TNG DARWIN PROCESSING FACILITY ENVIRONMENTAL RISK ASSESSMENT METHODOLOGY

1.1 INTRODUCTION

This document describes the assessment of environmental and social risks for TNG's Darwin Processing Facility (the Project). It describes the risk assessment methodology and presents the results of the assessment. This section presents the project's risks in the absence of mitigation measures, as well as after taking into account the application of mitigation measures. The objective of the risk assessment process is to ensure that significant risks are identified and evaluated in order to ensure an appropriate level of risk treatment is applied to mitigate such risks.

Prior to the Draft EIS submission in 2019, discussions between the Northern Territory Environmental Protection Authority (**NT EPA**) and the Proponent identified Environmental Factors that the EIS must address based upon the NT EPA Environmental Factor and Objectives version 1.0 (2018). NT EPA Environmental Factors and Objectives Version 2.0 (NT EPA 2021) provides an updated classification of the environmental factors. The EIS Supplement and this Risk Assessment have adopted the revised Factor categories as specified in the Version 2.0 document. These Environmental Factors and their objectives, against which potential impacts are assessed, are listed in Chapter 3 of the EIS Supplement.

1.2 METHODOLOGY

1.2.1 Approach and Method

The Terms of Reference (**TOR**; NT EPA, 2016) requires identification, analysis and mitigation of potential environmental impacts of the Project through a whole-of-project risk assessment. The approach to risk assessment involved:

- Establishment of context;
- Risk identification;
- Risk analysis;
- Risk evaluation:
- Risk treatment;
- Monitoring and review; and
- Communication and consultation.

This document describes the work that was undertaken to establish the context of risks and the process for risk identification, analysis, evaluation and treatment. Appendix M – Environmental Management Plan describes the monitoring and review procedures that will be adopted in relation to environmental risks. TNG will establish a risk register with health, safety and environmental risks which will be reviewed over the life of the project, including at all stages of the development of the Project. The risk and environmental impact assessment process informing this EIS is illustrated in Figure 1 and described in the sections below.

1.2.2 Environmental Context

The environmental risks of this project are determined by the environmental setting of the project and the project features. The NT EPA classifies 14 environmental factors (NT EPA, 2021) to guide the structure of formal Environmental Impact Statement (**EIS**) in the NT. The potential impacts of a proposal are assessed against the NT EPA's objectives for each factor to determine whether the impacts of the proposal are likely be significant.

Environmental Factors that could potentially be significantly impacted by the Project were identified by the NT EPA, and the reasons for their selection are discussed in the TOR. Based on the TOR, technical studies, site surveys and stakeholder consultation were undertaken to:

- Identify environmental values that could be impacted by the Project;
- Assess the conservation significance of the environmental values which could be impacted; and
- Determine how sensitive or vulnerable environmental values are to be impacted.

This information is documented in the Draft EIS chapter for each environmental factor, under the heading 'Existing Environment'.

The Draft EIS was made available for comment for a period of 12 weeks from 30 November 2019 to 21 February 2020. Copies of the Draft EIS were made available for public viewing on the NT EPA and TNG websites and in various physical locations in Darwin and Palmerston.

The NT EPA provided consolidated comments from NT Governmental Agencies in response to the draft EIS and 3 public submissions were received by the NT EPA and forwarded to TNG.

In accordance with clause 12 of the *Environmental Assessment Administrative Procedures 1984* (**EAAP**), the NT EPA directed TNG to provide a Supplement to the Draft EIS. The Supplement addresses comments raised through submissions on the Draft EIS and details Project amendments undertaken since the Draft EIS was completed.

The Project revision and supplementary information has had no effect to some Factors addressed in the Drat EIS, has provided additional information for others and led to changes in the Key Factors relevant to the Project. Each Factor addressed in the Draft EIS is listed in Table 3-1 of the Supplement with a description of its treatment in the Supplement and justification for changes or lack of changes.

This Project Risk Assessment has been developed based upon the revised Project as described in Section 2 of the Supplement and additional information to assess the risk based upon the revised Project is provided on a Factor by Factor basis in Section 3.

This Project Risk Assessment replaces that presented in the Draft EIS Appendix G.

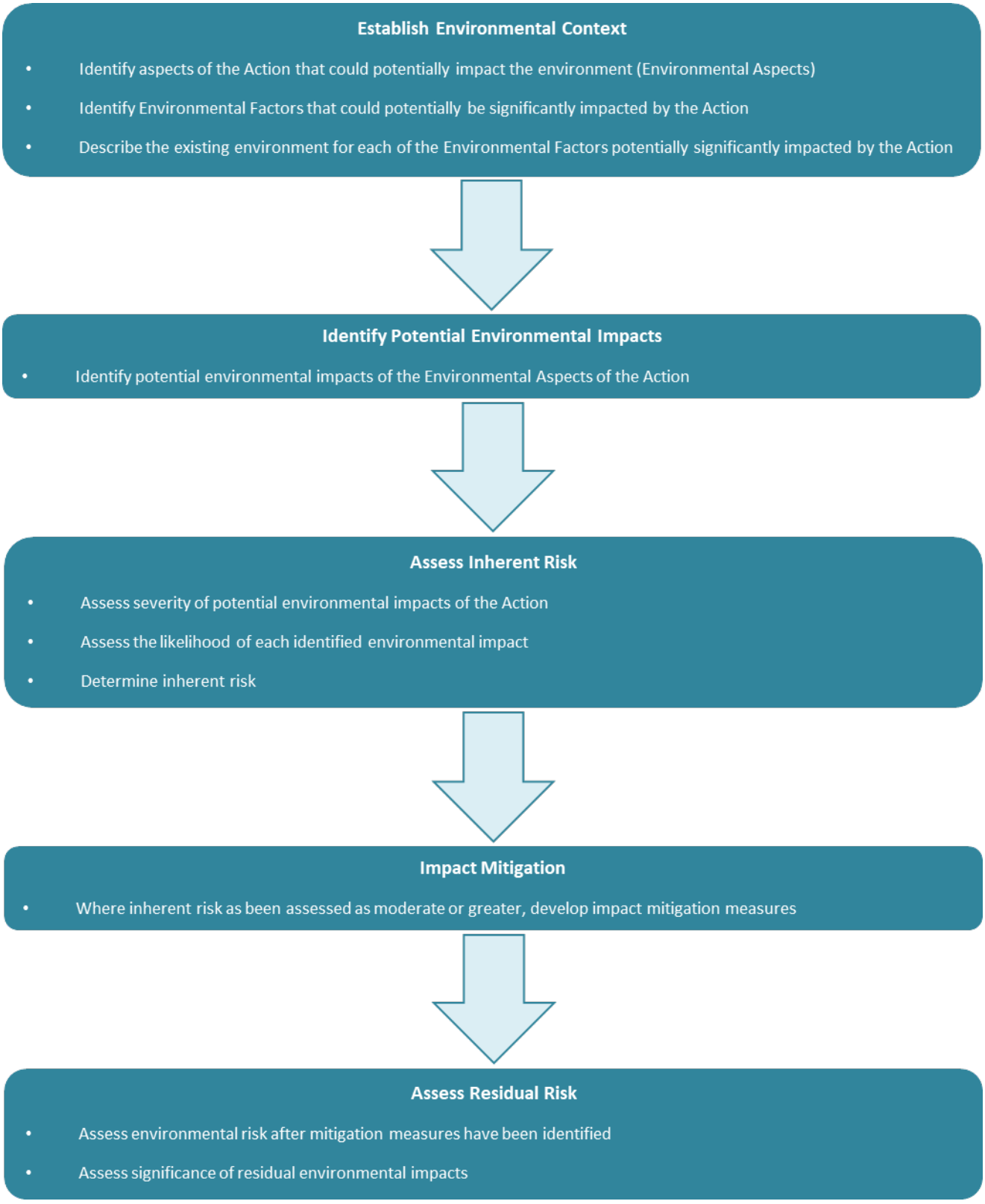

Figure 1: Risk and Environmental Impact Assessment Process

1.3 RISK IDENTIFICATION, ANALYSIS AND EVALUATION

For the purpose of impact assessment, the Project was divided into construction and operational phases. This differentiation simplifies impact assessment due to the significant differences in activities and potential impacts, and significantly different time scales over which activities take place, between the two phases. Environmental aspects of Site closure and rehabilitation have not been assessed in this EIS as the considerable project life (approximately 40 years) makes it difficult to predict the local demand for land, development plans and strategies, and other future social and environmental conditions likely to influence post-project land use at the Site.

Environmental Aspects of the Project were identified by considering the potential pathways along which different Project elements could interact with Environmental Factors. The pathways identified informed the development of a conceptual site model, and the Environmental Aspects and their interactions with the environment form the basis of the EIA. Identified environmental aspects are categorised according to the relevant stage/s of the Project in **Table 1**.

Table 1: Environmental Aspects of the Project and Relevant Phases

Environmental Aspect	Construction	Operation
Clearing of native vegetation	✓	
Water supply and use		✓
Non-process Waste management	✓	✓
Traffic	✓	✓
Chemical Management	✓	✓
Power generation and use		✓
Greenhouse gas emissions		✓
Process emissions		✓
Process waste management		✓
Storm water management	✓	✓
Workforce	✓	✓
Train loading and unloading		✓
Stockpiling		✓

For each environmental aspect of the Project, events/ incidents that could impact environmental values were identified. Potential direct and indirect impacts were then identified by considering cause and effect pathways for impacts to each Environmental Factor. The severity of each potential impact was assessed using the following criteria:

- Scale (extent);
- Intensity; and
- Duration and frequency.

Categories used to rate the severity of impacts are shown in **Table 2**.

Table 2: Categories used to assess the severity of potential impacts

More Severe ⟷ Less Severe

Scale			
Widespread	Regional	Localised	Limited
Impact occurs at a NT, national, international or global scale	Impact extends to the Darwin/ Palmerston region, and/ or greater Darwin Harbour	Impact is confined to the Site and areas directly adjacent to the Site, such as other allotments, Elizabeth River, and estuarine watercourses adjacent to the Site	Impact limited to the Site
Intensity			
High	Moderate	Low	Very Low
Impact irreversibly compromises the integrity of environmental values	Integrity of environmental values altered but impact can practicably be reversed	Impact alters the quality, abundance or distribution of environmental values without compromising their integrity, and can be easily and cheaply reversed	Impact does not significantly alter the quality, distribution or abundance of environmental values.
Timing, duration and frequency			
Permanent	Long term	Medium term	Short-term
Impact that is permanent; environmental values will not recover on human time scales	Impact that is measurable post-Project	Impact that is felt up to completion of operations	Impact that is felt up to completion of construction

1.4 RISK ASSESSMENT

The risk that potential Project impacts will result in one or more NT EPA objectives for an Environmental Factor being compromised was assessed in accordance with qualitative risk management principles described in *ISO 31000:2018 Risk Management – Principles and Guidelines* (International Standards Organisation, 2018).

Risk is a function of the likelihood of an impact occurring and the consequence of that impact on Environmental Factor objectives. The consequence and likelihood categories adopted are listed in **Table 3** and **Table 4**, respectively. The consequence assessment was informed both by the outcomes of the impact severity analysis described in the previous section, and the importance/ sensitivity of environmental values. A site and Factor specific interpretation of the consequences are listed in **Table 5**. Likelihood and consequence ratings were combined to derive an overall risk rating using the matrix shown in **Table 6**.

Table 3: Consequence Categories Adopted in Risk Assessment

Consequence or Severity of Impact	Description
Severe	A Severe impact has two or more of the following characteristics: • Widespread - Impact occurs at a NT, national, international or global scale; • High Intensity - Impact irreversibly compromises the integrity of environmental values; and/or • Permanent - environmental values will not recover on human time scales.
Major	A Major impact has two or more of the following characteristics: • Regional - Impact extends to the Darwin/ Palmerston region, and/ or greater Darwin Harbour; • Moderate - Integrity of environmental values altered but impact can practicably be reversed; and/or • Long term – Impact that is measurable post-Project.
Moderate	A Moderate impact has two or more of the following characteristics: • Localised - Impact is confined to the Site and areas directly adjacent to the Site, such as other allotments, Elizabeth River, and estuarine watercourses adjacent to the Site; • Low - Impact alters the quality, abundance or distribution of environmental values without compromising their integrity, and can be easily and cheaply reversed; and/or • Medium term - Impact that is felt up to completion of operations.
Minor	A Minor impact has two or more of the following characteristics: • Limited - Impact limited to the Site; • Very Low - Impact does not significantly alter the quality, distribution or abundance of environmental values; and/or • Short term - Impact that is felt up to completion of construction.
Insignificant	No noticeable/ measurable impact to values.

Table 4: Likelihood Categories Adopted in Risk Assessment

Likelihood category	Description
Almost certain	The event/ impact will occur or is expected to occur. The impact occurs regularly in association with similar projects and/ or in similar environments.
Likely	The impact will probably occur in most circumstances but there is some uncertainty about the likelihood. The impact has occurred on more than one occasion in association with similar projects and/ or in similar environments.
Possible	The impact could occur in some circumstances. The impact has occurred infrequently on similar projects and/ or in similar environments.
Unlikely	The impact is not expected to occur. The impact occurs very infrequently on similar projects and/ or in similar environments.
Rare	The impact is very unlikely to occur. The impact has not occurred on similar projects and/ or in similar environments.

Table 5: Consequence Categories Adopted in Risk Assessment adapted for each Factor with Site specific interpretation

Consequence or Severity of Impacts	Score	Terrestrial Environmental Quality	Terrestrial Ecosystems	Hydrological Processes	Inland Water Environmental Quality	Marine Environmental Quality	Benthic Habitat and Communities	Air Quality	Atmospheric Processes	Communities and Economy	Human Health
Severe	5	Soil disturbance, erosion or contamination that is measurably and permanently impacting environmental values that rely on good soil quality throughout the NT	Extinction of terrestrial flora, vegetation or fauna	Change in surface water flow volumes and/ or timing that permanently alters the ecological functioning and/ or amenity of Arafura Sea Change in ground water in a regional scale aquifer that permanently alters ecological health, beneficial uses and/ or amenity	Exceedance of baseline water quality that permanently alters the ecological functioning and/ or amenity of Elizabeth River	Exceedance of baseline water quality that permanently alters the ecological functioning and/ or amenity of Arafura Sea	Complete loss of a benthic habitat, community type and/or extinction of marine flora or fauna	Increase in exceedances of air quality regulations throughout the NT	Measurable increase in global GHG concentrations	Permanent impact that is felt by the majority of the NT population Unauthorised destruction of Aboriginal heritage item and/ or sites of world or national heritage significance	One or more fatalities More than one person injured with permanent disabilities
Major	4	Soil disturbance, erosion or contamination that compromises regional environmental values that rely on good soil quality, and would be costly and technically challenging to remediate	Regional scale impacts on terrestrial flora, vegetation or fauna that compromise post-Project biodiversity and/ or ecological integrity	Reduction in surface water flow volumes, groundwater levels and/ or timing of flows/ discharges that compromises regional ecological functioning, land use and/ or amenity post-Project Drawdown of groundwater in a regional scale aquifer that alters ecological health, beneficial uses and/ or amenity post-Project	Exceedance of baseline Elizabeth River water quality that continues for many years post-Project	Exceedance of baseline Darwin Harbour water quality that continues for many years post-Project	Regional scale impacts on benthic habitat or community and/or marine flora or fauna hat compromise post-Project biodiversity and/ or ecological integrity	Increase in exceedances of air quality regulations in the Darwin/ Palmerston region	Significant increase in NT GHG emissions, prohibiting meeting of the Net Zero emissions by 2050 target	Impact that is felt by a majority of the regional population post-Project Unauthorised damage/ desecration of Aboriginal heritage item and/ or sites of regional heritage significance such that integrity is lost	No fatalities One injury with permanent disability More than 10 injuries requiring hospitalisation
Moderate	3	Medium term soil disturbance, erosion or contamination in the vicinity of the Site that that alters soil characteristics but with no measurable impact to environmental values that rely on good soil quality, and can be remediated	Localised impact to flora, vegetation or fauna that alters the quality, abundance or distribution but with no measurable impact on biodiversity and/ or ecological integrity within months of the Project concluding	Localised reduction in surface water flow volumes, and/ or timing of flows/ discharges with no impact on ecological health, beneficial uses and/ or amenity. Localised drawdown of ground water throughout operations that recovers rapidly post-Project	Localised exceedances of baseline water quality that occurs throughout operations but ceases within months of the Project concluding	Localised exceedances of baseline marine water quality that occurs throughout operations but ceases within months of the Project concluding	Localised impact to benthic habitat or community and/or marine flora or fauna that alters the quality, abundance or distribution but with no measurable impact on biodiversity and/ or ecological integrity within months of the Project concluding	Localised increase in exceedances of air quality regulations	Moderate increase in NT GHG emissions	Impact that is felt by a small number of people during the Project, ceasing within months of the Project concluding Unauthorised activity but with no physical impact to a heritage item, or minor physical impact such that integrity is not lost	No fatalities No permanent disabilities 5-10 injuries requiring hospitalisation

Consequence or Severity of Impacts	Score	Terrestrial Environmental Quality	Terrestrial Ecosystems	Hydrological Processes	Inland Water Environmental Quality	Marine Environmental Quality	Benthic Habitat and Communities	Air Quality	Atmospheric Processes	Communities and Economy	Human Health
Minor	2	Short term soil disturbance, erosion or contamination in the vicinity of the Site that is reversible without significant remedial works	Impacts on flora, vegetation or fauna that do not measurably alter environmental values outside of the Site after construction concluding	Reduction in surface water flow volumes, groundwater levels and/ or timing of flows/ discharges at the Site with no impact on ecological health, beneficial uses and/ or amenity. Limited drawdown of ground water throughout operations that recovers post-construction.	Exceedances of baseline water quality at the Site ceasing within months of construction concluding	Exceedances of baseline marine water quality at the Site ceasing within months of construction concluding	Impacts on benthic habitat or community and/or marine flora or fauna that do not measurably alter environmental values outside of the Site after construction concluding	Increase in exceedances of air quality regulations at the Site	Negligible increase in NT GHG emissions	Impact felt by a small number of people at the Site during construction Unauthorised activity but with no physical impact to a heritage item	No fatalities No permanent disabilities Less than 5 injuries requiring hospitalisation
Insignificant	1	No measurable soil disturbance, erosion or contamination	No measurable impact on terrestrial flora, vegetation or fauna	No measurable change to hydrology	No significant change to baseline water quality	No significant change to baseline marine water quality	No measurable impact on benthic habitat or communities and/or marine flora or fauna	No measurable air quality impacts	No measurable GHG emissions	No noticeable impact to stakeholder or community values No impact to Aboriginal Sacred or other heritage sites	No fatalities No permanent disability No injuries requiring hospitalisation

Table 6: Risk Matrix Adopted in Risk Assessment

			Consequence				
			1	2	3	4	5
			Insignificant	Minor	Moderate	Major	Severe
Likelihood	5	Almost Certain	Medium	Medium	High	Very High	Very High
	4	Likely	Medium	Medium	High	Very High	Very High
	3	Possible	Low	Medium	Medium	High	Very High
	2	Unlikely	Low	Low	Medium	Medium	High
	1	Low	Low	Low	Low	Medium	High

1.4.1 Inherent Risk Assessment

For each potential impact, an inherent risk rating was assigned by ranking the likelihood and consequence of the impact in the absence of any mitigation (*i.e*. the worst-case scenario). The inherent risk rating considered the location and design of the Project, existing environmental conditions, impact sources and pathways, and the presence/ absence of important and/ or sensitive values and receptors.

1.4.2 Responses to Inherent Risk Levels

Each inherent risk rating was evaluated with reference to the risk level and response matrix in **Table 7** to determine the level of mitigation required. The higher the inherent risk level, the less tolerable/ acceptable the risk is likely to be to stakeholders and regulators, and the greater the requirement for impact mitigation.

Table 7: Risk Level and Mitigation Response Matrix

Risk level	Response
Very High	Risk is unacceptable. Specific action plans required to reduce risk to an acceptable level. Director/ CEO level management attention required.
High	Risk is generally unacceptable without action. Specific action plans required to reduce risk as low as is reasonably practicable (ALARP). Senior management attention required.
Medium	Risk is generally acceptable. Proactive action is required to reduce risk to ALARP. Requires routine monitoring and adaptive management in accordance with Environmental Management Plan. Line management attention required.
Low	Risk is acceptable. Management by routine policies and procedures.

1.4.3 Development of Impact Mitigation Measures

Practicable impact mitigation measures were developed for impacts with Very High, High, or Medium risk levels. Impacts with a Low level of inherent risk were still considered for further mitigation where specifically required by the TOR or where routine controls would further contribute to risk minimisation. Mitigation measures were developed with reference to environmental guidelines, professional and/ or academic experience of technical specialists engaged to work on the EIS and supporting studies, and personnel designing and developing the Project.

Mitigation measures were developed with the objective of reducing all risks to a level that is 'as low as reasonably practicable' (**ALARP**). This is defined as the level at which the resources involved in reducing the risk further would be grossly disproportionate to the benefit gained.

Each EIS chapter for the Environmental Factors assessed includes a summary of impact mitigation measures and monitoring programs that will be implemented. Revisions for some factors are provided in the Supplement. Details of how the proposed measures will be implemented over each phase of the Project are provided in the EMP, updated and submitted with the Supplement, or other specialist Factor Specific Management Plans. The purpose of these plans is to:

- Provide more detailed guidance to the Proponent and contractors on implementation of the mitigation measures in a manner that will be effective in reducing risk to an acceptable level; and
- Provide regulators with a level of confidence that the controls will be effective and are likely to be implemented.

The EMP will be reviewed annually and updated as required for the duration of the Project.

1.4.4 Residual Risk Assessment

Practicable mitigation measures were developed for the risk/pathway of each environmental impact with Very High, High, or Medium risk levels. Each of these risks/pathways was reassessed assuming implementation of proposed mitigation measures to determine a residual risk rating. The residual risk rating of each potential environmental impact represents the level of environmental risk associated with the Project. Where the residual risk of an impact was ranked as medium, high or very high, the potential for cumulative impacts from other current and future land uses was considered based on the information summarised in section 1.6 below.

1.4.5 Level of Certainty

For each potential impact, any information gaps/ uncertainties that could reduce reliability of the risk assessment, or certainty about the effectiveness of proposed controls, were identified. Each risk rating was assigned a level of certainty using the categories in **Table 8**.

Table 8: Level of certainty categories used to evaluate reliability of risk assessment

Level of Certainty	Description
High	Risk rating is based on testing, modelling or experiments. Baseline information is complete and an appropriate level of analysis has been undertaken. Proposed mitigation measures were recommended by technical specialists and are well developed with demonstrated efficacy. Minimal further work is required to adequately manage risk.
Medium	Risk rating is based on similar conditions being observed previously on a similar project and/ or in a similar environment. Baseline information has some gaps that are considered minor, and further work is unlikely to significantly alter the risk rating. While the efficacy of proposed mitigation measures has been demonstrated, some further work is required to provide details of implementation prior to commencement of the Project.
Low	Risk rating is based on professional opinion. Limitations in baseline information require that some assumptions are made, which introduces a level of uncertainty. Effectiveness of proposed controls and/ or the likelihood of implementation cannot be reliably assessed at this point in time. A substantial amount of further work is required to adequately manage risk prior to commencement of the Project.

1.4.6 Residual Impact Assessment

For each environmental factor, residual risk ratings assigned through the risk assessment process were used as the basis for assessing the significance of residual impacts. Impacts with a low residual risk rating, with a moderate to high level of certainty, are likely to have limited to no effect on the NT EPA's Environmental Objectives. Impacts assigned a residual impact rating of medium or higher are more likely to have an effect the NT EPA's Environmental Objectives, either because the mitigation measures require further work to demonstrate their efficacy, or because it is not practicable to avoid some level of impact.

The significance of residual impacts was assessed with regard to the likelihood of an effect on an Environmental Objective, and the following matters:

- Objectives of the *Environmental Protection Act 2019* (**EP Act**), EAAP or other NT environmental legislation;
- Values (e.g. effects to environmental factors and objectives), sensitivity and quality of the environment which is likely to be impacted;
- Extent (intensity, duration, magnitude, frequency and geographic footprint) of likely impacts;
- Consequence of likely impacts (or change);
- Resilience of the environment to cope with the impacts or change;
- Cumulative impact with other projects;
- Connections and interactions between parts of the environment to inform a holistic view of impacts to the environment;
- Level of confidence in the prediction of impacts and the success of proposed mitigation; and
- Public interest about the likely effect of the proposed Project on the environment and public information that informs the NT EPA's assessment.

A statement of residual impacts on each Environmental Factor is provided in the relevant Draft EIS and Supplement chapter.

The outcomes of the impact and risk assessment processes are documented in the Darwin Processing Facility Environmental Risk Register, appearing as **Table 9**.

1.5 ENVIRONMENTAL RISK ASSESSMENT

Table 9 presents the environmental risk assessment undertaken for the Project. It includes a description if the environmental and social risks associated with various project activities. The consequence and likelihood of each risk is provided in accordance with the rating system provided in **Table 3** and **Table 4** respectively, and an overall risk rating is provided in accordance with the matrix presented in **Table 6**. Risk ratings are provided for the activity both with and without mitigation allowing the effect of the mitigation measures to be understood. Table 9 also describes the mitigation measures that will be applied to the project and a level of certainty in relation to how effective the mitigation measures will be in reducing the risk rating.

Table 9: Darwin Processing Facility Environmental Risk Register

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
Environmental Factor: Terrestrial Environmental Quality										
Metal contamination from historical quarrying and fly-tipping	Dermal contact between site users and areas of gross contamination Lateral migration of surface water/runoff Vertical infiltration of contaminants of concern (**COC's**) from the surface to groundwater Lateral migration of COC's via groundwater	Adverse health impacts to site personnel Pollution of Elizabeth River and Upper Darwin Harbour Estuary, with adverse impacts to flora and fauna Adverse health impacts to recreational users and consumers of fish from Elizabeth River and Upper Darwin Harbour Estuary	3	3	Medium	Removal of fly-tipped waste from the site ensuring that the transport, handling and disposal of hazardous materials are in accordance with the *Dangerous Goods Act 1998* and associated regulations and licence conditions All stormwater areas shall be diverted to a retention ponds for monitoring and treatment (if required). Retained water will be monitored for quality. Implementation of the Contaminated Sites Procedure (EP-13) within the EMP (Appendix M).	1	3	Low	High
Petroleum hydrocarbon contamination from historical quarrying and fly-tipping	Inhalation of derived vapours Dermal contact between site users and areas of gross contamination Lateral migration of surface water/runoff Vertical infiltration of COC's from the surface to groundwater Lateral migration of COC's via groundwater	Adverse health impacts to site personnel Pollution of Elizabeth River and Upper Darwin Harbour Estuary, with adverse impacts to flora and fauna Adverse health impacts to recreational users and consumers of fish from Elizabeth River and Upper Darwin Harbour Estuary	3	3	Medium	Removal of fly-tipped waste from the site ensuring that the transport, handling and disposal of hazardous materials are in accordance with the *Dangerous Goods Act 1998* and associated regulations and licence conditions All stormwater areas shall be diverted to retention ponds for monitoring and treatment (if required). Retained water will be monitored for quality. Implementation of the Contaminated Sites Procedure (EP-13) within the EMP (Appendix M).	1	3	Low	High
Asbestos contamination from historical quarrying and fly-tipping	Presence of friable asbestos, fibrous asbestos, or asbestos fines that may become airborne	Inhalation of asbestos fibres by site users (including workers engaged in site clearance and construction works).	2	3	Medium	Inspection of disturbed areas and fly-tipped waste for the presence of asbestos; removal, transport and disposal of asbestos using licensed specialists. Implementation of the Contaminated Sites Procedure (EP-13) within the EMP (Appendix M).	1	3	Low	High
Site excavation during Project construction phase	Liberation of Acid Sulfate Soils (ASS), or Potentially Acid Sulfate Soils (PASS)	Adverse changes to the quality of soil and water Degradation of wetlands, water-dependent ecosystems and ecosystem services Loss of habitat ecosystem complexity and biodiversity Invasion and dominance of wetlands and waterways by acid-tolerant water plants and plankton species Reduction of soil stability and fertility	4	4	Very High	Implementation of the Acid Sulfate Soils Management Plan (Appendix L). In addition, the following measures will be taken: • Undertake a geotechnical assessment prior to construction to identify areas of occurrence of ASS. • Disturbance of ASS will be avoided where possible • Excavated ASS to be treated during construction in accordance with requirements of the ASS Management Plan to prevent acidic fluids leaching into surface water or groundwater. • Bunds will not be constructed with material containing ASS.	2	4	Medium	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
		Deterioration in water quality sources for stock, irrigation and human use by increasing acidity and heavy metal concentrations Acidification of surface water bodies increasing mosquito breeding, which may increase the prevalence of mosquito-borne diseases such as Ross River virus Loss of visual amenity due to rust coloured stains from iron precipitates at the soil surface Long term infrastructure damage through acidic water corroding metallic and concrete structures Leaching of toxic metals due to acidification of soil due to acid drainage				• Preparation of compliant ASS treatment pads. The area will be fully contained/constructed such that drainage/runoff water from the pad is directed to an appropriate receptacle for testing and treatment (if required). • Any spilled ASS material is to be transferred to the treatment pad immediately. • Awareness training of ASS handling requirements will be provided to personnel involved with the movement of soils, particularly during the construction phase • ASS treatment pads will have a guard layer of agricultural lime applied at a nominal rate of 10kg/m^2. • ASS material will be transferred to the treatment pad and placed on top of the guard layer. If ASS is to be treated in more than one layer, enough time will be allowed for validation testing and compliance of a layer before addition of extra material. • ASS material is to be spread out in windrows of 300 mm loose thickness for drying. Once dry, fine agricultural lime will be applied evenly over the surface and thoroughly mixed into the soil. • Treated ASS shall not be removed from the site until validation monitoring indicates that performance indicators have been met. • All stormwater or ASS leachate from stockpiles or other exposed areas shall be diverted to retention ponds and monitored for changes in pH, water level, Electrical Conductivity, total iron and aluminium concentrations; and • Treated with hydrated lime for pH adjustment of water if required. Soil erosion resulting in disturbance of ASS will be mitigated by the following: • Implementation of the Erosion and Sediment Control Plans (CCESCP and SBSMP) (Contained within Appendix C); and Water Management Procedure (EP-09) in the EMP (Appendix M); • Vegetation clearing will be undertaken in stages and in dry season conditions wherever possible; and • Erosion protection measures (bunding, spoon drains, silt fencing and sediment ponds) will be installed to contain any erosion.				
Hazardous substances used in operations phase	Spills/leaks of petrol, oils, lubricants, hazardous	Adverse health impacts to site personnel	3	4	High	Implement the Hazardous Material Management Procedure (EP-10) including the following:	2	4	Medium	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
	materials, paints, thinners, and litter.	Potential source of COI's that may contaminate downstream receptors				• Ensure stockpiles of bulk materials are located well clear of any waterway or drainage systems. • Construct bunds around fuel and chemical storage areas according to Australian Standards 1940: *2017 – The Storage and Handling of Flammable and Combustible Liquids* (unless quantity of the liquid stored is within that allowable as minor storage), environmental protection licence or Major Hazard Facility licence requirements. • Train personnel in implementation of safe work practices to minimise risks and impacts of spillage of fuels, chemicals and other contaminants. • Train personnel in incident reporting and emergency management procedures and encourage the reporting of issues and near misses. • Record and report all Petroleum, Oil and Lubricant (**POL**), chemical and hazardous substance spills • In the event of a chemical or hazardous substance spill, containment measures should be enacted and Safety Data Sheet (**SDS**) requirements complied with. • SDSs are to be located within storage areas, as well as centrally located and readily available to staff for use in case of an emergency. SDSs are to remain current at all times. • Ensure personnel have access to spill kits that contain an absorbent material, clearly marked oily waste disposal drum and a shovel. • In the event of a POL spill less than 20L on soil, remove the soil and dispose of in oily waste disposal drum. • In the event of a POL spill of between 20 and 80L, soak up as much as possible using absorbent, and turn/aerate the soil to allow natural processes (i.e. aeration and microbial systems) to breakdown the organic compounds (i.e. hydrocarbons). Remove contaminated soil if the spill occurs in the vicinity of drainage lines and waterways. If on a hard surface such as road or concrete, use absorbent and dispose in the oily waste disposal drum. • In the event of a POL spill greater than 80L, all contaminated soil is to be removed, and disposed of in a clearly marked oily waste disposal drum.				

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						• Undertake validation sampling of soil if the spill, or combined record of spills, is greater than 80L to confirm all contaminated soil has been removed • All contaminated soil and absorbent in the oily waste disposal drum should be disposed of by a licenced waste contractor. • If pooled water becomes contaminated, e.g. through a diesel spill, ensure it is contained and removed (and not discharged to sewerage system or natural water courses) • Any spillage of wastes, contaminants or other materials shall be cleaned up as quickly as practicable using procedures that prevent contaminants or material being transferred to the stormwater drainage system; • Keep sites free from build-up of waste materials by directing regular clean ups; • Avoid storing large volumes of materials on site; • Ensure equipment and vehicles have been washed down and inspected for POL leaks, prior to being transported to work sites; • Ensure herbicides used for weed control are registered and only applied by appropriately trained personnel.				
Environmental Factor: Terrestrial Ecosystems										
Construction of processing facility	Vegetation clearing leading to habitat loss	• Mortality or displacement of individuals • Decline in population size • Local extinction • Reduction in the carrying capacity of the environment, or a reduction in the species or individuals that the environment can support • Reduction in diversity	5	2	Medium	Ensure habitat to be cleared is well represented elsewhere on the Middle Arm Peninsula, and in the region. Implement the Ground Disturbance and Vegetation Clearing Procedure (EP-05) contained within the EMP (Appendix D), including: • Development and implementation of an internal Ground Disturbance Permit system whereby no land clearing is undertaken without completing a series of checks to ensure: o The proposed clearing has been approved; o Conditions in relation to soil and subsoil recovery, weed management, fauna clearing and other requirements have been assigned; and o Approved permits are assessed for compliance with permit conditions. o Proposed area of clearing is demarcated prior to clearing to avoid excessive or prohibited clearing.	2	2	Low	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						• Recover topsoil and biomass utilise the seed bank and woodchips and logs to conduct rehabilitation of disturbed areas as they become available.				
Construction of processing facility	Project design resulting in disturbance of conservation significant flora and vegetation	Loss of important vegetation types (mangroves, riparian vegetation and large habitat trees) Loss of conservation significant flora species	3	2	Medium	Prior to commencement of construction review the development envelope of the Project to ensure populations of the following flora species are excluded where possible: • *Cycas armstrongii* (VU); • *Tricoryne elatior* (NT); • *Polymeria pusila* (DD); and • *Buchnera* sp. ciliate bracts (DD). Ensure vegetation clearing occurs only in approved areas in accordance with a Ground Disturbance and Vegetation Clearing Procedure (EP-05) contained within the EMP (Appendix M) Habitat to be cleared is well represented elsewhere on the Middle Arm Peninsula, and in the region. Allocation of the Project to avoid sensitive and significant vegetation where possible.	2	2	Low	High
Site earthworks and addition of infrastructure	Alteration and sedimentation of surface water flows and water quality from erosion.	Loss of habitat quality from sedimentation of terrestrial habitats	2	2	Low	Implementation of the CCESCP and SBSMP (contained within Appendix C) and Implementation of the Water Management Procedure (EP-07) contained within the EMP (Appendix M) including: • Use of sediment basins where required; and • Use of a dedicated stormwater management system during operations. • Maintain natural flow paths wherever possible.	2	2	Low	High
Construction and operations activities (especially vehicle movement, and workshop activities).	Uncontrolled fire	Loss of fire sensitive species or vegetation. Reduction in habitat quality due to inappropriate fire frequency, or death of individuals.	3	3	Medium	Implementation of the Fire Management Plan (Appendix N) including: • Mine personnel will be trained in fire protection; • The site will be equipped with fire suppression equipment; • A hot work permit system will be implemented; and • Grassy weeds will be eradicated.	1	3	Low	High
Vehicle movement and earthworks during construction and operations	Increase in weed infestations or invasion by new weed species.	Reduced vegetation quality by competitively excluding native species. Weed infestations providing high fuel loads for fire	3	2	Medium	Implementation of the Weed Management Procedure (EP-06) contained in the EMP (Appendix M) including: • Review existing weed mapping and signpost areas of significant weed infestation; • Induct mine personnel on the identification and management of key weed species; • Implement weed hygiene procedures; • Avoid the spread of weedy grasses by having an objective of eradication;	2	2	Low	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						• Assess risk of spreading weeds with the Ground Disturbance Permit System in the Ground Disturbance and Vegetation Clearing Procedure (EP-05) within the EMP (Appendix M); and • Routinely undertake site infestation control measures and monitoring of infestations.				
Construction and operations activities	Ineffective or inappropriate rehabilitation	Lost opportunity to restore ecological function	3	3	Medium	A monitoring program, as detailed in the Rehabilitation Management Plan will be implemented to identify issues and management actions triggered by quantitative thresholds.	1	3	Low	High
Construction and operations activities	Dust generated from vehicle movements, cleared surfaces, loading/unloading and material stockpiles.	Reduced photosynthetic potential of vegetation covered in dust.	3	2	Medium	Implementation of the Dust Emission Management Procedure (EP-08) contained within the EMP (Appendix M) including: • Regular watering of active potentially dust generating areas and stockpiles areas; • Efficient and effective machinery operation; • Limit vegetation and soil clearing • Biannual photographic monitoring of vegetation health at site • Maintain the concentrate at Dust Extinction Moisture level; • Use of water sprays or misting nozzles during stacking operations; • Sprays on reclaim feeders; • Physical enclosure of transfer points and operating equipment; • Select operational procedures to take place inside sheds; • Open areas not required for vehicle access for operations will be sprayed with hydro mulch or sealed through the application of dust suppressant chemicals; and • Active road surfaces sealed, treated with a dust suppressant chemical or sprayed with water.	2	2	Low	High
Construction and operations activities	Saline or contaminated water used for dust control or water that has leaked from pipelines or water storage facilities contaminating soil and impacting vegetation.	Loss of vegetation due to salinity or contamination of soil	3	2	Medium	Water storage facilities and /or hazardous materials will be restricted to designated impermeable storage areas located at least 50m from any vegetation. Storage areas will be bunded and have appropriate drainage systems designed to capture any potential spills or leaks. Water used for dust suppression will be of a quality that does not negatively impact flora and vegetation.	2	2	Low	High
Construction and operations activities	Habitat fragmentation	Decline in population size Reduction in the carrying capacity of the environment, or a reduction in the species or	4	2	Medium	Site layout design to be compact and reduce areas of habitat fragmentation where possible. Rehabilitation of disturbed areas identified in the Rehabilitation Management Plan (Appendix B).	2	2	Low	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
		individuals that the environment can support Reduced reproductive success Reduction in diversity								
Construction and processing activities, and associated human use and waste production	Increase in abundance of introduced species	Mortality of individuals Decline in population size	3	3	Medium	Implementation of the Domestic and Industrial Waste Management Procedure (EP-11) within the EMP (Appendix M) to ensure all putrescible waste is securely stored until removed from site. Monitor sightings of feral fauna and undertake control measures in consultation with stakeholders.	1	3	Low	High
Construction and operations activities	Impact to fauna through the use of lighting, noise, vibration, or human movement	Displacement of individuals Disruption to breeding Reduced fitness	3	2	Medium	All light sources will be aimed towards work areas and away from surrounding habitat, using light shields as necessary to minimise light spill. Implement the Noise Management Procedure (EP-17) within the EMP (Appendix M). Allocate a vegetation buffer between the Project and significant fauna habitat features	2	2	Low	Medium
Earthworks and infrastructure construction and operation.	Fauna entrapment in infrastructure	Death or injury of fauna Decline in population size	4	2	Medium	• Ponds contain water not toxic to fauna • Fence ponds; • Install fauna egress points in water storage dams and/or sumps; • Ensure vegetation around barbed wire fences is kept to a minimum; • Avoid the use of barbed wire in fences where possible; and • Barbed wire fences will be inspected for trapped animals (particularly bats), and mitigation measures explored.	2	2	Low	High
Construction activities	Vehicle strike during vegetation clearing	Death or injury of fauna	4	2	Medium	Implement the Ground Disturbance and Vegetation Clearing Procedure (EP-05) contained within the EMP (Appendix D), including development and implementation of an internal Ground Disturbance Permit system whereby no land clearing is undertaken without completing a series of checks to ensure conditions in relation to: • fauna clearing and • the presence of a fauna spotter/catcher have been assigned as detailed in the BMP.	2	2	Low	High
Operations activities	Vehicle strike	Death or injury of fauna	2	2	Low	Maintain suitable speed limits. Erect warning signs in any locations where fauna are regularly sighted. Ensure employee and local contractor awareness of local fauna and encourage reporting of sightings and any incidents of vehicle strike or near misses.	1	2	Low	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
Environmental Factor: Hydrological Processes										
Site earthworks and addition of infrastructure	Alteration of surface hydrology – stormwater management	Scour from runoff velocity Changed quantity of surface and groundwater	3	3	Medium	Retain as much of Lot 1817 in a condition that will assist recharge of aquifer. This includes retaining (and/or enhancing through site rehabilitation activities) existing vegetation and soils.	1	3	Low	High
Vegetation clearing, soil compaction, and development of sealed or impervious surfaces	Reduced aquifer recharge from impermeable surfaces	Reduced recharge of groundwater Reduced discharge to tributaries and the Elizabeth River	3	2	Medium	Retain as much of Lot 1817 in a condition that will assist recharge of aquifer, including retaining existing vegetation and soils outside of the Development Envelope.	2	2	Low	High
Environmental Factor: Inland Water Environmental Quality										
Site construction works, including clearing of vegetation and earthworks for site preparation	Stormwater transporting sediment during the Construction phase	Increased sediment loads in surface water	4	3	High	To avoid stormwater transporting sediment during the Construction phase: • The Conceptual Construction Erosion and Sediment Control Plan (CCESCP; Appendix C) will be upgraded to include a more detailed design including: o Further soil sampling, including Emerson Class sampling and jar testing to inform final sediment basin design; Appropriate sediment control mechanisms will be installed, as determined through the updated CCESCP and the detailed design phase.	1	3	Low	
Tertiary storm surge (1 in 10,000 AEP) event	Inundation during storm surges	Contamination of surface water by hazardous chemicals with known risk to aquatic ecosystems due to breaching of primary and secondary containment during a 1 in 10,000 AEP storm surge event	2	5	High	Locate primary infrastructure in areas above the 1 % AEP flood levels. Model 0.1% AEP inundation and flood levels and locate processing plant infrastructure above these levels. Implementation of diversion infrastructure around site infrastructure, where identified through stormwater assessments.	1	5	High	Medium
Potential Contaminants of Interest (**COIs**) not contained properly in stockpiles	Surface runoff transporting potential COIs into surface waters	Alteration of the chemical characteristics and quality of the surface water	3	2	Medium	Infrastructure associated with sources of COIs will be located above the 1000-year storm surge elevation All runoff waters within areas where sources of COIs are stored, transported or used will be diverted into a managed water circuit separate from the general stormwater circuit, which incorporates appropriate bunding, sumps and isolation points where required. Water from these areas will be directed to the WRP for treatment. All runoff waters within the Development Envelope (outside of areas where COIs are stored, transported or used) will be diverted into a managed water circuit for monitoring and treatment (if required) in the stormwater system or WRP Rainfall will be intercepted on roofed spaces and diverted to a rainwater pond	2	2	Low	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						The chemical bulk storage tanks will be located in suitably bunded areas adjacent to the dedicated chemical transfer bay, with consideration for *Australian Standard AS1940:2017* Update of the Conceptual SBSWMP (Appendix C) to a detailed design including: • Detailed water quality modelling • final design of the minor and major stormwater systems, minor diversion systems and stormwater quality management features (e.g. SQUIDs, bioretention basins etc) • Detailed engineering hydraulic design / modelling • Determine the optimised stormwater harvesting design • Operational management, monitoring and maintenance plans developed with clear responsibilities assigned to relevant site personnel; and • The stormwater management system will be designed to effectively treats sediment, gross pollutants, nutrients and incidental hydrocarbons within stormwater runoff from non-process areas of the site.				
Potential COI's	Seepage transporting potential COIs into groundwater	Alteration of the chemical characteristics and quality of the groundwater	3	2	Medium	Low permeability bases will be used in areas where COIs are stored, i.e., concrete floors or hardstanding Ponds will be lined with impermeable liners to prevent seepage Ponds will be placed above the wet season water table Water used for dust suppression will be of suitable quality Waste will be containerised immediately and not stockpiled Implementation of ASS Management Plan in Construction Phase	2	2	Low	High
Leaks and spills of chemicals/reagents/concentrates/fuel during construction and processing activities	Contamination of surface and groundwater from spills and leaks	Altered chemical properties of surface water and groundwater	3	4	High	Implement the Hazardous Material Management Procedure (EP-10), as summarised previously in Environmental Factor: Terrestrial Environmental Quality	2	4	Medium	Medium
Environmental Factor: Marine Environmental Quality										
Construction and processing activities, and associated human use and waste production	Non-process waste (litter) entering waterways	Reduction in visual amenity Reduced water quality	3	2	Medium	Implement the Domestic and Industrial Waste Management Procedure (EP-11), in the EMP (Appendix M): • Recyclable materials, including cardboard, paper, glass, batteries, waste hydrocarbon	2	2	Low	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						drums and scrap metal, will be recycled wherever possible; • Housekeeping inspections of all work areas will be undertaken weekly; • Littering on site is prohibited and work and office sites are to be kept clean and tidy; • Rubbish containers are to be carried in vehicles and provided at all work area; • Waste management will be addressed in the site induction.				
Leaks and spills of chemicals/reagents/concentrates/fuel during construction and processing activities	Terrestrial based chemical spills entering marine environment through soil and groundwater pathways	Degradation of marine water quality within the Darwin Harbour system (and resulting impacts to marine fauna) Contamination of marine sediments within the Darwin Harbour system (and resulting impacts to marine fauna)	3	4	High	Implement the Hazardous Material Management Procedure (EP-10), as summarised previously in Environmental Factor: Terrestrial Environmental Quality	1	4	Medium	High
Tertiary storm surge (1 in 10,000 AEP) event	Inundation during storm surges	Contamination of surface water by hazardous chemicals with known risk to aquatic ecosystems due to breaching of primary and secondary containment during a 1 in 10,000 AEP storm surge event	2	5	High	Locate primary infrastructure in areas above the 1 % AEP flood levels. Model 0.1% AEP inundation and flood levels and locate processing plant infrastructure above these levels. • Implementation of diversion infrastructure around site infrastructure, where identified through stormwater assessments.	1	5	High	Medium
Clearing of vegetation exposing underlying soil surface	Sedimentation of marine environment via windblown or stormwater transportation	Degradation of marine water quality within the Darwin Harbour system. Contamination of marine sediments within the Darwin Harbour system	3	2	Medium	• No clearing of mangrove habitats; • Implement management procedures detailed in EMP (refer to Ground Disturbance and Vegetation Clearing Procedure (EP-05) contained within the EMP (Appendix M); • Implementation of appropriate site drainage to avoid or mitigate sedimentation impacts during the construction phase of the Project; • The GDP application will include risk based assessment of all environmental risks and identify controls to reduce the impacts of ground disturbance; • An estimate of the area to be disturbed and topsoil volumes to be moved and stored should be included in the GDP request submission where possible; • Lay down, parking and other storage areas will be located in approved GDP areas only. Where possible, existing cleared areas will be used for laydown areas. Vegetation clearing for these areas will be avoided where possible; and • Topsoil and subsoil will be stripped prior to earthworks and managed in accordance with	2	2	Low	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						the Rehabilitation Management Plan (Appendix B).				
Disturbance of AASS during construction	Contamination of marine environment resulting from disturbance of AASS	Acidification of soil, groundwater and stormwater, resulting in contamination of the marine environment	4	4	Very High	Implementation of the Acid Sulfate Soils Management Plan (Appendix L). Additional ASS management measures are outlined in the Environmental Factor: Terrestrial Environmental Quality	1	4	Medium	High
Environmental Factor: Marine Ecosystems										
Construction and processing activities, and associated human use and waste production	Non-process waste (litter) entering waterways	Entanglement and strangulation of dolphins, dugongs, turtle, crocodiles, and sawfish, causing injury or death Ingestion of waste by fauna, causing injury or death Smother or inhibit photosynthesis of sensitive benthic habitat and communities	3	2	Medium	Implement the Domestic and Industrial Waste Management Procedure (EP-11), in the EMP (Appendix M), as summarised in Environmental Factor: Marine Environmental Quality.	1	2	Low	Medium
Tertiary storm surge (1 in 10,000 AEP) event	Inundation during storm surges	Death of marine fauna from exposure to hazardous chemicals with known risk to aquatic ecosystems due to breaching of primary and secondary containment during a 1 in 10,000 AEP storm surge event	2	5	High	Locate primary infrastructure in areas above the 1 % AEP flood levels. Model 0.1% AEP inundation and flood levels and locate processing plant infrastructure above these levels. • Implementation of diversion infrastructure around site infrastructure, where identified through stormwater assessments.	1	5	High	Medium
Clearing of vegetation exposing underlying soil surface	Sedimentation of marine environment (increased turbidity) via windblown or stormwater transportation	Smothering of benthic habitat used by fauna for foraging	3	2	Medium	• No clearing of mangrove habitats; • Implement management procedures detailed in EMP (refer to Ground Disturbance and Vegetation Clearing Procedure (EP-05) contained within the EMP (Appendix M); • Implementation of appropriate site drainage to avoid or mitigate sedimentation impacts during the construction phase of the Project; • The GDP application will include risk based assessment of all environmental risks and identify controls to reduce the impacts of ground disturbance; • An estimate of the area to be disturbed and topsoil volumes to be moved and stored should be included in the GDP request submission where possible; • Lay down, parking and other storage areas will be located in approved GDP areas only. Where possible, existing cleared areas will be used for laydown areas. Vegetation clearing for these areas will be avoided where possible; and	2	2	Low	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						• Topsoil and subsoil will be stripped prior to earthworks and managed in accordance with the Rehabilitation Management Plan (Appendix B).				
Leaks and spills of chemicals/reagents/concentrates/fuel during construction and processing activities	Contamination from chemical leaks or spills	Pollution of habitat and communities with contaminants known to impact aquatic ecosystems Ingestion and coating of skin by hydrocarbons causing injury or death of airbreathing animals (i.e. cetaceans, sea snakes) Pollution causing immunosuppression, hepatoxicity, carcinogenesis, reproductive and development toxicity, dermal toxicity and neurotoxicity of marine fauna	2	3	Medium	Implement the Hazardous Material Management Procedure (EP-10), as summarised previously in Environmental Factor: Terrestrial Environmental Quality	1	3	Low	High
Altered stormwater and runoff regimes, causing uncontrolled stormwater flows.	Stormwater runoff entering marine environment	Decline in habitat and ecosystem health and/or potential fatalities of species Erosion of coastal and intertidal environment directly removing benthic habitat and communities or causing an overall decline in health	3	3	Medium	Implementation of the CCESCP and SBSMP (contained within Appendix C) and Implementation of the Water Management Procedure (EP-07) contained within the EMP (Appendix M) including: • Explore the potential for Stormwater harvest • Use of sediment basins where required; and • Use of a dedicated stormwater management system during operations. Maintain natural flow paths wherever possible.	1	3	Low	High
Environmental Factor: Air Quality										
Construction activities, operational activities, vehicle movement	Fugitive dust and particulate emissions	Dust deposition on vegetation reducing photosynthetic potential Dust deposition in the marine environment Adverse impacts to human health through dust inhalation	3	2	Medium	Implement the Dust Emission Management Procedures (EP-08) within the EMP (Appendix M), including: • Regular watering of active areas and stockpiles areas; • Use of dust control equipment and housekeeping practices within the Processing Facility; • Vehicle speeds on site roads will be restricted. Active road surfaces will be either sealed, treated with a dust suppressant chemical or sprayed with water, as required to reduce dust generation; • All equipment utilised on site will be maintained in an efficient and effective manner; • Limit vegetation and soil clearing to reflect operational requirements; • For cleared vegetation, minimise burning activities by re-using vegetation during the	1	2	Low	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						rehabilitation phase or chipping it for use on site or to export chips off site. • Retention of sufficient moisture in the concentrate stream to maintain the concentrate at its Dust Extinction Moisture Level; • Use of water sprays or misting nozzles during stacking operations; • Water cannons/sprays on stockpiles; • Sprays on reclaim feeders and transfer points; • Physical enclosure of transfer points and operating equipment;				
Processing operations	Stack gaseous emissions	Adverse impacts to nearby receptors through inhalation of nitrogen dioxide, sulphur dioxide, chlorine, hydrogen chloride or ammonia	2	3	Medium	In order to reduce stack emissions TNG will use scrubbers and/or filters for the control of atmospheric emissions from the Project stack sources, in accordance with the Air Quality Management Plan (Appendix B of Appendix G) Comply with requirements of the Environmental Protection Licence, where applicable.	1	3	Low	Medium
Environmental Factor: Atmospheric Processes										
Processing operations	Carbon emissions from direct and indirect Project sources	Contribution of carbon emissions (i.e. greenhouse gases), contributing to global climate change	4	3	High	Implement the Greenhouse Gas Emissions Procedures (EP-09) within the EMP (Appendix M). TNG will commit to developing a detailed Greenhouse Gas Management Plan (**GGMP**) prior to the commencement of operations that will: • Outline strategies to avoid, reduce, mitigate and offset the Projects direct (Scope 1) emissions contributing towards the State's aspiration of net zero GHG emissions by 2050; • Review the final facility design in relation to GHG intensity/efficiency; • Commit to 5-yearly reviews of energy efficiency and renewable use over the life of the project with a view of reducing Scope 1 emission by an average of 1% a year over 20 years; • Prepare an offset package; • Utilise strategies that are unique to the Project's specific circumstances; • Take into account opportunities for emissions reduction; • Propose timeframes as well as regular interim and long-term targets that reflect an incremental reduction in Scope 1 emissions over the life of the proposal; • Include requirements for periodic public reporting against targets; and	2	3	Medium	Medium

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						Account for and align with Commonwealth targets.				
Environmental Factor: Community and Economy										
Increased local workforce during construction and operations	Increased demand for local housing	Reduction in housing availability and affordability for low-income and vulnerable groups	3	3	Medium	Promote the employment of local personnel already residing and housed in Darwin: • wherever possible and where necessary skills are available. • Develop an Employment Strategy and Local Recruitment Policy. • Investigate cooperation with local skill training schemes. • Consider partnerships with local businesses, such as food catering companies, transport companies and a range of other service providers.	1	3	Low	Medium
Historic and current use of the site for recreational vehicle use	Unexpected public access to the site during construction works	Vehicle collisions Vehicle-pedestrian/pet collisions Injury to public resulting from illegal use of site	2	3	Medium	In the interest of maintaining public safety: • Install a boundary fence, entry gate, gate house and signage to deter unauthorised access to the site • Develop a Supply Chain Management Plan covering a wide range of transportation and supply chain matters, including public safety along transport routes and managing third party personnel conduct at work. • Ensure emergency exit points are situated at strategic locations around the site, for use in an emergency.	1	3	Low	Medium
Construction and operations activities	Noise and vibration generation from construction activities Noise generated from operation of processing equipment Noise from rail operations	Reduced amenity for nearby residents	2	2	Low	To avoid noise impacts at sensitive receivers during non-standard hours (7pm to 7am) by: • Prohibiting noise generating construction activities in non-standard hours and recommending construction activities occur during standard hours (7am – 7pm) where possible. • If out of hours construction is required, avoid operating particularly noisy machinery before 7am and after 7pm. To minimise, or avoid where possible, noise impacts by: • Implementing mitigation strategies detailed in the Noise Management EP-17 from the EMP (Appendix M). • Provide an induction to construction personnel (including sub-contractors) addressing responsibilities with regard to noise management outlined in the EMP (Appendix M). • Ensure truck drivers are informed of designated vehicle routes, parking locations, delivery hours and minimising engine braking and idling.	1	2	Low	Medium

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						• Provide education of supervisors, operators and sub-contractors on the need to minimise noise through toolbox meetings. • Avoid noisy plant working simultaneously where possible. • Ensure all equipment is equipped with appropriate noise controls (e.g. mufflers, silenced exhausts, acoustic enclosures, flashing lights as an alternative to revising beepers) and equipment is shut down and not left idling when not in use. • Ensure equipment is operated in the correct manner and adequately maintained - including replacement of engine covers, tightening of rattling components, repair of leakages in air lines and shutting down equipment not in use. • Consider the use of temporary solid screens for mitigation of noisy stationary equipment. • Establish a Complaints and Grievance Protocol to address noise complaints				
Construction and operations activities	Construction traffic, operational traffic	Traffic delays due to congestion along Channel Island Road Increased road safety risk due to increased use of Channel Island Road	2	3	Medium	To minimise, or avoid where possible, impacts to traffic by: • Developing a Traffic and Transport Management Plan (Draft version included as Appendix Y of Draft EIS. This document will be finalised as part of final design stage of the Project). • Provide a bus service to and from the site for staff, reducing traffic volumes on roads in the vicinity of the Project. • Investigate options of utilising existing infrastructure for 'Park and Ride' locations. • Develop safe and efficient parking on the site.	1	3	Low	Medium
Operations activities	Rail movement	Delays at level crossings at Channel Island Road and Jenkins Road	3	3	Medium	To minimise, or avoid where possible, impacts to traffic by: • Maximise the length of the proposed rail siding line to minimise the potential for delay at the level crossings. • Liaise with rail providers to review timing of rail movements to minimise impact on road traffic as much as practicable.	2	3	Medium	Medium
Site infrastructure	Construction of multi-storey buildings and stacks	Reduced visual amenity from public recreation areas, such as Elizabeth River	3	3	Medium	Minimise visual impacts of Project from Palmerston and Elizabeth River Boat Ramp by: • Ensuring core Processing Facility infrastructure is constructed on the southern peninsula of the site.	1	3	Low	Medium

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						Install the sulphate stack is located in area aimed at minimising visual impacts as much as practicable. Maintain or establish the following vegetation: • Screening vegetation along Channel Island Road wherever possible. • Mangrove belt around site boundary • Landscaping around site to improve amenity.				
Site infrastructure	Outdoor lighting of plant infrastructure	Nuisance and distracting lighting of nearby properties and roads	3	2	Medium	Design lighting in accordance with *Australian Standard 4282:1997 'Control of the obtrusive effects of Outdoor Lighting'* Install directional lighting wherever possible to reduce 'light spill' effects. Establish a Complaints and Grievance Protocol to capture any issues related to light impacts from the Project.	2	2	Low	Medium
Stakeholder consultation	Ineffective methods employed for liaison with stakeholders	Stakeholders are ill informed or not consulted about issues arising from the Project leading to dissatisfaction with the Project or Company	4	3	High	Implement the Community and Stakeholder Engagement Strategy (Appendix O of the EIS Supplement)) to guide the long-term consultation outcomes for the Project. Implement a complaints and grievance procedure for community members, incorporating an investigation and corrective action process, as appropriate. Establish a process of stakeholder engagement and participatory planning with the Larrakia people in order to: • Engage with relevant Indigenous stakeholders to ensure traditional activities in nearby areas are understood and not impacted. Implement mitigating strategies for environmental factors applicable to the Project to ensure no downstream impacts occur to heritage items and values as a result of Project activities.	1	3	Low	XX
Construction and operations activities	Site earthworks	Disturbance of culturally significant sites, including burial sites	2	3	Medium	To protect cultural heritage values by: • Including management of Cultural Heritage values in the EMP (refer to Aboriginal and Cultural Heritage Procedure (EP-04) in the EMP (Appendix M). • Develop a Code of Conduct for workers and inductions that cover awareness and protection of heritage values. • In the event that any skeletal remains are unearthed TNG will stop work and immediately report such disturbance to the	1	3	Low	Medium

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						Northern Territory police, and to the Director Heritage Branch, Department of Tourism and Culture (refer to the ERP – Draft EIS Appendix AA). • Any previously unrecorded archaeological sites encountered will be reported to the Northern Territory Heritage Branch for advice on how to respond. Procedures for unexpected heritage finds will be included in the EMP (refer to Aboriginal and Cultural Heritage Procedure (EP-04) in the EMP (Appendix M). Liaise with indigenous stakeholders as described above Maintain communication with indigenous stakeholders to ensure awareness of current local matters of cultural significance Maintain awareness of sacred sites and matters of cultural significance downstream of site Ensure soil material originating from the site remains within the site and is not disposed off-site unless it is not suitable for rehabilitation purposes Manage the Project so offsite impacts are mitigated Comply with the conditions and requests of the Authority Certificate obtained from AAPA.				
Fairness and equity	Use of resources such as water and power for Project operations	Increased pressure on Darwin's resources	3	3	Medium	Implement efficiency measures into the final design phase to reduce use of community resources as much as practicable.	1	3	Low	Medium
Environmental Factor: Human Health										
Unloading, loading and movement of trains and vehicles	Release of hazardous materials due to vehicle or rail accident	Injury or harm to employees, contractors, or general public	2	4	Medium	To avoid the release of hazardous materials through road or rail accident: • Ensure all vehicles are licensed and carry appropriate equipment to respond to a spill, including PPE. • Apply *Australia Dangerous Goods Code (ADG Code) for Transport by Road and Rail* requirements to all transport activities. • Establish designated transport routes to avoid local residential areas. • Conduct and document a safety assessment in relation to the operation of the facility, which involves a comprehensive and systematic investigation and analysis of all aspects of risks to health and safety that could occur in the operation of the Major Hazard Facility.	1	4	Medium	Medium

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						• Implement control measures that eliminate or minimise the risk of a major incident occurring at the Project. • Establish a Safety Management System (**SMS**) for the operation of the Project. • Prepare a Safety Case for the Facility that demonstrates that the Project SMS will control risks arising from major incidents and hazards that could cause a significant impact. The Safety Case must demonstrate the adequacy of the measures to be implemented by the operator to control risks associated with the occurrence of major incidents. • Australian Dangerous Goods Code requirements for storage compatibility will be adhered to.				
Construction and operations activities	Release of hazardous materials within the Project area.	Injury or harm to employees, contractors, or general public, particularly inhalation or irritation of skin	2	3	Medium	Implement the Hazardous Material Management Procedure (EP-10; as summarised previously in Environmental Factor: Terrestrial Environmental Quality), including providing staff with sufficient training to competently and safely handle hazardous materials, respond to spill incidents and a sound understanding of PPE requirements and equipment handling and reporting.	1	3	Low	Medium
Operations activities	Explosion on site.	Injury or harm to employees, contractors, or general public	2	4	Medium	To avoid an explosion on site: • Design and construction of the Facility in accordance with Australian and International Standards, Building Codes and Licence requirements. • Control of emission of flammable vapours, gases and mists (e.g. through the use of enclosed container and transfer systems, vapour recovery connections, sufficient ventilation). • Elimination of ignition sources from hazardous areas. • Installation of leak detection systems. • Storing the minimum required quantities of flammable / explosive materials. • Control of 'hot work' through an established permitting system. • Good housekeeping practices on site. • Implement the ERP, as required.	1	4	Medium	Medium
Construction and operations activities	Significant fire resulting from Project activities.	Injury or harm to employees, contractors, or general public	2	3	Medium	To minimise, or avoid where possible, the potential for a fire:	1	3	Low	Medium

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
						• Implement the ERP (Draft EIS Appendix AA), as required. • Implement the FMP (Appendix N). • Ensure fire response equipment (e.g. fire breaks, extinguishers, fire reels) is available, operational and maintained. Fire extinguishers to be used in accordance with *Australian Standard 1841.1-2007 (Portable Fire Extinguishers – General Requirements*). • Fire hydrants will be connected on a ring main throughout the Facility, designed as per *Australia Standard 2419.1-2005 (Fire Hydrant Installations*). Fire water will be sourced from the fire water surge tank. • A foam injection and deluge system will be required for the solvent extraction mixer settling units where the organic solution is used. The foam deluge system shall be designed as per *Australian Standard 2118.3-2010 (Automatic Fire Sprinkler Systems – Deluge Systems*). • Use of firewalls between high risk units where appropriate. • Personnel trained in the use of fire response equipment. • 'Hot work' permit system in operation. Where there is a perceived high risk (e.g. on Total Fire Ban days), ensure trained personnel are on standby when hot work is carried out on site. Deliberate lighting of fires on site to be prohibited.				
Personnel working outside	Environmental exposure of workers (e.g. climatic conditions)	Sunburn and heat stress of personnel Injury due to building damage during cyclone Injury due to flooding	4	3	Medium	To minimise personnel exposure to climatic elements: • All personnel (including contractors and office workers) will be trained in the risks associated with climate exposure, the signs and symptoms of over-exposure to heat and its effects (e.g. dehydration) and what to do in case of an emergency. First-aid facilities will be equipped to provide at least an initial response to incidents of this type. • Drinking water will be available across the site at clearly signposted locations. • To reduce sun exposure appropriate PPE (e.g. long sleeved shirts, trousers, hats and/or helmets) and sunscreen will be made available and their use made compulsory. Develop and implement a Cyclone Response Plan.	1	3	Low	High

Environmental Aspect	Risk Pathways	Impacts	Likelihood	Consequence	Risk Rating	Risk Treatment/Management/Mitigation Strategy	Likelihood	Consequence	Residual Risk Rating	Level of Certainty
Personnel working outside	Animal attacks and biting insects	Injury due to bites from venomous snakes, crocodiles, and free roaming dogs Nuisance, pain, irritation and infection caused by biting midges and mosquitoes Transmission of viruses by biting midges and mosquitoes	2	3	Medium	To minimise, or avoid where possible, bites from animals or insects by: • Site induction and personnel training to address potential risks associated with biting animals, how to avoid them and what to do in case of a bite or emergency. • Personnel provided PPE to provide protection from biting animals and deter biting insects e.g. boots, gloves, long sleeves, trousers. Implement BIMP (Appendix BB of Draft EIS).	1	3	Low	High

1.6 OUTCOMES

Overall, the risk assessment indicates that the potential impacts associated with the proposal are expected to pose a low to moderate risk to all of the NT EPA's environmental objectives. There are high residual risks associated with the following:

- Contamination of surface water and marine ecosystems by hazardous chemicals with known risk to aquatic ecosystems due to breaching of primary and secondary containment during a 1 in 10,000 AEP storm surge event

This risk is not expected to be unacceptable, but rather the high risk rating indicates that this would be a catastrophic event that can be mitigated to some extent by management and design, however it cannot be fully controlled or the risk eliminated.

The suite of management plans appended to the Draft EIS and Supplement seek to mitigate and manage the risks.

The technical studies and design detail available to inform the risk assessment were considered sufficient to allow for most risks to be assessed with a moderate to high level of certainty. The further work required so that all risks can be assessed with a high degree of certainty, is identified in the Commitments Register.

2 CUMULATIVE IMPACT ASSESSMENT

The TOR (section 4.9) requires an assessment of cumulative impacts associated with the Project.

Cumulative impacts are the combined impacts of past, current and future activities. To consider the cumulative impacts, the residual impacts of the current proposal were assessed in the context of impacts associated with existing developments in the region, as well as reasonably foreseeable future developments.

2.1.1 Assessment Approach

Cumulative environmental impacts have been assessed where the Project has the potential to contribute significantly to a regional environmental impact – i.e. where the Project has a residual impact rated as medium or higher (**section 1.4.6**). Where the Project has the potential to contribute significantly to a regional environmental impact, the potential for cumulative impacts from other current and future land uses was considered based on the publicly available information summarised below.

Where potential cumulative impacts were identified, these are noted in the risk register and the risk rating was re-evaluated. The sections below provide further detail in relation to the past, currently proposed, and reasonably foreseeable future activities that were considered as part of the cumulative impact assessment.

2.1.2 Past and Current Land Uses

The Site is located on undeveloped Vacant Crown Land within the proposed Middle Arm Industrial Precinct. Surrounding land uses include extractive industries, heavy industrial, infrastructure (rail, road, utilities), conservation, port/ wharves, and recreation. Lot 1817 is currently used for extractive industries.

Major developments in the vicinity of the site include:

- INPEX Ichthys Liquid Natural Gas Plant;
- Darwin Liquid Natural Gas Plant;
- Weddel and Channel Island Road Power Stations; and
- Channel Island Road accommodation.

A proposed future development includes the construction of an ethanol plant at Middle Arm by Coogee chemicals.

Much of the surrounding area is used for recreation; the Elizabeth River for fishing and boating and vacant crown land for four wheel driving, motorbike riding and dog walking.

The level of impact associated with past and current land-uses is summarised below:

- Review of satellite imagery indicates that land clearing and soil disturbance/erosion has occurred on a small to moderate scale on Middle Arm peninsula. Impacts are largely confined to the development areas identified above.
- Weed infestation appears to be concentrated in disturbance areas where there is discontinuous land use such as the extractive resources licence locations on Lot 1817.
- Clearing of terrestrial vegetation and potential disturbance of benthic habitat and communities under the Proposal would add to previous clearing in the locality for the INPEX and Darwin LNG Projects.
- Baseline surface water and groundwater quality monitoring undertaken in at the site indicates that the water quality has been minimally impacted by past or current land use. The Darwin Harbour Report

Card 2019 states that 'water quality in Elizabeth River Estuary and East Arm is excellent' (DEPWS, 2019). INPEX and Darwin LNG processing plants currently have licences to discharge waste water into Darwin Harbour.

- INPEX and Darwin LNG both contribute greenhouse gas emissions as a result of the LNG processing activities.
- The Project area does receive frequent bushfires, which has somewhat degraded habitat values. The cause of this impact is likely to be a combination of current land-use (i.e. informal recreation and resources extraction) and lack of active fire management across the areas of Vacant Crown Land.
- There is a moderate level of road traffic associated with the existing land–uses, concentrated during shift changes at the LNG processing facilities.

2.1.3 Summary

Potential cumulative environmental impacts in the Middle Arm and Palmerston/ Weddell regions were considered in the context of the existing land uses and reasonably foreseeable future developments. Based on these observations, the main residual environmental impacts associated with the Proposal that could contribute to cumulative impacts are the following:

- Disturbance of terrestrial habitat;
- Contribution to Northern Territory's greenhouse gas emissions; and
- Contribution to increased road traffic in the vicinity of the Project.

Taking cumulative impacts into consideration did not alter any of the residual risk ratings for the Darwin Processing Facility when mitigation and management measures are applied for traffic, terrestrial habitat and atmospheric processes.

3 REFERENCES

DEPWS (2019) Darwin Harbour Report Card 2019. https://depws.nt.gov.au/water/water-management/darwin-harbour/darwin-harbour-region-report-cards/2019-report-cards [accessed 31/01/2021].

International Standards Organisation (2018). *ISO 31000:2018 Risk Management – Principles and Guidelines* https://www.iso.org/obp/ui/#iso:std:iso:31000:ed-2:v1:en [accessed 30/01/2021].

NT EPA 2016 Terms of Reference for the Preparation of an Environmental Impact Statement. Darwin Refinery TNG Limited. May 2016. https://ntepa.nt.gov.au/__data/assets/pdf_file/0007/286747/terms_reference_darwin_refinery.pdf [accessed 30/01/2021].

NT EPA (2018) Environmental Factors and Objectives version 1.0 https://ntepa.nt.gov.au/__data/assets/pdf_file/0005/546791/guideline_environmental_factors_objectives.pdf [accessed 30/01/2021]

NT EPA (2021) NT EPA Environmental Factors and Objectives version 2.0 Environmental impact assessment General technical guidance. https://ntepa.nt.gov.au/__data/assets/pdf_file/0020/804602/guide-ntepa-environmental-factors-objectives.pdf [30/01/2021]