BEFORE THE WHANGAREI DISTRICT COUNCIL AND NORTHLAND REGIONAL COUNCIL

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of a resource consent application by Northport Limited under section 88 of the Resource Management 1991 for a port expansion project at Marsden Point
APPLICATION NO.	APP.005055.38.01 LU 2200107

REBUTTAL STATEMENT OF EVIDENCE OF BRETT JAMES BEAMSLEY

(HYDRODYNAMIC, MORPHODYNAMIC AND PLUME MODELLING)

3 October 2023

INTRODUCTION

1. My name is Brett James Beamsley.

2. I prepared a statement of expert planning evidence dated 24 August 2023.

3. My qualifications and experience, together with those for the other co-authors of the reports attached to Northport's application are set out at paragraphs 2-6 of my primary evidence.

4. I repeat the confirmation given at paragraph 7 of my primary evidence that I have read the Code of Conduct for Expert Witnesses and agree to comply with it.

SCOPE OF REBUTTAL EVIDENCE

5. This rebuttal statement of evidence responds to the statement of evidence of Professor Karin Bryan, dated 18 September 2023.

6. Professor Bryan questions in her evidence the approach used to calibrate and validate the hydrodynamic modelling carried out by MetOcean Solutions (MOS), and how this might affect the interpretation of the results and their application in downstream reports that rely on MOS data.

7. I respond to the issues that Professor Bryan has raised regarding the modelling conducted by MOS. They are:

   (A) Calibration and validation of the numerical model.

   (B) Changes at Blacksmith Creek area.

   (C) Bed shear stress and sediment sizes.

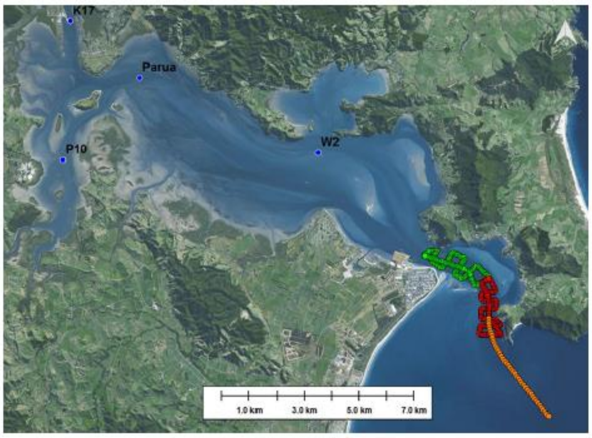
   (D) Effects of sea level rise.

A. Calibration and validation of the numerical model

8. MetOcean responded to inquiries concerning its methodology, including model calibration, through the s92 process (set out in items 25, 26, 27 and 28 of the S92(1) RFI document and response document dated 21 February 2023).

9. Hydrodynamic model calibration and validation was originally undertaken as part of the Whangarei Harbour study for Refining New Zealand, detailed in MetOcean Solutions (2017). The SELFE (now SCHISM) model was calibrated and validated against both measured current velocities (sampled using a vessel mounted ADCP) and water level

measurements at four locations within the inner and outer harbour. Additional validation of the hydrodynamic model has been undertaken against LINZ published tidal elevations at two locations within Whangarei Harbour (Whangarei Harbour and Marsden Point). The figures below show the location of the measurement sites.



2.4 Locations of current velocity measurements (Zone A in green, B, in red and C in orange) and water level measurements (K17, P10, W2 and Parua) used to calibrate and validate the SELFE tidal model within Whangarei Harbour and Bream Bay.

Figure 2.13. Positions of LINZ sites used for model validation.

10. The validation of the depth-averaged flows indicates the model can replicate the complex tidal hydrodynamics within the Whangarei Harbour environs. Quantile-Quantile plots of measured and modelled current velocities show a good correlation.

11. The boat mounted ADCP provided a valuable representation of the spatial current variations over a typical tidal cycle. Snapshots of the measured and modelled flows for the peak tidal ebb and flood show good agreement, including zones of high flow. As noted by Professor Bryan, "the strongest currents are most important because these are the currents that have the ability to suspend and transport sediment most effectively".

12. Comparisons between the measured and predicted water levels indicate that the model reproduces the tidal water elevation variability within Whangarei Harbour well. Additional validation of the hydrodynamic model undertaken against LINZ published tidal elevations at two locations within Whangarei Harbour, as evidenced in the figures below, show the model captures the timing and elevation of the tidal stages well.

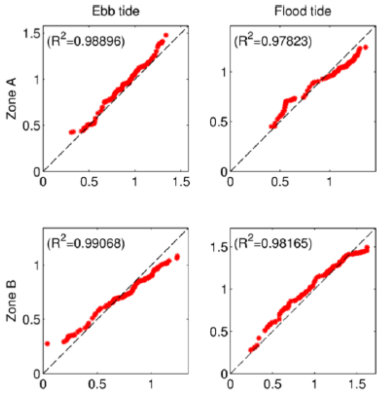


Figure 2.12 Quantile – Quantile plots of the measured and modelled (SELFE) peak tidal ebb and flood current speed (m/s) along the vessel tracks within zones A and B for both peak ebb and flood stages. The root mean squared errors corresponding to the different distributions are presented in the top-left corner of each plot.

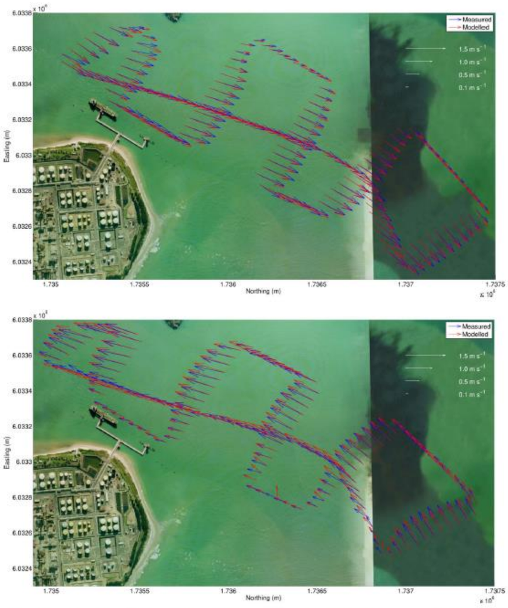


Figure 2.9 Modelled (SELFE) and measured velocity comparisons within Zone A (Figure 2.4) for the peak ebb (upper) and flood (lower) tidal stages.

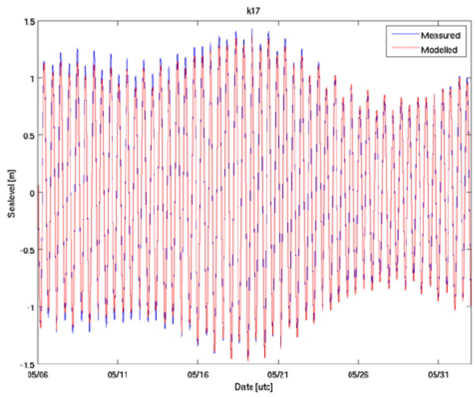


Figure 2.5 Measured and modelled water level comparisons at site k17.

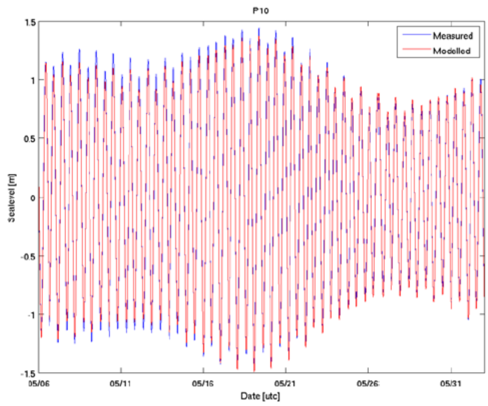


Figure 2.6 Measured and modelled water level comparisons at site p10.

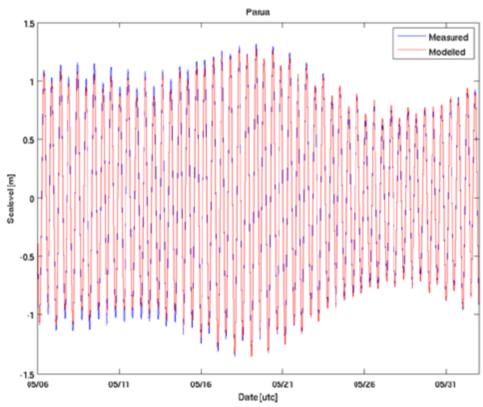


Figure 2.7 Measured and modelled water level comparisons at site Parua.

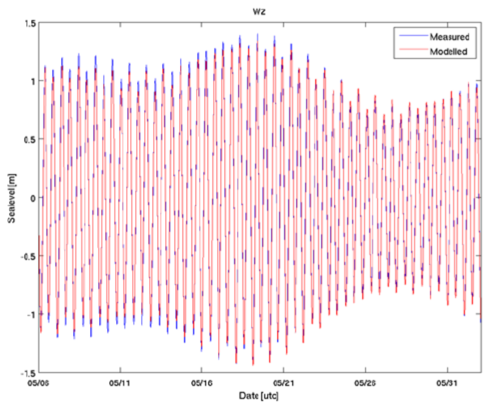


Figure 2.8 Measured and modelled water level comparisons at site W2.

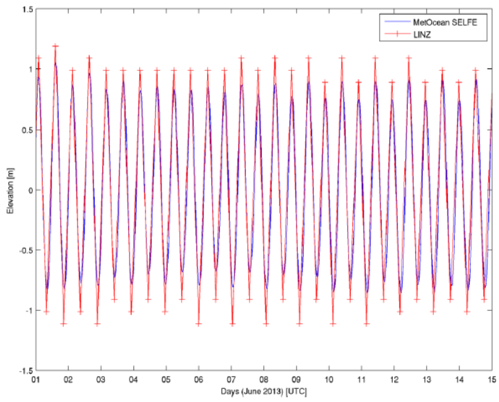


Figure 2.14. Comparison between modelled LINZ and MetOcean Solutions SELFE tidal elevation at Whangarei Harbour.

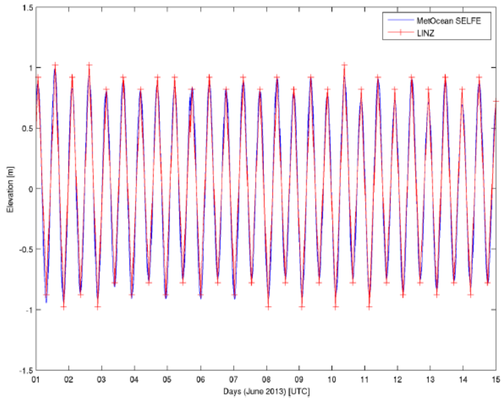


Figure 2.15. Comparison between modelled LINZ and MetOcean Solutions SELFE tidal elevation at Marsden point.

13. Having extensive measurements is always valuable for minimizing uncertainty. However, in this particular context, what is required is a level of certainty in our modelling that is sufficient for making evaluations of effects by comparing existing with modified scenarios. Given that the validation metrics meet the necessary criteria for validating the site effectively, I have confidence the model is representing well the hydrodynamics near the site and water volume changes within the inner harbour.

14. Our results show that effects resulting from the modified layout are limited to the port area. As we move further away from the port, the changes between the existing and proposed conditions become negligible – as illustrated in the figures below. Within the inner harbour, changes taking place across the entire catchment area will have a more substantial impact than the modifications made to the port.

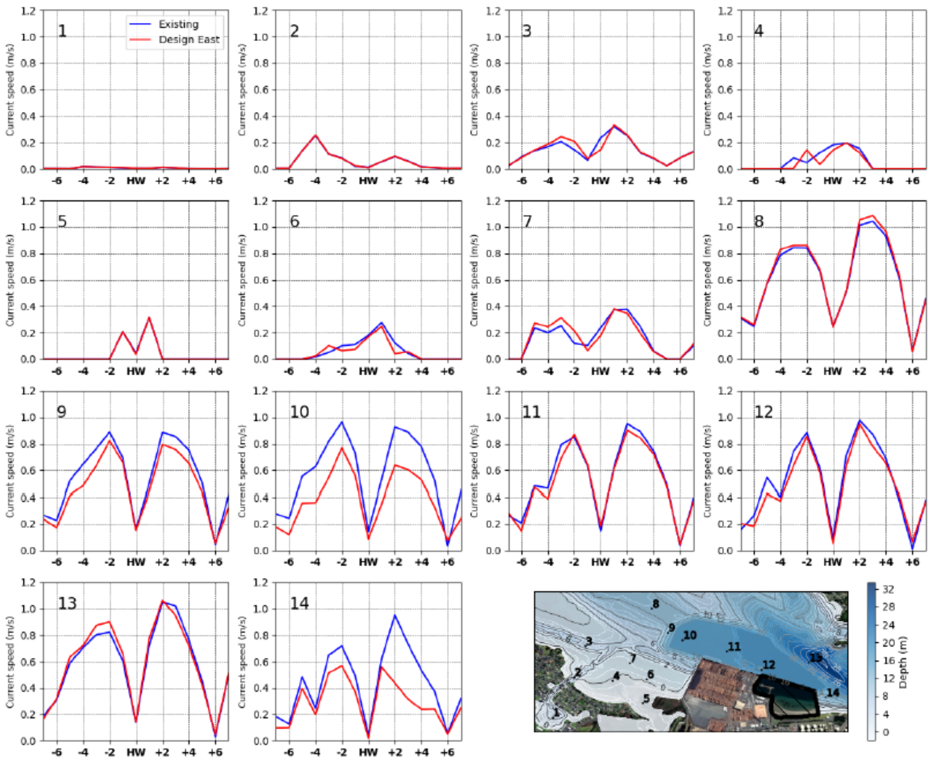


Figure 4-8 Comparisons between modelled current magnitudes for the existing and Eastern Reclamation (Design East) layout for 13 hours of a typical spring tidal cycle.

B. Changes at Blacksmith Creek area

15. Professor Bryan questions the level of changes taking place to the west of the proposed reclamation site, with special attention to the decrease in energy levels, suggesting a potential scenario of sediment retention and accumulation (refer paragraph 4.7 of her evidence).

16. The modelling results presented in MetOcean Solutions (2022) indicate that there is only a minor effect of the proposed layouts on the current field in the nearshore area surrounding Blacksmith Creek. On a spring tide, there is an increase of less than 0.2 m.s-1 on a flood tide and a decrease of 0.1 m.s-1 on an ebb tide (Figure 4.6 and Figure 4.7, reproduced below). There are also minor decreases in current speeds on the northern channel inside the harbour entrance opposite the port, however this is less than 0.2 m.s-1 reduction on a flood tide only. There are no potential changes to the current field in these areas during a neap tide (Figure 4.11 and Figure 4.12, also reproduced below).

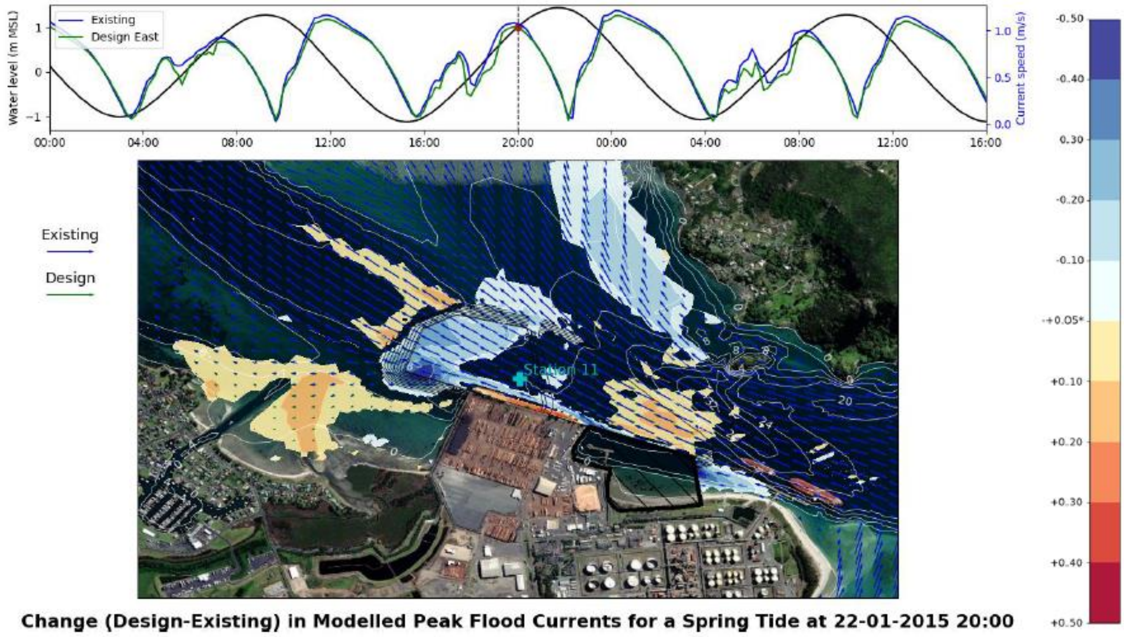


*Figure 4-6 Modelled current vectors for the existing and Eastern Reclamation (Design East) layout and difference in current magnitude during the peak of a flood spring tide. White depth contours are from the existing case and the black design lines display the proposed reclamation and dredging. * Note potential changes less than 0.05 $m.s^{-1}$ are masked as they are within the magnitude of model error and were not considered as a meaningful change.*

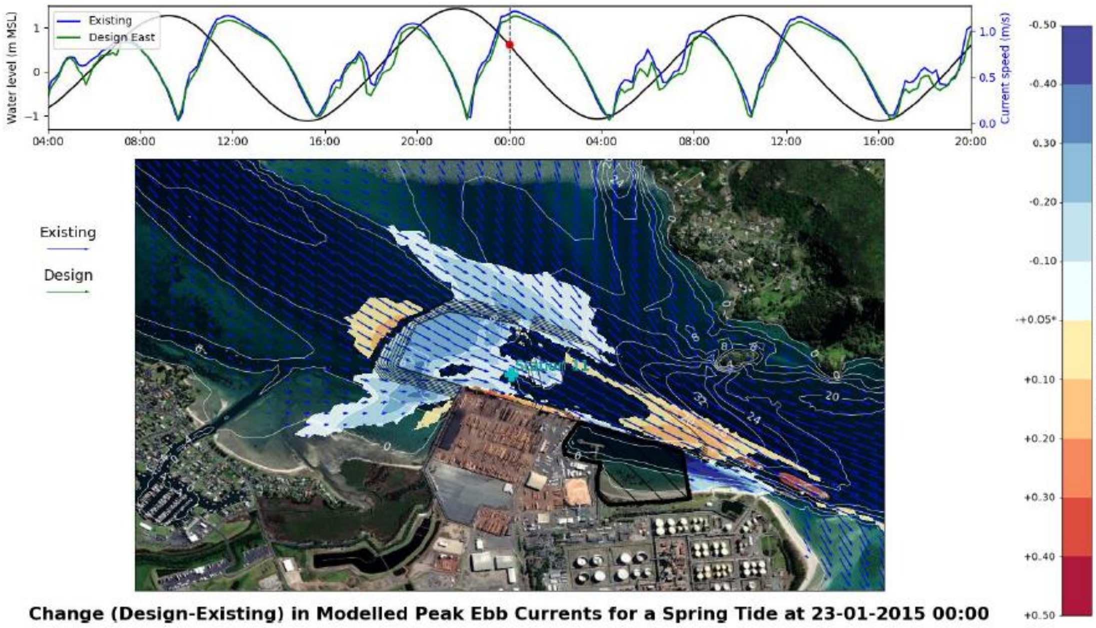


*Figure 4-7 Modelled current vectors for the existing and Eastern Reclamation (Design East) layout and difference in current magnitude during the peak of an ebb spring tide. White depth contours are from the existing case and the black design lines display the proposed reclamation and dredging. * Note potential changes less than 0.05 $m.s^{-1}$ are masked as they are within the magnitude of model error and were not considered as a meaningful change.*

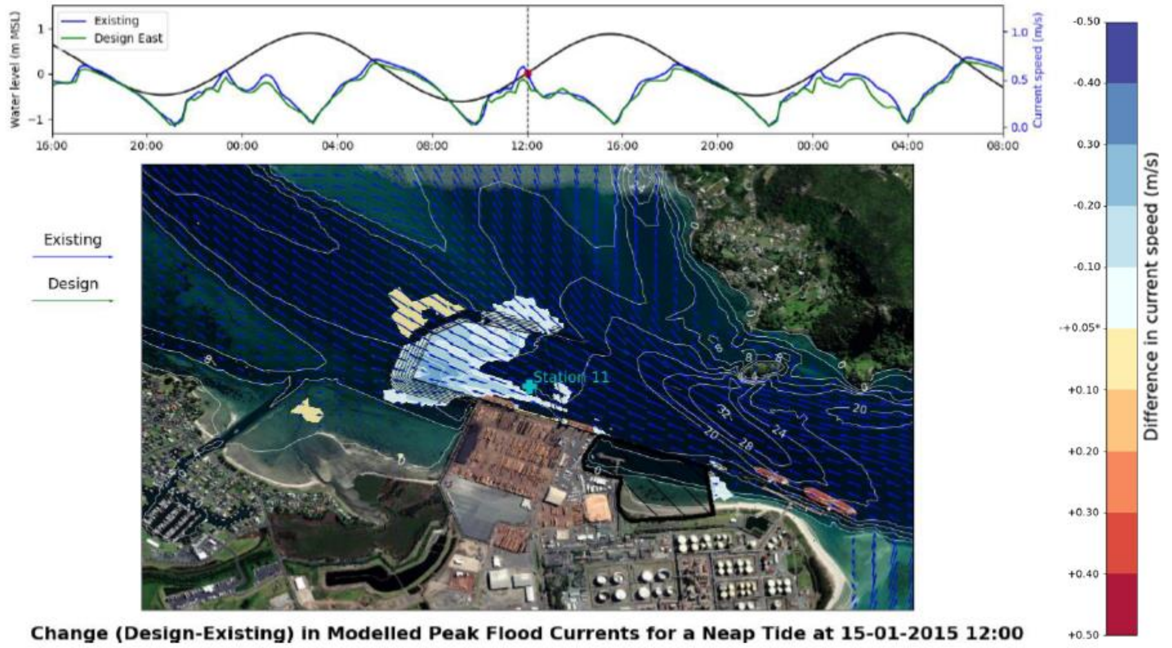


*Figure 4-11 Modelled current vectors for the existing and Eastern Reclamation (Design East) layout and difference in current magnitude during the peak of a flood neap tide. White depth contours are from the existing case and the black design lines display the proposed reclamation and dredging. * Note potential changes less than 0.05 $m.s^{-1}$ are masked as they are within the magnitude of model error and were not considered as a meaningful change.*

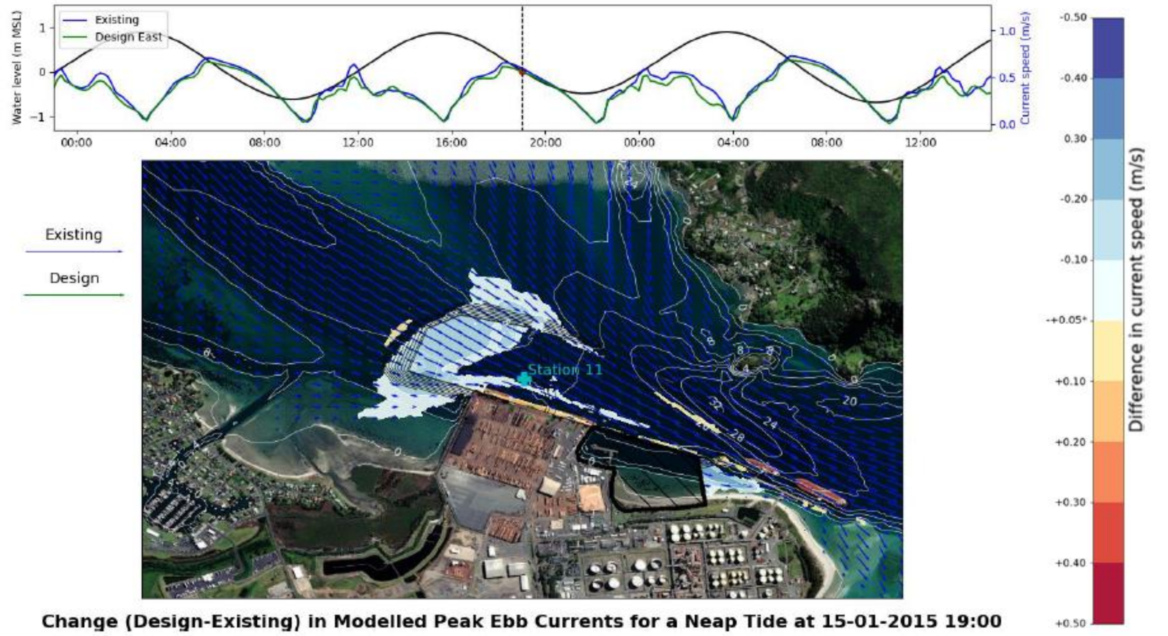


*Figure 4-12 Modelled current vectors for the existing and Eastern Reclamation (Design East) layout and difference in current magnitude during the peak of an ebb neap tide. White depth contours are from the existing case and the black design lines display the proposed reclamation and dredging. * Note potential changes less than 0.05 $m.s^{-1}$ are masked as they are within the magnitude of model error and were not considered as a meaningful change.*

17. In summary, the modelling results from MetOcean Solutions (2022) demonstrate that the proposed layouts have a minor impact on the current field in the nearshore area west of the port, around Blacksmith Creek. Nothing in the submitter evidence has caused me to change my position as expressed in my primary evidence.

C. Bed shear stress and sediment sizes

18. Professor Bryan expresses concern regarding the way that bedshear stress has been assessed in the numerical modelling (refer paragraph 4.6 of her evidence). Professor Bryan references Figures 3.23 and 3.24 of the MetOcean modelling report.

19. In response, I consider it is important to note that the MetOcean analysis was conducted at a broad level to demonstrate the potential impact of changes in current magnitude on bed shear stresses. The value of 200 µm was employed for illustrative purposes. The hydrodynamic modelling did not include sediments.

20. MetOcean Solutions (2018), which focused on the setup and calibration of the morphological model, show the comprehensive steps undertaken to apply a realistic sediment distribution into the model, with special attention given to sandbanks, whose migration is a critical factor in the modelling process. The morphological model included eight non-cohesive sediment fractions ranging from 100 to 2000 µm, and their initial spatial distribution within the model domain was based on the overall pattern derived from a sediment sampling study.

21. Core sampling carried out by NIWA (NIWA, 2012) at 109 sites within Whangarei Harbour showed surficial sediment was comprised of predominantly fine- to medium-grained size sand particles. Low to moderate concentrations of gravel, coarse sand and fine sand were also identified. The percentage of mud in the surficial sediment cores over eastern Whangarei Harbour was negligible.

22. Subsequently, a spin up run was undertaken. Throughout the simulation, the sediment grain size fractions were dynamically redistributed both vertically across layers and spatially within the model domain, influenced by the prevailing hydrodynamic patterns. By the end of the simulation, the composition of the bed had evolved to reflect a more realistic sedimentological setting aligned with the initial bathymetry, removing any discrepancies that might have arisen from the initial model setup.

Sediment class	Grain size (µm)	Mass percentage in active layer
Class 1	2000	5%
Class 2	1200	3%
Class 3	800	4%
Class 4	500	5%
Class 5	350	20%
Class 6	250	23%
Class 7	180	35%
Class 8	100	5%

23. Previous work has shown that the morphology of sand banks and channels within Whangarei Harbour was linked to the presence of a significant biomass of shellfish

(Morgan et al., 2011). The shell material produced by these populations maintaining stability by armouring the underlying sandy sediments from erosion (e.g., Mair Bank) . While most of the sandy material is predicted to be eroded under strong tidal current and breaking wave actions, the bio-stabilisation provided by live shellfish and their residual shell fragments played a dominant role maintaining Mair Bank stable.

24. In response to Professor Bryan's question regarding the assessment of bed shear stress in the numerical modelling, it is important to note that the MetOcean analysis mentioned in paragraph 4.6 of Professor Bryan's statement was conducted at a broad level to illustrate the potential impact of changes in current magnitude on bed shear stresses using a 200 µm value for demonstrative purposes. However, this analysis did not include sediments. On the other hand, MetOcean Solutions (2018) focused on morphological modelling and extensively detailed the steps taken to incorporate a realistic sediment distribution into the model. The methodology described in MetOcean Solutions (2018) indicates that the model reproduces well the complex dynamics of sediment interactions and bio-stabilization, particularly in areas like Mair Bank, as suggested by previous research. I believe the bed shear stress was well represented in the morphological modelling. The evidence presented by Professor Bryan has not led to any changes in my position as originally stated in my primary submission.

D. Effect of sea level rise

25. Professor Bryan commented that the impact of sea level rise (SLR) on the effects of the proposed reclamation should be investigated (refer paragraphs 1.4 and 4.5 of her evidence).

26. In response, I first note that according to Khojasteh et al (2021), the propagation of the tidal waves from the mouth to the upstream tidal limit of an estuary may be amplified, dampened, reflected, and/or deformed depending on the shape of an estuary. The authors reviewed several studies on how SLR may affect estuarine processes and created conceptual models of the effects of SLR on estuarine hydrodynamics.

27. Overall, in terms of tidal hydrodynamics, the potential effects of an increase in sea level may be: upstream migration of the tides, increase inundation of the intertidal area, increased tidal attenuation due to the activation of floodplain areas, and decreased drainage during the ebb tide cycle due to the elevated low tide at the ocean boundary.

28. Examining the tidal amplitudes for the validation sites K17 and P10 in contrast to W2, and the Whangarei Harbour and Marsden Point LINZ sites, it shows that there is tidal

amplification occurring upstream. The tidal amplitude is greater inside the harbour compared to the entrance. Based on the proposed models in Khojasteh et al (2021), it is possible that the tidal amplification will not continue in a scenario of SLR, with an increase in tidal range near the entrance.

29. In terms of sediment dynamics and net transport, SLR can potentially alter the tidal asymmetry, i.e., flood or ebb dominance, affecting the formation of flood and ebb tidal deltas and how much sediment is transported landward and seaward (Khojasteh et al, 2021). These effects also depend on the local hydrodynamics and sediment characteristics.

30. Overall, the impact of SLR near the entrance to Whangarei harbour are likely to be limited but are expected to be more significant further into the estuary than near the entrance where the port is located. Further consideration of, and comment on, the likely coastal process effects associated with SLR are provided by Mr Reinen-Hamill in his evidence.

CONCLUSION

31. I acknowledge that there are valid points made by Professor Bryan and I have taken steps to address these concerns. Upon careful consideration, I maintain my position stated in my primary evidence.

Dr Brett James Beamsley
MetOcean Solutions

3 October 2023

REFERENCES

Khojasteh, D., Glamore, W., Heimhuber, V., Felder, S. (2021). Sea level rise impacts on estuarine dynamics: A review. Science of the Total Environment 780, 146470.

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Morgan, K.M., Kench, P.S., Ford, R.B., (2011). Geomorphic change of an ebb-tidal delta: Mair Bank, Whangarei Harbour, New Zealand. N. Z. J. Mar. Fresh. Res. 45, 15–28.

NIWA (2012). Predicting suitable shellfish restoration sites in Whangarei Harbour - Larval dispersal modelling and verification. Report prepared for Ministry of Science and Innovation Envirolink Fund to Northland Regional Council.