MEMO

To:	Danny Walker	Ref:	21141
Cc:	Darryl Sycamore		
From:	Mark Hamer & Bryony Miller		
Date:	19/4/2023		
Subject:	Response to Cultural Impact Assessment – Suction dredge gold mining in the Clutha River		

1 Introduction

A Cultural Impact Assessment (CIA) of the suction dredge gold mining activity within the Clutha River was undertaken by Aukaha Ltd on the 23/3/2023 on behalf of the following four runaka:

- Te Rūnanga o Moeraki
- Kāti Huirapa Rūnaka ki Puketeraki
- Te Rūnanga o Ōtākou
- Hokonui Rūnanga

This CIA raised concerns regarding freshwater ecological impacts of the proposed activity. Cold Gold Ltd requested e3Scientific to provide comment on these concerns. This memo outlines the specific issues addressed within the CIA and provides responses to these.

Ecological comment is also provided regarding potential effects of a 200 m reasonable mixing zone from the dredge activity, as referred to in the s92 Request for Further Information from the Otago Regional Council.

2 Ecological Response to 200 m Reasonable Mixing Zone

The section 92 specifically stated:

> *Page 19 of the application describes that typically there will be no discolouration evident 50 m beyond the point of discharge, and any conspicuous discolouration will be managed to ensure no visual plume*

occurs beyond 100 m. Page 20 then says that the majority of sediment will fall out of the water column within 25 m of the discharge point.

However, the application states that a reasonable mixing zone of 200 m is sought "as a precautionary approach should any unforeseen pulses of clays or finer sediments be released that do not drop out of the water column quickly to ensure the dredge does not fall into non-compliance". The application describes this as an adaptive management model.

This does not appear to be an adaptive management approach, but instead a set limit of 200 m. An adaptive management approach would need to involve a 'monitor', 'trigger', 'action', 'cease' approach to ensure that the conditions don't allow for a conspicuous discharge to 200 m at all times, given that

At this point, both E3 Scientific and Ms Coates have indicated that they support a zone of reasonable mixing of 100 m.

Ms Coates review describes that if a zone of reasonable mixing of 200 m is sought, there would need to be evidence that sediment plumes beyond 100 m were insignificant enough so as to not alter fish and invertebrate behaviour.

If the applicant is still seeking a zone of reasonable mixing of 200 m, please

a. *provide an assessment of the effects of the proposal on aquatic ecology, and*
b. *provide an explanation on the adaptive management approach proposed, including potentially a set of adaptive management conditions for consideration.*

Here is e3scientific's response to question's a and b:

a. Suspended sediment is known to influence feeding efficiencies in salmonids (Greer, et al., 2015) and lead to weight loss (Cavanagh, et al, 2014). However, for native fish exposed to increased suspended sediment loads there is a reduction in feeding for some species (but not kōaro) and the exposure to high turbidity (640 NTU) for several hours did not suppress their feeding rates once back in clear water (Rowe & Dean, 1998). Cavanagh, et al, (2014) found effects on fish growth rates at turbidity's of 5-15 NTU. Laboratory trials have shown that kōaro will avoid high turbidity (25-420 NTU) 50% of the time and longfin eel elver didn't show any avoidance of suspended sediment (Boubee, et al., 1997).

High suspended sediment loads have been shown to reduce overall abundance and diversity in East Coast North Island streams though (Richardson & Jowett, 2002). Increased suspended sediment levels do not appear to affect eels (up to 200 NTU) but can directly affect juvenile fish through clogging gills leading to reduced growth rates (Cavanagh, et al., 2014). Indirectly, increases in sediment can influence migration, feeding success, growth rates, community structure and population size (Cavanagh, et al, 2014).

In terms of macroinvertebrates, lab trials found that even sensitive taxa were not affected by high (turbidity = 20000 NTU) short term doses of sediment (Suren, et al., 2005). However, it has also been found that increased suspended sediment will increase invertebrate drift, reduce invertebrate densities and alter community structure (Ryan, 1991).

All of the aforementioned suspended sediment levels are significantly higher than 1.62 (NTU) found 5 m below the dredge outfall. Therefore, e3scientific do not foresee an effect of suspended sediment on the aquatic ecology other than some avoidance behaviour.

b. An example of an adaptive management approach would be to suggest "The conspicuous change in colour or visual clarity of the Clutha River/ Mata-Au must reduce by 75% by a distance of 100 metres downstream from the point of discharge or 100% by 200m".

   In this scenario a weighted Secchi disk could be used to measure visual clarity at the dredge prior to starting dredging for the day. The adaptive management approach could be to continually visually assess from the dredge if a plume is visible at 100 m downstream of the dredge. If a plume is visible at 100 m downstream, Secchi disk readings should be taken at 100 and 200 m downstream of the dredge. At least once per day Secchi disk readings at the dredge, 100 and 200 m downstream of the dredge shall be undertaken even if no plume is observed at 100 m downstream of the dredge.

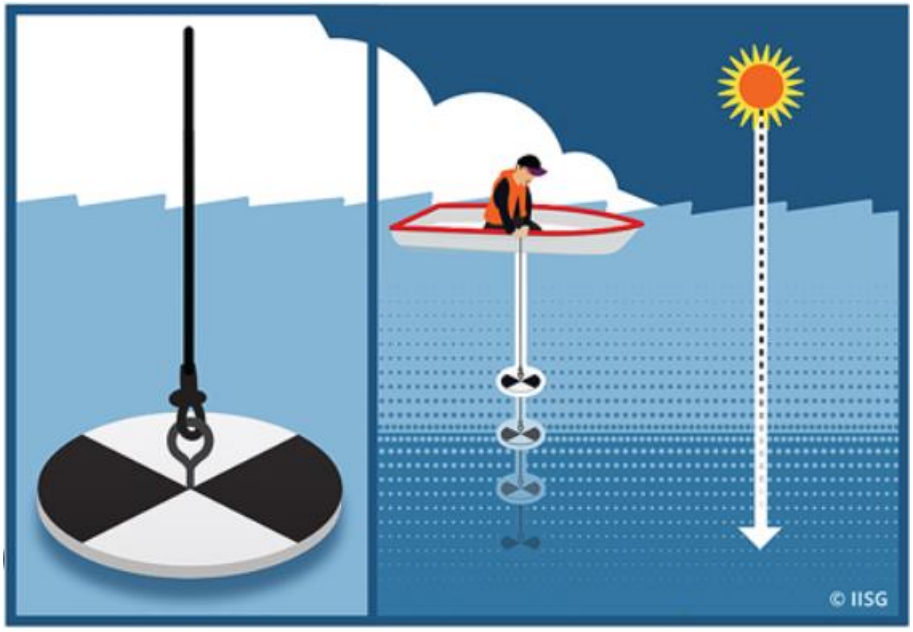
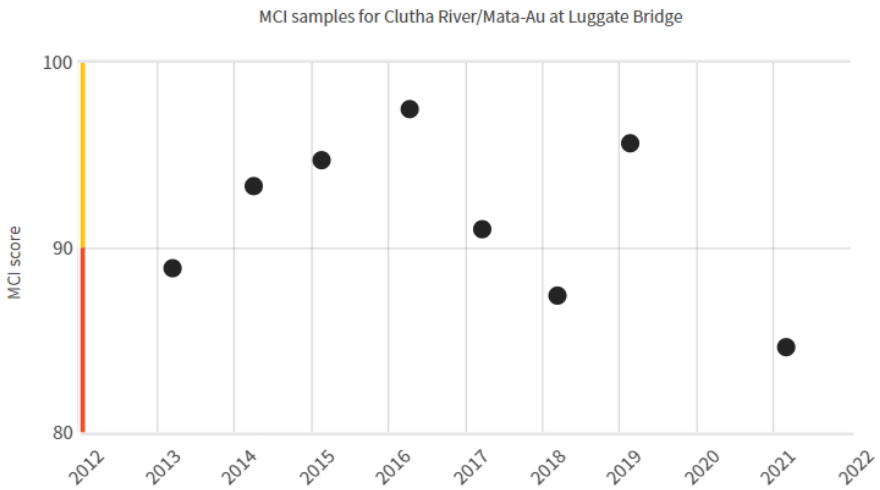


Figure 1: Example of a Secchi disk.

3 Ecological Responses to CIA matters

The table below provides both the CIA concerns and responses to address these specific concerns. Please note; these responses are restricted to matters of freshwater ecology and do not extend into cultural values.

Matter 1: It is noted that the freshwater assessment undertaken by e3Scientific only included macroinvertebrate sampling in three locations in the Central Otago district. There were no sampling sites within the Queenstown Lakes District and the effects on ecological values in that reach of the Mata-au are unknown.
The permit application #60299 was added after the field monitoring was undertaken hence no sampling was initially undertaken in the Queenstown Lakes District. However, the NIWA has a macroinvertebrate monitoring site at Luggate at the upper end of the #60299 reach. The results from Luggate Bridge site are comparable with that of the e3Scientific report (Jager, 2021) with MCI scores ranging from 85 to 98 over the last 10 years.



https://www.lawa.org.nz/explore-data/otago-region/river-quality/clutha-rivermata-au/clutha-rivermata-au-at-luggate-bridge/

The macroinvertebrate communities are used to aggregate the effects of nutrient enrichment and sedimentation into a single score. This section of river from Lake Hawea to Lake Dunstan is similar in terms of nutrient inputs and sediment, hence there is only one regional monitoring site on this section of river to represent the whole reach.
Therefore, e3scientific considers the ecological value assessment to be consistent across the #60299 reach also.

Matter 2: Moreover, all samples were taken from wadeable depths, whereas it is proposed that dredging will occur on the riverbed at depths between 2m and 15m. This raises the question of whether the freshwater assessment is fit for purpose.

Macroinvertebrates are difficult to sample in this wide deep river, sampling methods are limited to shallower edge habitats for safety and practicality reasons. Edge macroinvertebrate fauna's known to be more responsive than benthic fauna and are considered better for large river biomonitoring (Collier, et al., 2014).
In this case however e3scientific agree the macroinvertebrate monitoring would not identify direct effects of the proposed activity. Rather, it is used to help provide input to the ecological value assessment undertaken. A previous study has shown no significant difference in macroinvertebrate communities 5 days after suction dredging has occurred (Thompson, 2001). Therefore, e3scientific suggest trying to sample the deeper mid river habitats is not warranted.

Matter 3: The identification of tributaries of wider than 1m as exclusion zones for the proposed activities is welcomed, but this does not go far enough to support mana whenua values related to ecology and biodiversity. Disturbance of the bed and sedimentation should be avoided in the vicinity of all tributaries in the area of proposed activity.
e3scientific agree it would be best to map and confirm agreed tributary exclusion zones during the consenting process.

Matter 4: Kā Rūnaka believe that there is insufficient evidence on the effects of gold mine dredging on instream benthic environments and therefore, on taoka species and their survival. Of most concern are the effects on sediment dwelling species such as ammocoetes, as well as the eggs of kanakana, bully, and galaxiid species, and juvenile kōura and tuna.
e3scientific agree little is known on the effects of suction dredge mining on freshwater ecological values in New Zealand. Contact Energy have recently advised e3scientific that 593 adult lamprey have been trapped and transferred upstream of Roxburgh Dam in the last 12 years but not upstream of Clyde Dam. It is therefore very unlikely that lamprey will be present in this section of the Clutha River. In addition to this, lamprey ammocoetes prefer very slow flowing edge and backwater habitat consisting of silt substrates (Jellyman & Glova, 2002), not the sand and gravels and swift water present in the suction dredge localities. The only known location of lamprey eggs are on the underside of boulders in small streams (Baker, et al., 2016), so again this activity is unlikely to impact on lamprey eggs and development. The stretch of the Clutha River / Mata-Au in which suction dredging is proposed is identified as spawning habitat for brown trout and rainbow trout only, with a short stretch identified as kōaro spawning habitat. However, kōaro spawn at stream edges during high flow events, an area outside the suction dredging activity.

Matter 5: The application concludes that any elvers or mature eel drawn through the dredge would survive unharmed and that the impact on the tuna population will be inconsequential. The conclusions reached by the applicant are not supported by evidence. The potential effects of dredging on the tuna population above Lake Dunstan concerns mana whenua.
The intent of that statement was that the migration pathway of eels is unlikely to be affected. Adult eels would avoid the suction dredge operation because

migrating adults travel mostly at night and along the river bank edges. While in theory eel elver could bury themselves in mid-river substrates during the day and be present in the suction dredge area, on their migration upriver they would actively avoid the operations sound (Sand, et al., 2000) and sediment plume and therefore be very unlikely to be entrained by the dredge.
Matter 6: Hokonui Rūnanga have taken the firm stance of opposing any suction dredge mining due to the unknown effects on benthic species, including ammocoetes (juvenile kanakana that live 3-4 years in the sediment after their larval stages), Kākahi from spat to adult, eggs of multiple fish species including kanakana and galaxiids and also migrating elver.
As mentioned above e3scientific suggest it is very unlikely that lamprey will be present in this river reach. Kākahi predominantly inhabit lake environments, in riverine environments they prefer the base of riverbanks in slow flowing runs and silt sediment (Melchior, et al., 2022)rather than this compacted substrate and fast flowing river reach. Of the fish species likely to be present in the proposed reach, Clutha flathead galaxias, upland bully, common bully, rainbow and brown trout may spawn in gravels. This is outlined in Table 6 of the Suction Dredge Mining Upper Clutha River Freshwater Assessment Report (e3scientific, 2021) along with the likely spawning periods. Also, within the cited report (on page 23 and 24) is an explanation of why only trout spawning should be considered in the Clutha River mainstem with regards to this activity.
Matter 7: An ecological management plan prepared by a suitably qualified freshwater ecologist should form part of the application and be reviewed annually.
e3scientific agree that an ecological management plan could be prepared. However, given the proposed consent conditions it is considered that this can be completed as a condition of consent, not form part of the application.

Matter 8: The presence of kanakana cannot be ruled out due to a lack of surveying and more recent research indicates that kanakana have also been identified nesting under large boulders.
As stated above - Contact Energy have recently advised e3scientific that a total of 593 adult lamprey have been trapped and transferred upstream of the Roxburgh Dam in the last 12 years. However, none were released above Clyde dam therefore e3scientific suggest lamprey presence is very unlikely.

4 References

Baker, C., Jellyman, D. J., Reeve, K., Crow, S., Stewart, M., Buchinger, T., & Li, W. (2016). First observations of spawning nests in the pouched lamprey Geotria australis. *Canadian Journal of Fisheries and Aquatic Sciences*.

Boubee, J. A., Dean, T. L., West, D. W., & Barrier, R. F. (1997). Avoidance of Suspended sediment by the juvenile migratory stage of six New Zealand native fish species. *New Zealand Journal of Marine and Freshwater Research*, 61-69.

Cavanagh, J. E., Hogsden, K. L., & Harding, J. S. (2014). *Effects of suspended sediment on freshwater fish.* Christchurch: Landcare Research.

Collier, K. C., Hamer, M. P., & Moore, S. C. (2014). Littoral and benthic macroinvertebrate community responses to contrasting stressors in a large New Zealand river. *New Zealand Journal of Marine and Freshwater Research*, 560-576.

Greer, M. J., Crow, S. K., Hicks, A. S., & Closs, G. P. (2015). The effects of suspended sediment on brown trout (Salmo trutta) feeding and respiration after macrophyte control. *New Zealand Journal of Marine and Freshwater Research*, 49:278-285.

Jager, M. (2021). *Suction Dredge Mining Upper Clutha River Freshwater Assessment.* Arrowtown: e3scientific.

Jellyman, D. J., & Glova, G. J. (2002). Habitat use by juvenile lampreys (Geotria australis) in a large New Zealand river. *New Zealand Journal of Marine and Freshwater Research*, 36:503-510.

Melchior, M., Williams, A., Hamer, M., Pingram, M., Squires, N., & Collier, K. (2022). *Distribution and current state of freshwater mussel populations (Kāeo, Kākahi) in wadeable Waikato streams.* Hamilton: Waikato Regional Council.

Richardson, J., & Jowett, I. G. (2002). Effects of sediment on fish communities in East Cape streams, North Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 36:431-442.

Rowe, D. K., & Dean, T. L. (1998). Effects of turbidity on the feeding ability of the juvenile migrant stage of six New Zealand freshwater fish species. *New Zealand Journal of Marine and Freshwater Research*, 32:21-29.

Ryan, P. A. (1991). Environmental effects of sediment on New Zealand streams: a review. *New Zealand Journal of Marine and Freshwater Research*, 25:207-221.

Sand, O., Enger, P. S., Karlsen, H. K., Knudsen, F., & Kvernstuen, T. (2000). Avoidance Responses to Infrasound in Downstream Migrating European Silver Eels, Anguilla anguilla. *Environmental Biology of Fishes*, 57:327-336.

Suren, A. M., Martin, M. L., & Smith, B. J. (2005). Short-term effects of high suspended sediments on six common New Zealand stream invertebrates. *Hydrobiologia*, 548:67-74.

Thompson, R. (2001). *Impacts of gold-dredging activities on benthic macro-invertebrates of the upper Pomahaka River.* Dunedin: Bio-Logic Consultancy.