Peer Review
Coastal Processes Assessments and Effects of the Crude Shipping Project
Whangarei Harbour

Chancery Green, on behalf of Refining New Zealand, has commissioned a peer review of technical investigations to assess the physical process regime and impacts of deepening and realignment of the shipping channel leading to the Marsden Point Refinery, at the entrance to Whangarei Harbour. Specifically this document reviews three reports:


Collectively, the three reports provide a comprehensive overview of the environmental processes, physical components and dynamics of the study area and evaluate the potential effects of proposed dredging works on the coastal system. Each report provides an essential component of the assessment and there is considerable dependency of the successive reports on preceding work. This review examines each report below.


Due to the environmental complexities of large tidal entrances and their associated coastal environments, and the general paucity of detailed observational data from such systems, examining the potential effects of large capital works (such as the channel realignment and dredging proposed) is a challenging task. In such settings numerical modelling can provide a robust platform to better understand the complexities of the coastal process regime and identify critical factors driving morphological change. Such models can then provide useful platforms to examine the potential changes in processes and coastal morphology associated with development projects. Such a modelling approach was adopted to evaluate the effects of the Crude Shipping Project at Whangarei Harbour.

The initial report (MSL P0297-01) provides an overview of the modelling approaches taken to examine the effects of channel dredging and realignment on physical wave, current and sediment transport processes at the entrance to Whangarei Harbour. The report is an essential component of the physical impact work as it establishes the models used and validates their use in the study area. In essence this report acts as a technical annex to support the exploration of the models to examine effects of the Crude Shipping Project on the process regime and coastal morphology in the following report (MSL P0297-02).
The report introduces multiple modelling approaches designed to simulate the current environmental processes governing the inlet dynamics. A brief overview of the model components is provided below followed by broader commentary on the use and application of the models for this study.

- **Section 2. Wind modelling:**
  A robust approach to simulate the wind regime is developed. This step is critical to examine the influence of wind on wave and other current processes in the study area. There is good correspondence between measured and modelled wind conditions. The model appears to underpredict higher wind observations, although on average model outputs are higher in velocity than observations. It is stated that such differences have little impact on wave and current processes – though this is not demonstrated.

- **Section 3. Wave Modelling:**
  An industry standard model (SWAN) is adopted to characterise the wave climate in the study area. Model outputs are validated using physical wave observation data collected from the harbor system. In general, the model performs well at the offshore site. The model does not perform as well at the nearshore locations although in general differences in wave height are less than 0.1m. The report presents a thoughtful explanation for the observed discrepancies. The model outputs and validation suggest the model approach is sufficiently robust to examine changes in wave processes as a consequence of the dredging project.

- **Section 4. Regional Hydrodynamic Modelling**
  The ROMS model is adopted to provide a broader scale context for circulation and currents that influence the study area. Validation of the model is undertaken through a number of discrete ADCP current measurement programmes. The validation exercise notes good prediction of the bi-directional circulation and residual current although the tidal component is under predicted by approximately 20%. The model produces results that inform the boundary conditions of finer resolution models used to examine detailed processes within the harbor entrance.

- **Section 5. Harbour Tidal Hydrodynamic modelling**
  The SELFE model was utilized to generate a working model of the hydrodynamic processes of the harbor and intertidal areas at a finer scale than ROMS. Validation exercises indicate the SELFE model replicated velocity flow and direction well across the different tidal stages and provides a robust basis to evaluate changes in flow associated with channel dredging.

- **Section 6. Sediment Transport Modelling**
  A key component of the environmental assessment is to establish sediment transport processes (pathways and fluxes) in the study area and explore how alterations in these processes caused by dredge works might impact sediment fluxes and ultimately the physical configuration of the inlet/coastal system. The study uses Delft3D to achieve this component of the study driven by outputs from the SWAN and SELFE models and an understanding of the sedimentology of the inlet system. As articulated in the report Delft3D has been successfully applied to examine similar coastal systems throughout the world, which provides a measure of confidence in its application to Whangarei Harbour. The model is used to examine sediment transport patterns as well as changes in bed configuration.

- **Sections 7. Dredge Plume Modelling and 8. Disposal Plume Modelling**
  An MSL developed model (ERcore) is used to simulate the behaviour of suspended sediments generated through dredging operations (dredge and disposal plumes). Informed by knowledge of the sediment sizes from the study area the modelling work also considers a range of different dredge techniques that have the potential to release sediments at different rates and at different levels in the water column.
• **Section 9. Disposal Ground Modelling**

Lastly, the study examines the morphological dynamics of the offshore spoil grounds and applies Deflt3D to achieve this.

This report is a technically demanding one to navigate. However, each section now begins with a clear statement of the purpose of each model and how it contributes to the aims of the study. I make the following broader observations of the report.

• Given the complexity of the multiple models utilized in the study Figure 1.1 provides an excellent summary of how the different models are integrated to achieve a holistic overview of harbour/inlet processes. Such a framework provides a good ‘map’ for readers to navigate the modelling work.

• In general, the models adopted are well-established (industry standard) modelling tools that have been widely used to simulate coastal processes in nearshore and harbour settings in numerous studies throughout the world. The adoption of these widely used models provides a level of confidence in the approach taken in the study.

• The reports also reflect an advanced level of insight in model tuning and validation approaches to ensure they are maximised for the specific study needs.

• The study adopts a discrete range of environmental conditions encountered within the study area. This range includes both low energy and more extreme events. Such a range is prudent and minimizes the generation of too many simulations that can obscure the results.

• Validation of a number of the models is undertaken against field data, which generally show a good degree of correspondence. The good correspondence between simulations and field data provide confidence in the models to examine how the channel realignment project will alter processes and ultimately coastal morphology in the study area.

2. **MetOcean Solutions Ltd Report P0297-02: Predicted physical environmental effects from channel deepening and offshore disposal.**

The second report examines the physical impacts of deepening of the channel entrance to Whangarei Harbour on the physical process regime of the entrance and surrounding coastal area. Model simulations are the primary method used to explore changes in waves, currents and sediment fluxes. In general, the modelling analyses are methodical, present pre- and post-dredge scenarios and provide summary graphics of the likely changes expected in key processes as a consequence of dredging.

The overwhelming conclusion of the detailed modelling is that changes in the process regime (waves, currents, sediment transport) as a consequence of dredging and channel realignment are small in scale and will result in only subtle changes in coastal morphology. Such conclusions appear sound based on the analysis performed. The report stops short of assigning relative levels of significance to such changes, which are dealt with in the final Tonkin and Taylor analysis.

The report is long and deals with multiple potential impacts of dredging and channel deepening. Each section needs to provide a clear statement of purpose and make relevant connections to the preparatory modelling work presented in the first report.

The report contains a high number of figures, many of which span multiple pages with panels displaying subtleties reflecting the different modelling scenarios. There is a tendency for the report to provide relatively cursory descriptions of the results and force the reader to decipher the multitude of plots, which invariably include colour ramps. These plots are powerful in highlighting spatial variations but are difficult to infer detailed values at specific localities. I would recommend greater descriptive detail is added to the text that includes upper mid and lower values of the changes described in each section. Such changes
would only need tight paragraphs but would greatly assist the reader interpret the results and synthesize the figures.

For the purposes of public consultation it may be valuable to generate a shorter (less than 10 page) summary of each of the key modelling outputs. Such a document could have a pre- and post-dredge image for the key processes simulated and a brief interpretation of the level of changes observed.


The CPA report builds on the geotechnical field investigation (RHDHV, 2015) and hydrodynamic modelling reports (MSL, P0297-01 and P0297-02).

The report presents a sound background framework of the study area including the geological structure of the coastal system, the primary geomorphic units, and their composition (Section 3). Importantly, the report also canvasses the sedimentary composition of the broader system and explores differences between offshore, nearshore, delta, beach and inlet zones. Exploration of such differences in sedimentary character is important for the assessment in terms of exploring potential effects on sediment entrainment and deposition in different parts of the coastal system. While I would prefer to see an overview summary map of sediment texture of the system, the summary statement related to the sediments is sound (Section 3.5.5). The setting section also provides a robust overview of the sea level, tide and wave processes that operate in the study region, which draw heavily on the MSL (2016) report. The review of hydrodynamic processes is useful to assess potential changes in these processes.

Section 4 provides a robust overview of the coastal inlet system. In essence, this section constructs a holistic process model for the inlet system against which collective effects can be assessed. The section presents a robust analysis of the entrance as a dynamic inlet system and examines the relative stability of Mair Bank. Importantly, this section also presents a summary figure (4.6) representing the sediment transport fluxes in the system. This is a valuable figure as it highlights the relative magnitudes of transport in different parts of the inlet. It would be useful to further highlight in the summary (Section 4.3) the fact that alongshore fluxes are negligible compared with the large volumes of sediment that are transported through the inlet each year.

Section 5 presents a thorough assessment of the effects of proposed dredging works and channel realignment on the process regime, sediment transport fluxes and the net effects on geomorphic features of the inlet system. This section examines each process in depth and provides robust reasoning of the likely effects on both processes and geomorphic outcomes. In general, the report highlights that modelled changes in waves and currents will be small and that effects on the system will be commensurately minor as they will be less than the normal range of variability observed in the system. The section concludes that potential effects will be minor and not significant.

In summary, the report establishes a geomorphic and coastal processes model of the study area. This model is used to evaluate the effects of changes in the process regime, whether proposed activities could result in increased erosion or shoreline change, and the likely effects on the stability of the ebb delta and Mair Bank. I consider the report presents robust analysis of the coastal processes and provides a well-considered analysis of possible effects of the project on these processes. Ultimately, the report considers that any effects on processes will be minor and not lead to significant effects on the process regime or coastal landforms. Indeed, the changes outlined generally fall well within the normal range in variability documented for the coastal setting.

The final sections of the report contain some recommendations for mitigation and monitoring, which are sound in their design and appropriate for the low impact nature of the proposed activity.
4. Summary

Collectively the three reports provide an integrated and detailed analysis of the coastal process and geomorphic conditions of the Whangarei entrance system. The studies adopt leading modelling approaches and sound judgement in their application and interpretation. I consider the conclusions related to the impacts of the proposed dredging and channel realignment works to be sound and based on rigorous analysis and interpretation. Consequently, I consider the three reports are well compiled and provide a sound basis for consultation.

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