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2 April 2018

Phil Lake
Lowe Environmental Impact

Dear Phil

Re: Stage 1: Peer Review of Estuary/Ocean Receiving Environment Report A3I1b.

The following peer review is provided as part of the resource consent renewal process for the Wairoa wastewater treatment system. The Wairoa wastewater treatment system currently discharges treated wastewater into the Wairoa River estuary during falling overnight tides. Its current discharge consent expires on 31 May 2019 and requires a replacement consent application to be lodged with Hawkes Bay Regional Council (HBRC) by 30 November 2018. This will require the assessment of the current and future ecological effects of nutrient and pathogen loading into the Wairoa River estuary.

A benthic survey was completed in 2017 (Report A3I1b) to supplement previous EAM reporting undertaken in 2007 and 2011. However, difficulties and delays were encountered for sampling and reporting, and as a result, this report is not available for review. Therefore, this peer review considers the earlier reports with respect to the condition of the benthic sediment and biological environment within the vicinity of the current outfall and in the near-shore marine environment. The purpose of the peer review is to consider the existing report's assessment of the likely ecological effects from the treated wastewater discharge.

The areas of focus for the review include:

- Peer review of the appropriateness of benthic survey sampling and analyses for direct comparisons with previous reports.
- Peer review of the assessment of effects of the discharge on the estuarine environment's sediment characteristics and ecology.
- Identify any concerns about the methodologies used, accuracy of results, information gaps that require filling, or certainty of conclusions.
- If recommended as an outcome of this peer review, to provide a proposal with timeline and cost estimate for undertaking additional benthic surveying during April 2018.

The reports reviewed included:

- Larcombe, M. F., 1996. Wairoa Sewage Treatment Plant Discharge Effects on Wairoa Estuary, Bioresearches, Auckland.
- EAM, 2007. Assessment of Ecological Effects on the Wairoa River Estuary from the Wairoa Wastewater Treatment Plant Outfall. Prepared for the Wairoa District Council, July 2007.
- EAM, 2012. Monitoring of Benthic Effects of the Wairoa District Council Wastewater Treatment Plant Outfall Discharge at Sites in the Lower Wairoa River Estuary: 2011 Survey. Prepared for the Wairoa District Council, May 2012.

The appropriateness of benthic survey sampling and analyses for direct comparisons with previous reports.

The 2007 and 2011 EAM studies repeat similar methodologies to that described by Larcombe (1996), which used 3 sites for benthic sampling; 2 impact sites and 1 reference site (Figure 1). There is no reference in the Larcombe (1996) report as to why these sites were selected. However, this monitoring/sampling design developed by Larcombe (1996) is not appropriate for determining benthic effects associated with an effluent outfall of this type. The study design presented by Larcombe (1996) includes ecological, chemical and physical oceanographic components i.e., it is a multi-disciplinary approach, although the findings are poorly linked between respective disciplines. In order to determine the ecological effects on the estuary, the ecological and chemical sampling should be based on the findings of the dilution and dispersion studies reported in the same document, and consider a gradient of sampling with increasing distance away from the outfall (normally along the axis of dispersion, or if dispersion is more complex as in the present case, a grid or circular sampling design l (e.g. e.g. Mead and Greer, 2017; Mead, 2016; Mead, 2007; Mead *et al*., 2007)). This is also essential as the entrance area is in continual flux, and so spreading the sampling effort is essential rather than relying on only 3 sites.

Figure 1. Location of the outfall and sampling sites.

In this case, Sites A and B are situated 100 m downstream and upstream of the outfall respectively, which given the results of the dilution study indicate that they are within the immediate mixing zone of the discharge, while the single reference site is located 500 m upstream of the outfall (reference and assumes that no discharged water reaches this site. The drogue experiments used as a proxy to describe hydrodynamics and mixing suggest that there is an eddy on the western side of the estuary and entrance channel that retains discharge water on the out-going tide, and that during periods of river entrance closure or semi-closure, discharged effluent is unlikely to be well mixed at distances exceeding 200 m from the outfall. EAM (2011) relate the worse-case conditions when the estuary entrance is closed or semi-closed (note, the 2007 dye distribution experiment is not included as Appendix 1 of that report):

> *"These reports note that at times the estuary mouth can become partially or fully blocked heavily restricting river discharge into Hawke Bay and represents a worst case scenario for effluent discharge. This generally occurs during heavy sea conditions when the shingle bar is built up particularly during easterly generated swell. Although the consent requires WDC to store effluent during these periods the WWTP storage capacity is often exceeded and thus effluent has to be discharged into the estuary during these "restricted flow" conditions. The first effluent dilution study in 2007 during this worst case scenario showed that the effluent plume EAM (2011) did not disperse and remained close to the "boil" with minimal transport, effected only by wind. Dilutions of 5:1 at the "boil" where typical while the plume moved only a maximum of 150 m from the "boil" (Barter 2007). Under these conditions there is a significant human health risk when using the lower estuary for contact recreation, especially if these conditions persist for an extended period of time."*

However, the monitoring/sampling design does not include any potential impacts sites outside of the mixing zone (as shown in EAM (2007)). In addition, as noted above undiluted effluent (at least the dye proxy) was found to disperse more than 200 m beyond the outfall, and it is likely that the longer the estuary is closed or partially closed that high concentrations of effluent circulate the lower estuarine for prolonged periods of time. The data collected at the 2 impact sites between 1996 and 2011 indicate that the ecological communities have been impacted (as would be expected), however, impacts beyond the mixing zone are unknown.

The monitoring and thus detection of any ecological effects attributable to the outfall is also compromised by the lack of any background or reference surveys for the area prior to the operation of the outfall (as pointed out by EAM (2007)).

In terms of the analyses and direct comparisons of ecological attributes between reports, these have been done appropriately in terms of statistical analysis and since they mostly follow the same methodology can be compared directly. With respect to infaunal sampling, EAM (2011) report:

> *"Although the size of the infaunal samples collected in the 1996 survey was 0.05 m^2, compared to 0.013 m^2 used in the 2007 and present (2011) surveys, data were compared without scaling. The reason for not scaling results is that the number of species detected in a sample usually changes much more in relation to sample size or sampling intensity than the distribution of relative abundances (Huston 1997)."*

In my opinion, there is almost a 4x reduction in sample size in the EAM 2007 and 2011 infaunal surveys, and scaling would be appropriate for direct comparisons between these results and the initial surveys in 1996.

The assessment of effects of the discharge on the estuarine environment's sediment characteristics and ecology.

As described above, while the data collection methodology, parameters collected, and analysis of data is mostly appropriate, the monitoring/sampling design is focussed on the mixing zone next to the outfall and so does not consider impacts on the wider estuarine environment. This is especially true for areas to the south of the outfall where effluent is dispersed to and likely entrained by an eddy during open river mouth conditions; and/or poorly dispersed/diluted in this area when the river mouth is closed or semi-closed (Larcombe, 1996).

Resultantly, the assessment of the effects of the discharge is restricted to a relatively small area within the mixing zone of the outfall and so provides limited information on the effects on the wider estuarine environments in terms of sediment characteristics and benthic ecology. A dispersion gradient monitoring/sampling design with sufficient replication is therefore required to provide an understanding of impacts within and outside the immediate zone of influence of the outfall.

EAM (2011) report:

> *"Given the decreased species diversity there is some evidence that overall conditions in the river estuary are deteriorating over time. Additionally, the WDC discharge is also a measurable contributing stressor to infaunal communities, particularly at the downstream "impact" site A, and this is in evidence as an increased level of variability among the summary indices compared to the other monitoring sites. EAM 2011"*

With respect to effects of the WDC discharge, inferences are based only on the sites within the mixing zone, which are normally expected to be impacted, and highly variable; due to the monitoring/sampling design impacts of the discharge beyond this area are unknown.

Any concerns about the methodologies used, accuracy of results, information gaps that require filling, or certainty of conclusions.

The methodologies applied to collect and analyse the data are all industry standard and appropriate. However, major deficiencies in the sampling design means that there is a high degree of uncertainty with respect to the both localised (10s m) and wider (100s m) impacts to the lower region of the Wairoa Estuary.

As stated above, the gaps in these investigations are the spatial sampling design – there are only 2 impact sites immediately within the mixing zone, which is expected to be impacted due to the 'Press' impact of changes in water quality and suspended particulates since the outfall was commissioned. Baseline data prior to the outfall commencing operation is also a gap in the data that cannot be addressed.

In order to provide a better understanding of the environmental impacts of the outfall than presently exists, benthic surveying that incorporates a gradient of sample sites at increasing distances away from the outfall is likely the best option in the absence of any previous monitoring/sampling outside the area of immediate impact. A sampling design of this nature can be used effectively to gauge effects of point-source, press impacts typical of the Wairoa wastewater treatment system

If recommended as an outcome of this peer review, provide a proposal with timeline and cost estimate for undertaking additional benthic surveying during April 2018.

Based on the information contained within existing reports together with a lack of any data collection since 2011, it is recommended that a benthic survey is undertaken. The survey would include the existing sites and apply various aspects of the existing methodologies for ecological and sediment contaminant sampling, but also investigate the seabed at locations beyond the 100 m mixing zone using a systematic approach. Benthic data (ecological, sediment contaminant and grain size) collected by Hawke's Bay Regional Council as part of their State of The Environment Monitoring will be used to help develop a robust sampling design.

A proposal with timeline and cost estimate for undertaking additional benthic surveying is attached as a separate document.

Please let me know if you require further details or clarifications.

Yours sincerely

Dr Shaw Mead
Managing Director

References:

Mead, S. T., and D. Greer, 2017. *Silver Fern Farms Outfall – AEE Expert Review*. Prepared for Environment Canterbury, April 2017.

Mead, S. T., 2016. *Primary Statement of Evidence of Dr Shaw Mead; Biological and Physical Oceanography – MV Rena Consents*. Prepared for the Iwi Appellants, December 2016.

Mead, S. T., 2011. *Review of Pine Harbour Dredging Consents.* Environment Court Expert Witness report prepared for the Auckland Council, March 2011.

Mead, S. T., A. Moores and E. Atkin, 2011. *Pine Harbour Heavy Metal Investigation*. Prepared for Auckland Council, June 2011.