MEMO	
ATTENTION	Julia Byrne, Paul Barrett (Hawkes Bay Regional Council)
FROM:	Shane Kelly
CC	
DATE:	10 August 10, 2021
REGARDING	Clive River dredging application: Review of ecological assessment.

COAST & CATCHMENT
ENVIRONMENTAL CONSULTANTS

BACKGROUND AND SCOPE

Hawke's Bay Regional Council (HBRC) Regional Asset Manager is seeking consent to dredge accumulated sediment from the lower reach of Clive River using a cutter-suction dredge. Sediment, associated material and water will be piped from the dredge and discharged to the open coast, on the southern head of Clive River. Operations are expected to take around 67 days with the discharge of material occurring for 9 hours per day at a total discharge rate of 500 m^3/hour, and sediment discharge rate of 100 m^3/hour (based on 20% sediment content). Overall, 60,000 m^3 of material is expected to be removed from around 124,000 m^2 of riverbed. It is anticipated that this will increase river depths to around 1.6 m below mean sea level.

Two reports have been provided, that included assessments of sediment characteristics and quality, sediment depths, site bathymetry, modelled sediment dispersal and deposition, and potential ecological effects:

Mead, S., Atkin, E., Davies-Campbell, J., O'Neill, S. (2019) Lower Clive River sediment sampling and depth probing, and entrance bathymetry and ecological assessment. Client report for Hawkes Bay Regional Council, eCoast, Raglan, New Zealand. 33 pp.

Mead, S., McIntosh, R., Greer, D. (2021) Clive River dredging: Numerical modelling and ecological impact assessment. Client report for Hawkes Bay Regional Council, eCoast, Raglan, New Zealand. 57 pp.

The HBRC Consenting Authority commissioned me to review those assessments to determine whether the information provided is sufficient and robust enough to ascertain likely ecological effects, and to provide advice on the potential significance of ecological effects. Note that, my review does not cover technical aspects of the modelling carried out (as that is outside my area of expertise), but model outputs are considered in relation to ecological outcomes.

CONTEXTUAL MATTERS USED TO INFORM MY REVIEW OF THE ECOLOGICAL EFFECTS ASSESSMENT

GENERAL EFFECTS OF SEDIMENT ON MARINE SPECIES AND HABITATS

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. Their review consolidates information from a wide range of studies, and highlights that sediments:

- directly affect individual species, by clogging of the gills of filter feeders and decreasing filtering efficiencies (e.g., cockles, pipi, scallops);
- reduce settlement success and the survival of larval and juvenile phases of marine animals (e.g., paua, kina);
- reduce the foraging abilities of finfish (e.g., juvenile snapper); and,
- indirectly affect fisheries and biodiversity values through the modification or loss of important nursery habitats, particularly those composed of habitat-forming (biogenic) species (e.g., green-lipped and horse mussel beds, seagrass meadows, bryozoan and tubeworm mounds, sponge gardens, kelps/seaweeds, and a range of other 'structurally complex' species).

Additional detail is provided in reviews by Airoldi (2003), Gibbs and Hewitt (2004), Thrush et al. (2004), and in ongoing research on sediment effects (e.g., O'Meara et al. 2020).

QUALITY OF SEDIMENTS TO BE DREDGED

Mead et al. (2019):

- characterised sediments above and below the proposed dredging site;
- probed to determine sediment depths above the proposed dredge site; and,
- undertook a bathymetric survey of Waitangi Estuary below the proposed dredge site and in the area immediately offshore from where dredged material is to be deposited.

Further bathymetric data from the rivers feeding into the Waitangi Estuary were provided by HBRC (Mead et al. 2021).

The assessment of sediment quality indicated that sediment quality was poor above the proposed dredging area. It tended to be muddy (mostly >50% mud[1]), anoxic ("black with a slight odour of hydrogen sulphide"), enriched (mean, site total organic carbon concentrations of 1.8% to 3.4%, total nitrogen concentrations of 1766 to 3466 mg/kg, and total phosphorus concentrations of 646 to 1273 mg/kg), and had elevated zinc concentrations. Sediment oxygen concentrations were also measured "in the upper layer of sediment". This is not a typical measurement parameter[2], so I am uncertain about how those results should be interpreted (but the comparisons made between water column and sediment concentrations seem unlikely to be meaningful).

[1] <63 µm sediment fraction.

[2] 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.

CAUSES OF RIVER SEDIMENTATION AND PREDICTIONS OF DREDGING EFFECTS ON HYDRODYNAMICS AND INFILLING

Mead et al. (2021) indicate that the accumulation of sediment in the lower Clive River is caused by multiple factors, including:

- the diversion of the Ngaruroro River, which reduced flow rates in the lower Clive, and consequently, increased siltation;
- the uplifting of the riverbed by the 1931 earthquake which reduced the grade of the lower reaches and prevented new gravel from reaching lower sections;
- the input of terrestrial sediment.

Modelling predicts that the proposed river dredging will cause a slight reduction in current speeds in the lower river. Spring flood and ebb flows current speeds are predicted to decrease by up to approximately 0.1 m/s, while neap ebb and flood tidal currents are low (<0.05 m/s) and not affected greatly by the dredging. Reduced current flows are likely to increase sedimentation rates, with the 60,000 m^3 of dredged material expected to reaccumulate within 10–12 years.

PREDICTIONS OF THE DISPERSAL AND DEPOSITION OF DISCHARGED SEDIMENT

Modelling was used to predict the potential dispersal, dilution and deposition patterns of fine and sandy sediments from the proposed coastal discharge (Mead et al. 2021). The model simulated the continuous release of sediment for 9 hours per day for 67 days, from a discharge site that was approximately 3 m deep (MSL). The model was run over a 16-week summer (1 January 2018 through to 10 March 2018) and winter (1 June 2018 to 8 August 2018) period to examine sediment transport under different metocean conditions.

Key predictions from the dispersal modelling were:

- Sand rapidly falls out of suspension, with 99th percentile concentrations of suspended sand dropping from > 0.05 kg/m^3 in the vicinity of the outfall, to <0.0001 kg/m^3 within 100 m of the outfall in both summer and winter conditions.
- Fines remain in suspension for longer and therefore form larger plumes. Mean concentrations were relatively low (because sediment was only being discharged for a third of the time), but peak concentrations were high (up to 1 kg /m^3 close to the outfall). Concentrations of up to 0.3 kg/m^3 were predicted up to 500 m north of the discharge site.
- Sediment deposition is greatest near to the outfall with maximum deposition levels of nearly 1 m within 150 m of the outfall.
- The 0.01 m (1 cm) deposition footprint was predicted to extend to 800 m in winter and 500 m in summer.
- The footprint extended toward the north-east of the outfall with a smaller area extending to the south-east, and the maximum deposition pattern was very similar to the final deposition footprint.

CONCLUSIONS ON CONTEXTUAL MATTERS

Based on the above, I have concerns about the potential for the proposed activities to have significant adverse effects. In my opinion the significance and cumulative nature of sediment effects on the marine environment, suggests that a high level of care should be taken in the consideration of this application. My concerns are exacerbated by the high proportions of fine sediment in the dredge material, and poor sediment quality. The predicted depositional footprint and dispersal plumes, although temporary, are still sizable from a local context, affect an area with high ecological values, and will potentially compound effects on an environment that is already sediment stressed.

Given that, it would be prudent to expect a robust and thorough assessment of ecological effects, and for an appropriate level of caution to be applied when deciding on this application.

ECOLOGICAL ASSESSMENT

BENTHIC COMMUNITIES

Mead et al. (2019) conducted a benthic macrofaunal survey of a site in Waitangi Estuary below the proposed dredge area, and a site immediately offshore from where dredged material is to be deposited. I note that:

1. No living organisms were found in any of 10 ponar grab samples on the open coast, and only three species were found in the core samples in the southern embayment area of the lower estuary (an amphipod, estuarine snail, and polychaete worm). However, the ecological samples were sieved to 0.5 mm and sorted in the field. Many benthic invertebrates are tiny and can be very hard to spot and identify amongst other material retained on a 0.5 mm sieve. Ecological sample processing therefore requires specialist skills[3] and meticulous care. It is typically done in a laboratory, with samples being sorted on a white tray, using good lighting, commonly with the aid of a microscope. Samples typically take around an hour to process (Rod Asher, Biolive pers. comm.). I do not consider field-sorting of ecological samples to be good practice. Based on my experience, it is very unusual for no biota to be obtained from eight sediment samples at a site. That is also inconsistent with results obtained from other inshore sites in the area. For instance, Sim-Smith and Kelly (2019) recorded 41 taxa and 567 individuals in 20 core samples collected off Westshore Beach, and Smith (2013) obtained 83 taxa and 3315 individuals from 33 core samples collected around Pan Pac Forest Products' inshore outfall at Whirinaki. Note that those surveys used divers to collect cores (130 mm diameter), whereas Mead et al. (2019) used grab sampling that can be subject to sample loss if shell, pebbles or other objects prevent the jaws from closing properly.
2. The reported diversity and abundance of biota in Waitangi Estuary samples also appears low (4 taxa and 63 individuals in 10 samples, based on Figure 5.7 in Mead et al. 2019). In comparison, Smith (2013) obtained 19 taxa and 2408 individuals in 12 core samples collected along the nearby Tutaekuri Blind Arm and Awatoto Drain, while Bell (2019) reported averages of 7 taxa and around 200 individuals in five core samples obtained from Waitangi Estuary.
3. No sediment or ecological samples were obtained from within the proposed dredging area, and the potential effects of the proposed dredging and disposal were not initially assessed (this was the subject of a S92 request for further information).
4. An attempt was made to record the state of the seabed and the presence of epifauna using a drop-camera, but poor visibility prevented the usable images from being

[3] Competency in ecological sample processing generally requires years of training and practice.

obtained. Therefore, information on benthic epifauna potentially affected by the proposed activities was not provided. Poor visibility is generally expected for inshore coastal sites in the area. Consequently, ecological epifaunal surveys typically use dredge sampling instead of camera or video footage around Napier. Examples of biota obtained in dredge samples collected during three local assessments are appended. They illustrate that a relatively diverse and abundant epifaunal assemblage may be present in the area, and despite poor visibility, simple and commonly used sampling methods are available to characterise epifaunal communities.

Based on the above, I have concerns about the reliability of the benthic ecological results presented and about the lack of ecological data obtained from the proposed dredging footprint. These matters were not addressed in the response to the S92 request for additional information provided by Mead et al. (2021). That report indicates that additional sediment sampling was carried out at 11 stations within the proposed dredging footprint. However, the only additional information presented are general observations indicating that sediments at most stations were anoxic with a thin, aerated surface layer, a thick surficial layer. The exceptions were two stations at the seaward end of the proposed dredging area where incidental observations indicated that "a thick layer of surficial layer of living pipi (*Paphies australis*) and cockles (*Astrovenus stutchburyi*), many with barnacles and small anemones attached, and a mix of small gravel and dead bivalve shells was present". They also noted that "oxygen levels in the surficial sediment increase towards the mouth of the river, which was supported by the presence of small gastropods (*Potamopurgus estuarinus*) at sample sites 7 to 9" and the forementioned bivalves at sites 10 and 11. However, sediments from the proposed dredging area do not appear to have been analysed for grain size, contaminants or macrofauna.

BIRDS

Mead et al. (2021) indicates that the Waitangi Estuary is an exceptional habitat for wetland bird species, but the biodiversity values of Clive River are low. Examples of birds that use the area are provided (common names only), including: godwit, golden plover, black-billed gull, gannet, kotuku, spotless crake, bitten dotterels, stilts, and terns. However, a full list of birds, their taxonomic names, protection status, details of their habitat use, and which, if any, species are most vulnerable to adverse effects is not provided. In terms of dredging effects on birds, the assessment seems to imply that the only effect of concern is likely to be related to the generation of sediment plumes, and simply states "The impacts on fish species and coastal/wetland bird species are discussed above and below, respectively" (i.e., for birds, in the section related to the effects of disposal).

Under disposal effects, Mead et al. (2021) identify two key issues for birds: impacts on avifauna when placing and removing the pipeline, and effects of the discharge plume. In relation to disturbance effects during pipe placement, they simply state that:

> "*There are likely to be very short term impacts on avifauna when placing and removing the pipeline over the shingle bank, which are also considered less than minor. For example, the shingle bar closest to the sea often has wintering Black-fronted Terns that will be displaced temporarily*."

In relation to the discharge plume, three potential matters of concern are identified:

- "Will any species likely be adversely affected by in water visual changes arising from sediment in the water column?
- Will any species likely be affected by changes in food availability?
- Will any species likely be affected in relation to their ability to roost and nest?"

However, the subsequent assessment:

- fails to provide site-specific information on the species potentially affected;
- simply states that effects on unnamed intertidal feeders, roosting and nesting species will be less than minor (in a confused sentence that conflates dredging and discharge effects—last sentence of page 52); and,
- provides very general comments about seabird feeding habits, and foraging ranges relative to the size of the plume and concludes that effects on unnamed coastal bird species are anticipated to be less than minor and temporary.

Based on the above, I have concerns about the reliability of the assessment of effects on birds. In my opinion, the assessment does not adequately characterise the bird assemblage in Waitangi Estuary and Clive River, the importance of the proposed dredging and disposal areas for birds, and potential effects on birds.

I note that other assessments carried out in the area have been more detailed and would provide a good starting point for assessing effects on birds. For instance, Smith (2013) lists 23 bird species that he identified during surveys or from other literature. Ten of those species were classified as threatened, with: two endangered; two nationally vulnerable, and one nationally critical.

FISH

Mead et al. (2021) list the following fish as ones that frequent the Waitangi Estuary: inanga, kahawai, eels, mullet, warehou (rarely) and flatfish, and state that the effects of dredging on fish species will be less than minor and temporary. However, a full list of fish, their taxonomic names, protection status, details of their habitat use, and which, if any, species are most vulnerable to adverse effects is not provided.

No information is provided on the fish species found on the open coast, but the report concludes that the "discharge plume on the open coast is expected to have little impact on fish in the area, as the species in the area are unlikely to rely on visual capacity for feeding". It goes on to note that fish catches increased during prior disposal events due to fish being attracted to the infaunal species in Clive River dredge material [I note that, if correct, this suggests that reasonable abundances of benthic macrofauna are present in the dredging area]. Other effects associated with suspended sediment, noise, changes in physical habitats, and the incidental effects of prey being impacted (apart from the aforementioned effects on fish catches) are not considered.

General information is provided on freshwater fish[4], but little site-specific information is provided, apart from noting that the Karamu Stream banks provide important inanga spawning habitat, some 6 km up river from the SH2 Clive River bridge. Mead et al. (2021) conclude that dredging

[4] The use of Te Ara – The Encyclopedia of New Zealand as a key reference seems odd for a technical expert to use. It suggests to me that the writer's freshwater fish expertise may be limited.

would have only a very minor impact on inanga larvae being carried downstream and out to sea after hatching, but still recommend avoiding works during the late summer/early spring to ensure impacts do not occur.

Based on the above, I have concerns about the reliability of the assessment of effects on fish. In my opinion, the assessment does not adequately characterise the fish assemblage in Waitangi Estuary and Clive River, the importance of the proposed dredging and disposal areas for fish, and potential effects on fish.

I note that other assessments carried out in the area are much more detailed. For instance, Smith (2013) indicates that Waitangi Estuary is a nationally significant fisheries habitat and lists 14 fish species that he identified during his survey or from other literature. Five of those species were classified as threatened (at risk, declining). He also notes that the estuarine area is an important link for diadromous native freshwater fish, with Clive River, in particular, being identified as being the largest inanga (*Galaxias maculatus*) spawning site in Hawke's Bay.

BIOSECURITY

Mead et al. (2021) indicates that the Australian tube worm (*Ficopomatus enigmaticus*) is present on every pile on the Clive River Bridge from the low water mark to close to the riverbed (in some places >30 cm thick) and on clumps beside the bridge piles. They go on to state that:

"This aggressive invader is fast growing, forms colonies on shells, rocks, marine vegetation also jetties, marinas, boats and moorings. With the ability to grow on vessels and pipes, this can lead to heavy bio fouling and the clogging of underwater entry ports and pipes. Tubeworms, when established on vessels hulls are then easily transported to new areas, where new colonies can become dominant. These colonies of filter feeders compete with native marine life for essential nutrients and eventually displace previously established species (HBRC, 2020). Potential dispersion of this invasive species is related to its life-history and disposal methodology."

and conclude that:

"At present, the removal of the population of tube worms from the bridge piles in the lower Clive River is not proposed, and so in order to avoid further spread and colonization of this invasive species, it is recommended that all efforts are made during the proposed dredging to avoid physical contact with the tubeworm colonies. As these tube worms are a marine biosecurity risk, if/when they are removed from the bridge piles, they should ideally be disposed of to landfill (MPI, 2019), as disposing of them in other areas of the marine environment may lead to colonization and associated implications (HBRC, 2020). In addition, due to uncertainty in their life history, a precaution to ensure that physical interference does not instigate a spawning response, removal should be undertaken in the winter months when it is known they do not spawn in other parts of the world."

Based on that, and in particular uncertainties related to reproductive and spawning behaviour, I consider the risk of the proposed dredging and disposal to exacerbate the spread of this marine pest to be high.

OVERALL CONCLUSIONS

Overall, for the reasons outlined above:

- in my opinion the proposed dredging and disposal activities have the potential to cause significant adverse ecological effects;
- I have substantial reservations about the adequacy and robustness of the ecological assessment;
- I do not consider the detail provided in the ecological assessments corresponds with the scale and significance of ecological effects that the activity may have on the environment.

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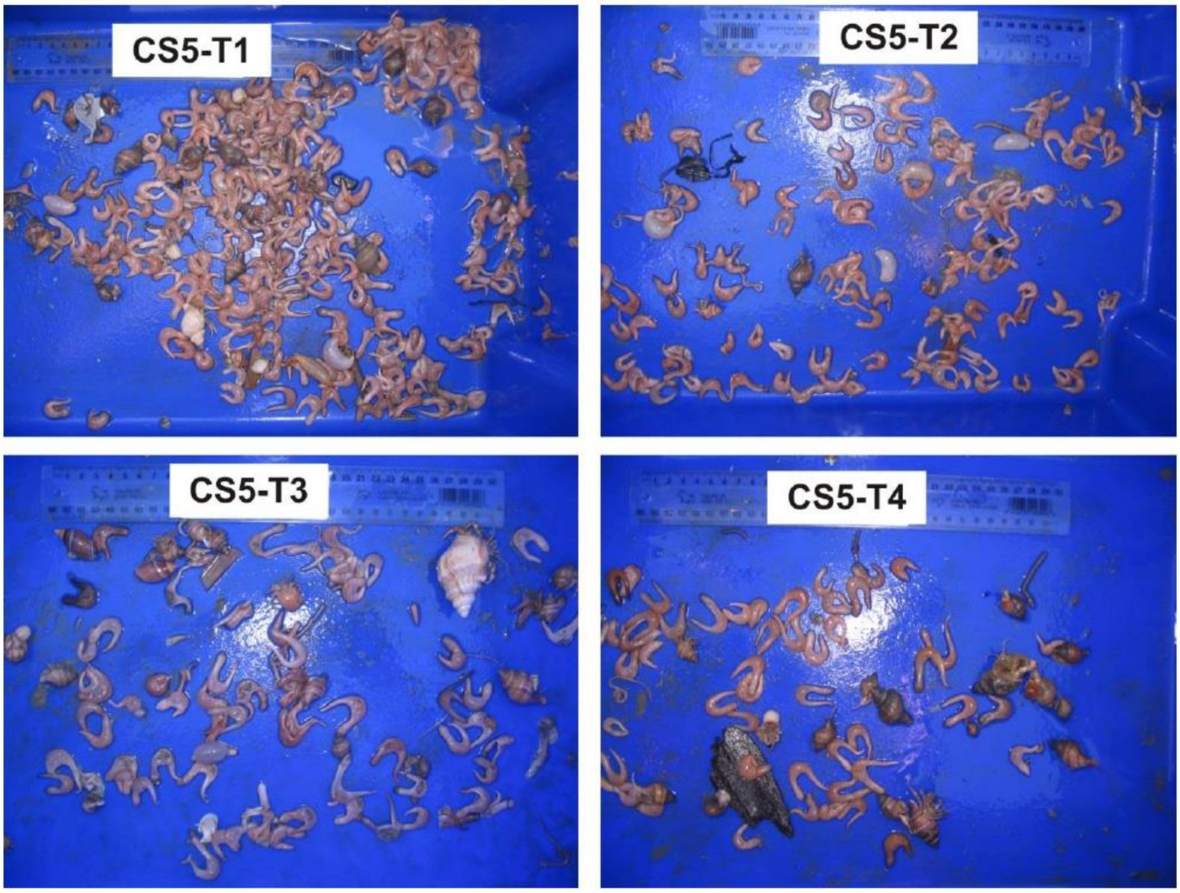
APPENDIX 1: IMAGES OF BIOTA OBTAINED IN DREDGE SAMPLES

Source: Smith (2008), existing dumping ground off Westshore Beach.

Figure 14: Contents of epibenthic dredge sampling tows T1, T2, and T3.

Source: Sneddon et al. (2017), offshore dumping ground, Napier Port.

Appendix 7. Benthic epifauna collected in the four dredge trawls conducted within the area of the proposed offshore spoil ground in 2005.



Source: Sim-Smith and Kelly (2019), proposed dumping ground off Westshore Beach.

Figure 12. Contents of: A. Dredge 1; B. Catenicellid bryozoans and red filamentous algae captured in Dredge 1; C. Dredge 2; D. *Carpophyllum plumosum*, *Petalonia* sp., and *Codium* fragile subsp. *novae-zelandiae* captured in Dredge 2; E. Dredge 3; and, F. Dredge 4 taken within the proposed disposal zone.

APPENDIX 2: COASTAL AND WETLAND BIRDS REORCED IN WAITANGI ESTUARY

Table 1: Bird species identified in Waitangi Estuary (adapted from Smith 2013).

Common Name	Taxonomic Name	Threatened Status	Origin
Australasian Bittern	*Botaurus poiciloptilus*	Threatened, endangered	Native
Banded Dotterel	*Charadrius bicinctus*	Threatened, nationally vulnerable	Endemic
Bar-Tailed Godwit	*Limosa lapponica*		Migrant
Black Billed Gull	*Larus bulleri*	Threatened, endangered	Endemic
Black Fronted Dotterel	*Charadrius melanops*		Native
Black Shag	*Phalacrocorax carbo novaezehollandiae*	At Risk, naturally uncommon	Native
Black Swan	*Cygnus atratus*		Introduced
Black-Backed Gull	*Larus dominicanus dominicanus*		Native
Caspian Tern	*Hydroprogne caspia*	Threatened, Nationally vulnerable	Native
Gannet	*Morus serrator*		Native
Grey Duck	*Anas superciliosa*		Native
Grey Teal	*Anas gracilis*		Native
Kingfisher, Kotare	*Todiramphus sanctus vagans*		Native
Kotuku (White Heron)	*Egretta alba modesta*	Threatened, nationally critical	Endemic
Little Black Shag	*Phalacrocorax sulcirostris*	At Risk, naturally uncommon	Native
Little Shag	*Phalacrocorax melanoleucos brevirostris*	At Risk, naturally uncommon	Native
NZ Shoveler	*Anas rhynchotis*		Endemic
Pacific Golden Plover	*Pluvialis fulva*		Migrant
Paradise Shelduck	*Tadorna variegata*		Endemic
Pied Stilt	*Himantopus himantopus leucocephalus*	At Risk, declining	Native
Pukeko	*Porphyrio melanotus*		Native
Spur Winged Plover	*Vanellus miles novaehollandiae*		Native
Variable Oystercatcher	*Haematopus unicolor*	At Risk, recovering	Endemic