RESPONSE TO REQUEST FOR INFORMATION ON SUPPLEMENTARY ENVIRONMENTAL REPORT (SER)

12 May 2026

GEMCO | EXCESS WATER DISPOSAL (OCEAN OUTFALL) PROJECT

No.	Information requested	GEMCO response
1	**Consultation**	
1)	Address the issues raised in submissions received in relation to the SER.	As detailed in response to (2) below, Groote Eylandt Mining Company Pty Ltd (GEMCO) has had numerous engagements with the Anindilyakwa Land Council (ALC) and Traditional Owners in respect of the Excess Water Disposal (Ocean Outfall) Project (the Proposal). Most recently, GEMCO met with the ALC on 30 April 2026 and discussed the following comments from the ALC's submission on the Supplementary Environmental Report (SER): "The discussions with senior men took place without the full understanding as to the size and impacts of the Project. The discussions held can in ALC's view only be described as preliminary, due to the number of people involved, inadequate knowledge of the extent of the project and its impacted area. Further detailed community consultations must be undertaken, to ensure that Traditional Owners can be heard and their concerns in this matter are fully considered before any discharge." Further information was also provided in relation to comments made regarding modelling of the discharge water. At that meeting, the ALC and GEMCO agreed to hold further meetings to address the above comments and enable further detailed consultations to be undertaken in the coming months to ensure that affected Traditional Owners can be fully informed and their concerns fully considered before any discharge commences.
2)	Provide evidence that GEMCO has consulted with (including informing and involving) potentially affected stakeholders.	The history of GEMCO's engagements with the ALC and Traditional Owner consultation on the Proposal can be summarised as follows: • **13 March 2023 –** GEMCO introduced the Proposal and held a preliminary consultation, facilitated by the ALC, with affected members of the Bara and Jaragba clans, who are identified by the ALC as the Traditional Owners and custodians of the land and sea

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		where the Proposal is proposed. The consultation was targeted at 'informing' as per the IAP2 Public Participation Spectrum[1]. The meeting was well attended, and positive feedback was given by senior Traditional Owners following the consultation. • **19 July 2023 and 30 August 2023** – GEMCO presented technical aspects of the Proposal to Traditional Owners. • **11 September 2023 –** ALC sent GEMCO a letter confirming Traditional Owner endorsement for GEMCO to proceed with further studies to inform the feasibility and suitability of the Proposal. • **24 October 2024** - An on-country meeting was held with senior Traditional Owners to discuss cultural, economic, and social values of the area identified for the Proposal. • **16 October 2024** – GEMCO met with ALC and presented updates on the referral, Proposal status and outcomes of environmental impact assessments. • **5 February 2025** – GEMCO met with ALC to discuss the Proposal and further engagement with Traditional Owners. • **20 February 2025** – ALC sent GEMCO a letter supporting GEMCO's process to date, with the right reserved to comment on the Environmental Referral Report (ERR). • **15 July 2025**- ALC met Traditional Owners to discuss the Proposal. GEMCO was not invited (or permitted) to present or attend this meeting, however a record of attendance and short summary of the meeting was provided to GEMCO which confirmed that sixteen Traditional Owners were present and feedback was positive. • **27 November 2025** - GEMCO met with the ALC and its environmental consultants to discuss the ALC comments submitted to the Northern Territory Environment Protection Authority (NT EPA) on the ERR. • **30 April 2026 –** GEMCO met with the ALC and its environmental consultants to discuss the ALC comments submitted to the NT EPA on the SER.
3)	Provide supporting evidence that the inputs and concerns of traditional owners and the ALC have been considered and addressed, and outline how those inputs were incorporated to the	The ALC has engaged with Traditional Owners, and GEMCO understands that these engagements have informed the ALC's submissions to the NT EPA. GEMCO understands it has responded and addressed all concerns raised by the ALC on behalf of Traditional Owners

[1] In its Stakeholder Engagement and Consultation guidance, the NT EPA recommends proponents adopt the International Association for Public Participation's (**IAP2**) core values of engagement, as principles for best practice stakeholder engagement.

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	planning and design of the proposed action, including any resulting changes.	in the ALC's Submission in Response to Public Consultation on GEMCO's Excess Water Disposal Project Proposal dated 19 September 2025. Notably, on 27 November 2025, GEMCO met with the ALC and its consultants to discuss the ALC's comments on the ERR. The issues and outcomes discussed at that meeting informed the SER. Please refer to Table 10 in Section 5 of the SER for evidence of how each issue raised by the ALC has been addressed. GEMCO acknowledge that the ALC has raised further concerns in its Submission in Response to Public Consultation on GEMCO's Supplementary Environmental Report for its Proposal dated 12 March 2026. GEMCO is engaging with the ALC in relation to these concerns, with an initial meeting between GEMCO, the ALC and its consultants having taken place on 30 April 2026.
4)	Demonstrate and include supporting evidence that object 3(d) and 3(e) of the EP Act and the NT EPA's expectations for stakeholder engagement in accordance with the NT EPA's Stakeholder Engagement and Consultation guidance have been met.	The ALC identified the Bara and Jaragba clans as being the relevant Traditional Owners of land and sea country identified within the Proposal area. GEMCO has engaged with Traditional Owners of those clan groups directly and through the ALC as detailed in response in (2) above. As noted in response to (1) above, in the coming months, GEMCO will be undertaking further engagement with the ALC to enable more detailed consultations and ensure that affected Traditional Owners can be fully informed and their concerns fully considered before any discharge commences.
5)	Demonstrate how Free, Prior and Informed Consent has been sought, including evidence of culturally appropriate, well-informed and non-coercive engagement undertaken sufficiently in advance of decisions or approvals.	GEMCO has followed and will continue to follow the principles of Free Prior and Informed Consent in its consultation with Traditional Owners for the Proposal, with consultation being culturally appropriate, well informed, and non-coercive. GEMCO engages with Traditional Owners through the ALC, who undertake a process of identifying the correct and appropriate custodians for the land. In all cases, GEMCO follows the direction of the ALC regarding engagement, ensuring that the location, time, and subject for a consultation is culturally safe and appropriate. The GEMCO External Affairs team. who (together with the ALC) facilitate the engagements, have extensive experience of living and working on Groote Eylandt and a sound understanding of cultural protocols. GEMCO acknowledge that there is more consultation required before the ALC will seek consent from Traditional Owners with respect to the Proposal.
2	**Submissions on the SER - Discharge modelling and supporting data**	
1)	The NT EPA notes that the SER and associated appendices describe the use of near field plume modelling (e.g. MERGE3 UTM) and far field hydrodynamic modelling (e.g. MIKE 3) to assess the impacts of	Two models were employed for the Proposal: the near-field model UM3 (not 'MERGE3 UTM'), and the far-field model MIKE3.

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	the proposed marine discharge. However, the SER does not clearly describe how the outputs of the near field modelling are incorporated into, or used to inform, the far field modelling. To assist the NT EPA's assessment, please clarify: a. The point of transition between the near field and far field modelling, including how this point corresponds to physically defined plume behaviour (e.g. initial dilution, plume rise or trapping depth); b. Which specific outputs from the near field modelling (such as dilution achieved, plume thickness or effective discharge concentration) were used to parameterise the far field MIKE 3 model; c. How the far field model represents near field mixing processes, noting that far field hydrodynamic models are not designed to resolve diffuser scale jet and buoyancy behaviour; d. Whether the linkage between near field and far field modelling is based on: i. physically defined plume characteristics; or ii. statistical or percentile-based dilution metrics; and e. The assumptions made at the near field / far field interface and how these assumptions ensure a conservative and precautionary assessment of marine impacts. Please include cross references to the relevant sections of the SER and modelling appendices where this linkage is described and provide additional explanation or clarification where such description is currently implicit rather than explicit.	The near-field model UM3 was used solely to develop a conceptual design for the diffuser. UM3, compared to MIKE3, is a much more efficient model for rapidly assessing a range of diffuser designs under steady-state conditions. UM3 does not integrate with MIKE3. The diffuser design determined through UM3 near-field modelling was replicated in MIKE3 for the far-field modelling. The 'jet' functionality in MIKE3 was applied to the far-field modelling. This is an integrated near-field model within MIKE3 that determines: • the horizontal and vertical position of the plume at the end of the near-field region • the level of dilution and entrainment of ambient water. This is determined for every time-step of the far-field model, with constantly updated ambient conditions that influence near-field behaviour. The plume is then simulated as a discharge point source into the correct cell as determined by the above, with dilution/entrainment matching the 'jet' model prediction. The jet prediction is run for each individual nozzle on the diffuser (i.e. 30 individual near-field plumes are simulated each timestep). This background information therefore informs the following responses to the individual points of clarification: a) As described above, UM3 does not inform the MIKE3 modelling other than determining the diffuser design. The internal 'jet' module within MIKE3 then allows fully integrated near-field/far-field coupling, accounting for near-field plume dilution/entrainment, rise height and positioning. b) Plume position and dilution/entrainment are determined by the 'jet' module to determine the total flux of discharge and ambient entrained water to simulate as a point source in the appropriate far-field cell (as determined by the plume vertical and horizontal position). c) As above d) The internal MIKE3 near-field/far-field linkage is based on 'physically defined plume characteristics' as predicted by the 'jet' model. e) As described above. No additional assumptions were applied by the environmental consultant (GHD), the near-field/far-field coupling is fully dynamic. The conservative assumptions applied are numerous and include: • Simulating a continuous 12-month discharge at 80 GL/a (representing assumed peak flow that would in reality only be maintained for shorter periods on the order of days) • Defining water quality based on the estimated 95^{th} percentile of analyte

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		concentrations (and again, simulated as constant across an entire year) • Simulating water quality analytes as numerically conservative (i.e. ignoring decay/transformation processes) • Adopting the 1st percentile dilution contour (99th percentile parameter concentration) to define the mixing zones of each parameter. f) The linkage of the 'jet' module within the far-field modelling process is not explicitly described in the report but has now been detailed within these responses. With reference to UM3, the modelling report outlines the purpose of the near-field modelling with UM3 was to determine an appropriate diffuser design, which was then incorporated into the far-field model (Section 3.1).
2)	The NT EPA notes that the SER and associated appendices define and apply a mixing zone extent for the proposed discharge of mine affected water to the marine environment. The mixing zone plays a critical role in determining where temporary exceedances of water quality guideline values may be acceptable and where full compliance is required. To assist the NT EPA in its assessment, please provide a clear explanation and justification of the mixing zone extent, including: a) Why the spatial extent of the mixing zone was determined based on percentile-based dilution outcomes (e.g. 1st percentile dilution) rather than physically derived near field plume behaviour (e.g. initial dilution, plume rise or trapping depth), and the justification for this approach. b) Why the selected mixing zone extent is considered appropriate having regard to i. the nature and duration of the proposed discharge; ii. characteristics of the receiving marine environment; and iii. protection of identified environmental and cultural values; c) How the mixing zone extent aligns with contemporary best practice approaches, which typically distinguish between: i. near field processes used to define the mixing zone; and ii. statistical metrics used to assess compliance beyond the mixing zone;	For clarity, the mixing zones presented in the ERR and SER modelling are used for the sole purpose of carrying out an environmental impact assessment. Individual (and conservative, as described below) mixing zones are predicted for each key water quality parameter assessed to describe the extent of environment that may be exposed to the plume. The approach for defining a mixing zone boundary where compliance against water quality criteria conditions (that may be imposed as part of the environmental (mining) licence (EML) approval process) will be further developed within GEMCO's proposed operational monitoring plan. It is not necessarily the case that the mixing zone adopted for compliance monitoring will need to align with the modelling predictions. Given the conservative nature of the modelling, the compliance mixing zone may be defined based on a less conservative prediction of the mixing zone spatial extent. Responses to the specific queries raised are provided below: a) The process of calculating dilution targets and simulating the far-field spatial extent of dilution to define a mixing zone is an industry-standard approach. One recent NT example that adopted this approach includes the TNG Darwin Processing Facility Outfall Project. Near-field characteristics only describe the plume behaviour within spatial scales of tens of metres, which is often not far enough to meet water quality objectives. Far-field modelling is required to determine the total spatial extent of the mixing zone. Defining the mixing zones for each parameter based on the 1st percentile dilution (i.e. 99th percentile concentration) is an extremely conservative approach. For example, ANZG (2018) recommends use of the below statistics in determining how often a criterion should be met to be considered unimpacted: • Medians for physico-chemical stressors (i.e. criteria can be exceeded half the time) • 95th percentile for toxicants (i.e. criteria can be exceeded 5% of the time).

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	d) Whether alternative mixing zone extents or definitions were considered, and if so, why these were not adopted; e) How compliance with relevant water quality objectives is demonstrated outside the mixing zone, including how exceedances are treated within the mixing zone. f. Please include cross references to the relevant sections of the SER and appendices where the mixing zone is described and justified and provide additional explanation where the rationale is currently implicit rather than explicit.	The 1st percentile dilution defines the boundary beyond which the adopted guideline value for a parameter is exceeded only 1% of the time. This approach is in fact more conservative than industry standard. b) As above, the mixing zones for the parameters assessed have been derived in a highly conservative manner that results in predicted impacts that are very likely to over-estimate actual impacts from the Proposal. i. The discharge will be continuous. As such, a long-term (12 month) simulation was carried out. ii. Characteristics of the receiving environment considered in the modelling include baseline water quality, which has been defined from available data to inform dilution targets, and the benthic habitats present on site (particularly relevant to the sediment modelling). iii. The conservative nature of the modelling predictions, and the low risk of impacts to environmental and cultural values, provides confidence that the values of the receiving environment will be protected. c) As outlined above, the mixing zone extent has been defined in a more conservative manner to contemporary best practice. Near-field processes are not usually used to define mixing zones, as near-field monitoring program. The mixing zone for compliance monitoring may likely to differ from the conservatively derived mixing zones presented in the ERR/SER (i.e. it may be proposed to be smaller in extent, with statistical metrics aligned with typical industry practice per ANZG, as detailed above). d) Per above, the study has adopted a highly conservative approach. Compliance with water quality objectives must be demonstrated through monitoring during operation. The modelling serves only as a predictive tool to estimate the spatial extent of potential impacts to inform the ERR/SER. A marine compliance monitoring plan is intended to be developed during the EML approval process. As such, the SER does not detail the specifics of compliance monitoring. GEMCO's approach to compliance monitoring during operation is provided in Appendix D.
3)	Address the issues raised in submissions received in relation to the SER and the matters outlined in the following points: a. Provide evidence that the potential cumulative impacts (both the combined impacts with other stressors and the accumulation of impacts over the duration of the marine	a) Cumulative impacts were modelled in the SER in response to queries on the ERR provided by the Department of Lands, Planning and Environment (DLPE) Flora and Fauna division. GEMCO and GHD met with NT EPA, including members of the Flora and Fauna division, on 4 December 2025 to outline the proposed approach to updating the modelling to address cumulative impacts. The SER update was aligned with the approach presented, and was deemed satisfactory by the Flora and Fauna division to

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	discharge) of the following have been adequately assessed and identify specific avoidance and mitigation measures related to the management of: i. nitrate from the discharge water and sewage treatment plant (STP); and ii. metals and metalloids in the discharge water (total load and dissolved fractions); and iii. sediment concentration and turbidity levels of the discharge water and turbidity generated by the discharge process. b. Demonstrate that the PN1-PN4 and PS13-PS16 reference sites are representative of ambient marine water quality and provide evidence that they are not affected by discharge from the sewage treatment plant (STP). c. Provide tabulated water quality data (totals and dissolved fractions) sufficient to verify summary statistics and graphs for all mine pits and the STP discharge. Include key parameters, date ranges, and representative statistics (median, percentiles, min/max) to allow assessment of variability. Justify derivation of 95th percentile of the volume-weighted mixed analyte concentrations, includ0ing assumptions and data regarding turbidity, flow rates, pit volumes, and timing of dewatering. d. Evaluate on-site water treatment methods to improve the quality of the discharge water (e.g. reduction of suspended solids and metals/metalloids) prior to end-of-pipe discharge, with defined end-of-pipe water quality limits (totals and dissolved fractions) relevant to the receiving environment. e. Provide details of the modelling approach for both near-field and far-field discharges, including all parameters, assumptions, and domain definitions. Demonstrate that the models account for wave effects, temporally varying currents and depths, variations to salinity and temperature of discharge waters, periods of minimal tidal flow, and provide calibration or sensitivity testing for advection and dispersion processes to ensure reliable representation of contaminant transport and	address the concerns as is evidenced by that division's formal response to the SER. It is our understanding, following the discussion between GEMCO, GHD and NT EPA on 23 April 2026, that the remaining uncertainty regarding these factors relates to transparency around the data used as inputs to the model. In response, GEMCO is providing detailed datasets to enable further assessment of the adequacy of the modelling inputs, and including additional memorandums developed by Indo Pacific Environmental. GEMCO awaits any further feedback on the use of this data. b) As discussed with the Mining Division on 7 April 2026 and 23 April 2026, the specific sites of PN1-PN4 and PS13-PS16 were used only to establish a baseline for suspended sediment concentrations (SSC) – these specific sites were not the focus of the Indo-Pacific Environmental (IPE) (2023a) definition of baseline water quality or other data sources adopted. For further clarity, the following datasets were used to inform the baseline water quality defined in the modelling study: • Monthly sampling from the reference site of GEMCO's STP monitoring program, located ~800 m south of the port, was used to define ambient conditions for nutrients and salinity. These nutrient and salinity data span from March 2015 to July 2023 and September 2022 to July 2023, respectively. It is noted that the median nitrate and phosphate measurements from the GEMCO wastewater discharge monitoring data at the reference site were below the Limit of Reporting (LOR), as were the majority of all measurements. In these cases, half of the LOR was assumed to represent the ambient concentration. This is outlined in section 3.4 of the modelling report. • Baseline conditions for turbidity and suspended solids were derived as detailed in Section 2.5 of the modelling report. • Baseline concentrations of zero were assumed for rare-earth elements and hydrocarbons per Table 3 of the modelling report. • All other baseline conditions were defined as the median of baseline data calculated by IPE (2023a) as outlined in Section 3.4 of the modelling report. c) The tabulated raw water quality data for the mine pits (quarries) are provided as a CSV file attached to this submission (*cleaned_quarry_data.csv*). The STP discharge data are provided in Appendix A. Calculated summary statistics for each quarry and analyte are provided in the file *analyte_distributions_quarry.csv*. The volume weighted analyte concentrations were calculated from the individual quarry water quality data discussed above in conjunction with projected dewatering flow rate data refer to *gemco_quarry_annual_water_volumes.csv*. This analysis was initially

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	flushing. The assessment of impacts should be updated to reflect any outcomes, findings, or new information arising from the matters addressed above.	provided in IPE 2023b and was updated to include pH in IPE 2023c. A explanatory memorandum for the data files is also provided in Appendix E. To produce the overall mixed 95th percentile concentrations, the concentration of all water contributing to the total discharge water volume by each quarry was assumed to be the 95th percentile of that analyte calculated using only data from that individual quarry. The concentration of analytes in the mixed discharge water was then calculated for each financial year using the flow data for each quarry to calculate the relative contribution to the total discharge water. All analytes except for pH were calculated using simple mixing of each analyte at the relative proportions of each quarry's flow contribution. As pH is a logarithmic scale, simple averaging for volume weighting does not correctly reflect the change in pH with quarry water mixing. As such, IPE converted the pH data to hydrogen ion concentration in mol/L ($H^+ = 10^{-pH}$) for use in the volume weighting process. As lower pH waters (more acidic) have higher concentrations of hydrogen ions, to derive the minimum and 5th percentile pH for the overall discharge water, the 95th percentile and maximum hydrogen ion concentrations were used in the volume weighting calculations. After determining the volume weighted hydrogen ion concentration of the discharge water, the result was converted back into pH units ($pH = -\log_{10}(H^+)$). The resulting analyte concentrations are presented in *export_all_analytes_flow_adjusted_concs.csv*. This approach assumes that: • The data available for each individual quarry is sufficient to characterise the 95th percentile. For some analytes/quarries, the relatively low number of samples introduces some uncertainty in the estimation of the 95th percentile concentration. Nevertheless, adopting the 95th percentile of all analytes from all quarries to represent the final mixed concentration is a conservative approach that ensures any uncertainty is skewed towards the worst-case end of the spectrum. • All samples are representative of the entire quarry volume at the time of sampling (i.e. individual quarries are assumed to be well mixed). • Short-term (e.g. sub-daily) fluctuations in water quality are minor, and as such samples are assumed to sufficiently represent water quality on the day of sampling. • The volume weighted calculations rely on the projected flow rate data. During the initial calculation carried out in 2023, projected dewatering flow rate data was provided by GEMCO for each quarry anticipated to be operational from the period between the 2024 – 2033 financial years. GEMCO has advised that these flow

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		projections remain as credible an estimate of future flows beyond 2027 as is likely to be generated by any new flow projection exercise. As such, the dataset has been retained in the updated 2026 work to provide consistency with previous calculations that have informed subsequent marine modelling works. d) GEMCO currently manages water quality as part of its approved bushland discharge and soon to commence riverine discharge programs. GEMCO is not required to add chemicals to treat water prior to existing disposal methods. Water is managed via reticulation through holding voids with water blended to achieve the turbidity and salinity criteria for the discharge method concerned. GEMCO actively manages water quality via: • **Suspended clays**: mixing with more water with higher electrical conductivity to induce natural flocculation. • **Suspended sediments**: dilution and settling in large water body. • **Metals**: dilution. The Proposal will use the above mechanisms to support the management of water quality. Chemical treatment of mine water (e.g. coagulation/flocculation) prior to discharge is not planned for the Proposal, as it is not considered necessary to achieve the water quality objectives discussed in the ERR and SER. In addition to these water treatment approaches, water quality will also be managed through: • Diversion drains to minimise sediment laden run-off entering quarries. • Implementation of erosion and sediment controls, where necessary. • Water quality monitoring of individual source quarries to identify management options, e.g. water not considered suitable for ocean discharge, e.g. water containing highly dispersible smectite, will be re-used as concentrator make up water or for dust suppression. NH2 quarry will hold around 2 GL of water. This represents a significant opportunity to blend water prior to discharge. The design of the Proposal also acts as a mitigation to the risk of high turbidity. The pumping placement arrangement will be of fixed nature and as such the pump will not move up and down with the rise and fall of the pit water level. The pumps will be kept well above the bottom of the quarry so there is less chance of pumping basal sediment laden water at the bottom of a pit sump. The design also incorporates inline real-time monitoring of turbidity, pH and EC with monitoring back to a central control room. Pump

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		shutdown protocols will be developed for agreed turbidity levels. Active water treatment options (e.g. chemical dosing) are expensive and not considered feasible for the Proposal. In addition, water treatment plants to treat the full volume of water are also not feasible. Previous work done at GEMCO at a conceptual level has shown that the operating costs alone to implement a flocculation system to enhance sedimentation would be in the order of $1M/GL of water treated. In addition, active water treatment would create potentially more impactful issues such as the need to manage some form of waste stream from the treatment plant. Given that many of the flocculants/coagulants contain aluminium, which has the potential to pose an environmental risk, it is a better environmental outcome to use natural flocculation or the management options described above to treat the water. The water quality monitoring shows that metal concentrations in quarries are generally low and therefore chemical treatment is not required. In addition, modelling has demonstrated that metals are almost immediately diluted at the discharge. e) Details of the requested information are largely available in the modelling report. Please refer to the following sections: • Near-field modelling – section 3.2 and 4.1, with additional details provided within this response. • Far-field modelling – Section 3.9 and 4.2. • Assumptions adopted are detailed throughout the report. A list of conservative assumptions that informed the assessment are outlined at the end of Section 5. • Wave modelling is detailed in Section 3.9.3.2, with the results detailed in Section 4.3 and 4.5. • Temporally varying data – this is inherent to the dynamic far-field modelling approach. Details on temporally varying inputs for these parameters are provided in Section 3.9.5. The salinity of the discharge was set at a consistent 0 PSU (Table 3). While not outlined in the report, the mine discharge was simulated with a varying temperature equivalent to the ambient receiving waters predicted at the discharge location. • Periods of minimal tidal flow are inherently accounted for by the one year simulation duration, which includes a vast range of dynamically varying tidal conditions. • Calibration/sensitivity testing of advection and dispersion processes – the model has been well validated to measured currents, waves and water levels as outlined in Section 4.2. Dispersion parameters have used default model parameters. As the Proposal does not yet exist, there is no field data to undertake calibration of

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		dispersion parameters. Validation of the modelling is proposed, at which point calibration of the dispersion parameters may be carried out. The above information is provided for clarity to address the queries raised. No updates to the impact assessment are currently planned. The impact assessment conclusions provided in the ERR and SER remain valid.
4)	Provide supporting documents that are not publicly available, including, but not limited to: a. IPE (2023b). Memorandum - Volume weighted assessment of dewatering discharge analyte concentrations. Prepared by Indo-Pacific Environmental for GEMCO, August 2023. b. IPE (2023c). Volume weighted assessment of dewatering discharge pH. Draft memorandum produced by IPE for GEMCO, 21 November 2023.	The two documents referred to in the RFI are provided in Appendix B and Appendix C. Copies of these documents were also provided to DLPE's Mining Division on 16 April 2026 at its request.
5)	Demonstrate that the waste management hierarchy (Part 2 of the EP Act) has been considered and applied to the proposed marine discharge.	The waste management hierarchy is embedded in GEMCO's approach to mine water management. GEMCO has considered a number of options for management of excess water, having regard to the waste management hierarchy. The highest levels of control in the hierarchy are 'avoid' and 'reduce'. In order to avoid and reduce, GEMCO will look to backfill quarry voids so that water does not need to accumulate in these voids and require removal and disposal. GEMCO will also ensure that surface water is directed away from entering quarries using bunding. Direct rainfall into an open quarry cannot be avoided. The next highest levels of control in the hierarchy are 'reuse', 'recycle' and 'recover'. Mine water is already reused for operational activities (wherever practicable). There are two reuse options for GEMCO to help reduce the amount of water requiring disposal. Firstly, the GEMCO process plant requires around 9-11 GL of make-up water per year to process the manganese ore. Secondly, around 1-2 GL of water is required each year for dust suppression on haul roads. It is important to note that there will be a strong preference to direct more turbid water to the process plant and for dust suppression in order to further minimise any potential to reduce the water quality that is being directed to the Proposal. As has been previously discussed, inflow volumes to the quarries exceed operational water demands, thus triggering the need for further controls. The remaining levels of control in the waste management hierarchy are 'treat' and 'dispose'. The approach for the treatment of water has been detailed in response to question 3d) above. GEMCO will use natural flocculation and mixing/dilution to manage water quality prior

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		to discharge to ocean. NH2 quarry will hold around 2 GL of water. This represents a significant opportunity to blend water prior to discharge. No chemical treatment of the mine water is planned. Although discharge is the least preferable control in the waste management hierarchy, the higher levels of control are either not practicable or already being implemented.
4	**Suspended solids/turbidity modelling**	
	Demonstrate that the modelling used to define impact zones for the discharge applies sediment deposition thresholds that are appropriate to the receiving environment and the continuous duration of the discharge. This should include justification that the thresholds are based on site-specific conditions or a suitably conservative approach, and that they accurately characterise the extent and magnitude of potential impacts.	The selection of sedimentation thresholds considered a review of receptor-specific (not site-specific) tolerance levels for seagrass and corals. INPEX (2022) was one reference reviewed (15 mm for corals, 40 mm for seagrass to define the Zone of Moderate Impact (ZoMI)), while receptor-specific thresholds in the Western Australian (WA) EPA technical guidance were also reviewed (~44 mm for corals, 40 mm for seagrass for the ZoMI). The WA EPA technical guidance was referenced as it is specifically noted as "leading practice technical guidance for marine dredging" by the NT EPA in the Draft Marine Dredging Guideline (NT EPA, 2023). Whilst the proposed action is not a dredging program, the potential impact pathways associated with increased SSC are comparable, thus the use of impact assessment approaches for dredging are applicable for this Proposal element. As stated in the modelling report, the lower end of the reviewed values (15 mm) was adopted as a conservative approach to represent deposition impacts to both coral and seagrass. Further, the results indicate the threshold is not exceeded anywhere in the model domain. The assessment is considered appropriate given the conservative threshold adopted (i.e. the lowest from a range of reviewed literature pertaining to coral and seagrass impacts) and the prediction of maximum deposition of around half the adopted value (<8 mm).

Appendix A: Water quality data – Sewage Treatment Plant

The following table presents data from GEMCO's annual Environmental Mining Report (EMR). The data supporting the table below is from monthly reporting during the period from January 2022 to October 2025 of GEMCO's treated effluent.

Analyte	N	LOR	Units	Min	P5	P20	Median	P80	P95	Max
>C_{10}-C_{40} Fraction(sum)	46	100	µg/L	<100	<100	<100	160	580	1455	2500
Ammonia	47	Various (0.005-0.25)	mg/L	<0.005	0.0065	0.02	0.87	8.1	18.6	20.7
Aluminium	1	5	µg/L	46	46	46	46	46	46	46
Copper	46	0.5	µg/L	1.5	3.4	6.8	10.6	18.9	56.2	274.0
Iron	1	2	µg/L	28	28	28	28	28	28	28
Lead	1	0.1	µg/L	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Manganese	46	0.5	µg/L	11.5	13.3	33.5	126	475	806	894
Nitrate as N	47	0.01	mg/L	<0.01	0.02	0.9	4.0	5.1	7.7	8.5
Phosphate	45	0.001	mg/L	<0.001	0.18	0.41	1.1	3.4	6.7	13.2
Total Nitrogen as N	47	0.1	mg/L	4.0	5.0	6.3	8.5	13.3	25.6	30.6
Total Phosphorus as P	47	0.01	mg/L	0.3	0.5	0.8	1.9	4.3	8.3	14.8
Turbidity-Field	46	NA	NTU	0.0	0.0	2.9	9.1	27.1	80.0	237.7
Zinc	46	1	µg/L	13	28	44	62.5	82	105	218

In addition to this, four csv data files have also been supplied as detailed below:

- Cleaned _quarry _data.csv
- Analyte_distributions_quarry.csv
- Export_all_analytes_flow_adjusted_concs.csv
- Gemco_quarry_annual_water_volumes_v3.csv

Appendix E provides a description of each of the files.

Appendix B:

IPE (2023b). Memorandum - Volume weighted assessment of dewatering discharge analyte concentrations. Prepared by Indo-Pacific Environmental for GEMCO, August 2023

MEMORANDUM

To:	Will Longworth	Groote Eylandt Mining Company Pty Ltd	**Date:** 31/08/2023
From:	Jesse Wansbrough Simon Longbottom	Indo-Pacific Environmental	
Subject: Volume weighted assessment of dewatering discharge analyte concentrations.			

Purpose

Indo-Pacific Environmental was requested to estimate the analyte concentrations in the total mixed discharge water using the available data on analyte concentrations in each individual quarry and the projected dewatering flow rates for each quarry which were provided as supplementary data by GEMCO.

Method

Projected dewatering flow rate data was provided for each quarry anticipated to be operational from the period between the 2024 – 2033 financial years. Data was provided for base case and worst case flow volumes. Following the outcome of discussions regarding the dewatering mixing zone modelling the base case flow rates were chosen for use in this assessment. There was no predicted dewatering for any quarry for the 2032 – 2033 financial years so these were excluded from the calculations.

Due to projected mine expansion in GEMCO's eastern and southern lease areas there were many quarries in the projected dewatering flow dataset that were not included in the quarry water quality monitoring dataset as they have not yet been established. We accounted for the gaps in the available data using two approaches which differed in the conservatism of the assumptions used. In both approaches the two estimates were produced, based on either the 95th percentile or maximum concentrations of each analyte. To produce the overall mixed 95th percentile or maximum concentrations the concentration of all water contributed to the total discharge water volume by each quarry was assumed to be the 95th percentile or maximum concentration of that analyte calculated using only data from that individual quarry. The concentration of analytes in the mixed discharge water was then calculated for each financial year using the flow data for each quarry to calculate the relative contribution to the total discharge water.

Approach 1 – Less conservative

In Approach 1 only quarries for which there was both analyte concentration data and projected flow rate data were used to calculate the overall mixed dewatering discharge water analyte concentrations. This approach assumes that the sample of quarries for which there is analyte concentration data available is a representative sample of the water quality in the remainder of the quarries for which no data is available. This approach also assumes that the data available for each individual quarry is sufficient to characterise the analyte concentration distribution within that individual quarry. The precision with which a percentile can be estimated is heavily dependent on sample size, with percentiles further from the median requiring increasingly large sample sizes to estimate with accuracy. Guidance provided in ANZG (2018) outlines a minimum of 36 samples to estimate a 90th percentile accurately. Many of the datasets for individual quarry analytes have sample sizes well below the level needed to accurately estimate the 95th percentile of the analyte distribution (Table 1). Without a substantial amount of additional data collection, which is currently impractical, this limitation can be noted but there are few available additional options to address it. When sample sizes are small the general solution is to pool spatially or temporarily distinct samples to increase sample size. However, modelling the individual quarry concentration and contribution was initiated to move away from the original estimates based on pooled quarry data and so re-pooling the data here to increase sample size would not be effective.

The number of samples available per quarry varied between both quarries and analytes. As rare-earth elements (REE) were pooled, the sample sizes were relatively high overall and estimates are likely to be somewhat accurate for REE concentrations (sample size range 14 – 252 samples per quarry, mean = 118). In contrast, the quarry nutrient data was particularly sparse with a maximum of 6 observations and a mean of 3 per quarry for Nitrate, as such extreme care should be taken when interpreting the output for nutrient concentrations in particular (Table 1).

The predicted analyte concentrations of the overall mixed dewatering discharge water can be seen for Approach 1 for each financial year in Table 2. The highest concentration of each analyte and the year that occurred in is provided in Table 3.

Approach 2 – More conservative

In Approach 2 all quarries for which there is projected flow data were included in the calculations. Where there was no analyte concentration data for individual quarries, either due to no sampling or to the quarry not being operational yet, the 95th percentile and maximum concentrations calculated previously (See IPE Report Table 8) for the overall discharge water (i.e., using all quarry data) where used instead. This approach has the same issue regarding sample sizes for the individual quarry estimates that Approach 1 does, however the magnitude of this impact is likely ameliorated somewhat by the use of the overall 95th percentile analyte concentration as replacement data for those quarries which have no sample data.

The predicted analyte concentrations of the overall mixed dewatering discharge water can be seen for Approach 2 for each financial year in Table 4. The highest concentration of each analyte, and the year that occurred in, is provided in Table 5.

Results

As discussed above, the lack of data for individual quarries results in 95th percentile estimates with extremely high uncertainties. The selection of approach used to estimate the overall mixed dewatering discharge analyte concentrations will depend on risk tolerance.

Table 1. Number of analyte concentration samples available for each quarry.

Analyte	Mean Samples Per Quarry	Max Samples Per Quarry	Min Samples Per Quarry
Aluminium	17.7	45	3
Antimony	8.5	19	1
Arsenic	8.9	20	1
Cadmium	8.9	20	1
Chromium (Cr VI)	8.9	20	1
Cobalt	8.8	19	1
Copper	8.9	20	1
Iron	17.6	45	3
Lead	8.9	20	1
Manganese	17.7	45	3
Mercury	1.8	4	1
Nickel	8.9	20	1
Silver	8.5	19	1
Thallium	8.4	18	1
Tin	8.5	18	1
Vanadium	8.8	19	1
Zinc	17.7	46	3
Rare-earth elements	118.4	252	14
>C10 – C40 Fraction (sum)	17.1	38	3
Ammoniacal Nitrogen	2.9	4	2
Nitrate Nitrogen	3.1	6	2
Total Nitrogen	2.8	3	2
Phosphate	2.8	3	2
Total Phosphorus	2.8	3	2
Turbidity (NTU)	15.7	41	3

Table 2. Approach 1 - Estimated analyte concentrations of mixed discharge water derived from projected dewatering volumes and measured analyte concentrations of each quarry. Table only includes quarries for which analyte concentration data and predicted dewatering volumes are available. Concentrations are in µg/L unless specified otherwise.

	Number of	95th Percentile								Maximum							
Analyte	**Quarries**	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31
Aluminium	16	282.75	325.35	301.66	96.23	114.17	244.37	244.37	244.37	471.81	537.38	504.06	221.82	266.67	475	475	475
Antimony	16	0.51	0.51	0.51	0.51	0.51	0.52	0.52	0.52	0.57	0.58	0.57	0.59	0.61	0.75	0.75	0.75
Arsenic	16	0.68	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.09	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Cadmium	16	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Chromium (Cr VI)	16	0.55	0.59	0.58	0.57	0.5	0.5	0.5	0.5	0.7	0.86	0.84	0.77	0.5	0.5	0.5	0.5
Cobalt	16	0.92	0.78	0.75	0.59	0.61	0.75	0.75	0.75	1.33	0.78	0.75	0.59	0.61	0.75	0.75	0.75
Copper	16	1.81	1.81	1.71	0.77	0.83	1.25	1.25	1.25	2.68	2.32	2.19	0.77	0.83	1.25	1.25	1.25
Iron	16	41.55	44.28	42.82	25	25	25	25	25	42.08	44.9	43.39	25	25	25	25	25
Lead	16	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Manganese	16	241.95	292.08	280.56	167.78	85.17	135.38	135.38	135.38	266	323.48	312.37	211.18	110.11	179	179	179
Mercury	4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Nickel	16	1.38	1.94	1.87	2.02	1.03	1.5	1.5	1.5	2.8	3.46	3.29	2.45	1.22	1.5	1.5	1.5
Silver	16	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Thallium	16	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Tin	16	0.73	0.64	0.63	0.57	0.58	0.69	0.69	0.69	1.25	1.08	1.04	0.95	1.06	1.75	1.75	1.75
Vanadium	16	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Zinc	16	20.16	19.19	19.43	16.44	16.44	7	7	7	47.94	49.38	48.02	28.82	27.44	19.25	19.25	19.25
Rare-earth elements	16	3.4	3.84	3.58	1.86	2.17	4.25	4.25	4.25	40.45	48.26	44.65	15.77	19.17	42.5	42.5	42.5

Analyte	Number of Quarries	95th Percentile FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	Maximum FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31
>C10 – C40 Fraction (sum)	16	50	52.37	50	50	50	50	50	50	307.59	166.24	153.48	153.64	176.67	335	335	335
Ammoniacal Nitrogen	11	153.19	164.9	154.33	181.33	204.74	457.54	457.54	457.54	177.4	189.95	177.55	208.59	238.06	532.5	532.5	532.5
Nitrate Nitrogen	11	296.56	308.25	299.87	302.75	160.29	285.9	285.9	285.9	310.87	319.45	310.42	311.91	169.89	306	306	306
Total Nitrogen	11	261.18	290.21	287.71	317.18	161	239.75	239.75	239.75	271.01	298.24	295.45	321.82	164.44	245	245	245
Phosphate	11	2.87	2.32	2.14	1.7	1.96	2.1	2.1	2.1	3.12	2.51	2.32	1.82	2.11	2.25	2.25	2.25
Total Phosphorus	11	5.34	3.99	3.97	4.55	2.5	2.5	2.5	2.5	5.5	4.01	3.99	4.59	2.5	2.5	2.5	2.5
Turbidity (NTU)	16	105.59	119.93	114.09	48.25	43.57	46.49	46.49	46.49	293.12	224.98	219.2	107.33	113.96	60.15	60.15	60.15

Table 3. Approach 1 - Summary table outlining the financial years which contained the highest concentrations for each analyte in Table 2. Concentrations are in µg/L unless specified otherwise.

Analyte	95th Percentile		Maximum	
	Year	Conc.	Year	Conc.
Aluminium	FY25	325.35	FY25	537.38
Antimony	FY29	0.52	FY29	0.75
Arsenic	FY24	0.68	FY24	1.09
Cadmium	FY24	0.06	FY24	0.06
Chromium (Cr VI)	FY25	0.59	FY25	0.86
Cobalt	FY24	0.92	FY24	1.33
Copper	FY24	1.81	FY24	2.68
Iron	FY25	44.28	FY25	44.90
Lead	FY24	0.50	FY24	0.50
Manganese	FY25	292.08	FY25	323.48
Mercury	FY24	0.05	FY24	0.05
Nickel	FY27	2.02	FY25	3.46
Silver	FY25	0.50	FY25	0.50
Thallium	FY25	0.50	FY25	0.50
Tin	FY24	0.73	FY29	1.75
Vanadium	FY25	5.00	FY25	5.00
Zinc	FY24	20.16	FY25	49.38
Rare-earth elements	FY29	4.25	FY25	48.26
>C10 – C40 Fraction (sum)	FY25	52.37	FY29	335.00
Ammoniacal Nitrogen	FY29	457.54	FY29	532.50
Nitrate Nitrogen	FY25	308.25	FY25	319.45
Total Nitrogen	FY27	317.18	FY27	321.82
Phosphate	FY24	2.87	FY24	3.12
Total Phosphorus	FY24	5.34	FY24	5.50
Turbidity (NTU)	FY25	119.93	FY24	293.12

Table 4. Approach 2 - Estimated analyte concentrations of mixed discharge water derived from projected dewatering volumes and measured analyte concentrations of each quarry. Table includes all quarries for which predicted dewatering volumes are available, where analyte concentration data was not available for a quarry the overall 95th percentile or maximum concentration from the total dataset was used as conservative estimate. Concentrations are in µg/L unless specified otherwise.

	95th Percentile								Maximum							
Analyte	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31
Aluminium	318.75	375.27	347.78	202.83	241.32	371.93	362.76	275.22	958.08	1395.15	1190.34	1003.93	1231.10	1894.97	1792.95	818.35
Antimony	0.51	0.50	0.51	0.51	0.51	0.51	0.51	0.52	0.85	1.09	0.98	1.00	1.12	1.48	1.42	0.93
Arsenic	0.64	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1.87	2.12	1.78	1.80	2.14	3.11	2.93	1.13
Cadmium	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.09	0.10	0.09	0.09	0.10	0.14	0.13	0.07
Chromium (Cr VI)	0.54	0.56	0.56	0.55	0.50	0.50	0.50	0.50	0.96	1.27	1.17	1.13	1.05	1.37	1.31	0.71
Cobalt	0.83	0.68	0.68	0.56	0.57	0.60	0.62	0.71	2.06	2.30	1.96	1.87	2.21	3.22	3.04	1.35
Copper	1.65	1.52	1.51	0.84	0.89	1.10	1.12	1.21	4.13	5.09	4.41	3.45	4.17	6.33	5.97	2.48
Iron	38.27	37.34	37.76	25.00	25.00	25.00	25.00	25.00	240.29	403.14	326.49	319.21	393.93	614.48	572.12	167.54
Lead	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Manganese	256.26	299.97	290.06	210.17	168.34	239.11	231.66	160.46	1806.13	3094.30	2501.81	2474.68	2985.21	4732.78	4405.59	1280.10
Mercury	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Nickel	1.90	2.68	2.47	2.60	2.11	2.95	2.85	1.85	4.82	6.90	6.05	5.51	5.50	8.18	7.70	3.11
Silver	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.80	1.04	0.93	0.93	1.05	1.37	1.31	0.71
Thallium	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Tin	0.68	0.59	0.59	0.55	0.55	0.58	0.59	0.66	1.60	1.77	1.59	1.55	1.76	2.48	2.42	1.93
Vanadium	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Zinc	20.92	20.92	20.73	18.63	19.19	16.87	16.16	9.39	77.35	102.17	90.06	77.28	88.71	121.90	114.52	44.07
Rare-earth elements	9.67	15.05	12.51	11.47	14.10	22.11	20.83	8.57	84.26	124.85	106.11	86.86	107.07	169.40	160.28	73.18

Analyte	95th Percentile								Maximum							
	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31
>C10 – C40 Fraction (sum)	50.00	51.52	50.00	50.00	50.00	50.00	50.00	50.00	578.20	707.61	584.26	593.18	719.47	1110.32	1054.61	522.47
Ammoniacal Nitrogen	138.63	144.10	140.53	161.18	170.96	256.75	271.17	408.99	480.73	522.91	457.44	449.59	529.55	827.24	806.06	603.77
Nitrate Nitrogen	432.80	455.43	424.53	413.26	350.65	517.10	500.49	341.80	535.97	566.83	518.30	497.16	453.81	680.59	653.68	396.58
Total Nitrogen	479.14	521.62	480.25	480.61	422.71	612.17	585.41	329.80	537.91	584.87	533.83	527.10	479.06	700.90	668.14	355.24
Phosphate	4.29	4.12	3.69	3.20	3.76	4.89	4.69	2.77	5.19	5.05	4.49	3.90	4.62	6.17	5.89	3.20
Total Phosphorus	8.38	7.91	7.23	7.29	6.68	9.18	8.70	4.11	11.65	11.45	10.16	9.93	9.95	14.41	13.55	5.38
Turbidity (NTU)	128.87	156.96	144.97	98.84	108.72	148.88	141.53	71.25	876.46	1306.82	1074.45	1012.48	1246.58	1901.09	1768.82	505.29

Table 5. Summary table outlining the financial years which contained the highest concentrations for each analyte in Table 4. Concentrations are in µg/L unless specified otherwise.

Analyte	95th Percentile		Maximum	
	Year	Conc.	Year	Conc.
Aluminium	FY25	375.27	FY29	1894.97
Antimony	FY31	0.52	FY29	1.48
Arsenic	FY24	0.64	FY29	3.11
Cadmium	FY24	0.06	FY29	0.14
Chromium	FY25	0.56	FY29	1.37
Cobalt	FY24	0.83	FY29	3.22
Copper	FY24	1.65	FY29	6.33
Iron	FY24	38.27	FY29	614.48
Lead	FY24	0.64	FY24	1.08
Manganese	FY25	299.97	FY29	4732.78
Mercury	FY30	0.05	FY29	0.05
Nickel	FY29	2.95	FY29	8.18
Silver	FY24	0.50	FY29	1.37
Thallium	FY25	0.50	FY25	0.50
Tin	FY24	0.68	FY29	2.48
Vanadium	FY24	5.00	FY24	5.00
Zinc	FY25	20.92	FY29	121.90
Rare earth elements	FY29	22.11	FY29	169.40
>C10 - C40 Fraction (sum)	FY25	51.52	FY29	1110.32
Ammonia	FY31	408.99	FY29	827.24
Nitrate as N	FY29	517.10	FY29	680.59
Total Nitrogen as N	FY29	612.17	FY29	700.90
Phosphate as P	FY29	4.89	FY29	6.17
Total Phosphorus as P	FY29	9.18	FY29	14.41
Turbidity (NTU)	FY25	156.96	FY29	1901.09

End Document

Appendix C:

IPE (2023c). Volume weighted assessment of dewatering discharge pH. Draft memorandum produced by IPE for GEMCO, 21 November 2023.

MEMORANDUM

To:	Will Longworth	Groote Eylandt Mining Company Pty Ltd	Date: 21/11/2023
From:	Jesse Wansbrough Simon Longbottom	Indo-Pacific Environmental	
Subject: Volume weighted assessment of dewatering discharge pH			

Purpose

Background

GEMCO is investigating the feasibility of ocean discharge for excess water at a location adjacent to GEMCO's port facility. Indo-Pacific Environmental was requested to estimate the analyte concentrations in the total mixed discharge water using the available data on analyte concentrations in each individual quarry and the projected dewatering flow rates for each quarry which were provided as supplementary data by GEMCO. The outcomes of the initial volume weighted discharge water quality analysis were reported to GEMCO in Indo-Pacific Environmental (2023b).

The previous volume weighted water quality analysis focused on potential toxicants and stressors and did not include pH. For pH, the volume-weighted approach employed by IPE (2023b) could not be simply applied due to the complexities in mixing various excess mine water storages into a storage prior to discharge with differing pH as other factors (e.g. alkalinity) determine the mixed solution values.

Characterisation of the receiving environment

The annual marine monitoring data set was previously used to characterise the analyte concentrations currently present in the receiving environment (Indo-Pacific Environmental 2023a). Due to the annual sampling frequency this data was only representative of late dry season conditions. Additional monthly sampling data has been provided from the GEMCO sewage outfall waste monitoring program which will provide important information on the annual variation of pH in the Milner Bay receiving environment.

Scope

As such, this memorandum:

- Provides a volume weighted approach for assessing the pH of the dewatering discharge water.

- Provides a summary of the updated available pH data for the marine receiving environment, incorporating monthly data from the Sewage Waste Discharge Monitoring Program.

Methods

Volume Weighting Approach

Projected dewatering flow rate data was provided by GEMCO for each quarry anticipated to be operational from the period between the 2024 – 2033 financial years. Data was provided for base case and worst case flow volumes. Following the outcome of discussions regarding the dewatering mixing zone modelling the base case flow rates were chosen for use in this assessment. There was no predicted dewatering for any quarry for the 2032 – 2033 financial years so these were excluded from the calculations.

In the initial volume weighted assessment of discharge water analyte concentrations two assessment approaches were used to account for the uncertainty in analyte concentrations of quarries which have not yet been established, and therefore have no analyte concentration data available. In the less conservative approach, the available quarry data was considered a representative sample of the potential quarry data and only quarries with available data were included in the volume weighted assessment to derive potential discharge water concentrations. In the second, more conservative approach, quarries for which there was no available data were assumed to have analyte concentrations equal to the 95th percentile of that analyte concentration in the available data set.

In GHD's Marine Discharge Modelling Report (GHD 2023), the discharge water quality was modelled at the concentrations derived using approach 1. To provide consistency between reports, approach 1 has been adopted within this memorandum to determine the pH of the dewatering discharge water. Unlike the concentrations of the potential toxicants assessed in the previous volume weighted assessment, the pH of the discharge water is a potential stressor to the marine environment at low pH's, as such, the 5th percentile and minimum pH's for each quarry were used in the volume weighted approach. To produce the overall mixed 5th percentile or minimum pH, the pH of all water contributing to the total discharge water volume by each quarry was assumed to be the 5th percentile or minimum pH calculated using only data from that individual quarry. The pH of the mixed discharge water was then calculated for each financial year using the flow data for each quarry to calculate the relative contribution to the total discharge water.

pH calculation

As pH is a logarithmic scale, simple averaging for volume weighting does not correctly reflect the change in pH with quarry water mixing. As such, we converted the pH data to hydrogen ion concentration in mol/L ($H^+ = 10^{-pH}$) for use in the volume weighting process. As lower pH's (more acidic) have higher concentrations of hydrogen ions, to derive the minimum and 5th percentile pH's for the overall discharge water, the 95th percentile and maximum hydrogen ion concentrations were used in the volume weighting calculations. After determining the volume weighted hydrogen ion concentration of the discharge water, we converted the result back into pH units ($pH = -\log10(H^+)$).

Assumptions

The volume weighting approach assumes that the data available for each individual quarry is sufficient to characterise the variability of the pH within that individual quarry. The precision with which a percentile can be estimated is heavily dependent on sample size, with percentiles further from the median requiring increasingly large sample sizes to estimate with accuracy. Guidance provided in ANZG (2018) outlines a minimum of 36 samples to estimate a 10th or 90th percentile accurately. Many of the quarries have sample sizes well below the level needed to accurately estimate the 5th percentile of the pH distribution (Table 1). Without a substantial amount of additional data collection, which is currently impractical, this limitation can be noted but there are few available additional options to address it. When sample sizes are small the general solution is to pool spatially or temporarily distinct samples to increase sample size. However, modelling the individual quarry concentration and contribution was initiated to move away from the original estimates based on pooled quarry data and so re-pooling the data here to increase sample size would not be effective. pH is particularly temporally variable in comparison to the concentration of many other potential physico-chemical stressors or toxicants. Where quarry sumps have high levels of organic material or algal growth, pH may fluctuate widely throughout the day as ecosystem metabolism varies due to changes in the rates of respiration and photosynthesis. With few pH samples available quantification of diel fluctuation is not possible. This approach also assumes that there is no buffering capacity in the quarry waters, which is supported by the low levels of alkalinity measured.

Additional baseline pH data for marine receiving environment

In addition to the pH data collected during the annual MEMP, we incorporated monthly pH data collected from 5 sites surrounding the port as part of the Sewage Waste Discharge Monitoring Program. Following data import, all pH data was assessed for abnormal and potentially incorrect results. Visual inspection of the data distribution indicated two sets of uniformly low observations across sites, these points were comprised of only data collected in the annual MEMP in the years 2014 and 2017 (Figure 1). The extent to which these were outside the bulk of the distribution and lower than expected values for seawater indicated that in these two sampling years there was likely an issue with the calibration of meter used. As such, the data from 2014 and 2017 were excluded from the analysis. A single point collected during the monthly sewage discharge monitoring program was unexpectedly low (< 7) which may have been the result of measurement error or of an unmixed plume from the sewage outfall. In either case it was considered not-representative of the general Milner Bay conditions and excluded. The exclusion of these spurious data points has resulted in a higher 20th percentile than previously reported for the Milner Bay area than reported in Indo-Pacific Environmental (2023a) which provided a less detailed summary of all analyte data.

Results

Volume weighted pH of discharge water

There were few available pH measurements for each quarry in the dataset. The number of pH measurements available ranged from 1 at ASE quarry to a maximum of 11 at F3N (Table 1). As discussed above, the lack of data for individual quarries results in 5^{th} percentile and minimum estimates with extremely high uncertainties. We provided volume weighted estimates using both the minimum and 5^{th} percentiles of the individual quarry distributions. Use of the minimum is inherently more conservative, however there is very little difference in the predicted values so use of the 5^{th} percentiles may make no practical difference in the predicted mixing zone requirements. Using the volume weighting approach, the worst case scenario for pH is expected to occur in 2031 financial year with a 5^{th} percentile pH of 5.23, however the 2025 financial year has very similar predicted pH values (Table 2).

Table 1. Approach 1 - Estimated analyte concentrations of mixed discharge water derived from projected dewatering volumes and measured analyte concentrations of each quarry. Table only includes quarries for which analyte concentration data and predicted dewatering volumes are available. Concentrations are in µg/L unless specified otherwise.

Quarry	Number of samples	5th Percentile	Minimum
ASE	1	6.27	6.27
BSC	7	5.98	5.95
CN	7	5.09	5.07
DN	7	5.52	5.52
DNE	3	6.54	6.54
DSS	7	5.64	5.52
DSW	6	5.98	5.94
ES	7	5.24	5.17
F3	9	5.01	5.01
F3N	11	4.70	4.6
F3Q	3	5.65	5.64
J	2	5.44	5.43
N3	1	5.73	5.73
N4	7	5.38	5.33
NH	7	5.36	5.33
O	3	5.89	5.87
W1	4	5.54	5.53
W2	7	5.54	5.52
W4	5	4.80	4.79
WW1	7	5.72	5.65

Table 2. Volume weighted dewatering discharge pH for the financial years between 2025 – 2031. The worst case scenario represents the year with the lowest predicted volume weighted discharge water pH.

Financial Year	5th Percentile pH	Minimum pH
FY25	5.27	5.22
FY26	5.31	5.25
FY27	5.52	5.51
FY28	5.45	5.44
FY29	5.43	5.42
FY30	5.45	5.43
FY31	5.23	5.22
Worst case	**5.23**	**5.22**

Additional baseline pH data for marine receiving environment

In total the available pH data collected during the annual MEMP comprised 167 field measurements, including 93 from port sites, 29 from northern control sites, 15 from southern control sites and 30 collected from STP Outfall sites (sewage discharge point). The data was collected annually across the 2013 – 2023 period between October - December each year. As such we consider the available data sufficient to characterise the pH of the Milner Bay marine receiving environment reasonably accurately during the late dry season period. There was little difference observed in the pH distributions between sites in the northern control, southern control, or port sites (Figure 2). This suggests that all sampling sites are relatively representative of the pH in the overall region, as such all available data was included to calculate the site specific trigger value.

Overall, there was higher variability observed in the monthly pH readings collected as part of the sewage waste discharge monitoring program than there was across all groups of sites surveyed during the annual marine monitoring program (Figure 2). This is likely due to the seasonal variation captured by the monthly sampling frequency of the sewage outfall monitoring program. The incorporation of this monthly data is important to characterise the pH variation of the receiving environment. Current ANZG (2018) guidance for the derivation of site-specific trigger values for physico-chemical stressors outlines a minimum of 2 years of monthly monitoring data for an appropriate site to provide sufficient data to characterise the baseline variation. The available waste discharge monitoring dataset comprises monthly monitoring data for 5 sites over the January 2022 – November 2023 period. In combination with the annual data collected during the MEMP sampling, we consider this sufficient to adequately characterise the pH of the Milner Bay marine receiving environment.

As recommended by ANZG (2018), where potential stressors are due to low levels of a parameter (i.e., dissolved oxygen or pH in this case) the site specific trigger value can be derived from the 20th percentile of the parameter distribution rather than the standard 80th percentile. As such we suggest an updated pH trigger value of 8.00 for the Milner Bay receiving environment, which is the 20th percentile of the combined available pH data sets (Table 3).

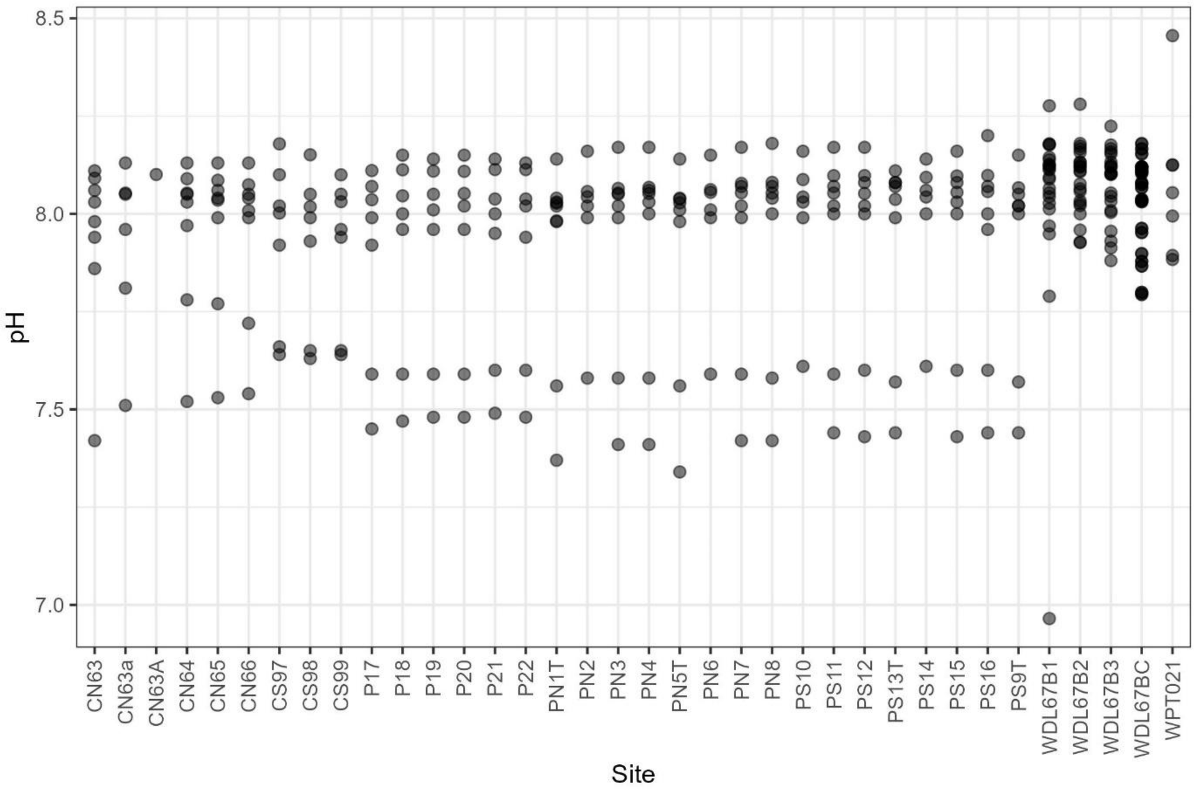

Figure 1. Available marine pH data for the Milner Bay receiving environment. Note the spurious readings visible as two lines of uniformly low pH readings.

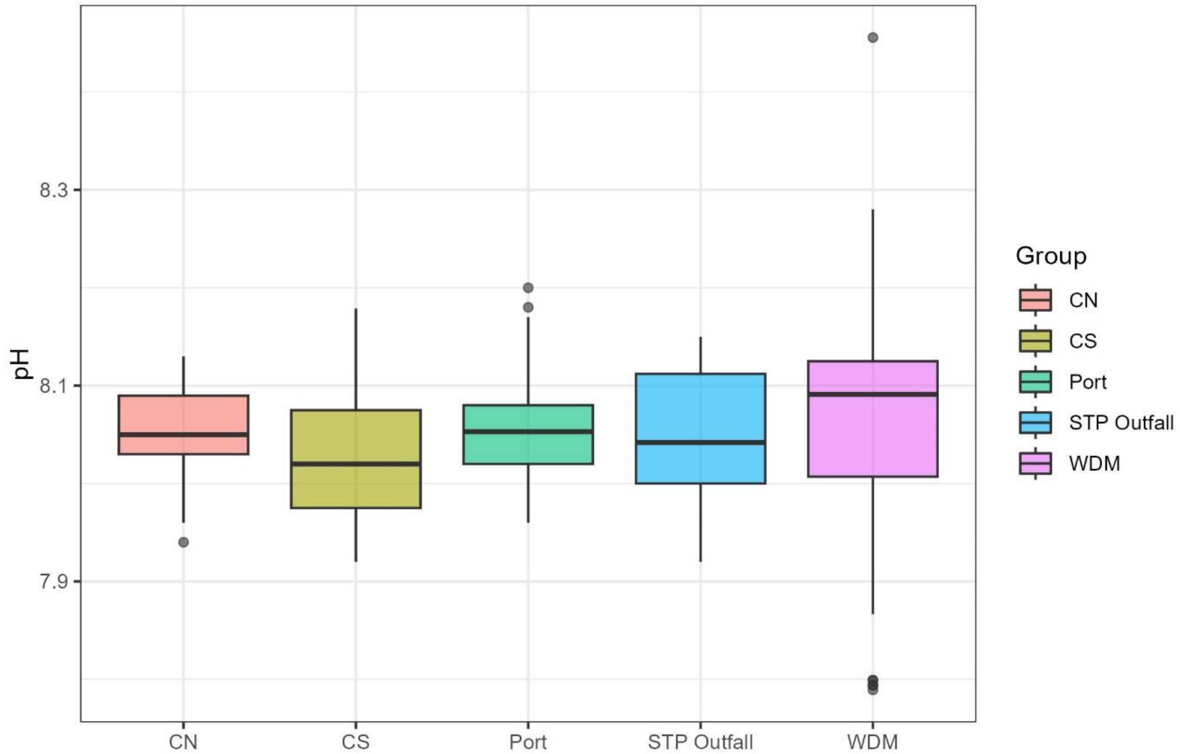

Figure 2. Distribution of pH observations from data collected in the annual MEMP sampling program, including at the northern and southern control sites, port sites and STP outfall sites, in addition to monthly data collected at sites around the port area as part of the ongoing sewage waste discharge monitoring program.

Table 3. Summary of available pH data for the marine receiving environment. The 20th percentile values are highlighted in bold.

	n	Min	1st	5th	**20th**	50th	80th	95th	99th	Max
MEMP Data										
Port Sites	93	7.96	7.98	7.99	**8.01**	8.05	8.10	8.17	8.18	8.20
Northern Control Sites	29	7.94	7.95	7.96	**8.00**	8.05	8.09	8.13	8.13	8.13
Southern Control Sites	15	7.92	7.92	7.93	**7.96**	8.02	8.10	8.16	8.17	8.18
STP Outfall Sites	30	7.92	7.93	7.94	**7.98**	8.04	8.11	8.15	8.15	8.15
Waste Monitoring Data										
Waste Discharge Monitoring Sites	116	7.79	7.79	7.87	**7.96**	8.09	8.13	8.18	8.28	8.46
Overall Marine Receiving pH	283	7.79	7.80	7.91	**8.00**	8.05	8.12	8.17	8.23	8.46

References

ANZG (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

GHD (2023). *GEMCO Excess Water Disposal Project | Marine Discharge Modelling Report*. Prepared for GEMCO Pty Ltd.

Indo-Pacific Environmental (2023a). *Development of water quality trigger values for discharge to marine environment*. Report to GEMCO.

Indo-Pacific Environmental (2023b). *Volume weighted assessment of dewatering discharge analyte concentrations*. Memorandum to GEMCO.

End Document

Appendix D: Proposed approach to compliance monitoring

Monitoring of source water

- Monthly monitoring of water quality in NH2 quarry
- Setting of management trigger values – based on model assumptions of discharge water quality.
- This program is in addition to the near-real time in-line turbidity, pH & electrical conductivity (EC) monitoring outlined in the SER.

Monitoring in the receiving environment

- Monthly monitoring of metals/metalloids in the receiving environment at the mixing zone boundary and at appropriate reference locations beyond the mixing zone
- Setting of trigger values using ANZG approach with values set using baseline information/ANZG guidelines/other literature sources.
- Results from monitoring will be linked to a Trigger-Action-Response Plan (TARP)
- This program is in addition to the near-real time turbidity monitoring in the receiving environment as outlined in the SER.

Trigger-Action-Response-Plan (TARP)

- The TARP will focus on adaptive management based on:
    - Near real-time monitoring results
    - Laboratory analysis results (noting delay associated with laboratory analytical timeframes)
- TARP responses may include:
    - Investigations of cause
    - Temporary cessation of discharge
    - Investigation of potential for environmental harm
    - Reporting to regulator

Appendix E:

Indo-Pacific Environmental Memorandum. Explanation of datasets provided in RFI response to Direction to provide further information on Supplementary Environmental Report (SER)

MEMORANDUM

To:	Will Longworth	Groote Eylandt Mining Company Pty Ltd	**Date:** 8/05/2026
From:	Jesse Wansbrough	Indo-Pacific Environmental	
Subject: Explanation of datasets provided in RFI response to Direction to provide further information on Supplementary Environmental Report (SER)			

Purpose

To support the request for additional information in relation to the Supplementary Environmental Report issued by the NT EPA in response to GEMCO's Excess Water Disposal Project application, Indo-Pacific Environmental was requested to provide the cleaned data set used in the development of the volume weighted assessment of dewatering discharge analyte concentrations.

Raw Quarry Water Quality Data Set

File name:
cleaned_quarry_data.csv

Description:

Raw water quality data for each quarry with available data was provided to Indo-Pacific Environmental as an exported dataset from GEMCO's database. The quarry dataset was then filtered and cleaned prior to use. Cleaning involved standardisation of units of measurement and identification of spurious results. The complete cleaned dataset is provided with this memorandum.

- Data Cleaning

The quarry dataset was then inspected for errors including misnamed analytes, incorrect units, spurious results, and missing data.

- 6 measurements from the F3 quarry were removed due to NAs.
- Multiple analytes were found to have non standardised units such as measurements in both mg/L and µg/L and were all standardised to µg/L.
- For electrical conductivity 5 data points were identified in mg/L and 5 in mS/cm while the remainder were in µS/cm. From the measurements it was not possible to be certain if these were actually recorded in µS/cm or mS/cm and so were excluded from the dataset.

- QA/QC plots were generated for each analyte to visually identify further spurious outliers.

- Data Filtering

Only quarries for which there was both analyte concentration data and projected flow rate data were used to calculate the overall mixed dewatering discharge water analyte concentrations. As such the total dataset was filtered to the quarries used in the analysis

This dataset is provided to address the first request of 3c) of '*Provide tabulated water quality data (totals and dissolved fractions) sufficient to verify summary statistics and graphs for all mine pits'*.

Table 1. Summary of columns in cleaned_quarry_data.csv.

Column Name	Summary
Site	GEMCO quarry that the water quality sample was collected from.
Date	The water quality analyte that is reported in the applicable table row.
Chem	The water quality analyte that is reported in the applicable table row.
Text_result	Original raw data column as exported from GEMCO's database.
Orig_unit	Original unit of measurement.
Processed_result	Working data column where units of measurement have been standardised and values below the LOA have been halved.
Unit	Unit of measurement for analyte in row.
Matrix_code	A column from GEMCO's database outlining what type of sample it is. Both WS and WW indicate a water sample.
Fraction	The fraction or type of water sample assessed. Values for this column are T, D, N. T: Total – unfiltered water sample. D: Dissolved – 0.45 µm filtered water sample. N: Not applicable for that analyte.
Loa	Limit of analysis, the lowest concentration of an analyte the laboratory is able to detect.
Loa_unit	The unit of measurement of the LOA column.
Detection	Was the measurement detected – above the LOA. Values are Y, N. Y: Yes it was detected. N: No detection.
Chem_rare_earth_grouped	A secondary chem column where all rare earth elements are grouped into a singular rare_earth category for analysis.
Numeric_detection	A helper column for detection where the Y and N values of the detection column are replaced with 1 and 0 to facilitate logical tests on data.

Quarry Water Quality Summary Data Set

File name:
analyte_distributions_quarry.csv

Description:

To address the second request of '*Include key parameters, date ranges, and representative statistics (median, percentiles, min/max) to allow assessment of variability*' a second supplementary file is attached which contains calculated summary statistics for each quarry and analyte.

The dataset contains summary statistics for each analyte measured at each quarry available in the complete water quality data set outlined above.

Table 2. Summary of columns in analyte_distributions_quarry.csv.

Column Name	Summary
Site	GEMCO quarry that the water quality sample was collected from.
Analyte	The water quality analyte that is reported in the applicable table row.
Fraction	The fraction or type of water sample assessed. Values for this column are T, D, N. T: Total – unfiltered water sample. D: Dissolved – 0.45 µm filtered water sample. N: Not applicable for that analyte.
Unit	Unit of measurement the analyte is reported in.
Number	Number of samples collected/used in calculation of analyte distribution for the row.
Detections	Number of samples for that row where the analyte was above the laboratory limit of detection.
Ratio	The ratio of analyte detections to number of samples collected. Ratio = Detection/Number columns.
Minimum	The lowest concentration for that analyte and quarry in the dataset.
20th Percentile	20^{th} Percentile for that analyte and quarry in the dataset.
Median	Median for that analyte and quarry in the dataset.
80th Percentile	80^{th} Percentile for that analyte and quarry in the dataset.
95th Percentile	95^{th} Percentile for that analyte and quarry in the dataset.
Maximum	The highest concentration for that analyte and quarry in the dataset.

Predicted Quarry Flow Data Set

File name:
gemco_quarry_annual_water_volumes.csv

Description:

The volume weighted calculations were based on the projected flow rate data. Projected dewatering flow rate data was provided by GEMCO for each quarry anticipated to be operational from the period between the 2024 – 2033 financial years.

The dataset contains the predicted flow rates (ML) for each quarry listed for the 2024-2023 period.

Table 3. Summary of columns in gemco_quarry_annual_water_volumes.csv.

Column Name	Summary
Site	GEMCO quarry that the flow prediction is for.
Case	Which flow prediction was used. Base: Base case or regular flow prediction.
Unit	Unit of measurement the flow is reported in.
FY24 – FY33	Predicted flow for that financial year.

Volume Weighted Analyte Concentration Data Set

File name:
export_all_analytes_flow_adjusted_concs.csv

Description:

Volume weighted analyte concentrations were calculated from the individual quarry water quality data discussed above in conjunction with projected dewatering flow rate data. To produce the overall mixed concentrations the concentration of all water contributed to the total discharge water volume by each quarry was assumed to be the percentile of that analyte calculated using only data from that individual quarry. Concentrations were calculated using percentiles including the 20^{th}, 50^{th}, 80^{th} and 95th percentiles to provide a range of discharge scenarios. The concentration of analytes in the mixed discharge water was then calculated for each financial year using the flow data for each quarry to calculate the relative contribution to the total discharge water.

This dataset contains the final predicted volume adjusted discharge water analyte concentrations.

Table 4. Summary of columns in export_all_analytes_flow_adjusted_concs.csv.

Column Name	Summary
Analyte	The water quality analyte that is reported in the applicable table row.
Sample Fraction	The fraction or type of water sample assessed. Values for this column are T, D, N. T: Total – unfiltered water sample. D: Dissolved – 0.45 µm filtered water sample. N: Not applicable for that analyte.
Unit	Unit of measurement the analyte is reported in.
Year	Financial year of volume weighted analyte concentration prediction.
20th Percentile	Volume weighted calculation using 20th percentile concentrations from Quarry Water Quality Summary Data Set.
Median	Volume weighted calculation using median concentrations from Quarry Water Quality Summary Data Set.
80th Percentile	Volume weighted calculation using 80th percentile concentrations from Quarry Water Quality Summary Data Set.
95th Percentile	Volume weighted calculation using 95th percentile concentrations from Quarry Water Quality Summary Data Set.
Maximum	Volume weighted calculation using maximum concentrations from Quarry Water Quality Summary Data Set.

End Document