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PO Box 8  
Port Chalmers

Attention: Lincoln Coe

Dear Lincoln

## **Review of Port of Otago Dredging Project: Harbour and Offshore Modelling**

### **1 Context**

Tonkin & Taylor (T&T) were asked to provide an independent high level review of the NIWA Report HAM2008-179, Port of Otago Dredging Project: Harbour and Offshore Modelling, for Port Otago Limited. The report was obtained from the website (<http://www.portotago.co.nz/10/3.html>). The report combines two separate contractual pieces of work, i.e. wave modelling undertaken by MetOcean and the hydrodynamic/sediment transport modelling by NIWA. The review makes comment on both of these separate studies.

Specifically, this high level review provides comment on:

- a The general robustness of the modelling approach in relation to a fit-for-purpose appraisal of the likely physical environmental effects and available field data
- b The appropriateness of the tools and techniques used and how they compare with international best practice
- c Whether the recommendations and findings from the study are soundly based and reasonable given the uncertainties.

### **2 Summary**

This modelling study of proposed dredging of the main shipping channel to 15 m below Chart Datum is a comprehensive study of the hydrodynamics, sediment transport and wave climate within Otago Harbour. Simulating the transport of sediment released from both the active dredging head and subsequent release at the disposal site, is an in-exact art rather than a precise science. There are a number of sediment and hydrodynamic properties which cannot be accurately measured in a practical manner. The authors have chosen to be conservative where in doubt and bracket the results using reasonable high and low estimates for some of the major parameters.



- a The modelling approach generally appears to be robust and fit for the purpose of predicting changes to coastal physical process, due to the proposed works, as per the reported design. The methodology used, and level of analysis, is appropriate given the magnitude of the Project Next Generation.
- b The modelling packages used (Mike21, Mike3, the PA module, and SWAN) are well established and industry accepted coastal modelling tools. These modelling packages appear to have been correctly and professionally used. This includes calibration and validation of the models. T&T suggest that the vertical profile of suspended sediment concentration could have been simulated if Mike3 had been used within the Harbour Model. T&T acknowledge the increase in computational time required and the limitations of Mike3 Regular Grid in shallow tidal environments. T&T also suggest that an increase in grid resolution may improve the model results. In particular, this applies to the constrictions near Goat Island (Harbour Model) and the entrance to the Harbour (Offshore Model). These are detailed further in the comments below. T&T suggest that Mike3 FM and the Mud Transport module may have been used as an alternative model for the Harbour Model. The use of Mike3FM would have allowed for increased resolution in particular areas. The use of the Mud Transport Model may have avoided some the difficulties experienced with the PA module.

The modelling of long-term evolution of the deposited sand mound is particularly difficult to simulate. The authors have developed a methodology to estimate this long-term change. This method has not been peer reviewed or accepted by industry. While the basis of this method appears sound, this high level review has not reviewed this methodology in depth.

While T&T would have used different DHI modules and a different methodology for this modelling study, the final conclusions are likely to be similar to those given in the NIWA / MetOcean Report.

- c The modelling results obtained appear to be sound with no unexpected or unexplained predictions. The conclusions drawn from the results and the recommendations are sound.

A few typographical errors, consistency errors and suggestions for clarity of reading were found during this review. As a high level review, these are not reported here but can be made available to the authors on request.

### 3 Recommendations

The following are general recommendations or queries regarding the content of the Report made during the review. Page numbers or Figure numbers are used to identify the relevant part of the Report.

*T&T suggest that as a Project Report of over 300 pages and 13 Chapters, an Executive Summary would be useful.*

*P 15. When discussing the wind climate, a wind rose from Taiaroa Head would be useful. (Refer Fig 9.2)*

*P25. When discussing the cell grid size, it is useful to mention the typical size of important hydrodynamic features, such as the width of the main channel. The gap between Port Chalmers, Goat Island and Quarantine Island is approximately 120 m, or only 4 cells wide. The model would be improved by using a higher grid resolution in this area. It would be useful to explain why the Flexible Mesh model was not used for the Harbour modelling.*



Quite a comprehensive volume of field data has been measured within Otago Harbour from various sources. A literature review of published works on Otago Harbour would be useful. A summary table or map of all the field data available and used in this study would also be useful (locations, dates, data type recorded etc), with a description of how the data was used in this study (i.e. model boundary conditions, calibration, verification).

P34. The report states that a new Mannings n value of 32 was tried, but no significant improvement was found so the original values were used. The original (and therefore final) values are not given in the report and should be included.

P34. Model results were configured to produce velocities at the Braystoke locations. The report should clarify if the depth-average model results were transformed in the vertical to point velocities.

P34 and Fig 4.5. The difference in ebb tide u velocity at approximately 10:15 between measured (-0.68 m/s) and modelled (-0.42 m/s) is quite high. This should be commented on, mentioning that the modelled result is slower and therefore conservative in terms of sediment advection.

Fig 4.6 and Fig 4.7. Figure 4.6 is from midnight to 2pm. Is the analysis in Fig 4.7 also from midnight to 2pm? This regression should be done over an integer number of tidal cycles to avoid a bias towards one part of the tidal cycle.

P. 40. T&T would question the text "by tuning the resistance parameter". The report would indicate that a value of Mannings was tried, but no improvement was made, so the original value was used. T&T disagrees that this constitutes 'tuning' the resistance parameter. Suggest that a spatially varying resistance parameter (shallow and main channel areas) may improve the calibration. Similarly p56 states "the model tuning parameters, principally the bed resistance coefficient" implies that other parameters were tuned as part of the calibration process. The report needs to clearly state which other parameters were adjusted and what values were used.

P41. Explain how does the adjustment of modelled elevation (3.08 m etc) compares to the local gradients over the 30 m cell (i.e. does the bed level in this cell vary by more than 3m?). Explain why pressure calibration of the S4 was not done and what error can be attributed to this.

Fig 4.22. T&T would expect a better comparison with ebb tide velocities than shown here. Please explain the discrepancy between modelled and measured (on p50) and comment on the consequences of the model under predicting ebb tidal velocities.

P 56. With regard to the comment "comparing apples with oranges". In such a comprehensive study it does not seem appropriate to conclude that like is not compared with like, implying that the incorrect method has been used. This issue would indicate that the resolution in this area needs to be increased to adequately represent the local bathymetry. To achieve better resolution we suggest the use of the Flexible Mesh version of M21.

P56. The ADCP "shows a good visual match". This is difficult to see in the fig 4.26 (suggest a bigger colour difference in vectors?) Can a quantitative match be made with the ADCP? Particularly as the ADCP is the best measurement of currents in the main channel, which is the strongest advection of sediment. See Fig 12.

P 57. Please clarify why 1 January to 5 February 2007 selected.

Fig 5.4a and others. Please clarify the value of the "white" area in the middle of the harbour.

*P 83. The ‘predominantly “sand source” ’ is difficult to understand until the rest of the chapter is read. We suggest providing a context for this earlier in the Chapter.*

*Fig 6.4 – It would be useful to label discharge point on this plot*

*P 108. “Channel velocities generally slow down” – this is not conservative, in regard to sediment advection. A comment on this would be useful.*

*P110. It would be useful to make some quantitative assessment on the profile of SSC. Similarly, it would be useful to give a comment (or reference to companion report) on the ecological effect of the potentially much high SSC than reported, which may occur within a layer of the water column. This section suggests that a three dimensional model is required, such as Mike3.*

*P111. In the second bullet point, please clarify what these results mean in relation to a) the visual plume, b) ecology.*

*P 119. Explain where the wet bulk density of 1300 kg/m<sup>3</sup> was obtained from.*

*P186. The harbour wave model just assumes wind waves. Please explain if swell penetration into the harbour is relevant and needs to be taken into account.*

*P193/194; Fig 10.1 or 10.2. Suggest make bigger and show locations of disposal sites. My concern is that Site A0 may not have a high enough resolution. In the DHI grid generator, you can define an area of higher grid resolution (cf text “...but more highly resolved in the area of interest ...” This does not seem to be shown in Fig 10.2.)*

*Also in Fig 10.2. The entrance from the Harbour appears to be only 1 cell wide. The approach used, of inserting a volume source in the Harbour entrance to account for the tidal flux is sound, however care is required at the entrance to ensure that the momentum flux of this flow stream is properly represented. This will depend on the location of the source point (not shown in Fig 10.2), the depth at the entrance, and the orientation of the entrance. In particular, the depth of the entrance cell (Fig10.2) appears to be below zero, i.e. very shallow. This may simulate unrealistic velocities exiting from the Harbour. These velocities will, in part, drive the circulation observed outside of the entrance (see Fig 10.4). Thus the circulation may be quite sensitive to grid resolution and the Harbour entrance. Much of the analysis of Site A1 was based on this flow circulation (top of Page 198 and others).*

*P198, S 10.3. Confirm that the residual current over the 61 days was over an integer number of tidal cycles.*

*P201. It would useful to explain why the DHI PA model was selected over the MT module. Use of the MT module would enable direct output of sediment deposition on the seabed (p202).*

*P 202, Para 2. Note, Wind is not an output of Mike3.*

*P202. “and assuming all particles ... would contribute to the total deposition”. Clarify what is meant by “contribute”. Are you saying that all particles in suspension at the end of the simulation in any cell are assumed to be deposited on the seabed?*

*P203. Wet bulk density is assumed to be 1600 kg/m<sup>3</sup>. Cf this with deposited wet density on P119. Explain difference (due to packing within hold??)*



*P243. 2<sup>nd</sup> bullet pt. Please explain what the consequences of this are in terms of the visual plume and ecology. Need to explain that this is assessed in companion report. Similarly, on P253 it states that James et al assesses the deposition rates on ecology, but no mention of SSC effects is given. Please confirm if SSC are also assessed in James et al.*

*P262. A comment on the choice of the long-term sediment transport method explained in Appendix 2, over use of the DHI sand transport model would be useful.*

*P265, Fig 12.1. This figure would provide a good validation of the Mike3 model. T&T suggest that this should be used in Section 4.3.*

*P 306. A plot to compare simulated results at A1 and A0 would be useful to back up the assumption that measured currents at A0 will also apply at A0.*

*P313. "Sediment plume modelling ... lower towards the surface". The harbour model was only 2D and therefore cannot predict vertical profiles of SSC. T&T recommend that this text be corrected.*

*P315, last para re environmental effects – this should also be said in the Intro or Exec Summary.*

## **4 Applicability**

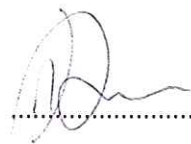
This report has been prepared for the benefit of Port Otago with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

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