BEFORE AN EXPERT PANEL **FTAA-2504-1048**

UNDER	the Fast Track Approvals Act 2024
IN THE MATTER	of a substantive application for marine consents that would otherwise be applied for under the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
BY	Trans-Tasman Resources Limited

EVIDENCE OF DARRAN HUMPHESON (ACOUSTICS) ON BEHALF OF TRANS-TASMAN RESOURCES LIMITED IN RESPONSE TO COMMENTS RECEIVED

13 OCTOBER 2025

HOLM | MAJUREY

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EXECUTIVE SUMMARY

1. This evidence addresses underwater acoustics issues related to Trans-Tasman Resources Limited's (**TTR**) application for marine consents under the Fast Track Approvals Act 2024 (**FTAA**). My assessment responds to concerns raised by submitters, including recreational diving groups, and expert reports (notably the JASCO report and the evidence of Dr D Clement for Forest and Bird).

2. Key conclusions:

   (a) **Diver Safety and Enjoyment:** Underwater noise from TTR's activities is predicted to be well below recognised thresholds for hearing damage to divers. As long as noise remains below levels associated with discomfort or hearing risk, recreational amenity is generally unaffected.

   (b) **Marine Mammal Assessment:** Updated underwater sound modelling has been undertaken using current best practice and regulatory guidance (including National Marine Fisheries Service Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (**NMFS 2024**)), with results provided to assist Dr Childerhouse's marine mammal impact assessment on behalf of TTR.

   (c) **Ambient Noise:** The South Taranaki Bight (**STB**) is not a quiet marine environment; vessel traffic and other activities already contribute significant underwater noise. TTR's operations will at times be above background levels within approximately 25 km of the mining activity, but the overall noise environment is dominated by existing vessel activity.

   (d) **Noise Assessment Scope:** The assessment has focused on continuous noise sources (crawler and Integrated Mining Vessel (**IMV**)), consistent with international guidance. Sensitivity analysis has considered the cumulative effects of transient TTR sources such as support vessels and use of the IMV's positioning systems. Non-TTR vessel noise is shown to be significant in the STB.

(e) **Monitoring and Best Practice:** Recommendations are made to align underwater noise monitoring and compliance with ISO 17208-3 (2025), ensuring robust, internationally recognised measurement protocols.

(f) **Mitigation**: The primary mitigation for underwater noise is embedded in equipment design and operational management. Adaptive measures are available if monitoring indicates sustained exceedance of noise limits.

3. Overall, the evidence demonstrates that TTR's proposed activities are unlikely to cause harm to divers or result in significant additional acoustic impact on the STB environment, provided that recommended best practices and consent conditions are followed.

INTRODUCTION

Qualifications and experience

4. My full name is Darran Humpheson. I am a Technical Director of Acoustics at Tonkin & Taylor Limited (**T+T**).

5. I hold a Bachelor of Science degree with Honours in Applied Physics and a Master of Science degree in Environmental Acoustics. I am a Member of the Acoustical Society of New Zealand and a Member of the United Kingdom's Institute of Acoustics. I am a New Zealand representative of the International Organisation for Standardisation (**ISO**) technical committee ISO/TC 43 SC1 "Noise", and I am also a member of the Joint Standards Australia/Standards New Zealand Committee AV-001 Acoustics. I am an accredited RMA commissioner.

6. I have been employed in acoustics since 1991 and have previously held positions as a consultant for international firms AECOM (Technical Director 2013-2019), Bureau Veritas (Technical Director 2012-2013), RPS Group plc (Technical Director 2002-2012) and as a UK Ministry of Defence scientist (1991-2002).

7. For the past 19 years I have provided assessments and advice on a range of projects involving underwater acoustics, including work for Lyttleton Port and the Interislander terminal development in Wellington Harbour.

Code of Conduct

8. I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Practice Note dated 1 January 2023. I have read and agree to comply with that 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.

Involvement in project

9. In 2013-14, I was commissioned by the Environmental Protection Authority (**EPA**) to review the first application TTR made for ironsand mining in the STB.

10. I was subsequently engaged by TTR to provide acoustics assessments in support of its second application to the EPA in 2017 and at the 2024 EPA hearing.

11. My evidence before the 2017 Committee comprised:

    (a) A written report dated 2 May 2017 and associated noise contour map, which were provided to the DMC as Appendices 3 and 4 to the Second Supplementary Statement of Expert Evidence by Dr Simon Childerhouse dated 1 May 2017;[1]

    (b) A presentation summary of evidence dated 22 May 2017;

    (c) Oral evidence on 22 May 2017 (Transcript pages 3062-3109);

    (d) Written answers to requests for clarification from the 2017 DMC, dated 22 May 2017:

        i. Memo to Vicki Morrison-Shaw, 1 page, Subject: TTRL - Distance Reduction Data;

        ii. Memo to Vicki Morrison-Shaw, 2 pages, Subject: TTRL – IMT Crawler Noise Clarification;

    (e) Written answers to questions from Forest & Bird, 3 pages, dated 22 May 2017;

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1 Updated as per Report 4b - Rebuttal evidence Dr Simon Childerhouse - marine mammals - January 2024.

(f) Written answers to questions from Ruby Haazen, by Memo to Vicki Morrison-Shaw, 3 pages, Subject: TTRL – Questions, dated 23 May 2017;

(g) Written answers to questions from Karen Pratt, by Memo to Vicki Morrison-Shaw, 1 page, Subject: TTRL – Responses to Questions Directed to Dr Childerhouse, dated 24 May 2017;

(h) A signed written statement dated 25 May 2017 confirming my role and my compliance with the Environment Court's Code of Conduct for Expert Witnesses.

12. My evidence before the 2024 EPA Expert Panel comprised:

(a) A statement dated 16 February 2024, which included a consultant's advice note dated 23 January 2024 that was prepared for Dr Childerhouse.[2]

(b) A presentation summary that was presented at the hearing.

Scope of evidence

13. This evidence responds to comments from:

(a) South Taranaki Underwater Club.

(b) Wanganui - Manawatu Sea Fishing Club and Patea & Districts Boating Club Inc.

(c) Evidence of Dr D Clement for Forest and Bird.

(d) Evidence of Dr L Torres for KASM.

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2 Report 4a – Darran Humpheson evidence responding to Dr Simon Childerhouse 16 February 2024.

14. I also respond to the JASCO 2025 Report[3], which was included in Forest and Bird' comments.

15. My evidence is limited to matters concerning underwater acoustics. The interpretation of underwater sound levels and their potential impacts on marine mammals is addressed in Dr Childerhouse's evidence on behalf of TTR.

16. While not contained in this evidence brief, I have also provided further response comments in the response tables provided as part of TTR's wider comments response package to the FTAA Panel. I confirm that comments in response to underwater acoustics have been provided by myself and are within my scope of expertise.

RESPONSE TO SUBMITTER COMMENTS

Updated underwater modelling

17. To assist Dr Childerhouse with his response to comments I have undertaken further modelling of underwater sound levels. He uses this new information in his Evidence[4].

18. At the 2024 Hearing, I prepared an advice note dated 23 January 2024 (referenced in paragraph 11(a)). Weighted sound levels were provided for five marine mammal hearing groups using the frequency weightings of Southall et al 2019[5]. The five weightings are:

    (a) Low frequency cetaceans (**LF**)

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3 JASCO, Trans-Tasman Resources Limited's Fast-Track Application - Taranaki VTM, 2025 Scientific Peer Review in Relation to Underwater Noise and Marine Mammals, 29 August 2025.

4 Childerhouse, S. (2025). Evidence of Simon Childerhouse (Marin Mammals) on behalf of Trans-Tasman Resources Limited in Response to Comments Received, 13 October 2025, 92p, 94p, 96p.

5 Southall et al. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 2019, 45(2), 125-232, DOI 10.1578/AM.45.2.2019.125.

(b) High frequency cetaceans (**HF**)

(c) Very high frequency cetaceans (**VHF**)

(d) Phocid carnivores in water (**PCW**)

(e) Otariid carnivores in water (**OCW**)

19. Since then, updated guidance from National Marine Fisheries Service (**NMFS 2024**)[6] has revised criteria for auditory injury[7] (**AUD INJ**) and temporary threshold shift (**TTS**). These weighting functions and thresholds differ from those in Southall et al. (2019), requiring updated underwater modelling and assessment to align with current industry best practice.

20. In February 2023, NMFS summarised[8] acoustic thresholds for application under the US Marine Mammal Protection Act. NMFS has adopted an unweighted (linear) root-mean-square (**RMS**) received level of 120 dB re 1μ Pa for continuous underwater noise, above which marine mammals are predicted to experience behavioural disturbance qualifying as Level B harassment[9].

21. As the NMFS 2024 guidance does not address behavioural effects, I have prepared updated modelling, which is included within my Consultant Advice Note 'Trans-Tasman

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[6] National Marine Fisheries Service. 2024. Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0): Underwater and In-Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-71, 182 p.

[7] Auditory injury has the same definition as permanent threshold shift.

[8] National Marine Mammal Service: Summary of Marine Mammal Protection Act Acoustic Thresholds, February 2023. https://www.fisheries.noaa.gov/s3/2023-02/MMAcousticThresholds_secureFEB2023_OPR1.pdf

[9] Acts that have the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by disrupting behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. [source NMFS]

Resources - Acoustic Modelling 2025' (**2025 Advice Note**) (**Attachment 1**).

22. This modelling includes unweighted sound level contours to illustrate the spatial extent of underwater sound levels (see Appendix A: Figure 4 at Attachment 1). The innermost contour represents the 120 dB re 1μ Pa RMS threshold. This contour is the same as illustrated in Schedule 7 of the Proposed Conditions.

South Taranaki Underwater Club, and Wanganui - Manawatu Sea Fishing Club and Patea & Districts Boating Club Inc.

23. Submissions from the South Taranaki Underwater Club, Wanganui–Manawatu Sea Fishing Club, and Patea & Districts Boating Club Inc. express concerns about underwater noise impacts on divers. Previous TTR applications did not specifically address these effects.

24. Commercial diving operations typically reference in-air occupational limits (e.g., 85 dB LAeq over 8 hours) and adapt them for underwater use via helmet transfer functions or in-ear measurements. Underwater sound pressure levels (**SPLs**) above approximately 160–170 dB re 1 μPa are commonly reported to cause strong discomfort in divers, with levels around 180–190 dB re 1 μPa associated with injury risk, depending on frequency and exposure duration (HSE RR735[10]).

25. Experimental studies of recreational and military divers indicate aversion and test termination at approximately 148 dB re 1 μPa (100–500 Hz) and 157 dB re 1 μPa (500–2,500

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10 HSE RR735: Anthony, Wright & Evans (2009). Review of diver noise exposure. https://www.havtil.no/contentassets/03de2df46ec6451ba635bbb2b2466509/hse-review-of-diver-noise-exposure-2009.pdf

Hz), with dizziness and balance effects reported at 176–185 dB re 1 μPa (Parvin; Fothergill[11]).

26. New Zealand legislation[12] sets in-air occupational limits of LAeq,8h = 85 dB and Lpeak = 140 dB (unweighted). These apply regardless of hearing protection, and PCBUs[13] must manage risks to as low as reasonably practicable.

27. WorkSafe's Occupational Diving Guidelines[14] focus on safe diving operations but do not specify underwater acoustic limits; however, PCBUs are required to assess and control noise risks from underwater tools and operations.

28. In air, SPLs are referenced to 20 μPa, the nominal threshold of human hearing. Underwater SPLs are referenced to 1 μPa for to standardisation purposes only (acknowledging water's higher density and acoustic impedance). A given nominal dB value therefore corresponds to different absolute pressures: for example, 120 dB re 20 μPa ≈ 2 Pa (air) versus 120 dB re 1 μPa ≈ 1 Pa (water). These reference differences, combined with water's efficient transmission, explain why underwater SPLs appear higher.

29. Humans primarily detect underwater sound via bone conduction pathways to the inner ear, bypassing the outer and middle ear that dominate in-air hearing. Consequently, in-air A-weighted limits and exposure-response relationships cannot be directly applied underwater (HSE RR735).

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11 Parvin (Subacoustech) seminar deck incl. Fothergill et al. aversion results (2005/2000/2001): http://resource.npl.co.uk/docs/science_technology/acoustics/clubs_groups/13oct05_seminar/parvin_subacoustech.pdf

12 Health and Safety in Employment Regulations 1995, Reg 11

13 Person Conducting a Business or Undertaking

14 WorkSafe NZ — Occupational diving guidelines: https://www.worksafe.govt.nz/topic-and-industry/occupational-diving/occupational-diving-forms-and-guidelines/

30. Parvin et al. developed an underwater noise weighting scale (UW). For a typical hearing range of 25 Hz to 16 kHz, the difference between in-air A-weighting and UW-weighting is shown in Figure 1.

31. Use of the UW-weighting scale enables underwater noise levels to be assessed and compared directly to in-air dB(A) levels if the diver's ear is wet (i.e., water in the ear canal). As shown in Figure 1, the human ear is very insensitive to sound when experienced with a "wet ear."

32. I used the dBSea underwater model developed for TTR (previously applied in the 2017 and 2024 assessments) and manually entered the UW-weighting values from Parvin et al. I then adjusted the calculated levels because the sound sources in the model are referenced to 1 µPa, whereas the UW-weighting is referenced to 20 µPa (a 26 dB difference between the two reference levels).

33. At 1 km from the sound source, the overall UW-weighted level is approximately 65 dB re 20 µPa, well below recognised thresholds for hearing damage for humans. To reach 85 dB would require a diver to be within 100 metres of the activity for 8 hours. I therefore consider that noise from TTR's activities will not harm divers with "wet ears."

Figure 1: Comparison of A-weighting and UW-weighting functions

34. For helmeted divers, received sound levels are lower due to mixed transmission paths, and self-generated breathing noise is typically the main source of exposure. SPLs inside helmets range from 80–100 dB(A), near or above the occupational limit for even short exposures. (HSE RR735). The greater risk to divers' hearing arises from self-generated breathing noise, not TTR's activities.

35. The submissions also comment on divers' acoustic enjoyment.

36. Unlike terrestrial environments where natural soundscapes contribute significantly to amenity, underwater sound perception for humans is fundamentally different. Divers do not require a specific underwater sound level to enjoy their experience. This is because human ears are adapted for air conduction. When submerged, the outer ear is flooded, and the middle ear's impedance mismatch reduces airborne-like sensitivity. Consequently, natural underwater soundscapes (e.g., marine life, distant surf) are often faint or imperceptible without electronic aids.

37. Enjoyment is not linked to hearing a minimum sound level; rather, divers value visual and tactile experiences. Underwater noise only becomes an amenity issue when it is intrusive, such as from boat engines, pile-driving, or sonar, because these can cause discomfort, stress, or disorientation. Research shows aversion thresholds for divers start around 160–170 dB re 1 μPa, well above typical ambient ocean noise (90–120 dB re 1 μPa) (HSE RR735). Therefore, as long as noise remains below levels associated with discomfort or hearing risk, amenity is generally unaffected (HSE RR735).

38. Underwater noise from TTR's activities is predicted to be well below recognised thresholds for hearing damage to divers. As long as noise remains below levels associated with discomfort or hearing risk, recreational amenity is generally unaffected.

39. On page 169 of The South Taranaki Underwater Club submission, the following statement is made:

'the average source level of the William Fraser [dredge] is approximately 168 dB re 1 μPa @ 1m. TTRL are proposing the CONDITION for the combined noise of the Integrated Mining vessel and crawler to be 130 dB re 1 μPa @ 1m'*

40. The Club implies that TTR's proposed source level is incorrect given that the IMV will be significantly larger than the William Fraser (68 metres versus 345 metres in length).

41. The Club's statement is incorrect as the 130 dB re 1 μPa of Condition 11 relates to the sound level limit at 500 m from the IMV in one of three discrete frequency bands. The actual design level for the total combined sound source level is specified in Condition 12, i.e. 'not more than 177 dB re 1μPa RMS linear at one (1) metre'.

42. This 9 dB difference indicates that TTR's source level, is both reasonable and consistent with its expected size and power and can be achieved through appropriate design and construction.

JASCO 2025 Report

43. The JASCO 2025 Report raises three acoustic concerns which are within my expertise:

    (a) Insufficient baseline data (ambient noise data) due to limited and non-systematic surveys, affecting confidence in marine mammal assessments.

    (b) Incomplete noise assessment, as not all vessels and sources are included, and cumulative impacts are not fully evaluated.

    (c) Monitoring methodology is not robust and does not align with best practice.

44. I address each one of these topics below.

Baseline data

45. Although TTR has not conducted ambient acoustic monitoring, the relevance of baseline data was addressed at the 2017 and 2024 hearings (refer to paragraph 11(a), 11(b), 2017 Transcript pages 3070-3074, and 12(b)).

46. My main observation is that the assessment of underwater noise is independent of the ambient noise environment. The suite of underwater noise conditions (Conditions 11 – 18 of Attachment 1 – Proposed Marine Consent Conditions) requires that sound levels at specific distances (500 m and 1 m) achieve absolute sound levels. There is no relative test, i.e. comparison to the existing ambient noise environment. As I have noted previously within this statement, it will be a requirement of TTR to achieve the noise limits of the conditions. The crawler and IMV will have to be designed and certified to meet these noise limits and TTR will need to commit resources to ensure that the acoustic emissions of their proposed activities achieve the noise limits.

47. Notwithstanding that no ambient data has been recorded by TTR, I have previously referenced other sources of data. For example, in my written report dated 2 May 2017[15], I considered ambient noise data in Section 5. Ambient data within the STB was acquired in 2017 by JASCO[16] and I compared the measured data, which I consider to be representative of typical ambient levels in the STB, to the noise from TTR's activities. I concluded that within approximately 25 km from the mining activity, TTR's operations will be above the background sound levels as determined by JASCO's Leq noise metric, i.e. will just exceed the average. At the time I

15 Updated as per Report 4b - Rebuttal evidence Dr Simon Childerhouse - marine mammals - January 2024.

16 McPherson, C. and J MacDonnell. 2017. Summary of Ambient Noise Within the South Taranaki Bight: Analysis of Mooring 2. Document 01351, Version 1.0. Technical report by JASCO Applied Sciences for NIWA.

undertook the comparison, I only presented unweighted sound levels.

48. Since the JASCO (2017) study, there have been other studies which have recorded ambient noise data. For example, the Ministry of Primary Industries commissioned JASCO (2019)[17] to undertake underwater sound propagation modelling to illustrate exposure for Māui Dolphins on the West Coast North Island. Vessel traffic noise, seismic surveys, and platform noise were modelled based on recorded vessel traffic during one month in summer (March) and one month in winter (July). Two calculation points were included in the STB. An example one-month Leq unweighted sound level map is shown in Figure 2 below.

49. Modelled unweighted sound levels in the STB can be seen to range from 100 dB to 120 dB re 1 μPa. As this illustration shows the one-month Leq value, instantaneous sound levels will be greater. The JASCO (2019) report notes that recorded sound levels in the STB during March ranged from 98 dB to 138 dB, and 73 to 109 dB during the month of July, at a distance of 12 nm from the shore line (approximately 22 km). The JASCO (2019) data supports my previous observations that the STB is not a quiet area.

50. As illustrated in Appendix A: Figure 4 of my 2025 Advice Note (see Attachment 1), modelled crawler and IMV sound levels around 100 dB unweighted would occur at a distance of 12 nm / 22 km from the mining activity. As the TTR activity will be relatively constant[18] Appendix A: Figure 4 of my 2025

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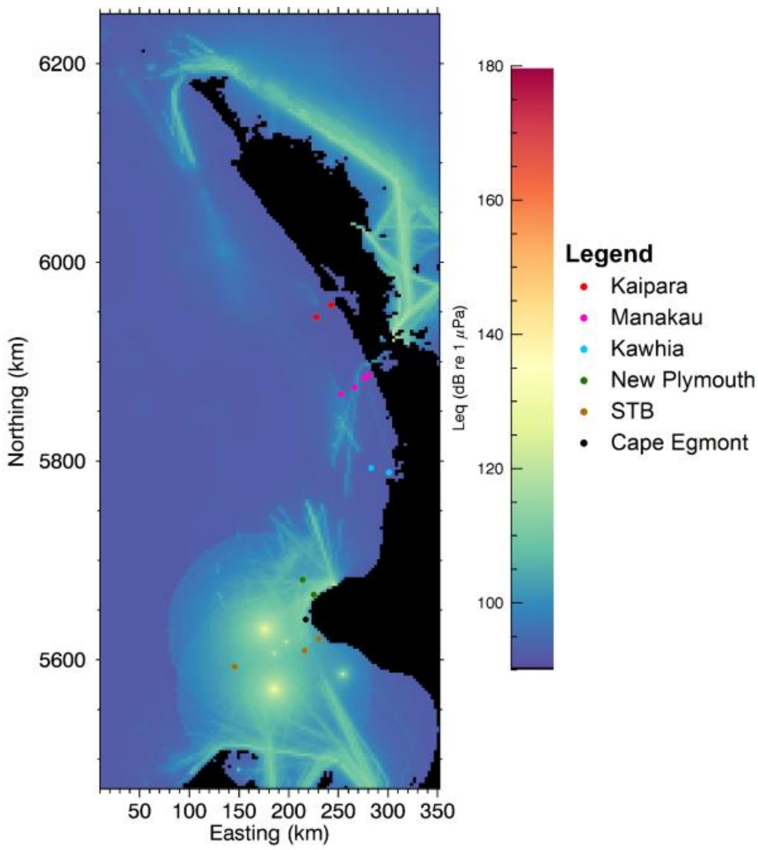
17 McPherson, C.; Zizheng, L.; Quijano, J. (2019). Underwater sound propagation modelling to illustrate potential noise exposure to Maui dolphins from seismic surveys and vessel traffic on West Coast North Island, New Zealand.

18 During production noise will be constant. However, there will be down time due to the likelihood of severe sea states and harsh weather conditions. It is anticipated that this down time will occur for 29% of the time.

Advice Note and Figure 11 of the JASCO (2019) Report (Figure 2 below) can be compared. Overall, the range of noise levels generated by TTR's activities would not be dissimilar to existing ambient noise levels, although I do note that noise would be generated in a new area of the STB. Dr Childerhouse considers the significance of that noise on marine mammals when he interprets the results of my 2025 Advice Note[19].

51. While this comparison is helpful, there is also the potential for TTR noise and noise from other activity to be additive, meaning that noise levels in the STB increase. I consider the issue of ambient creep when I respond to the evidence of Dr Clement for Forest and Bird.

Figure 2: One-month equivalent continuous underwater noise levels (Leq) for July: Broadband SPL. (Source - Figure 11 of JASCO report)



[19] Childerhouse, S. (2025). Evidence of Simon Childerhouse (Marin Mammals) on behalf of Trans-Tasman Resources Limited in Response to Comments Received, 13 October 2025, 38p,

Noise assessment incomplete

52. The JASCO 2025 Report considers that the underwater noise impact evaluation does not consider all project vessels, e.g., anchor handling tug, floating storage and offloading vessel, or all noise sources, e.g., higher power sonars, acoustic anti-biofouling devices, and positioning systems.

53. In Section 3 of my report dated 2 May 2017 (referenced in paragraph 11(a)), I described the various noise sources expected on site, including the crawler, the IMV, with and without the dynamic positioning system (**DPS**), bulk carriers, and the trans-shipment floating storage and offloading (**FSO**) vessel. 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 that 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.

54. In Section 4.2 of my 2 May 2017 Report (referenced in paragraph 11(a)), I undertook a sensitivity analysis which included the 'base' sound source levels from the crawler and IMV but included the noise generated by the IMV's DPS and the operation of the FSO under power. With these additional noise sources, the received unweighted sound level at 500 m was predicted to increase from 135 dB to 142 dB re 1 μPa, on the assumption that all sources are operating simultaneously.

55. At the 2017 Hearing, I presented an illustration of source levels (referenced in paragraph 11(b)), and I repeat that information in Figure 3 below. Non-TTR vessel sound sources were included for comparison. This information illustrates that

non-TTR vessels that transit through the STB can generate higher levels of noise than those modelled for the TTR activities, which supports my earlier comments regarding the ambient noise environment. While non-TTR noise sources, specifically vessels, are transient, Figure 2 does illustrate that cumulative noise levels from vessel traffic is significant, i.e. the STB is esonified by vessel noise. Meaning that the average noise from vessel traffic can be higher than average noise from TTR's operations (based on the unweighted sound level contours of my 2025 Advice Note Appendix A: Figure 4, and the anticipated downtime of approximately 29%[20].

56. It should be remembered that the sound levels I have presented so far are unweighted. To evaluate auditory effects on marine mammals requires the sound levels to be weighted using the relevant weighting function from NMFS 2024. Dr Childerhouse considers the significance of the weighted levels in his evidence[21].

57. I note that Section 2.6 of the JASCO 2025 report states that my 2017 acoustic modelling report (referenced in paragraph 11(a)) does not appear to be included in the application[22]. As a result, JASCO was unable to review my 2017 modelling report. I consider that access to my report would have assisted JASCO's review, as it addresses noise sources beyond the IMV

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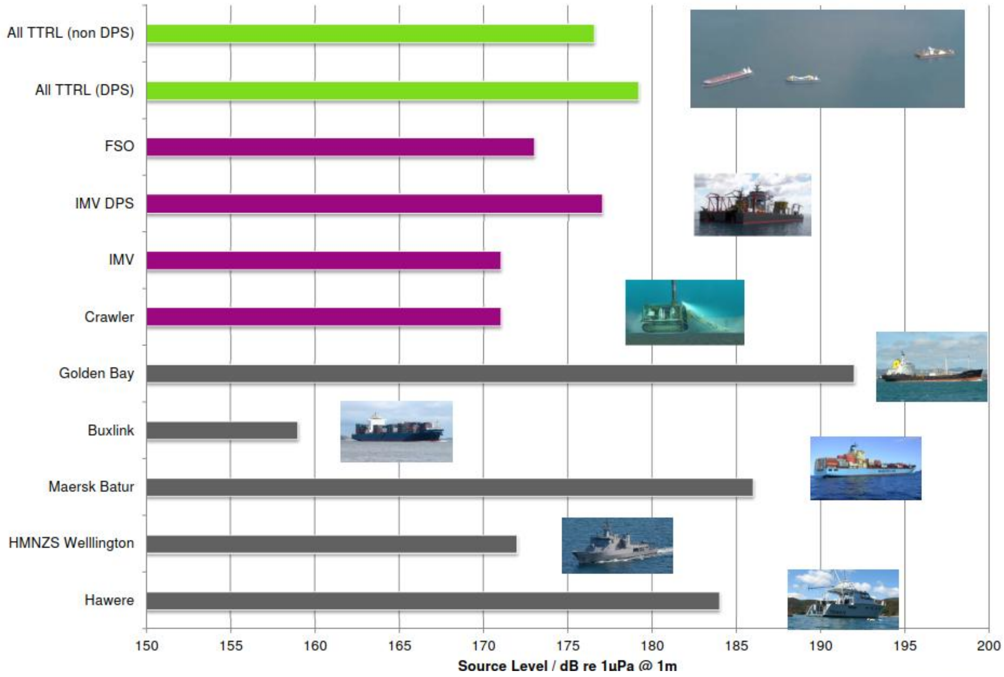
20 If noise is present all the time the Leq contours from TTR's activities will be identical to those shown in Appendix A: Figure 4 of Attachment 1. A 5 dB correction would then apply for a downtime of ~29%.

21 Childerhouse, S. (2025). Evidence of Simon Childerhouse (Marin Mammals) on behalf of Trans-Tasman Resources Limited in Response to Comments Received, 13 October 2025, 96p.

22 Updated as per Report 4b - Rebuttal evidence Dr Simon Childerhouse - marine mammals - January 2024. The report was uploaded to the application website on 22 September 2025. https://www.fasttrack.govt.nz/__data/assets/pdf_file/0008/12311/TTR-response-to-Minute-4-request-for-Humpheson-2017-Report_Redacted.pdf

and provides relevant information on other aspects of the project's acoustic environment.

Figure 3: Comparison of different source levels



Monitoring best practice

58. Proposed Conditions 11 to 18 of Attachment 1 – Proposed Marine Consent Conditions are relevant to underwater acoustics. The JASCO 2025 Report has stated that the measurement requirements of Condition 11 do not follow best practice – it contains arbitrary measurement distances, depths and sound levels.

59. Although the Conditions 11 to 18 specify measurement locations, operating conditions, and reporting requirements, it is essential that underwater noise measurements and compliance assessments adhere to internationally recognised best practice. Specifically, reference should be made to ISO 17208-3: *Underwater acoustics — Quantities and procedures for description and measurement of underwater sound from ships — Part 3: Requirements for measurements in shallow water*, or any subsequent revision. ISO 17208-3, released in September 2025, is directly applicable to shallow water

environments such as the mining area, whereas Parts 1 and 2 address deep water scenarios[23].

60. ISO 17208-3 is relevant because:

(a) **Depth and range alignment**: It addresses shallow water propagation effects and measurement protocols consistent with the ~30 m measurement depth and 300–1,000 m ranges specified in Condition 11.

(b) **Frequency band compliance**: it supports accurate broadband and one-third octave band analysis, aligning with the low, mid, and high-frequency ranges in Condition 11(b).

(c) **Calibration and environmental controls**: it ensures robust calibration and environmental condition checks, consistent with Condition 11(d) and (e).

(d) **Source level calculation**: it provides methods for deriving source levels at 1 m, aligning with Condition 12.

(e) **Reporting transparency**: it promotes standardised documentation, supporting Condition 18 reporting requirements.

61. I consider TTR's acoustic assessment to be comprehensive, robust, and consistent with international best practice. No changes to the proposed conditions are necessary to achieve best practice; however, it may be helpful to include an advisory note explaining the relationship between Conditions 11–18 and best practice:

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23 Defined as greater than the larger of 150 metres or 1.5 times the overall ship length.

> ***Advice Note:*** *All underwater noise measurements and associated compliance assessments required under Conditions 11 to 18 must be undertaken in general accordance with internationally recognised best practice for underwater acoustic measurements, such as ISO 17208-3: 'Underwater acoustics — Quantities and procedures for description and measurement of underwater sound from ships — Part 3: Requirements for measurements in shallow water', or any subsequent revision. Where ISO 17208-3 is not directly applicable, equivalent methodologies that achieve the same level of technical rigour and transparency must be used.*

Dr D Clement for Forest and Bird

62. Dr Clement raises similar matters to the JASCO 2025 Report, which I have addressed:

    (a) Lack of baseline underwater noise data in the STB; and

    (b) Model does not include all vessel sources or cumulative noise.

63. Regarding the second matter, Dr Clement raises the issue of ambient creep, meaning a potential increase in the existing ambient soundscape within the mining area and adjacent regions. As noted in paragraph 50, TTR's predicted noise emissions are broadly comparable to existing ambient noise levels in the STB, although noise will be introduced into a new area of the STB. The extent of this additional noise is limited, as demonstrated by the weighted sound level contours in Figures 1–3 of my 2025 Advice Note (Attachment 1). I have not undertaken a specific ambient creep assessment for the reasons outlined at the 2017 Hearing (section 5 of my report referenced at paragraph 11(a)). My previous opinion remains unchanged: I do not consider that the project will significantly increase the existing ambient soundscape outside the mining area.

64. Dr Clement raises two further matters:

    (a) Single-value noise limits may be exceeded due to operational variability; and

    (b) No clear mitigation if noise limits are exceeded.

65. The proposed consent conditions specify single-value underwater noise limits; however, these should be understood in the context of operational variability.

66. Regarding single value limits, underwater acoustic emissions from the crawler and IMV will fluctuate due to factors such as sea state, equipment loading, and dynamic operations. International best practice, including ISO 17208-3, recognises that compliance should be assessed using representative averages and uncertainty analysis rather than instantaneous peaks. Occasional exceedances do not necessarily indicate non-compliance if the overall operational profile remains within the prescribed criteria.

67. Regarding mitigations, underwater noise mitigation options are inherently limited compared to airborne noise control. The primary mitigation measure is embedded in the design phase of the crawler and IMV, as required by Condition 12, and verified through certification under Condition 13 prior to deployment. Beyond this, physical retrofits are generally impractical. Therefore, operational measures represent the most feasible approach if monitoring indicates sustained exceedance.

68. If exceedances occur, practical responses include:

    (a) Temporarily reducing production rates or adjusting crawler duty cycles.

    (b) Optimising vessel thruster use and maintaining mechanical components to minimise noise.

69. Over the life of the project there will be technology changes which may offer practical improvements in operational performance. These enhancements may also provide acoustic benefits, e.g. more efficient motors, pumps, etc; resulting in future noise reductions.

70. These measures, while not explicitly mandated by the suite of conditions proposed, align with best practice and demonstrate a proactive approach to managing underwater acoustic impacts. However, if consent is granted, TTR would be required to comply with the noise limits set out in the conditions regardless of the identification of any specific mitigations within the conditions themselves. Therefore, I do not consider the that mitigations are required to be specified in the conditions as any breach of the conditions would fall to a compliance matter for the regulator to address.

Dr Torres for KASM

71. Dr Torres raises similar matters that I addressed at the 2024 EPA Hearing:

    (a) the sound propagation model is fundamentally flawed due to a lack of relevant empirical data on the source levels of noise produced; and

    (b) the need to assess the impacts of the mining operation across a more realistic range where sound and sediment plume will extend.

72. There are no known seabed mining projects of a comparable scale to that proposed by TTR. Consequently, no directly applicable measured sound level data exists. Proxy data was therefore used in 2014, with measured data from a De Beers diamond mining crawler serving as the basis for estimating the likely sound levels and frequency characteristics of the TTR crawler. Adjustments to the De Beers source level were applied to reflect differences in particle size within the uplift

pipe (expected to reduce noise) and anticipated technological improvements in crawler design.

73. The De Beers data is standardised to a reference distance of 1 metre from the sound source. Sound level data measured at different distances is used to derive a sound transmission loss which is then used to derive the sound level at 1 metre. The sound source level can then be used to derive sound levels at different distances accounting for the sound transmission/propagation conditions due to water properties (sound speed profile, temperature, salinity, current and tide), sea floor properties (speed of sound, density, attenuation and thickness of each layer), seabed properties (stratification), and depth of water (bathymetry). This assessment approach is industry best practice and applies equally to in-air modelling as to underwater modelling.

74. In the event consent is granted, TTR will be required to ensure that the noise emissions of the crawler and IMV comply with the absolute sound level requirements of Conditions 12 (design and construction stages) and 11 (commissioning and production stages), and, once operational, meet the compliance verification requirements of Conditions 13 to 18. Conditions 11 and 12 specify absolute sound level limits, independent of ambient noise conditions in the STB.

75. My 2025 Advice Note (Attachment 1 below) presents unweighted and weighted noise contours which can be used to assess the impacts of the mining operation across a wide spatial range. These contours address Dr Torres comment regarding a more realistic spatial range.

CONCLUSION

76. In conclusion, my assessment reaffirms the opinions expressed in my reports and advice presented as part of the previous applications and hearings regarding underwater acoustics for

the TTR project. The updated modelling (Attachment 1 below) and review of submitter concerns confirm that:

(a) Underwater noise from TTR's activities will not pose a risk to diver safety or exceed recognised thresholds for hearing damage. As long as noise remains below levels associated with discomfort or hearing risk, recreational amenity is generally unaffected.

(b) The assessment methodology and monitoring recommendations are consistent with current international best practice.

(c) The STB is already subject to significant underwater noise from vessel traffic, and TTR's operations will not substantially alter the overall acoustic environment outside the mining area.

(d) The consent conditions, if implemented with the recommended advisory note on best practice, provide a robust framework for managing and monitoring underwater noise.

77. I am satisfied that the evidence and recommendations provided address the key concerns raised and support the granting of marine consents for TTR's proposed activities, subject to adherence to the specified conditions and best practice protocols.

Darran Humpheson

13 October 2025

ATTACHMENT 1 - CONSULTANT ADVICE NOTE 'TRANS-TASMAN RESOURCES - ACOUSTIC MODELLING 2025' (2025 ADVICE NOTE)

Tonkin+Taylor

CONSULTANT'S ADVICE NOTE

CAN-002

CAN Subject:	Trans-Tasman Resources – Acoustic Modelling - 2025		
Project/site:		Date:	10 October 2025
Client:	Trans-Tasman Resources Limited	TT project No:	1093411.0000
To:	Dr Simon Childerhouse		
Copy to:	TTRL		

1 Introduction

NMFS (2024)[1] identifies sound pressure levels above which auditory injury (AUD INJ) (previously called permanent threshold shift PTS) and temporary threshold shift (TTS) are anticipated in each of the five marine mammal hearing groups when exposure occurs over a period of 24 hours. The threshold levels for non-impulsive noise sources are shown in Table 1.1 below.

Table 1.1 includes the Southall et al 2019[2] thresholds used in the 2024 modelling (T+T CAN001) as attached to the 2024 evidence of Mr Humpheson.

Table 1.1: Summary of PTS and TTS onset thresholds

Hearing Group	Parameter	Onset thresholds (received level) dB re 1 µPa^2.s			
		2024 NMFS		Southall 2019	
		AUD INJ (PTS)	TTS	PTS	TTS
Low frequency (LF) cetaceans	$L_{E,p,LF,24h}$	197	177	199	179
High frequency (HF) cetaceans	$L_{E,p,HF,24h}$	201	181	198	178
Very high frequency (VHF) cetaceans	$L_{E,p,VHF,24h}$	181	161	173	153
Phocid pinnipeds in water (PW)	$L_{E,p,PCW,24h}$	195	175	201	181
Otariid pinnipeds in water (OW)	$L_{E,p,OCW,24h}$	199	179	219	199

NMFS 2024 also included updated weighting functions for each hearing group, as shown in Figure 1.1. Sound level calculations using the NMFS 2024 weightings result in different received sound levels compared to the Southall et al 2019 weightings.

[1] National Marine Fisheries Service. 2024. Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0): Underwater and In-Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-71, 182 p.
[2] Southall et al. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 2019, 45(2), 125-232, DOI 10.1578/AM.45.2.2019.125.

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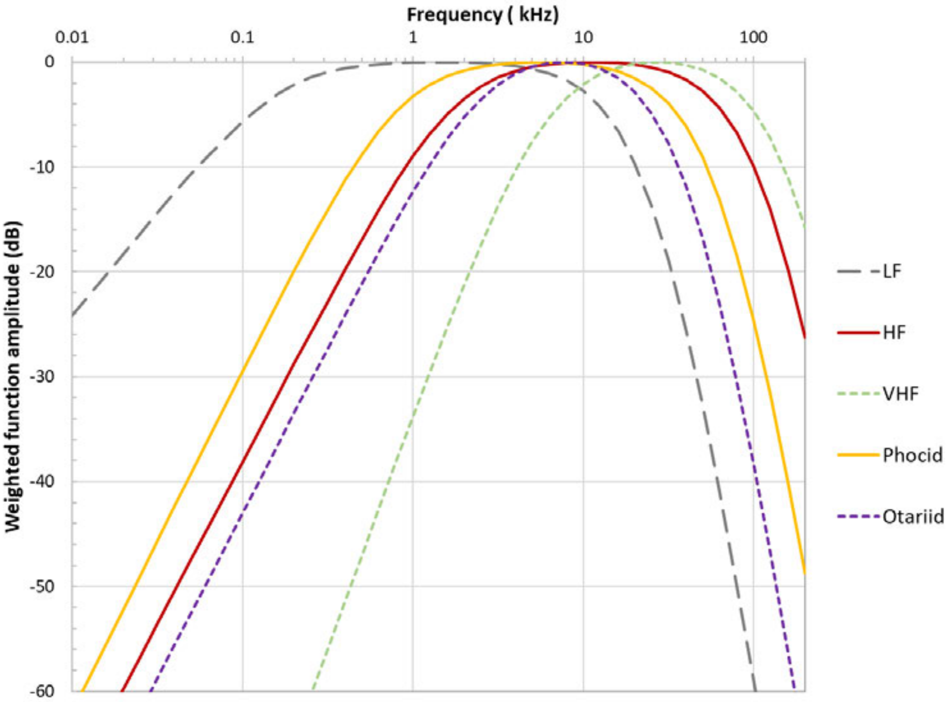

Figure 1.1: NMFS 2024 hearing response weighting.

2 Modelling inputs

2.1 Sources

A central point within TTRL's mining permit area was selected for the noise modelling, with NZTM coordinates 1696235, 5585673. The water depth at this location in the model is 34 m, i.e. identical to the 2017 and 2024 modelling. Two noise sources were modelled at this location:

1 TTR crawler – on seabed at depth of 30 m

2 IMV – integrated mining vessel at 5 m depth

Sound pressure levels for the two sources (unchanged from previous assessments) are shown in Table 2.1 below.

Table 2.1: Sound pressure levels for sources in dB for each octave band (Hz)

Source levels	**Level**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**16k**	**32k**	**64k**	**128k**	**160k**
TTR Crawler	171	161	168	163	160	158	154	142	136	134	130	128	125	122	119
IMV	171	170	164	143	144	138	133	129	120	100	97*	94*	91*	88*	85*

* Data above 8 kHz assumed to drop by -3 dB per octave (conservative)

2.2 dBSea parameters

A split solver sound transmission algorithm has been used as appropriate for low / high frequencies - noise sources are low frequency biased, and generally low frequency sound propagation will dominate. These parameters are unchanged from previous assessments. dBSea version 2.4.28 (latest 2D model) was used for the most recent calculations.

Table 2.2: Summary of dBSea parameters

Bathymetry	250 m resolution sourced from NIWA
Grid resolution	Set to map resolution, approx. 250 m
Frequencies	31.5 Hz to 128 kHz
Solver	Split, dBSeaModes (normal modes) to 125 Hz, dBSeaRay (ray tracing) for >250 Hz
Water properties	Temperature 18 °C, salinity 35 ppt, pH 8
Seafloor properties	Sand extending infinitely

3 Results

Sound level contours are attached at Appendix A with the maximum sound pressure level at all depths projected to the surface. The results include three contours for each cetacean hearing group and unweighted contours. The weighted levels used the NMFS 2024 auditory weighting parameters.

Appendix B shows the 2024 Hearing contours for comparison, which used the 2019 Southall weighting parameters. Unweighted contours were not produced for the 2024 Hearing.

Assuming 24 hour exposure, the calculated distances for AUD INJ and TTS criteria are shown below in Table 3.2. N/A denotes that the relevant criteria is not achieved, i.e. sound exposure levels are less than the criteria at 1 m from the sound source. Distances are rounded. The distances assume that the species of interest is exposed to the same sound level continuously throughout the 24 hour exposure period, i.e. the animal does not move.

Table 3.1: Onset distances

Hearing Group	AUD INJ (PTS) / metres	TTS / metres
Low frequency (LF) cetaceans	N/A	475
High frequency (HF) cetaceans	N/A	<10
Very high frequency (VHF) cetaceans	N/A	75
Phocid pinnipeds in water (PW)	N/A	50
Otariid pinnipeds in water (OW)	N/A	<10

Underwater sound levels at different distances (500 m, 1000 m, 1500 m and 2,000 m) have been calculated based on accumulated onset exposure levels from 10 seconds to 24 hours. The 24 hours levels enable direction comparison with the exposure values in Table 1.1. The SPL data represents the instantaneous sound level.

An unweighted root mean square sound level of 120 dB re 1µPa is achieved at a distance of approximately 3.6 km from the sound source.

Table 3.2: Exposure calculations

	Distance / m	SPL dB re 1µPa	SEL dB re 1µPa^2.s				
			10 sec	10 min	1 hr	3 hr	24 h
un-weighted	500	135	145	163	167	170	184
	1000	130	140	157	162	165	179
	1500	129	139	156	161	164	178
	2000	128	138	155	160	163	177
Low frequency	500	127	137	155	159	162	176
	1000	122	132	149	154	157	171
	1500	121	131	148	153	156	170
	2000	120	130	147	152	155	169
High frequency	500	109	119	137	141	144	158
	1000	104	114	131	136	139	153
	1500	103	113	130	135	138	152
	2000	102	112	129	134	137	151
Very High frequency	500	97	107	125	129	132	146
	1000	92	102	119	124	127	141
	1500	91	101	118	123	126	140
	2000	90	100	117	122	125	139
Phocid	500	115	125	143	147	150	164
	1000	110	120	137	142	145	159
	1500	109	119	136	141	144	158
	2000	108	118	135	140	143	157
Otariid	500	106	116	134	138	141	155
	1000	101	111	128	133	136	150
	1500	100	110	127	132	135	149
	2000	99	109	126	131	134	148

4 Applicability

This Consultant's Advice Note is issued subject to our terms of engagement with our Client. Where issued to a person who is not our Client, it is intended to assist that person in carrying out their work on the project. It is not an instruction, and it is not to be construed as relieving any party of its responsibilities.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Prepared by:

....

Darran Humpheson
Technical Director, Acoustics

10-Oct-25
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Appendix A Sound pressure level contours 2025

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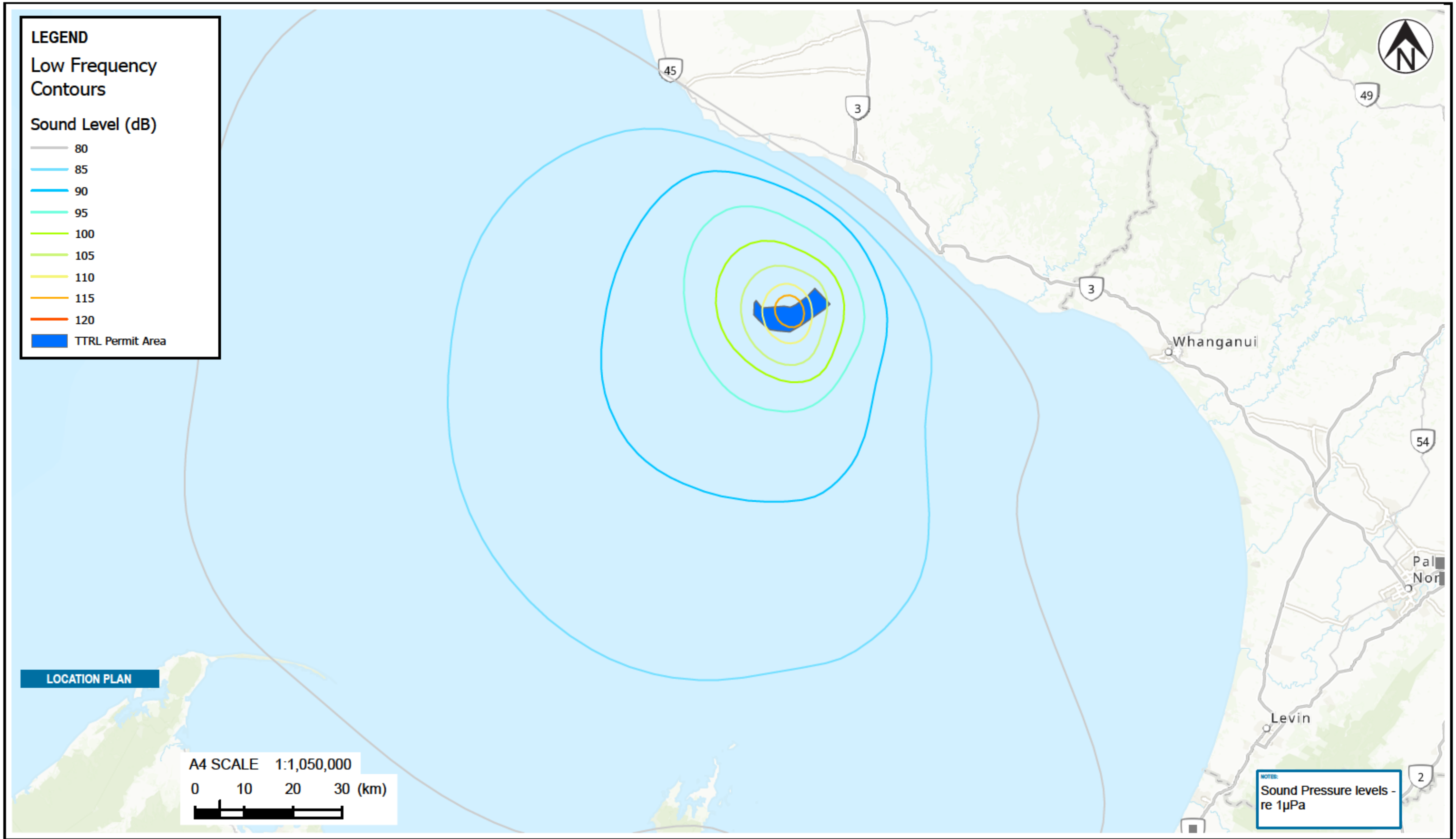

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TITLE NMFS 2024 LOW FREQUENCY HEARING GROUP CONTOURS
SCALE (A4) 1:1,050,000 **FIG No.** FIGURE 1. **REV** 1

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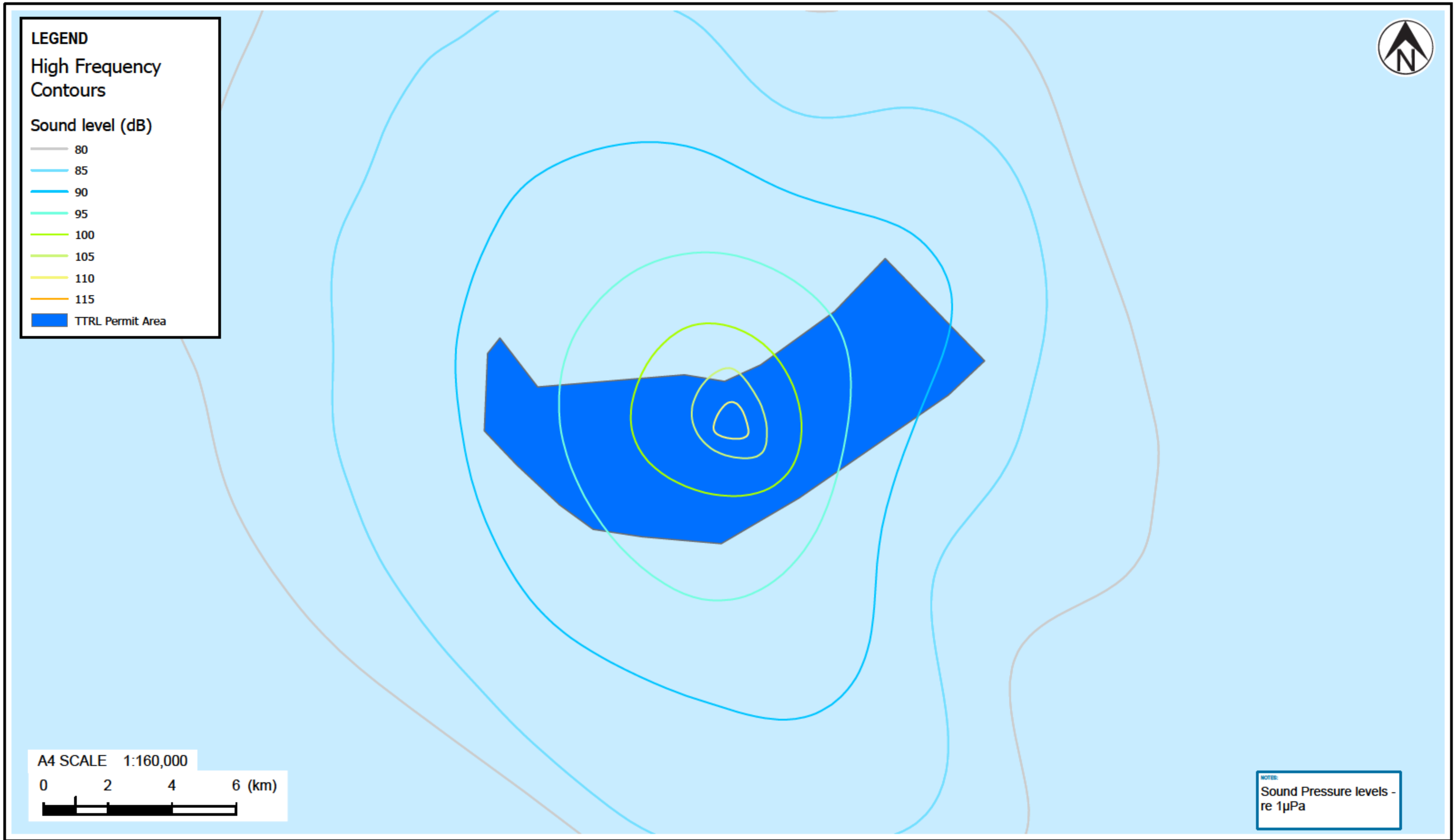

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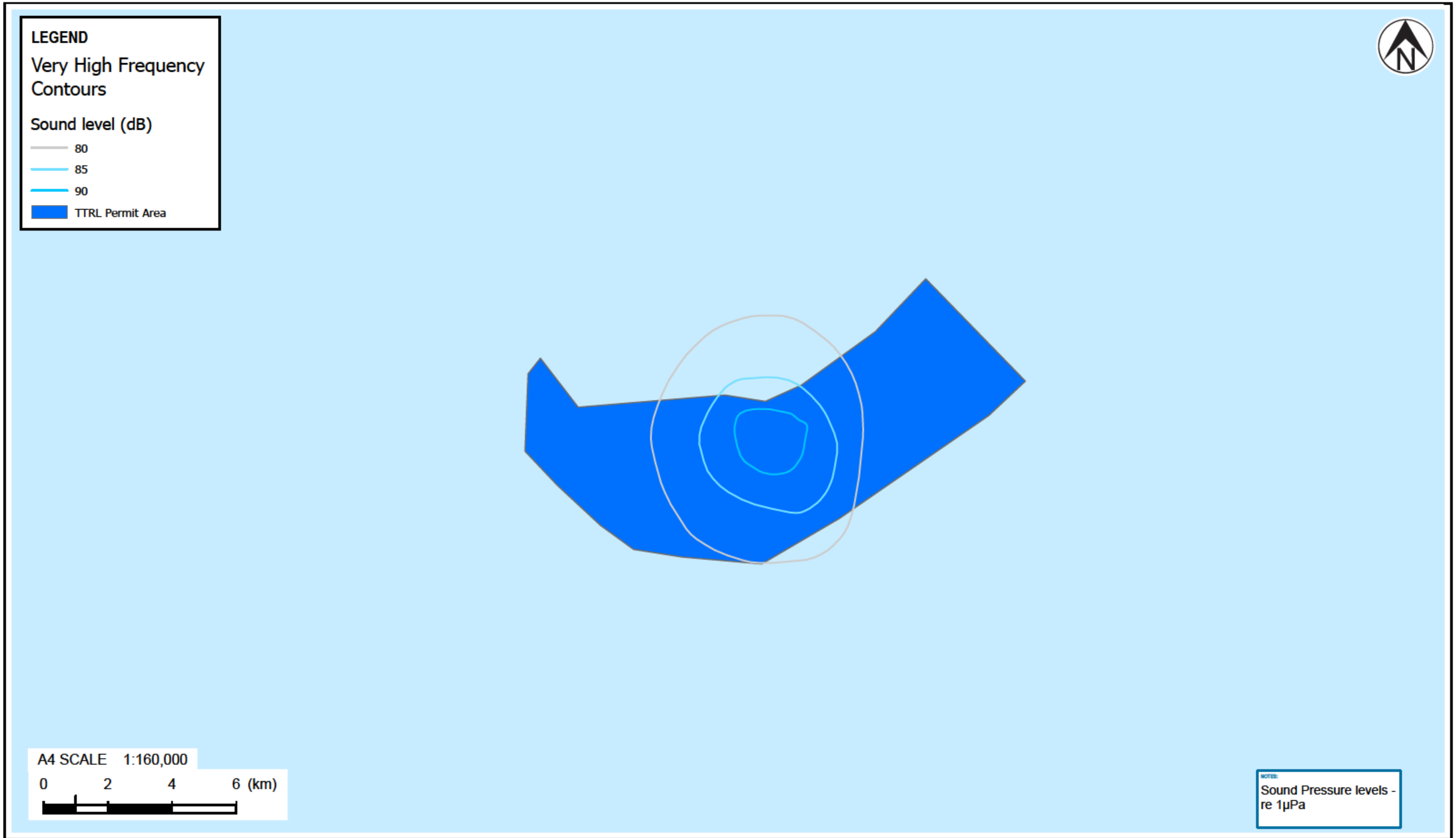

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SCALE (A4) 1:160,000 FIG No. FIGURE 3. REV 1

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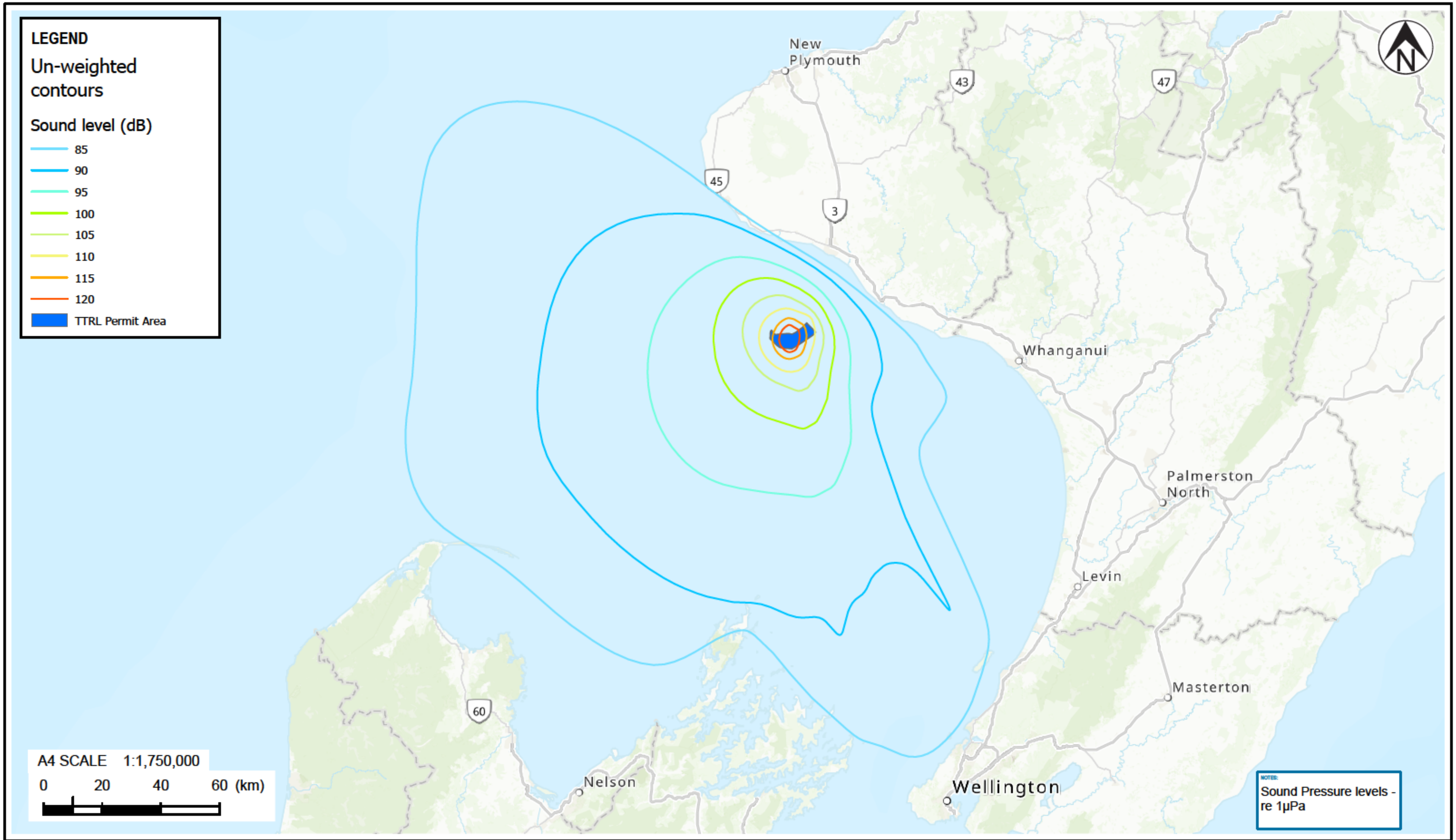

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SCALE (A4) 1:1,750,000 **FIG No.** FIGURE 4. **REV** 0

Appendix B Sound pressure level contours 2024

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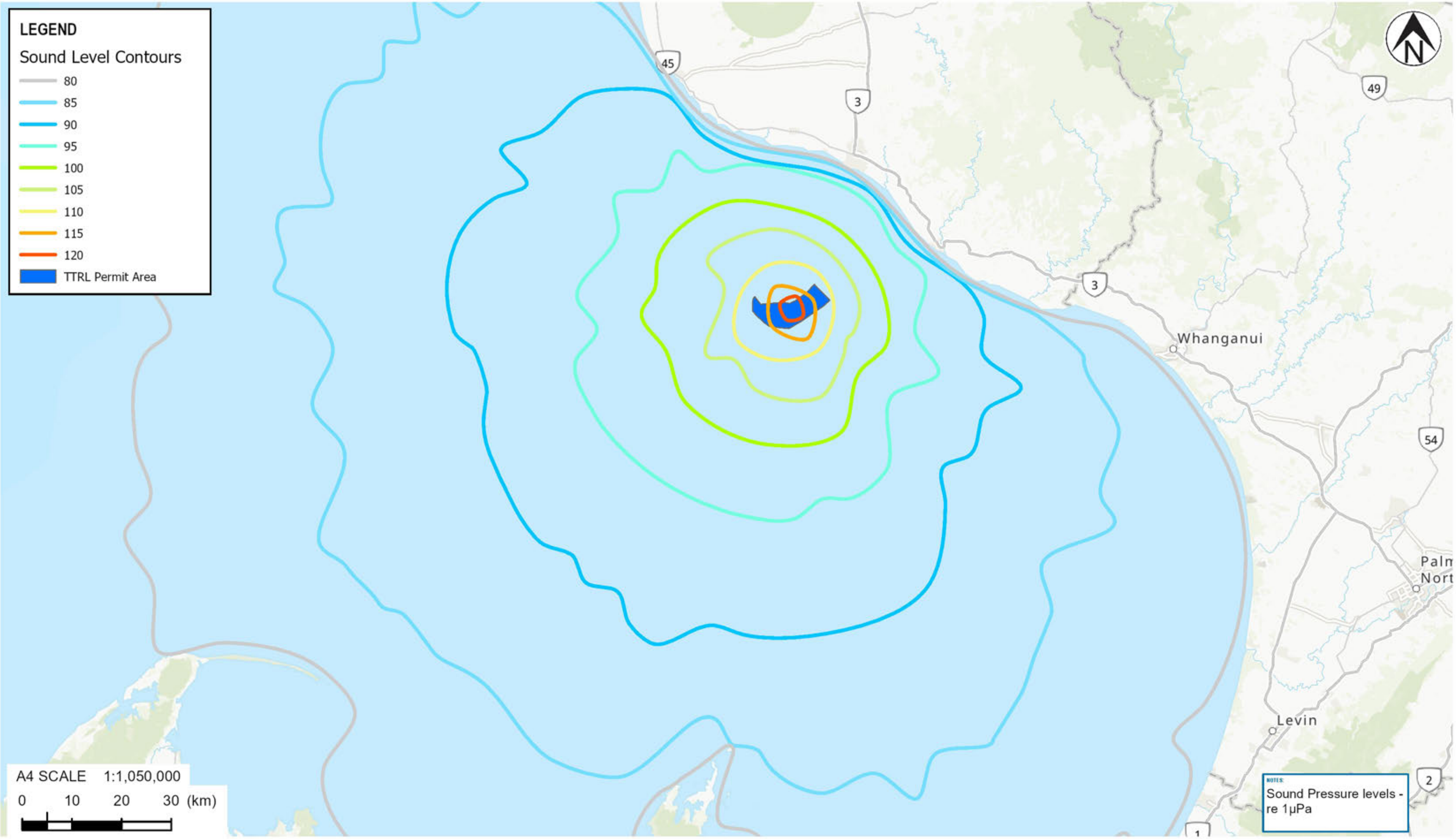

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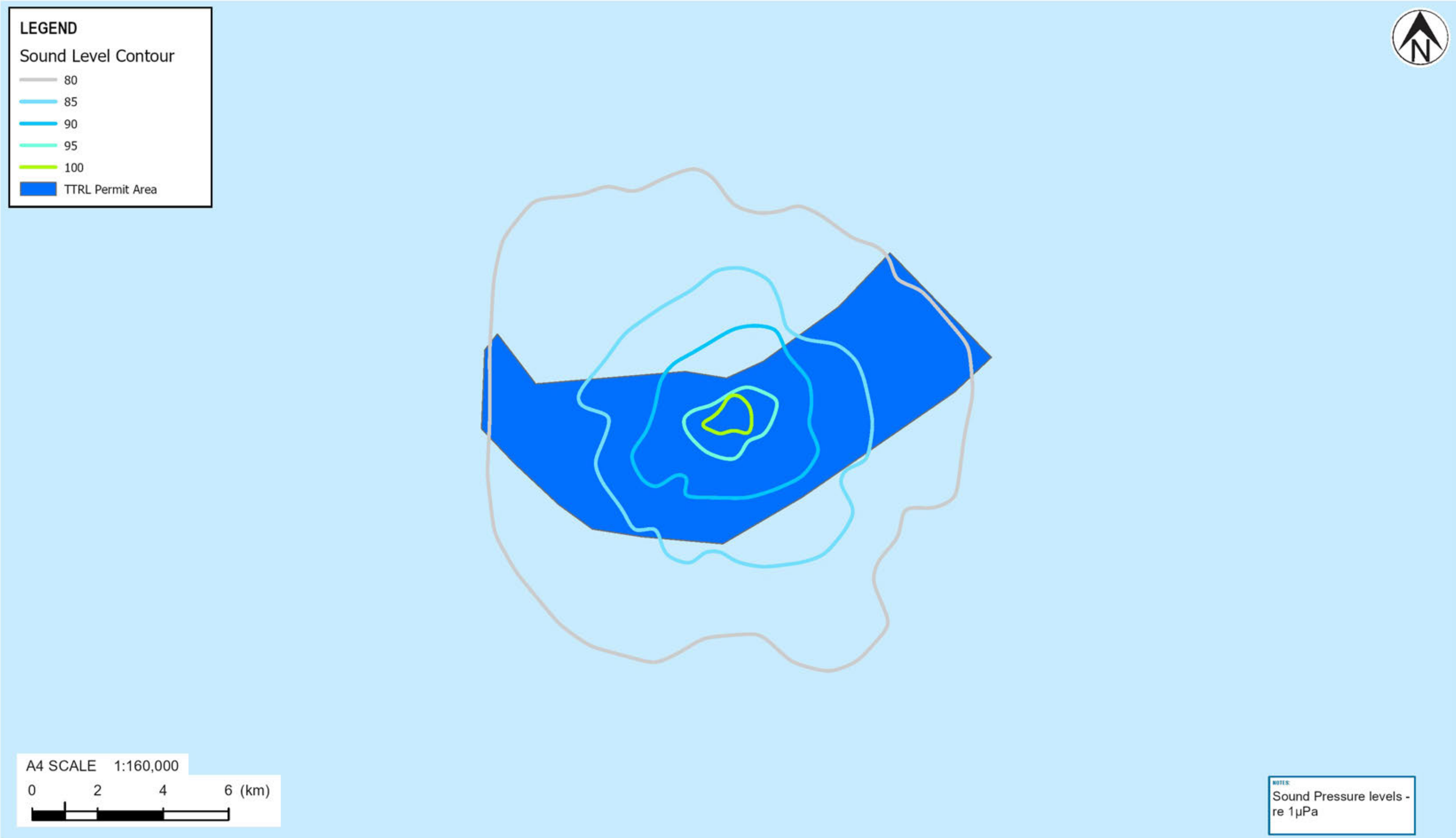

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SCALE (A4) 1:160,000 FIG No. FIGURE 2. REV 0

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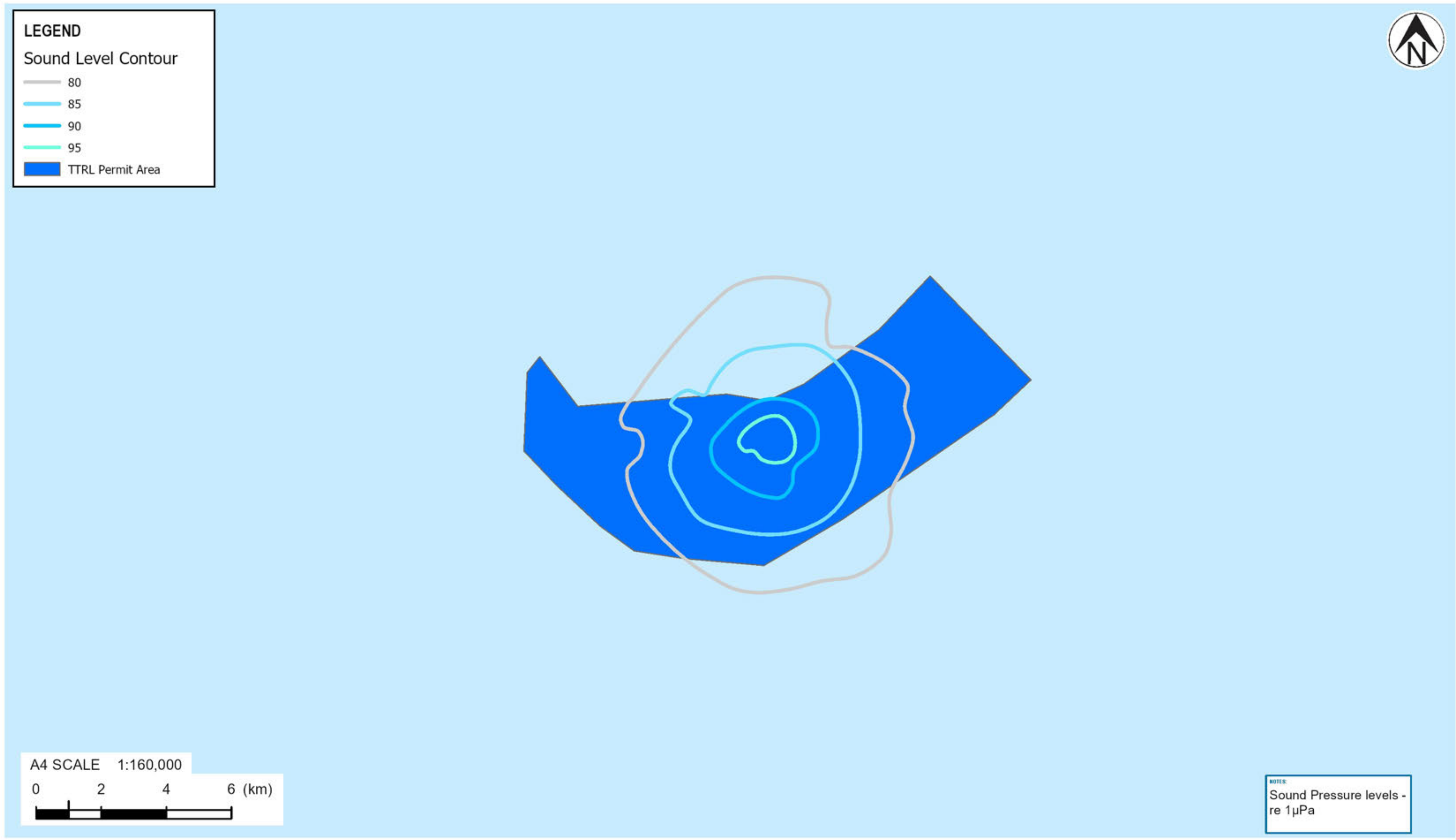

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TITLE	VERY HIGH FREQUENCY HEARING GROUP CONTOURS

SCALE (A4) 1:160,000 FIG No. FIGURE 3. REV 0