Before the Hearing Panel appointed by Canterbury Regional Council

IN THE MATTER OF The Resource Management Act 1991

AND

IN THE MATTER OF Applications CRC172455, CRC172522, CRC172456 and CRC172523 by Lyttelton Port Company Limited to undertake various activities within Lyttelton Harbour and offshore surrounds

TABLED AT HEARING

Application: LPC - channel deepening project

Date: 9 May 2017

Addendum to Section 42A Officer's Report of Dougal Greer of eCoast.

Introduction

1. My name is Dougal Greer. My experience is as outlined in my s42A report. I am a physical oceanographer and director of marine consultancy eCoast based in Raglan, New Zealand. I have a background in statistics, modelling and physical marine processes more generally.
2. I have been working with ECan to help review the methodology for establishing trigger levels as presented by Prof Fox. In undertaking this review, I have also reviewed the monitoring methodology and the EMMP produced by Vision Environment as these are relevant to the trigger level methodology.
3. This review has also taken into consideration evidence from Prof Fox, Ms Andersen and Mr Pettersson. This includes Prof Fox's summary of evidence (28 April 2017) and the recently updated trigger conditions (5 May 2017).
4. Prof Fox's methodology, as outlined in two reports, that formed part of the application, provide procedures for post-processing turbidity time series data and a statistical methodology for establishing turbidity Trigger Values for the proposed LPC dredging project. This methodology has been augmented by his more recent summary of evidence.

Trigger levels

5. While the use of trigger levels is common in dredge operations the details of their use varies between projects. Some use duration, frequency, intensity or combinations of these metrics. In some cases, specific ecological thresholds are used for trigger values.
6. Trigger values are used to establish when turbidity from consented activities have appreciably exceeded expected levels and may lead to unforeseen environmental impacts. The method for calculating trigger values will determine when different management responses are implemented. If trigger values are calculated incorrectly, and are too permissive, they could allow harmful turbidity levels to occur unnoticed. If they are too restrictive they will cause frequent and unnecessary interruptions to the dredging operation.
7. For this project, ecological based triggers are not proposed because of the absence of knowledge around local ecological effects in response to raised turbidity levels. Instead the methodology proposes to use a year of measured baseline time series data added to a year of representative modelled dredge

time series data as the basis for developing trigger values. The aim is to use a percentile based approach to identify when turbidity at the monitored sites is raised above expected levels. Inherent in this is the idea that the cumulative increase in turbidity, as indicated by the modelling, have been signed off as acceptable by ecologists.

8. The proposed methodology details the use of a moving window (reporting period) to assess trigger threshold exceedances. A 30-day windows is proposed for this purpose.

9. In the application, Prof Fox proposed a methodology for identify higher order percentiles of frequency and mean duration of threshold exceedances. This is based on a previous methodology and is built on within Prof Fox's reports. In his more recent summary of evidence, the use of frequency and duration have been put aside in favour of using 'duration of exceedance' over the space of a reporting period. This method was summarised in the revised draft of the trigger conditions produced on 5 May 2017 (3 days ago).

10. While reviewing this document I realised that the proposed methodology has a flaw that results in very conservative trigger values which would result in frequent and unnecessary management responses. The proposed trigger values are presented in the following table:

Turbidity Trigger	Intensity (percentile of baseline + modelled dredge addition)	Allowable duration of exceedance (hours) per 30 day period
Tier 1	80%	144
Tier 2	95%	36
Tier 3	99%	7.2

11. I will illustrate the problem by focusing on the 99th percentile case. We expect the 99th percentile to be exceeded 1% of the time. 1% of the 30-day (720 hour) period is 7.2 hours. This means that even in the absence of an impact we would expect to see the 99th percentile exceeded for 7.2 hours in a period of 30 days. Because the moving window is a just a sample, sometimes the duration of exceedance in the windows will be more and sometimes it will be less than 7.2 hours. In fact, the duration of exceedance will be less than 7.2 hours approximately half of the time and above 7.2 hours approximately half of the time. This means that using this threshold, the Tier 3 management response will be triggered 50% of the time even in the absence of a larger than expected dredge impact. This concept also applies to the Tier 1 and 2 turbidity triggers, and they too will cause management responses to be triggered 50% of the time.

12. The concept of using duration of exceedance to trigger management responses is not inherently flawed, but an extension to this methodology will be required to increase the current duration of exceedance triggers to appropriate values. This extension is essential to producing workable trigger values going forward.

Combining Baseline and Modelled Dredge Data

13. It has been made clear in Prof Fox's evidence that the trigger values are to be calculated by using combined baseline and modelled dredge time series data. If this is to be undertaken, the modelled time series data should be taken from a model simulating the same year during which the baseline data was collected. This is because at monitoring locations, the meteorological and oceanographic conditions (wind, waves and tides) that can cause increased background turbidity may also give rise to increased turbidity from the dredging activities. It will not be possible to undertake this modelling until the end of the baseline monitoring period.

Filtering Turbidity Data

14. Prof Fox suggests the use of a class of multiple pass moving average filter (the Kolomogorov-Zurbenko (KZ) Filter) to remove high frequency noise from turbidity time series data. This is known as a low pass filter because it allows low frequency to pass through it. This filter has the advantage that it optimally preserves discontinuities in the signal.

15. This KZ filter was also partially chosen because of its ease of implementation in the automated monitoring scheme. While this is an advantage, this filter does not have a specified frequency cut-off unlike other low pass filters. Furthermore, this class of filter can selectively remove frequency components in a way that may not be expected. This can be explored by performing frequency decomposition on the signal before and after filtering to determine which frequencies have been removed and it would be of worth to undertake this analysis on the filtered data in this project.

Monitoring Programme

16. The monitoring programme provides for measurement of turbidity at 15 locations, and this data is to be used to develop trigger levels and to monitor dredge effects. Overall, the monitoring programme uses state of the art instrumentation, and the use of two telemetered SONDEs at each location provides good assurance for the collection of unbroken turbidity records at each location. The data is to be published on an online web based system which provides an intuitive system for accessing and assessing the monitoring results.

17. In their evidence, both Prof Fox and Ms Andersen make reference to the self-referencing nature of the monitoring stations and the absence of control locations in the monitoring programme. The use of control sites is a standard practice in most monitoring designs. This fits into a standard monitoring methodology called Before After Control Impact (BACI). This method stipulates undertaking baseline monitoring and continued monitoring during the dredge operation (Before/After) and this is being undertaken in this programme. But it also stipulates that monitoring should be undertaken at both the impact locations, and at control locations, where the impacts of the dredging are not expected to be seen (Control/Impact). Prof Fox and Ms Andersen state that the use of control sites has fallen out of favour in monitoring programmes though in my own experience I am not aware of any studies, peer reviewed or otherwise, that set this precedent. Ms Andersen states that the control needs to be the same as the impact site when the impact is removed. It is important that impact and control sites have similar environmental settings. However, valuable information can be gained by analysing the direction and magnitude of change at both control and impact sites without comparing them directly with one another.

18. As is noted in the application, there has been a general paucity in measured Suspended Sediment Concentration (SSC) data along the North Canterbury coastline until the initiation of this monitoring programme. Though perceptions are that background SSC is generally high along this stretch of coastline, Ms Andersen indicated in her presentation that turbidity measurements to date show that the background SSC levels are generally lower than anecdotal evidence suggests. This would indicate that the dredging activities may be expected to be larger, in relative terms, than was previously thought. It should be clarified with ecologists whether or not this has any bearing on their assessment of dredge effects.

Assurance Monitoring

19. Additional 'assurance monitoring' will involve tracking sedimentation rates through bathymetric surveys, ecological surveying and water quality sampling, physical shoreline surveys, dredge hopper validation and monitoring of specific species (mussels and marine mammals).

20. Although the ecological and biological aspects of the assurance monitoring are beyond the scope of this review, it is worth noting that it is appropriate that this additional monitoring is being carried out to ensure that the trigger value approach is adequately protecting the marine environment.

21. The assurance monitoring is not intended to be used for within-dredge adaptive management, but is instead intended to provide guidance between dredge stages. This means that if some adverse effect is highlighted by the assurance monitoring, there is no mechanism to address the effect until the dredge phase has been completed, which may allow for adverse effects to develop.

Data Availability

22. As previously noted, there is a lack of SSC and turbidity monitoring data in this area. The data currently being collected as part of this application could be extremely useful for research purposes. Consideration should be given to making these data available to other relevant experts a) for public good science and b) so that the real-time analysis of the data can be verified by others.

Signed:  Date: 9 May 2017

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