Seabed Minerals Authority
Runanga Takere Moana
COOK ISLANDS

NATIONAL ENVIRONMENT SERVICE
TU'ANGA TAPOROPORO
COOK ISLANDS

G17: Environmental Risk Assessments

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1. Purpose

A key function of the Seabed Minerals Authority (**Authority**) is to regulate seabed minerals activities in the Cook Islands jurisdiction through monitoring the performance of title holders and taking enforcement action as required under the Seabed Minerals Act 2019 (**SBM Act**). A key function of the National Environment Service (**Service**) is to permit or consent to activities after passing environmental impact assessment and review as required by the Environmental Act 2003 (**Environment Act**).

This guideline is to assist licence holders and other stakeholders with the content of an environmental risk assessment (**ERA**). Per Environment (Seabed Minerals Activities) Regulations 2023 (**Environment Regulations**), G18 Guideline for an Environmental Impact Assessment Processes, licence holders are required to complete an ERA for all Tier 2 and Tier 3 activities and are additionally required to complete an Environmental Scoping Exercise (**ESE**) and Environmental Impact Statement (**EIS**) for all Tier 3 activities i.e., trial mining or mining (which includes minerals harvesting).

This Guideline should be read in conjunction with the Authority's and Service's publication, "*Information Note: An Operating Framework for Standards and Guidelines relating to Seabed Minerals Activities*."

2. Legislative context

This Guidelines is issued by the Authority and the Service pursuant to section 11(e) of the SBM Act: *Functions of Authority*, section 13A of the SBM Act: *Authority may issue standards and guidelines*; Part 9 of the Environment Regulations: *Applicable standards and applicable guidelines* to assist licence holders with meeting obligations in relation to:

a) Part 5 of the Environment Act 2003: *Environmental Impact Assessment*
b) Definition within the Environment Regulations

The contents of this document are for guidance only, and do not constitute formal legal requirements. Licence Holders remain subject to the applicable legal requirements under the SBM Act, Exploration Regulations, Licence conditions, Environment Act and Environment Regulations. If a Licence Holder chooses not to follow any particular part of this Guideline, the Authority may request an adequate written explanation as to why this is the case, to help assess whether the statutory requirements have been met.

Any information the Licence Holder supplies to the Authority will be managed in accordance with section 17 and 18 of the SBM Act.

3. Scope

This Guideline applies to all Licence Holders, including any associates and affiliates, conducting exploration activities within the Cook Islands Exclusive Economic Zone or Continental Shelf under an Exploration Licence granted by the Cook Islands Government.

This Guideline advises Licence Holders of the information required for an Environmental Risk Assessment. Environmental Risk Assessment (ERA) is defined and referenced in Environment (Seabed Minerals Activities) Regulations 2023. An ERA is a key part of the EIA process prior to application for either a consent or a permit and may be part of an Environmental Scoping Exercise.

4. Environmental Risk Assessment

It is expected that an ERA will:

a) Comprise an assessment of all pressures and risk assessment of resulting effects;
b) Be conducted for all effects identified to be caused and potentially caused by the activities (or pressures) including consideration of mitigation measures;
c) Extend as appropriate to social economic and cultural aspects as well as receiving environment within the Cook Islands; and
d) In the case of application for a consent, be documented in a fit for purpose report.

An ERA may also:

a) Include a risk assessment of each effect using a process in line with G02 Hazard Identification and Risk Assessment, if deemed appropriate by the applicant;
b) Involve effect assessment methods such as significance, compliance criteria; and
c) Be structured and comprised per more detailed guidance in Annex A.

5. Other References

ANZECC/ARMCANZ (2023) *Australian and New Zealand guidelines for fresh and marine water quality*. Available at: https://www.waterquality.gov.au/guidelines/anz-fresh-marine (Accessed: 29 June 2023).

Canter, L. and Ross, B. (2010) 'State of practice of cumulative effects assessment and management: the good, the bad and the ugly', *Impact Assessment and Project Appraisal*, 28(4), pp. 261–268. doi: 10.3152/146155110X12838715793200.

Clark, M. R. *et al.* (2017) *Preparation of Environmental Impact Assessments: General guidelines for offshore mining and drilling with particular reference to New Zealand*. Wellington, New Zealand. Available at: https://niwa.co.nz/sites/niwa.co.nz/files/EMOM_EIA_guidelines_Revision_Jan2017.pdf.

Convention on Biological Diversity (2021) *First Draft of the Post-2020 Global Biodiversity Framework Note by the Co-Chairs*. Available at: https://www.cbd.int/doc/c/abb5/591f/2e46096d3f0330b08ce87a45/wg2020-03-03-en.pdf.

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Fletcher, W. J. (2005) 'The application of qualitative risk assessment methodology to prioritize issues for fisheries management', *ICES Journal of Marine Science*, 62(8), pp. 1576–1587. doi: 10.1016/j.icesjms.2005.06.005.

International Finance Corporation (2013) *Good Practice Handbook for Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets*. Washington D.C., United States: International Finance Corporation.

MacDiarmid, A. *et al.* (2011) *Expert Risk Assessment of Activities in the New Zealand Exclusive Economic Zone and Extended Continental Shelf*. Wellington, New Zealand. Available at: https://environment.govt.nz/assets/Publications/Files/niwa-risk-assessment.pdf.

McIntosh, A. and Pontius, J. (2017) 'Tools and Skills', in *Case Studies for Integrating Science and the Global Environment*. Elsevier, pp. 1–112. doi: 10.1016/B978-0-12-801712-8.00001-9.

US Federal Geographic Data Committee (2012) *Coastal and Marine Ecological Classification Standard*. Available at: http://www.fgdc.gov/standards/projects/cmecs-folder/CMECS_Version_06-2012_FINAL.pdf.

6. Version Control

Version	Date
Version 1	12 April 2024

7. Annex A: Structure and Content of an ERA

The content of this guidance is adapted in part from ISBA/27/C/4, ISBA/27/C/5, (MacDiarmid *et al.*, 2011; Clark *et al.*, 2017; McIntosh and Pontius, 2017). Only parts of the guidance may apply, depending on the exact context and objectives of the ERA.
Additional selected papers and reports of possible use are in part XIII of ISBA/27/C/4.

7.1 Planning and scoping

*This is a set of **basic** questions and answers that ideally fit onto a single page. What receptors are at risk? Receptors may consider including the relevant components of the ecosystem and may include marine biological communities, physicochemical features, ecological processes and functions, humans, and the ecosystems services they access, etc. What exactly are the pressures or activities of concern? What are the expected resultant effects? How might these effects cumulate over time and with other effects from this or other activities? At what scale does the effect extend to? How long does it take for effects to appear? How permanent are the effects?*

For each of aspects of the ERA, evidence brought to the assessment is be described and cited, which may fall on a spectrum from quantified dose-response ecotoxicological data to modelled data, to information from other deep-sea mining studies to information from other marine systems to professional judgement suitably defined.

Also, explain what level of detail the ERA goes into; this being relevant to the stage in the EIA *process when the ERA is conducted. For example, an ERA in an ESE will very likely be less detailed and confident than the ERA in the EIS for mining or minerals harvesting. ERAs for later stages of development ideally references earlier ERAs to explain material changes in understanding of pressures and potential effects and changes in confidence in risks, scope, problem formulation etc.*

Questions to be addressed may include:

- *What and who is at risk? (including marine environmental resources and values, on-island environments, socioeconomic and cultural resources and values and other uses and users of the subject area(s).*
- *What exactly are the environmental pressures or activities of concern?*
- *What are the expected resultant effects?*
- *How might these effect cumulate over time and with what other potential effects from this or other activities?*
- *At what spatial scale are the effects likely extend?*
- *How long will it take for effects to appear? How long will the effects persist? Will the effects be temporary/reversable or permanent/ irreversible?*

Any ERA would include the basic objective of identifying (prioritising) the most important issues for the EIA to focus on, and do so in a way that is systematic, thorough, and underpinned (through expert involvement) by the evidence base existing at the time.

The objective of the planning is to get the risk assessment team aligned with key issues and priorities for the ERA. It may result in a list of roughly characterised effects to assess further in the ERA.

As the process of the ERA proceeds it might be necessary for the risk assessment team to revisit the planning and scoping.

The risk assessment team ideally will include a mix of environmental risk assessment and subject matter experts, their backgrounds and experience will comprise a sub-section of any ERA, ESE or EIS report.

7.2 Effects Assessment

7.2.1 Model Development

Before estimating the severity, extent, and if appropriate, likelihood of an effect, it may be helpful to develop a predictive model that diagrams the relationships and pathways between the pressure, the effect(s) and the environmental factor at risk of harm. Such models can qualitatively help identify the key pieces of data or information necessary to complete the assessment as well as quantitatively inform severity and extent of effects.

For accuracy and completeness, the model may need to call on review work e.g., reviews of:

- *current environment (including social and economic) values and systems based on data collected to date and highlighting those aspects most uncertain or most vulnerable to the impacts of the project;*
- *the intended activities, identifying those likely to have environmental impacts;*
- *existing studies of the environmental effects of relevant activities, and an analysis of the relevance and quality of the studies as they might apply to the project.*

Particular predictive models of potential use include:

- *Habitat mapping*
- *Predictive habitat suitability modelling*
- *Hydrodynamic modelling of sediment plumes and sedimentation footprints*
- *Modelling of genetic connectivity.*

For all models the following details may be included as relevant to enable a robust assessment of the model outputs:

- *Modelling methodology*
- *Inputs, including the value, quantity, spatial and temporal extent of all data to the model*
- *Assumptions used in the model*
- *Sensitivity testing of the model*
- *Calibration of the model (e.g., from component testing (i.e., collector tests) or test mining)*

- *Description of the model runs, including the duration of time the model has been applied, the seasonal variations incorporated, and how these relate to the estimated project life.*
- *Remaining uncertainties relating to the model and its interpretation.*

Where predictive models have been used to inform an EIS for a permit for mining or minerals harvesting, the EMMP can allow for the validation of predictions made by the model.

Gather the details needed to outline exactly what the ERA can address for each effect, i.e., the environmental factor(s) you want to assess effect on and come up with an exact plan to assess this effect. This includes specifying whether the goal is to assess effects on a particular species, a functional group of species, ecosystem function, a specific habitat, a geographic location of concern, as well as maybe identified socioeconomic and cultural values and identified other uses and users of the subject area(s). It also needs to lay out all of the specific questions or concerns that need to be included in the assessment.

7.2.2 Rationalisation and Description of Effects to be Assessed

The methodology for how pressure-effect relationships have been identified and rationalised to those that will be assessed will be described. This includes specifying how potential effects have been screened in or out of assessment, how the receptors have been categorised (e.g., particular species, a functional group of species, ecosystem function, a specific habitat, or geographic location).

This rationalisation and description of effects to be assessed may also describe:

- *How effect magnitude, duration and extent are used to develop rankings/scores/scales.*
- *How low probability or un-planned events such as accidents are assessed in contrast to planned activities such as discharges.*
- *How evidence and uncertainty is used to assess effects and evaluate mitigation potential.*

The objective of this step is to ensure that the assessment of risk is clear, fit for purpose, and partitioning the assessment effects into appropriate levels of the ecosystem and spatial scales that enable the overall significance of risk to be ranked.

As the process of the ERA proceeds it might be necessary to re-evaluate this step.
Additional guidance on various pressures, effects and environmental (physicochemical, biological) factors that may be of note can be found in ISBA/27/C/5 section 6 clauses 68, 71, 73, and 75 and for socioeconomic factors in clause 82.

7.2.3 Assessment of Effects

7.2.3.1 Effect Mechanisms

This is a concise statement of the expected potential mechanisms of how the mineral harvesting or mining project can cause an effect. It can capture the range of potential effects on receptors and lead to formulating key questions to be addressed in baseline studies and monitoring. For example:

- *How will sediment and any associated bioavailable elements, heavy metals and contaminants be transported and dispersed in the Marine Environment?*
- *How will the concentrations of sediments, elements, metals and contaminants change as they disperse and settle?*
- *Which marine organisms are present (or likely to be present, based on past monitoring or life history information) in the zone of exposure?*
- *What are the spatial scales and representativeness of biological communities in potential mining areas and adjacent areas?*
- *What are the expected exposure pathways?*
- *How would acute or sublethal toxicity be expressed in terms of consequences for populations of organisms in the vicinity of the mining project?*
- *How will the mineral harvesting or mining project deplete technical skills needed elsewhere in the community?*

These questions can be rephrased as ‘status indicators or hypotheses based on estimated effects that can be tested statistically with empirical data during the mining operation. For example:

- *Suspended sediment plumes above project targets will not extend beyond an expected zone.*
- *Biological community composition will remain unaffected in representative undisturbed habitat at scales that maintain ecosystem function.*
- *The life histories of migratory, mobile pelagic species will not be adversely affected.*
- *Leaching of elements from ore collection will not disperse beyond the area of mining.*
- *Technical training programs will grow the labour pool of skilled workers for the project.*

This identification of status indicators or hypotheses moves beyond simple description of impacts to enable the development of monitoring indicators and targeted studies that subsequently aid the development of appropriate and effective mitigation measures.

7.2.3.2 Prediction approaches

Several techniques may be used for predicting and presenting potential impacts: as appropriate to the circumstances. Choices may be based on, inter alia:

- *Existing baseline and monitoring data from analogous systems;*
- *Expert judgment with adequate reasoning and supporting data;*
- *Reference to appropriate prescriptive emissions standards e.g. (ANZECC/ARMCANZ, 2023);*

- *Experiments or tests;*
- *Numerical calculations and mathematical models;*
- *Physical or visual analysis;*
- *Economic valuation of environmental impacts.*

7.2.3.3 Effect significance

Per the Environment Regulations, significance applies:

- *In considering whether to grant a permit or not the permitting authority National Environment Council (NEC) needs to "reach a conclusion about the likely significant effects of the activity (including the expected effects deriving from the vulnerability of the activity to risks of accidents or incidents) on the environmental factors" per clause 42 (3), as well as the appropriateness of mitigation measures in clause 43 (1) (b); extending to:*
- *In evaluation of EISs as being fit for purpose (sufficient information such that significant effects are adequately understood);*
- *In considering environmental bonds in association with closure plans;*
- *In deciding on permit renewals and/or revision of EMMPs in terms of any increase in significance of effects;*
- *With regards to offenses if the significance of effects increases without reasonable excuse;*
- *In evaluation of ERAs being complete (all significant effects need to be included).*
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Importantly, there are no explicitly defined levels of significance within Environment Regulations. These may be proposed by the ERA team as part of the ERA or ESE report.

One possible complementary approach might be to use concepts of ***severity*** *and* ***extent*** *(scale) to better define significance. There is some precedent in the regulations for this in that sample dredging below 10,000 m^2/year is a Tier 1 activity but over 10,000 m^2/year is Tier 2.*

A classification of severity by environmental factor can be based on Table 1 c) in ISBA27/C/4 as follows:

Severity Class	***Negligible***	***Minor***	***Moderate***	***Severe***	***Major***	***Catastrophic***
Key Species	Undetectable for populations of these species	Possibly detectable, but little impact on population size and none on their dynamics	Affected but long-term recruitment/ dynamics not impacted	Affecting recruitment levels of populations or their capacity to increase	Likely to cause extinctions if continues	Extinctions are imminent/ immediate
Protected Species	Almost none are impacted	Some individuals impacted but no impact on population.	Level of interaction/ impact moderately affects population	Level of impact severely affects population levels	Likely to cause extinctions if continues	Extinctions are imminent/ immediate

Severity Class	*Negligible*	*Minor*	*Moderate*	*Severe*	*Major*	*Catastrophic*
Ecosystem functional change	Interactions may be occurring, but it is unlikely that there would be any change outside of natural variation	Affected species do not play a keystone role – only minor changes in relative abundance of other constituents	Measurable changes to the ecosystem components without there being a major change in function (i.e., no loss of components)	Ecosystem function altered measurably, and some function or components are missing/declining/ increasing well outside historical acceptable range and/or allowed/ facilitated new species to appear.	A major change to ecosystem structure and function. Different dynamics now occur with different species or groups now affected.	Total collapse of ecosystem processes. The diversity of most groups is reduced and most ecological functional groups (primary producers, grazers etc.) have disappeared. Ecosystem functions such as carbon cycling, nutrient cycling, flushing and uptake have declined to very low levels.

Temporal considerations are to some extent built into the outcomes in the above table but warrant special consideration where relevant during the assessment process. The following scale may be used.

Term	**order**
very fast	< 1 month
fast	< 5 years
slow	5 – 100 years
very slow	>100 years

This can be combined with extent (also based on Table 1 c) in ISBA27/C/4) as follows:

significance matrix

extent (of the **habitat** or habitat management zone)

severity sequence						
N/A					Catastrophic	***Catastrophic***
Negligible	Moderate	Moderate	Severe	Major	Catastrophic	***Major***
Negligible	Moderate	Moderate	Severe	Major	Catastrophic	***Severe***
Negligible	Minor	Moderate	Moderate	Severe	Major	***Moderate***
Negligible	Minor	Minor	Moderate	Moderate	Major	***Minor***
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	***Negligible***
≤1%	*1-5%*	*5-30 %*	*30-70 %*	*70-90 %*	*>90%*	
Negligible	***Minor***	***Moderate***	***Severe***	***Major***	***Catastrophic***	

Adapted from ISBA27/C/4 Table 1 c)

Matrix of significance based on severity versus extent. Adapted from ISBA27/C/4 and in turn (Fletcher, 2005; MacDiarmid et al., 2011; ERIAS Group, 2016) as well from the 30% area conservation target (Convention on Biological Diversity, 2021).

7.2.3.4 Cumulative Effects

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other previous, existing, planned, and/or reasonably anticipated future actions, projects or activities (International Finance Corporation, 2013).

Furthermore, a cumulative impact assessment includes two components:

1) *The anticipated future condition, which is the total effect of the other existing, and predictable future developments and external natural environmental and social drivers, and*
2) *The contribution of the development under evaluation to the cumulative impacts.*

This definition of cumulative impacts therefore considers the additive impact of the primary activity (i.e., the current Project) and third-party activities. By taking account of existing or other projects planned in the foreseeable future, it is intended to overcome the deficiencies associated with the limited scope of an individual project-based environmental and social impact assessment.

There are several evaluation criteria that may be considered:

- *Temporal accumulation – often where perturbations are so close in time there is no opportunity for recovery between disturbances (consider duration and frequency of perturbation);*
- *Spatial accumulation, where perturbations are so close in space that they overlap (consider geographic scales, boundaries, directional patterns);*
- *Perturbation type (single, multiple, likely trigger for further effects). This can also consider indirect effects further from the area of physical disturbance;*
- *Processes of accumulation, including synergistic effects or progressive "nibbling" in small amounts (consider cause and effect, what is additive versus interactive);*
- *Functional effects (causing changes in ecological processes or controlling properties);*
- *Structural effects (spatial changes in biological or physical composition).*

Further guidance may be found via a Cumulative Effects Assessment and Management process (CEAM), which also incorporates a management aspect to specify mitigation measures for cumulative effects overall e.g. (Canter and Ross, 2010).

7.2.3.5 Risk and Ranging Assessment

Risk Assessment is a process that might only apply to certain effects, namely those that are expected to be significant and that have material uncertainty as to their likelihood. The environmental risk assessment will demonstrate and emphasize high-risk activities, but still document low-risk elements.

Risk Assessment is especially relevant to accidents or low probability extreme events (eg weather related) and environmental risking will ideally be in line with other project risk assessments (e.g. as carried out per G02 Hazard and Risk Identification).

Inclusion of an environmental risk assessment expert at the outset can help select the best tools.

Ranging Assessment is a probabilistic approach. For effect assessment, it may involve the different likelihoods of the range of possible consequences of the effects.

As it is significance that drives decision making, risking of effects may then revolve around the significance of the effects as discussed in the section above. The risking needs to be implicit in terms of scale given the extensive nature of seabed mineral deposits and associated habitats.

The risk assessment process may take guidance from G02 Hazard and Risk Identification, which details:

- *Risk Analysis and Level via:*
  - *Frequency/Probability Assessment;*
  - *Consequence Assessment;*
- *Risk Evaluation via:*
  - *Risk representation;*
  - *Cumulative Risk;*
- *Risk Treatment (or mitigation).*

Risk assessment can be based on a combination of:

- *existing research;*
- *ecological principles;*
- *general frameworks;*
- *specific calculations;*
- *professional judgement.*

Calculations can be used to determine the levels of exposure that will lead to harmful effects, the expected duration or lag in the timing of this risk, which plants and animals are most at risk, and what degree of exposure is likely to have harmful effects.

Noting again that level of detail for the ERA would depend on the stage in the EIA process, other possible tools, in order of sophistication and complexity, are:

- *Checklists;*
- *Matrices;*
- *Networks or causal chain analyses;*
- *Overlay maps*

Two additional sources of guidance are ISO31010 (IEC-ISO 2009) and a report and presentations from a 2018 workshop on risk management for deep-sea mining (MIT 2019).

7.2.3.6 Confidence

Confidence (or certainty/uncertainty) by the risk assessment team is an important factor to be considered when assessing effects and will also help illustrate gaps in knowledge for follow up work. As ERAs are redone or updated through the EIA process confidence may improve but regardless good industry practice in Environmental Management maintains that monitoring will continue to check for unexpected ecosystem responses (emergent properties) that may arise due to unknown synergistic/antagonistic relationships, hysteresis, etc.

Uncertainty can be assigned to both the identification of environmental values (the baseline study) and the assessment of impacts. The following groupings provide a useful way to approach this requirement:

- *Acknowledge uncertainty, arising when there is incomplete understanding of structures, processes, interactions or system behaviours;*
- *Uncertainty related to the unpredictability of chaotic (often random) components of complex systems or of human behaviour;*
- *Structural uncertainty, arising from inadequate models, ambiguous system boundaries, or oversimplification or omission of processes from models;*

- *Value uncertainty, arising from missing or inaccurate data, inappropriate spatial or temporal resolution, or poorly known model parameters;*
- *Interpretation uncertainty, arising when values or terms are or may be interpreted differently by different user groups.*

Then it may prove useful to use the following steps to reduce uncertainty:

- *Identify sources of uncertainty;*
- *Reduce uncertainty where possible;*
- *Acknowledge and manage the residual (unavoidable) uncertainty.*

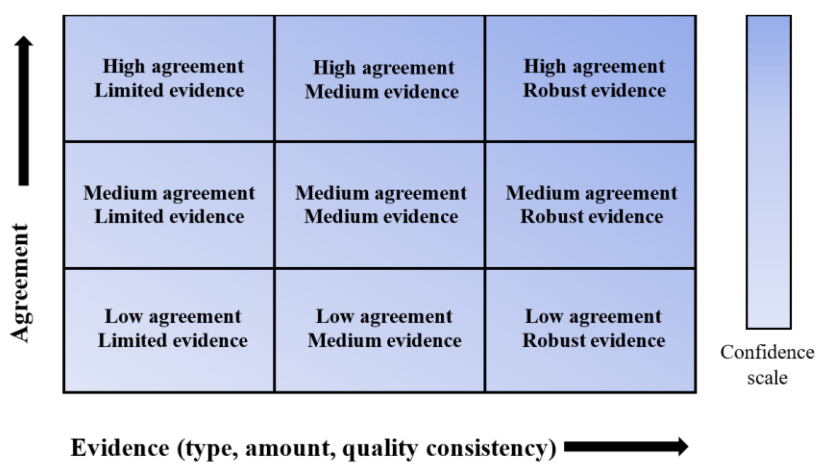
Qualitative or quantitative measures of uncertainty or confidence can both be useful. With some possible scales below. It is best also to state any limitations.

Such a scale that is meaningful in normal language might be: certain, probable, unlikely:

- *Certain/near certain: probability estimated at 95 per cent chance or higher.*
- *Probable: probability estimated above 50% but below 95%.*
- *Unlikely: probability estimated above 5% but less than 50%.*
- *Extremely Unlikely: probability estimated at less than 5%.*

Alternatives could include:

Confidence		**Rationale for confidence score**
Low	a	No data exist and no consensus among experts
	b	Data exist, but are considered poor or conflicting
	c	Agreement among experts, with low confidence
High	a	Consensus among experts, with high confidence, even though data may be lacking
	b	Consensus among experts supported by unpublished data (not been peer-reviewed but is considered sound)
	c	Consensus among experts supported by reliable peer-reviewed data or information (published journal articles or reports)



This Intergovernmental Panel on Climate Change approach to confidence, has the confidence scale increasing from bottom left to top right.

7.2.4 Mitigation

An EIA process through the EIS and EMMP can describe the alternatives explored by the applicant at a high level. The alternatives and mitigation in the EIA will ideally directly link to the options considered in the project PFS per S06 Scoping, Pre-feasibility, and Feasibility Studies.

Whatever process is adopted to facilitate the evaluation of options, it is important that:

- *Options are selected and ranked within the context of As Low As Reasonably Practicable (ALARP);*
- *The process is undertaken in a structured and logical way, and*
- *decisions are properly recorded and reasoned for later incorporation into the appropriate section of the EIS.*

Mitigation measures may be approached through a hierarchy, i.e.:

- *Avoid/prevent;*
- *Minimise;*
- *Rehabilitate/restore; and*
- *Offset.*

Environmental pressure/effect mitigation needs to allow for flexibility to avoid:

- *overemphasis on peripheral issues, i.e., reducing one relatively minor effect may lead to major cost and engineering compromises that might even increase effects elsewhere in the system; and*
- *applicants aiming to permit for effects that are overly severe to aid in engineering margins.*

7.3 Scales

The scales below are recommended in the description of effects including cumulative effects. They were developed to be fit for purpose in the Cook Islands and do not represent to be relevant in other jurisdictions.

Scale	km^2	Examples	Example distances
Interregional	**Hundreds of millions**	• Essentially the global oceans • Pacific Ocean	• 15,000 km between some nodule fields
Regional	**Millions**	• Transboundary areas such as the Western South Pacific High Aragonite Saturation State Zone • CI EEZ managed under Marae Moana ± extended continental shelf submission	• 1,500 by 1,000 km • 1,500 by 2,000 km
Sub-regional	**Hundreds of thousands**	• Level 1 habitat management zone • Penrhyn abyssal plain basins	• 500 x 600 km • 700 x 700 km
Project*	**Thousands to tens of thousands**	• Typical exploration licence or sub area of an exploration licence proposed for minerals harvesting under EIA (with inclusions and buffers)	• ~200 x 100 km (Moana Minerals EL3)
Local**	**Tens to hundreds**	• Representative commercial scale panels (months to 1 year) or equivalent remnant • Average abyssal hill-top	• 1-12 x 1-12 km • 20 km by 3 km for an average abyssal hilltop
Path***	**0.0001 (or 100s of m^2)**	• Collector track, including small test patterns and panels	• 15 m by 1000 m long collector track

*equates to Coastal and Marine Ecological Classification Standard - Tectonic Setting Subcomponent; **CMECS - Physiographic Setting Subcomponent to Geoform Level 1; ***CMECS - Geoform level 2; (US Federal Geographic Data Committee, 2012)

A key implication of the above series of scales is that, cumulative effects aside, environmental effects that are controlled and of acceptable significance at a given scale are controlled and of acceptable (likely lesser) significance at the larger scales.