Baseline Environmental Monitoring, Program 1: Stygofauna Sampling - Exploration Permit # 51985 at Puhipuhi, Northland

Prepared for

Evolution Mining NZ Pty Limited

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Limitations:

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Appendices

1.0 Introduction

Pattle Delamore Partners Ltd ('PDP') has been engaged by Evolution Mining NZ Ltd (ENZ) to undertake baseline monitoring of groundwater quality prior to any potential exploration drilling or exploration drilling-related environmental disturbance at Puhipuhi, Northland (Program 1). Program 1 comprised the sampling of privately owned and operated wells (or groundwater bores) and springs within the vicinity of ENZ's tenement (Exploration Permit #51985). Consultation with individual landowners was undertaken by ENZ to identify landowners who wished for their well(s) and/or spring(s) to be sampled.

This report presents the results of the stygofauna (groundwater fauna) samples collected from 11 sites in early March 2016.

Stygofauna are any animals living in groundwater systems or aquifers and vary from occasional accidental visitors to those which are well adapted and specialised ground dwellers. As a result, the aquatic animals are often classified according to their use of these habitats (Figure 1). Stygoxens show no affinity to subsurface habitats, stygophiles actively exploit resources in the subsurface zone for part of or throughout their life cycle, and stygobites are a specialised subterranean group of animals found almost exclusively in subterranean habitats.

The Stygofauna of New Zealand is poorly characterised, and our knowledge lags behind that of Australia, North America and Europe. As of 2004, there were 102 species described; however, it is probable that the total New Zealand groundwater fauna exceeds several hundred species (Fenwick *et al*., 2004). This lack of taxonomic knowledge currently limits our ability to accurately identify different species and groups and prevents description of the true biodiversity or comparison across different regions in New Zealand. Additionally, sparse sample coverage in New Zealand and the proportion of short range endemics (unique species which are only found in one small area) further limits our ability to comment on the health or community structure found at different sites.

From the sporadic data which has been collected throughout New Zealand, stygofauna communities are known to be dominated by water mites, but also include a large diversity of amphipods, copepods, freshwater snails, and worms of various types (Scarsbrook *et al.,* 2003).

2.0 Scope and Objectives

The purpose of Program 1 was to:

- characterise the existing (baseline conditions) groundwater quality at Puhipuhi, as far as practicable from existing privately owned sample

sites, prior to any potential exploration-related environmental disturbance; and

- to provide data for input into the hydrological and hydrogeological models to be developed in Program 3; and
- collect baseline data for stygofauna in the Puhipuih area.

This report relates to the stygofauna component of Program 1, while the groundwater, hydrological and hydrogeological aspects are discussed in a separate report (PDP, 2016).

3.0 Methodology

Stygofauna samples were obtained from groundwater bores and springs at the same time as groundwater quality samples were collected.

Initial identification of potential bore and spring locations was undertaken by ENZ in association with a local Ngati Hau representative. Landowners were approached to see if they had a bore or spring which they would permit to being sampled as part of ENZ's baseline study. Where landowners gave permission, an initial site inspection/reconnaissance was completed by ENZ/Ngati Hau representative, to gain basic access and logistical information on the sample site before the sampling was conducted. The final program included groundwater and stygofauna samples from 11 sites; five bores and six springs.

For bores, samples were collected using the existing pump infrastructure installed in the bore, from as close to the well head as possible. Samples were physically collected either from the rising main, or from a valve attached to the rising main.

For springs, samples were collected directly from pools as close to the head/expression area of the spring as possible to minimise potential atmospheric and land surface influences. Some of the springs have been dammed for water supply purposes. For this situation, samples were collected directly from the water held within the dam. In one case, samples were collected from the overflow point of the dam where water was continuously flowing.

The remainder of spring samples were collected from natural seepages. These samples were collected directly from the closest pool to the head that was large enough to accept the sample containers.

3.1 Stygofauna Sampling

Stygofauna sampling was undertaken following, as far as was practical, the Western Australian guidelines (WA EPA, 2007) and following advice from NIWA, who were subcontracted to complete the fauna identification.

In summary, bore or spring water of a known volume was passed through a 63 micron net. For most sites, 100 L of water was sieved, however, in some cases (i.e. where spring flow was low), a lesser volume (40-50 L) was sieved. Following sieving, all material remaining on the net was washed into a sample jar using denatured 70% ethanol. Additional ethanol was added as required for preservation during transport to the laboratory.

For samples from bores, the 'purge' water was targeted for stygofauna sample collection, as per the guidelines (WA EPA, 2007). Samples from springs were collected as close to the head/expression area of the spring as possible. Flow in some of the springs was very low and thus collection of sample water for sieving was difficult. Surface debris were caught in the sieve, although no attempt was made to remove debris from the samples in the field, to avoid accidently discarding specimens.

Samples were sent to NIWA, under standard chain of custody procedures, for assessment at their Riccarton laboratory, Christchurch, New Zealand.

3.2 Taxonomic Identification (NIWA)

Samples were initially sorted under stereo microscope. Invertebrates were counted and sorted in to major groups. Representatives from all the major groups found in each sample were closely examined to distinguish more precise taxonomic groupings. It should be noted that the New Zealand stygofauna are poorly studied, and their taxonomy is poorly described, limiting the level to which individual specimens can be identified.

The taxonomic groupings were classified as either surface dwelling (epigean) or sub-surface dwelling (hypogean). This classification was based on body pigmentation in the absence of other information relating to the habitats sampled, such as bore depth.

Results were compiled into an Excel file and basic diversity statistics were calculated (Appendix B).

4.0 Results

Full taxonomic results for the samples are presented and summarised in Table 1, Appendix B.

Samples collected from bores yielded between one and two different taxa groups per sample. Two taxa identified in the bore samples are generally considered to be ground dwelling invertebrates and could be classified as stygobite (see Figure 1). The remaining two taxa are generally considered to be surface or near surface dwellers and would be classified as stygophile or stygoxen (see Figure 1). Abundance of stygofauna in the bore samples varied between two and 90 individuals. In terms of groundwater taxa, the samples from all bores were

dominated by water mites (Acarina) and copepods. These groups are common and appear to be wide spread in New Zealand's groundwater (Fenwick 2016 pers. comm, 7 April).

Spring samples indicated greater diversity with between one and 20 different taxa groups per sample. the number of taxa considered to be ground dwelling (and therefore classified as stygobite) varied from zero to five. However there were a greater number of taxa, between one and 16, which would generally be considered surface or near surface dwellers. Overall, of the 29 taxa recorded in total within the spring samples, seven are groundwater taxa and 22 are surface taxa. Abundance was also typically higher in the spring samples, with between 1 – 800 individuals. Most taxa groups present are widely spread in New Zealand. Of note are the indeterminate Amphipod and *Paraleptamphopus* which are thought to have poor dispersal capabilities and could therefore be restricted to this area (Fenwick 2016 pers. comm, 1 April).

5.0 Discussion

The fauna collected in this survey indicate moderate diversity, when compared with surveys summarised by Scarsbrook *et al*. (2007), from a range of locations and habitat types (springs and groundwater) throughout New Zealand. The groundwater fauna was dominated by smaller crustaceans including copepods and ostracods, and water mites. These groups have been found in samples collected throughout New Zealand and are thought to be widely distributed.

Poor knowledge of the taxonomy of New Zealand's stygofauna limits identification of specimens to family level at best in many cases. As a result, it is difficult to compare samples between locations and assess what the relative health is of a particular site or collection of sites. There is also currently a very poor understanding of the sensitivity of taxon groups to contaminants or physiochemical environmental factors.

In the absence of more detailed information relating to habitat, body pigmentation may indicate which zone animals occupy. Animals found in sub-surface environments (caves, deep groundwater, amongst river bed gravels, springs and bore holes) have little need for body pigmentation and are generally unpigmented or lightly coloured (as can be seen on Figure 1) compared with animals found at or near the surface, where pigmentation may serve to camouflage or otherwise protect the animal. There is no clear delineation of these zones (Figure 1) and some animals occupy the intermediate zone or transition between zones and body pigmentation may be variable between individuals from the same site, or different sites.

The current data set was collected from five existing water supply bores of variable construction and condition, and six springs, some of which have been significantly altered by human activity to capture water for supply use. In the

absence of accurate information relating to the construction and depth of bores and better taxonomic knowledge of the fauna it is difficult to classify specimens as truly representative of groundwater or near surface habitats within or in the vicinity of ENZ's tenement. Despite this limitation, the samples provide some insight into the stygofauna in the Puhipuhi area and will provide a useful baseline to measure any future sampling against.

The intrinsic values and ecosystem services provided by groundwater fauna are currently poorly understood in New Zealand, however basic ecological principles suggest that a reduction in biodiversity increases the risk of a decline ecosystem function and services. The primary negative impacts on groundwater fauna are likely to be from contamination by organic and inorganic substances, e.g. from agricultural, industrial and wastewater discharges (Fenwick 2016 pers. comm, 1 April). Groundwater habitats are also likely to be affected by variations in water levels, especially when the pattern of drawdown is unnatural.

Stygofauna, due to their physical size, should present no risk to human or animal health where bores are adequately screened and filtered as recommended by Ministry of Health (2008).

In order to provide further information about the stygofauna at the site and their habitats, it is recommended that fauna samples are collected from new bores post construction. Sampling bores of known construction will provide further useful data and help characterise the stygofauna community present.

6.0 References

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Appendix A: Figure

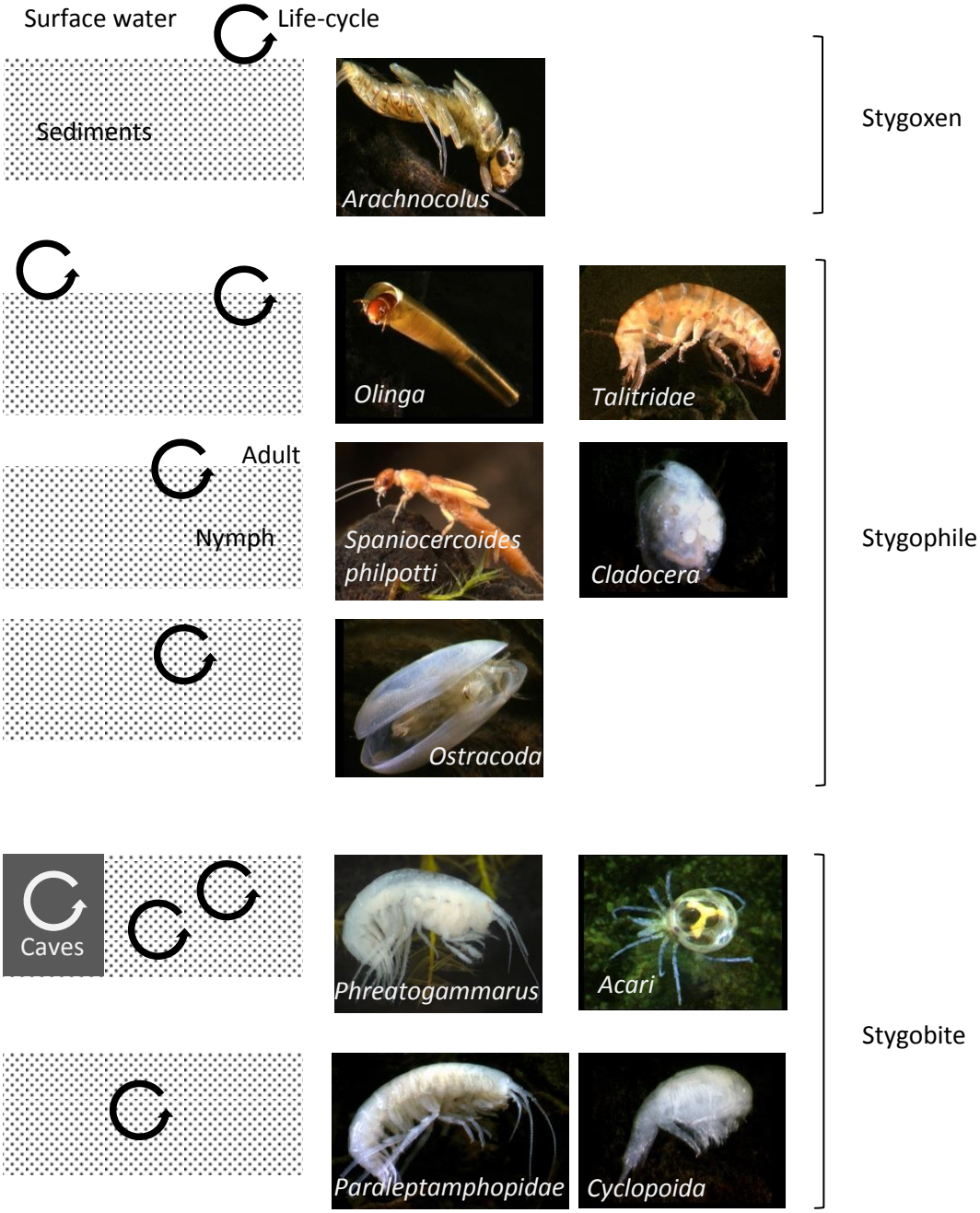

Figure 1: Classification of aquatic invertebrates based on affinities with groundwater environments. (Modified from Collier & Scarsbrook 2000). Images Landcare Research

Appendix B: Stygofauna Sample Results

Table 1: Stygofauna indentification

PDP Sample No			GW01	GW02	GW03	GW05	GW06	GW07	GW08	GW09	GW10	GW11	GW12
Sample date			2/03/16	2/03/16	1/03/16	2/03/16	4/03/16	3/03/16	3/03/16	3/03/16	4/03/16	3/03/16	3/03/16
Sample time			10.00	08:55	14:40	14:10	10:50	10:15	11:30	09:00	09:00	13:10	13:55
Bore/Spring			Bore	Bore	Bore	Bore	Bore	Spring	Spring	Spring	Spring	Spring	Spring
Well depth (m)			N/A	14.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
pH (field)			7.64	5.23	5.46	6.4	8.26	7.12	6.4 (lab)	5.3	5.8 (lab)	5.36	6.64
Conductivity (uS/cm)			232.5	115.4	66	104	406.9	74.6	67.8	66.6	54.6	65.4	71.1
Volume sampled (L)			100	100	100	100	100	100	100	100	40	100	50
Family	Genus	Sur/GW[3]											
Crustacea - Amphipoda	Indeterminate	GW										2	
Paraleptamphopidae	Paraleptamphopus	GW								1		15	
Talitridae	Indeterminate	Sur											2
Crustacea - Branchiopoda													
Cladocera	Indeterminate	Sur						63	1				
Crustacea - Copepoda													
Cyclopoida	Indeterminate	GW						27				51	3
Harpacticoida	Indeterminate	GW						32				514	18
1st instar nauplii[1]	Indeterminate	GW				2		13				29	
Crustacea – Ostracoda	Indeterminate	GW						15		6	1	68	3
Insecta – Diptera													
Ceratopogonidae		Sur						6					1
Empididae		Sur											4
Orthocladiinae	Indeterminate	Sur						1			11	2	
	Naonella	Sur											3
Chronomini	Harrisius	Sur											1
	Paucispinigera	Sur											14
	Polypedilum	Sur						4			1		2
Tanypodinae	Indeterminate	Sur						4				3	1
Chironominae	Tanytarsus	Sur											
Dixidae	Paradixa	Sur						5				3	5
Insecta -Ephemeroptera													
Leptophlebiidae	Indeterminate	Sur											18
	Arachnocolus	Sur						1					
	Zephlebia	Sur						1					
Insecta - Trichoptera													
Philoptamidae	Hydrobiosella	Sur											4
Insecta - Coleoptera													
Scirtidae	Indeterminate	Sur										5	1
Myriapoda - Symphyla	Indeterminate	Sur								1			
Annelida	Indeterminate	Sur				1		10		7	58	30	10
Nematoda	Indeterminate	Sur						3			5	10	3
Plathyhelminthes	Indeterminate	Sur								2			
Tardigrades	Indeterminate	Sur						2				2	
Chelicerata - Acarina	Indeterminate	GW	88	2	1		5	38		21	8	75	55
Hexapoda - Collembola	Indeterminate	Sur	2		20			2		10	16	7	24
Total individuals			90	2	21	3	5	227	1	48	100	816	179
Taxa richness[2]			2	1	2	2	1	17	1	7	7	15	20
Surface taxa			1		1	1		12	1	4	5	8	16
Groundwater taxa			1	1	1	1	1	5		2	2	5	4

Notes:

1. *Nauplii are juvenile stages which are unidentifiable as they lack descriptive features*
2. *Number of different taxa identified within a sample*
3. *Indicates surface (Sur) or groundwater (GW) dwelling taxa*