BEFORE THE ENVIRONMENTAL PROTECTION AUTHORITY
AT WELLINGTON

IN THE MATTER	of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
AND	
IN THE MATTER	of a decision-making committee appointed to reconsider a marine consent application by Trans Tasman Resources Limited to undertake iron ore extraction and processing operations offshore in the South Taranaki Bight

EXPERT REBUTTAL EVIDENCE OF DR HELEN SKYE MACDONALD ON BEHALF OF TRANS TASMAN RESOURCES LIMITED

23 JANUARY 2024

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INTRODUCTION

1. My name is Helen Skye Macdonald. I prepared expert evidence dated 19 May 2023 with respect to these proceedings on behalf of Trans-Tasman Resources Limited (First Statement). My qualifications and experience are set out in paragraphs 1-3 of my First Statement.

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

3. The purpose of this Rebuttal Evidence is to respond to matters raised in submitter evidence relevant to my area of expertise. This evidence relates to the setup of the regional ocean model of Hadfield 2015[1] (the sediment model domain) which models the far field dispersion for background sediments and the dispersion of a given input of sediment from mining operations. The properties and volume of sediments inputted from the mining operations in the Hadfield 2015 report and the worst-case scenario report was provided to NIWA by TTR and Dr Mike Dearnaley. The purpose of this model is to look at dispersion and the footprint of a given sediment input from the mining operations and to compare to background sediments.

4. I agree with Professor Luick's comment in paragraph 12 of his evidence that "the technical reports reflect a genuine attempt to predict the sediment plume and deposition patterns". I consider that the submitter comments addressed towards the model are minor criticisms that are not expected to introduce large uncertainties into the results of the model. I discuss in more detail comments from:

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[1] https://www.epa.govt.nz/assets/FileAPI/proposal/EEZ000011/Applicants-proposal-documents/8e6049938f/NIWA-Sediment-Plume-Modelling-Report-Full-version.pdf

(a) Professor John Luick;

(b) Dougal Greer; and

(c) Karen Pratt.

EVIDENCE OF PROFESSOR JOHN LUICK

5. In paragraph 12(a) of his evidence Professor Luick states that a bottom attached plume is reported in the Hadfield 2015 report but is not seen in the figures. Professor Luick is concerned that the vertical profile of sediments is indicative of an issue with the sediment density.

6. The statement from the Hadfield 2015 report describes the nearfield plume behaviour and how this is inputted into the far field sediment model domain. Once in the model, the plume can mix into the water column depending on environmental conditions, and the mixing seen in Figure 5.2 is an expected result. The vertical cross section in Figure 5.4-5.6 cited by Professor Luick are transects across the plume, chosen as snapshots to demonstrate variability in this region. These snapshots are at different times and positions and are unsuitable for understanding the evolution of the plume over a couple of days. Figure 5.5 shows a plume in the top ~40m of water sitting in ~40 m depth. Figure 5.6 is 2 months later when the plume is travelling in a different direction (offshore) and shows the plume in the top ~40 m of water in up to 100 m depth. The difference between these figures is consistent with a plume that is evolving in time and moving offshore versus onshore and does not give me cause for concern about the sediment density.

7. In paragraph 12(d) of his evidence Professor Luick expresses concern that the sediment model domain does not cover a large enough region and there is a potential for accumulation

of sediments in the mid-bight due to a recirculation seen in a figure of average velocities.

8. There is a large amount of variability in the region and there is not a persistent recirculation in the mid Taranaki Bight. I have considered material created by Mark Hadfield using the larger Cook Strait model domain that demonstrates the time-varying currents in this region. The recirculation that Professor Luick sees in the mean is not evident as a persistent feature in the time-varying fields.

9. Furthermore, a recirculating eddy that captures suspended sediments is not a known phenomenon of this region but if one were to exist then it will already be very turbid due to accumulation of background sediments. However, given the variability, I do not consider that suspended sediments will accumulate over time in this region.

10. Mark Hadfield has done some analysis which shows that the far field (>3 km from the source) concentrations are not sensitive to the grid spacing. I expand on this point later in my evidence in my response to a similar comment from Karen Pratt. It was impractical to run the sediment model over a larger domain; however, in my view increasing the resolution and spatial domain of this model will not materially change the modelled results.

11. In Paragraph 12(e) Professor Luick states that large scale wind forcing is not captured in this grid, raising concerns about vertical velocity. The modelled vertical velocities have not been ignored as stated by Professor Luick in paragraph 15(b), and the vertical movement of sediment is calculated using a combination of modelled vertical velocity and sediment sinking velocity. The model domain is sufficient to capture local wind driven processes such as upwelling/downwelling and these will be created locally within the model domain.

Larger-scale wind driven processes are included in the model via the horizontal boundaries.

12. In paragraph 12(e) Professor Luick asks for order of magnitude model assessments. These sorts of estimates are a lower standard of assessment than the ones presented in section 3 of Hadfield 2015. Professor Luick suggested comparisons which I consider are inappropriate for assessing sediments particle fall rates. Mixing and other vertical current movements will make an estimate based on only sediment fall rates inaccurate (as stated by Professor Luick himself in his paragraph 12(e)). Use of velocity directions from HYCOM (or other similar models) is also inappropriate as HYCOM does not have tides and has a relatively poor resolution of the Cook Strait region.

13. In paragraph 15 Professor Luick suggests that a discrepancy in vertical velocity may produce a velocity shear. The figure he cites (figure 3.4) has three panels:

    (a) Top is a scatter plot of velocities;

    (b) Middle is the velocity along the main direction of the currents (i.e., flow in the direction that the main current is heading); and

    (c) Bottom is perpendicular to the main direction of the current and is slower.

14. The bottom panel has the larger model versus observation difference as a percentage of the flow, but this discrepancy is not "often double the observations" as described by Professor Luick. This across-current flow is much less than the main component of flow (middle panel) and I would not expect this discrepancy to create a large vertical shear. Professor Luick asks for a thorough examination of the model's ability to represent vertical velocities. However, we don't have

good vertical velocity data to inform the requested analysis and vertical velocity comparisons are not usually performed for coastal models of this scale due to the difficulties in obtaining observed vertical velocities.

EVIDENCE OF DOUGAL GREER

15. Dougal Greer, at paragraph 16, asks that "SSC contour plots and median and 99th percentile plots should be generated for shorter periods of time corresponding to the periods of highest release" (for the worst-case scenario). However, statistical analysis such as the 99th percentile cannot be generated for short time periods as there are not enough data points (i.e., the 99th percentile occurs once in every 100 data point which we get once every 50 days which is much more than the 20-day periods of high releases). We did include time series at locations of interest which showed how short-term increases relate to the median and 99th percentile.

16. Dougal Greer, at paragraph 17 asks about anthropogenic versus non anthropogenic sources of sediments as the background comparator. We cannot do this as we do not have the pre-anthropogenic riverine data to generate these simulations.

EVIDENCE OF KAREN PRATT

17. On page 43 of her submission, Karen Pratt asks for a 10-year model run. It was not computationally feasible to run this model for 10 years. However Mark Hadfield[2] has compared the windspeed, significant wave height and river flows over a

[2]https://www.epa.govt.nz/assets/FileAPI/proposal/EEZ000004/Evidence/359e8511a9/EEZ000004-20-Mark-Hadfield-Sediment-plume-modelling.PDF

period 2008 to 2014 and he states that he has "confirmed that the analysis period is not anomalous".

18. On page 43 of her submission Karen Pratt asks for a model run at an intermediate location for sediments released between the sites A and B explored in Hadfield 2015. The two sites chosen in the Hadfield 2015 report represent the extreme ends of the proposed mining region. There is not a large spatial variation in current speed and directions across the mining region and we expect that the results of an intermediate site will produce a plume that sits in between the plumes generated at site A and B.

19. On pages 15, 53, 55-56 of Karen Pratt's submission she brings up the issue of the complex bedforms (particularly noted near site 7) which can create a variation in susceptibility to sand resuspension. She asks about using multibeam work to assist in modelling of Patea Shoals.

20. These bedforms vary on a small scale (in the Green and Black paper cited, the study locations were only a few 100 meters apart) and it would not be computationally feasible to model these variations. Regardless of the region or resolution chosen for the sediment model domain, we will encounter the same issue with varying bedforms throughout the sediment model domain. This issue will affect background and mining sediments and a localised increase in resuspension will result in more mining and background sediments being resuspended in a localised region.

21. I also note that the modelled seabed is not completely uniform as stated on pages 15 and 53 of Karen Pratt's submission. It does vary spatially but does not capture bedform variations less than the horizontal model resolution of 1km.

22. On pages 49-50 of her submission, Karen Pratt raises the issue of model resolution. Karen Pratt quotes part of a statement from Hadfield from a different hearing which discusses the effect of resolution on the scale. This quote omits much of the relevant material in Hadfield's statement, which can be found in full on the EPA's website.[3]

23. Hadfield argues there that small scale features and variations of size less than the grid size (1km in this case) will not be well represented in the model. Some regions (especially within a few kilometres of the source) will have a more dispersed plume (wider and of less sediment concentrations) in a 1km grid spacing than a 500 m grid spacing. This issue will affect a model run of any resolution.

24. In the statement cited by Karen Pratt, Hadfield compares figures of suspended sediments calculated from model runs of differing resolution (see pages 36-40 of the Hadfield statement). He states that "The comparisons indicate that in the far field (i.e., more than 2–3 kilometres from the source) concentrations are not sensitive to the grid spacing". I agree with this statement and believe that we will get similar results if this experiment were rerun for the updated model runs used in the present hearing.

25. On page 57 of her submission Karen Pratt makes a request that the conditions for sediment reflect seasonality. Conditions are discussed in more detail in Mr Mitchell's evidence, but I confirm that the sediment modelling does have time-varying riverine inputs and therefore reflects seasonal variations, and we have shown both summer and winter statistics in section 5.1.3 of the sediment report.

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3 https://www.epa.govt.nz/assets/FileAPI/proposal/EEZ000004/Evidence/359e8511a9/EEZ000004-20-Mark-Hadfield-Sediment-plume-modelling.PDF

CONCLUSIONS

26. Submitters have raised concerns about the sediment modelling domain setup, particularly surrounding the region and time periods covered, the model resolution, vertical velocities and the positioning of the sediment plume in the water column. After reviewing these comments, and given the impracticalities of larger model runs, I still consider the sediment model domain to be an appropriate setup to model the dispersion of inputs of sediment from background processes and mining operations.

Helen Macdonald

Dr Helen Skye Macdonald

23 January 2024