eCoast Marine Consulting and Research
PO Box 151
Raglan,
New Zealand.
Ph. +64 21 423 224
www.ecoast.co.nz
info@ecoast.co.nz

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Harry Donnelly
Project Engineer
Hawke's Bay Regional Council

Dear Harry,

Re: Response to Review of Numerical Modelling and Ecological Assessment for Dredging of the Lower Clive River by Shane Kelly.

I have gone through the points in the review, and we have updated the report where applicable (sediment, fish, and birds). Here, I have addressed the various points raised so that they may be provided as part of the submission for resource consent application as clarifications of points. I was surprised that the reviewer did not contact me to discuss the reports, which is common practice with this kind of review (e.g., they are not papers submitted to a journal, and we should be working together to achieve sustainable development/resource use), as well as the tone of some of the footnotes. In summary, the points raised in the review do not change the conclusions of the assessment:

- Waitangi Estuary and the lower Clive River score poorly with respect to species diversity, richness, and physical traits, are very low since it is a highly impacted site due to both natural (e.g., the 1931 earthquake) and human-induced impacts dating back almost 100 years. This is supported by a number of similar ecological assessments of the site.
- Overall, the ecological impacts (including benthic ecology bird and fish life in the area to be dredged and the inshore area of disposal) of dredging the 1.4 km stretch of the lower Clive River are considered minor to less than minor and temporary. Dredging will be undertaken for 9 hours per day over a 67-day period (it is a temporary, or pulse, impact and not a permanent change or press impact), there is only local disturbance at the dredge-head in the lower Clive River (the suction dredge sucks in 80% water and 20% sediment).
- With respect to the discharge of this material on the open coast, within the local environmental context, this part of the coast at the entrance to the Clive River/Waitangi Estuary is almost permanently effected by high concentrations of suspended sediment, both due to being discharged by the Clive and surrounding rivers, and due to resuspension of fine sediments in the nearshore area. It is a highly impacted estuary, and the adjacent part of the coast is similarly degraded due to suspended sediments. A Section has been added to the report to demonstrate this, Section 6.3 – Suspended Sediments). Cumulative impacts of discharging the dredge material to the exposed coast are considered very low, since as demonstrated in Section 6.3, this area is subject to almost constant sediment discharge. In addition, this coastal area is relatively exposed meaning that the fine sediments will be transported offshore into deeper water, while the coarser fractions of sand will become part of the nearshore and beach sediment system.
- Dr Kelly notes that "The effects of sediment on marine habitats and species have been extensively studied in New Zealand. It is well known that terrigenous sediments cause a multitude of adverse environmental effects. This fact was recognised by a panel of 105 New Zealand marine experts who ranked "River inputs: Increased sediment loading" 3rd equal (with

"Fishing: Bottom trawling") out of sixty-five identified threats to the marine environment (sitting below ocean acidification and warming sea temperatures, MacDiarmid et al. 2012). In their review of land-based effects, Morrison et al. (2009) indicate the effects of sedimentation, including both suspended sediment and deposition effects, and associated decreases in water clarity, as arguably the most important issues for coastal fisheries and supporting biodiversity." and includes several dot-points of potential impacts. I agree with this statement concerning the impacts of terrestrial sediment on marine and estuarine environments (although some of the impacts are not relevant to the site; e.g., reduce settlement success and the survival of larval and juvenile phases of marine animals (e.g., paua, kina)), and eCoast (2021) have recommended that "Both reduction in terrestrial sediment and modifications to the hydrology of the Clive River could be considered for the future management of the site." in order to reduce sediment inputs to the river and coast; as demonstrated in Section 6.3 of the report, this is a region-wide issue that needs to be addressed, although the Clive River entrance area is one of the worst sites along the coast..

- Dr Kelly notes "Sediment REDOX potential has been proposed as a potential indicator of sediment enrichment (e.g.,Robertson et al. 2016), but I have never heard of oxygen used in a New Zealand study." The method we applied is used internationally and was requested in the Scope of Works for this project.
- With respect to benthic sampling and the results obtained, Dr Kelly comments on the methodology, the low numbers of species found and that no sediment or ecological samples were obtained within the proposed dredging area. As noted in the methodology of Mead et al., 2019), "Samples were sieved through 500 µm mesh and 70% isopropyl alcohol and with rose Bengal (i.e., the same methodology as Boffa Miskell, 2021) was on hand to preserve species that could not be identified in the field for later identification at Leigh Marine Laboratory." Dr Kelly questions this methodology and suggests that ecological sample processing generally requires years of training and practice. While I agree that taxonomy, the identification of organisms to the lowest possible classification does require training, practice, and the use of a microscope (which is why we utilise the Leigh Marine Laboratory for sample identification or unknown species), the ecological sampling methodology undertaken was industry standard. When you have sample material that is a mix of sand, gravel, and finer sediments, it is sieved in 500 µm mesh. This leaves behind gravel and shell fractions that are transferred to a white sorting tray, sorted through and the large material is discarded once they have been checked *in the field*. Living organisms are then counted (sometimes also measured, e.g., bivalves) and some ecologists may preserve everything that is identified in 70% iso-propyl alcohol, while others will record the findings in the field and only keep and preserve unknown specimens for later identification.
- With respect to the low numbers of benthic infauna found in the estuary samples, Dr Kelly provides previous studies to that have higher numbers of taxa and individuals, which is assumed to support his statements about methodology. It is a fundamental of benthic ecology, that the species present and their abundances (and thus biodiversity) are related to the habitat, that is, the substrate, the physical and the chemical properties of the site. The sites that Dr Kelly presents are quite different from the lower Clive River and adjacent coast. For example, the nearshore habitat at Whirinaki (Smith, 2013) is some 22 km north of the Clive River entrance and is not comparable to the Clive River nearshore habitat, with the latter being dominated by high sediment discharge and being in the southern embayment (i.e., south of Port Napier) that has markedly reduced water quality (Appendix A of our report). Similarly, Westshore does not experience and almost continual discharge of sediment laden

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water, is much more sheltered, while the sampling methodology used was different (i.e., not comparing apples with apples).

- Dr Kelly also presents the Boffa Miskel investigations of the Ravenstone outfall into the lower Clive River as evidence that the numbers of taxa and individuals that were found in our surveys as being too low. With respect to low numbers of infauna in the Lower Clive River estuary (or Waitangi Estuary), Boffa Miskell (2021) found <140 individual specimens at the Waitangi control site in 2019 (rather than around 200 cited by Dr Kelly), and markedly lower numbers at other sites in 2019, and very low numbers at this site in 2011 (Figure 30 of BM (2021) shown here as Figure 1). This Figure well demonstrates the variability of benthic communities through time and spatially. As can be seen by the red circles, in 2011 the Waitangi control site in the lower Clive River close to where eCoast (2019a) sampled was found to have only 1 taxa and around 10 individual specimens in 2011 out of all core samples (versus 4 taxa and 63 individuals eCoast (2019b)), while all sites can be seen to vary greatly in each component presented; some trend up, some trend down, others vary up and down. The numbers of species and individual macroinvertebrates found by eCoast (2019b) fit well within these distributions surveyed in the general area (cyan dots), which all indicate relatively low biodiversity (i.e., Shannon-Winer Diversity Indices mostly <1.2).

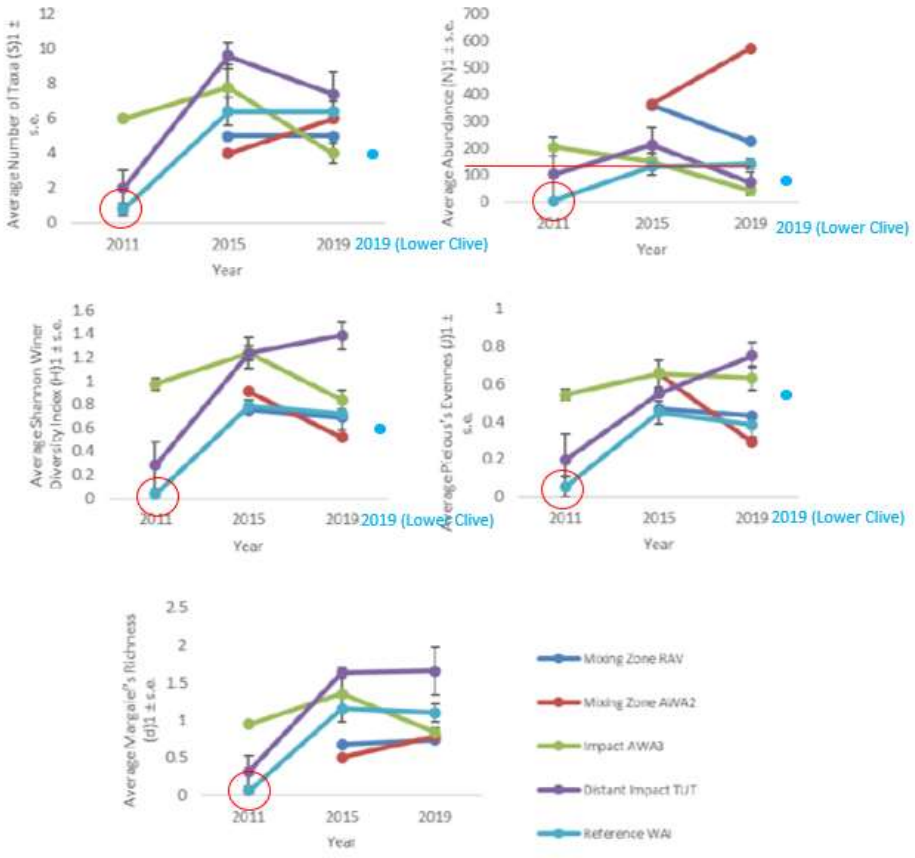

Figure 30: Temporal comparison of macroinvertebrate summary indices at discharge sites.
Source: Boffa Miskell (2019).

Figure 1. Adapted from Boffa Miskell (2021), with the eCoast (2019b) results overlaid in cyan that demonstrates that these data fit very well with BM (2021). The red circles indicate that in 2011, the reference site in Waitangi Estuary close to where eCoast (2019b) sampled had significantly lower numbers of taxa and individuals than found by eCoast (2019b).

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- Boffa (2021) conclude that "These results as a whole do not appear to indicate degradation in ecosystem health between sites and over time (throughout the sample period between 2011 and 2019), resulting from impacts associated with stormwater and process water discharges. Spatial and temporal changes that have occurred appear to be as a result of natural variation over time and natural habitat differences within the estuary." The authors also note that *Potamopyrgus antipodum* and *Paracorophium excavatum* are consistently represented across the three surveys at the reference site (WAI) (Boffa Miskell, 2021); the same findings as reported by eCoast (2019b).
- With respect to Dr Kelly's assertion that "no sediment or ecological samples were obtained within the proposed dredging area". The footprint of the proposed dredged area was sampled by eCoast (2019a), and analysed for sediment grain sizes and contaminants, with observations of ecology also being recorded.
- Dr Kelly notes that eCoast (2019b) used grab sampling that can be subject to sample loss if shell, pebbles, or other objects prevent the jaws from closing properly. This is correct, however, if the Ponar grab sampler did not fire or was found to have no sample material in it, it was redeployed until a sediment sample was collected for analysis.
- I agree that it is unusual to find no living organisms in benthic samples (cores or grabs). However, it is the case in areas where there is high sediment run-off and poor water quality. For example, Mead and Haggitt (2012-2015) undertook a 3.5-year monitoring programme of the Makara Estuary and on some occasions in both the lower and upper estuary, zero live specimens were found in samples (like the Lower Clive River, it is highly sediment impacted). Similarly, Haggitt and Mead (2010, 2011) undertook benthic sampling of the Porirua Harbour for Boffa Miskell as part of the Transmission Gully road development and found no living specimens in the channel areas of the northern arm of the harbour, which is in very poor condition due to both sediment and contaminant run-off.

Please let me know if you require any further information.

Yours sincerely

Dr Shaw Mead
Environmental Scientist/Managing Director
s.mead@ecoast.co.nz