Dear Leon,

We decided to send through our concerns in the format of a letter. The intent of this letter is to outline our concerns and to being a discussion with yourself and MetOcean. I have specific concerns related to the hydrodynamic modelling – which is very important as it underpins most of the numerical investigations. I require some clarification on the methodology and why two separate hydrodynamic models were employed. I also want to understand the methodology behind the hydrodynamic calibration and validation. More specific comments related to this are provided in the letter. Most of the studies were executed very thoroughly.

Executive summary

Northport Ltd (NPL) is proposing to expand its facilities located on the southern shore of Whangarei Harbour entrance. The proposal includes reclamation of 23 ha of estuarine area and dredging of approximately 23 ha of channel area. Three numerical investigation were conducted to understand the likely abiotic impacts of the proposed expansion. Most of the calibration of these model have been conducted in previous studies. After a high-level review of the previous (2018) studies the calibration does seem reasonable, albeit it not being extensive due to limited measure data availability (especially the hydrodynamic and wave validation). The present studies utilise the modelling tools developed from those previous studies, considering new port expansion scenarios. It is our opinion that the hydrodynamic modelling report requires revision. The results presented are currently not adequately supported by thorough methodology nor scenario explanations. Specific concerns and comments are addressed in this letter. The sediment plume and morphology studies where very thorough and thus robust/defendable given we can obtain certainty regarding the hydrodynamic modelling.

1 Introduction

Northport Ltd (NPL) is proposing to expand its facilities located on the southern shore of the Whangarei Harbour entrance. It is proposed that approximately ~23 ha of intertidal and subtidal estuarine habitat, to the west and east of the existing port footprint, be reclaimed to provide additional wharves and greater dry land area for port operations (potentially including a shipyard). Additional subtidal marine habitat outside of the proposed reclamation will be dredged to deepen the channel and a ship turning basin. NIWA (Dr Christo Rautenbach) was contracted by the Northland Regional Council to review three reports by the MetService (MetOcean division). These reports cover the hydrodynamic, morphology and sediment transport (dredge plume) numerical modelling of the proposed expansion. The current reports were based on a set of previous studies conducted in 2018 (refer to References). Most of the calibration and validation of the numerical models were presented in these older studies. The new studies presented some increases in numerical computational grid resolution, updated bathymetry information and sets of new port expansion scenarios.

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2 Review results

2.1 Hydrodynamic modelling

In general, the English needs to be reviewed. At numerous points in the reports the strange sentence construction made the results difficult to follow. I did attempt to start a list of recommendations but soon realised the list will be too long and thus too time consuming.

The hydrodynamic modelling has been executed in the open-source software called the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM) and is an appropriate tool for the purpose of this study.

- To make the results presented here more defendable I would suggest adding a few references of international studies addressing the same physical phenomena. This will give the reader a better understanding of the capabilities of SCHISM and why it is appropriate for the current investigation. Especially because the large time stepping mechanism of SCHISM is referred to in Section 2.1 as being larger than other numerical models. It will be appropriate to list some published examples of grid cell size, depth and the resulting time step employed.
- Figure 2-1 is not introduced in the text. I suspect the reference to Figure 2-3 in Section 2.2 was supposed to be Figure 2-1. In the caption of Figure 2-1 the grid construction and layout are mentioned but unfortunately, I was not able to see the grid in Figure 2-1. Are the dense blue areas in Figure 2-1 due to a sudden increase of grid resolution? If so, that might be a concern as one might introduce an artificial boundary that way (E.g. the hydrodynamics might see it as a sort of an obstacle). This might not be the case but without clearly seeing the grid it's difficult to tell. An improve figure showing the model grid would also help show what is meant by: "Within the proposed dredged and (western and eastern) reclamation areas, the grid nodes and elements are aligned to the reclamation layout and dredged bathymetric features." Generally, if the authors were bit more explicit it would help the reader understand the effort that went into the computational grid construction.
- The depth convention must also be mentioned (E.g. positive bathymetry is depth w.r.t. the vertical datum etc.). I would also suggest using a red-white-blue colour scale to depict differences, as this would make things easier to interpret. In general, it might also be a good idea to move away from the jet colour scheme (albeit this comment being subjective). There are many better alternatives, with the cmocean open source package providing some.
- In Section 2.3, please be consistent in the way you refer to LSC2. Do you have some references of other studies implementing this vertical meshing scheme? Given that this is not a commonly used vertical meshing scheme additional evidence for this approach would be beneficial (e.g. references). Zhang et al. (2015), for example states this is a new method. For robust commercial application, it will be beneficial to know that this vertical meshing scheme has been widely employed. According to Zhang et al. (2015) they only had an example of monotonously increasing and decreasing bathymetry (refer to Figure 2 1).

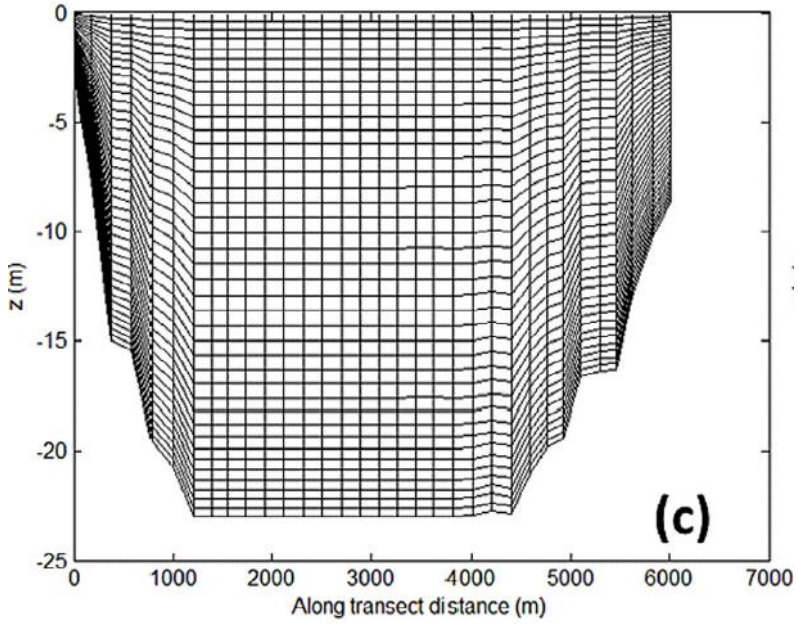

Figure 2 1: Figure 3 (c) from Zhang et al (2015), illustrating their newly proposed vertical meshing scheme.

They did also give another example close to the present study's scenario, given in Figure 2 2. More evidence of accuracy using this degenerate prism will be most welcomed.

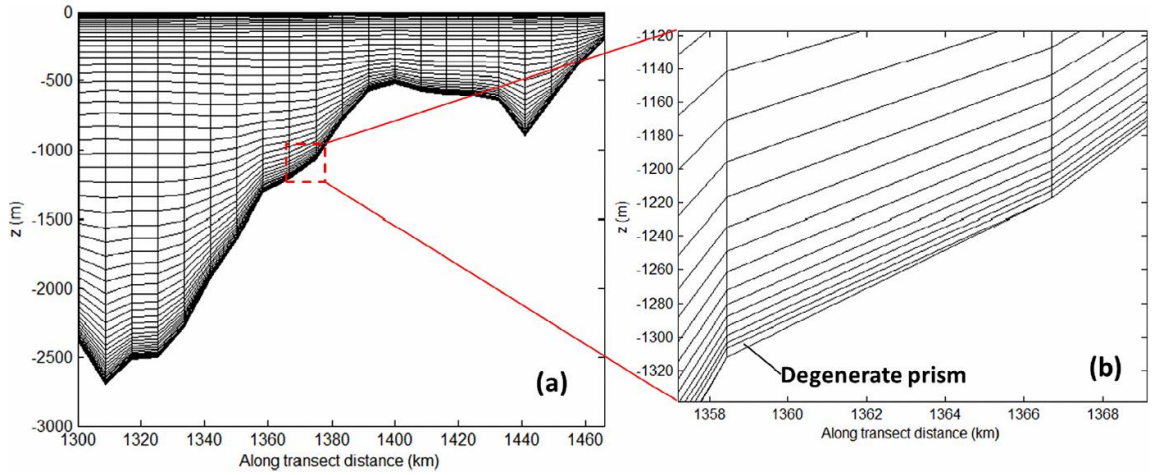

Figure 2 2: Figure 13 from Zhang et al. (2015) illustrating their second example of an undulating bathymetry.

- Please correct the references section to contain the calibration references mentioned in the text. The reference report illustrating the calibration was really nicely presented. I do see that that report was based on the SELFE model (the SCHISM modelling system is a derivative of the original SELFE model). Was the exact same numerical grid, bathy etc. used? Was the numerical solver the same? The water level calibration at Marsden point looked really good while at Whangarei harbour the tide was under predicted. The latter probably due to local, shallow water frictional effects. It should also be mentioned that the previous report does not present a thorough calibration but that was surely due to limited data availability? The calibration results that are presented look good.

- To be able to assess Section 3.1 additional information about the typical wind conditions is required. Are there measured data available? Can some wind roses be provided? Are Figures 3-1 and 3-2 extreme cases? Why was 8m/s chosen? Why only two directions? For how long were the simulation run? The contours in these plots are difficult to see. Are they bathy contours?
- What was the main motivation to not do the hydrodynamic modelling with Delft3D? It's a bit unusual to have a whole section comparing two models while everything could just have been done with one model. It makes it a bit difficult to defend. For example, the hydrodynamic report does not show any data just the correlations between Delft3D and SCHISM and therefore does not communicate any accurate. Rather just that the models compare well. I suggest clearly outlining why this two-model approach was chosen and presenting some calibration results in this report, even though it was done previously. If I understand correctly, the numerical grid has changed, and it will show due diligence to represent the calibration with the available data. This will just make the conclusions of the report really defendable given the limited amount of measured data available. Ideally longer time series of measured currents will make extreme condition calibration viable and relevant. I thus do have concerns regarding the validity of the model given the lack of data.

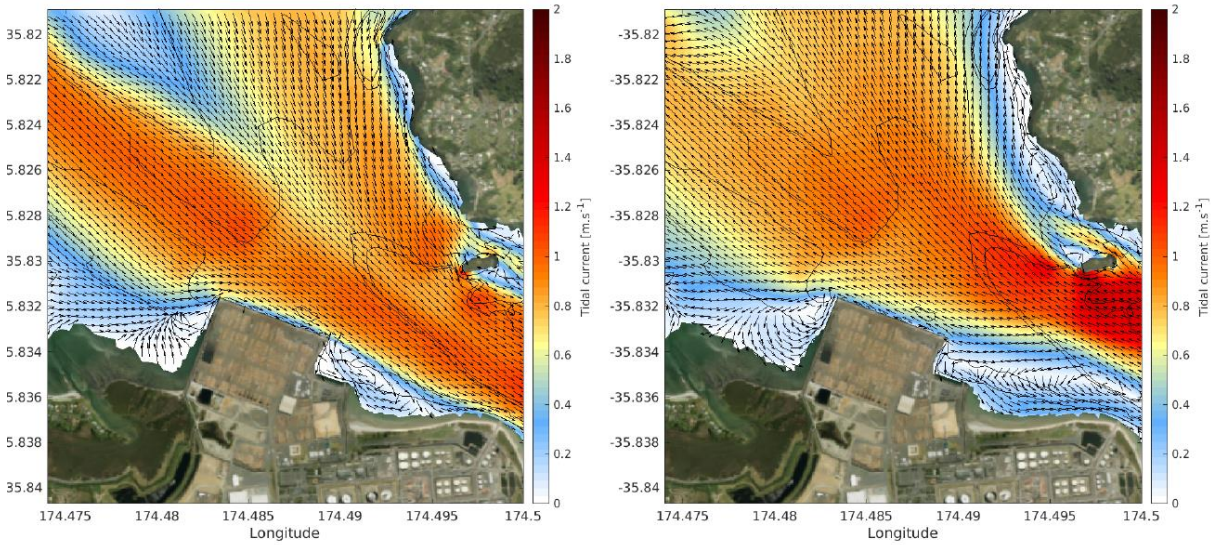

Figure 2 3: Figure 3.5 from the original calibration report [Modelled peak ebb (left) and flood (right) flows in the port environs showing formation of back eddies in the lee of the port structures both up and down stream.]

- Figures 3-4 and 3-5 are excellent. These were a great and creative way of illustrating hydrodynamic change effectively. In Figure 3-6 and 3-9 the points of major change are number 6, 10 and 14. From these snapshot results there does seem to be water movement. Do these areas draining quickly and often enough to avoid stagnant water with high residence time, was this investigated? In Figure 2 3 the original calibration report's water circulation snapshot is given. Here the drainage of the water behind the port, to the west, is clear. The same in Figure 2 4. The draining patterns looks a bit different to the new report which might be due to the increased resolution? The lee eddies are not formed in the new report flow examples. This is concerning as this feature is crucial for water resident times.

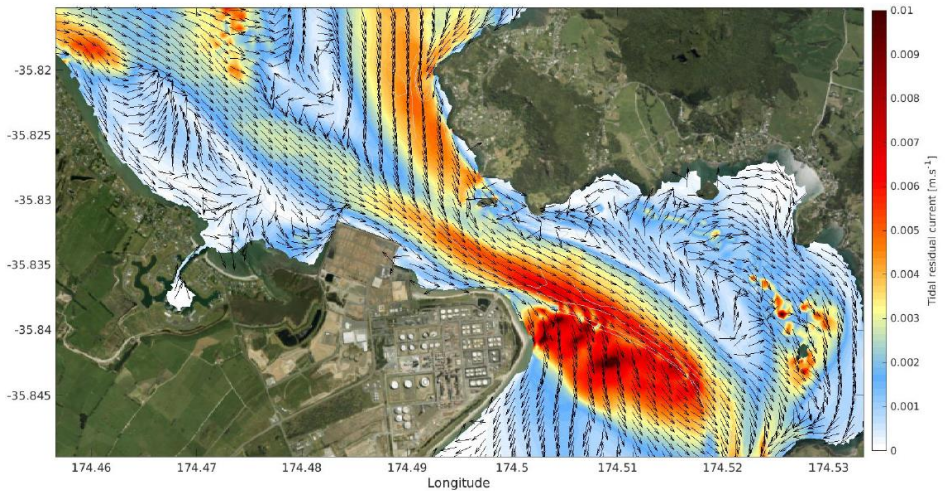

Figure 2 4: Figure 3.9 from the original calibration report [Spring tide mean residual tidal current velocity determined over one complete tidal cycle for the existing harbour configuration].

- Just to make the study defendable and robust it might be good to clearly talk about these phenomena and the effect the new port expansion will have on the hydrodynamics. Also highlight how this study is different to the calibration model and the time steps illustrated as flood and ebb. These eddy dynamics will be crucial for the ecological considerations and general water quality. I suggest residence time plots to be added to report, to provide confidence that the new sheltered areas will be flushed frequently enough[1].

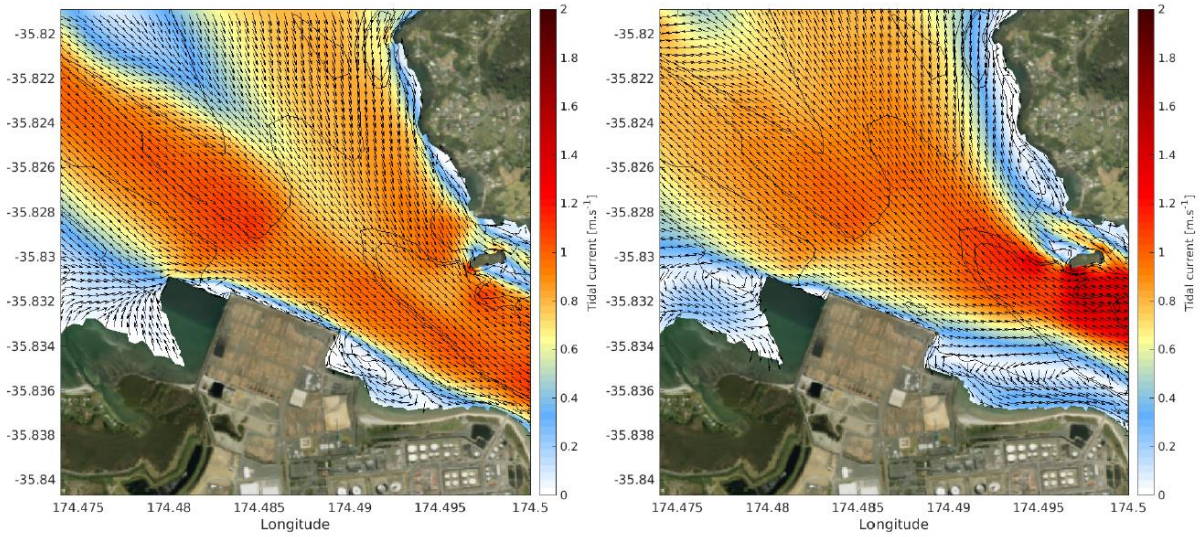

Figure 2 5: Figure 3.14 from the original calibration report [Modelled peak ebb (left) and flood (right) flows in the port environs showing formation of back eddies in the lee of the port structures both up and down stream for the Stage 1 bathymetry].

Specific comments

- Figure 1 the red circle indicating the location of Whangarei is incorrect.

[1] These are for both lee side areas but especially the west.

- The second sentence of the introduction is too long. Please revise and ensure the grammar is correct.
- Figure 1-2, please be clearer in the caption. Font in the red area is not legible.
- In general, the English needs to be reviewed properly.

2.2 Coastal Morphology modelling

In general, the morphology reports are put together very nicely. Would it be possible to indicate the dredge areas more clearly on Figure 1.2? I understand it's a scale drawing, but it might be nice to be able to clearly see the areas of interest.
I went through the original calibration reports but couldn't find the hydrodynamics and wave calibration and validation of the Delft 3D model? Where can I find this information? All the settings of these models are well explained. Was domain decomposition used in the original Delft 3D model? Is that how the sharp change in resolution was implemented? Is the SCHISM model grid exactly the same as the previously calibrated model? The presented validation of the morphological model looks good. The report is clearly written and defendable.

2.3 Dredge plume modelling

Very interesting and nice report to read. Scientifically robust and very complete. Overall an excellent piece of work. This report also highlights how important it is that the hydrodynamics report is thorough and very well defendable. Some paragraphs are centred and other not – just for consistency and to improve the readability of the report, I suggest the following small corrections:

- On page 17 there are some empty brackets: "…dredger production rate ( )".
- Page 21, line 3: ("2018) .OpenDrift").
- Figure 3-4's caption format.

As with the morphological report, I wonder if Figure 1-2 could be made more legible or add some text outline exactly where the dredging will take place?

3 Acknowledgements

We thank Jared and Greg of Northport Limited (NPL) for the site visit and for answering our questions.

4 References

MetOcean Solutions Ltd. 2018a. 'Dredging Plumes'. Report prepared for Northport Report P0367 – 04 Rev B.
MetOcean Solutions Ltd. 2018b. 'Hydrodynamic Modelling - Methodology, Validation and Simulations'. Report prepared for Northport Report P0367 – 02.
MetOcean Solutions Ltd. 2018c. 'Morphodynamic Evolution Modelling for the Northport Environment - Five Year Morphological Prediction of the Swinging Basin Morphological Response'. Report prepared for Northport Report P0367 – 05.
MetOcean Solutions Ltd. 2018d. 'Morphodynamic Evolution Modelling for the Northport Environment - Morphological Model Calibration'. Report prepared for Northport Report P0367 – 01 Rev B.
MetOcean Solutions Ltd. 2018e. 'Morphodynamic Evolution Modelling for the Northport Environment - Predicted Morphological Response to Proposed Capital Dredging and Land Reclamation'. Report prepared for Northport Report P0367 – 03.
MetOcean Solutions Ltd. 2018f. 'Northport Dredging Project - Dredging Plume Modelling'. Report prepared for Northport Report P0367 – 01.

Yinglong J. Zhang, Eli Ateljevich, Hao-Cheng Yu, Chin H. Wu, Jason C.S. Yu, A new vertical coordinate system for a 3D unstructured-grid model, Ocean Modelling, Volume 85, 2015, Pages 16-31, ISSN 1463-5003, https://doi.org/10.1016/j.ocemod.2014.10.003.

Best regards,

Dr Christo Rautenbach 02/07/2021

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NIWA
Taihoro Nukurangi

Dear Stacy,

I herewith confirm that I had a look at the Northport response letter (issued on the 21st of February 2023) and still agree with my original review. Numerical model validation is limited by data availability and given that measured data was sparce, this is an appropriate numerical modelling approach.

Best regards,

Dr. Christo Rautenbach

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