**BEFORE THE ENVIRONMENTAL PROTECTION AUTHORITY**

**AT WELLINGTON**

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| **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 ALISON MACDIARMID ON BEHALF OF TRANS TASMAN RESOURCES LIMITED

**23 JANUARY 2024**

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**INTRODUCTION**

1. My name is Alison Bronwyn MacDiarmid.

2. I prepared expert evidence dated 19 May 2023 (**First Statement**) with respect to these proceedings on behalf of Trans-Tasman Resources Limited (**TTR**).

3. My qualifications and experience as a marine ecologist are set out in paragraph 2 of my First Statement.

4. I repeat the confirmation given at paragraph 6 of my First Statement that I have read the Code of Conduct for Expert Witnesses and agree to comply with it.

5. The purpose of this Rebuttal Evidence is to respond to matters raised in submitter evidence relevant to my area of expertise.

6. In particular, I respond to matters raised in the evidence of:

   (a) Professor Emeritus Elisabeth Slooten;

   (b) Dr Jeremy Graham Helson;

   (c) Captain Andrew Peter Smith;

   (d) Dr Gregory Matthew Barbara; and

   (e) Ms Karen Pratt.

**EVIDENCE OF PROFESSOR EMERITUS ELISABETH SLOOTEN / CETACEAN HABITAT MODELS AND HEAVY METAL CONTAMINATION OF SEDIMENTS**

7. Professor Emeritus Slooten, in paragraph 16 of her evidence, sets up a false dichotomy stating that "habitat models are not a substitute for population surveys". No such claim has been made and they are best considered complementary approaches. Well designed and carried out population surveys, even if repeated over seasons and years can never monitor all locations, at all times. Cetacean habitat use

models which complement surveys by using associated environmental variables to fill in the gaps in space and time. Habitat models based on well-designed survey data are best as they provide high quality presence and absence data. However, if survey data is not available or is limited in extent then habitat use models based on presence observation data provide the best available evidence of cetacean use of an environment. The modelling by Stephenson et al. (2020 and 2021) referred to in my evidence should be viewed in this light. I also add this modelling is state of the art, was peer reviewed and is published in scientific literature.

8. In paragraph 18(a), Professor Emeritus Slooten notes that "A standard method for validating habitat models is to use a subset of the data to build the model, and then test it using the remaining data." This is what Stephenson et al. (2020) did. They used presence and absence data independently collected by the New Zealand Ministry for Primary Industries (MPI) inshore fisheries observers to validate the predicted probability of occurrence for models for five species for which there were ≥50 positive species records in the MPI data set. They found that all models had some predictive power, with models for dusky dolphin and Hector's dolphin performing strongly, while models for killer whales, bottlenose dolphin and common dolphins were weaker, in part because the MPI data were limited to areas of interest for fisheries and therefore suffered from spatial bias.

9. In paragraph 30 Professor Emeritus Slooten outlines her concern that the proposed mining activity will bring sediment with higher heavy metal content to the seabed surface, making it available for food web transfer to higher trophic levels including fish, marine mammals and birds.

10. I note that this problem of heavy metal contamination was the subject of expert conferencing at the 2017 hearing and

that the experts agreed on all points. In paragraph 589 of the 2017 DMC decision, it is noted that dilution and mixing will rapidly dilute heavy metal concentrations below trigger levels and there will be no impact on the nearshore environment. The experts agreed that there may be impacts on a small area immediately near the site and for a small distance down current. They concluded that there was a low risk of changes to the background concentrations of nickel and copper. However, they also supported monitoring to confirm that concentrations will not result in increased risk of ecotoxic effects to biota.

11. Paragraph 593 of the 2017 DMC decision notes that TTR confirmed it will be examining the discharge from the processing vessel in relation to a comprehensive suite of metals.

**EVIDENCE OF DR JEREMY GRAHAM HELSON / FISHERIES MANAGEMENT FOR THE FISHERIES SUBMITTERS**

12. In paragraph 24 Dr Helson suggests there had been insufficient information provided to adequately quantify or assess the impact that that plume could have on fish. I disagree. A review of the spatial and foraging ecology of the key fauna occurring in the South Taranaki Bight (**STB**)[1] identified that for most fish species, there should be negligible effects of mining 50 Mt per annum according to standard evaluation criteria. This is principally because the scale of the mined area and the areas of elevated suspended sediment concentrations (SSC) are small compared to the area used by the populations of these species. Consequently, they are likely to be displaced from, or experience a decrease in prey

[1] Report 17_NIWA Assessment of the scale of marine effects Report FINAL September 2015.pdf

abundance or availability over a very small part of their distribution.

13. One non-commercial species, eagle ray, may be affected to a moderate extent by the proposed iron sand recovery activities.

14. In paragraphs 38-52 Dr Helson raises his concerns that there is a deficit of information and assessment by TTR about the potential presence of habitat of particular significance for fisheries management in and near the TTR project area making it difficult for submitters to comment on whether the proposal is consistent with the environmental principle of protecting habitats of particular significance for fisheries management. I note that to-date these habitats have not been defined by the responsible Government agency, Fisheries New Zealand, and in this absence the evidence submitted by TTR has focused on fish distributions in relation to the proposed activities and how they may be impacted.

**EVIDENCE OF CAPTAIN ANDREW PETER SMITH / FISHERIES MANAGEMENT FOR THE FISHERIES SUBMITTERS**

15. In paragraphs 40 and 41 of his evidence Captain Smith raises his concerns that if the mining activity displaces fish species from one fish management area (e.g., FMA7) into another fish management area (e.g., FMA8), then that has a commercial and financial impact on quota holders who can only lawfully fish in the area in which they hold quota. This concern was addressed in the above mentioned review of the spatial and foraging ecology of the key fauna occurring in the STB,[2] which concluded that fished species are likely to be displaced from or experience a decrease in prey abundance or availability over only a very small part of their distribution. This is principally

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[2] Ibid, n1.

because the scale of the mined area and the areas of elevated SSC are small compared to the area used by the populations of these species within the relevant QMA.

16. I also note that for several species commercially fished in the South Taranaki Bight the quota is managed over amalgamated QMAs to form a Fishery Management Area. Jack mackerels in the STB, for example, are managed in JMA7 which combines QMAs 7, 8 and 9. Thus the question of transboundary movement of fish in relation to the proposed mining operations is negated for these species.

17. In paragraphs 42-44 Captain Smith highlights the importance of rocky reefs to many fished commercial species. I agree that some commercially fished species such as butterfish and rock lobsters are highly dependent on reef habitats but most others such as blue cod, leather jackets, and snapper make use of a variety of benthic habitats including rocky reefs.

18. In paragraph 47 Captain Smith raises his concerns that the mining operations will add to the background suspended sediments in STB. I agree which is why in my primary evidence my conclusions are based on the modelled background plus mining derived suspended sediment concentrations.

19. Captain Smith raises concerns that over the 35-year duration of the mining consent, there will be 1.57 billion tonnes of sand and sediment discharged into this area over and above what would have been there naturally. I point out that all the discharged sediment will be derived from the seafloor sands already in the mining area and that the vast majority of extracted sands are relatively course and will fall almost immediately to the seafloor, backfilling the mining pit as the mining vessel slowly traverses the area. It is the much smaller amount of finer material that will remain suspended in the

water collum for some time that is of concern, and this is what has been included in the plume modelling.

20. In paragraph 49 of his evidence Captain Smith states his view that we cannot assume the prospect of any recovery of the benthic communities affected by the proposed mining and considers it is quite likely that the level of harm to the benthic ecosystems will be irreparable. I disagree and draw to the attention of the DMC newly published research undertaken in the Kaikoura canyon where a diverse deepwater benthic population has shown remarkable recovery after being completely buried by the avalanche of sediments released by the 2016 Kaikōura earthquake.[3,4] The results show that all fauna dramatically decreased immediately after the turbidity flow event, and by four years after the disturbance the benthic communities were similar to, but not yet the same as, the pre-event communities. Full recovery was modelled to take as little as 4.5 years or up to 12 years. In the warmer, shallower sandy waters of the STB where disturbance by storm events and land derived sediments is common, recovery of the sea floor community, once mining in the immediate area has stopped, should occur faster than in the deep, less frequently disturbed, waters of the Kaikōura Canyon.

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[3] Bigham KT, Rowden AA, Bowden DA, Leduc D, Pallentin A, Chin C, Mountjoy JJ, Nodder SD and Orpin AR (2023) Deep-sea benthic megafauna hotspot shows indication of resilience to impact from massive turbidity flow. Front. Mar. Sci. 10:1180334. doi: 10.3389/fmars.2023.1180334

[4] Katharine Bigham (2023). Resilience of deep-sea benthic communities to turbidity flows following the 2016 Kaikōura Earthquake. PhD thesis, Te Herenga Waka—Victoria University of Wellington. https://openaccess.wgtn.ac.nz/articles/thesis/Resilience_of_deep-sea_benthic_communities_to_turbidity_flows_following_the_2016_Kaik_ura_Earthquake/24646104

**EVIDENCE OF DR GREGORY MATTHEW BARBARA / MARINE ECOLOGY FOR FISHERIES SUBMITTERS**

21. In paragraphs 33-37 of his submission Dr Barbara raises his concern that benthic surveys referenced in TTR's reports were inadequate because they would have overlooked organisms smaller than 4mm. I disagree and refer the DMC to the extensive survey of the benthos seabed sediments and the associated infauna sampled from 103 sites in and around the proposed mining site during the spring of 2011. Macrofauna (>500 µm) and smaller meiofauna (63-500 µm) were systematically processed from sediment cores from these sites.

22. Dr Barbara also identified that the benthic sampling did not include benthic diatoms. While this is the case the evidence of Dr Cahoon[5] addresses the impact of the proposed mining operations on the microphytobenthos (MPB) which includes benthic diatoms.

23. In paragraphs 41-43 of his evidence Dr Barbara expresses his concern about the long-term impacts of the mining process on the removal of benthic organisms and refers to the DISCOL seabed mining experiment that has demonstrated that decades after the mining trial there is still significantly lower benthic invertebrate heterogeneity in the area. I consider the DISCOL experiment to be an entirely inappropriate comparison to the likely impact of the proposed mining operations in the STB. The DISCOL experiment was conducted in the cold (1.8 °C) deep-sea Peru Basin at around 4000 m depth where manganese nodules have been slowly growing over millions of years in this undisturbed environment. In the warmer, shallower sandy waters of the STB where disturbance by storm events and land derived sediments is common,

[5] Expert evidence of Dr. Lawrence Cahoon on behalf of Trans-Tasman Resources Limited, 9 December 2016.

recovery of the sea floor community, once mining in the immediate area has stopped, should occur faster than in the cold, very deep, infrequently disturbed abyssal plains in the Peru Basin.

24. Dr Barbara implies that the subsurface sediments in the proposed mining area may be high in organic matter which can lead to anoxia and production of sulfide, which in high concentrations can inhibit the growth of oxygen dependent organisms reducing the abundance and diversity of invertebrates. I point out that Vopel et al. (2013)[6] found low levels of organic matter (<1% dry weight) and acid volatile sulfides (AVS) in sands from the mining area and found no evidence for increases with sediment depth for either measure.

25. In paragraph 44 Dr Barbara states that laboratory analysis by Vopel indicated copper levels in elutriates from unprocessed ore would be elevated and cause harm to the environment. In fact, Vopel reports that the concentrations of copper in elutriate extracts of unprocessed sediment core samples were below the detection limits.

26. Vopel does report that copper in elutriates of <u>processed</u> ores were elevated and again I note that this problem of heavy metal contamination was the subject of expert conferencing at the 2017 hearing and refer to my summary above in paragraph 10.

27. In paragraphs 61- 74 Dr Barbara raises his concerns that the "worst case" plume modelling on which I based my conclusions about the scale of impact on benthic and rocky reef communities may under-represent pockets of very fine

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[6] Vopel, K., Robertson J., & Wilson P.S. (2013). Iron sand extraction in South Taranaki Bight: effects on seawater trace metal concentrations. AUT Client report: TTRL 20138, 62 p.

material in sub-surface sediments in some of the mining area, thereby invalidating my conclusions. This problem was discussed extensively during the 2017 hearing and resolved by TTR undertaking to stop mining in any part of the proposed mining area if the finer material in the sands reached an agreed threshold of an average of 1.8% ultra-fines over the course of a week of mining operations (Condition 4d).

**EVIDENCE OF MS KAREN PRATT / EFFECTS OF SEDIMENTATION**

28. On pages 43-58 of her evidence Ms Pratt raises concerns about the plume modelling and specifically the validity of the "worst case" modelling on which I based my conclusions about the scale of impact on benthic and rocky reef communities. As I state in paragraph 27, this problem was discussed extensively during the 2017 hearing and resolved by TTR undertaking to stop mining in any part of the proposed mining area if the finer material in the sands reached an agreed threshold of 1.8% ultra-fines over the course of a week of mining operations (Condition 4d).

29. On page 65 of her evidence Ms Pratt suggests that the tubeworm *Euchone* sp A may stabilise the sandy habitat when occurring at the high densities reported by Beaumont et al. (2015) and that this question deserves research. I agree this would be an interesting research question to pursue in relation to the recovery of sea floor biota but do not consider this research is a necessary pre-condition to mining. Stabilisation of sand by *Euchone* sp A may hasten recovery of biota in sediments disturbed by mining so in my estimation of benthic biota recovery times I have taken the more cautious approach of not assuming this is the case.

30. On page 74 of her submission Ms Pratt states she cannot find my responses or references to where qualitative, temporal, quantitative and spatial aspects have been addressed in

making my conclusion in paragraph 20 of my primary evidence. Here I was referring to all the information placed before the 2017 hearing relevant to assessing the impact of the sediment plume on the STB ecosystem. This material in total covered a wide range of qualitative, temporal, quantitative and spatial aspects.

31. On page 74 Ms Pratt asserts that plume effects need to be considered on a temporal basis. This is indeed what was done with the plume model fields calculated every 60 seconds (i.e., a timestep of 60 seconds) and model outputs (which were used to calculate most statistics/figures in the plume modelling reports) occurring every 12 hours. Suspended sediment concentration figures, including timeseries were created from outputs averaged over 12-hours. Changes in bottom sediment thickness (erosion and deposition) were calculated using 12 hourly snapshots. The regions of SSC about 2mg/l and 3mg/l used to assess effects on biota were done on a 12 hourly average.[7]

32. On pages 76 and 77 of her evidence Ms Pratt critiques the studies of benthic species responses to elevated SSC cited in my evidence for including non-New Zealand species and estuarine species and cites studies indicating a sub-lethal decline in shellfish condition at relatively low SSC in some species. I note that the inshore areas in the STB are frequently turbid due to frequent wave activity and intermittent high river discharge of terrestrial sediments. Thus, studies of species from other turbid environments in New Zealand or overseas are relevant to the STB.

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[7] Macdonald, H.S and Hadfield, M.G. (2017). South Taranaki Bight Sediment Plume Modelling Worst Case Scenario, 51 p.

33. I further note that in the laboratory experiment quoted by Ms Pratt[8] on page 77 of her evidence the target SSCs were achieved by adding sediment collected from a roadworks site near Whitianga to seawater. The particle size composition of this sediment was not analysed but given its source it is likely to have comprised a high percentage of very fine terrigenous clay material and organic matter. In a similar study Hewit et al. (2008)[9] found that suspended terrigenous clay affected cockle (*Austrovenus stutchburyi*) feeding rates and condition more than resuspended marine sediments with cockle condition peaking at SSCs around 200-400 mg/l. I note that the proposed mining operations will resuspend entirely marine sediments which Vopel[5] noted contained low levels of organic matter.

34. The studies by Hewitt, Ellis,[10] and Schwarz are useful in indicating that it is prolonged exposure of 11-14 days to suspended sediment concentrations above 15, 15, 26, 75, 80, and 400 mg/l that causes sponges, oysters, mussels, pipis, horse mussels, and cockles to exhibit significant decreases in body condition respectively. I note that the plume modelling indicates that outside the 2-3 km immediately adjacent to the mining site the median mining derived near bottom SSC adds just 2 mg /l or less to background SSC and that peaks in SSC at key sites are of short duration (12 hours to a few days).

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8 Schwarz, A.M., Taylor, R., Hewitt, J., Philips, N., Shima, J., Cole, R., Budd, R., 2006. Impacts of terrestrial runoff on the biodiversity of rocky reefs. New Zealand Aquatic Environment and Biodiversity Report 7 (109), 1176–9440.

9 Hewitt J., Hatton S., Saffi, K., Craggs R. (2008). Effects of suspended sediment levels on suspension-feeding shellfish in the Whitford embayment. Auckland Regional Council Technical Publication No, 159, 43 p.

10 Ellis, J.; Cummings, V.; Hewitt, J.; Thrush, S.; Norkko, A. (2012). Determining effects of suspended sediment on condition of a suspension feeding bivalve (Atrina zelandica): results of a survey, a laboratory experiment and a field transplant experiment. Journal of Experimental Marine Biology and Ecology 267: 147– 174.

35. On page 79 of her evidence Ms Pratt refers to the problem of unidentified reefs in the STB that prevent an assessment of the impacts of the sediment plume on reef fish on every reef. While I agree that a full survey to map the position of every reef would be ideal, I suggest that the location of a sufficient number reefs is known in order to assess the impact on reef fish populations close to and far away from the mining site.

**CONCLUSIONS**

36. The evidence statements of Professor Emeritus Slooten, Dr Helson, Captain Smith, Dr Barbara and Ms Pratt have raised concerns regarding cetacean habitat models, heavy metal contamination of sediments, and effects of sediments on seafloor biota and suggest that these concerns are sufficient for the DMC to reject TTR's application. I do not agree and insofar as the issues raised relate to the matters addressed in my evidence, I am satisfied that the cetacean habitat use modelling and the impacts of suspended sediment on marine biota are sufficiently well defined and in adequate detail for me to have confidence that granting consent, subject to the proposed conditions, will avoid material harm, and will favour caution and environmental protection in relation to the effects of the proposed mining operations and resulting sedimentation.

37. I confirm that the issues raised by the submitter evidence I have addressed above have not altered any of the conclusions in my First Statement.

AB MacDiarmid

**Dr Alison MacDiarmid**

**23 January 2024**