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Lake Way Aquatic Invertebrate Review

Salt Lake Potash is proposing to extract potash (potassium sulphate) from brine at Lake Way, south of Wiluna in the Northern Goldfields region of Western Australia. Brine extraction will occur within mining leases held by Blackham Resources. Mining of gold currently occurs in part of these leases on the bed of Lake Way in the open Williamson Pit.

Currently, environmental approval is being sought for the Demonstration Plant Project, which will have an annual production of 50,000 tonnes of potash. It is planned to increase production to 200,000 tonnes (or more) of potash per annum (hereafter referred to as the Lake Way Potash Project). This review examined the possible impacts of the Potash Project on aquatic invertebrates in Lake Way.

The Lake Way Potash Project, which sits in close proximity to Toro's Wiluna Uranium Project and will utilize some of the infrastructure of that project, includes the following proposed infrastructure in and around Lake Way (Figure 1):

- A network of open trenches that intercept shallow brine under Lake Way (i.e. the hypersaline groundwater in the lakebed sediments);
- A network of 10-12 bores intercepting deeper brine(in the Carey palaeochannel) on the eastern side of the lake;
- A series of open evaporation ponds into which brine from the trenches and bores is pumped to become further concentrated, with subsequent precipitation of salts; and
- A plant west of the lake in which purification occurs and from which potash is dispatched.

Hydrogeology of Lake Way

Lake Way is an ephemeral salt lake associated with the western side of the Carey palaeochannel. The southern part of the system is extensively braided and only the channels flood; the northern section of the lake is an open playa containing some islands and receives some inflow most years via West and Uramurdah Creeks and occasionally floods extensively. Knight Piesold (2019) suggest inflows of 44 GL and 560 GL occur with annual recurrence intervals of 10 years and 100 years (Table 1).

Surface water recharges into the groundwater system in Lake Way in wet years and the lake is considered to be a groundwater sink (Kinnell and Jeuken (2018). The lakebed and its shore comprise a mixture of halite, gypsum, clay, sand and silica. (Mann and Deutscher 1978).

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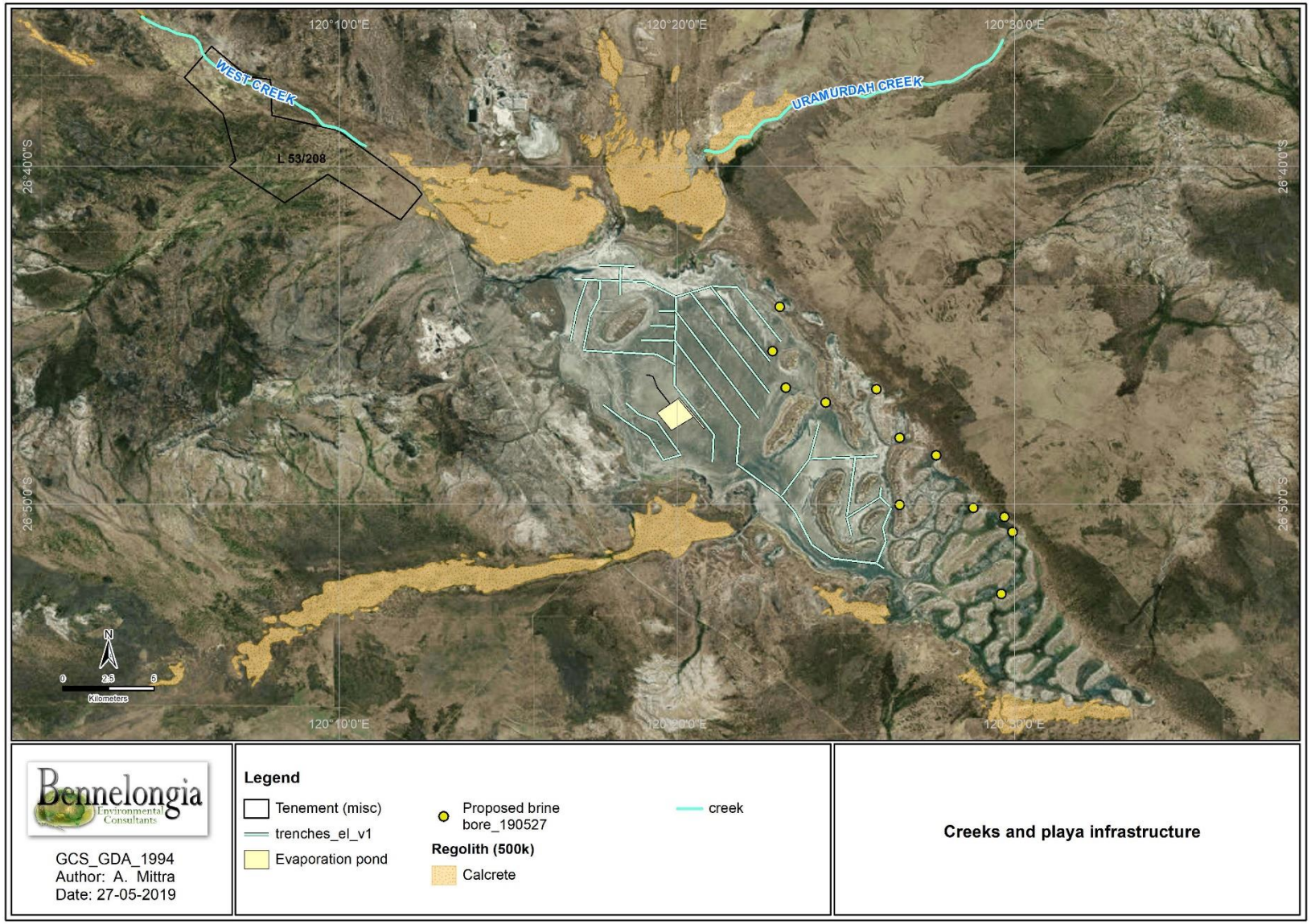

Figure 1. Location of Lake Way Potash Project, with brine trenches and other infrastructure on the lakebed shown. Position of infrastructure is approximate.

Table 1. Flood volumes at Lake Way in relation various rainfall or frequency of flooding events.

Storm Event	Flood Level (m)	Flood Volume (GL)
Cyclone Bobby (1995)	491.6	153.0
10 year ARI	490.3	43.8
100 year ARI	491.7	171.9
PMP[1]	493.4	556.1

[1]Maximum probable precipitation.

Groundwater salinity under, and around, Lake Way is stratified. After heavy rainfall, the watertable under the lake is raised as a result of recharge of fresh rainwater into the aquifer. There is little quantitative information of surface water salinity but in April 2006 when lake depth was 8-15 cm, after flooding from cyclonic rain in January and February, salinity was approximately 150,000 mg/L TDS (ranging from 135,000 to 191,000 TDS at sites in the northern part of the lake) (Outback Ecology 2006).

Aquatic invertebrate fauna at Lake Way

The aquatic invertebrate fauna at Lake Way is poorly documented because most surveys have relied on hatching eggs from dried sediment (e.g. Outback Ecology 2009; Bennelongia 2017). Sampling associated with monitoring of the discharge from the Matilda Mine in the northern part of the playa has collected rotifers, brine shrimps, ostracods and copepods occur at the northern end of the lake (Table 2).

No sampling has occurred in the small hyposaline wetlands in swales surrounding Lake Way although, based on results from similar salt lakes, it is likely that most of the aquatic invertebrate biodiversity at Lake Way is associated with these smaller wetlands. For example, of the 193 species collected at the ephemeral Lake Disappointment in the Great Sandy Desert in 2017, only 10 were collected from the large hypersaline playa (Bennelongia 2017). The same phenomenon was observed at the ephemeral Lake Carey, 400 km south of Lake Way, with very few of the 119 species collected from the lake and associated wetlands being found in the large hypersaline playa (Timms *et al.* 2006) However, the number of species in the main Lake Carey playa was greater during large flood events that resulted in a period of flooding with low salinity water.

Both species of brine shrimp collected from the main playa (or lakebed) of Lake Way (*Parartemia laticaudata* and *Parartemia veronicae*), and the ostracod *Patcypris outbacki*, are relatively widespread in arid zone salt lakes (Halse and Martens 2019; Timms 2010). The other ostracod is an undescribed species of *Reticypris*. Its distribution is unknown but likely to include other large salt lakes. The copepods and rotifer were not identified to species level, and so their distributions are unknown. However, based on the ranges of related species, they are also expected to occur widely.

Table 2. Aquatic invertebrates collected from the main playa at Lake Way.

Group	Species	Source
Rotifera	Bdelloidea '2:2'	1
Crustacea		
Branchipoda	*Parartemia laticaudata*	1, 3
	Parartemia veronicae	2, 3
Ostracoda	*Patcypris outbacki*	1 (without species name)
	Reticypris 'sp. nov.'	3
Copepoda	Cyclopoida	3 (in earlier sampling)
	Harpacticoida	3

1 Bennelongia 2017; 2 Timms 2010; 3 Outback Ecology 2006.

Searches of the records of the Western Australian Museum yielded no additional records of aquatic invertebrate species.

Lakebed Disturbance

The most spatially extensive proposed disturbance on the lakebed of the main Lake Way playa is trenching (Figure 1), although the 100 km of trenches will directly disturb only 150 ha of lakebed. In contrast, the ponds will cover 1,400 ha. Despite their small footprint, this report considers that potential changes in the pattern of inundation resulting from trenching are the element of the Lake Way Potash Project most likely to affect aquatic invertebrates negatively. Trenching may affect the pattern of indundation resulting from small inflows in two ways:

- Inflows from Uramurdah and West Creeks may be diverted by trench spoil, resulting in a distribution of water across the northern lake that does not reflect historic patterns of inundation.

- The groundwater drawdown caused by pumping the trenches may increase the volume of inflow required to flow lakebed soils and provide free surface water (see Knight Piesold 2019).

Large inflows (probably those greater than 10 years ARI) naturally entirely flood the trench network (see Knight Piesold 2019) and the resultant pattern of inundation is unlikely to be affected by the trenches because flows would be expected overtop the trench spoil.

In relation to smaller inflows, Salt Lake Potash is committed not to interfere with the main flow paths of water during small inundation events.

Possible Impacts of the Lake Way Potash Project on Aquatic Invertebrates

The likely impacts on aquatic invertebrates of lakebed disturbance at Lake Way were considered by HydroDeoEnviro (2019) with the following conclusions:

- A more diverse aquatic invertebrate species than currently documented would occur only after larger inflows. The egg banks for these species are likely to be located on the periphery of the main playa and outside the area of trenching.

- From a salinity perspective, the existing dewatering discharge from the Matilda Mine into the northern part of Lake Way represents a greater threat than the Lake Way Potash Project to the salt tolerant species occurring in the lake during small inflow events

This review adds one additional conclusion and a caveat.

- The additional conclusion is that if changes occur to the frequency or distribution of small flood events and the duration of associated inundation (as may occur because of groundwater drawdown or surface flow into trenches) there may be loss of some habitat for the aquatic invertebrate species using the northern end of Lake Way. However, current information suggests the species are not (or are unlikely to be) restricted to Lake Way.

- The caveat is that existing understanding of ecology and structure of the aquatic invertebrate community at Lake Way is incomplete. Sampling has been undertaken principally for the purpose of monitoring dewatering discharge from Matilda Mine and has occurred either when the lake was dry or only shallowly flooded and the implications of trenching may be incompletely understood.

In conclusion, exiting information suggests that the Lake Way Potash Project will have minimal conservation impacts on aquatic invertebrates. However, additional field studies and hydrological modelling should be undertaken to confirm this conclusion.

References

Bennelongia (2017) Aquatic ecology and waterbirds at Lake Disapopointment: additional studies. Bennelongia Pty Ltd, Jolimont, 36 pp.

Halse, S., and Martens, K. (2019) Four new genera and five new species of 'Heterocypris' from Western Australia (Crustacea, Ostracoda, Cyprinotinae). *European Journal of Taxonomy* **493**, 1-35.

HydroDeoEnviro (2019) Assessment of impacts to the macroinvertebrate egg/cyst bank from lakebed disturbance and brine abstraction - Lake Way. Unpublished report.,

Kinnell, R., and Jeuken, B. (2018) Lake Way Goldfields Salt Lake Project - Blackham Resources tenements SOP resource estimate. Groundwater Science, Adelaide, 64 pp.

Knight Piesold (2019) Memorandum: Lake Way Project - updated flood study. Knight Piesold Consulting, Perth,

Mann, A.W., and Deutscher, R.L. (1978) Hydrogeochemistry of a calcrete-containing aquifer near Lake Way, Western Australia. *Journal of Hydrology* **38**, 357-377.

Outback Ecology (2006) Monitroing of Lake Way during mining operations. Outback Ecology, Jolimont, 35+ appendices pp.

Timms, B.V. (2010) Six species of the brine shrimp Parartemia Sayce 1903 (Crustacea: Anostraca: Artemiia) in Western Australia. *Zootaxa* **2715**, 1-35.

Timms, B.V., Datsun, B., and Coleman, M. (2006) The wetlands of the Lake Carey catchment, northeast Goldfields of Western Australia, with special reference to large branhipods. *Journal of the Royal Society of Western Australia* **89**, 175-183.

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