

Joint Witness Statement

BEFORE THE ENVIRONMENTAL PROTECTION AUTHORITY

IN THE MATTER of the Exclusive Economic Zone and Continental Shelf
(Environmental Effects) Act 2012 (the Act)

AND

IN THE MATTER of an Application under Section 38 of the Act for
Marine Consent by Trans-Tasman Resources Limited (TTRL)
in relation to the iron sand extraction and processing
application (the Application)

JOINT STATEMENT OF EXPERTS IN THE FIELD OF EFFECTS ON BENTHIC ECOLOGY

Dated Monday 20th February, 2017

INTRODUCTION

1. Expert conferencing of the Effects on Benthic Ecology experts took place in person and by videoconference on Wednesday, 15th February, 2017.
2. The conference was attended by:
 - a) Dr. Mark James (MJ)
 - b) Dr. Alison MacDiarmid (AM)
 - c) Dr. Greg Barbara (GB)
 - d) Mr. Ian Baxter (IB)
 - e) Dr. Ngaire Phillips (NP)
 - f) Dr. Shaw Mead (SM)

CODE OF CONDUCT

3. We confirm that we have read the Environment Court's Code of Conduct 2014 and agree to comply with it. We confirm that the issues addressed in this Joint Statement are within our area of expertise.

SCOPE OF STATEMENT

4. In our conference we discussed the issues relevant to the Application which arise within our field of expertise. Prior to attending the conference we each read the relevant parts of the Application, the evidence and independent reports prepared by the other expert(s) and circulated.
5. The issues are:
 - a. Recovery timeframes and influence of sedimentation (MJ7, MJ8, AM15, AM16, AM18)
 - b. Areal extent of effect of light attenuation on primary production (MJ9, AM10)
 - c. Potential for food web effects (MJ10)
 - d. Subtidal reefs (MJ11, AM7, AM24, AM25, AM26)
 - e. Basis of updated impact predictions (MJ12, MJ13)
 - f. Best case or worse case assessed? (MJ14)
 - g. Location of plume generation (MJ15, AM20)
 - h. Seasonality and natural disturbance (MJ17, AM17)
 - i. New species (AM1)
 - j. Clams (AM2, AM3, AM4, AM5)
 - k. Bivalve rubble (AM6)

- l. Cawthron report (AM8)
- m. Applicability of Wellington Harbour experimental outcomes to STB (AM12, AM13)
- n. Role of iron in re-colonisation (AM12)
- o. Effects on species not found (AM14)
- p. Terminology – ‘background’ vs ‘natural’ (AM19)
- q. Mining area relative biodiversity (AM21)
- r. Tolerance limits and sensitivities to suspended sediments (AM22)
- s. Long-term effects of elevated nickel and copper on larvae (AM23)

The discussion of the issues above covered the questions in the DMC minutes directed to SM, namely paragraphs 26, 34-36, 39, 40 and 42.

- 6. In relation to each issue we discussed points of agreement and disagreement in relation to:
 - a. Facts;
 - b. Assumptions;
 - c. Areas of uncertainty or lack of information; and
 - d. Expert opinions / conclusions.
- 7. In this Joint Statement we report the outcome of our discussions in relation to each issue by reference to points of agreement and disagreement relating to facts, assumptions, uncertainties and expert opinions / conclusions. We have noted where each of us is relying on the opinion or advice of other experts. Where we are not agreed in relation to any issue, we have set out the nature and basis of that disagreement.
- 8. It is noted that the draft marine consent conditions proposed by the Applicant were not discussed in detail due to time constraints, though some suggestions for additional monitoring are made.

LIST OF ISSUES

Recovery timeframes and influence of sedimentation		
MJ7, MJ8, AM15, AM16, AM18	AGREED	DISAGREED
Facts	Recovery timeframes are predictions that, pre-development, are necessarily based upon assumptions derived from factual observations made elsewhere. Based upon experts' experience elsewhere, it was agreed that recolonisation of the seabed by biota will occur following iron extraction.	Nil
Assumptions	<p>Based upon experts' experience elsewhere, it was agreed that it could be assumed that:</p> <ul style="list-style-type: none"> • Regardless of whether full 'recovery' occurs, the suite of species that is established in the benthic community post-mining is likely to fulfil the same ecosystem function as that which is present pre-mining. • As 'larger biota', it could take several years for starfish and coral populations to attain their pre-mining characteristics (noting that it was unclear as to what was meant by 'coral' in the question – no hard or soft corals have been recorded [or are considered likely to occur] in the mining area, though some soft corals are present on nearshore reefs). 	<p>There was disagreement over whether or not it could be assumed that 'recovery' would occur within the mining area (i.e. whether benthic communities would become established that are the same as those present pre-disturbance), with the following points of view presented:</p> <ul style="list-style-type: none"> • A different progression of species may become established due to changes in substrate, therefore there will be no 'recovery' (SM, GB). • Over time the benthic communities will 'recover' as the area will be recolonised from populations nearby and in the plankton and sand movement will progressively alter the surface features such that they will

	<ul style="list-style-type: none"> • The recovery of prey species of eagle rays may be affected over a limited area in the immediate vicinity of the mining. • Sediment plumes from mining in adjacent blocks may influence the successional development of the benthic communities in the mined blocks. However, the plumes will be dynamic and their influence will decrease with increasing distance from the site of the actual mining operation. 	become indistinguishable to those present pre-disturbance (MJ, AM, IB).
Importance	Given the localised spatial area of impact of the mining operation, recovery timeframes are not considered by MJ, AM and IB to be of high importance in assessment of the acceptability of the proposed action from a benthic ecology perspective. SM holds a contrary view.	
Other comments on questions	<p>It was agreed that MJ and AM were conveying the same message with respect to recovery timeframes, albeit using slightly different terminology.</p> <p>It was considered that the knowledge of the reproduction and early life histories of the types of biota that are likely to recolonise the mined area and surrounding impacted areas are sufficiently well known for the purposes of impact assessment.</p>	

Effect of light attenuation on primary production		
MJ9, AM10	AGREED	DISAGREED
Facts	Effects of light attenuation on primary production are predictions that, pre-development, are necessarily based upon assumptions derived from factual observations made elsewhere. Noting that, in this session, benthic (not water column) primary production was being considered; based upon experts' experience elsewhere, it was agreed that:	Nil

	<ul style="list-style-type: none"> • Nearshore macroalgal communities are sufficiently distant from the mining operation that there is a negligible risk of light attenuation being sufficiently high for them to be affected. • If macroalgae are present on reefs closer than 5 km from the mining area, then primary production may be inhibited at times but there is negligible risk that they would be destroyed due to light attenuation as they have strategies (e.g. photoadaptation, carbon storage, switching to respiration) to cope with reduced light levels, which they would currently experience on a periodic basis due to natural and anthropogenic disturbances. 	
Assumptions	<p>It was agreed that, although predictions of impacts were based upon best available information and model outputs, which were in turn based upon various assumptions with respect to input parameters:</p> <ul style="list-style-type: none"> • The impact assessment was made on the basis of the outputs from several models, of which the Wallingford model was only one. Hence changes in the Wallingford model would not directly translate into changes in predicted carbon flux. • All models have inherent inaccuracies, but the modelling undertaken for this Project took variability in many parameters into account and was done to the highest standard available. • Until monitoring was undertaken during mining operations, it would not be possible to determine the factors by which any of the models may be inaccurate. It is noted that, within the Environmental Monitoring and Management Plan (EMMP), compliance limits have been placed on SSC levels. 	Nil
Importance	As effects of light attenuation on benthic primary production would be localised and temporary, it is not considered to be of high importance in assessment of the acceptability of the proposed action.	
Other comments on questions	The terminology 'minor' and 'moderate' is based upon accepted criteria described in reports submitted with TTRL's application.	

Potential for food web effects		
MJ10	AGREED	DISAGREED
Facts	<p>Based upon experts' experience elsewhere, it was recognised that food webs are highly complex and that effects on benthic fauna would not necessarily translate into measurable food web effects.</p> <p>It was agreed that data collected for the Project demonstrated that benthic fauna within the mining area are also present outside of the zone of potential impact from the Project.</p>	Nil
Assumptions	<p>It was recognised that, with exceptions, higher trophic level species are typically motile and can range over broad areas, so if benthic fauna prey resources were depleted in the vicinity of the mining it could be assumed that they would forage elsewhere in the South Taranaki Bight (STB) or on other sources. It is noted above that the recovery of prey species of eagle rays may be affected over a limited area in the immediate vicinity of the mining.</p>	Nil
Importance	<p>The potential for food web effects is considered by MJ, AM and IB to be sufficiently low that it does not represent an important issue for assessment of the acceptability of the proposed action from a benthic ecology perspective. SM holds a contrary view based on the range of uncertainties and the large spatial scale of potential impact; GB has some uncertainty.</p>	
Other comments on questions	<p>The predictions of the likelihood of food web effects was partly informed by modelling, but more so by an understanding of trophic dynamics and food web interactions in similar environmental settings.</p>	

Subtidal reefs		
MJ11, AM7, AM24, AM25, AM26	AGREED	DISAGREED
Facts	<p>The following facts were presented and accepted as true:</p> <ul style="list-style-type: none"> • The initial distribution of reefs available for use was based upon the DOC reef database which was suspected of including some sand waves. • TTRL surveys and analysis found that some of the areas shown as reefs on the charts were in fact sand waves. • A full multibeam swath mapping survey of the mining area indicated a complete lack of rocky reef inside the area. The multibeam survey data were used as inputs to the bathymetry maps shown in TTRL documents. • Video surveys further inshore located some rocky outcrops (the closest of which was about 5 km from the mining area) but the complete region between the mining area and the coast was not sampled or multibeam mapped. • Submitters have presented evidence that other subtidal reefs exist (inshore of the mining area) that have not been biologically surveyed. • Additional surveys by TTRL were focussed upon nearshore habitats, including reefs, as this is where concerns were raised with respect to sedimentation and light attenuation effects. 	Nil
Assumptions	<p>Based upon the following, it is assumed that there is minor risk of significant impact from sedimentation or elevated suspended sediment concentrations (SSC) from the Project to benthic communities on any un-surveyed subtidal reefs:</p> <ul style="list-style-type: none"> • The locations of the un-surveyed reefs provided by the Submitters. • Time series data extracted from model outputs show that sedimentation rates beyond 2 km, and increases in SSC beyond 8 km, from the mining 	Nil

	area are predicted to be low compared with assumed tolerances for benthic biota.	
Importance	The risk of significant impact to benthic communities on any un-surveyed subtidal reefs beyond 8 km is considered by MJ, AM and IB to be sufficiently low (from elevated SSC or sedimentation) that it does not represent an important issue for assessment of the acceptability of the proposed action from a benthic ecology perspective. It is further considered that investigations of the subtidal reefs identified by the submitters is not warranted. SM's view is that the often large model under-estimations at the seabed and the unknowns with regard to un-surveyed reefs in close proximity to the operation means that it is difficult to have certainty about the importance of potential impacts to these benthic communities.	

Basis of updated impact predictions		
MJ12, MJ13	AGREED	DISAGREED
Facts	<p>The following facts were presented and accepted as true:</p> <ul style="list-style-type: none"> • The updated impact predictions were based upon revised models of sediment dispersion, optical effects and primary production, and upon more detailed analysis of some model outputs and thresholds for different biota from experience and reports on other systems. • No additional information on benthic communities and habitats from field surveys had been gathered in the time between the two TTRL applications. • It was agreed that the benthic surveys were not temporally optimal and were not intended or designed to document seasonal variability of communities. • No functional analysis was undertaken on the stability of habitats, but that the dominant functional groups within the STB are unlikely to change dramatically seasonally due to species such as the dog cockle that form beds that last for many years. 	Nil

	<ul style="list-style-type: none"> It was agreed the inclusion of additional monitoring sites within the mining area would provide a more robust BACI analysis for determining recovery/ re-colonisation rates within processed areas. 	
Assumptions	It was assumed that the revised model outputs, and their more detailed analysis, provided sufficient increased understanding of carbon flow to the benthos, optical effects, etc., that further information on benthic communities would not materially alter the outcome of the impact assessment.	Nil
Importance	The updated impact predictions are considered sufficiently robust that this does not represent an important issue for the purpose of assessment of the acceptability of the proposed action from a benthic ecology perspective. It was considered by MJ, AM and IB that the collection of further information on the benthic communities in or around the mining area was not warranted; GB did not share this view. SM considers that increased understanding of the benthic communities in the mining area and in close proximity (i.e. within 5 km from the operation) would increase the confidence in the predicted impacts.	
Other comments on questions	It was confirmed that the evidence of Shaw Mead had been read.	

Best case or worse case assessed?		
MJ14	AGREED	DISAGREED
Facts	<p>It was agreed that 'best case' and 'worse case' are subjective terms and no facts could be presented to assist with the resolution of this issue.</p> <p>It was, however, agreed that monitoring would be required to assess the veracity of the modelling outputs.</p>	Nil

Assumptions	Similarly, there were no clear assumptions made with respect to this issue.	<p>MJ and AM considered that the basis of assessment was a 'realistic case' and considered that the potential scenario presented by the submitter was unrealistic. MJ considered that the modelling undertaken was conservative and that impacts were likely to be less than those modelled. GB agreed, provided plume generation fell within the ranges predicted.</p> <p>SM maintained that there was insufficient information upon which to judge whether or not the impact assessment was based upon 'best', 'worse' or 'realistic case' conditions and considered that the impacts were under-predicted (in part due to large under-predictions in the model outputs versus the measured data at the seabed) and there would be the potential for permanent changes in benthos to occur.</p>
Importance	The key issue of importance in assessing the acceptability of the proposed action is whether potential impacts have been adequately assessed for a 'realistic case', rather than whether a 'best case' or 'worse case' has been presented. In the event that the project is approved, it will be highly important that a robust environmental monitoring and management programme be implemented to confirm predictions and mitigate the risk of significant impacts upon benthic communities.	

Location of plume generation		
MJ15, AM20	AGREED	DISAGREED
Facts	It was agreed that the absence of a mining plan from the latest TTRL document could limit the understanding of potential impacts by some readers.	Nil

	<p>MJ confirmed that a mining plan had been developed and was flexible; it would be progressively refined on the basis of drilling results and was based on single pass mining. This would dictate where within the mining area the activity would be undertaken at any given time.</p> <p>MJ and AM confirmed that different locations and volumes of sediment loading had been taken into account during the assessment. The two locations at which plume generation was assessed represent the physical 'extremes' of the mining operation (i.e. one closest inshore, the other furthest offshore).</p>	
Assumptions	Nil	Nil
Importance	This issue is not of high importance for the assessment of the acceptability of the proposed action as it relates to the planning of mining operations, rather than to the potential impacts arising therefrom. SM noted that the location/planning of the mining operation is important with respect to the impacts on the recolonisation of already worked areas due to the proximity of the continuing operation.	

Seasonality and natural disturbance		
MJ17, AM17	AGREED	DISAGREED
Facts	<p>AM presented the following facts with respect to this issue:</p> <ul style="list-style-type: none"> • The NIWA study was initially intended to provide a snapshot of benthic communities within a single short period of time. • Sampling was spread over a longer timeframe due to weather conditions. 	Nil

	<ul style="list-style-type: none"> The area over which sampling was undertaken was extended to cover potential disposal sites identified by TTRL. 	
Assumptions	Nil	<p>There was disagreement with respect to the following assumption:</p> <ul style="list-style-type: none"> MJ, AM and GB are of the view that, given the natural disturbance regime in the STB, the biota present would be adapted to periodic perturbation, which provides insight into their resistance to impact and their capacity to recover from impacts. SM does not share this view, since the background levels at the proposed mining site have never previously been anywhere near as high as will occur if mining was taking place; the offshore waters will be subject to annual discharge rates that are higher than many of the rivers at the coast.
Importance	<p>This importance of this issue for assessing the acceptability of the proposed action is whether the existing data provide adequate confidence that either the existing communities will recover over time, or that communities of equivalent ecosystem functionality will become established. The general consensus was that information on seasonality would be of interest, but that it is not critical information for assessment purposes.</p>	

New species		
AM1	AGREED	DISAGREED
Facts	<p>AM presented the following facts with respect to this issue:</p> <ul style="list-style-type: none"> • New species were found during the NIWA survey. This was to be expected as the biota of the west coast shelf area of NZ are poorly described due to a paucity of sampling. This also applies broadly to offshore areas around all of NZ. • Most new species were found in the bryozoan beds at the foot of slope, offshore from the mining area. • Those new species that were found within the mining area were also found outside of the mining area; no new species were found exclusively within the mining area. 	Nil
Assumptions	<p>From the experts' knowledge of the life histories of similar species, it is assumed that the same species would be found in similar habitats elsewhere in the STB, and more broadly offshore NZ. Hence it is considered there would be negligible risk of the Project leading to extinction of the new species.</p> <p>From an ecotoxicity perspective, it is assumed that the new species would be no more susceptible to toxic effects than similar known species.</p>	Nil
Importance	Expert knowledge indicates that this issue is not of high importance for assessing the acceptability of the proposed action as no species were found exclusively within the mining area or within the area of potential impact.	

Clams		
AM2, AM3, AM4, AM5	AGREED	DISAGREED
Facts	The key fact with respect to this issue is that surf clams presently exist in waters that are (at least periodically) highly turbid.	Nil
Assumptions	<p>From model outputs, it is assumed that SSC and sedimentation rates would be insufficiently high to pose a risk of significant impact upon the clams or their food sources.</p> <p>From a consideration of the low levels of heavy metals concentrations in the sediments to be mined, and the dilution that would occur between the mining area and the surf clam habitat, it is assumed that there is negligible risk of significant impacts on clams from any heavy metals that may be released into the water column from the mining activity.</p> <p>It is presumed that the reference to the sensitivity of clams to algal blooms refers to toxic algal blooms being generated as a result of the release of nutrients from the mined sediments. Considering the distance between the mining area and the surf clam beaches (e.g. Foxton), and the assumed low levels of nutrients in the sediments to be mined, it is assumed that the operation poses a low risk of triggering algal blooms that could affect the surf clam beaches.</p>	Nil
Importance	The key importance associated with this issue is that monitoring of the mining operation would need to be sufficiently robust to affirm the low levels of SSC and sedimentation in the coastal zone that is shown in the modelling results. Monitoring of heavy metals in solution and particulate form within and beyond the sediment plume will address concerns regarding potential exposure of clams to heavy metals.	
Other comments on questions	Knowledge of the distribution and biology of the surf clams was considered to be sufficient for the purposes of risk assessment. Detailed knowledge of the sensitivity of surf clams to fine sediment, algal blooms and heavy metal concentrations was considered by AM and MJ to be of low	

	importance, given the predicted very low likelihood of the clams being exposed to these stressors as a result of Project operations.
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Bivalve rubble		
AM6	AGREED	DISAGREED
Facts	The dredge efficiency was maintained by modifying the deployment practice to prevent clogging of the equipment. The species make-up of the bivalve rubble habitats is described in Beaumont et al (2015). The dominant species was the dog cockle.	Nil
Assumptions	Nil	Nil
Importance	Nil	

Cawthron report		
AM8	AGREED	DISAGREED
Facts	The Cawthron report draws heavily on the NIWA survey reports; the original NIWA data were used for the assessment as the Cawthron report didn't contain data to a sufficient level of detail. Any rare and vulnerable ecosystems and habitats of threatened species identified in the Cawthron report were distant from the mining area.	Nil
Assumptions	Nil	Nil

Importance	Nil
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Applicability of Wellington Harbour experimental outcomes to STB		
AM12, AM13	AGREED	DISAGREED
Facts	<p>The following facts were presented:</p> <ul style="list-style-type: none"> Initial experimental work in the STB found that physical oceanographic disturbance was too great for successful execution of the experiments. The experimental results were not critical to the assessment of potential impacts from the Project; the risk assessment would be unchanged if the results were not considered. 	Nil
Assumptions	Nil	Nil
Importance	The experimental outcomes are of no importance for the assessment of the acceptability of the proposed action.	

Role of iron in re-colonisation		
AM12	AGREED	DISAGREED
Facts	<p>The following facts were presented:</p> <ul style="list-style-type: none"> • The Wellington Harbour experiment was not designed to predict re-colonisation; only to look at responses of benthic communities to the reduced iron concentrations in sediments. • Studies conducted elsewhere (e.g. the Pilbara region of Western Australia) have shown that benthic fauna abundance varies more greatly with particle size distribution (PSD) than with iron content. • Within the STB, there was no correlation between fauna abundance and iron content; it was more closely correlated with PSD. 	Nil
Assumptions	On the basis of the above facts, it is assumed that re-colonisation rates following mining will be more closely linked to sediment PSD than to sediment iron concentrations.	Nil
Importance	<p>This issue is not of direct importance for the assessment of the acceptability of the proposed action. However, it signifies the need to:</p> <ul style="list-style-type: none"> • Include iron in the suite of metals to be analysed in sediments and water during the mining operation, though the potentially confounding effect of changes in PSD will also need to be considered during data interpretation. • Increase the number of monitoring locations within the mining area. 	

Effects on species not found		
AM14	AGREED	DISAGREED
Facts	<p>The following facts were presented and agreed as true:</p> <ul style="list-style-type: none"> It is not possible to census the entire suite of species present in any marine area; hence surveys comprise a sub-sampling of the species present within a study area and some uncommon species may not be collected. 	Nil
Assumptions	<p>It is assumed that the fauna sampled by NIWA are representative of the more common species present in the broader region and that effects upon any species not found would be similar to those on fauna that were sampled.</p>	<p>There is disagreement over the assumption that modelling was conservative:</p> <ul style="list-style-type: none"> MJ, AM and GB consider that the models upon which the impact assessment is based are conservative and actual impact zones are likely to be no larger than those predicted by the models. SM disagrees that the modelling is conservative as the model underestimates surface SSC by a factor to 2 (Hadfield) to 5 (as shown in plots), and underestimates SSC at the seabed by often over 10 times.
Importance	<p>This issue is not of direct importance for the assessment of the acceptability of the proposed action. However, it signifies the need to ensure that monitoring of the mining operation is sufficiently robust to affirm the model predictions.</p>	

Terminology – ‘background’ vs ‘natural’		
AM19	AGREED	DISAGREED
Facts	It was agreed that existing SSC and sedimentation in the STB region are affected by anthropogenic inputs to rivers; hence these are considered to be ‘background’ rather than ‘natural’ levels.	Nil
Assumptions	Nil	Nil
Importance	The fact that incorrect terminology was used to describe background SSC and sedimentation rates is not of importance for the assessment of the acceptability of the proposed action from a benthic ecology perspective. It has been acknowledged that the use of the term ‘natural’ was incorrect.	

Mining area relative biodiversity		
AM21	AGREED	DISAGREED
Facts	A comparison between the biodiversity within the mining area and within similar systems in NZ and elsewhere is presented in MacDiarmid et al (2015).	Nil
Assumptions	Nil	Nil
Importance	As the submitter was not aware of this comparison, this issue is not of importance for the assessment of the acceptability of the proposed action.	

Tolerance limits and sensitivities to suspended sediments		
AM22	AGREED	DISAGREED
Facts	It is not known whether the benthic communities in the STB are at their 'natural stress loads'.	Nil
Assumptions	It is assumed that experimentally derived tolerance limits and sensitivities of similar species to those in the vicinity of the mining operation are appropriate to apply in the risk assessment of the Project.	Nil
Importance	The key importance associated with this issue is that monitoring of the mining operation would need to include monitoring of benthic communities, regardless of whether or not measured SSC levels exceed criteria levels. This will mitigate the risk that criteria levels, set relative to background concentrations, are too high to prevent impacts upon benthic communities (e.g. if they are already at their 'natural stress loads').	

Long-term effects of elevated nickel and copper on larvae		
AM23	AGREED	DISAGREED
Facts	The tolerance of larval stages of benthic species in the Project area to long-term exposure to elevated nickel and copper concentrations is unknown.	Nil
Assumptions	On the basis of measured nickel and copper concentrations in the sediments to be mined, it is assumed that dilution within the water column will be sufficiently high to alleviate the risk of significant impacts upon larval stages.	Nil
Importance	The key importance associated with this issue is that the Project would benefit from:	

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| | <ul style="list-style-type: none">• Ecotoxicity testing as part of the Baseline Environmental Monitoring Plan (BEMP) to establish tolerance levels (to nickel and copper) of larval stages of benthic species that are similar to species occurring in the vicinity of the Project.• Water and sediment quality monitoring as part of the BEMP and the EEMP, undertaken to determine whether metal concentrations are below the 95% protection level in the ANZECC & ARMCANZ (2000) water quality guidelines at sites further than 1 km from the mining site (to take into account dilution and mixing) and are above background levels. Toxicity monitoring using relevant biota would be undertaken if levels exceed the ANZECC & ARMCANZ guidelines. |
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UNCERTAINTIES

17. We **agree** that the following material matters are uncertain and where that uncertainty lies:
- a. Whether the benthic communities that would develop in the mining area post-mining would be the same as those that existed pre-mining and whether they would serve the same ecosystem function. Due to the many factors with the potential to affect the suite of species that would develop in the area.
 - b. The accuracy of each of the models used as the basis for impact assessment. Due to the inherent reliance of models on series of assumptions.
 - c. Whether there are subtidal reefs in closer proximity to the Project area than those that have been surveyed. Due to the absence of surveys of all potential subtidal reef features in the region.
 - d. Whether the new species found in and around the Project area are also present in other shelf areas around NZ. Due to the paucity of research data on benthic species in other shelf areas.
 - e. The extent to which toxicants and nutrients will be released from the mined sediments and diluted in the surrounding water column. Due to the inability for laboratory testing to precisely replicate field conditions.
 - f. Whether re-colonisation following mining will be more closely linked to sediment PSD than to sediment iron concentrations. Due to the inability for laboratory testing to precisely replicate field conditions.
 - g. Whether experimentally derived tolerance limits and sensitivities to suspended sediments of similar species to those in the vicinity of the mining operation are applicable to the species actually present. Due to potential inter-species differences in sensitivities.

Notwithstanding the uncertainties listed above, MJ, AM and IB consider that, whilst not everything is known, there is sufficient information to make a realistic and robust assessment and to predict effects, with most of the uncertainties being related to variability and others related to needing confirmation of predictions made in the assessment. MJ, AM and IB consider that additional information would not have changed the outcomes of the assessment.

18. No matters relating to uncertainty were **not agreed**. That is, there were no issues in which a fact stated by one party was considered by another party

to be an assumption. All disagreements were limited to differences in opinion around assumptions drawn from agreed facts.

19. We **agree that addressing the following matters** would assist in improving the certainty and knowledge gaps discussed above (noting the comment above under 17 related to MJ, AM and IB) and could be developed further through monitoring as part of the EMMP and operational management solutions:
 - a. Monitoring of mined areas to follow the succession of species that recolonise the mined sediments, and to assess the sediment characteristics that are most strongly correlated with the biological characteristics of the developing community.
 - b. Monitoring of parameters that are appropriate to verify model predictions.
 - c. Monitoring to determine the extent of toxicant and nutrient release from sediments during mining to confirm if these are as predicted.
 - d. Monitoring of benthic invertebrates and infauna communities' composition during mining to ascertain whether the water quality criteria levels are adequately low to provide for their protection.

MATTERS FOR THE DMC'S CONSIDERATION

Environmental triggers and monitoring locations – these were not discussed due to time constraints.

QUESTIONS

Nil

CONDITIONS

These were not discussed in detail due to time constraints. However, in the course of discussions during conferencing it was agreed that the following inclusions to the monitoring programme would be beneficial:

- a. Additional monitoring sites within the mining area to provide a more robust BACI analysis for determining recovery/re-colonisation rates of processed areas.
- b. Analysis for iron in the water and sediment monitoring program.

REFERENCES

20. We have referred to the following documents in our discussions:
 - a. Expert witness statements from each of the participants.

b. NIWA reports prepared in support of TTRL's application.

SIGNED:

A handwritten signature in blue ink, appearing to read 'M. James', written over a light blue grid background.

Dr. Mark James (MJ)

A handwritten signature in blue ink, appearing to read 'I. Baxter', written in a cursive style.

Mr. Ian Baxter (IB)

A handwritten signature in black ink, appearing to read 'Alison MacDiarmid', written in a cursive style.

Dr. Alison MacDiarmid (AM)

A handwritten signature in blue ink, appearing to read 'Ngaire Phillips', written in a cursive style.

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Dr. Greg Barbara (GB)

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Dr. Shaw Mead (SM)