lake Wells Potash Project Subterranean Fauna Assessment

Prepared for:  
Australian Potash Limited

June 2020  
Final Report

Short-Range Endemics | Subterranean Fauna

Waterbirds | Wetlands





# Lake Wells Potash Project Subterranean Fauna Assessment

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## EXECUTIVE SUMMARY

Australian Potash Limited proposes to develop the Lake Wells Potash Project (the Project) at Lake Wells in the northeastern Yilgarn region of Western Australia. This will involve the extraction of naturally occurring potassium-rich groundwater brines underlying the Lake Wells salt lake system to produce sulphate of potash. Groundwater drawdown associated with the Project may alter habitat for subterranean fauna (stygo fauna and troglo fauna). This report provides the results of desktop and field surveys to determine the ecological and conservation values of subterranean fauna at Lake Wells.

Neither stygo fauna nor troglo fauna have previously been recorded in the vicinity of the Project, probably due to the lack of prior survey. The closest records of subterranean fauna to the Project area come from the Yamarna Calcrete PEC in the Yeo Palaeochannel to the south of Lake Wells.

Geologically, the Lake Wells area is characterised by Quaternary aeolian deposits, depositional sheet wash and playa/lacustrine deposits. The lacustrine clay is overlain by a variable, mixed alluvial sequence comprising sand, clay, evaporite and precipitate deposits. Basement rocks include Archaean granitic rocks rich in potassic and calcic feldspar, along with greenstone rocks including basalt, gabbro, felsic schists and chert-shale-BIF units. Low salinity aquifers occur in surficial alluvial deposits throughout the Lake Wells area and in fractured rock, particularly to the south of the main playa network in the proposed southern fractured rock borefield. Deep hypersaline aquifers from which brine will be produced are not prospective for stygo fauna. The desktop review did not identify prospective habitat for troglo fauna.

Using methods in line with EPA sampling guidelines, a total of 103 samples targeting stygo fauna were collected from 56 bores (including exploration holes; production and monitoring bores; and pastoral bores and wells). Effort for troglo fauna consisted of scraping and trapping at 10 holes. Forty-six per cent of bores sampled for stygo fauna yielded stygo fauna and at least 40 species of stygo fauna were recorded from major groups including oligochaete worms, rotifers, nematodes, amphipods, syncarids, cyclopoid and harpacticoid copepods, and ostracods. Syncarids (eight species) and harpacticoid copepods (17 species) appear to be particularly speciose in the study area. Twenty-nine of the 40 stygo fauna species recorded are only known from the Lake Wells area.

It is assumed for the purposes of this baseline report that only groundwater drawdown of >5 m in the brine borefield will potentially impact stygo fauna. Five species of stygo fauna are known only from within the modelled >5 m drawdown: the harpacticoid copepods *Nitocrellopsis* sp. B13, *Nitocrellopsis* sp. B15, *Nitocrellopsis* sp. B16, *Nitocrellopsis* sp. B17 and the amphipod Chiltoniidae 'BAM143a'. An additional four species are potentially restricted to the area of the borefield in which >2 m drawdown will occur.

It has been assumed that drawdown from the process water borefield will be restricted to the Off-Playa Development Envelope. Four species of stygo fauna are known only from this area. They are the syncarids *Atopobathynella* sp. B26, *Atopobathynella* sp. B35, *Kimberleybathynella* sp. B08 and the ostracod *Riocypris* sp. (1000 mg L<sup>-1</sup>).

Five troglo fauna species were collected from the off-playa Development Envelope and other sites outside the main playa network. They represent a depauperate troglo faunal community.

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## 1. INTRODUCTION

Australian Potash Limited proposes to develop the Lake Wells Potash Project (the Project) at Lake Wells, approximately 160 km northeast of Laverton, in the northeastern Yilgarn region of Western Australia (Figure 1). The Project will involve the extraction of naturally occurring potassium-rich groundwater brines underlying the Lake Wells salt lake system and their concentration in solar evaporation ponds for the production of sulphate of potash (potassium sulphate), an important plant fertiliser. Additional infrastructure is likely to include salt harvesting and treatment facilities, access and haul roads, an airstrip, accommodation and administration facilities, utility supplies and drainage, and a borefield to produce 'low salinity' groundwater for potash processing and domestic purposes. An indicative layout of the Project is shown in Figure 2.

The final layout and impact footprint of the Project is yet to be determined but it is possible that groundwater drawdown associated with the Project may alter habitat for subterranean fauna. Accordingly, this report provides the results of desktop and field surveys to determine the ecological and conservation values of subterranean fauna at Lake Wells. The specific aims of the work were:

1. To determine the likelihood of subterranean fauna (stygo fauna and troglotauna) occurring in the vicinity of the Project by assessing hydrogeology, potential habitat and previous records of subterranean fauna;
2. To document the assemblages and species of subterranean fauna present at Lake Wells through field survey; and
3. To evaluate the conservation values of subterranean fauna species and assemblages at Lake Wells in the context of proposed developments at the Project.

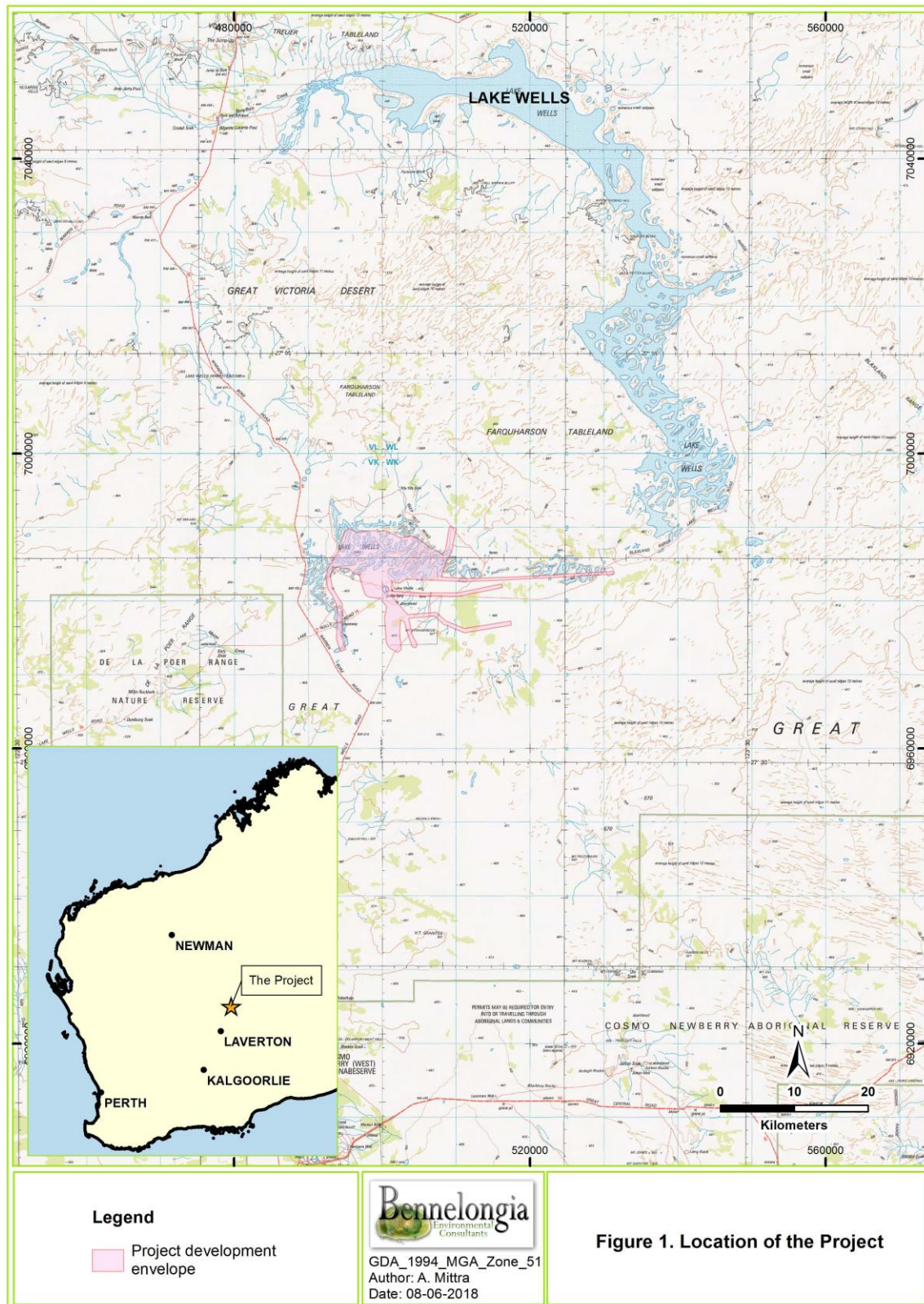
## 2. SUBTERRANEAN FAUNA FRAMEWORK

Subterranean fauna include aquatic stygo fauna and air-breathing troglotauna. Both groups typically have reduced or absent eyes and are poorly pigmented due to lack of light. Other morphological and physiological adaptations, such as vermiform bodies, elongate sensory structures, loss of wings, increased lifespan, a shift towards K-selection breeding strategy and decreased metabolism, reflect the habitats occupied by subterranean species (Gibert and Deharveng 2002). With the exception of a few species of fish, all subterranean fauna species in Western Australia are invertebrates. Stygo fauna species are considered to be ecologically important for the maintenance of groundwater quality through purification and nutrient cycling (Boulton *et al.* 2008).

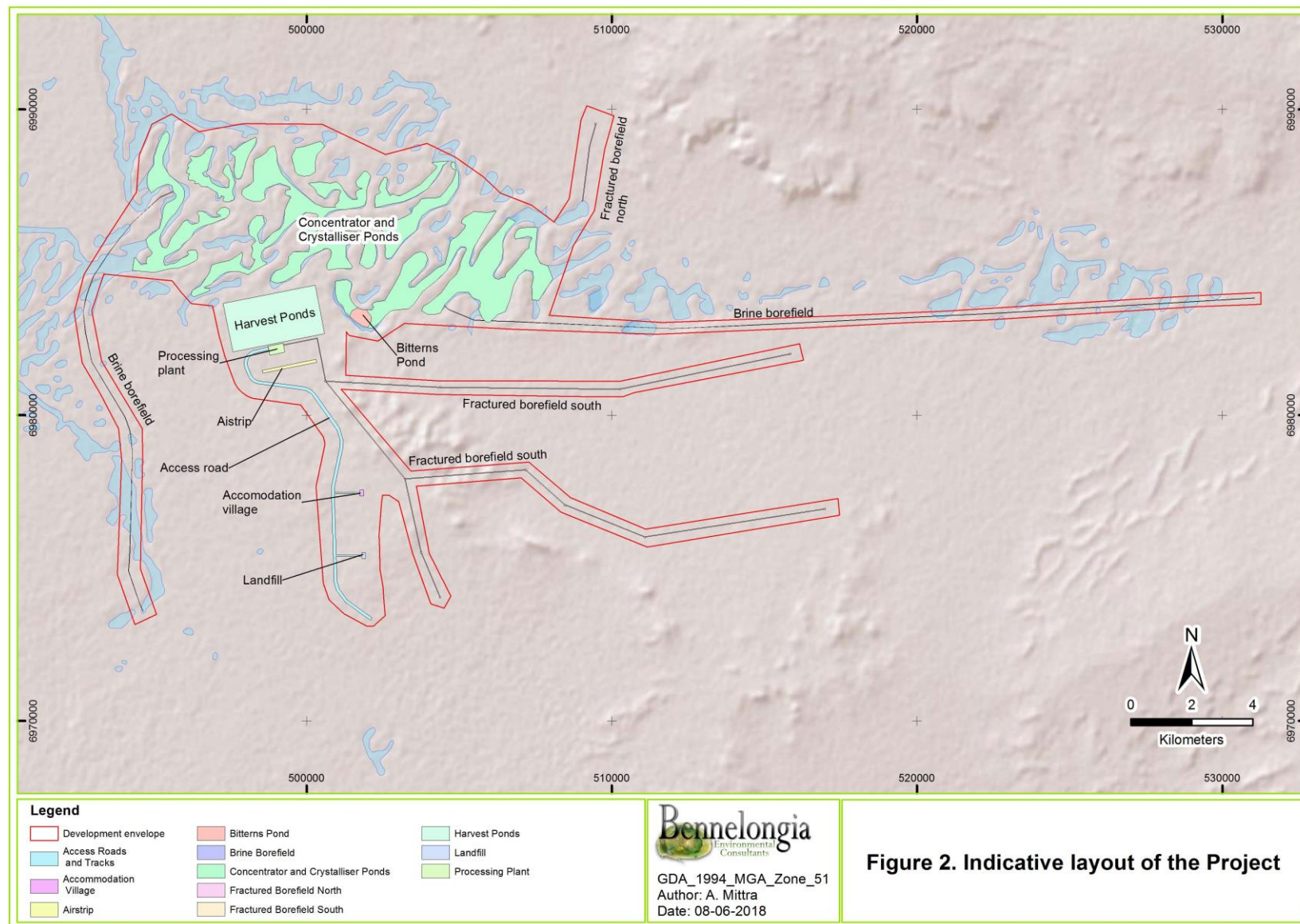
While some subterranean species are obligate inhabitants of groundwater (stygo bites) or deep subterranean spaces above the water table (troglotauna), others use these habitats only for part of their life cycle (stygo philes and troglotauna). These species with some surface occurrence usually have larger distributions than obligate subterranean species as a result of greater dispersal opportunities.

Although inconspicuous, subterranean fauna contribute markedly to the overall biodiversity of Australia. The Yilgarn and neighbouring Pilbara regions of Western Australia are recognised as hotspots of subterranean faunal biodiversity, with more than 4,000 subterranean species likely to occur (Halse 2018), the majority of which remain undescribed. Nearly all subterranean species satisfy Harvey's (2002) criteria for short-range endemism (SRE), namely a total range of less than 10,000 km<sup>2</sup>, occurrence in discontinuous or fragmented habitats, slow growth and low fecundity. Given that species with small ranges are more vulnerable to extinction following habitat degradation than wider ranging species (Ponder and Colgan 2002), it follows that subterranean species are highly susceptible to anthropogenic threats such as groundwater abstraction.

In Western Australia the Environmental Protection Authority (EPA) requires consideration of subterranean fauna as part of environmental impact assessment (EPA 2016a, b).



**Figure 1.** Location of the Lake Wells Potash Project.



**Figure 2.** Indicative layout of the Project.

### 3. DESKTOP ASSESSMENT

The desktop component of this work reviews previous records of subterranean fauna and habitat information, including geology and hydrogeology, to determine the likelihood of subterranean fauna occurring in the vicinity of the Project.

#### 3.1. Previous Records of Subterranean Fauna

Previous records of subterranean fauna in the vicinity of the Project were collated by searching available databases (Bennelongia, Western Australian Museum) and relevant literature for records of subterranean fauna within an area of approximately 10,000 km<sup>2</sup> (defined by 26.604°S, 122.489°E and 27.624°S, 123.57°E).

Neither stygofauna nor troglifauna have previously been recorded in the search area, probably because of the lack of prior survey in the vicinity of Lake Wells. The closest records of subterranean fauna to the Project area come from the Yamarna Calcrete PEC in the Yeo Palaeochannel to the south of Lake Wells. The records from Yamarna, which hosts a rich stygofauna community (Bennelongia 2016b), are 75 km from the Lake Wells system but the habitat in the two areas is potentially similar (although separate and with less calcrete at Lake Wells).

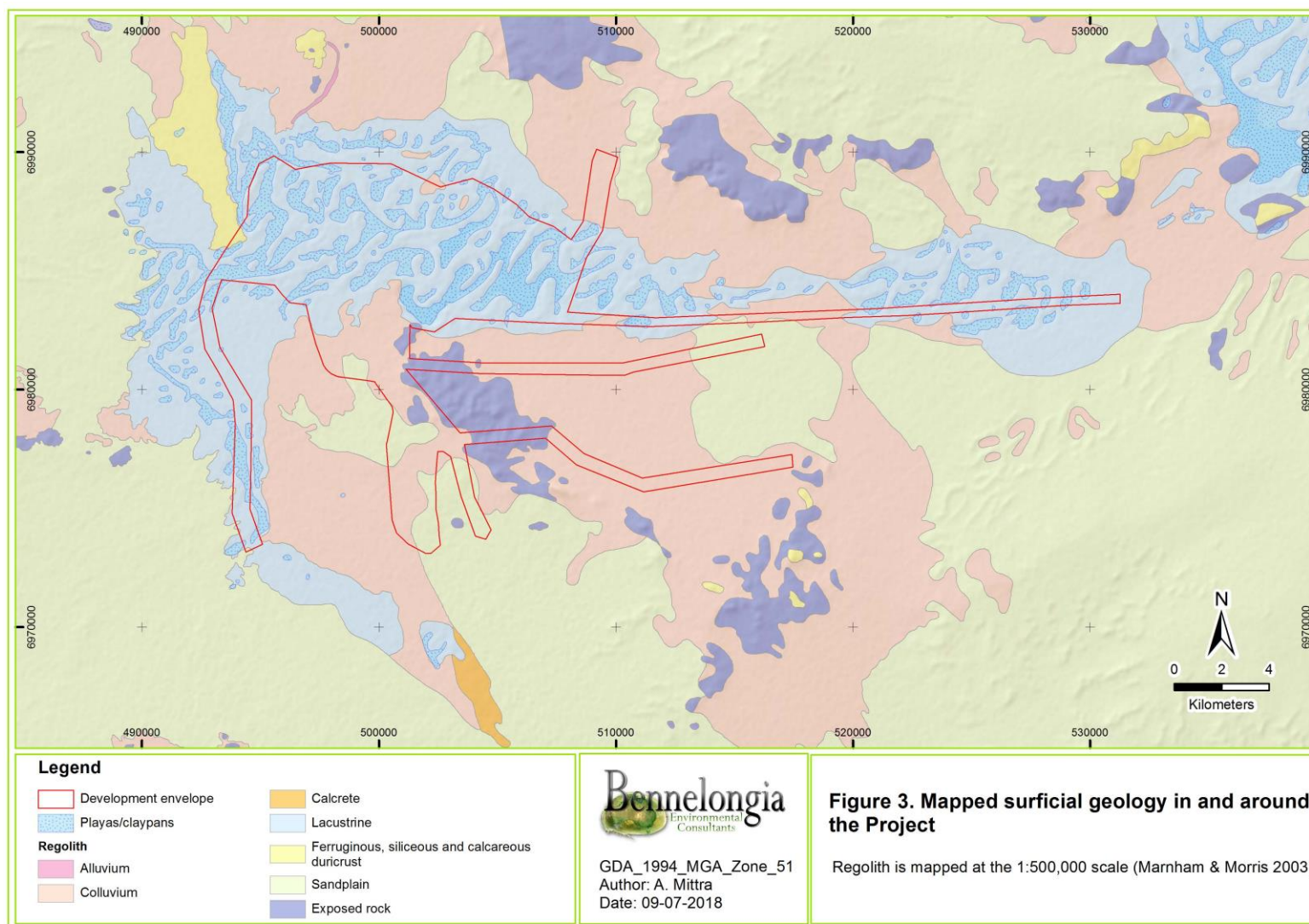
#### 3.2. Geology and Hydrogeology

Geologically, the Project area is characterised by Quaternary aeolian deposits, depositional sheet wash and playa lake deposits. Basement rocks include Archaean granitic rocks rich in potassic and calcic feldspar, along with greenstone rocks including basalt, gabbro, felsic schists and chert-shale-BIF units. Historic and recent drilling programs have revealed a variable regolith horizon consisting of surficial or near-surface evaporite and sand/silt, silcrete (with or without laterite), common lake clays with some well sorted sand units and puggy lacustrine clays with minor sand/silt. Archaean basement rocks including transitional porphyry, granite, ultramafic and amphibolite types were logged at the end of some holes.

Thirty-two brine exploration drill holes have been drilled in the Project area. Consistent with the wider regional setting, drilling results show a deep Tertiary valley with predominantly lacustrine clays and minor sand interbeds at depths of up to 140 mbgl. The lacustrine clay is overlain by a variable, mixed alluvial sequence comprising sand, clay, evaporite and precipitate deposits. There is a reasonably consistent sand unit, 1–15 m thick, at the base of the alluvial sequence that has been intersected by 21 of the 32 drill holes at depths of between 29 mbgl and 77 mbgl.

Aquifer units proposed for brine extraction in the Project area include (AQ2 2019; Figure 3):

- **Surficial:** Pliocene–Quaternary mixed alluvial/lacustrine sediments comprising clayey sands, calcrete, laterite and evaporite deposits (~0–30 mbgl). Permeability is most low, although the calcrete and silcrete have adopted permeability values of 1 m per day.
- **Upper sand:** Pliocene, predominantly sand unit with variable clay content at the base of the surficial aquifer. It has an adopted permeability of 0.5–3 m per day and is connected to the surficial aquifer.
- **Clay with minor sand interbeds:** Low-permeability, low-yield Miocene clay aquitard comprising puggy lacustrine clay with sandy interbeds (~30–150 mbgl). It has mostly low but variable permeability, with adopted permeability values of 0.07–0.8 m per day. Permeable parts of this aquitard will connect the upper and basal sand aquifers when the basal sand aquifer is pumped.
- **Mixed sand and clay:** Interbedded sand and clay, with adopted permeability of 0.4–0.8 m per day. The relatively even permeability of this aquifer facilitates downward leakage from the surficial and upper sand aquifer when the basal sand aquifer is pumped.



**Figure 3.** Mapped surficial geology in and around the Project area.

- **Basal sand:** Eocene basal sand forming a major permeable aquifer and high yields of brine (>150 mbgl). It has adopted permeability of 2-3 m per day.

Freshwater aquifers outside the main playa network occur mostly in fractured rock. The depth to watertable south of the palaeochannel is approximately 6-36 mbgl and salinity is approximately 1,000-2,000 mg/L TDS. Little is known about these aquifers but the major storage is considered to be in fractures and faults, some of which have been expanded by secondary weathering (Australian Potash undated).

Freshwater aquifers occur in alluvium and colluvium, and in the underlying fractured rock, in areas surrounding the main playa network but the precise salinity, depth and connectivity of these aquifers is presently unclear (AQ2 2017). Surficial geology in the vicinity of Lake Wells is shown in Figure 3.

### 3.2.1. Brine Bores

Brine bores will be placed in and around the main network of salt lake playas of Lake Wells. Permeability estimates for brine aquifers, combined with test pumping, indicate that brine can be pumped from the upper sand and basal sand units. Abstraction from the basal sand unit will facilitate depressurisation and under-drainage of the overlying clay aquitard, while abstraction from the upper sand will drain the overlying surficial aquifer. There is also the possibility to increase abstraction from the surficial aquifer through constructing drainage trenches (6–10 m deep) on playa surfaces (AQ2 2017).

The production rate of sulphate of potash is proposed to be 100,000 Tpa for the first five years, increasing to 200,000 Tpa thereafter. Based on these rates and mean-weighted averages of potassium concentrations in aquifers, the brine borefield must produce  $46.4 \text{ ML day}^{-1}$  ( $16.9 \text{ GL yr}^{-1}$ ) of brine continuously for the first five years and  $102.2 \text{ ML day}^{-1}$  ( $37.3 \text{ GL yr}^{-1}$ ) thereafter. Analysis suggests water levels will fall below the base of the upper sand aquifer during the first year of operation and after 30 years of operation there will be 130 m of drawdown in the southern western part of the palaeochannel (within the Project tenements). Along most of the palaeochannel there will be 50 m of drawdown (Figure 4; AQ2 2019).

### 3.2.2. Process Water Borefield

A process water borefield with a capacity  $0.8 \text{ GL yr}^{-1}$  is proposed to supply water to the process plant and to meet potable water requirements (Australian Potash undated). The freshwater production bores for this purpose are proposed to be located in the Off-Playa Development Envelope south of Lake Wells (see Figure 2). Likely bore locations have not been determined and the extent of groundwater drawdown associated with the borefield has not been estimated.

## 3.3. Assessment of Habitat Prospectivity

The available geological information suggests that Lake Wells has low-to-moderate prospectivity for subterranean fauna. Prevailing geologies are predominantly lacustrine deposits (clays and playa lake deposits) that are unlikely to provide the subterranean matrix of interstices, vugs and holes required to host significant assemblages of stygofauna and troglofauna. Troglofauna habitat is further limited by shallow depths to groundwater through much of the Project area.

Stygofauna are generally more common (and communities more diverse) in fresh and brackish aquifers, although Bennelongia have recorded rich communities in considerably saline environments (e.g. around  $50,000 \text{ mg L}^{-1}$ , Bennelongia 2017) and there are records of stygofaunal amphipods and copepods at salinities around  $100,000 \text{ mg L}^{-1}$  near Wiluna (Outback Ecology 2012). Nevertheless, it is considered unlikely that stygofauna (and even more so troglofauna) occur underneath the playa surfaces that will host brine extraction because of unsuitable geology and hypersalinity.

While there is low prospectivity for subterranean fauna under the Lake Wells playa system, the lower salinity aquifers external to Lake Wells (including the area proposed for low salinity water production

outside the brine borefield) are predicted to be moderately prospective for stygofauna. It is also possible that areas of low salinity groundwater occur in the upper surficial aquifer within the parts of the playa system.

While the available information suggests the aquifer targeted for production of low-salinity water occurs predominantly in fractured rock, AQ2 (2017) suggest that alluvium, colluvium and calcrete are present in the off-playa surficial aquifer, which increases its prospectivity. Alluvial, colluvial and especially calcrete aquifers are prime stygofauna habitat. Stygofauna have also been recorded from fractured rock aquifers (Bennelongia 2016; Halse 2018).

Troglofauna may also occur in alluvium, colluvium and calcrete, although the threat to these species from groundwater drawdown is minimal because relative humidity in the vadose zone is controlled by distance from the surface rather than distance to the watertable. Consequently, the principle focus of subterranean fauna investigations was stygofauna.

## 4. FIELD SURVEY

The aims of field survey were to determine whether subterranean fauna occur in the vicinity of Lake Wells and, if so, to characterise the communities and species with a focus on their conservation values.

### 4.1. Sampling Effort

Three rounds of field survey were undertaken (Table 1). In March 2017, 15 bores were sampled for stygofauna (Table 1). One of these bores was in the proposed brine borefield (bore PLWDD004) and 14 bores intercepted fresh or slightly saline groundwater to the north and south of the proposed brine field (except for bore LAGC047, which had a salinity similar to seawater). Six exploration holes were sampled for troglofaunal. Two litter traps were deployed at each of two sites (LWHDH010 and TROG3), and three sites (TROG 1, TROG 2 and TROG 3) were also scraped for troglofauna. Traps from five sites were retrieved two months later by Jim Williams (Botanica Consulting). One troglofauna trap was unable to be retrieved due to damage to the hole (LAGC047) by earthmoving equipment. In October 2017, 45 bores were sampled for stygofauna. Twenty-one of these bores had been recently drilled. In May 2018, 43 bores were sampled for stygofauna. Sampling sites and effort are shown in Figure 4 and a complete list of sites and samples is given in Appendix 1.

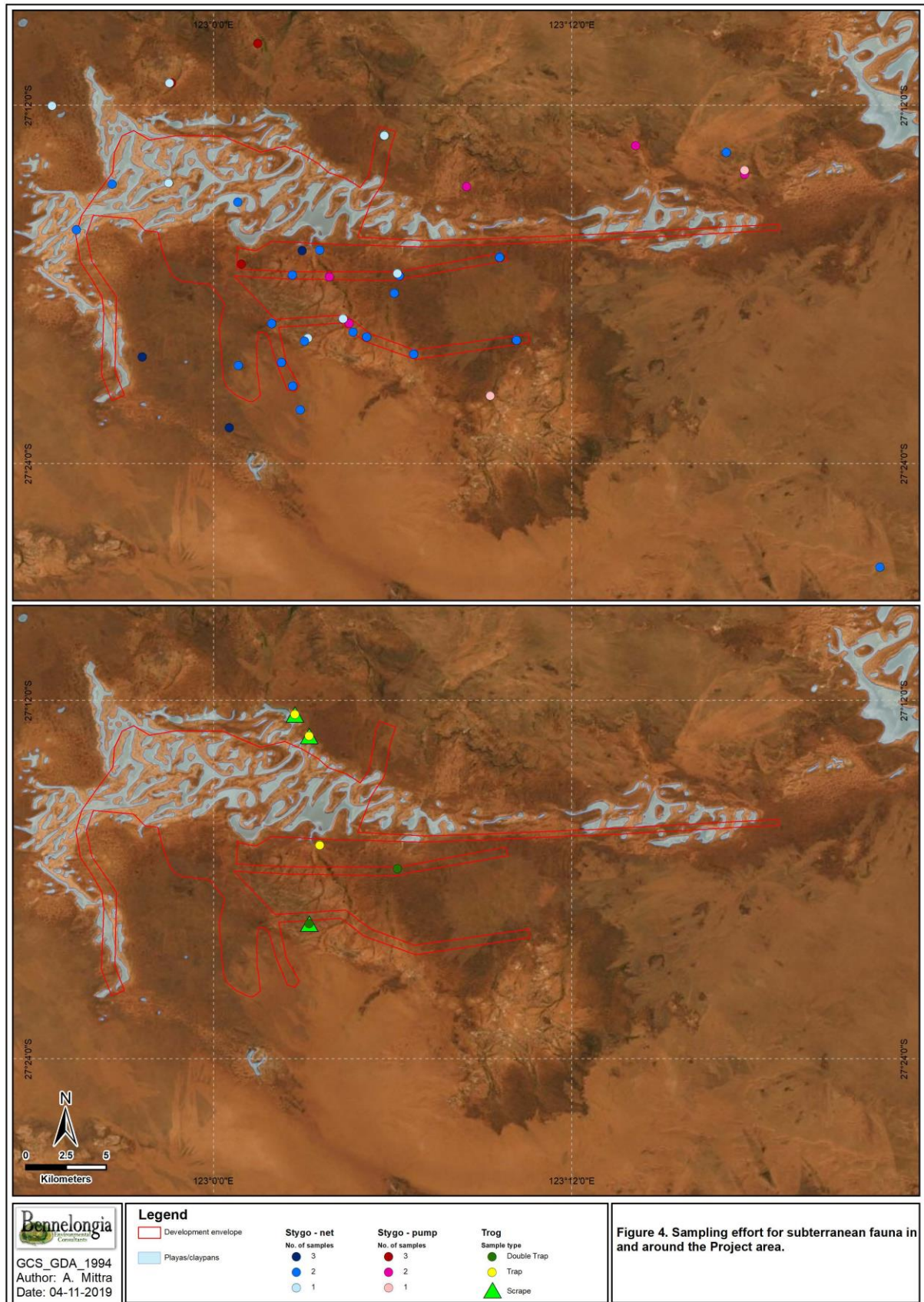
**Table 1.** Sampling effort for subterranean fauna at Lake Wells in March 2017.

	No. of Bores	Net	Pump	Scrape	Trap*
<b>March 2017</b>					
Stygofauna	15	8	7	-	-
Troglofauna	6	-	-	4	8
<b>October 2017</b>					
Stygofauna	45	38	7	-	-
<b>May 2018</b>					
Stygofauna	43	37	6	-	-

\*Two troglofauna litter traps were set at two sites (LWHDH010 and TROG3).

#### 4.1.1. Stygofauna Methods

Sampling for stygofauna followed the methods recommended by the EPA (2016b), whereby stygofauna were sampled at each bore using weighted plankton nets. Six hauls were taken at each site, three using a 50 µm mesh net and three with a 150 µm mesh net. The net was lowered to the bottom of the hole and jerked up and down to agitate the benthos (increasing the likelihood of collecting benthic species) and then slowly retrieved through the water column. Substrate in the terminal vial was collected after each haul. Nets were washed between holes to minimise site-to-site contamination. Net hauling was not possible at pastoral bores fitted with windmills. At these bores, the pump outflow was filtered for between 20 minutes and over 24 hours through a 50 µm mesh net. Samples were preserved in 100% ethanol and refrigerated at a constant 4 °C. Previous work has shown that results from pumping and



**Figure 4.** Sampling effort for subterranean fauna in and around the Project.

net hauling are similar in terms of the species collected (Eberhard *et al.* 2009; Hancock and Boulton 2009).

*In situ* water quality parameters – temperature, electrical conductance (EC) and pH – were measured at each bore with a TPS WP-81 field meter. Standing water level and total depth of hole were also measured using a Solinst water level meter.

In the laboratory, samples were elutriated to separate out heavy sediment particles and sieved into size fractions using 250 µm, 90 µm and 53 µm screens. All samples were sorted under a dissecting microscope and stygofauna specimens identified to species level where possible using available keys and species descriptions. When necessary for identification, animals were dissected and examined under a differential interference contrast compound microscope. If stygofauna did not represent a described species, they were identified to species/morphospecies using characters from species keys.

#### 4.1.2. Troglofauna Methods

Two sampling techniques were used to collect troglofauna from drill holes. Cylindrical PVC traps (270 mm x 70 mm, entrance holes side and top) were baited with moist leaf litter (sterilised by microwaving) and lowered on nylon cord to the most suitable habitat within each drill hole. Holes were covered at the surface while traps were set to minimise the ingress of surface invertebrates. Scrapes were collected immediately prior to setting traps using a troglofauna net (weighted ring net, 150 µm screen, various apertures according to diameter of the hole) that was lowered to the bottom of the hole, or to the watertable, and scraped back to the surface along the walls of the hole. Each scrape comprised four sequences of lowering and retrieving the net. Samples were preserved in 100% ethanol and refrigerated. Scrape and trap samples within the same site were treated as sub-samples of a single sample for reporting purposes.

In the laboratory, troglofauna were extracted from the leaf litter in traps using Tullgren<sup>®</sup> funnels under incandescent lamps. The light and heat drives the troglofauna and other invertebrates out of the litter into the base of the funnel containing 100% ethanol which acts as a preservative. After about 72 hours, the ethanol and its contents were removed and sorted under a dissecting microscope. Litter from each funnel was also examined under a microscope for any remaining live or dead animals. Preserved scrapes were elutriated in the laboratory to separate animals from heavier sediment and screened into size fractions (250 µm and 90 µm) to remove debris and improve searching efficiency. Samples were then sorted under a dissecting microscope.

All fauna picked from scrapes or extracted from bait were examined for troglomorphic characteristics (lack of eyes and pigmentation, well developed sensory organs, slender appendages, vermiform body). Troglofauna specimens were identified to species or morphospecies level using the same techniques employed for stygofauna unless they were damaged, juvenile or the wrong sex for identification.

#### 4.2. Molecular Analyses

DNA analyses were conducted on 23 animals using the COI and 12S barcoding genes to confirm or refine morphological identifications. Either legs or whole animals (depending on their size) were transferred directly into ATL buffer and proteinase K after confirming species identification. DNA extraction and amplification were undertaken twice, first by Bennelongia (called Job 30, both COI and 12S targeted) followed by EcoDiagnostics (called Job 31, only COI targeted). In both jobs, five standard primers were used to amplify COI (forward primers LCO1490 and C1-J-1718 and reverse primers HCO2918, HCOout and HCOoutout; Folmer *et al.* 1994; Kambhampati and Smith 1995) and 12S (SR-J-14197, SR-J-14199 and SR-N-14745; Simon *et al.* 2006, Kambhampati and Smith 1995). EcoDiagnostics used four additional crustacean primers to amplify COI (CrustDF1, CrustDR1, LoboF1 and LoboR1). EcoDiagnostics did not successfully sequence any of the material using seven primer combinations and the remaining elutes were requested by Bennelongia, however, the plate format in which the elutes were

provided is designed for use by robots and Bennelongia anticipated a high chance of contamination between samples. DNA sequencing was undertaken by AGRF (Australian Genome Research Facility) and taxonomic implications were determined by Bennelongia.

### 4.3. Personnel

Field survey was undertaken by Michael Curran, Anton Mittra and Grant Pearson. Species identifications were completed by Stuart Halse (ostracods), Mike Scanlon (oligochaetes) and Jane McRae (all other groups). Molecular analyses were done by Michael Curran. Reporting and mapping was undertaken by Anton Mittra.

### 4.4. Overview of Stygal Community

A total of 849 stygofauna specimens belonging to at least 40 species were recorded across the three rounds of survey in and around Lake Wells (Table 2). Major groups that comprise the stygal community in the area include oligochaete worms, rotifers, nematodes, amphipods, syncarids, cyclopoid and harpacticoid copepods, and ostracods. Syncarids (eight species) and harpacticoid copepods (17 species) appear to be particularly speciose in the study area.

The majority of recorded species (29 of 40) are currently only known from collections at Lake Wells (grey shading in Table 2). The known ranges of these species are necessarily restricted to the area covered by survey (although their true ranges may extend more widely) because of the lack of sampling in the surrounds, but it is considered probable that many species do in fact have small distributions. The distributions of these species are discussed in Section 0.

Of the 56 holes and bores sampled, at least 26 (46%) yielded stygofauna species. A small number of specimens were recorded from two brine production bores, PLAC018 and PLAC026, but it is strongly suggested these animals are contaminants from bores sampled shortly beforehand (despite careful hygiene procedures). In bores that yielded, the number of species varied from one to nine. The high-yielding bores were located south of the main playa network (e.g. LAGC043, LGRB100 had eight and nine species respectively, Lake Wells Bore and Diorite Bore both had six species), north of the main playa network (Mt Barretts Bore had six species) and to the northwest of the main playa network (Exploration Hole 1 had eight species).

### 4.5. Molecular Analysis: General Results

Eight animals were successfully sequenced for COI and six for 12S (Appendix 2). The COI fragments were between 499 and 713 base pairs (bp), and 470 to 588 bp for 12S.

#### Syncarida

COI sequencing were successful for *Kimberleybathynella* sp. B08, *Kimberleybathynella* sp. B10 and two morphologically indeterminate (immature) specimens of the *Kimberleybathynella* collected from Lake Wells and Eric's bores, respectively. The latter two specimens yielded identical sequences, which is highly unusual and strongly suggests contamination between the two samples, however this sequence was divergent by 30% from congeners and is considered to represent a new species (*Kimberleybathynella* 'BSY180'). It is not possible to compare *Kimberleybathynella* 'BSY180' to *Kimberleybathynella* sp. B09 (which did not yield for COI) using genetics, although it is considered unlikely that they are the same species. They are 9.4–15.4 km apart.

12S sequences were obtained for *Kimberleybathynella* B09, *Kimberleybathynella* sp. B10 and a morphologically indeterminate syncarid specimen (*Syncarida* sp.) and all three animals appear to be distinct from one another.

Both COI and 12S were successfully sequenced for *Atopobathynella* sp. B35 with results confirming that it is a new species most closely related to (but still distinct from) *Atopobathynella* sp. B08, a species

**Table 2.** Stygofauna species recorded over three rounds of survey in and around the Project area.

Higher order identifications ("\*") were not included in final counts of richness. Grey shading indicates species known only from Lake Wells. Yellow highlights denote probable contaminants.

Higher Classification	Lowest Identification	Comer Bore	Diorite Bore	Eric's	Exploration Hole 01	Gibson Bore	Golden Bore	Grimwoods Bore	Lake Wells Bore	LGAC043	LGRB100	LWFRM001	LWFRM002	LWFRM007	LWFRM008	LWFRM010	LWFRM012	LWFRM014	LWFRP004	LWFRP005A	LWFRP008	LWFRP010	LWFRP012	LWHDH010	Mt Barrett's bore	PLAC018	PLAC026	TROG3	Yilly Yilly Bore	Total No. of Sites	Total No. of Sites
Annelida	Oligochaeta sp.*								1																					1	1
Aphanoneura																															
Aeolosomatidae	Aeolosoma sp.																									1				1	1
Clitellata																															
Enchytraeida																															
Enchytraeidae	Enchytraeidae sp. B22		1					7	50	33		13				1					2			5	1				5	10	118
Haplotaxida																															
Tubificidae	Tubificidae sp. B05		29																											1	29
	Tubificidae sp. B06				2																									1	2
Rotifera																															
Eurotatoria																															
Bdelloidea	Bdelloidea sp. 2:2										1																		30	2	31
Nematoda	Nematoda sp.			3			6		1	2	11																		12	6	35
Arthropoda																															
Crustacea																															
Malacostraca																															
Amphipoda																															
Chiltoniidae	Chiltoniidae sp.*																									1				1	1
	Chiltoniidae `BAM143a`										21																			1	21
	Chiltoniidae `BAM143b`																									100				1	100
Syncarida	Syncarida sp.*											1																		1	1
Bathynellidae	Bathynella sp. B38		1						4																					2	5
Parabathynellidae	Atopobathynella sp. B26								1			5																		2	6
	Atopobathynella sp. B35																													1	3
	Kimberleybathynella `BSY180`			1					1											3										2	2
	Kimberleybathynella sp. B08														1				8											2	9
	Kimberleybathynella sp. B09																									3				1	3
	Kimberleybathynella sp. B10		1																											1	1
	Parabathynellidae gen. nov. sp. B11		1						4												1									3	6
Maxillopoda																															
Cyclopoida																															
Cyclopidae	Dussartcyclops (Dussartcyclops) uniarticulatus										6									10						8				3	24
	Fierscyclops (Fierscyclops) fiersi				30																									1	30
	Goniocyclops sp. B10 (3332)																												2	1	2
	Halicyclops eberhardi s.l.				3																									2	4
Harpacticoida	Harpacticoida sp.*																													1	1
Ameiridae	Nitocrellopsis sp.*						2			10																				2	12
	Nitocrellopsis sp. B12									15														10				2		3	27
	Nitocrellopsis sp. B13									1														50						2	51
	Nitocrellopsis sp. B14						1			1	2																			3	4
	Nitocrellopsis sp. B15										60																			1	60

Higher Classification	Lowest Identification	Corner Bore	Diorite Bore	Eric's	Exploration Hole 01	Gibson Bore	Golden Bore	Grimwoods Bore	Lake Wells Bore	LGAC043	LGRB100	LWFRM001	LWFRM002	LWFRM007	LWFRM008	LWFRM010	LWFRM012	LWFRM014	LWFRP004	LWFRP005A	LWFRP008	LWFRP010	LWFRP012	LWHDH010	Mt Barrett's bore	PLAC018	PLAC026	TROG3	Yilly Yilly Bore	Total No. of Sites	Total No. of Sites
	<i>Nitocrellopsis</i> sp. B16									20	25																			2	45
	<i>Nitocrellopsis</i> sp. B17									10																				1	10
	<i>Nitocrellopsis</i> sp. B18																													1	27
	<i>Nitocrellopsis</i> sp. B19						2			5	10																			3	17
	<i>Nitocrellopsis</i> sp. B22				10																							1		2	11
	<i>Nitocrellopsis</i> sp. B23				10																									1	10
	<i>Nitocrellopsis</i> sp. B24																5													1	5
	<i>Nitocrellopsis</i> sp. B25				1																									1	1
Canthocamptidae	<i>Australocamptus</i> sp. B18																												11	1	11
Miraciidae	<i>Schizopera</i> sp. B31		1		10																									2	11
	<i>Schizopera</i> sp. B32					1																								1	1
	<i>Schizopera</i> sp. B40				1																									1	1
Parastenocarididae	<i>Parastenocaris jane</i>											20							10	5		20								4	55
	<i>Parastenocaris</i> sp.*		1																											1	1
Ostracoda	Ostracoda sp. unident.*								6		6		2			1		2											1	6	18
Cyprididae	<i>Riocypris</i> sp.	1																												1	1
	<i>Sarscypridopsis</i> sp. BOS1017	15							5					1			2						10							5	33
	<i>Sarscypridopsis</i> sp. BOS1018																													1	1
	<b>TOTAL abundance</b>	16	35	4	67	1	11	7	73	97	142	39	2	1	1	2	2	7	31	5	3	20	10	65	141	1	3	2	61		
	<b>TOTAL richness</b>	2	6	1	8	1	3	1	6	8	9	3	0	1	1	1	1	1	4	1	2	1	1	3	6	1	2	1	5		

collected by Bennelongia from Telfer (divergence of 18%). Sequencing was unsuccessful for *Atopobathynella* sp. B26, although this species is morphologically distinct from *Atopobathynella* sp. B35.

### Oligochaeta

Sequencing of COI was successful for Tubificidae sp. B06 and comparisons to available oligochaete sequences including those in the Bennelongia database and animals sequenced by Brown *et al.* (2015) confirms it is a new species that has not been collected outside the current survey area. Comparison with Tubificidae sp. B05 (collected from Diorite Bore) was not possible because this animal failed to sequence, but the specimens are morphologically distinct.

### Amphipoda

COI sequencing was successful for amphipod specimens collected from LGRB100 and Mt Barrett's Bore, which were 8% divergent. Based on previously reported within and between-lineage divergences for Chiltoniidae (King *et al.* 2012), the result is interpreted to indicate that the two bores harbour separate, related species: Chiltoniidae 'BAM143a' from LGRB100 and Chiltoniidae 'BAM143b' from Mt Barrett's Bore. However, this magnitude of divergence has sometimes been treated as intra-specific (e.g. Subterranean Ecology 2011) and treatment of the animals as separate species is precautionary.

## 4.6. Potentially Restricted Species

It is assumed for the purposes of this baseline report that only groundwater drawdown of >5 m in the brine borefield will potentially impact stygofauna. Five species of stygofauna are known only from within the modelled >5 m drawdown: the harpacticoid copepods *Nitocrellopsis* sp. B13 collected at salinities of 9900-15900 mg L<sup>-1</sup>, *Nitocrellopsis* sp. B15 (12500 mg L<sup>-1</sup>), *Nitocrellopsis* sp. B16 (10700-15700 mg L<sup>-1</sup>), *Nitocrellopsis* sp. B17 (15100 mg L<sup>-1</sup>) and amphipod Chiltoniidae 'BAM143a' (12500 mg L<sup>-1</sup>).

It should be noted, however, that an additional four species are potentially restricted to the area of the borefield in which >2 m drawdown will occur. The additional species are the harpacticoid copepods *Nitocrellopsis* sp. B14, *Nitocrellopsis* sp. B19, *Nitocrellopsis* sp. B24 and ostracod *Sarscypridopsis* 'BOS1018'.

It has been assumed that drawdown from the process water borefield will be restricted to the Off-Playa Development Envelope. Four species of stygofauna are known only from this area. They are the syncarids *Atopobathynella* sp. B26 collected at 920-5500 mg L<sup>-1</sup>, *Atopobathynella* sp. B35 (1750 mg L<sup>-1</sup>), *Kimberleybathynella* sp. B08 (1750-1800 mg L<sup>-1</sup>) and the ostracod *Riocypris* sp. (1000 mg L<sup>-1</sup>).

A single species may be impacted by drawdown from both borefields. The harpacticoid *Nitocrellopsis* sp. B24 was collected from bore LWFRM014, which lies within the brine borefield drawdown and the off-playa Development Envelope. Salinity at this bore was 47600 mg L<sup>-1</sup>.

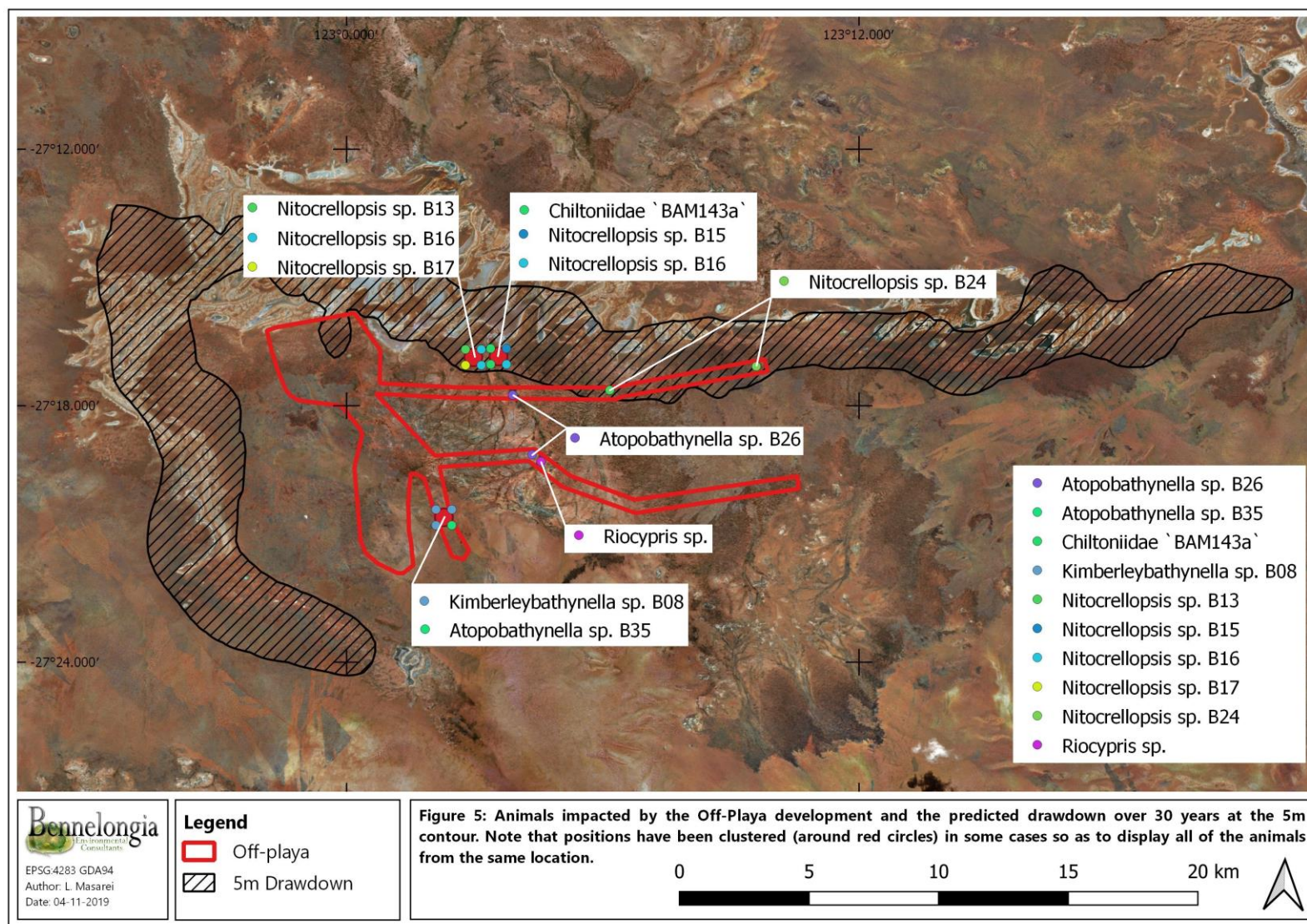
## 4.7. Species Accounts

The known and likely ranges of all stygofauna species known only from the Lake Wells area are discussed below, with the results of molecular analyses incorporated where available.

### 4.7.1. Oligochaeta

#### Enchytraeidae sp. B22

This earthworm appears to be widespread at Lake Wells, having been recorded at 10 bores, and has a minimum inferred linear range of 21 km (**Figure 6A**). Notably, it was recorded bore north and south of the playa network. Bore construction logs for collection sites in the southern fractured rock borefield, as well as the collection of this species in moderate-to-high abundances in shallow pastoral bores (Diorite, Grimwoods and Lake Wells Bores) and a shallow exploration bore (LGAC043), indicate that the main habitat for Enchytraeidae sp. B22 is shallow surficial aquifers. However, as suggested by the construction



**Figure 5.** Stygofauna species known only from within the brine borefield (5 m drawdown contour) or the Off-Playa Development Envelope.

details of collection site LWFRM010, which is slotted at 60–72 mbgl, it may also occupy deeper aquifers (alternatively its collection in LWFRM010 may indicate a fault in the bore casing). There is good evidence to suggest that this species is at least moderately widespread in association with surficial aquifers around Lake Wells and it is considered likely that its distribution extends beyond the Project area.

#### **Tubificidae sp. B05**

This earthworm was collected only from the pastoral bore called Diorite Bore, south of the main playa network (Figure 6B). It is not possible to define the range of species collected from single locations but it is likely that the range of Tubificidae sp. B05 will match the extent of the shallow surficial aquifer from which it was collected. (While precise bore construction details are unavailable most, if not all, pastoral bores at Lake Wells target aquifers at depths of 30 m or less.) The collection of the widespread Enchytraeidae sp. B22 from Diorite Bore provides some evidence of habitat connectivity for oligochaetes over a large area and it is possible that Tubificidae sp. B05 is a patchily distributed or low-abundance species with a similar range. Some oligochaete species in the Pilbara have distributions across several catchment basins (Brown *et al.* 2015), although this has not been confirmed for species of the family Tubificidae, and the analogy between the Pilbara and Yilgarn (and more specifically the Project area) is uncertain.

#### **Naididae 'B006'**

This worm was also collected from just one bore, Exploration Hole 1, located in the northern part of the brine borefield (Figure 6B). Molecular comparisons using the COI and 12S genes of Naididae 'BOL006' to available sequences in GenBank and Bennelongia databases confirm that the species is known only from the current work. According to mapped surficial geology, Exploration Hole 1 samples a duricrust unit that is interpreted to contain calcrete.

### **4.7.2. Amphipoda**

#### **Chiltoniidae 'BAM143a' (inside 5 m drawdown contour) and Chiltoniidae 'BAM143b'**

These two species of chiltonid amphipod were delineated based on COI sequences that showed a divergence of approximately 8%. Some previous molecular work on species of chiltonid suggests that divergence within lineages is very low (0.2–1%, King *et al.* 2012), although similar levels of variation to that observed at Lake Wells between the two species have sometimes been interpreted as indicative of a single species in calcrete aquifers (e.g. Subterranean Ecology 2011). Both species at Lake Wells were collected from single bores, with Chiltoniidae 'BAM143a' at LGRB100 within both the drawdown of the brine borefield and the Off-Playa Development Envelope. Chiltoniidae 'BAM143b' was recorded 9.1 km away at Mt Barrett's Bore, north of the main playa network (Figure 6B). Both bores sample shallow surficial aquifers.

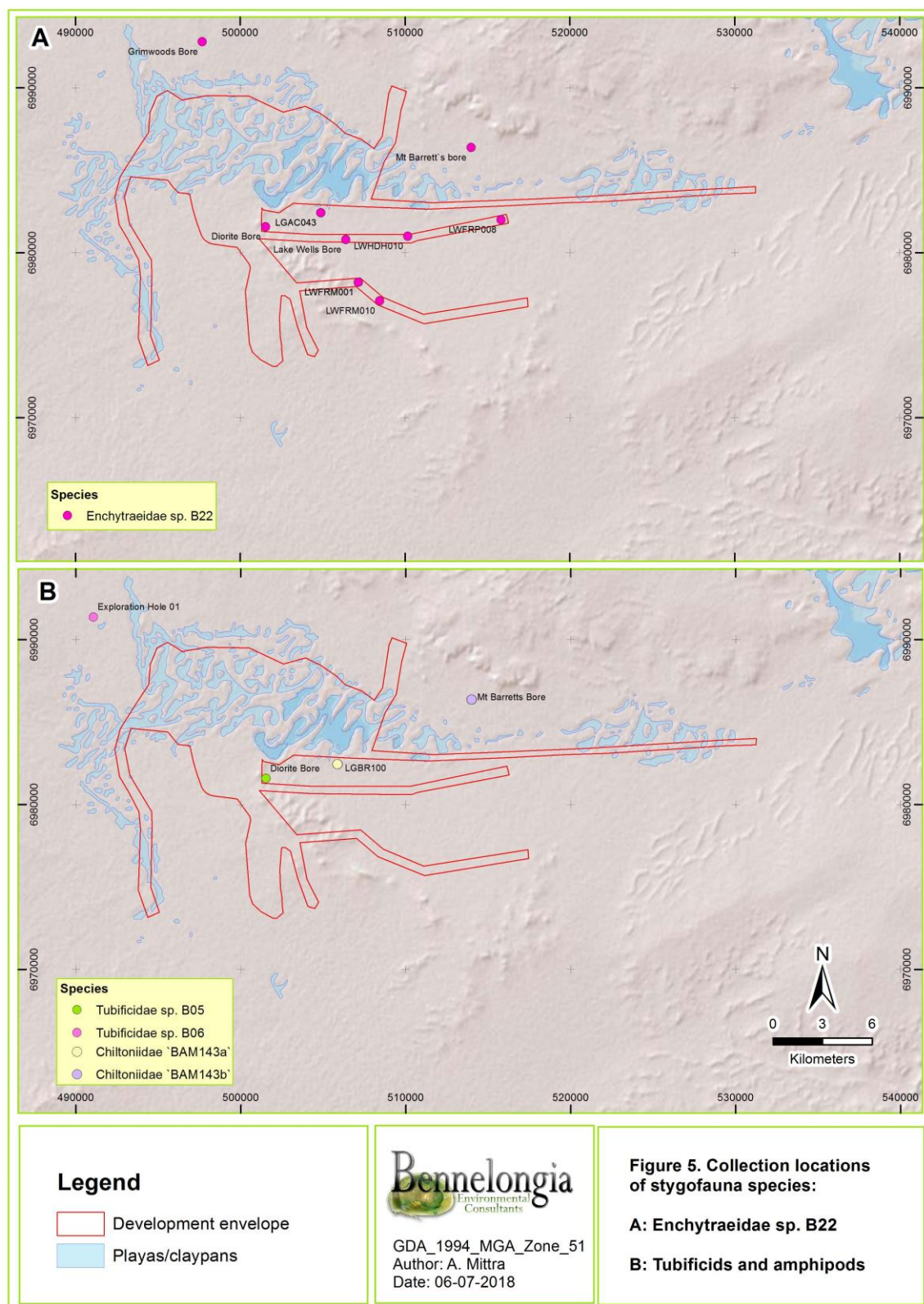
It is considered likely that Chiltoniidae 'BAM143a' and Chiltoniidae 'BAM143b' are, in fact, the same species but further sampling is required to confirm this conspecificity. In the interim, two species are recognised.

### **4.7.3. Syncarida**

Syncarids are small shrimp-like crustaceans that are almost exclusively groundwater inhabitants. The Western Australian syncarid fauna is significantly diverse (Guzik *et al.* 2008; Perina *et al.* 2018) and this is reflected in the aquifers at Lake Wells, with a total of eight species recorded. All the species likely to be new species potentially restricted to the Lake Wells area. Stygal syncarid species typically have small ranges and many species in the Yilgarn are endemic to single aquifers (Guzik *et al.* 2008).

#### **Bathynella sp. B38**

This syncarid is from the family Bathynellidae and was collected from two pastoral bores 4.9 km apart – Diorite Bore and Lake Wells Bore (Figure 7A). Both bores are to the south of the main playa network, relatively close to the southern fractured rock borefield and are likely to target the shallow surficial



**Figure 6.** Collection locations of stygofauna species. A: Enchytraeidae sp. B22. B: Tubificids and amphipods. (Tubificidae sp. B06 = Naididae 'BOL006').

aquifers considered to be the main habitat for *Bathynella* sp. B38. While the actual distribution of *Bathynella* sp. B38 may be wider than currently documented, as a result of being associated with palaeochannel deposits, the species is considered likely to have a relatively small range. Potential drawdown in the habitat of *Bathynella* sp. B38 is unknown.

#### ***Atopobathynella* sp. B26 (inside 5 m drawdown contour)**

One of five species of the family Parabathynellidae collected at Lake Wells, *Atopobathynella* sp. B26 was recorded in both a shallow pastoral bore (Lake Wells Bore) and a production bore (LWFRM001) to the south of the main playa network (**Figure 7A**). Bore LWFRM001 is slotted at 11.5–35.5 mbgl and collection depths indicate that surficial aquifers are the likely habitat of *Atopobathynella* sp. B26. Despite failure to yield genetic sequences, *Atopobathynella* sp. B26 is distinguishable morphologically from *Atopobathynella* sp. B35.

#### ***Atopobathynella* sp. B35 (inside 5 m drawdown contour)**

This parabathynellid species was recorded from a single bore (LWFRP004) south of the main playa network (**Figure 7A**). This bore is slotted at 24–30 mbgl as well as at 60–72 mbgl and both intervals coincide with fractured rock (Australian Potash 2017). It is considered more likely that *Atopobathynella* sp. B35 was collected from the shallower interval, although this cannot be confirmed. The extent of habitat connectivity in fractured rock aquifers in terms of both area and depth is unclear, as is the likely range of *Atopobathynella* sp. B35.

#### ***Kimberleybathynella* sp. B08 (inside 5 m drawdown contour)**

*Kimberleybathynella* sp. B08 was collected from two bores (LWFRP004 and LWFRM008) 12 m apart south of the main playa network (**Figure 7B**). This parabathynellid species was successfully sequenced for COI and showed significant divergence from *Kimberleybathynella* sp. B10 and *Kimberleybathynella* 'BSY180'. It could not be compared to *Kimberleybathynella* sp. B09 using genetics but it is morphologically distinct from that species. Bore logs show that LWFRM008 is slotted at 60–72 mbgl in granite and mafic geologies, while LWFRP004 (as described above for *Atopobathynella* sp. B35) is slotted at 24–30 mbgl (considered the likely access point for *Kimberleybathynella* sp. B08) and at 60–72 mbgl in fractured rock. The preferred habitat for *Kimberleybathynella* sp. B08 appears to be moderately deep fractured rock aquifers, unless the PVC casing of LWFRM008 contains a breach above the slotted interval, allowing *Kimberleybathynella* sp. B08 to be collected from a shallower habitat.

#### ***Kimberleybathynella* sp. B09**

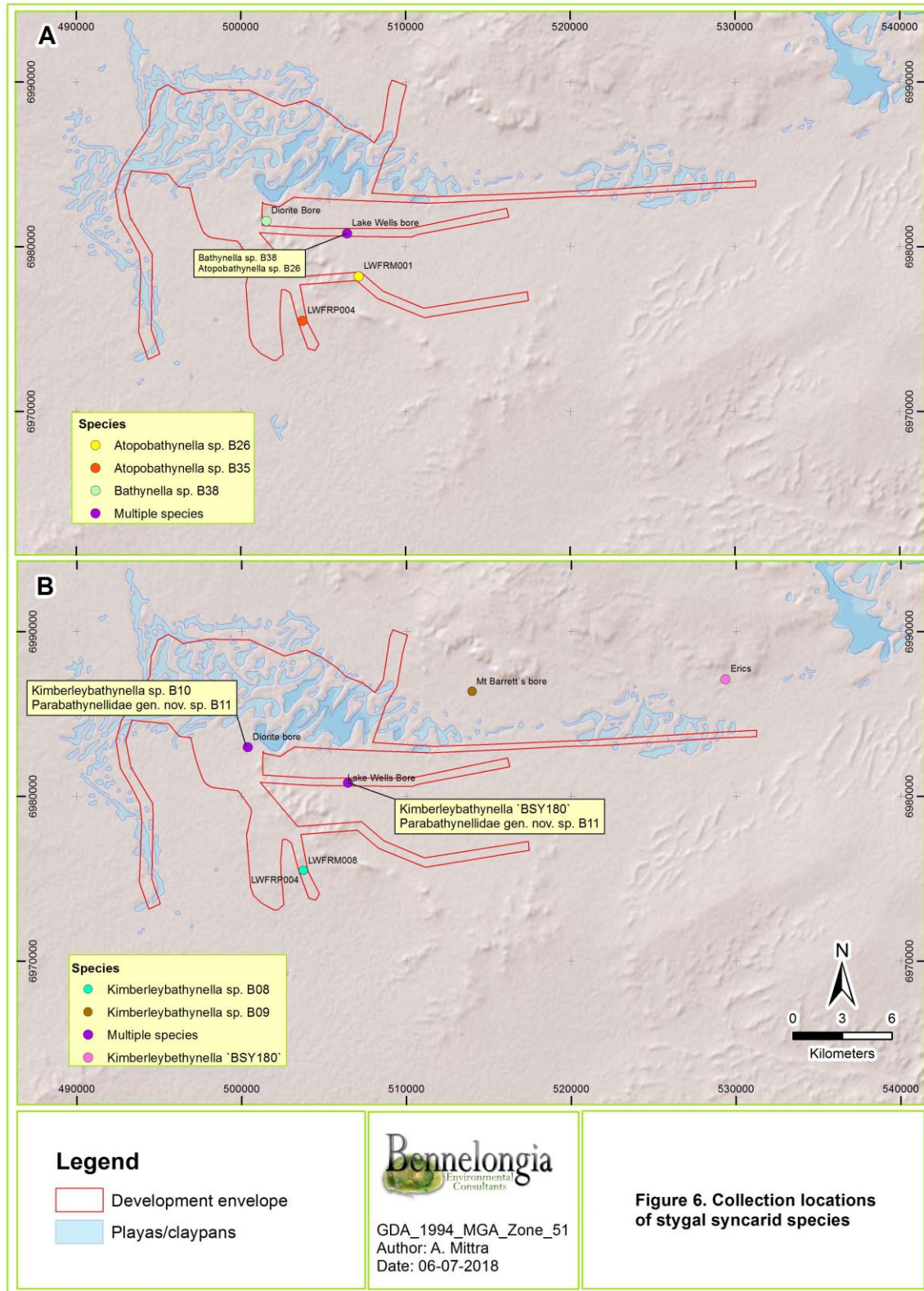
This parabathynellid species, despite failing to yield a COI sequence, is considered to be separate species from other *Kimberleybathynella* species based on morphological characters. Sequencing of the 12S gene showed it to be significantly divergent from *Kimberleybathynella* sp. B10. It was recorded at a single pastoral bore, Mt Barrett's Bore, to the north of the main playa network (**Figure 7B**). As pastoral bores at Lake Wells are known to be relatively shallow, the preferred habitat of this species is considered to be shallow surficial aquifers.

#### ***Kimberleybathynella* sp. B10**

*Kimberleybathynella* sp. B10 was identified based on morphology and subsequent molecular work using the COI gene confirmed that this species is significantly divergent from *Kimberleybathynella* sp. B08, *Kimberleybathynella* sp. B09 and *Kimberleybathynella* 'BSY180' (see below). A single animal was collected from Diorite Bore, which samples a shallow aquifer in the surficial alluvium or palaeochannel deposits that are the likely habitat of this syncarid.

#### **Additional *Kimberleybathynella* specimens – *Kimberleybathynella* 'BSY180'**

In addition to the species above, specimens belonging to the genus *Kimberleybathynella* were collected from Eric's (north of the main playa) and Lake Wells Bore (to the south of the main playa). COI sequencing showed that specimens from at least one of these bores belong to another species *Kimberleybathynella* 'BSY180' that is >30% divergent from congeners (and may in fact be a different genus). Owing to



**Figure 7.** Collection locations of stygal syncarid species. (Parabathynellidae sp. B11 omitted from legend)

contamination issues, it is unclear whether the new species is common to both Eric's and Lake Wells Bore.

#### **Parabathynellidae gen. nov. sp. B11**

Based on morphology this species represents a new genus. It was recorded from three bores to the south of the main playa network – Diorite Bore, Lake Wells Bore and LWFRP008 – over a linear distance of 14.3 km (Figure 7B). The collection of this species from both shallow pastoral bores and in LWFRP008, which is slotted at 23.8–41.8 mbgl, suggests this species occupies the shallow surficial aquifer. The moderately large linear range of this species provides evidence for habitat connectivity, most likely in shallow surficial aquifers, along the southern edge of Lake Wells.

#### **4.7.4. Cyclopoida**

##### **Gonicyclops sp. B10 (3332)**

This new species was recorded in low abundance to the north of the main playa network at Yilly Yilly Bore (Figure 8A).

#### **4.7.5. Harpacticoida**

Harpacticoid copepods are highly diverse in Western Australian groundwaters and have been found to exhibit remarkable radiation within sections of Yilgarn palaeochannels, especially where calcrete is present (Karanovic and Cooper 2012; Karanovic *et al.* 2014). Sixteen harpacticoid species from three families (Ameiridae, Canthocamptidae and Miraciidae) have been recorded at Lake Wells and 15 of these are only known from the study area.

##### **Nitocrellopsis sp. B12**

This species was collected from three sites south of the main playa network (LGAC043, LWHDH010 and TROG3) and has a known linear range of approximately 6 km (Figure 8A). The holes are shallow (in one case 5.5 m) suggesting that habitats occupied by *Nitocrellopsis* sp. B12 are in a shallow surficial aquifer.

##### **Nitocrellopsis sp. B13 (inside 5 m drawdown contour)**

This species was collected from two bores to the south of the main play network – LGAC043 and LWHDH010 – over a linear distance of 5.5 km (Figure 8A). Both holes are relatively shallow indicating the preferred habitat of *Nitocrellopsis* sp. B13 occurs in shallow surficial aquifer.

##### **Nitocrellopsis sp. B14 (inside 5 m drawdown contour)**

This species was collected from three bores, including a pastoral bore a considerable distance from the main playa network, resulting in a minimum inferred linear range of nearly 12 km (Figure 8A). It appears to occupy shallow surficial aquifers.

##### **Nitocrellopsis sp. B15 (inside 5 m drawdown contour)**

It is not possible to determine the likely range of this harpacticoid species as it was collected from a single exploration bore (LGRB100) to the south of the main playa network (Figure 8B), although considering the shallow depth of this hole (3.8 m), it is likely to occupy shallow surficial aquifers.

##### **Nitocrellopsis sp. B16 (inside 5 m drawdown contour)**

This harpacticoid was collected from two exploration bores (LGAC043 and LGRB100) to the south of the main playa network and approximately 1.3 km north of the fractured borefield (Figure 8B). The species has a minimum linear range of about 1 km. The likely magnitude of drawdown in the vicinity of the collection sites is unknown.

##### **Nitocrellopsis sp. B17 (inside 5 m drawdown contour)**

This species is known from a single, shallow bore LGAC043 south of the main playa network in an area that appears to host a high diversity of harpacticoid species (Figure 8B). The species was collected from the shallow surficial aquifer.

***Nitocrellopsis* sp. B18**

This species was collected from Mt Barretts Bore north of the main playa network (Figure 8B).

***Nitocrellopsis* sp. B19**

This species has the same known distribution as *Nitocrellopsis* sp. B14, with a linear range of 11.8 km. It was collected at LGAC043, LGRB100 and Golden Bore south of the main playa network (Figure 9A).

***Nitocrellopsis* sp. B22**

This harpacticoid was collected from Exploration Hole 1 north of the main playa network (Figure 9A) in a shallow surficial aquifer. Observations in the field and mapped surficial geology suggest that a small calcrete aquifer occurs in this area and this is the likely habitat for *Nitocrellopsis* sp. B22. An individual of this species was also recorded in a sample from brine production bore PLAC026, however it is strongly suspected that this represents a contaminant that was actually collected in Exploration Hole 1, which was sampled a short time beforehand.

***Nitocrellopsis* sp. B23**

This is one of eight stygofauna species collected from Exploration Hole 1 (Figure 9A) in what appears to be a shallow, moderately saline calcrete aquifer.

***Nitocrellopsis* sp. B24 (inside 5 m drawdown contour)**

This harpacticoid species was collected from a single monitoring bore LWFRM014 south of the main playa network (Figure 9A). Construction logs show that the bore is slotted at 24–48 mbgl, coinciding a section of sand and sandy clay with calcrete gravel that possibly denotes occurrence of palaeochannel..

***Nitocrellopsis* sp. B25**

This is one of five harpacticoid species, and the third species of *Nitocrellopsis*, collected from Exploration Hole 1 to the north of the main playa network (Table 2; Figure 9B). It was represented single animal.

***Schizopera* sp. B31**

Three species of the genus *Schizopera* collected during the survey., *Schizopera* sp. B31 was recorded at both Diorite Bore (south of the main playa network) and Exploration Hole 1 (north of the playa), with a linear range of 14.3 km (Figure 9B). Occurrence in these locations suggest there is habitat connectivity for stygofauna species throughout shallow surficial aquifers in the vicinity of the Project.

***Schizopera* sp. B32**

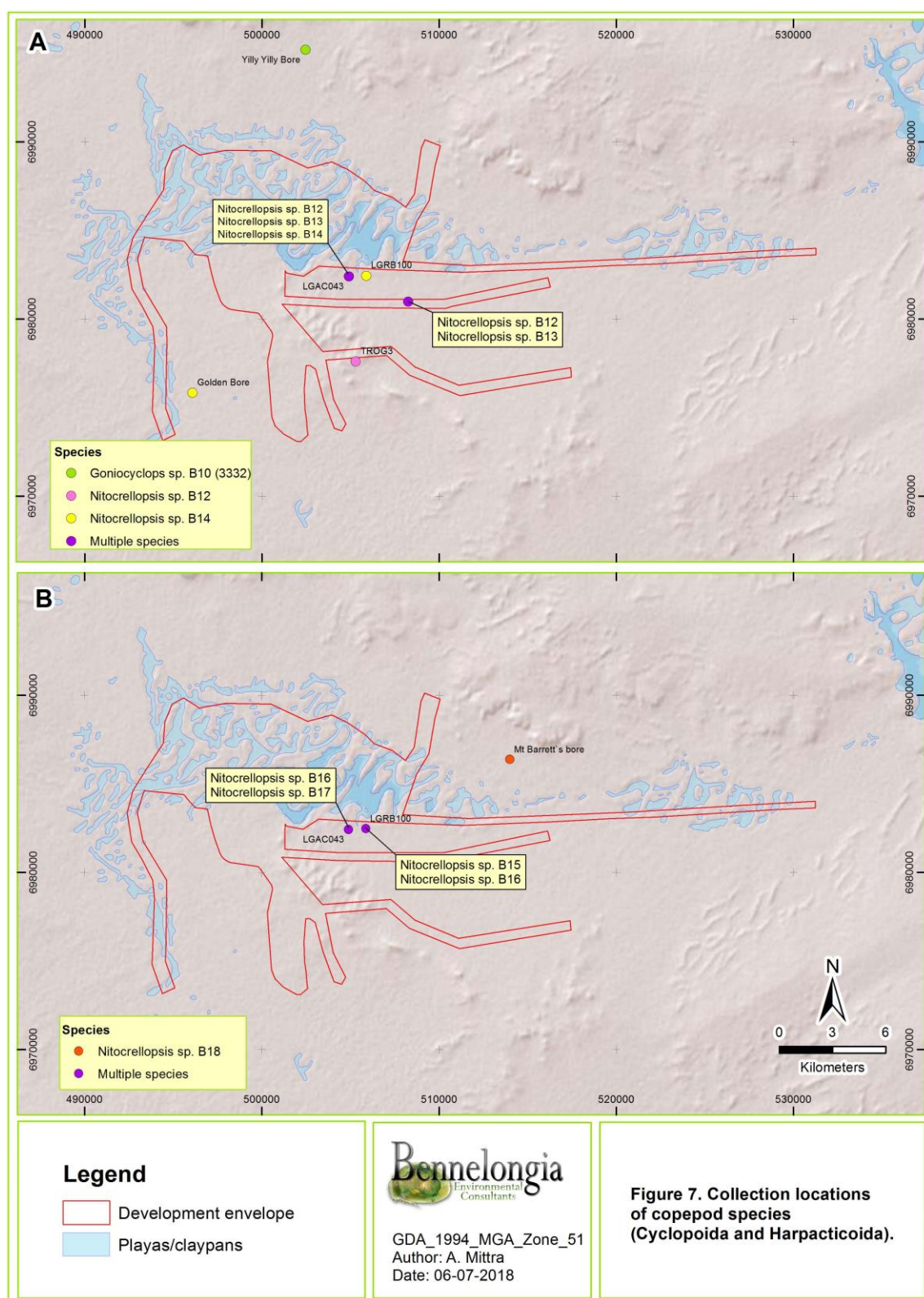
This harpacticoid was collected to the south of the playa network at Gibson Bore (Figure 9B), a pastoral bore that accesses a shallow surficial aquifer.

***Schizopera* sp. B40**

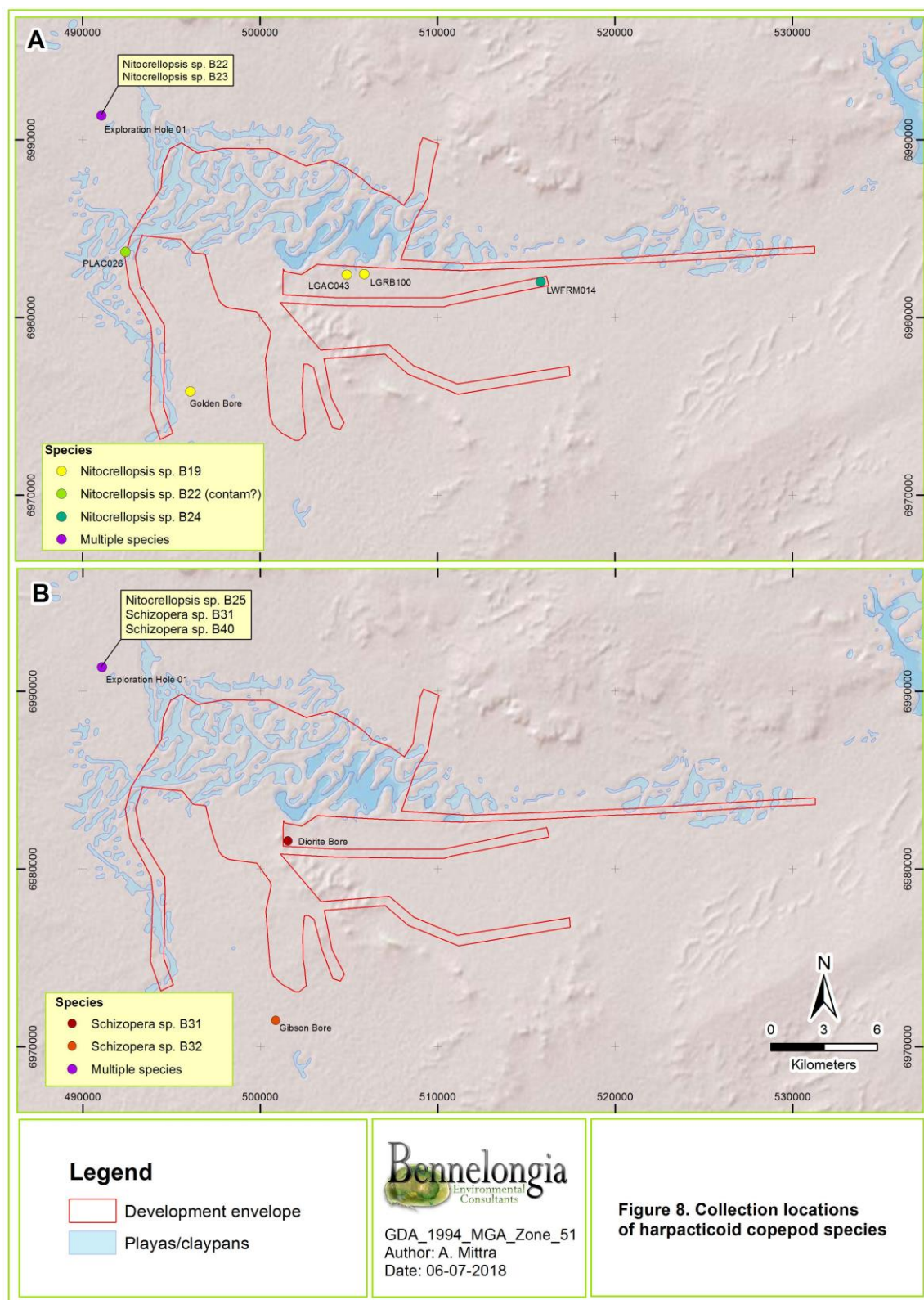
This is another new species of harpacticoid known only from Exploration Bore 1 to the northwest of the Project and main playa network (Figure 9B). While there is no information about the likely range of the species, the threat of habitat loss in the calcrete aquifer sampled by Exploration Bore 1 is low due to distance from the Project area.

***Riocypris* sp. (inside 5 m drawdown contour)**

This cyprid ostracod was collected as a single valve. While identifiable to genus, it could not be identified to species level. It is possible the animal belongs to the described species *Riocypris hinzeae*, which is known from wells in the Depot Springs aquifer 300 km west of Lake Wells. It is considered that, even if *Riocypris* sp. belongs to a new species it is likely to be a stygoxene with surface dispersal and, consequently, a substantially wider range than the area around Lake Wells. Ostracods of the family Cyprididae have limited affinity for groundwater but a suite of species (including some *Stenocypris*, *Bennelongia* and *Cyprinotus* species) are frequently recorded as stygoxenes (Halse *et al.* 2014).



**Figure 8.** Collection locations of copepod species (Cyclopoida and Harpacticoida).



**Figure 9.** Collection locations of more harpacticoid copepods.

## 4.8. Overview of Troglafauna Community

A total of five troglafauna species were recorded at Lake Wells, comprising three isopods, a dipluran and a troglaphilic bug (Table 3). The low yield of troglafauna in terms of both abundance and richness is considered to represent a depauperate community, reflecting limited habitat prospectivity.

**Table 3.** Species of troglafauna collected at the Project.

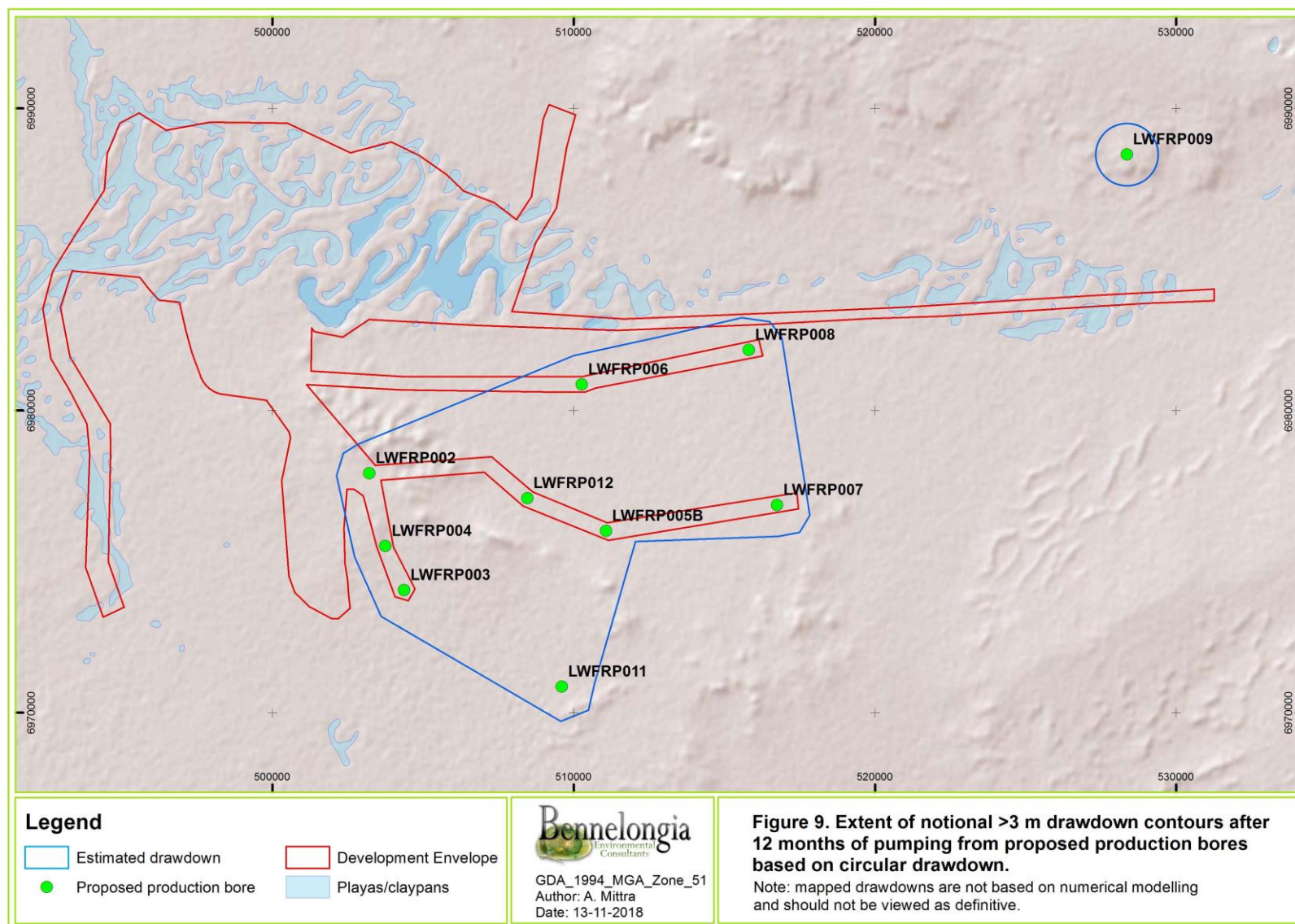
Higher Classification	Lowest Identification	No. of sites	Total abundance	Comments
<b>Arthropoda</b>				
<b>Crustacea</b>				
<b>Isopoda</b>				
Armadillidae	Armadillidae sp. B12	2	29	Collected at two pastoral bores, known linear range of 6.5 km.
Philosciidae	Philosciidae sp. B32	1	1	Collected in a net sample at bore LGRB100.
Platyarthridae	<i>Trichorhina</i> sp.	1	1	Collected at a single pastoral bore south of the Project.
<b>Hexapoda</b>				
Entognatha				
<b>Diplura</b>				
Japygidae	Japygidae sp. B41	1	1	Collected in a net sample in the fractured rock borefield.
<b>Insecta</b>				
<b>Hemiptera</b>				
Meenoplidae	<i>Phaconeura</i> sp.	1	1	Troglophile, probably at least moderately widespread, collected from a single pastoral bore.

**Table 4.** Known distributions of potentially restricted species relative to the notional extent of >3 m drawdown after 12 months.

Higher Classification	Lowest Identification	TOTAL No. of Sites	Minimum inferred linear range	Outside notional >3 m drawdown contour (12 months)
<b>Annelida</b>				
Enchytraeidae	Enchytraeidae sp. B22	10	21 km	yes
Tubificidae	Tubificidae sp. B05	1	-	yes
	Tubificidae sp. B06	1	-	yes
<b>Arthropoda</b>				
<b>Crustacea</b>				
Malacostraca				
<b>Amphipoda</b>				
Chiltoniidae				
	Chiltoniidae `BAM143a`	1	-	yes
	Chiltoniidae `BAM143b`	1	-	yes
<b>Syncarida</b>				
Bathynellidae	<i>Bathynella</i> sp. B38	2	5 km	yes
Parabathynellidae	<i>Atopobathynella</i> sp. B26	2	2.7 km	yes
	<i>Atopobathynella</i> sp. B35	1	-	no
	<i>Kimberleybathynella</i> `BSY180`	1-2	-	unknown*
	<i>Kimberleybathynella</i> sp. B08	2		no
	<i>Kimberleybathynella</i> sp. B09	1	-	yes
	<i>Kimberleybathynella</i> sp. B10	1	-	yes
	Parabathynellidae gen. nov. sp. B11	3	14.3 km	yes
<b>Cyclopoida</b>				
Cyclopidae	<i>Goniocyclops</i> sp. B10 (3332)	1	-	yes
<b>Harpacticoida</b>				
Ameiridae	<i>Nitocrellopsis</i> sp. B12	3	6 km	yes
	<i>Nitocrellopsis</i> sp. B13	2	5.5 km	yes
	<i>Nitocrellopsis</i> sp. B14	3	11.8	yes
	<i>Nitocrellopsis</i> sp. B15	1	-	yes
	<i>Nitocrellopsis</i> sp. B16	2	1 km	yes
	<i>Nitocrellopsis</i> sp. B17	1	-	yes

	<i>Nitocrellopsis</i> sp. B18	1	-	yes
	<i>Nitocrellopsis</i> sp. B19	3	11.8	yes
	<i>Nitocrellopsis</i> sp. B22	2	-	yes
	<i>Nitocrellopsis</i> sp. B23	1	-	yes
	<i>Nitocrellopsis</i> sp. B24	1	-	no
	<i>Nitocrellopsis</i> sp. B25	1	-	yes
Miraciidae	<i>Schizopera</i> sp. B31	2	14.3 km	yes
	<i>Schizopera</i> sp. B32	1	-	yes
	<i>Schizopera</i> sp. B40	1	-	yes

\*Eric's is outside, and Lake Wells Bore within, the notional drawdown area.



**Figure 10.** Extent of notional >3 m drawdown contours after 12 months of pumping from proposed production bores based on circular drawdown.

## 5. CONCLUSIONS

This combined desktop and field survey was undertaken in order to determine the presence and diversity of subterranean faunal assemblages in the vicinity of the Lake Wells Potash Project.:

- The review of habitat information identified that low salinity aquifers in surficial deposits and underlying fractured rock were moderately prospective for stygofauna. Prospective habitat for troglofauna was not identified.
- Hypersaline aquifers underlying Lake Wells, which will be targeted for brine extraction, are considered unlikely to harbour subterranean fauna.
- Field survey for stygofauna across three rounds of sampling revealed a rich stygal community in surficial alluvial or colluvial aquifers and in fractured rock aquifers of low to moderate salinities. This includes alluvial or colluvial aquifers at the edges of the palaeochannel, and possibly overlying the brine aquifer in some areas. No evidence was found for occurrence of stygofauna in brine aquifers at depth. The troglofaunal community at Lake Wells is likely to be depauperate and is unlikely to be threatened by proposed works.
- Forty stygofauna species were collected during field survey, with 29 of these are known only from the Lake Wells area. Ten of the species are known to date only from within the area of significant(>5 m) drawdown associated with the brine borefield. Four species are known only from within the off-playa Development Envelope that will house the processing water borefield.
- The moderately extensive distributions of a number of species throughout the study area provide some evidence for habitat connectivity extending beyond the likely zone of drawdown influence. These distributions also provide some support that rare (singleton) and potentially restricted species have wider ranges.
- Five troglofauna species were collected from the off-playa Development Envelope and other sites outside the main playa network. They represent a depauperate troglofaunal community.

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## 7. APPENDICES

## Appendix 1. Samples taken for subterranean fauna at sites in and around the Project area during field survey over three rounds.

Stygofauna										
Bore/hole	Latitude	Longitude	Site type	Sample	Depth to water (metres below top of collar, mbtoc)	End of hole (mbtoc)	Date	Temperature	EC (µS/cm)	pH
Big Les's Bore	-27.2169	123.0954		Net	4	8	19/10/2017	24.8	4580	7.03
Corner Bore	-27.3218	123.0759		Net			7/03/2017	26.4	817	7.06
Exploration Hole 01	-27.2003	122.9099		Net	3.95	4.15	24/05/2018	21.8	34000	6.98
Gibson Bore	-27.3800	123.0089		Net	3.52	5	7/03/2017	32.3	16530	5.83
				Net	4.65	5.65	19/10/2017	22.6	15000	7.47
	-27.3800	123.0089		Net	3.94	5	26/05/2018	20	14980	7.92
Golden Bore	-27.3404	122.9602		Net			7/03/2017	25.4	23790	5.67
				Net		7	20/10/2017	20.6	26400	6.37
				Net	2.96	5.96	29/05/2018	23.4	27100	7.12
LAGC047	-27.2848	123.1598		Net	6.61	73	6/03/2017	27.5	60900	6.18
Lake Wells Bore	-27.2958	123.0649		Net			18/10/2017	28.6	8800	7.08
LGAC043	-27.2811	123.0495		Net	0.93	21	6/03/2017	28.8	16610	6.34
				Net	2.5	16	19/10/2017	25.5	15080	7.49
				Net	2.32	5.5	25/05/2018	23.1	10740	7.4
LGRB100	-27.2808	123.0593		Net	3.1	3.8	6/03/2017	28.5	20480	6.2
				Net	3	21	25/05/2018	21.7	20530	7.14
LWDRM003	-27.2432	122.9751		Net	3	56	18/10/2017	27.8	167200	5.32
LWDRM005	-27.2441	122.9434		Net	5	73	18/10/2017	24.2	176600	5.66
				Net	4	63	24/05/2018	22.1	185400	5.81
LWFRM001	-27.3191	123.0724		Net	13	67	18/10/2017	26.9	2950	6.82
				Net	15.16	51	24/05/2018	24.3	1533	6.78
LWFRM002	-27.3267	123.0781		Net	17	71	19/10/2017	21.2	1430	7.51
				Net	16.21	54.5	24/05/2018	24.6	1381	6.75
LWFRM003	-27.3301	123.0528		Net	25.29	63	26/05/2018	21.9	1888	7.52
LWFRM004	-27.3316	123.0508		Net	20	66	19/10/2017	26.7	1694	7.34
				Net	28.37	57	26/05/2018	22	1654	7.47
LWFRM005	-27.3217	123.0327		Net	21	69	19/10/2017	26.1	1732	7.56
				Net	22.97	76	26/05/2018	22.6	1635	7.52
LWFRM006	-27.3700	123.0486		Net	76	9	19/10/2017	26.6	15400	7.03
				Net	10.05	72	26/05/2018	21.4	16390	7.31
LWFRM007	-27.3566	123.0443		Net	12	75	19/10/2017	25.2	2610	7.25
				Net	13.76	74	26/05/2018	21.5	2550	7.4
LWFRM008	-27.3436	123.0380		Net	18	73	19/10/2017	28.1	2820	6.91
				Net	18.94	76	26/05/2018	22.2	2940	7.37
LWFRM009	-27.3452	123.0139		Net	9	76	19/10/2017	20.5	5770	7.65
				Net	11.89	72	26/05/2018	22.6	22000	7.2
LWFRM010	-27.3294	123.0855		Net	15	71	18/10/2017	24.9	1611	7.86
				Net	16.97	59	24/05/2018	24.4	1557	6.99
LWFRM011	-27.2951	123.1040		Net	6	29	17/10/2017	25.9	55200	6.87
				Net	5.4	26	25/05/2018		55000	7.02
LWFRM012	-27.3049	123.1011		Net	9	76	18/10/2017	28.6	159200	6.13
				Net	11.54	65	25/05/2018	20.5	180500	6.26
LWFRM013	-27.3312	123.1692		Net	23	61	17/10/2017	22.4	17000	7.38
				Net	23.32	63	25/05/2018	19.4	12480	6.88
LWFRM014	-27.2846	123.1599		Net	7	27	17/10/2017	26.9	68200	6.88
				Net	6.84	21	25/05/2018	19.5	70200	6.97
LWFRM014 R (Redrill)	-27.2849	123.1600		Net	6	41	17/10/2017	27.2	142100	6.57
				Net	7.54	46	25/05/2018	21.2	144900	6.65
LWFRM015	-27.2263	123.2866		Net	40	90	17/10/2017	31.8	3620	7.6
LWFRM016	-27.4578	123.3723		Net	22	60	17/10/2017	26.1	6870	7.29
				Net	20.05	63	28/05/2018	23	6720	6.87
LWFRP001	-27.3191	123.0725		Net	13	67	18/10/2017	26.6	1674	7.61
				Net	15.17	49	25/05/2018	21.1	1507	6.99
LWFRP002	-27.3218	123.0326		Net	69	22	19/10/2017	26	1677	8.12
				Net	23.02	64	26/05/2018	22.1	1645	7.16
LWFRP003	-27.3567	123.0443		Net	16	80	19/10/2017	24.9	2790	6.52
				Net	14.9	76	26/05/2018	21.7	2560	7.24
LWFRP004	-27.3435	123.0380		Net	16	69	19/10/2017	26.1	2970	7.7
				Net	19.17	71	26/05/2018	21.3	2930	7.03
LWFRP005A	-27.3389	123.1119		Net	21	86	18/10/2017	26.2	1770	7.43
				Net	20.24	65	25/05/2018	20.5	1652	7.31
LWFRP005B	-27.3390	123.1120		Net	21	87	18/10/2017	26.5	1700	7.67
				Net	20.32	63.5	25/05/2018	20.3	1638	6.79
LWFRP006	-27.2952	123.1039		Net	6	67	17/10/2017	28.2	136400	6.55
				Net	7	64	25/05/2018		147400	6.6
LWFRP007	-27.3311	123.1694		Net	20	85	17/10/2017	21.1	3650	7.24
				Net	23.3	70	25/05/2018	19.7	3470	7.05
LWFRP008	-27.2848	123.1598		Net	6	40	19/10/2017	27.8	131200	6.33
				Net	7.15	40	25/05/2018	21.1	138000	7.12

Stygofauna										
Bore/hole	Latitude	Longitude	Site type	Sample	Depth to water (metres below top of collar, mbtoc)	End of hole (mbtoc)	Date	Temperature	EC (µS/cm)	pH
LWFRP009	-27.2262	123.2865		Net	35	87	17/10/2017	26.5	6430	6.81
				Net	38	88	26/05/2018	22.4	6520	6.63
LWFRP010	-27.2947	123.0441		Net	10.59	72	16/10/2017	27.4	4740	7.73
				Net	9.98	53.5	24/05/2018	23.6	5210	7
LWFRP012	-27.3293	123.0856		Net	18	66	18/10/2017	25.5	1687	7.44
				Net	16.46	54	24/05/2018	23.9	1384	6.73
LWHDH010	-27.2939	123.1027		Net	5.9		6/03/2017	25.8	25700	6.04
PLAC018	-27.2540	123.0136		Net	2	50	18/10/2017	19.5	185100	7.2
				Net	1.8	45	27/05/2018	17.1	184700	6.94
PLAC026	-27.2695	122.9235		Net	5	55	18/10/2017	28.6	153300	5.61
				Net	4	43	24/05/2018	23.8	144000	6.32
PLWDD004	-27.2433	122.9749		Net	0.7	25	5/03/2017		156000	5.95
Twin Spinner	-27.2225	123.2358		Net			17/10/2017	30.4	2780	6.79
Ye Old Grimwoods Well	-27.1876	122.9754		Net	3.9	4.3	24/05/2018	17.5	145.6	6.7
Corner Bore	-27.3218	123.0759		Pump			19/10/2017	21.9	1719	7.47
				Pump			24/05/2018	22.9	1575	7.49
Diorite Bore	-27.2887	123.0157		Pump			6/03/2017	20.1	4200	6.85
				Pump			17/10/2017	22.5	4120	7.5
				Pump			23/05/2018	19.8	4230	6.89
Eric's	-27.2384	123.2966		Pump			4/03/2017	30	4030	6
				Pump			17/10/2017	28.7	3310	7.44
Gregs Grimwoods Bore	-27.2363	123.2966		Pump			4/03/2017	26.5	3470	6.03
	-27.1875	122.9767		Pump			5/03/2017	27	5100	5.77
				Pump			18/10/2017	24.1	4860	7.18
				Pump			24/05/2018	19.4	4830	7.21
Lake Wells Bore	-27.2958	123.0649		Pump			4/03/2017	26.7	9140	6.95
				Pump			23/05/2018	19.9	7420	7.03
Mt Barrett's bore	-27.2453	123.1415		Pump			20/10/2017	21.8	10800	7.28
				Pump			23/05/2018	22.6	10820	7.43
Pete's pool	-27.3622	123.1547		Pump			19/10/2017	19.6	1534	7.21
Twin Spinner	-27.2225	123.2358		Pump			4/03/2017	30.1	2620	6.53
Yilly Yilly Bore	-27.1656	123.0247		Pump			6/03/2017	31.3	604	6.06
				Pump			18/10/2017	23.8	2000	7.38
				Pump			24/05/2018	20.7	406	7.14

Troglofauna								
Bore/hole	Latitude	Longitude	Sample	Site type	Depth to water (metres below top of collar, mbtoc)	End of Hole (mbtoc)	Date	Trap depth (mbtoc)
LGRB100	-27.2808	123.0593	Trap	NA	3.1	3.8	6/03/2017	
LWHDH010	-27.2939	123.1027	Trap Deep	NA	5.9		6/03/2017	5
LWHDH010	-27.2939	123.1027	Trap Shallow	NA	5.9		6/03/2017	4
TROG1	-27.2078	123.0455	Scrape	NA	3		5/03/2017	
TROG1	-27.2078	123.0455	Trap	NA	3		5/03/2017	2
TROG2	-27.2199	123.0535	Scrape	NA	4.2		5/03/2017	
TROG2	-27.2199	123.0535	Trap	NA	4.2		5/03/2017	3
TROG3	-27.3245	123.0534	Scrape	NA		9	7/03/2017	
TROG3	-27.3245	123.0534	Trap Deep	NA		9	7/03/2017	8
TROG3	-27.3245	123.0534	Trap Shallow	NA		9	7/03/2017	3

## Appendix 2. Summary of results of genetic sequencing work.

Yes = success; No = fail; blank = no attempt.

Group	Identification (morphology)	Bore Code	Date Collected	Renamed	J30		J31
					COI	12S	COI
Syncarid	Syncarida sp.	LWFRM001	18/10/2017		No	Yes	
Syncarid	<i>Atopobathynella</i> sp. B26	LWFRM001	24/05/2018		No	No	No
Syncarid	<i>Atopobathynella</i> sp. B35	LWFRP004	26/05/2018		Yes	Yes	
Syncarid	<i>Bathynella</i> sp. B38	Lake Wells Bore	23/05/2018		No	No	No
Syncarid	<i>Kimberleybathynella</i> sp.	Eric's	17/10/2017	<i>Kimberleybathynella</i> `BSY180`	No	No	Yes
Syncarid	<i>Kimberleybathynella</i> sp.	Lake Wells Bore	23/05/2018	<i>Kimberleybathynella</i> `BSY180`	No	No	Yes
Syncarid	<i>Kimberleybathynella</i> sp. B08	LWFRP004	26/05/2018		Yes	No	
Syncarid	<i>Kimberleybathynella</i> sp. B09	Mt Barrett's bore	23/05/2018		No	Yes	No
Syncarid	<i>Kimberleybathynella</i> sp. B10	Diorite Bore	23/05/2018		Yes	Yes	
Copepod	<i>Nitocrellopsis</i> sp. B12	LGAC043	19/10/2017		No	No	No
Copepod	<i>Nitocrellopsis</i> sp. B12	LWHDH010	6/03/2017		No	No	No
Copepod	<i>Nitocrellopsis</i> sp. B13	LWHDH010	6/03/2017		No	No	No
Copepod	<i>Nitocrellopsis</i> sp. B15	LGRB100	6/03/2017		No	No	No
Copepod	<i>Nitocrellopsis</i> sp. B16	LGRB100	25/05/2018		No	No	No
Copepod	<i>Nitocrellopsis</i> sp. B17	LGAC043	19/10/2017		No	No	No
Copepod	<i>Nitocrellopsis</i> sp. B24	LWFRM014	25/05/2018		No	No	No
Copepod	<i>Parastenocaris jane</i>	LWFRP010	24/05/2018		No	No	No
Annelid	Enchytraeidae sp. B22	Lake Wells Bore	23/05/2018		No	No	No
Annelid	Enchytraeidae sp. B22	Yilly Yilly Bore	24/05/2018		No	No	No
Annelid	Tubificidae sp. B05	Diorite Bore	23/05/2018		No	No	No
Annelid	Tubificidae sp. B06	Exploration Hole 01	24/05/2018		Yes	Yes	
Amphipod	<i>Yilgarniella</i> sp. B04	LGRB100	25/05/2018	Chiltoniidae `BAM143a`	No	Yes	Yes
Amphipod	<i>Yilgarniella</i> sp. B04	Mt Barrett's bore	23/05/2018	Chiltoniidae `BAM143b`	Yes	No	