THE PEW CHARITABLE TRUSTS

2005 Market Street, Suite 2800, Philadelphia, PA 19103-7077 P +1.215.575.9050 F +1.215.575.4939
901 E Street NW, 10th Floor, Washington, DC 20004 P +1.202.552.2000 F +1.202.552.2299
Avenue des Arts 40, 1040 Brussels, Belgium P +32.2.274.1620 F +32.2.274.1630
The Grove, 248A Marylebone Road, London, NW1 6JZ P +44 (0) 20.7535.4000

18 May 2020

Dr. Vijay Kumar
Dr. G. A. Ramadass
Ministry of Earth Sciences, Government of India

CC:
Michael Lodge, Secretary-General
Chapi Mwango, Chief, Contract Management Unit
International Seabed Authority

Dear Drs. Kumar and Ramadass,

The Pew Charitable Trusts is an independent non-profit, non-governmental organization dedicated to serving the public interest by improving public policy, informing the citizenry and stimulating civic life. One of our core areas of interest is global oceans governance and marine conservation. In this regard, we are engaged in the ongoing discussions at the International Seabed Authority (ISA) on deep seabed mining. Our work focuses on the development of a strong precautionary mining code that minimizes environmental harm from seabed mining activities in the Area.

In 2017, Pew assembled the Code Project, an international collection of scientists and legal scholars, to review and comment on aspects of the evolving governance regime for mining in the Area. At Pew's request, members of the Code Project reviewed the Environmental Impact Statement (EIS) recently circulated by the Government of India Ministry of Earth Sciences concerning the planned technical trials of a nodule collector pre-prototype in 2021. On behalf of the Code Project, we respectfully submit the attached comments. We take this opportunity to thank the Government of India for the opportunity to participate in this consultation, and for responding positively to requests from the international community to extend the deadline for the consultation process. We thank you for demonstrating your commitment to transparent and meaningful stakeholder participation.

India will be among the first countries to conduct equipment testing in the Area and to circulate an EIS to that effect. In many ways, this process will provide a benchmark for future proponents of mining activities.

While the EIS clearly represents the culmination of a significant investment of time, energy and effort, members of the Code Project have identified a series of critical gaps in its presentation and content. As further detailed in the attached comments, the document departs from the ISA's 'Recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area' (ISBA/25/LTC/6/Rev.1) in ways which call into question its completeness, accuracy, and statistical reliability. While some of these gaps may be consistent with previous testing-related environmental impact statements submitted by other contractors, the data and monitoring plan presented in this EIS make it impossible to confirm, without significant revision and further scientific study, that this test will ensure effective protection for the marine environment or will result in usable

environmental data to assess future commercial-scale seabed mining. We submit these comments trusting that they can be received in the spirit in which they are offered – with acknowledgement of the effort that has gone into the EIS already and an eagerness for future collaboration toward its improvement.

As you are likely aware, recent revisions to ISBA/25/LTC/6 clarify that the LTC will review an EIS for completeness, accuracy, and statistical reliability and make recommendations as to whether the proposed activity should be incorporated into the programme of activities under a contract (ISBA/25/LTC/6/Rev.1 para. 41). While the LTC review is likely to shed light on the issues raised in the attached comments, the ISA process for reviewing Environmental Impact Statements remains incomplete: entire steps of the assessment process – like scoping – are excluded from the Recommendations; there is no review of the acceptability of anticipated environmental impacts or the sufficiency of a proposed monitoring framework; there is no procedure for stakeholders to provide comments to the LTC during its review, except on invitation; there is no decision-making or permitting structure for exploration activities; and there is no consultative mechanism to promote a dialogue between the ISA and the contractor prior to the submission of an EIS.

We anticipate that the Government of India will be responsive to stakeholder concerns, but the absence of a strong evaluative and decision-making framework at the ISA creates a fragmented and uneven playing field for all contractors. We hope that the Government of India will act as a leader in pushing other ISA Members to address these lacunae and ensure that all contractors are held to the same high standard for protecting the marine environment.

I thank you again for the opportunity to submit these comments for your consideration and review and hope that you might find them useful. Please do not hesitate to reach out if further discussion with us or with members of the Code Project could further your work.

Yours Sincerely,

Andrew Friedman
Project Lead, Seabed Mining
The Pew Charitable Trusts

Code Project Comments Regarding Environmental Impact Statement Prepared by the Government of India Ministry of Earth Sciences

Background:

The Government of India's Ministry of Earth Sciences (MoES) plans to conduct technical trials concerning a nodule collector pre-prototype in the Central Indian Ocean Basin in 2021. In preparation for this test mining, the MoES prepared an Environmental Impact Statement (EIS) and invited stakeholder comments. The International Seabed Authority (ISA) circulated an announcement for stakeholder consultation to its membership on 27 March 2020, noting that the Government of India submitted its EIS on 15 March 2020. The EIS was submitted pursuant to ISBA/25/LTC/6[1] 'Recommendations for the guidance of contractors for assessment of possible environmental impacts arising from exploration for marine minerals in the Area', Para 34 which encourages contractors to submit environmental impact assessment prior to the proposed mining activity.

In 2017, Pew assembled the Code Project, an international collection of scientists and legal scholars, to review and comment on aspects of the evolving governance regime for mining in the Area. At Pew's request, members of the Code Project reviewed the EIS and respectfully offer the following comments.

Summary and General Recommendations

1. Future stakeholder consultation should occur prior to EIA: On April 9th, the Government of India announced that its deadline for stakeholder comments was extended to 24 May 2020. This additional time for review was welcome. However, given there was no stakeholder engagement undertaken regarding the scoping of the EIS, or the communication of a proposed release date for the EIS, and taking into consideration also the global events associated with COVID-19, even this extended review is inconsistent with industry standards.

2. Formal EIA Scoping is required. Scoping is a standard process for initiating an EIA and is fundamental in making the EIA process fit for purpose through such mechanisms as: defining a clear study area; establishing the most important issues for the EIA based on an initial environmental risk assessment; identifying primary data needs for surveys; establishing suitable methodologies to assess impacts; and establishing suitable terms of reference for the EIA through public consultation. Stakeholders should be consulted at the scoping phase of the EIS, with advance notice given regarding its publication and more time should be given for review. Many of the concerns raised by this EIS might have been identified and resolved at an earlier stage.

3. Statistically useful and defensible data are required in order to monitor changes caused by test mining impacts. While it might be assumed that impacts from this particular test mining activity will be limited, more data that are statistically defensible are needed in this EIS to confirm such an assumption. For example, the area sub-sampled for macrofauna (and for each of the other environmental parameters) amounts to no more than 0.025m^2 in total from 5 box cores (in total 1.25m^2) in each of the Preservation Reference Zone (PRZ) and the Impact Reference Zone (IRZ). The PRZ and IRZ each cover an area of 750 km^2. This means the EIS proposes to use sampling for macrofauna which covers an area the size of a

[1] Revised at ISBA/25/LTC/6/Rev.1

computer screen to manage an area of the international seabed roughly the size of Chennai and its suburbs. While the EIS presents baseline data for the entire contract area, data specifically relating to the test mine area and the PRZ are extremely limited. This is a significant departure from industry standards, and an alarming precedent for future test mine EISs. The EIS must detail existing data within the proposed PRZ and IRZ and explain its relevance to the test mining activity, including justifications that the species compositions of the IRZ and the PRZ are comparable (ISBA/25/LTC/6/Rev.1, Paragraph VI.C.38(o), page 12/40) and how this information will be used to create a statistically defensible (ISBA/25/LTC/6/Rev.1, Paragraph IV.B.35, Page 11/40) monitoring program sufficient to detect natural and test-mining impacts and recovery over time. This should include clear and concise mapping for each dataset to distinguish between site-specific and regional data.

4. Plume modelling specific to IRZ and test mining area is required: Validation of a hydrodynamic model describing the extent and behaviour of a sediment plume (and subsequent sedimentation rates on the seafloor) should be the principle contribution for a small test of nodule collection like the one proposed in this EIS. This hydrodynamic model is necessary to assess potential impact and the adequacy of a proposed monitoring regime. Yet the EIS describes a plume model developed for a previous test (in 1997) without offering any modelling or model outputs for this proposed activity, specifically the predicted impacts of either the sedimentation plume in the water column, or the associated sedimentation rates.

5. A framework is required to show how the test mine monitoring data will be used to inform future commercial scale mining: A key objective of test mining is to improve the understanding of impacts so that predictions about impacts of a large scale mine can be better informed (ISBA/26/LTC/6/Rev.1, Paragraph IV.C.37, Page 12/40). Of critical importance to this process is a robust monitoring plan and clearly defined plume model outputs. This EIS lacks needs both.

6. **Impact mitigation needs to be considered in the EIS:** The environmental statement should describe the measures proposed to mitigate any likely significant effects of a development. These measures may include aspects of the project design or environmental mitigation approaches that should be put in place prior to the test and monitored/managed after.

7. Environmental risk assessment is recommended to form a part of the EIS: While some risks associated with the planned trials and some likely impacts are identified in the text, no attempt has been made to summarise this in an assessment of individual environmental risks, their consequence and likelihood. This helps identify appropriate control measures and estimate their efficacy (linked to the above point on mitigation). This is a standard feature of environmental assessment in most jurisdictions and would be a valuable addition here.

Comments relating to Specific Sections of the EIS

Section 1 – Introduction

Recommendation: A scoping process, including stakeholder consultation, should have been conducted prior to the EIA to identify the appropriate scope of the report and to assess the relevant risks.

- Section 1.4 Scope and Structure of the Report:
    - There is no mention of a scoping process and references to the 'scope of the report' are high level. One result may be that the extraneous details are included while important details are excluded. Typically, a formal EIA scoping phase, including an initial Environmental Risk Assessment, would consider a combination of:
        - Existing knowledge of the physical and biological baseline to inform the selection of a test site (and impact reference zone (IRZ)) that is representative of the areas to be commercially mined in the future in terms of both nodule coverage and general environmental characteristics;
        - Establish the likely plume propagation area through previous sediment disturbance experiments (e.g. in the CIOB and CCFZ) and modelling;
        - Based on the above, identify the key environmental issues (or risks) and the study area needed to capture the direct footprint of the test mining machine and other areas impacted by varying levels of sediment deposition; and
        - A systematic identification of other potential sources of disturbance (light, sound, vessel emissions, etc.) and their likelihood of having significant impacts.
    - The lack of an Environmental Risk Assessment at scoping also results in the EIA not having specific objectives beyond meeting legal requirements. These might include:
        - Developing and adequate environmental baseline;
        - Assuring that the test mining location will not adversely affect a unique or highly valued aspect of the marine ecosystem;
        - Predicting the potential impacts of test mining and planning the environmental monitoring activities accordingly;
        - Providing the basis for monitoring during and after test mining.
        - Justify the selected location for the test site and its associated IRZ and PRZ; and
        - Describing in detail the monitoring plan and how the results will advise full-scale commercial mining.
- EIA scoping is also a key opportunity for public consultation that has been missed.

Section 3 – Area of operation and description of the proposed collector test

Recommendation: This section should be revised to incorporate mapping that shows all relevant aspects of the test mine area in relationship to each other and the broader Central Indian Ocean Basin. The location of the IRZ and Preservation Reference Zone (PRZ) should be supported by additional geophysical and biological data explaining why they are effective reference areas (in addition to comparative nodule cover). Risks must also be weighted and subject to management plans and procedures, including for vessel discharges, hydraulic oil spills, and pelagic interactions.

- Section 3.1.1 (Location) should incorporate clear mapping of the Indian contact area, the test mine area, the IRZ and PRZ in the context of the broader Central Indian Ocean Basin (CIOB), and in the context of the sampling points. A map showing the test mine area in the context of the proposed mine area does not appear until page 213 of the EIS.[2]
- Section 3.2 (IRZ and PRZ)
    - Critically, the IRZ must be a close match, in terms of nodule resources, geochemistry, biology, geomorphology etc., to the PRZ. The EIS must therefore incorporate data on these additional factors to justify the choices made. The choice appears to be based solely on nodule cover. For example, there are at least significant geomorphological discrepancies between the IRZ and PRZ: the seabed environment in the PRZ is influenced by 3 seamounts, while the IRZ by just one seamount in the corner of the area. Large-scale geomorphological features are known to have significant effects on the characteristics of sediments and their biology.
    - The site for test mining is not specified other than it being in the IRZ. The IRZ has an area of approximately 200 km^2 compared with a planned direct footprint of the test mining activity of less than 0.002 km^2. As a result, the baseline of the actual test site and the area around it that will be affected by sediment are not described. A reasonable comparison would be an oil and gas company basing an EIA of an exploration well to be located somewhere within a 15x15 km square rather than providing planned coordinates.
    - Section 3.5 (Risks associated with the planned trials) – Risks should be weighted according to likelihood and potential consequence, and specific procedures or management actions should be prescribed for the treatment of risk. For instance:
        - Section 3.5 (b)– The management strategy for discharges from the vessel, which notes that "Accidental or intentional discharges from the ship are not envisaged" is insufficient. It is necessary to have management systems, procedures and supplies in place to deal with spills and accidental discharges.
        - Section 3.5 (g) – Best practice regarding hydraulic oil on subsea systems is to use biodegradable oils. The document notes that the hydraulic oil quantity is "less than $1m^3$ ", however this is potentially still up to 1000 litres of oil, which would be a significant spill.
        - Section 3.5 – Typical offshore extractive practice would address the potential for impacts to pelagic megafauna during vessel operations or launch and recovery processes.
        - It is evident from the echosounder record presented in Fig. 4.1.2.1, as well as the description of bottom features, that there is considerable local-scale heterogeneity in the geomorphology of the seabed. These features pose risks to the mining equipment not reflected in the EIS. The only mapping by swath is from a ship mounted system. It is important to clarify the resolution of the swath system and whether or not it is adequate to resolve seabed hazards. Very high resolution mapping using deep-tow systems or AUVs has been carried out by other contractors as a necessary step to understanding the seabed in the test-mine area.

[2] Note also Figure 3.2.1.2 (Page 37) maps a position for the PRZ that is different from the coordinates given at Table 3.2.1.1. There are also discrepancies in the position of the PRZ between the tables and figures and the labelling as block 90C or 90B.

Section 4 – Baseline physico-chemical environment

Recommendation: The EIS must provide, and the contractor may need to collect, the additional data required to ensure an effective environmental baseline. The sampling program reflected in the EIS must be expanded significantly to meet this standard.

- Fig 4.1.5.2 shows how each of the five box core samples taken are sub-sampled for a wide variety of parameters, including macrofaunal and meiofaunal biology. As noted above, a small number and size of samples mean that very few organisms are sampled. This, coupled with a limited overall number of samples in a regular grid, will be insufficient to characterise vast areas of heterogeneous habitats on the seabed. Larger individual samples (whole 50x50cm boxcore samples are recommended for macrofauna) and a more intense sampling regime, potentially stratified by acoustically-derived habitats, are recommended.
- Section 4.2 (Bathymetry)
    - Section 4.2.4 (Bathymetry of the contract area) should incorporate a high-resolution large bathymetric map (with colour bar rather than contours) of the contract area to enable a better understanding of the features and is the more typical presentation of these data. These data are presented for the PRZ and IRZ
    - At Section 4.2.10 (Bathymetry and sediment thickness in IRZ and PRZ) sediment thickness seems to have been determined by point measurements from the Teledyne Parasound sub-bottom profiler. The bathymetry indicates a relatively complex terrain, and the point samples suggest that the patterns in the subsurface are similarly complex. These cannot be clearly characterised by samples taken 8km apart, especially as 4/10 samples are not clear. We would recommend that profiles obtained with the Teledyne Parasound sub-bottom profiler are presented across several sections of the IRZ and PRZ showing subsurface sediment patterns.
    - Referring to Fig 4.2.10.1b (PRZ) three samples were taken on or in close proximity to abyssal hills and two on gently sloping areas. A stratified random sampling approach (with greater intensity of sampling) would better suit the heterogeneity of the geomorphology and seabed.
    - Section 4.4.2.3 – This section seems to indicate only two points of data for suspended particulate matter (SPM). This is a low rate of sampling, given the critical importance of determining baseline SPM and subsequently any impacts associated with plumes.

    - The regional data of environmental variables presented in the contoured map figures from page 123 onwards are all based on just one (sub)sample at each point in any one sampling period. There are no data on the variability of the environmental parameters at each point and at each sampling period. The exceptions are the ten box core samples taken in 2015, five in the PRZ and five in the IRZ. These samples show that local variability is as great as the regional trends depicted in the contour maps. These maps do not show regional trends; they merely reflect the local variation that would have been found if more than one (sub)sample had been taken at each point. This strongly suggests that additional baseline sampling is required to understand the variability in environmental parameters, especially in those parameters to be used in 1) monitoring impacts and 2) in regional and local management planning. Larger sample sizes and a sampling strategy that takes into account the local heterogeneity (e.g. stratifying the sampling plan by geomorphology)

may help reduce the variability in the data to more acceptable levels and provide statistically defensible data for use in monitoring.

- Additional Comments
    - A clearly defined study area is a fundamental starting point for the EIA process and is usually established at the scoping stage.
        - The extensive baseline descriptions in the report variously refer to: an undefined 'study area'; the broadly defined Central Indian Ocean Basin (CIOB); the Indian Contract Area (as legally defined); and other references.
        - The proposed footprint of the test mining activity is defined at a scale of 1/8°x1/8°; i.e. nearly 200 km^2. In contrast the planned direct footprint of the test mining activity is less than 0.002 km^2 (based on a 1.6 m width of test machine and 1.1 km cumulative length of transects), with a larger area of seabed affected by sediment deposition from the plume.
        - Typically, a study area might be defined at several levels, which for a deep-sea mining activity could include: the *direct footprint* of the activity; a *wider affected area* over which impacts (noise, sediment transport) of the activity are likely to be propagated; and a *wider regional description* to place the characteristics of the affected area in context (e.g.: Is it exceptional compared with the norm? Is it reflective of the norm? Is it impoverished compared with the norm?). Establishing the study area focuses baseline data acquisition, interpretation and presentation.
    - Clearer and more consistent presentation of baseline data, the use of graphical and mapped information to present spatial data, is needed. Various important environmental baseline information is presented in different ways at different scales on different map bases. Some graphically presented baseline information (e.g. Figure 4.4.1.4.1 'Locations for current meter moorings in the area') does not include the test site locations or even the Indian Contract Area. This makes it difficult for the reader to understand the relationship between information and its relevance to the Test Mining EIA. On examination of different mapped or spatial information in the report some examples include the following.
        - All three groups of current meter moorings are outside the Indian Contract Area and a considerable distance from the selected PRZ and test site (the IRZ) (see Figure 4.4.1.4.1).
        - Similarly, the EDS and PRS used to underpin impact assessments extensively in the EIA are also outside the Indian Contract Area and a considerable distance from the selected PRZ and test site (the IRZ) (see Figure 6.2.4.1).
        - Nodule fauna sample stations do not appear to cover either the PRZ or IRZ and also do not appear to be from areas of high nodule abundance (see Table 5.6.1).
    - All data presented in Sections 4 and 5 should be presented as means and standard deviations, while disclosing the number and size of samples upon which the data are based on.

Section 5 – Baseline biological environment

Recommendation: A synthesis of the geological, geochemical and biological data would improve understanding of the relationships between biological parameters and help to elucidate any relationships with environmental factors. This would allow conclusions to be drawn as to the environmental variables that would be most effective in monitoring impacts and would guide the monitoring plan. It would also help to identify the large discrepancies between this EIS and the "Recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area" (ISBA/26/LTC/6/Rev.1).

- General comments:
    - Studies mentioned should be linked to existing information of relevance about the region, including other regional ecological studies, taxonomic studies showing distributions of species observed, and more general/theoretical studies that could help explain patterns observed.
    - The EIS must describe any links between the environmental variability observed and other environmental factors. This is an important part of understanding the response of "seabed communities to natural environmental variability before the mining-related activities" – which is a key aim of the environmental baseline under ISBA/25/LTC/6.
    - The EIS must also identify missing information or recommendations made to close gaps in knowledge. This would be very valuable to understand the limitations of the current work and direction of future work.
    - It would be valuable to compare the various fractions of biology (e.g. megafauna, macrofauna etc) together. This is very challenging at present by the use of different looking maps at different scales. Some synthetic work would improve understanding of the relationships between biological parameters and help elucidate any relationships with the environment.
    - Methodological reporting could be strengthened here and elsewhere by making it, and data collected, publicly available and subject to peer review. The only reference in the report to data suggests data are held in a series of databases (Table 1.2.2.4) that do not appear to be publicly accessible. Having open access data and metadata would allow independent verification.
- Section 5.1 (Marine birds and mammals) does not provide any data on the marine birds and mammals that may frequent the area.
    - It is recommended that, at least, a search of IUCN and other threatened/vulnerable species databases be undertaken, to determine whether any listed species may be present. The report should also include data on whether migratory species may pass through the area, and whether the test timing will impact on migration of these species.
    - It is further recommended that international experts on marine birds and mammals are consulted and reports published on the conclusions from those discussions.
- Section 5.2 (Water column biology)
    - This section contains a large amount of information, but the specific relevance of each figure and data point to the contract area and to the test mining site is not explained. What is the relevance of these data and how will they be used in monitoring impacts?
    - It must also account for the modern understanding of phytoplankton ecology in oligotrophic waters, and the importance of picophytoplankton in the marine environment.

- No data are presented on the sampling strategy (number of samples at each point, time of day of sampling) for the water column studies for either phytoplankton or zooplankton. No data specific to the PRZ and IRZ are presented. This information should include, at least:
    - For phytoplankton: how were cell counts made, what were the sample sizes, what was the variation at each point? Why have picophytoplankton been excluded?
    - For zooplankton, what types of sampling gear were employed? What was the mesh size? Why have data not been presented to show day and night differences? What time of day were the samples taken, especially in relation to diurnal vertical migration at dawn and dusk? Were opening/closing nets used or oblique tows?

- Section 5.3 (Midwater fauna): The EIS does not include consideration of pelagic communities in the water column and near-bottom (in the benthic boundary layer) that may be impacted by operations (e.g. noise and discharge plumes) as required under ISBA/25/LTC/6, Section B para 15(d)(iv). The release of crushed, fine, particulate material 80m above the bottom has the potential to impact benthopelagic communities (i.e the specialist pelagic zooplankton and fish living with the Benthic Boundary Layer - within 100m of the seabed).
- Section 5.4 (Benthic communities (generally))
    - The authors report they have used the same methods to sub-sample a box core as in previous surveys (Fig 4.1.5.2) to ensure consistency between sampling periods. They also report total macrofaunal densities of c. 100 to 400 individuals per sq.m (this is the full range, not the mean, 22 to 132 individuals per. One box core (0.25 sq.m) will therefore result in 25 to 100 individuals (full range). The box core is subsampled for macrofauna using a 8cm diameter plastic tube ($50cm^2$) or one fiftieth of the area of the box core. A total of five box core samples were taken in each of the PRZ and IRZ.
    - It is impossible to produce statistically significant results using this approach. The number of macrobenthos individuals that might be sampled varies between 0 and 2 individuals (exceptionally, a few more specimens may be found) of total macrofauna. In addition, there appear to be issues of pseudoreplication in subsampling several samples from the same box core. It cannot be used to characterise spatial or temporal variation, particularly given the considerable local-scale heterogeneity in the geomorphology of the seabed, shown in the echosounder record (Fig. 4.1.2.1) and recognized in the EIS text. A revised EIS (and sampling plan) must show how this variability has been addressed and how future monitoring will resolve spatial variability with statistically significant changes in biological communities over time.
    - In addition, no data are presented on how the box core samples were handled to demonstrate conformance with the methodology recommended in ISBA/25/LTC/6/Rev.1. How was sampling by quadrants made? Why are lower abundances recorded for these data? What was the temperature of the sieving water? Was preservative used? How was the water overlying the core sampled? The overlying water is usually added to the top sample layer of sediment? Was this done? Is this why sub surface maxima are reported??
    - Given the gaps in knowledge about deep ocean fauna, and the often wide spacing of sampling points (multiple kilometres apart) in the data presented, the use of species accumulation curves, showing how many new species are encountered per each sample analysed, would help determine whether the rate of sampling is appropriate. This curve should show that no new species are discovered once sampling is sufficiently saturated.

- It also appears that the mapping data were not used to design the sampling approach. Such an approach to sampling (stratified sampling) is recommended multiple times in ISBA/25/LTC/6/Rev.1 and can increase the power of subsequent investigations.
- As the existing sampling is inadequate for a baseline study against which to measure impacts and the recovery of benthic faunal communities, a new, dedicated and comprehensive benthic sampling program is required.

- Section 5.4.1 (Megafauna)
  - The megafaunal evaluation was based on a total of 300 photographs.
  - It is not clear what the area coverage of each photograph is or the aerial extent of the whole survey - this should be documented and broken down by transect, as ecological metrics presented are typically highly dependent on the sampling effort. Typical values for deep-sea photographs for biological analysis can be used to approximate the area of each photograph (e.g., the Russian Neptune camera used at the site before (Rodrigues, et al., 2001) provided 3.6 m^2 images of the seafloor). As such we estimate that the aerial coverage of the total assessment presented here (300 photos) is around 1000 m^2. If this is the case, the numbers of animals encountered in all the data must be less than 1000 individuals. It looks from figure 5.4.1.1 that there are around 12 transects, meaning each transect covers less than 100m^2 of seafloor. This means that typical transects would have fewer than 100 individuals. Recent recommendations (Simon-Lledo et al 2019 Prog. Oceanogr.) suggest that individual sampling units should cover more than 300 individuals to make good assessments of most ecological parameters. Furthermore, when individual taxon densities are compared with the sample area some transects only encountered a handful of individuals (e.g., line number 3.1 (22 no.100m^{-2}) probably equates to seeing around 20 animals. The information in Fig 5.4.1.8 and 5.4.1.9 suggest that even fewer individuals were encountered (several transects look like they have less than 5 individuals). These numbers of individuals mean that the rest of the ecological metrics are effectively meaningless. This is supported by the values of the metrics, which also suggest extreme undersampling (e.g. Pielou's Evenness (J') ~= 1, which most likely means almost all taxa were only observed once in each transect). This could be resolved by analysing some of the 49,700 other photographs obtained.In addition, the size of the benthic megafauna evaluated here should be specified. It appears, from the species lists, that only large organisms (e.g. more than 10 cm) are evaluated. There are no scales on Fig 5.4.1.10b, which would be helpful. Megafauna are often defined as being >1cm. This portion of the fauna between 1 and 10cm are likely to be more numerous than the >10cm fraction. It would appear there is a large gap between the big macrofauna and the smaller megafauna, which is unreported and impossible to ascertain from these data. This is a major gap, would not be regarded as good scientific practice and will almost certainly lead to difficulties in comparing with other studies in the future.
  - An assessment of temporal patterns in the megafauna should be reported. Other deep-sea observations show high interannual variability in megafaunal numbers. Presenting data from a snapshot in time may limit the conclusions that can be made from this work - especially when the link is made to future changes resulting from mining activities.

    - ISBA/25/LTC/6 recommends several additional studies on the megafauna that have not been done, specifically time-lapse observations and baited camera/trap studies. Specimens are obtained in grab samples (Fig 5.4.1.10), but these are not identified to species level. This would be valuable information, even/especially if they are new species. DNA analysis on specimens could confirm identification. ISBA/25/LTC/6/Rev.1 states "It is important that molecular studies be undertaken in conjunction with morphological taxonomic analyses."
    - Scientific literature in the same area of interest (e.g., Rodrigues, et al., 2001 study carried out on megafauna in the northern part of the area indicated in Fig 5.4.1.1) is not cited or included here (despite sharing some of the same authors as the EIS; see Rodrigues et al., 2001, https://doi.org/10.1016/S0967-0645(01)00049-2). This is referred to in the INDEX section 6.2.6 but pre-impact data (of which there is some) could add much needed data to this section as well. Not including all information, especially in an area with very little information, may lead to poor representation of the communities present and erroneous conclusions.
    - Data quality analysis should be employed to better understand the implications of the limited data on the ecological conclusions (see, e.g., Simon-Lledo, et al., 2019 https://doi.org/10.1016/j.pocean.2018.11.003)

- Section 5.4.2 (Macrofauna)
    - The sample locations presented in Figure 5.4.2.2.2 use the same nomenclature, but do not match, the sample locations in Figure 4.5.3.1.2. For example, sample BC-6, which has one of the highest macrofaunal densities, is well outside of the contract area in Figure 5.4.2.2.2, but is inside the IRZ in Figure 4.5.3.1.2.
    - In addition, Figure 4.5.3.1.2, comparing the mine site to the test mining site, should be included in section 3.1, to put the test mine location into context.
- Section 5.4.3 (Meiofauna)
    - No information is presented on how the meiofaunal samples were taken, e.g. what size diameter of the sub-sample plastic tube, how many specimens were there per sample, how many samples were taken at each site?
    - The data presented in Fig 5.4.2.2.2 relate to data collected prior to 2001 and not to the IRZ and PRZ sampling of 2015 in Fig 4.5.3.1.2
- Section 5.5 (Biological communities in IRZ/PRZ)
    - Given the requirement of ISBA/25/LTC/6/Rev.1 that the PRZ and IRZ should be representative of the mining area, it would be most useful to present data for the PRZ and IRZ together, for the sake of comparison.
    - Macrofaunal density at the IRZ site (5 samples) had a mean of 556 and standard deviation of ± 648 no/m2. In any data set where the standard deviation exceeds the mean, clearly a different sampling method and more data are required.
    - It appears that the megafauna were not assessed in the PRZ or IRZ by any method. This is not clear. They should have been assessed and referred to explicitly in this section.
- Section 5.6 (Nodule fauna)
    - A map showing nodule fauna sampling locations would make it possible to determine whether the sample locations (and subsequent data relating to abundance and diversity) are relevant to the proposed test mining activity.
    - Sampling a small number of nodules may not be a suitable method for assessing environmental impacts from test mining. The focus might instead be on using high

resolution, wide area AUV photographic surveys (using best available technology) of attached megafauna.

- Section 5.7 (Ecosystem functioning)
    - This section is qualitative only and the information provided is general in nature, does not explicitly refer to typical assessments of ecosystem functioning and provides no information specific to this test (or even the Indian Ocean).
    - Studies specifically targeting ecosystem function are necessary in order to determine the baseline function and any changes resulting from the test mining process. This is an important aspect of the EIS that has implications for an impact assessment of a full scale mine. Data regarding the extent of microbial recolonization and activity (from measurements of redox potential and zonation and diagenetic fluxes in sediments (for example)) will provide critical information about the recovery following mining activities. As such, this test should be considered as part of the post-test monitoring plan.

Section 6 – Potential impacts of nodule collector trial on physico-chemical environment

Recommendation: This section should also be revised to provide more detail concerning the test mine at issue and to test certain assumptions which appear to be incorrect. A new field campaign seems necessary to provide adequate information regarding benthic impacts. In addition, more detail must be provided concerning the plume model, its outputs, and its methodology to determine whether it is fit for purpose.

- This section indicates that it describes "potential impacts that could occur during a full-scale mining operation for polymetallic nodules on the physico-chemical environment." The section preamble goes on to state that "many of the potential impacts will not be applicable to [the mine trial]". Rather than list non-relevant impacts, an effective EIS should instead describe impacts relating to the specific test mine at issue.
- Section 6.1.2 (Water column impacts)
    - The potential impacts of accidental spills has not been addressed, however test mining with a discharge at 80m above the bottom will impact unique pelagic organisms in the benthic boundary layer.
    - The EIS should assess sediment compaction and sediment cohesion, especially of any unconsolidated sediments created which might be repeatedly resuspended.
- Section 6.1.4 (Effects of plume dispersal)
    - This section makes several important unsubstantiated assumptions, which are not supported by the latest observations / experiments on plume behaviour. For example:
        - 1) "[T]he activity is restricted to collection of nodules on the seafloor and discharging them immediately behind the collector, which is not likely to create a sediment plume except for a minor disturbance about 0.5-1 m above the seafloor that would settle within the tracks." This is a speculative assumption and not specifically included in the modelling work (the model detailed in section 6.4 assumes discharge at 80 m above the seabed) or detailed in reliable observations. Even epibenthic sled disturbance (likely less than nodule collectors) causes plumes that extend well outside the tracks, with "strong sediment blanketing" up

to around 100m away (Peukert et al., 2018 https://doi.org/10.5194/bg-15-2525-2018).

- 2) "Hence, it is not expected to cause any harm to the biota or changes on the sediment deposition patterns on the seafloor." No basis is provided to support this statement. All the results from previous experiments would suggest that the opposite is expected to occur (as reviewed, e.g., in Jones, et al. 2017 doi:10.1371/journal.pone.0171750)

- Section 6.2 (Results of benthic impact experiment)
  - This section presents the data obtained from a benthic impact experiment undertaken in 1997 (INDEX), but without consideration as to its relevance to the currently proposed test mine site. The INDEX project used the same methodologies as the regional baseline study with the same limitations (described above) of exceptionally small sample sizes and the lack of statistically defensible data. In addition, it was not possible at that time to ensure precision sampling of the impact area from a surface ship 5000m above the seabed (as described below). A critical evaluation of the methods used by the INDEX project, undertaken with old technologies in 1997, could be used to plan a better sampling programme for the new test mining exercise.
  - The INDEX experiment had to sample a small impact target zone no more than 200m in width from a surface ship 5000m above the seabed. Conventional sampling methods using a cable depth were used. A box core deployed to 5000m from a ship might pay out about 5070m of wire (equating to a wire angle of about 10 degrees from the vertical). This means that the box core might land on the seabed anywhere in an 800m radius of the ship's position. Some cores may have landed in the zone directly impacted, some in the sedimentation zone, some in areas not impacted. The method was the best that could be achieved at the time, but produced poor data. How will precision sampling be ensured in this EIS using best available technologies of the 2020s?
  - Another element regarding the INDEX project would be its rather surprising conclusion of fairly fast recovery times of the benthic ecosystem in an area with very low OM and particle supply (2mm per 1000 years). This is inconsistent with the results of other studies (as reviewed, e.g., in Jones, et al. 2017 doi:10.1371/journal.pone.0171750)
  - As already mentioned, the low numbers of macrofauna in each sample (<10 individuals) makes any robust assessment impossible and undermines several assertions regarding macrofauna, for example:
    - "The macrofaunal and meiofaunal density show that although restoration was initiated after the experiment, their numbers have been very low subsequently, not only in the experimental area but in the reference area as well probably due to natural underwater disturbances."
    - "From the above observations, it can be inferred that although the environmental conditions have not been restored to the pre-disturbance / baseline . . . the initial effect of the disturbance experiment has waned off."
  - The monitoring design and the statistical power of the experiment are insufficient to detect even serious impacts, which are likely to be long-lasting if they are as observed in other experiments. From the information presented, it is not possible to solve this problem without conducting a new field campaign (using modern technologies) to revisit the test site.

- Section 6.3 (Development of a sediment plume dispersion model)

- This describes in detail the preparation of the plume dispersion model, specifically the oceanographic inputs to the "HYCOM" model and updates and validations to the "Hydrodyn-SEDPLUM model" (the model used for the current proposed test mine) using previous data, but does not provide sufficient description of the model processes to determine whether either model is appropriate. However, at no stage are the outputs/ results of the model presented. This would be a major flaw in an EIS – the prediction of the extent and characteristics of a sediment plume is arguably the highest priority in terms of data collection during test mining, and the validation of a hydrodynamic plume is critical in order to demonstrate that impacts can be robustly predicted for a full scale mine.
- A standard EIS would typically clarify important aspects of the plume model methodology, such as: 1) how it addresses different particle sizes or fractions; 2) the interference of grids on the model outputs; 3) the effect of shear strength on resuspension; 4) the depth of penetration of the mining system; or 5) the range of particle sizes among the crushed nodules. More information on the methodology is critical in order to understand what features contribute to the accuracy (or inaccuracy) of the model after the test. An EIS should also explain how the engineering design and characteristics of the proposed test mine equipment have been integrated into the model.
- The EIS should also clarify the test mine location in the context of the model domain. The model domain includes the whole of the IRZ, or a portion thereof. Figure 6.3.3.9 provides bathymetry and what could be the IRZ overlain, but refers instead to the Benthic Impact Area, which is undefined.
- Figures 6.3.3.11 – 6.3.3.17 show the (presumably) predicted sediment plume dispersion during an activity that occurred in 1996, but should further explain its relationship to the proposed test mine activity.

- Section 6.4 (Estimations of area, volume and weight of sediment and nodules to be disturbed during nodule collection trials)
    - A prediction as to the area over which a sediment plume may occur is required to understand potential impacts, but is absent. In addition, it is not clear if or how the hydrodynamic model has informed any estimates in this section. As such, it appears that predictions regarding volume of sediment to be mobilised have been made on a purely geographical basis, and that no prediction regarding the extent to which those sediments will be mobilised in the water column, and resettled, has been made.
    - Again, information on recovery from the above-referenced 1997 test is presented in detail, but without analysis of its relevance to the current proposed test mine or the proposed post-test monitoring regime.
- Section 6.5 (Likely impacts of nodule collector trial)
    - This section makes many links to the INDEX experiment. Many aspects of the analysis of data from this experiment requires substantial amendment . For example, the macrofaunal data are based on observations of extremely few individuals - rendering them entirely statistically indefensible. As such, statements presented in the EIS based on this study may not be accurate, a few example statements (of many) include "These areas were devoid of any biological activity except for occasional megafauna.", "The areas away from the tow zone did not show any effects of disturbance".

Section 7 - Potential impacts of nodule collector trial on biological environment

Recommendation: This section should focus on the reduction of major environmental impacts through engineering design. Accurate and complete baseline data and plume modeling, as described above, will be required for this analysis.

- Section 7.3 (Impacts in midwater)
    - The initial statement of this subsection - "The water column below 500 meters from surface is considered to host extreme conditions to support life" – is not correct.
- Section 7.4 (Impacts at the seafloor)
    - This section should be informed by outputs of the hydrodynamic model regarding the extent of impacts, and baseline data regarding benthic fauna that is specific to this mine site. The EIS should also explain the value of mine site's fauna in a regional context (for example, it should address whether the proposed test mine site is proximal to any unique features (such as seamounts)). This context would assist with informing the assessment of impacts to fauna.
    - As with section 6.4, this section describes in detail the outcomes of the 1997 test, but must take the further step of predicting impacts of the current test mine activity in relation to accurate and comprehensive baseline data.
    - The additional bars featured in Figs 7.4.3 and 7.4.4 are presumably standard deviations, but if so, it is not clear why, in each sampling period data set, the deviations are all identical, even though the means are not. This is highly unusual for biological data.
    - At Fig 7.4.7, the value associated with the vertical scale of meiofaunal abundance is unclear.
    - The term 'restoration' in this section, and in earlier text of the EIS, should only be used as defined by the Society for Ecological Restoration (SER) for active interventions taken to improve ecosystem functioning and biodiversity, rather than 'natural rehabilitation'. See "International Principles and Standards for the Practice of Ecological Restoration" (https://www.ser.org/page/Publications). In considering 'restoration' (as defined above), and as part of the 'Mitigation Hierarchy' of Avoid-Minimise-Restore, the EIS should set out how it will use the monitoring phase of the test mining experiment to devise and test restoration actions to speed up the natural rehabilitation of abyssal ecosystems impacted by commercial-scale mining.
- Section 7.5 (Faunal abundance changes related to plume deposition (blanketing))
    - This section should address the scale of sedimentation and its biological effects in an environment with sediment accumulation rates of 2mm per 1000 years. How will it be assessed if the deposition of 2mm within 1 week might affect biological communities?

    - It is not clear why the EIS does not refer to the impact/recovery on megafaunal communities as assessed in the INDEX experiments. These data were gathered and presented in Rodrigues et al 2001 (https://doi.org/10.1016/S0967-0645(01)00049-2). Note that these data also have (severe) limitations, as described above regarding Section 6.2.
- Section 7.7 (Effects of toxic discharges on faunal organisms) – the impacts to benthic fauna associated with potential oil spills must be considered.

Section 8 – Plan for environmental impact assessment and monitoring of proposed activity

Recommendation: Monitoring of environmental data is a critical component of any testing activity. For proper evaluation of this monitoring program, design flaws must be addressed, and significantly more detail must be provided.

- This section may need to be retitled, as it does not contain the impact assessment (which comes in previous sections) but rather the monitoring plan.
- Section 8.1.1 (Impact assessment of benthic conditions)
    - This section mentions environmental data were collected on a cruise in 2019, but none of these data have been presented. Some elements of the environmental data reported as having been collected in Section 8.1.1 are also missing from the EIS.
    - The proposed use of AUV / ROV surveys in IRZ and PRZ for precision sampling and high resolution surveys is welcome, but this section must also describe which systems will be used, along with evidence of their past performance, as well as detailed plans of how and when they will be deployed to achieve the test program aims.
- Section 8.1.2 (Impact assessment in the water column) – this section should elaborate when, where and how frequently water quality sampling will be undertaken.
- Section 8.1.3 (Hydrodynamic studies using deep sea moorings and current meters)
    - The locations for moorings provided in Figure 8.1.3.1 (the 'regional' monitoring locations) are too far apart for a test mine activity. Using the PRZ, at a distance of 116km from the test mine location (IRZ), is not appropriate for the size of the plume expected to be generated, and will not provide relevant data relating to the extent of far-field impacts.
    - It appears that the three large moorings for baseline data described in this section are to collect data on the physical oceanography in the region and "for estimating biogenic and lithogenic fluxes to the seafloor". They are not for monitoring resuspension of sediments as part of the collector test. Further explanation is required, including how the data will be used to guide the plume modelling within the time frame of the collector tests.
    - The 4 to 5 short term moorings, with a sediment trap at 25m above the bottom described in Fig 8.1.6.1 are for monitoring the plume during the collector test. It appears that monitoring equipment for the purposes of validating the plume, including sediment traps, will be mounted 90m above the seafloor (although figure 8.1.3.2 indicates the lowest sediment trap will be located 107m from the seafloor). However, section 6.3 indicates that "solids discharged at 80m above seafloor tend to be directed towards the seafloor". Consequently, the traps are unlikely to catch sediment and provide valid data. Compare this to section 6.3, which indicates that sediment traps were placed 7m above the seafloor for the 1997 trial.
    - Figure 8.2.1 provides the locations for moorings to monitor near field effects. It is not clear whether this figure relates to the positions of the short moorings or to all sampling activities including box coring. Notwithstanding the point above regarding height of sediment traps, the proposed monitoring points reflected in this figure may not provide sufficient data to determine the extent of plume and sedimentation impacts from the test mine. The lack of linear monitoring points will make it difficult to determine the point at which impacts are no longer observable, or to validate any predictions made by the hydrodynamic model (albeit that no predictions have been offered in this EIS).

- More generally, monitoring the plume requires high spatial and temporal resolution. Are 4 to 5 sediment traps adequate or should better technologies, such as AUVs with particle sensors and turbidity metres, be used? What is the best data collection possible?
- Table 8.2.1 shows that only two sampling periods are planned for environmental monitoring - the first immediately after impacts have occurred, the second (monitoring cruise) just 1 year later. No commitment is made to longer term monitoring other than "Further observations / cruises will be planned based on the results of the monitoring cruise". If the test mining is to be used to inform future test mining or commercial mining, a more detailed and longer monitoring plan is needed.
- No details are provided about the biological and chemical sampling programme

- Section 8.2 (Impact assessment and monitoring plan)
  - This section appears to refer to the longer-term monitoring plan, but does not elaborate upon the scope, nature, extent, or schedule of post-test mine monitoring. Given the need to monitor recovery of benthic organisms in particular, and to gather data which may also inform the nature of recovery of the ecosystem as a whole in the context of a proposed full scale mine, these are critical details that must be included in a final EIS.
  - As above, much greater detail and planning needs to be given on the monitoring programme for all environmental variables that will be measured.
  - A detailed plan with deadlines not just for sampling, but analysis and reporting to the Authority should be provided, and would be expected in other offshore industries.
  - While the test mining monitoring plans may yield useful data on design and operational performance, in terms of environmental impact the test operational discharges would seem to diverge significantly from the sorts of discharges that might be expected in a commercial operation. This has ramifications, which are not acknowledged, to the value of monitoring the test mining activity and being able to extrapolate data for use in EIAs of full-scale commercial mining.
  - Overall, the monitoring plans lack detail and linkage to the predicted impacts of test mining. In terms of the data expected to be generated by the monitoring, there is no real indication of how this would then be used to support an evidence base for the likely impacts of commercial mining, especially in terms of modelling the near and far-field sediment plume and sediment deposition.