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9 November 2025

Hon. Kit Toogood
Panel Chair
C/- The Environmental Protection Authority

[redacted]

Dear Hon. Kit Toogood,

**Review of Information on Underwater Generated Noise from the Taranaki VTM Project (FTAA-2504-1048)**

## Preface

This review aims to be accessible to a range of audiences, including the Expert Consenting Panel, technical acoustic experts, academics, ecologists, planners and lawyers. Readers are cautioned that the broad scope of audiences has necessitated some simplified descriptions or generalisations of technical concepts. Consequently, careful consideration of the context and potential limitations of the terminology and technical concepts is advised.

This review addresses a significant number of documents, reports, reviews and evidence. The opinions expressed in this review have been derived from a critical evaluation of the information reviewed. Some of the opinions expressed are explained only briefly for brevity and to ensure that this review is understandable to the range of audiences that may read it. The author is available to provide a more detailed explanations and justifications if they are required.

This review addresses the author's primary issues of concern. There may be other minor issues or inconsistencies with the application and assessments that are not addressed here. These are expected to be minor and inconsequential to the outcome of any revised assessments.

## Personal Statement

1. My name is Matthew Keith Pine. I hold the degrees of Ph.D. in Marine Science and B.Sc. in Biological Sciences from the University of Auckland.
2. I have been working in the field of underwater acoustics and noise effects on the marine environment for more than 12 years and have authored and co-authored over 50 peer-reviewed scientific papers on underwater noise and/or noise effects on the marine environment since 2012.
3. I have completed Post-Doctoral Research Fellowships at the Chinese Academy of Sciences (China, 2014-2017) and Department of Biology at the University of Victoria (Canada, 2017-2020) in passive acoustics monitoring, noise propagation modelling, and noise effects on marine mammals and fishes.

4. I also specialise in edge machine learning for bioacoustics research, particularly for passive acoustic monitoring and marine mammal acoustic detection and tracking.

5. I have been asked by the Environmental Protection Authority (**EPA**) to critically assess the technical information addressing underwater noise generated by the proposed iron sand extraction and processing activities associated with the Taranaki VTM Project (the **Activity**).

6. I am a regular expert witness in Council and Environment Court hearing processes. I confirm that, in my capacity as author of this report, I have read and abide by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

## Purpose & Scope

7. The purpose of this review is to assist the Expert Consenting Panel to understand whether the application documents provide a sufficient and reliable basis for understanding the nature and magnitude of underwater noise levels and effects generated by the activity.

8. I have been instructed to focus on the characterisation, prediction and measurement of underwater noise generated by the proposed mining and support activities.

9. I have been instructed not to review noise effects on marine mammals, or other species, unless specific issues regarding noise thresholds or disagreements in the reviewed reports directly bear on interpretation or reliability of noise generation information.

10. I use the same terminology and reference units for acoustic metrics as in the application, to prevent any confusion for the Expert Panel.

## Applicant Documents

11. I have reviewed a number of documents that are relevant to the proposal.

### Report 28 – Hegley Acoustics Consultants Assessment of Noise Effects (2015)[1]

12. I consider the Hegley 2015 report unreliable, lacking in scientific rigour and cannot be relied upon for assessing the effects of noise on the marine environment.

### The AECOM Report (2017)[2]

13. It appears that the 2017 AECOM report supersedes the Hegley 2015 report and constitutes the main underwater acoustic assessment in this application. It is very important to note that the AECOM 2017 report forms the foundation for the noise effects of the activity on marine mammals.

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[1] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0016/4318/Report-28-Hegley-Assessment-of-Noise-Effects-FINAL.pdf

[2] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0008/12311/TTR-response-to-Minute-4-request-for-Humpheson-2017-Report_Redacted.pdf

14. The 2017 AECOM Report was supplemented in 2024 by CAN-001 from T+T attached to the evidence of Dr Simon Childerhouse (Report 4b)[3]. The 2024 updates involved:

    - M-weighting functions from Southall et al. (2019) were applied to the source levels used in the updated 2024 T+T report; and
    - The propagation loss modelling method was changed in the 2024 T+T report to a 'split-solver' method, whereby 'normal modes' modelling was used for frequency bands below 1/1 octave band of 250 Hz, and a 'ray tracing' method used for bands above, and including, 250 Hz. The 2017 AECOM report had used only a normal modes propagation loss model for all bandwidths in dBSea.
    - The source position in the 2024 T+T report was changed to a shallower depth of 35m and the bottom layer in the models (the seafloor) was changed to an infinite depth sandy layer. These compare to a depth of 45m and a confined 15m deep sandy layer in the 2017 AECOM report.

15. All other assumptions and model input data in the updated underwater noise models in the 2024 T+T report were unchanged from the 2017 version, including the sources modelled and their source levels.

## The T+T Reports

16. There are two T+T reports in the application that I refer to in this review:

    a. The **2024 T+T report (CAN-001)** mentioned above and this is appended to Dr Simon Childerhouse's Rebuttal Evidence to the EPA, dated 23 January 2024[4], and again to Mr Darran Humpheson's Expert Evidence to the EPA dated 16 February 2024[5].

    b. The **2025 T+T report (CAN-002)** that is appended to Mr Humpheson's Response to Comments Received Evidence to the Expert Panel dated 13 October 2025[6]. The 2025 T+T Report (CAN-002) updated the M-weighting functions and effects thresholds to the current 2024 NMFS guidance in reply to the peer-review undertaken by JASCO Applied Sciences[7].

17. My review often refers to the 2017 AECOM report, the 2024 T+T report (CAN-001) and the 2025 T+T report (CAN-002) collectively as the **Modelling Reports**.

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[3] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0018/4275/Report-4b-Rebuttal-evidence-CHILDERHOUSE-Jan-2024.pdf

[4] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0018/4275/Report-4b-Rebuttal-evidence-CHILDERHOUSE-Jan-2024.pdf

[5] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0017/4274/Report-4a-Further-evidence-HUMPHESON-Feb-2025.pdf

[6] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0017/13184/2-9-Appendix-J-SOE-Darran-Humpheson-Acoustics,-Tonkin-and-Taylor-Ltd.pdf

[7] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0013/13207/Forest-and-Bird-JASCO-peer-review-on-underwater-noise-and-marine-mammals.pdf

## My general position

18. After reviewing all the elements of the proposed activity, including the multiple support vessels and their operations, I consider that issues exist with the methodology used to assess the noise generation itself, the assumptions made, and the propagation loss models themselves.

19. After reviewing the Modelling Reports, I consider the underwater noise assessment for the proposed activity to be incomplete and scientifically questionable. I consider that ultimately it is unreliable for informing the assessment of noise-related impacts from the proposed mining activities on marine mammals.

20. From a management point of view, there are two key issues that stem from an unreliable underwater assessment in this case:

    - The M-weighted noise models, and therefore TTS threshold ranges presented to the marine ecologists assessing the impacts, are incorrect because the underlying models in the Modelling Reports suffer from fundamental issues.

    - I consider that compliance with Condition 11 will likely be impracticable, and maybe even impossible, if not very difficult, to achieve in practice. This has the potential to erode the protection to marine mammals.

21. Some of the same issues have also been highlighted by independent peer-review of the underwater acoustic assessment by JASCO Applied Sciences (Jolliffe et al. 2025).

22. Jolliffe et al. (2025) did not review the 2017 AECOM report, however, due it not being included in the application at the time.

23. The 2017 AECOM report does not include any marine mammal effects modelling, stating that to be out of the report's scope. The predicted noise levels in that report were therefore unweighted, and no effects were included. Instead, it focused on predicting the source levels of the activity, the range-dependent propagation loss from the mining operation and presenting sound pressure level contour maps. This acoustic model appears to have formed the basis of the noise limits set in Condition 11 and 12.

24. After reviewing the 2017 AECOM report and the numerous updates since (most recently the 2025 T+T report (CAN-002)), I have five concerns. These are:

    - The source levels of the IMV and crawler used are likely to be too low.

    - Large assumptions have been made regarding the operation of the IMV's DP system and the reasoning expressed for excluding support vessels from the underwater noise assessment.

    - The application of the ray tracing model in the propagation loss calculations used in the 2024 T+T report (CAN-001) and again in the 2025 T+T report (CAN-002).

    - The misinterpretation of the NMFS guidance on the cumulative sound exposure thresholds.

- Long-term/chronic changes to the underwater soundscape around South Taranaki Bight (**STB**) are not considered.

25. I explain each of these concerns in the sections below.

## Source levels & support vessel operations

26. The Modelling Reports consider multiple noise sources associated with the proposed operations, including the machinery noise, DP thruster noise and from the FSO support vessel. The Modelling Reports do not, however, give any serious consideration for the other support vessel types or noise sources associated with the activity, namely the sonar systems and acoustic positioning systems used by the crawler itself and some support vessels (such as the Geotechnical Support Vessel (GSV) and the Environmental Monitoring Vessel (EMV).

27. Sonar systems and other equipment generally emit high and sometimes very high frequency acoustic signals. By contrast, the IMV, crawler and support vessel noise is generally low frequency. The high frequency noises that have not been modelled by the applicant may not be as far-reaching as low frequency sounds (that they have modelled), but they can still have impacts on delphinid species, especially Hector's and Maui dolphins, with hearing sensitivities that overlap with some sonar systems.

28. The Modelling Reports cite data from De Beers' operation in Namibia in 1994 and 1995 when estimating the broadband source levels of the crawler and to justify the assumed source levels associated with the IMV. Those references were also used to obtain the source spectra.

29. The Modelling Reports also considers the DP thrusters onboard the IMV, however states that under normal circumstances, the DPS will not operate and therefore not be additive to the overall source level of the IMV + crawler operation.

30. Published source level data for the IMV + crawler is unavailable and scarce. It is therefore necessary to make assumptions on the source levels. I consider that estimating source levels/spectra is commonly done for underwater noise modelling in New Zealand and internationally.

31. The source levels used in the Modelling Reports are:

    - IMV: 171 dB re 1 µPa @ 1m.
    - IMV + DP thrusters: 177 dB re 1 µPa @ 1m.
    - Crawler: 171 dB re 1 µPa @ 1m.
    - FSO: 173 dB re 1 µPa @ 1m.

32. I am not confident that these source levels are reliable because:

a. I am unable to reach the same octave source spectrum for the IMV, crawler, or DPS from the De Beers' 1994 and 1995 data. This Curtin University review[8] of the 2017 AECOM Report reached the same view during the 2017 hearing.

b. Published data from similar machinery onboard floating production storage and offloading (FSPO) vessels with DPS used in the offshore oil and gas industry show source level variations between 173 and 188 dB re 1 µPa @ 1m while operating (Erbe et al. 2013[9]). This same paper was cited in the 2017 AECOM report. Despite this, however, the Modelling Reports assume a source level of 177 dB re 1 µPa for the IMV+DP which is 4dB lower than the median level reported by Erbe et al. (2013)). The reasoning behind this 177dB value is not explained in the Modelling Reports.

c. The FSO source level of 173dB re 1 µPa @ 1m in the Modelling Reports is not referenced or explained.

33. The Modelling Reports deliberately exclude the DP noise from the IMV noise source model: the reason given is that in normal conditions the DPS will not operate and therefore thruster noise will not be additive to other extraction and processing noise from the IMV. This is a very important assumption because if it is not true, the source level of the IMV will be 6 dB higher based on the applicant's own source levels in Table 1 of the 2017 AECOM report).

34. I disagree with using the assumption that the DP will be inoperative most of the time (as implied in the 2017 AECOM report) to justify excluding it because the DPS will be engaged at some point, and therefore the underwater noise assessment does not control for the worst-case scenario. Modelling the worst-case scenario is best practice and widely done in underwater noise assessments in New Zealand and internationally.

35. To illustrate why this is important, the 2025 T+T report (CAN-002) states that the TTS range for low-frequency cetaceans (which includes blue whales and humpback whales) is 475m (see Table 3.1 Onset distances of the 2025 T+T report). At 500m, the modelled LF-weighted sound exposure ($L_{E,p,24hr}$) level is reported as 176 dB re 1 µPa$^2$s (Table 3.2 of the 2025 T+T report), which is 1 decibel below the NMFS (2024) TTS threshold of 177 dB re 1 µPa$^2$s (LF-weighted). However, this is based on an IMV source level of 171 dB re 1 µPa, which is acknowledged in the Modelling Reports to increase to 177 dB re 1 µPa if the DPS is engaged onboard the IMV. Therefore, when the DPS is engaged, that TTS range of 475m for LF cetaceans will extend well beyond 500m. If the FSO (which is also equipped with dynamic positioning) approaches and as the offloading process continues over several hours, that TTS range for LF cetaceans will extend even further.

36. With the DSP being engaged possibly thousands of times over the 20 years that the mining operation is to occur, coupled with the issues with the modelling that I explain

[8] https://www.epa.govt.nz/assets/FileAPI/proposal/EEZ000011/Evidence/aff2527ccb/Curtin-University-review-UnderwaterNoise.pdf

[9] Erbe, C., McCauley, R., McPherson, C., & Gavrilov, A. (2013). Underwater noise from offshore oil production vessels. *Journal of the Acoustical Society of America*, *133*(6), EL465–EL470. Accessible here: https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/erbe_2013_underwater_noise_from_offshore.pdf

below, I consider that the following statement (made in the Taranaki VTM Application Document[10]) under Section 5.9 Noise Effects) is misleading:

> *"The comparison of the estimated underwater noise data (Table A) with the m-weighted thresholds for TTS and PTS provided in (Table B) indicate clearly that there is no risk of either TTS or PTS for any marine mammal species at 500m or further from the operation even if they spend 24 hours in the area."*

37. The Modelling Reports deliberately exclude all movements of the support vessels (such as the FSO, CEV and AHV) in all acoustic models, based on them being intermittent. This is not best practice, and I consider it is somewhat unusual to effectively ignore those vessels given the offloading operations are an integral part of the proposed activity. The Curtin University peer review[11] points this out as well.

38. The Taranaki VTM Application Document explains that the FSO vessel must travel at least 2km between the CEV and IMV, meaning this potentially noisy offloading activity (potentially as noisy as the IMV based on Table 1 of the 2017 AECOM report) will push the unweighted noise contours further out.

39. The offloading/transfer between the FSO and CEV is not continually occurring, as correctly identified in the 2017 AECOM report. However, when offloading does occur it could exceed a noise level of 135dB re 1 µPa at 500m.

40. The cumulative noise exposure from these multiple, often moving, noise sources was given some consideration to the additional noise sources at the mining site, i.e., the crawler, IMV + DPS, and the FSO (without its DPS operating). In that scenario, the unweighted sound pressure level at 500m (the compliance level of Condition 11c designed to provide the Expert Panel with a definitive limit of allowed noise) would be exceeded by approximately 7 dB[12]. Given that a doubling of acoustic energy equates to approximately 3dB increase, an increase of 7dB is substantial.

41. The significance of a 7dB increase to the effects ranges for marine mammals (and therefore noise exposure and potential acoustic disturbance) is acknowledged in the 2017 AECOM report, where in the Executive Summary it states that by adding *"other support ships and dynamic positioning thrusters on-board the integrated mining vessel"* to their point-source model, that the 120 dB re 1µPa contour for behavioural response increases from 10km to 23km from the mining area. That is a 130% increase in the behavioural response effects range.

42. The applicant's method of adding noise from spatially distinct sources (e.g., the FSO + IMV) to a single source position point is not commonly done, especially when the independent sources to the IMV (i.e., the FSO, CEV) can produce substantial noise levels potentially several kilometres apart.

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[10] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0017/4337/Taranaki-VTM-FTA-Application.pdf

[11] https://www.epa.govt.nz/assets/FileAPI/proposal/EEZ000011/Evidence/aff2527ccb/Curtin-University-review-UnderwaterNoise.pdf

[12] Based on Paragraph 54 of Mr Humpheson's evidence to the Expert Panel, dated 13 October 2025.

43. In my experience, modelling multiple independent sources separately in time and then combining them to form cumulative noise models is a standard method for assessing cumulative sound exposures from multiple sources in the marine environment. This method has been used for several resource consent applications in New Zealand, as well as internationally and in peer-reviewed scientific studies. An example of such a cumulative noise model that was constructed using that type of method is provided in Figure 2 of Mr Humpheson's reply evidence dated 13 October 2025. I was not involved in that project.

44. I therefore disagree with the Taranaki VTM Application Document Section 5.9 *Noise Effects* where states "*it is unrealistic to define a specific point source for the combined noise sources given all the noise sources are spread over a large area*" as a defence for why cumulative sound exposure models were not built. I consider that it can be done and should have been done.

45. I consider that the actual extent of likely noise levels and effects has not been appropriately modelled. I consider that this may lead to consequential errors in the assessment of the effects of the noise emissions.

## Propagation loss modelling

46. The Modelling Reports adopt propagation loss modelling using the commercially available dBSea software. The 2024 T+T report (CAN-001) and 2025 T+T report (CAN-002) adopt normal modes and ray or beam tracing models to estimate the range-dependent propagation of noise underwater. The 2017 AECOM report only used normal modes models.

47. These propagation models are widely used, well tested and standard methods in underwater acoustics.

48. However, the criteria for determining the specific frequency that determines whether normal modes or ray/beam tracing models are used is critical. The specific frequency can change and is determined by the properties of the propagation environment/water column in question. The most important variable is this case is the depth (i.e., the waveguide) to wavelength ratio.

49. Ray and beam tracing models are valid for higher frequencies, generally with wavelengths greater than 10x (often >20x is preferred for implementations such as BELLHOP) the water depth (McCammon et al. 2022[13]). Normal modes are commonly used for low frequencies and can be computationally efficient.

50. The 2017 AECOM report states that a normal modes model was used for all bands. However, in the updated modelling results in the 2024 T+T report (CAN-001) and again in the latest update 2025 T+T report (CAN-002), the propagation modelling was changed to

[13] McCammon, D., Hamm, C., Brooke, G., et al. 2014. Review and inventory of current underwater sound propagation modeling methods (JIP Solicitation No. JIP 08-08). Maritime Way Scientific Ltd for the Joint Industry Programme on E&P Sound and Marine Life.

use normal modes ('dBSea Modes solver') for octave bands below 250Hz, and ray tracing ('dBSea Ray solver') for bands above (and including) 250Hz.

51. The wavelength at 250Hz is approximately 6.1m. This is based the water properties in Table 2.2 of the 2025 T+T report (CAN-002), being a water temperature of 18°C, salinity of 35ppt, pH8 and a depth of 34m. This wavelength ($\lambda$) to depth (D) ratio is well below the general rule of thumb of D>10$\lambda$ (or D>20$\lambda$ for BELLHOP) used to establishing true validity of ray and beam tracing models. Because of this, the rays being 'drawn' by the ray model do not propagate through the waveguide as they would be if modelled using a more valid model for that wavelength (such as normal modes, or parabolic equations (PE)) (Erbe et al. 2023[14]). The use of a ray model for low frequency bands in acoustically shallow water will result in a higher propagation loss over distance than would likely occur in nature.

52. It is not standard practice to model frequencies below 1kHz in acoustically shallow waters using ray trace models. This is because the absolute limits of validity for those models in shallow waters occur below 1kHz and the model becomes very sensitive to the input parameters (i.e., the environmental data inputted, which are based on assumptions and generalisations). Instead, using wave models (such as normal modes or parabolic equation models) are much safer, especially in environmental management contexts.

53. Those wave models are available in dBSea, as normal modes was used for octave bands below 250Hz. This could, therefore, be easily extended to at least 1kHz (1.2kHz would be safer still).

54. Using ray tracing models for frequencies below 1kHz for this proposed activity is also problematic given much of the acoustic energy is below 1kHz. Those low frequencies propagate the furthest and are fundamentally important frequency ranges for low-frequency cetaceans.

55. I consider that the applicant's use of ray tracing models for low frequency octave bands with extremely limited validity in acoustically shallow water, and high degree of sensitivity to the input parameters at those edges of validity, will be substantially underestimating the sound field, especially the TTS range for LF cetaceans.

56. This is reflected in the updated contour plot (Figure 4 of Appendix A of the 2025 T+T report (CAN-002)), where the contours are substantially smaller, and show lower unweighted sound pressure levels at the furthest distances than in the 2017 AECOM report (see Map 1 appended to the 2017 AECOM report). For example, reading off Figure 4 of the 2024 T+T report, the 90dB re 1 µPa contour is more than 100km closer to the centre of the application area than in the AECOM report. This is a substantial difference.

57. The issue of applying the ray tracing model for frequencies below 1kHz is further illustrated by the inconsistency between the 2017 AECOM report and Mr Humpheson's October 2025 reply evidence. In Paragraph 50 of Mr Humpheson's reply evidence dated 13 October 2025, it states modelled crawler and IMV sound levels around 100dB unweighted would occur at a distance of 12 nm (22 km) from the mining activity. However, in the 2017

[14] Erbe, C., Duncan, A., Vigness-Raposa, K.J. (2022). Introduction to Sound Propagation Under Water. In: Erbe, C., Thomas, J.A. (eds) Exploring Animal Behavior Through Sound: Volume 1. Springer, Cham.

AECOM report's Executive Summary, it states that the 120dB contour reaches 23km. This is only 1km further, but a 20dB difference. Furthermore, that 120dB contour was based on the IMV + DSP + crawler + FSO, so was 8 dB louder than that used in Mr Humpheson's October 2025 reply evidence.

58. The use of a normal modes model up to and including at least the 1kHz (1.2kHz would be better still) octave band would be more appropriate. This would deliver a larger and more accurate acoustic footprint.

59. I note there is an inconsistency where the unweighted sound pressure levels presented in Table 3.2 of the 2025 T+T report (CAN-002) shows identical values to the 2027 AECOM report (Table 4 of the 2017 AECOM report), despite changing the propagation models. This does not make sense.

60. Finally, the sediment layer used in the model is "*sand extending infinitely*" and has been applied throughout the STB region in the noise model (i.e., the seabed is assumed to be homogenous). Based on Report 11, 11a and 11b, the seafloor is not homogenous but contains muddy deposits over gravel, sands and gravely sands in some areas near the activity area. The acoustic reflectivity of gravelly sands is substantially higher than sandy sediments and using soft, sandy sediments of indefinite depths will be overestimating the propagation loss with range than if gravel, or gravelly sands, were incorporated.

## Why appropriate acoustic models matter

61. Proposed Condition 11a states:

> *"The combined noise from the IMV and the Seabed Sediment Extraction Device ("Crawler") operating under representative full production conditions must be measured at a nominal distance…."*

62. Proposed Condition 12 states:

> *"The consent holder must design and construct the crawler and IMV to achieve, at full production, a total combined noise source level (measured in water), of not more than 177 dB re 1 µPa RMS linear at one (1) metre."*

63. In Report 4b[15], Paragraph 13 states:

> *"it is not essential to be able to predict the underwater noise levels of the operation for the simple reason that TTR have proffered Condition 11 that sets the maximum allowable level of underwater noise from the operation."*

64. I understand the point made in Paragraph 13 of Report 4b, but after reviewing the Modelling Reports and supporting information as part of this application, I believe that Condition 11 (noise limits) will likely be exceeded often. This is based on the reasons explained above regarding the noise sources included, the assumptions around the

[15] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0018/4275/Report-4b-Rebuttal-evidence-CHILDERHOUSE-Jan-2024.pdf

source levels used and the use of a ray tracing model for frequencies below 1kHz in approximately 35m of water.

65. Even if compliance with Condition 11 is achieved, I consider the simple noise limit would not adequately control the effects that have been described in the application because the propagation loss appears inaccurate, and Condition 11 does not include any support vessel operation.

66. Condition 11 only limits the noise from the IMV and the crawler, when it is acknowledged in the Modelling Reports that the FSO alone is a significant noise sources that is mobile. The mobile nature of the support vessels makes compliance with a limit at a fixed distance from the IMV impracticable to monitor and meaningless control of effects of the mining operation as a whole.

67. Furthermore, exceeding 135dB re 1 µPa at 500m is likely since the FSO and CEV offloading operations, as well as the offloading from the IMV to the FSO, have been completely ignored in the effects modelling. The offloading operations can be as loud as the IMV according to Modelling Reports, where the FSO source level is stated as being 1dB below that of the IMV + crawler. This means a receiver could be several kilometres from the IMV + crawler noise but reaching the onset TTS threshold sooner than expected due to the FSO unloading to the CEV.

## NMFS guidance for effects of noise on marine mammals

68. Reviewing the effects of noise on marine mammals is outside my brief, however, the application of NMFS M-weighting function and effects thresholds (that inform the assessment on marine mammals) are well within my expertise.

69. The 2024 T+T report (CAN-001) presents the M-weighting functions and auditory injury/TTS thresholds applied based on Southall et al. (2019)/NMFS (2018). Those functions and thresholds were outdated when the present application for consent under the Fast Track Approvals Act was submitted (April 2025).

70. The 2024 NMFS guidance provides substantial updates to the M-weighting functions and thresholds used in the 2024 T+T report. The NFMS updates are based on the best available science. Accordingly, I consider that these must be applied to the TTR noise effects assessment. This issue was also raised in the JASCO peer review by Jolliffe et al. (2025)[16].

71. In response to the JASCO peer-review, the applicant submitted updated underwater noise effects models to reflect the current NMFS (2024) guidance. The updated M-weighting contours and TTS ranges are provided in the 2025 T+T report (CAN-002).

72. However, after reading Mr Humpheson's October 2025 reply evidence, I consider that there is a clear misinterpretation of the NMFS guidance and what the SEL metric means.

[16] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0013/13207/Forest-and-Bird-JASCO-peer-review-on-underwater-noise-and-marine-mammals.pdf

73. This misinterpretation is very important because it has been carried forward as part of Mr Humpheson's defence for excluding the movement and operation of support vessels (mainly the FSO, CEV and AHV vessels) in the marine mammal effects modelling, as well as the exclusion from any noise controls in proposed in the Conditions.

74. As I set out above, I disagree these support vessels can be excluded from the underwater noise modelling, as it is not industry standard or best practice to do so. This was also stated in the JASCO peer-review.

75. Paragraph 53 of Mr Humpheson's response evidence states:

> *"…For my assessment, only the crawler and IMV were modelled in dBSea, as these are the sources operating as continuously over a 24-hour period as sea conditions allow. Other sources were excluded because marine mammal guidance (NMFS 2024) evaluates cumulative noise exposure over 24 hours, assuming an animal remains at a fixed position and is continuously exposed – an unlikely scenario given the marine mammals rarely stay in one location for that duration. Therefore, only the combined noise generation of crawler and IMV were assessed to inform the marine mammal effects assessment."*

76. I consider that this reasoning is flawed because it misunderstands the definition of the 24-hour accumulation period (used in the SEL threshold metric, $L_{E,p,24h}$). This metric is specifically designed to allow for the summation of acoustic energy from sources that are intermittent, non-continuous or continuous. It is designed to predict potential hearing effects based on a cumulative sound exposure over a maximum accumulation period of 24hrs, regardless of the noise source's duty cycle or whether the animal receiver is stationary/present.

77. The 24 hours is an accumulation period, not a required exposure duration. The $L_{E,p,24hr}$ metric represents the maximum baseline accumulation period recommended for assessing exposure, but it does not require the source to be present for 24 hours or the animal receiver to be exposed for that duration. The $L_{E,p,24hr}$ threshold can be exceeded well inside 24 hours if the cumulative exposure required to achieve TTS is reached.

78. A good way to conceptualise the $L_{E,p,24hr}$ metric is to consider acoustic energy as a dose, and there is a maximum allowable dose within 24hrs before TTS onset begins. The $L_{E,p,24hr}$ TTS threshold represents that allowable dose over a 24hr period, and the TTS range/contour in an effects model represents the distance from the noise source within which that dose will be exceeded, regardless of exposure duration.

79. The $L_{E,p,24hr}$ metric calculates the cumulative exposure (i.e., increasing dosage levels) from noise events over an accumulation period of 24 hours. This calculation involves summing the energy of multiple exposures to generate a single equivalent level. This is a precautionary approach as it assumes no recovery of hearing between repeated exposures.

80. Since the IMV + crawler is so slow moving (i.e., 70m per hour) over a series of small 'blocks' (each block is 300m x 300m), treating as a stationary source could be reasonable in this case, as the Modelling Reports have done. For faster moving sources, however, such as the support vessels, exposure modelling that integrates the vessel's speed and

additional noise-generating equipment would be used to determine the distance at which the accumulation of sound energy reaches the $L_{E,p,24hr}$ threshold.

81. The problem with excluding the support vessels in this application, is that some of them (i.e., the FSO) are almost as loud the IMV + crawler[17] and they have the potential to increase the cumulative acoustic energy exposure (dosage) at a faster rate than expected if only considering the IMV + crawler. The support vessels (the FSO offloading to the CEV) will be more than 2km away from the IMV and are present for long periods of the proposed operation's lifespan of 20 years. This spatial separation compounds the issue of excluding them because the rate at which the sound exposure increases through time (i.e., the noise dose would be accumulating at an animal receiver) will be substantially underestimated if an animal receiver was closer to the FSO offloading to the CEV than the IMV + crawler operating more than 2km away.

82. This is also the case when the IMV is offloading to the FSO, since only the IMV + crawler has been considered in the effects models, and even more so if the DPS is engaged.

## Taranaki VTM Application Document

83. The Taranaki VTM Application Document[18] provides a high-level overview of the noise effects in Section 5.9. The *Noise Effects* Section 5.9 states that:

> *"…the assessment was made on the basis of the likely type of underwater noise that will be generated by the activity."*

84. I consider this to be untrue, based on the reasons set out above.

85. Section 5.9 goes on to state that no attempt has been made to assess impacts within 500m around the operation as it:

> *"…is unrealistic to define a specific point source for the combined noise sources given all the noise sources are spread over a large area…"*

86. I consider this is to be inaccurate and inappropriate, based on the reasons set out above.

87. The Taranaki VTM Application Document suggests that the underwater noise modelling does not need to predict the actual (i.e., accurate) underwater noise levels of the operation because Condition 11 sets a maximum allowable level of underwater noise from the operation. The applicant proposes that Condition 11 is designed to provide the Expert Panel the confidence required as the maximum levels can be definitively known at this time.

88. As I previously explain in Paragraph 64, I believe Condition 11 is likely to be exceeded often, and I consider that the modelling used to determine the noise levels out to and beyond the distances at which conditions 11 are based are flawed.

89. Section 5.9 states (underlining my emphasis):

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[17] Based on Table 1 of the 2017 AECOM report.

[18] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0017/4337/Taranaki-VTM-FTA-Application.pdf

*"Comparing the combined SPLs of the operation estimated with the 120 dB re 1 µPa threshold for potential behavioural effects indicates that it is only Low Frequency cetaceans (e.g. blue whale, southern right whale) where a behavioural disturbance may occur out to a distance of 1,500m from the operation. This suggests that further than 1,500m from the operation, there is unlikely to be an impact on behaviour."*

90. I consider that this is misleading because the 120 dB re 1 µPa threshold is an unweighted level threshold but appears to be applied directly to the LF-weighted SPLs in the model. I believe this because in the Executive Summary of the 2017 AECOM report, it is stated that the 120 dB re 1 µPa SPL is reached at 10km, and in Figure 4 of the 2025 T&T report (CAN-002), the contour is approximatively 3.16km (reading off Figure 4). Neither contour is close to the 1.5km stated in Section 5.9.

91. Finally, Section 5.9 states:

*"…the combined noise level estimated to be generated by the SBC unit and IMV combined is 177 dB re 1 µPa . This is significantly lower… than the average level of 187 dB re 1 µPa for large vessels…This suggests that the potential behavioural effects from the operation will be significantly less than we would expect to see from a large vessel noting that this operation is very slow moving compared with a faster moving large vessel."*

92. I consider that this comparison is misleading because the noise effects, including behavioural, are not only dependent on the instantaneous sound pressure level, but also the exposure duration. Therefore, although the IMV + crawler noise is quieter than a large ship transiting the STB, the overall sound exposure level (i.e., the accumulated acoustic dose) over that maximum accumulation period of 24 hours can be higher from the extremely slow moving IMV (which moves at 70m per hour).

## Additional notes

93. The underwater acoustics material submitted with the application is entirely focused on the noise generation of the mining operation itself. An assessment of how the operation will alter the existing soundscape is missing entirely in the application documents. I consider that this is very important given this is a new noisy activity that has the potential to generate chronic (long-term) adverse noise effects. Chronic means producing underwater radiated noise continuously for 20 years.

94. No characterisation of the existing soundscape is provided by the applicant. I consider that an assessment to understand the noise generation of the proposed activity in the context of the receiving environment, and how the proposed activity will change the existing soundscape is a typical component of impact assessments.

95. Multiple consent applications in New Zealand have undertaken passive acoustic monitoring to establish the existing soundscape before the consenting phase. Many of these have involved dredging activities at a far smaller scale than TTRL's application. For example, Northport Limited's port expansion project. Additionally, but not limited to, Port of Tauranga, Port Taranaki, McCallum Bros Ltd and others have undertaken passive

acoustic monitoring to characterise the existing soundscape to contextualise the noise generation and effects that might be likely from their proposals.

96. It is my experience that it is also standard practice in airborne environmental noise assessments to undertake noise monitoring to establish the existing noise environment and for the same general reasons.

97. This application deviates from typical consent applications in New Zealand in that it does not present any passive acoustic monitoring data to characterise the existing soundscape. Such data would also provide supplementary insights on marine mammal presence in and around the mining area.

98. The lack of passive acoustic monitoring was also raised in JASCO's peer-review (Jolliffe et al. 2025), and Dr Deanna Clement's Statement of Evidence to the Expert Panel, dated 6 October 2025.

## JASCO Applied Sciences Peer Review (Jolliffe et al. 2025)

99. JASCO Applied Sciences was engaged by the Department of Conservation to review the application in relation to the underwater noise and marine mammals[19].

100. The 2017 AECOM report was not reviewed by JASCO due to being unavailable to them at the time. Consequently, the JASCO review is largely focused on the effects of noise on marine mammals, as well as the proposed Conditions relating to underwater noise and marine mammal monitoring.

101. Notwithstanding, however, the JASCO review does raise important concerns regarding the underwater noise assessment's scope and noise modelling.

102. Since reviewing marine mammal noise effects is outside my brief, my review is focused on the noise generation, modelling and monitoring aspects of the JASCO review.

103. The main issues relating to the generation of underwater noise and modelling methods from the mining operations raised in the JASCO report are summarised as:

> *"Deficient underwater noise modelling and the scope of the assessment."*

104. The JASCO review points out that including only the IMV and the crawler in the underwater noise modelling is not best practice and renders the assessment incomplete. I agree, based on the points that I have explained above.

> *"All non-vessel noise sources (sonar, acoustic positioning systems etc) have not been considered."*

105. The Modelling Reports do mention the presence of these other sources, but concludes that they are insignificant and therefore does not consider them at all. The Taranaki VTM Application Document does mention the use of acoustic positioning devices, sonar,

[19] https://www.fasttrack.govt.nz/__data/assets/pdf_file/0013/13207/Forest-and-Bird-JASCO-peer-review-on-underwater-noise-and-marine-mammals.pdf

MBES, and other equipment that emit sound into the environment. While the noise effects of these sources these are not expected to propagate as far as the lower frequency mining operations and vessel noise, they can have impacts on Very High Frequency cetaceans near the source (within a few hundred metres). Therefore, I consider that these concerns in the JASCO review are valid.

*"The underwater noise modelling does not present the worst-case scenario."*

106. I agree, for the reasons explained above.

*"Outdated NMFS M-weighting functions and thresholds used in the effects assessment and must be updated."*

107. I agree with this. I note that the underwater noise modelling has been updated in the 2025 T+T report (CAN-002). However, due to the unexplained change to the propagation loss model (the introduction of dBSea Ray for octave bands 250Hz and above), I believe these updated contours are invalid and cannot be relied upon yet.

108. Section 2.8.2 Methodology Robustness of the JASCO review states:

*"…the conditions appear to be focused on the use of 130 dB SPL within specified frequency bands, (or unweighted 135 dB SPL) as the level which cannot be exceeded at 500 m with 500 m being the range to be monitored by marine fauna observers. It is unclear why 130 dB has been selected noting the industry standard threshold for behavioural response is 120 dB (note: this represents the median level at which marine mammals are expected to respond to continuous noise)."*

109. After reviewing the Application documents, including the Modelling Reports and Statements of Evidence from hearings going back to 2017, I am unable to find any explanation for where the 130 dB re 1 µPa in specified frequency bands, or the broadband 135 dB re 1 µPa, at 500m limit comes from. I am unaware of any international standard that stipulates such as noise limit. It would be helpful for the applicant to clarify where and how this limit originated.

110. The JASCO review also lists relevant standards that are relevant to Condition 11 and 12, especially when those conditions are related to the source level measurement of the IMV and crawler. I agree with these recommendations and I consider that relevant standards should be adopted and specified when they are applicable.

## Conclusion

111. I consider that the underwater acoustic modelling that forms the foundation of the noise effects contours and the potential acoustic disturbance in the marine environment is not yet reliable, nor does it follow best practice and industry standard methodologies.

112. In short, the source levels used in the modelling appear to be underestimated and are unlikely to be representative of a typical mining operation that aims to operate continuously, 24/7 for 20 years in an open water environment. This is important because it undermines the ability for Condition 11 and 12 to manage noise levels and effects.

113. My low confidence in Condition 11 or 12 to manage noise levels and effects is further compounded by the overestimated propagation loss, especially for octave bands between 250Hz and 1.2kHz, due to the misuse of one of the propagation loss models and assuming a sandy seafloor of infinite depth throughout the STB.

114. In conclusion, I consider that the documents do not provide a sufficient and reliable basis for understanding the nature and magnitude of underwater noise generated by the activity.

115. I consider that additional analyses would be needed to provide sufficient and reliable basis for understanding the nature and magnitude of underwater noise generated by the proposal. The noise modelling would be updated in a way that would resolve my points above and that follows best scientific practice.

Please contact me if you require any further information.

Yours sincerely,

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Principal Marine Scientist