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

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EXPERT EVIDENCE OF DR ALISON MACDIARMID ON BEHALF OF TRANS TASMAN RESOURCES LIMITED

19 MAY 2023

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INTRODUCTION

Qualifications and experience

1. My name is Alison Bronwyn MacDiarmid. I am a Regional Manager at the Wellington campus of the National Institute of Water and Atmospheric Research (**NIWA**), where I have been employed since 1987. I was awarded a Bachelor of Science by the University of Auckland in 1979, a Master of Science by the University of Auckland in 1981, and a PhD in Zoology by the University of Auckland in 1988.

2. I have 36 years of professional experience in marine ecology and fisheries, particularly spiny or rock lobsters and other reef associated species, scampi, hoki, and orange roughy and have previously served on fisheries stock assessment working groups for several species, and on the Ministry for Primary Industries Biodiversity Research Advisory Group and Aquatic Environment Working Group. I have broad research interests and experience in marine biodiversity, historical marine ecology, marine ecosystem goods and services, the state of the marine environment, and human impacts on marine ecosystems. In addition, over the last 20 years I have led many investigations for commercial clients on a variety of research questions. I have authored 51 science journal papers, nine book chapters, 74 consultancy reports and 122 conference presentations. In 2013 I was presented the New Zealand Marine Sciences Society Award for an outstanding contribution to New Zealand marine science. In 2013 I was also presented with the NIWA Excellence Award for Leadership.

3. I previously gave evidence for Trans-Tasman Resources Limited (**TTR**) before a Decision-making Committee (**DMC**) in 2017.

4. My evidence before the 2017 Committee comprised:

(a) Expert Evidence of Alison MacDiarmid on behalf of TTR 15 December 2016;

(b) Expert Rebuttal Evidence of Alison MacDiarmid on behalf of TTR 9 February 2017;

(c) Expert Supplementary Evidence of Alison MacDiarmid on behalf of TTR 1 May 2017;

(d) Joint Statement of Experts in the Field of Effects on Benthic Ecology, 20 February 2017;

(e) Joint Statement of Experts in the Field of Effects on Fish, 17 February 2017;

(f) Joint Statement of Experts in the Field of Effects on Fishing (Commercial, Recreational and Customary Fishing), 15 February 2017;

(g) Joint Statement of Experts in the Field of Effects on Marine Mammals, 3 March 2017;

(h) Written responses to questions approved by the DMC in Minute 21, 17 February 2017;

(i) Summary of Expert Evidence of Dr Alison MacDiarmid, 20 February 2017;

(j) Oral evidence on 21 February 2017 (Transcript pages 412-432, 435-442); and

(k) Oral evidence on 3 March 2017 (Transcript pages 1083-1090).

5. I also helped to prepare various reports which formed part of TTR's application, which are listed here:

(a) South Taranaki Bight Factual Baseline Report (MacDiarmid et al., 2015);[1]

(b) Benthic habitats, macrobenthos and surficial sediments of the nearshore South Taranaki Bight (Anderson, MacDiarmid & Stewart, 2015);[2]

(c) Benthic flora and fauna of the Patea Shoals region, South Taranaki Bight (Beaumont, Anderson and MacDiarmid, 2015);[3]

(d) Zooplankton communities and surface water quality in the South Taranaki Bight February 2015 (MacDiarmid et al., 2015);[4]

(e) South Taranaki Bight Fish and Fisheries (MacDiarmid, Anderson and Sturman, 2015);[5]

(f) Assessment of the scale of marine ecological effects of seabed mining in the South Taranaki Bight: Zooplankton, fish, kai moana, sea birds, and marine mammals (MacDiarmid, Thompson and Grieve, 2015);[6] and

(g) South Taranaki Bight Commercial Fisheries: 1 October 2006 – 30 September 2015 (MacDiarmid and Ballara, 2016).[7]

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1 Report 1-NIWA STB Baseline Environmental Report FINAL November 2015.pdf + Appendices 1-4.

2 Report 2-NIWA Benthic Habitats, Macrobenthos and Surficial Sediments of the Nearshore South Taranaki Bight Report-FINAL November 2015.pdf

3 Report 3-NIWA Patea Shoals Benthic Ecology FINAL November 2015.pdf

4 Report 9_NIWA Zooplankton Communities and Water Quality Report FINAL May 2015.pdf

5 Report 10-NIWA South Taranaki Bight Fish and Fisheries Report FINAL November 2015.pdf + Appendices A-C

6 Report 17_NIWA Assessment of the scale of marine effects Report FINAL September 2015.pdf

7 Report 18-NIWA South Taranaki Bight Commercial Fisheries Report FINAL

Code of conduct

6. I confirm that I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Practice Note dated 1 January 2023. I agree to comply with this Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

7. I have been asked to review and update my evidence taking into account the decision of the Supreme Court in *Trans-Tasman Resources Ltd v Taranaki-Whanganui Conservation Board and Others* [2021] NZSC 127.

8. Specifically, Counsel for TTR have asked me to review and update my evidence concerning the effects of sediment on biota, including primary producers, invertebrates, fish and marine mammals, in the South Taranaki Bight (**STB**) on the basis that the previous DMC did not correctly apply the legal requirements to protect the environment from material harm, or to make a decision favouring caution and environmental protection.

9. I do not repeat my previous evidence but confirm that the opinions I expressed in that evidence, and the basis for those opinions, remains the same except to the extent that I explicitly address in this further evidence. In order to explain my opinions, I have in places summarised aspects of my previous evidence.

May 2016.pdf

UPDATING EVIDENCE

10. Since my 2017 evidence, there is new information available for the STB on the modelled distribution of marine mammals[8,9] and 17 genera of marine benthic invertebrates,[10] and new information on the responses of two benthic species to elevated suspended sediment concentrations, and on the distribution of some rocky reefs within the Coastal Management Area.[11] I refer to these new studies in the relevant section below.

Updated information on cetacean habitat modelling

11. Prior to TTR's application NIWA was commissioned to undertake habitat modelling of three threatened species of whale and dolphins, southern right whales (*Eubalaena australis*), Hector's dolphins (*Cephalorhynchus hectori* and the sub-species Maui's dolphin *C.H. maui*), and killer whales (*Orcinus orca*). This was undertaken on a New Zealand wide scale, using sightings data available at that time, to determine the suitability of marine habitats in the STB, specifically the areas likely to be affected by mining activities, for these three species. The approach and findings are reported in Torres et al. (2015).[12]

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8 Stephenson F, Goetz K, Sharp BR, et al. Modelling the spatial distribution of cetaceans in New Zealand waters. Diversity and Distributions (2020): 1–22. https://doi.org/10.1111/ddi.13035

9 Stephenson, F., J. E. Hewitt, L. G. Torres, T. L. Mouton, T. Brough, K. T. Goetz, C. J. Lundquist, A. B. MacDiarmid, J. Ellis, and R. Constantine. (2021). Cetacean conservation planning in a global diversity hotspot: dealing with uncertainty and data deficiencies. Ecosphere 12(7): e03633. 10.1002/ecs2.3633

10 Lundquist, C., Stephenson, F., McCartain, L., Watson, S., Brough, T., Nelson, W., Neill, K., Anderson, T., Anderson, O., Bulmer, R., Gee, E., Pinkerton, M., Rowden, A., Thompson, D. (2020) Evaluating Key Ecological Areas datasets for the New Zealand Marine Environment. NIWA Client Report 2020109HN. Prepared for the Department of Conservation, 138 p.

11 Morrison et al. (2022). Offshore subtidal rocky reef habitats on Pātea Bank, South Taranaki. NIWA Client Report 2022229AK, 211 p. see Policy-and-Planning-February-2023-web-version-v2.pdf (trc.govt.nz)

12 Report_4_NIWA_Cetacean_Habitat_Models_2_September_2016

12. However, these models have since been superseded by modelling carried out by Stephenson et al. 2020[1] who used an updated and more extensive set of at-sea marine mammal sightings data (>14,000 records) and two different methods of using high-resolution (1 km^2) environmental data layers from each sighting locality to predict the suitability of habitats for 30 whale and dolphin species within New Zealand's Territorial Sea and Exclusive Economic Zone (**EEZ**). Using these models Stephenson et al. (2020) identified whale and dolphin species diversity hotspots while Stephenson et al. (2021) applied distributional and statistical uncertainty criteria to more clearly identify areas of high whale and dolphin conservation value.

13. I refer to the findings of Stephenson et al. (2020 and 2021) below but note that while these models indicate the suitability of a particular location for a species of whale and dolphin, they don't necessarily indicate that individuals of a species will occur there. This is critical when applying these models to species such as Maui's and Hector's dolphin, southern right whales, humpback whales and sperm whales that have undergone a historical population decline and may still be recovering. For these species the habitat suitability modelling may indicate a larger area of suitable habitat than presently occupied. For these reasons an area of otherwise suitable habitat may yield low counts of a particular species, or they may be completely absent.

14. Stephenson et al. (2020) identified the STB as a region of low (inshore) to moderate (offshore) suitability for cetaceans generally but found the deeper waters of the STB to be <u>the</u> key area for blue whales (*Balaenoptera musculus musculus* and *B. m. brevicauda*) in the New Zealand region. The deeper areas of the STB were also found to be of moderate (0.4) or better suitability for minke whale (*Balaenoptera acutorostrata*), dwarf minke whale (*Balaenoptera*

acutorostrata), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*) and pilot whales (*Globicephala melas* & *Globicephala macrorhynchus*). The southern approaches to the STB in Cook Strait were identified as areas of moderate (0.4) or better suitability for sperm whales (*Physeter macrocephalus*). The shallow waters of the STB (<35 m water depth) were found to be of moderate (0.4) or better suitability for common dolphin (*Delphinus delphis*), killer whale (*Orcinus orca,* especially close inshore), Hector's dolphin (*Cephalorhynchus hectori hectori*, particularly south of Whanganui), and humpback whale (*Megaptera novaeangliae*, in shallow waters around Cape Egmont, and southwards along the Manawatu and Kapiti coastlines, Cook Strait, and the Marlborough Sounds).

15. Stephenson et al. (2021) concluded that generally while inshore areas around New Zealand had lower whale and dolphin richness estimates than offshore areas, these remain important for conservation for species with limited ranges. In particular when fully taking into account the limited range of some species, areas of overlapping species distribution, and the higher certainty of model predictions in some areas, the inshore areas in the STB were identified as being among the top 5% for cetacean conservation value in the New Zealand region inside the EEZ boundary and the STB as a whole in the top 15% of areas.

Benthic invertebrate distribution modelling

16. Models of the predicted probability of occurrence are available for 17 benthic invertebrate genera including 9 corals, 2 sponges, 3 bryozoans, 2 lamp shells, and 1 bivalve, which include one or more species of habitat-forming/sensitive environment species (Lundquist et al. 2020). In part these models use the information previously collected by NIWA during benthic surveys undertaken for TTR[2,3] and

while useful for predicting the occurrence of these genera outside the areas sampled do not change my conclusions.

Updated information on rocky reef occurrence in the STB

17. NIWA random sampling surveys undertaken for TTR[2,3] confirmed the presence of rocky reef habitats at 12 sites inshore of the proposed project area (**PPA**). More recently, Morrison et al. (2022)[10] identified further areas of rocky reef in this same general area, and it is highly likely that other areas of rocky reef occur in this area inshore of the PPA and may be known to the local fishing and diving community but remain to be formally mapped.

18. These rocky habitats are islands of biological diversity among the otherwise low diversity communities occurring on the surrounding sandy flats. Although much rarer in spatial extent than surrounding sands, rocky reefs support a much more abundant and diverse benthic biota dominated by suspension-feeders and primary producers. Outcrop assemblages were characterised in NIWA surveys by bryozoans, macroalgae and sponges, as well as more motile species, (e.g., crabs, amphipods, starfish, brittle stars, gastropods and polychaete worms).

ASSESSMENT OF EFFECTS OF SEDIMENTATION

19. My assessment of impacts of sediments suspended in the water column and deposited on the seabed on flora and fauna outside of the PPA is dependent on the quality of the

sediment plume[13,14], optical[15], and primary production[16] modelling undertaken. In this regard I note that:

(a) Models of this sort are inherently uncertain because of the complexity of the natural systems they are trying to represent and the variability of components in such systems;

(b) Despite this, models of this sort are in my experience both necessary and useful for undertaking effects assessments;

(c) The modelling undertaken is state of the art, and has been vigorously reviewed and challenged already through the 2017 DMC procedures; and it is my understanding that there was reasonable consensus among experts in 2017 that the modelling was fit for purpose;[17]

(d) In particular the modelling undertaken by Macdonald & Hadfield (2017)[14] incorporated a "worst case scenario" and sediment related effects have been assessed on that basis, which gives confidence that the assessments are appropriately cautious.

20. I have been asked by Counsel to address a number of findings made by the DMC in 2017, as described by the Court of Appeal at paragraph 111 of its judgment. As I understand it,

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13 Hadfield, M. & Macdonald, H. (2015). Sediment Plume Modelling. NIWA Client Report No: WLG2015-22, prepared for Trans Tasman Resources Ltd, 117 p.

14 Macdonald, H. & Hadfield, M. (2017). South Taranaki Bight Sediment Plume Modelling - Worst Case Scenario. NIWA Client Report No: 2017049WN, prepared for Trans Tasman Resources Ltd, 51 p.

15 Pinkerton, M. & Gall, M. (2015). Optical effects of proposed ironsand mining in the South Taranaki Bight region. NIWA Client Report No: WLG2015-26, prepared for Trans-Tasman Resources Ltd, 79 p.

16 Cahoon, L.B., Pinkerton, M., and I. Hawes. 2015. Effects on primary production of proposed iron sand-mining in the South Taranaki Bight. Report to Trans-Tasman Resources, Ltd. 28 pp.

17 Joint Statement of Experts in the Field of Effects of Sediment Plume on Primary Production, Dated 14 February 2017, Issue 8, paragraph 33.

the Court inferred that these findings amounted to a determination by the last DMC that the sediment plume would give rise to material harm. I have applied the Supreme Court's guidance that what amounts to "material harm" is to be determined on the facts, and this requires qualitative, temporal, quantitative and spatial aspects to be weighed. When those aspects are weighed, I consider the findings of the DMC in 2017 do not necessarily amount to a decision that the sediment plume would cause material harm. In any event, I am instructed by Counsel that these may be matters for the new DMC to consider afresh.

21. In paragraph 111(a) the Court of Appeal refers to findings by the 2017 DMC that under some circumstances (i.e., the "worst case" modelling undertaken by MacDonald and Hadfield (2017)) there will be:

(a) significant effects on macroalgae on at least part of Graham Bank;

(b) significant effects on microphytobenthos within 1-2 km of the mining site;

(c) moderate effects on primary production of the Patea Shoals as a whole; and

(d) significant effects on primary production at environmentally sensitive areas such as The Crack and The Project Reef.

Notwithstanding these findings, I consider the harm described is "immaterial" when taking into account the evidence put before the 2017 DMC that provides what the Supreme Court considers qualitative, temporal, quantitative and spatial aspects.

22. Specifically, I reach this conclusion based on the evidence of Prof. Dr Larry Cahoon, a US based expert in benthic micro-algal ecology of continental shelf ecosystems,[18] who noted:

    (a) the resilience of primary producers including phytoplankton, microphytobenthos and macroalgae ("seaweeds") to short-term fluctuations in light availability (photo-adaptation) typical in the STB because of background storm and high river runoff events;

    (b) the likelihood that primary production by phytoplankton in the STB is likely nutrient-limited, not light limited;

    (c) that many microalgae may also be capable of heterotrophic production (mostly uptake of dissolved organic material), with this mode of production supplementing or even replacing primary production (photosynthetic formation of new organic matter), particularly when light is limiting; and

    (d) that macroalgae have the additional advantage of being able to store photosynthetic products in their larger bodies for extended periods of time, enabling them to adapt to quite substantial changes in light availability.

23. Dr Cahoon also noted that while there will be significant and detectable effects on light levels and thus primary production in the plume in the immediate vicinity of the active mining site (<2 km distant), these effects would decrease exponentially with distance from the site of active mining as the presence of the plume will be more intermittent at sites > 2 km from the

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

actual mining site owing to increasing variability in flow vectors with distance from the mining site. Given the relatively small spatial footprint of sand mining activities and inherent variability in the physical environment Dr Cahoon considered that on the scale of the sediment model domain, impacts of mining on primary production would be statistically indistinguishable from natural variability.

24. Dr Cahoon concluded that the impacts on primary production and ecosystem processes dependent on it from this project will be temporally limited, spatially limited, occurring in an environment where physical disturbance on much greater scales is a normal feature, and well within the adaptive capacity of the primary producer community. He foresaw no significant impacts on primary production or ecosystem processes dependent on it at any but very local and temporary scales. He considered the proposed sand-mining activities represent an impact to which continental shelf ecosystems are robustly adapted and from which they recover rapidly.

25. I rely on these aspects of Dr Cahoon's evidence to conclude that the various harms described in paragraph 111(a) of the Court of Appeal's decision are immaterial.

26. In paragraph 111(b) the Court of Appeal also noted the 2017 DMC was 'concerned for effects [of sediment] at locations demonstrated to have a rich and diverse benthic fauna, such as The Crack and The "Project Reef"'. It is pertinent here to repeat some of my original evidence and introduce some new evidence on the ecologically consequential concentrations of suspended sediment on benthic invertebrate fauna. Specifically, I note that:

    (a) Filter feeding bivalves, especially those occurring in naturally turbid environments can compensate

efficiently for a decrease in food quality over a wide range of suspended sediment concentrations (**SSC**) by maintaining an effective pre-ingestive mechanism of selection for organic particulate matter, as well as increasing filtration and rejection rates (Navarro and Widdows 1997).[19]

(b) A laboratory experiment has indicated that SSC of 80 mg/l or higher have adverse effects on the condition of the horse mussel *Atrina zelandica* (Ellis et al. 2002).[20]

(c) Green-lipped mussels, *Perna canaliculus*, decline in filtration rate only when SSC is above about 1,000 mg/l (Hawkins et al. 1999).[21]

(d) More recently the response of two New Zealand invertebrate species (a common cushion sponge *Crella incrustans* and large dog cockle *Tucetona laticostata*, which are both present within the STB) to elevated suspended sediments has been experimentally assessed as part of the Sustainable Seas National Science Challenge.[22,23] Both had high survival rates and no effect was observed on oxygen consumption following four weeks of exposure to SSCs

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19 Navarro, J.M.; Widdows, J. (1997). Feeding physiology of *Cerastoderma edule* in response to a wide range of seston concentrations. Marine Ecology Progress Series 152: 175–186.

20 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.

21 Hawkins, A.J.S.; James, M.R.; Hickman, R.W.; Hatton, S.; Weatherhead M. (1999). Modelling of suspension-feeding and growth in the green-lipped mussel *Perna canaliculus* exposed to natural and experimental variations in seston availability in the Marlborough Sounds, New Zealand. Marine Ecology Progress Series 191: 217–232.

22 Cummings, V.J., Beaumont, J., Mobilia, V., Bell, J.J., Tracey, D., Clark, M.R., Barr, N. (2020). Responses of a common New Zealand coastal sponge to elevated suspended sediments: indications of resilience. Marine Environmental Research, 155: 104886.

23 https://www.sustainableseaschallenge.co.nz/tools-and-resources/sponges-and-suspended-sediment-on-the-south-coast/

of up to approximately 700 mg/L. Although sediments had accumulated internally within *C. incrustans*, around a third of sponges had cleared these sediments two weeks after the elevated SSCs were removed.[22]

27. I note that the modelled spikes in background plus mining derived SSC on inshore reefs are much lower (by up to 1 or 2 orders of magnitude) than the concentrations reported in the above studies[24] and conclude that effects on reef fauna will be negligible and thus of no 'material harm'.

28. Further, I note that the 2017 DMC was seemingly satisfied that inclusion of 'The Crack' and 'Project Reef' as compliance monitoring sites would address their concerns regarding the impact of mining derived sediments.

29. In paragraph 111(c) the Court of Appeal summarised the 2017 DMC's concerns regarding the effects of mining elevated SSC in areas such as The Crack and "Project Reef" may include either temporary or permanent displacement of fish species. I note that in fact the 2017 DMC took a wider view referring[25] to my own evidence where I considered these effects to be "very small" in the context of the overall distribution of species, meaning that less than 1% of their distribution will be affected. The 2017 DMC noted other fish experts agreed with my view. While there may be some localised short term displacement of some fish species, this probably occurs during every natural disturbance (storm) event, and I consider the effects in total do not amount to material harm as defined by the Supreme Court. The new DMC may find the assessment of mining impacts on fished species undertaken by MacDiarmid et al.

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[24] See Figure 4 in Expert evidence of Dr. Lawrence Cahoon on behalf of Trans-Tasman Resources Limited, 9 December 2016

[25] At [437].

(2015)[6] useful in providing the required weighting of qualitative, temporal, quantitative and spatial aspects.

30. In paragraph 111(d) the Court of Appeal summarised the 2017 DMC's concerns regarding the impact of the sediment plume on the rohe of Ngāti Ruanui and Ngā Rauru, listing in particular the severe effects on seabed life within 2 - 3 km of the project area and moderate effects up to 15 km from the mining activity.

31. All the parties agree that very close to wherever the mining operations are currently taking place the effects will be extreme at the suction face and within 1-2 km of the point where sediment is returned to the seabed. However, it is important to note that this will not occur over the entire PPA all at once but will sequentially and gradually occur within a short distance of the mining ship as it traverses the PPA over the course of 35 years. I note that the PPA and immediately adjacent areas are very exposed, high energy, highly dynamic sandy environments and are thus subjected to frequent episodic disturbances from wave events and river inputs during high rain-fall events. Consequently, the existing benthic community in the PPA is dominated by short-lived, opportunistic and early successional or colonisation stages, with a very low abundance of longer lived organisms. This community is well-adapted to disturbance and will in time recover once the immediate disturbance has ceased.

32. The time it will take for the benthic community to recover is not able to be stated with precision as recovery rates need to be inferred from studies undertaken in more sheltered locations.

33. Generally, communities associated with sand in high energy environments are very frequently disturbed and are likely to be continually in an early transitional stage. The longer lived species in these communities, such as large starfish (which were found at low densities of six per ha in the PPA), could take several years to fully recover in the area where sands are extracted and re-deposited. But there is the potential for some movement of these mobile species into the area immediately after the iron sand recovery activities move to the next block.

34. In summary, the dominance by early successional stages in the area where the actual excavation and sand re-deposition takes place means that recovery should be relatively rapid and likely to be at the scale of months to a year. Recovery of some taxa such as small polychaete worms would be expected to start within a few weeks of the iron sand recovery operations moving elsewhere within the consent area. However larger, long-lived biota could take months to several years to fully recover in the excavation area.

35. Drawing on the assessments outlined above, and on the additional detail set out in my earlier evidence I consider the effects from discharge of mining sediment on biota, including primary producers, invertebrates, fish and marine mammals, will not result in material harm.

CONDITIONS

36. Confirming the recovery of the benthic environment in the PPA is an integral part of the proposed monitoring programme established by the consent conditions.

37. I am instructed by counsel for TTR that the Supreme Court considered the 2017 DMC placed too much reliance on the proposed monitoring programme — particularly, that pre-commencement monitoring was being used to address issues

of incomplete information and/or uncertainty that ought to have been addressed as part of the consent assessment.

38. I do not agree with that assessment. The 2017 information was in my opinion comprehensive, and sufficient to enable a proper assessment of all the effects associated with the sediment discharge. The monitoring program was not to address a deficiency in the application, but:

(a) to supplement the already sufficient information in the application with the most up-to-date baseline dataset prior to commencement; and

(b) to impose requirements to ensure that the directly-impacted benthic environment of the PPA recovers at a rate that ensures there is no material harm.

CONCLUSIONS

39. The proposed mining area and adjacent areas in the STB are one of the best studied shallow exposed shelf marine environments in Aotearoa New Zealand with a wealth of studies generated by the applicant that add to a body of existing information. The information is the best available and sufficient for me to give my expert opinion on the effects of the proposed mining operations and resulting sedimentation on biota in the STB.

40. I acknowledge there are uncertainties in making this assessment, most particularly the inherent uncertainty that comes from reliance on models that are attempting to represent complex natural systems comprised of many variable components and incorporating a specific human disturbance.

41. In light of the Supreme Court's findings, I have considered whether 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 on biota in the STB, including ecological effects on marine mammals. In my opinion, it will.

Dr Alison MacDiarmid

19 May 2023