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Our ref: DEPWS2023/0120

Ms Kylie Fitzpatrick
Department of Environment, Parks and Water Security
PO Box 3675
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Dear Ms Fitzpatrick

Re: Darwin Pipeline Duplication - Supplementary Environmental Report

The Department of Environment, Parks and Water Security (DEPWS) has assessed the information contained in the above application and provides the following comments:

Flora and Fauna Division

The Flora and Fauna Division have reviewed the Supplementary Environmental Report (SER) and considers that the proponent has addressed the majority of the comments and information requirements arising from the referral.

The Flora and Fauna Division agrees with the proponent's assessment that:

(i) impacts from the pipeline duplication proposal will likely be localised, and that impacts to ecological values of the harbour more broadly will be minor;
(ii) slightly elevated metal concentrations at specific locations are likely due to local seabed geochemistry and are unlikely to be a concern to maintaining Darwin Harbour Water Quality (WQ) objectives; and
(iii) residual impacts on marine habitats and marine fauna associated with direct disturbance of benthic habitats in the trenching corridor, indirect impacts associated with the short-term marine water quality, and impacts on marine fauna associated with noise and light emissions are expected to be minor.

Based on the information provided, the Flora and Fauna Division generally agrees with the proponents' assessment in relation to level of impacts. We note, however, that the methods under which the proponent came to this conclusion are not to industry standard, and further information is provided in the **Attachment 1**.

The Flora and Fauna Division reiterates its previous advice and recommends that the proponent implements the tie-in switch option as this will avoid duplication of the pipeline and therefore avoid environmental impacts altogether.

While the risks from the proposal are considered minor, the Trenching and Spoil Disposal Management and Monitoring Plan (TSDMMP) could be strengthened by addressing comments on topics underpinning the risk assessment: thresholds, zones of influence/impacts and understanding of ecosystem values and monitoring requirements. The Flora and Fauna Division also recommends that the final TSDMMP is reviewed by an independent expert and circulated for comment before any monitoring/work commences.

Should you have any further queries regarding these comments, please contact the Development Coordination Branch by email DevelopmentAssessment.DEPWS@nt.gov.au or phone (08) 8999 4446.

Yours sincerely

Maria Wauchope
Executive Director Rangelands
5 July 2023

Attachment 1 - Submission on the supplementary environmental report (SER)

Santos– Darwin Pipeline Duplicate Project

This submission is made under regulation 123 of the Environment Protection Regulations 2020

Government authority: Department of Environment, Parks and Water Security – Flora and Fauna Division

Summary: The Flora and Fauna Division (FFD) has assessed the SER and found that if the proponent implements the tie-in switch option the pipeline duplication is not required and therefore avoids environmental impacts altogether.

The FFD agrees with the proponent that residual impacts, the potential environmental risks and the significance of these are likely to be low but notes that the operation of the pipeline may have additional impacts that are yet to be assessed. It is noted that there are deficiencies in how the proponent came to this conclusion and therefore some uncertainty remains.

The FFDs' concerns are listed in the table below. The suggestions provided in the table below should inform the design of monitoring programs proposed in the TSDMMP and provide certainty that the proponents predicted environmental outcomes will be met. The remaining items listed in the Direction to include additional information in the Supplementary Environmental Report (SER) are considered adequately addressed by the sections listed in Table 1.1, page 20 of the SER.

Section of SER	Theme or issue to be addressed	Comment
General	Provide the rationale for duplication of the existing Bayu-Undan pipeline, given that the potentially significant environmental impacts of the proposal could be avoided through use of the existing pipeline.	The proponent has provided reasoning for the duplication of a section of the Bayu-Undan to Darwin pipeline in Section 3.2. The main reason is to enable the existing pipeline to be used for carbon capture and storage (CCS) at the Bayu-Undan facility. The proponent further states that The Bayu-Undan CCS project is not being assessed in this Darwin Pipeline Duplication (DPD) Project SER and is provided for context (SER Section 1.1 Project Overview, p26) and that the CCS project will be assessed through a separate project proposal. As the CCS project remains to be assessed there is no certainty that the duplication of the pipeline is needed. Furthermore, all the environmental impacts to flora and fauna and ecosystem processes that support them can be completely avoided by placing a tie-in switch where the Bayu-Undan and Barossa gas pipelines meet. This is acknowledged by the proponent (SER Section 3.3, Table 3.1). The FFD recommends that a tie-in switch option is taken, because it adheres to the first principle of environmental impacts assessment "to anticipate and avoid the

		adverse significant biophysical, social and other relevant effects of development proposals". Furthermore, an approval of the pipeline duplication may tacitly infer that the CCS project will be approved.
	Information used	Sections 8 and 9 of the SER and its appendices have almost entirely relied on reports associated with developments in Darwin Harbour (e.g. INPEX, Ship Lift, Conoco Phillips, Darwin Port Expansion, Mandorah Marine Facilities). The SER has limited references to relevant literature.
Marine Environmental Quality		
	Provide interpreted outcomes of proposal-specific sediment dispersion plume modelling. The model must be developed using relevant contemporary modelling methodology and should address all proposal activities that have the potential to generate turbid plumes. Revise the impact assessment for sedimentation in the context of: • proposal-specific data; • sediment dispersion/plume modelling outputs; and • updated habitat data (see below). Provide a draft trenching/dredging and spoil disposal management plan (DSDMP) for sub-sea trenching activities that includes: • baseline (pre-construction) condition of habitats within the zone of influence of the proposal (as required above) and relevant parameters to be monitored to detect impacts; • quantitative trigger levels for relevant parameters (and description of their derivation) corresponding to investigative and/or adaptive management actions that must be taken in the event that monitoring indicates trenching/dredging activities are likely to impact sensitive receptors; and	The proponent has adequately applied a hierarchy of hydrodynamic, wave and sediment transport models (Section 8.5.1.1 and Appendix 3). The approach is comparable to standards used for other dredging proposals in Australia. The FFD has concerns around the modelling window periods (Section 8.5.1.3 of the SER) and interpretation of the sediment dispersion plume modelling to inform thresholds, zone of influence and zones of impacts (Section 8.5 and Appendix 3 of the SER). Firstly, the proponent considered that plume modelling was not required for proposed backfill and stabilisation of the pipeline as using quarry rock material should not be a significant source of suspended sediment. The FFD accepts this argument. However, the proponent failed to consider the fact that when the rock is dumped on the pipeline and surrounding seabed it will also resuspend seabed sediments. This could be a significant source depending on the seabed substrate and therefore should have been modelled. **Plume dispersal - modelling windows:** The SER has acknowledged that plume dispersal modelling window (1 October – 9 November) falls outside the expected date for trenching activities (early 2024). It considers that "… the modelling scenarios are still representative of potential environmental conditions", The SER does not provide any further evidence to support this statement. Cardno (2022[i]) and Andutta et al. (2019[ii]) provide data that show October turbidity values more in line with Dry season averages (<50 NTU, maximum values) and Wet season conditions between January and March/April can reach well in excess of 200 NTU during monsoonal periods. As such, the FFD disagrees with the statement that there is no substantial difference in WQ conditions between October and Jan/March. Therefore plume dispersal modelling should have been representative of Wet season

	• quantitative limit values relevant parameters (and description of their derivation) corresponding to stop work, recommencement and/or investigative actions if sensitive receptor monitoring results exceed limit values.	conditions, especially given that trenching is likely to occur in early 2024 (Section 5.4.5 of the SER). Further, the plume dispersal modelling could have benefited from Cumulative Probability Total Suspended Solids (TSS) graphs for sites with sensitive receptors. These, in conjunction with time series Suspended Sediment Concentration (SSC) graphs and plume dispersion maps, are invaluable in assessing the risk of turbidity to sensitive receptors. **Tolerance limits:** The proponent solely relies on INPEX's established seasonal tolerance limits for excess SSC and sedimentation (Section 6.1 of the SER, INPEX 2018[iii]), however, provides no discussion if they are fit for purpose. INPEX derived thresholds only take into account the intensity of the stressor without considering duration and frequency of the disturbance. As trenching will happen in pulses of activity, it would have been appropriate for the SER to provide a discussion about species' thresholds in context of time-duration of elevated SSC. The proponent may want to acquaint themselves with a wider range of relevant and more recent literature and data (e.g. Jones et al. 2019[iv], Lavery et al. 2018[v], Collier et al. 2016[vi], Abdul Wahab et al. 2019[vii], Pineda et al. 2017[viii]) to establish thresholds for sensitive receptors. In addition, the community groups listed in Table 8.2 of the SER is limited, as it does not include tolerance thresholds for macroalgae and phototrophic / mixotrophic sponges. Further, proposed threshold parameters does not include light, which is considered best practice (see references Western Australian Marine Science Institution (WAMSI) Dredging Node and Great Barrier Reef Marine Park Authority (GBRMPA) Dredging guidelines). **Zones of Influence:** The SER follows INPEX (2018) to define zones of influence and impacts. The derived zone of influence is based on "… where sensitive receptor communities are predicted to be indirectly influenced by elevated SSC and sedimentation". To derive this zone, the SER arbitrarily used the exceedance values of 95th percentile of modelled elevated SSC and 3mm sedimentation thickness. No discussion has been provided for why these values are considered appropriate. For example, Fisher et al. (2019) considers the 95th percentile a zone of high impact, not zone of influence, as the SER suggest; and Jones et al. (2015, 2017[ix]) point out in their review that 80µm sediment thickness can inhibit coral larvae settlement.

		The FFD considers the use of '…where sensitive receptor communities are predicted to be indirectly influenced by elevated SSC and sedimentation…' more appropriate for determining zones of impact, because these are species specific. The zone of influence is better defined by 'the extent where environmental parameters that are predicted to change beyond background conditions due to project activities' (i.e. irrelevant of sensitive receptors). The Australian Guidelines for Water Quality Monitoring and Reporting[x] identifies the 80th percentile (or 20th percentile) of background as a detectable change against background conditions. Consequently, the zone of influence would be defined by the 80th percentile of background SSC levels and sedimentation rates. As the natural sediment deposition rates are largely unknown for Darwin Harbour, the precautionary approach should be adopted and any amount of sediment deposition from trenching, dredge spoil disposal and suspended sediments should be considered an environmental change, and thus should be also included into the extent zone of influence. The need for an accurate assessment of zone of influence extent is fundamental for a robust risk assessment because it allows to • define the extent for the risk assessment; • assess which sensitive receptors could be impacted on and where they are located in relationship to, for example, elevated SSC; and • determine whether there are any data gaps in understanding of composition and extent of sensitive receptors within the zone of influence (which in turns informs the need and extent for additional benthic surveys to map sensitive receptors and/or validate predictive habitat maps). **Zone of Impacts**: To define zones of impact, the proponent has used thresholds derived by INPEX (2018). Effectively the SER concludes that there is only a zone of high impact where direct trenching occurs (with a 20m buffer). There is no zone of medium impact, nor a zone of influence. This is odd, given that Figures 7.9 – 7.16 clearly show the extent of elevated SSC and time series data (Figures 7.18 – 7.27) show that SSC values can exceed beyond even INPEX thresholds, let alone those suggested by Jones et al. (2019) or other WAMSI Dredging Science Node and GBRMPA publications. Hence there must be zones of impact outside the direct footprint of trenching and dredge spoil disposal activities.

		The FFD believes that a robust risk assessment cannot be undertaken in part due to the uncertainty around the extent of the projects indirect footprint (see also Benthic habitats assessment). The FFD recommends that the following suggestions should be considered to inform the design of environmental monitoring programs as proposed in the TSDMMP and strengthen the environmental outcomes: • undertake a cumulative impact assessment for elevated SSC from all project activities, including e.g. trenching, rock dumping, dredge spoil disposal, pipeline laying; • implement Western Australia Environmental Protection Agency (WA EPA) Technical Dredging Guidelines for species specific thresholds to derive zones of impact; • that light Photosynthetically Active Radiation (PAR) is used as a trigger and is expressed as benthic daily light integrals; • trigger values are absolute and set against natural background values (i.e. no WQ reference sites used to determine if a trigger is reached).
	Demonstrate how Marine Environmental Quality would be protected in the event of discharge of hydrotest water in NT waters. Demonstrate that any discharge of hydrotest water in Commonwealth waters would not cause an exceedance of the 99% species protection level in any NT waters e.g. if a discharge were to be near the jurisdiction boundary. Describe the proposed mitigation measures to manage potential impacts of hydrostatic test water discharges to the marine environment. Include detail about hydrostatic test water discharge characterisation, dispersion modelling, physical and toxicity impacts, marine fauna impacts, chemical selection and dosing, discharge volume and rate, and criteria for toxicant concentrations in discharge water. Include consideration of how the 99% species protection concentration (ANZG) would be	The proponent has adequately assessed the potential impact of contingency discharges of treated seawater and modelled the extent of discharge (Section 8.5.2 and Appendix 5). However, the proponent has identified that metal concentrations are elevated at specific sites. The proponent believes this is due to local seabed geochemistry characteristics and will not be detrimental to Darwin Harbour water quality objectives. The FFD agrees with the proponent's conclusion.

	met for high conservation ecosystems or chemicals that have a tendency to bio accumulate.	
Marine Ecosystems		
	Provide the outcome of additional benthic habitat surveys of the proposal footprint and the zone of influence in Darwin Harbour, at the proposed spoil disposal site, and on knolls and rocky/mixed sedimentary environments within the zone of influence outside of Darwin Harbour. Surveys should use appropriate methods, with sufficient sampling intensity to provide robust understanding of baseline extent and composition of benthic primary producer habitats (see submission from the DEPWS). Survey design should be developed in consultation with the FFD of DEPWS. Revise the assessment of potential impacts to benthic habitats (including seagrass meadows in Fannie Bay, Shoal Bay and Casuarina Coastal Reserve) using the benthic habitat survey data and sediment dispersion model outputs.	The proponent has undertaken two additional benthic habitat surveys to verify the benthic habitats present in areas where impacts may occur (Section 9.4.3 and Appendix 6). The SER has discussed the potential impacts to benthic habitats within the zone of influence (Sections 8.5.1, 9.5.1 and Appendix 3 Section 4.1). The impact assessment for the Marine Ecosystems factor (Section 9 of the SER) concludes that the Project will have a minor residual impact on marine habitats and marine fauna associated with direct disturbance of benthic habitats in the trenching corridor, indirect impacts associated with the short-term marine water quality impacts. **Benthic habitat surveys**: The aim of the surveys was to verify the predicted habitat maps developed by Australian Institute of Marine Sciences (AIMS) so that a decision could made about whether the predicted habitat maps can be relied on to inform risk assessment or further benthic surveys are required to understand the extent of sensitive receptors within the zone of influence. The FFD considers the approach undertaken by the proponent to inform this decision does not meet the appropriate standard for the following reasons: • Section 2.2 of Appendix 6 (Pipeline Benthic Survey) mentions that benthic imagery was analysed in detail by RPS' marine scientists to characterise topographic features, benthic habitats and macrofaunal communities. However, the section lacks detail on: (i) which benthic habitat classification was used, e.g. the National benthic habitat classification scheme (CATAMI[xi]); and (ii) definitions of habitat descriptive metrics (e.g. low\high reef profile, low\medium\high density biota), and decisions rules for assigning benthic habitat data to benthic habitat classes. Using different classification systems may introduce error in matching the two data sets. Consequently, it is uncertain whether the proponent's biological and geomorphological classified data can be compared to existing data sets. This is an issue given the objective of the benthic surveys. The above concerns seem to be confirmed in Table 3.1 of Appendix 6 (Pipeline – Benthic Survey Report) where there seems to some inconsistency in assigning benthic habitat data to benthic mapping classes. For example, transect INPHCWOD (Table 3.1, which is most probably a typographic error and should be INPSGWOD, see Figure 4.3 (page 95 of Appendix 6)) found seagrass to be present

		at 5-15% cover. However, this site is mapped as silty shelly sand with sparse to no biota (soft corals). Fifteen percent cover for seagrass in Darwin Harbour is considered high and should be mapped as a seagrass meadow and confirms AIMS predictive habitat map; INPHCCH is considered low profile reef, however with up to 50% cover of coral, this could be considered a coral community or at least a mixed community. • The proponent compared collected benthic community data and predictive habitat maps through descriptive means. The proponent concluded that that collected data did not compare well with predictive habitat maps in shallow waters. Nevertheless, the SER continued using the predicted habitat for its risk assessment with the caveat that where collected data refuted predictive maps the assessment used the newly collected data. It is unclear to the FFD how the proponent has adjusted the predictive map to inform the risk assessment. Furthermore, the FFD considers that the SER could be improved by providing a qualitative and quantitative assessment of how well the collected data matches the predictive habitat maps. There are number of reasons for taking this approach. Firstly, it provides a science-based assessment through robust statistical methods; secondly, it forces the collection of benthic data at a sufficient intensity required for statistical analysis (see comment below); and thirdly, if the uncertainty analysis identifies that the predictive maps are inaccurate, then collected data will allow additional benthic habitat modelling to derive an 'updated' habitat map that reflects the proponent's collected data. Depending on the outcome of the statistical assessment, either habitat map will then be sufficient for understanding the presence and extent of sensitive receptors and allow for a risk assessment. • The above comment leads into deficiencies around proponent's survey design. The benthic surveys were conducted over two separate field programs: a nine-day program to describe the benthic habitats along the pipeline route and a five-day sampling program for project corridor – 2km area on either side of the proposed pipeline - and the dredge spoil disposal area. The second field program was combined with other survey objectives (e.g. heritage surveys). Overall, it collected habitat data from about 41 sites on the pipeline route and 24 within the project area. Of the sites sampled, it seems that seven sites were resurveyed INPEX monitoring sites, i.e. sites with known benthic habitat types.

		• Within the context of the proponent's assessment the survey areas are well beyond their identified area of zone of influence. However, the FFD has concerns about how the zone of influence has been derived (see above comments) and thus areas with sensitive receptors have been excluded. For example coral communities at the Vernon Islands and seagrass meadows at Woods Inlet and along the northern Cox Peninsula coastline. No consideration has been given to phototrophic / mixotrophic sponges. • The sites selection was based on locations of predicted presence of sensitive receptors. The proponent has acknowledged that the authors of the predictive habitat maps have placed a number of caveats around the interpretation of model outputs. They have used the caveats as to why their data did not compare well with the predicted habitat maps in shallow waters. However, the survey design may have also played a role in this error. The proponent should have used the caveats around accuracy and error of the predictive model to inform the survey design in terms of transect length and survey intensity. For example, Figure 9.4 of the SER shows that seemingly short towed underwater-video transects were undertaken. Appendix 6 does not provide any details about transect length and the variability of benthic cover along a transect. Therefore it is difficult to assess whether transect length is an issue. Nevertheless, in general, short transects are unlikely to take into account the patchy nature of benthic habitats in Darwin Harbour. Nor do the short transects address the spatial uncertainty of towed underwater-video data underpinning the predictive habitat map, which may be up to 100m. Therefore, if short transects are required then there is also a requirement to increase survey intensity to capture the presence of sensitive receptors adequately. A single survey site is inadequate to assess the adequacy of the predictive habitat map, in particular in areas where there is no data underpinning the model, for example, northern Cox Peninsula coastal waters. Furthermore, manually identifying survey sites, without considering statistical rigour can lead to biased results. The proponent could have used a spatially balanced stratified sampling design (e.g. GRTS, Stevens and Olsen 2004[xii]). However, there are many ways to resolve this issue and expert advice should be sought. • The predicted benthic habitat map does not include the Vernon Islands/Gunn Point area. This area is of high conservation value. Given that sedimentation

		occurs in this area, and therefore elevated SSC must occur, benthic surveys should have been undertaken to characterise and map the presence and composition of sensitive receptors (e.g. corals, macroalgae and phototrophic/mixotrophic sponges). The purpose of this survey would be twofold: (i) to inform the risk assessment, and (ii) identify a suitable monitoring site to validate that there is no detrimental impact to benthic communities from project activities. • It is unclear why the proponent resurveyed INPEX monitoring sites, for which there is already benthic habitat data available (e.g. INP-prefixed sites, Section 9.4.3 of the SER). It may have been preferable to survey nearby unverified seabed habitats and thus increase the number of validation points. **Threatened and migratory species assessment:** The FFD considers that there are some weaknesses in the revised desktop assessment of likelihood of occurrence of *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed species. It used a 5km buffer for highly mobile species, which is effectively a 3km buffer from the project area. This is inadequate to determine the presence of threatened and migratory species and their likelihood of occurrence (unlikely, known to occur). For example, the Grey Plover and Oriental Plover have both been recorded from Sandy Beach and East Arm Wharf[xiii, xiv, xv] and therefore should receive the 'known to occur' rather than 'unlikely'. Hawksbill turtle should also be 'known to occur', as feeding habitat is present within the 3km buffer from the project area. Nevertheless, the proponent has identified the key species at risk from project activities, no matter what likelihood of occurrence criteria it assigned, and thus has adequately discussed the appropriate species for their risk assessment. **Benthic community assessment:** The FFD cannot fully assess the risk to benthic communities due to the concerns around determining zones of influence/impacts and thresholds (see above). However, the SER does provide time series graphs for selected sites that contain sensitive receptors (Figures 7.18 – 7.27 Appendix 3). These figures seem to indicate that the time duration and frequency of elevated SSC above medium zones of impact and high impact thresholds (as identified by WASMI for corals, seagrass and phototrophic/mixotrophic sponges) are unlikely to be a risk to these sensitive receptors. This assessment could be further strengthened by also showing Cumulative Probability TSS graphs for sites within sensitive receptors. Based on the visual assessment of time-series SSC plots, the FFD concludes that the risk to sensitive receptors from the project activities to be likely low and not significant. Nevertheless, there remains some uncertainty due to concerns about how the

		proponent has applied zone of influence, zones of impacts and thresholds for species; and the absence of any statistical analysis of frequency and duration of elevated SSC above thresholds (as defined in WAMSI and GBRMPA publications [xvi, xvii, xviii, xix, xx, xxi, xxii, xxiii]).
	• Provide an underwater noise assessment conducted using contemporary best practice, including interpreted outcomes of underwater noise modelling, and modelling of cumulative noise resulting from the proposal and existing activities at sensitive receptors. • Provide a detailed draft marine megafauna management plan for construction activities that includes: o Baseline (pre-construction) cumulative noise within the zone of influence of the proposal and relevant parameters to be monitored to detect impacts; o Noise trigger levels for relevant parameters (and description of their derivation) corresponding to actions that must be taken in the event that monitoring indicates that construction activities are likely to impact protected species; and o Management actions to be applied if noise triggers are exceeded in accordance with the environmental decision-making hierarchy.	The SER has undertaken an assessment of underwater noise impacts, including interpreted outcomes of modelling (Section 9.5.1.8 and Appendices 8 and 9 of the SER). A Marine Megafauna Noise Management Plan is in Appendix 7 of the SER. This includes for the monitoring of management zones (fauna observation and exclusion zones) and management actions, in accordance with the environmental decision-making hierarchy, that are triggered if marine megafauna enter these zones. The proponent has proposed a 150m observation zone and a 50m exclusion zone with a 10 minute observation period prior to work commencing. The zones are primarily based on EPBC Regulations for vessel interactions at sea which is focused on tourism activities. The FFD considers that the zones are likely inappropriate for the proponent's activities. In light of other dredging activities [xxiv, xxv, xxvi, xxvii, xxviii] in Australia it is recommended that: • A 20 minute observation period is undertaken by a dedicated, trained marine fauna observer to determine whether marine megafauna are present. • Vessel speed is restricted to six knots, once marine megafauna has been sighted within the monitoring zone. • During trenching, pipe-laying and rock dumping a 300m radius monitoring zone should be used. This range is supported by SER's TTS range modelling for dolphins and other large dredging proposals. This distance will also allow slower moving species (Dugong and Turtle) to have enough time to avoid shipping activities and allow skippers to adjust vessel speeds to six knots. It will also provide the contractor enough time to implement mitigation actions if a species enters the exclusion zone. • If any marine megafauna are sighted within the 300m exclusion zone, then all activities (trenching, pipe-laying, rock dumping and trench spoil disposal) are halted until marine fauna have left the exclusion zone or are not sighted for 20minutes after the last sighting. • Trench spoil disposal can occur if no marine megafauna have been sighted at the trench spoil disposal site within a radius of 300m of the dump site. If marine

		megafauna have been sighted the skipper can dispose of trench spoil in an alternative site outside the 300m radius or wait 20 minutes after the last sighting. The FFD also recommends that the proponent: (i) undertakes monitoring to verify noise modelling outputs to ensure it is within the modelled predicted values; and (ii) implements measures suggested by National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2020, or any subsequent version thereof.
Marine Environmental Quality and Marine Ecosystems	The monitoring program for the draft DSDMP must provide for the assessment of cumulative impacts associated with trenching/dredging and spoil disposal, including from the addition of concurrent or consecutive dredging programs not related to the proposal. The DSDMP should include: • a communications strategy for engaging with government authorities and other proponents undertaking or proposing to undertake dredging in the harbour; and • a proposed approach to managing dredging in coordination with other proponents/dredging projects to avoid significant cumulative impacts to Darwin Harbour from dredging activities.	The proponent has drafted a TSDMMP (Appendix 4). The proponent has noted that "*the final decision is yet to be made as to the exact trenching methodology to be adopted and, key components of the monitoring programme such as parameters to be monitored, monitoring locations, numbers of monitoring sites, and the durations and frequency of the monitoring programme may change depending on the final trenching methodology selected*". Given this uncertainty, the FFD recommends that the following monitoring requirements are at least incorporated into the final TSDMMP: • The key water quality parameters to measure are depth (m); temperature; salinity (if activities are undertaken during the Wet); total suspended sediments (TSS); turbidity as Nephelometric Turbidity Unit (NTU); seabed light at the seabed expressed as PAR, benthic daily light integral (DLI) and a percentage of solar radiation at the sea surface (%); and WQ parameters that influence quantity and quality of light reaching the seabed (e.g. suspended sediments, organic material, water colour, phytoplankton) for the developing site specific light attenuation coefficients. Parameters require to be continuously logged, with turbidity, temperature and light (surface and seafloor) for all monitoring sites to be telemetered. This will allow for reactive management actions, if required, and allow for identification of faulty equipment. Approval should be conditioned that faulty equipment is replaced within a certain period, given logistical considerations. • WQ monitoring program requires clearly defined outcomes, objectives and performance criteria, including clear description of methodologies in how data is collected, frequency of data collection, monitoring campaign frequency, sampling frequency, sampling position. • Sediment deposition is monitored in areas where elevated sediment deposition is predicted to occur and around the trench spoil disposal area (to validation of sediment transport modelling and the statement that sediments will not be transported from the trench spoil disposal ground)

		• Location of WQ monitoring is collocated within known extents of sensitive receptors (in order to assess cause and effect). Monitoring sites should include the Vernon Islands (due to sediment deposition and elevated TSS). • Baseline monitoring includes a condition assessment for sensitive receptors. For example, seagrass: cover, above and below ground biomass, carbohydrate content, vertical rhizome growth; corals: life form, mucus, bleaching, sediment cover, necrosis; and phototrophic / heterotrophic sponges: bleaching, necrosis). Condition metrics provides a baseline against which a trigger event can be assessed against. As such, the FFD considers the proposed use of a Remotely Operated Vehicle (ROV) for determining the condition of sensitive receptors inadequate. • Plume monitoring includes a sampling program to validate spatial extent of predicted plume. This should be daily at least over a full neap-spring tidal cycle; monitoring should include drone and remote sensing assessment techniques for the whole trenching period. Sampling program to validate spatial extent of predicted plume should be daily at least over a full neap-spring tidal cycle. Further validation of 3D plume behaviour could be characterised for tidal and neap-spring cycles using ADCP transects As part of approval conditions, the FFD recommends that: • the collected raw and processed data should be provided to the NT EPA in an appropriate format (so that it can be incorporated into existing databases) with metadata by means of six monthly reporting. The data should be provided under a Creative Commons licence. • The final TSDMMP is reviewed by an expert and circulated for comment before any monitoring/work commences. • All interactions with wildlife are reported to DEPWS through the NT Wildwatch portal[1].

[i] Cardno 2022, Sediment transport Report. New Marine Facilities to Service Mandorah and Cox Peninsula. Document ZMD01890

[ii] Andutta, F. P., Patterson, R. G., & Wang, X. H. (2019). Monsoon driven waves superpose the effect from macrotidal currents on sediment resuspension and distribution. Estuarine, Coastal and Shelf Science, 223, 85-93. https://doi.org/10.1016/j.ecss.2019.04.036.

[iii] INPEX, 2018. Maintenance Dredging and Spoil Disposal Management Plan. Document L060-AH-PLN-60010

[iv] Jones et al. 2019. Theme 4 Synthesis Report: Defining thresholds and indicators of coral response to dredging-related pressures. Western Australian Marine Science Institution (WAMSI). Perth, Western Australia pp. 36.

[1] https://biocollect.ala.org.au/nt-wildwatch

[v] Lavery et al. 2018. Synthesis Report: Defining thresholds and indicators of primary producer response to dredging-related pressures. Report of Theme 5 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 32 pp.
[vi] Collier et al. 2016). Light thresholds for seagrasses of the GBR: a synthesis and guiding document. Including knowledge gaps and future priorities. Report to the National Environmental Science Programme. Reef and Rainforest Research Centre Limited, Cairns (41pp.).
[vii] Abdul Wahab et al. 2019. Defining thresholds and indicators of filter feeder responses to dredging-related pressures - final synthesis report. Report of Theme 6 – prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia 26 pp.
[viii] Pineda et al. 2017. Effects of combined dredging-related stressors on sponges. Scientific Reports. 7: 5155. DOI:10.1038/s41598-017-05251-x
[ix] Jones et al. 2017 Effects of sediments on the reproductive cycle of corals. Report of Theme 7 – Project 7.1 Western Australian Marine Science Institution, Perth, Western Australia, 35 pp.
[x] ANZECC and ARMCANZ, 2000. Australian Guidelines for Water Quality Monitoring and Reporting.
[xi] Althaus et al. 2015. A standardised vocabulary for identifying benthic Biota and susbstrata from underwater imagery, CATAMI, https://catami.org/
[xii] Stevens and Olsen 2004. Spatially Balanced Sampling of Natural Resources. J Am Stat Assoc 99:262–278
[xiii] Lilleyman et al. 2015. Final report on Project D13-0379 –Darwin – East Arm Port Project. Report to the Department of Business, Northern Territory Government
[xiv] Lilleyman et al. 2018 Distribution and abundance of migratory shorebirds in Darwin Harbour, Northern Territory, Australia. Northern Territory Naturalist (2018) 28:30-42.
[xv] Department of Environment, Parks and Water Security, Mala database (accessed 19 June 2023).
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