11 TERRESTRIAL FLORA AND VEGETATION

11.1 METHODS

A Flora Survey Report has been produced to support this NOI - the full report is provided at Appendix D.

11.1.1 Desktop Analysis

Prior to the field assessment, a desktop assessment was undertaken to gain an understanding of the ecological values of the Gunn Point area and associated landscape, including vegetation communities and threatened species that could be present. Primary data sources consulted for the study area were:

- NR Maps (Northern Territory Government, 2017), a mapping database, was searched for ecological and landscape information, including vegetation community mapping and threatened species records.
- The Commonwealth Government's Protected Matters Database Search Tool (http://www.environment.gov.au/epbc/protected-matters-search-tool) was consulted for threatened species and communities listed by the Commonwealth Government under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) predicted to be present within the Project area - search encompassed all land within 5 km of the Project site.
- Litchfield Shire Remnant Vegetation (Northern Territory Government 2002), mapping produced at 1:100,000.
- Litchfield Municipality Land Units (Northern Territory Government 2015), land mapping produced at 1:25,000.

11.1.2 Field Assessment

Three site visits were undertaken, an initial site reconnaissance on 7th of April 2017, a six day site survey from July 2-7, 2017, and another single day survey on 7 September, 2017. The initial site reconnaissance was undertaken to gain site familiarity and confirm general vegetation community patterns. The six day site survey was undertaken with the following objectives:

- To map vegetation communities present on the site at a 1:10, 000 scale, NVIS level 5 -Association level (Executive Steering Committee for Australian Vegetation Information 2003).
- To survey for the presence of threatened species and their supporting habitats, and to conduct population surveys if present (it was known prior to the survey that the vulnerable cycad *Cycas armstrongii* was present).
- To identify weeds present on the site.

The six day survey investigated a number of potential footprints for the hatchery within the site (Figure 56). The eventual footprint location (Figure 5) was chosen based upon avoiding a number of environmental constraints, most notably *C. armstrongii* (see below). The single day survey on 7 September was undertaken to confirm that the results of the earlier surveys were valid for the chosen footprint (Figure 5), and to perform counts of individuals of *C. armstrongii* within the chosen footprint.

11.1.3 Vegetation Community Mapping

A field survey method was developed using the Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping (Brocklehurst et al. 2007). Vegetation communities were mapped by traversing the site thoroughly on foot and in a vehicle, undertaking numerous check sites in each vegetation community. Road sites were also conducted regularly. Both types of site are outlined below:

- Check sites – these surveys can be completed relatively quickly and as such a large number can be completed for each vegetation type. The objective is to document a vegetation community's main species composition, structural formation (dominant layer percent cover and height) and site data such as geology, soils and landforms. Typically, the most common species in each layer are recorded, and other noteworthy species (e.g. weeds, rarely encountered species etc.). Both targeted and random meanders were undertaken to gather the data for check sites. Tree heights were measured with an inclinometer, and canopy cover was estimated by an experienced observer.
- Road sites – these surveys entail brief notes on the dominant species and structural formation present at a location. They can be completed from a vehicle and are an essential aid in confirming aerial photo patterns during the mapping process.

In addition, ecological condition of vegetation communities was assessed at check sites, using the Vegetation Assets, States and Transitions (VAST) classification (Thackway and Lesslie 2005).

11.1.4 Threatened Species Searches

Habitat suitable for threatened species identified in the desktop survey as potentially present was traversed to search for these species and make a closer assessment of habitat value. Unfortunately, a fire had swept through the majority of the Project site in the weeks preceding the six day survey, and most of the ground layer was either charred, absent or re-sprouting. As a result, this element of the survey was compromised and further targeted surveys for species with the potential to be present are proposed prior to commencement of construction (see Section 11.4.1.2).

11.1.5 Population Survey for Cycads

A population of the vulnerable *Cycas armstrongii* is present on the Project site, and an assessment of population density was undertaken so as to arrive at an estimate of overall population within the proposed Project footprint.

Absolute counts (i.e. counts of all cycads) were undertaken for the majority of the Project footprint. The high density of cycads, however, in some areas of the Project footprint, namely the location of the power station and incinerator and the site administration, access control point and warehouse did not allow for absolute counts. In these areas, an estimate of population density per hectare was obtained using the following method:

1) Three squares of five hectares each were selected, corresponding with areas proposed for the Project footprint at the time of the survey.

2) Within these squares, a total of 25 plots of 100 m^2 each (10 m x 10 m) were chosen at random prior to arriving on site, by placing a dot in a digital map representing the south east corner of each plot.

3) The coordinates for each south east corner were located in the field, and the plot was marked out with flagging tape (which was removed when the plot was finished).

4) All cycads located within these plots were counted, with the count divided into adults (stem taller than 50 cm) and juveniles (stem equal to or less than 50 cm).

5) By calculating the average cycad density per 100 m^2 from these 25 plots, then multiplying that number by the area covered by the particular Project infrastructure, an estimate for the cycad population was able to be calculated.

Cycad density was not high within *Eucalyptus tectifica* and *Corymbia polysciada* low woodland and deciduous mixed species low woodland. In these areas, absolute counts rather than estimates were possible and were conducted within the project footprint as it was at the time of the field survey. This involved surveys over 10.5 ha in total, mapped in Figure 56- one five hectare plot (area 4), one four hectare plot (area 3), a one hectare plot (area 1), and a half hectare plot (area 2).

11.1.6 Weeds

The location and density of all weed species observed was noted.

11.1.7 Assessment of Likelihood of Occurrence of Conservation Significant Species at the Site

For each species identified within the databases and predictive models for the Gunn Point area, an assessment of the likelihood of site occurrence was undertaken. The conclusion in regard to site occurrence for each species was based on the known ecological requirements, presence of local records, and the presence and condition of suitable potentially habitat resources on the site.

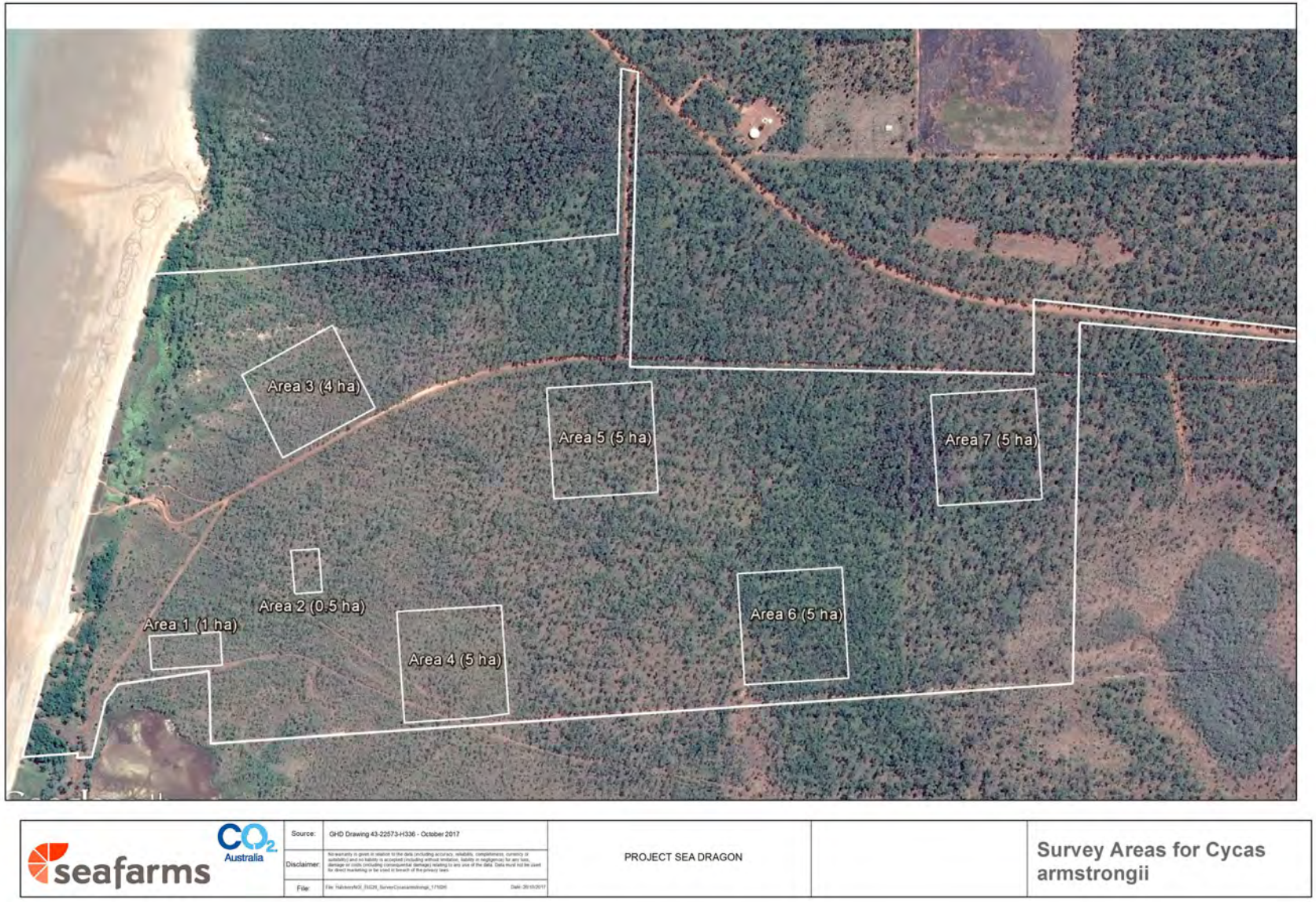

FIGURE 56 SURVEY AREAS FOR CYCAS ARMSTRONGII

11.2 EXISTING ENVIRONMENT

11.2.1 Vegetation Communities

Nine vegetation communities occur on the Project site – these communities and their condition are summarised in Table 28, and mapped on Figure 57. No threatened ecological communities or species listed under the EPBC Act were predicted to occur within the Project site, and none were observed.

Approximately 60% of the Project site is dominated by one community, *Eucalyptus tetrodonta* woodland to low woodland on the lateritic plain. This community also contains the highest concentration of the only threatened species found during the survey, the cycad *Cycas armstrongii*, listed as Vulnerable under the TPWC Act.

Eighteen percent of the site is occupied by deciduous mixed species low woodland. This community occurs on lower run-off slopes, and occupies most of the ground between the Koolpinyah plateau and the coastal plain. It is characterised by a mixture of sclerophyllous and non-sclerophyllous species including Melaleuca viridiflora, *Corymbia polysciada*, *Gardenia megasperma, Xanthostemon paradoxus, Terminalia ferdinandiana* and, in places, *Lophostemon lactifluus*. It contains a population of *C. armstrongii*, but in much lower densities that those found in *E. tetrodonta* woodland.

The next most common vegetation community (approximately 11%) on the Project site is low woodland dominated by *Eucalyptus tectifica* and *C. polysciada*. It occupies the run-off slope formed by the eroding Koolpinyah plateau, and occurs slightly down slope of the *E. tetrodonta* woodland which dominates that surface. This community also contains *C. armstrongii*, but as with mixed deciduous species woodland, the population density is relatively low.

The remaining six communities present each comprise less than 3% of the site. *M. viridiflora* low open forest dominates a broad drainage line and shallow depression in the south east of the Project site, and woodland of *Corymbia polycarpa* and *Erythrophleum chlorostachys* occupies the fringe of a closed depression wetland located just off the south east corner. The remainder of the site is comprised of four communities that occupy the narrow coastal sand plain. None of these communities contain *C. armstrongii* populations. However, two vegetation communities, monsoon vine thicket and mangrove low closed forest, which occur in a mosaic together on the coastal sand plain, are considered to be sensitive vegetation types under the Land Clearing Guidelines (Department of Natural Resources, Environment, the Arts and Sport 2010).

In general, all communities except those on the coastal sand plain were considered to be in an intact, essentially unmodified ecological condition, using the VAST assessment framework (see Flora Survey Report in Appendix D).

11.2.2 Flora of Conservation Significance

Twelve species of conservation significance have been recorded within a 15 km radius of the Project site, they are outlined in Table 29. Of these, one is endangered, four are vulnerable, four are near threatened, and three are listed as data deficient under the TPWC Act. One (*Stylidium ensatum*) is also listed as endangered under the EPBC Act. Only one of these species was found on site – the vulnerable cycad *C. armstrongii*.

However, it should be noted that one or more fires had occurred over approximately 95% of the Project site and adjoining areas in the month before the six day survey (some were still burning at the time of the survey). These fires had removed almost the entire ground layer, and some of the shrub layer, in the areas it had burnt.

Of the vegetation communities present on the Project site, only monsoon vine thicket, mangrove low closed forest and *M. viridiflora* low open forest/woodland were entirely or mostly unaffected by this fire.

Based on the assessment of likelihood presented in Table 29, in addition to *C. armstrongii*, another four threatened flora species are considered possible to occur on site - Typhonium praetermissum, the Melville Island Desmodium (*Desmodium tiwiense*), *Operculina turpethum* and *Pittosporum moluccanum*.

Detection of *Desmodium tiwiense, Operculina turpethum* may have been compromised by the burn that had occurred prior to the survey. Surveys for *Typhonium praetermissum*, a cryptic terrestrial aroid not visible above ground for most of the year, are best conducted in late December. Potential habitat for this species has been mapped through the middle of the Project site (see Figure 58).

11.2.2.1 *Cycas armstrongii*

Cycas armstrongii is an NT endemic cycad growing to six metres and restricted to the Tiwi Islands, the western tip of the Coburg Peninsula, and the mainland south and east of Darwin for approximately 90 km. It is described as locally abundant, but has been listed as vulnerable because it has less than one percent of its population in the protected area estate, and is prevalent in areas subject to ongoing residential and industrial development.

The major threatening processes affecting this species are clearing associated with urban development, and a predicted increase in fire intensity associated with the invasion of exotic grasses - primarily Gamba grass (*Andropogon gayanus*) and mission grass (*Cenchrus polystachyios*). Increases in fire intensity have the potential to kill cycads and reduce seed viability (Kerrigan et al. 2006).

Population surveys based on 75 100 m^2 plots conducted for this species (the method is outlined in Section 11.1.5) recorded an average of 887 individual *C. armstrongii* per ha in *E. tetrodonta* woodland on the site, of which approximately 46% are likely to be adults (adult is defined as having a stem height of greater than 50 cm). Population density mapping is presented in Figure 59. Across the 90 ha of this habitat type, this suggests there may be approximately 79, 830 individuals present just within the *E. tetrodonta* woodland, of which 36, 700 are likely to be adults. Numbers within the 75 100 m^2 plots surveyed varied from zero cycads (recorded in 13 plots) to 45 (recorded in one plot). Most 100 m^2 plots (52%) recorded six cycads or less, and 75% of the plots had 14 cycads or less. Only 16% of the plots had 20 or more cycads, and only one plot had more than 29.

Individuals of *C. armstrongii* were also found in *E. tectifica* and *C. polysciada* low woodland and deciduous mixed species low woodland, but in much lower densities – an average of 30 individuals per hectare was recorded based on absolute counts of all cycads present within four plots totalling 10.5 ha. The average percentage of adults as a proportion of the population was higher in these communities than for the *E. tetrodonta* woodland – 72%.

This suggests that the total population of *C. armstrongii* within these habitats may be 670, including approximately 480 adults. However, clusters of cycads are sometimes present in relatively small areas (e.g. half a hectare) with densities of up to 240 individuals per hectare. For instance, within area 1 (see Figure 56), located in deciduous mixed species low woodland, 54 cycads were counted within a 0.2 ha area, but only nine were recorded in the remaining 0.8 ha.

11.2.3 Threatening Processes

The field assessment revealed that the coastal sand plain area is heavily utilised by visitors for camping, beach fishing, and trail-bike riding, and, consequently, showed signs of heavy human use including abundant litter, ranging from plastic and bottles to large sheets of corrugated iron; open (unburied) latrine sites; evidence of

soil compaction; and occurrences of impromptu clearing. In addition, weeds, which were not present over most of the site (where present they were restricted to the immediate edge of tracks), were abundant on the coastal sand plain, and it was considered possible that fire frequency is increased (this latter impact affects the entire site, not just the coastal sand plain). Increased weeds and fire frequency were considered possibly attributable to heavy human use. These findings are corroborated in the Fauna Habitat Assessment Report (Appendix E).

11.2.4 Weeds

In general, weeds are restricted to the areas being utilised by the public for recreation – outside of these areas, exotic species were almost completely absent (with the exception of hyptis - *Hyptis suaveolens* and gamba grass - *Andropogon gayanus*). Impacts from weeds are most serious on the foredune and swale area – here, perennial mission grass (*Cenchrus polystachyios*), Mossman River grass (*Cenchrus echinatus*) and spiny-headed sida (*Sida acuta*) are all prevalent. Low densities of hyptis are also present in low woodland on the run-off slopes. All weeds found on site are declared Class B and C weeds in the NT.

Declared weeds recorded on site are listed in Table 30 below.

TABLE 28 VEGETATION COMMNITIES AND CONDITION

Community	Defining species	VAST condition[1]	Values
Lateritic level to gently undulating plains (the Koolpinyah surface)			
Eucalyptus tetrodonta woodland to low woodland on the lateritic plain (~112 ha on Project site)	Upper: *Eucalyptus tetrodonta, Eucalyptus miniata, Corymbia confertiflora, Erythrophleum chlorostachys* Mid: *Cycas armstrongii, Livistona humilis, Pandanus spiralis, Buchanania obovata* Ground: *Heteropogon triticeus, Sorghum intrans, Chrysopogon latifolius, Hibbertia juncea*	Type I – Residual	Contains high densities of the vulnerable species *Cycas armstrongii*, over 1000 plants/ha in some places. The western edge of this community may provide habitat for the vulnerable aroid *Typhonium praetermissum*.
Undulating to rolling plains – run-off slopes forming the erosive face to the Koolpinyah surface			
Eucalyptus tectifica & *Corymbia polysciada* low woodland on gentle run-off slopes (~19.5 ha on Project site)	Upper: *Eucalyptus tectifica, Corymbia polysciada, Erythrophleum chlorostachys* Mid: *Melaleuca viridiflora, Acacia dimidiata, Calytrix exstipulata* Ground: *Heteropogon triticeus, Sorghum intrans, Sorghum plumosum*	Type I – Residual	Contains relatively low densities of the vulnerable species *Cycas armstrongii* – between 0 and 225 plants/ha. May provide habitat for the vulnerable aroid *Typhonium praetermissum*.
Deciduous mixed species low woodland/ low open woodland on lower run-off slopes (~33.5 ha on Project site)	Upper: *Corymbia polysciada, Melaleuca viridiflora, Erythrophleum chlorostachys, Xanthostemon paradoxus, Gardenia megasperma, Lophostemon lactifluus* Mid: *Melaleuca viridiflora, Planchonia careya, Grevillea pteridifolia* Ground: *Heteropogon triticeus, Sorghum intrans, Themeda triandra*	Type I – Residual	Contains relatively low densities of the vulnerable species *Cycas armstrongii* – between 0 and 175 plants/ha. May provide habitat for the vulnerable aroid *Typhonium praetermissum*.

Community	Defining species	VAST condition[1]	Values
Corymbia polycarpa and *Erythrophleum chlorostachys* open woodland fringing internal depressions (~3 ha on Project site)	Upper: *Corymbia polycarpa, Erythrophleum chlorostachys, Melaleuca viridiflora* Mid: *Melaleuca viridiflora, Grevillea pteridifolia, Pandanus spiralis* Ground: Absent (due to fire) except for dense clusters of *M. viridiflora* seedlings	Type I – Residual	Forms a buffer for an adjacent *M. viridiflora* and *M. cajuputi* ephemeral wetland.
Depositional surfaces – open and closed depressions			
Melaleuca viridiflora low open forest/ woodland on broad shallow drainage lines and localised depressions (~3 ha on Project site)	Upper: *Melaleuca viridiflora, Lophostemon lactifluus, Pandanus spiralis, Corymbia polysciada* Mid: absent Ground: *Eriachne burkittii, Heteropogon triticeus, Sorghum plumosum, Eriachne agrostidea*	Type I - Residual	It may provide habitat for small trigger plants (Stylidium spp.), including the endangered *S. ensatum* (although it is considered unlikely to occur on this site).
Coastal sand plain – a low dune and shallow swale system occupying the narrow finger of land between the beach and the run-off plain			
Melaleuca dealbata open woodland on the coastal sand plain (~6 ha on Project site)	Upper: *Melaleuca dealbata, Corymbia polysciada* Mid: *Pandanus spiralis, Hibiscus tiliaceus, Ficus aculeata* Ground: *Imperata cylindrica, Flagellaria indica, Cyperus javanicus, Cenchrus polystachyios**	Type II - Modified	It may provide habitat for the near threatened species *Operculina turpethum*, a vine recorded from directly adjacent to this community, within the Project site. May provide habitat for the vulnerable aroid *Typhonium praetermissum*.
Foredune grassland/ forbland on the coastal sand plain (~3 ha on Project site)	Upper: *Hibiscus tiliaceus, Ficus aculeata* Mid: absent Ground: *Spinifex longifolius, Ipomoea pes-caprae, Cenchrus polystachyios*, Imperata cylindrica*	Type II - Modified	It may provide habitat for the near threatened species *Operculina turpethum*, a vine recorded from directly adjacent to this community, within the Project site.

Community	Defining species	VAST condition[1]	Values
Monsoon vine thicket on the coastal sand plain (~3.5 ha on Project site, in a mosaic with the mangrove low closed forest community 11)	Upper (emergent): *Schefflera actinophylla* Upper 2: *Millettia pinnata, Hibiscus tiliaceus, Thespesia populnea, Acacia auriculiformis, Trema tomentosa, Flagellaria indica, Flueggea virosa, Cathormion umbellatum, Clerodendrum floribundum, Abrus precatorius, Manoon australe, Pisonia aculeata, Ficus aculeata* Ground: *Cenchrus polystachyios*, Cenchrus echinatus*, Sida acuta**	Type II - Modified	It may provide habitat for the near threatened species *Pittosporum moluccanum* (a small tree recorded from monsoon vine thicket within two kilometres of the Project site) and *Operculina turpethum* (a vine recorded from within a few hundred metres of monsoon vine thicket on the Project site). This community is considered a sensitive vegetation type under the Land Clearing Guidelines
Mangrove low closed forest on the coastal sand plain (~3.5 ha on Project site, in a mosaic with the monsoon vine thicket community)	Upper: *Avicennia marina, Lumnitzera racemosa, Rhizophora stylosa, Thespesia populnea, Hibiscus tiliaceus* Mid: absent Ground: *Sporobolus virginicus, Ipomoea pes-caprae*	Type II - Modified	Due to its narrow width (usually no more than 20 m) and close co-occurrence with monsoon vine thicket, it has been mapped together with that community. This community is considered a sensitive vegetation type under the Land Clearing Guidelines.

1VAST = Vegetation Assets, States and Transitions (Thackway and Lesslie, 2005)

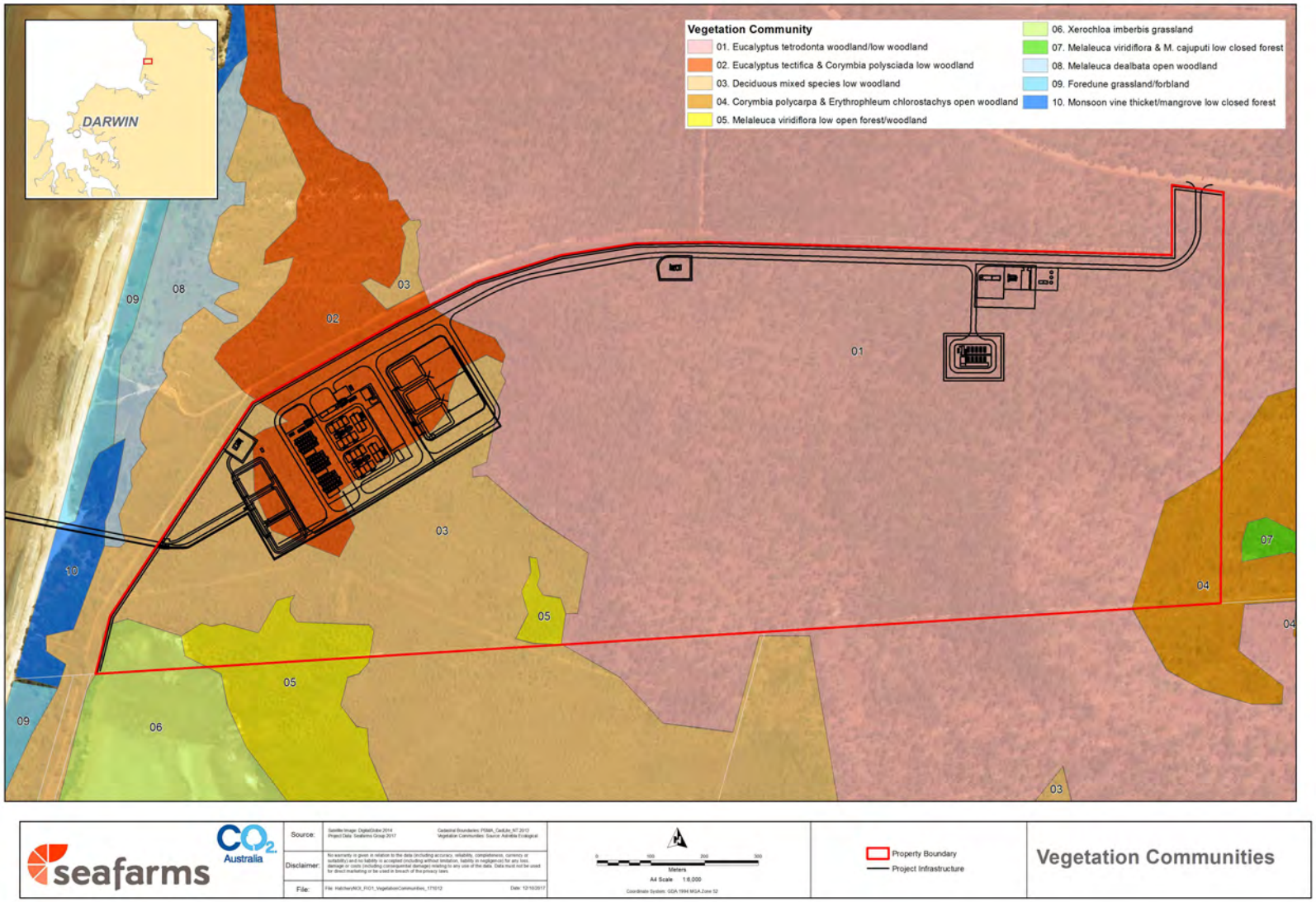

FIGURE 57 VEGETATION COMMUNITIES

TABLE 29 ASSESSMENT OF LIKELIHOOD OF OCCURRENCE OF CONSERVATION SIGNIFICANT FLORA ON THE PROJECT SITE

Species	TPWC Act Status	Record Location	Discussion	Likelihood of Occurrence
Stylidium ensatum	Endangered*	1 record 15 km south of site	An annual herb to 22 cm tall flowering June-July. Preferred habitat is poorly drained grassy flats with damp peaty or heavy clay soils, which stay damp well into the dry season (TSSC 2016). Poorly drained sandy soils have also been associated with this species (Green & Cuff 2016a). It has been recorded growing with sedges, perennial grasses and herbs, and shrubs including *Melaleuca viridiflora, Lophostemon lactifluus, Banksia dentata* and *Osbornia sp.* (Bean 2000; TSSC 2016).	Unlikely – no peaty/clay soils that stay damp well into the dry season are present on site (although there may be suitable habitat in areas of wetland along but outside of the southern boundary of the site). A 2016 survey by the NT Herbarium of the Litchfield local government area, including numerous sites in suitable habitat in Tree Point Conservation Park and vicinity, did not find this species (Green & Cuff 2016a). It was not observed during the field survey (but an earlier fire had burnt out suitable habitat).
Crepidium marsupichila (Malaxis) (formerly *Malaxis marsupichila)*	Vulnerable	3 records 10-13 km north of site	A deciduous terrestrial orchid with a flower stem to 50 cm, flowering and fruiting January-May. It grows in colonies in soils with abundant leaf litter, favouring moist, shady sites along the margins of littoral or monsoon rainforest. It is an NT endemic only recorded from two populations, both at the extreme north of Gunn Point (AVH 2017; Kerrigan & Cowie 2006b).	Unlikely – littoral rainforest/monsoon vine thicket is present on the site, but it is heavily impacted by regular human visitation. Shady sites on the margins of this vine thicket are particularly popular with campers and have been compacted and regularly disturbed. It was not observed during the field survey (although the season was not correct for surveys for this species, and an earlier fire had burnt suitable habitat).
Cycas armstrongii (Armstrong's cycad)	Vulnerable	40 records on site and across greater Darwin region	A locally abundant cycad to 6 m tall, endemic to the NT and with the main population from Gunn Point south to Mt Bundey and the Litchfield National Park, including records from the Tiwi Islands. It prefers open grassy	Present – a common species on site, with population densities of between 800 and 1,000 cycads per hectare in the eastern half. They are less common in the western half of the site.

Species	TPWC Act Status	Record Location	Discussion	Likelihood of Occurrence
			woodlands on well drained soils (AVH 2017; Kerrigan et al. 2006).	
Freycinetia excelsa	Vulnerable	1 record 13 km north of site	A woody climber (a pandanus) found in wet, evergreen lowland and spring fed rainforests, sometimes in sandstone gullies (Northern Territory Herbarium 2015; Kerrigan & Cowie 2006a).	Unlikely – the site does not contain wet, evergreen rainforest, and this species was not recorded in the field survey.
Typhonium praetermissum	Vulnerable	23 records 5-8 km north of site	A perennial geophyte (ie a predominately subterranean herb) emergent between November and January/February. This species is endemic to the Darwin/Litchfield area. It has been seldom collected, but is known to occur in woodland, sometimes in full sun, in red-brown clay soil and shallow or gravelly lateritic soil. It is a generally cryptic species that appears to be naturally rare (Northern Territory Herbarium, 2015; Westaway & Cowie, 2012).	Possible – suitable habitat is present on site and populations have been located in the Gunn Point area. Green and Cuff (2016b) have mapped a corridor of potential habitat for this species through the middle of the Project site (see Figure 58). It was not observed during the field survey (although the season was not correct for surveys for this species).
Avicennia integra (stilted grey mangrove)	Near Threatened	1 record 4 km south of site	A mangrove endemic to the NT (the only endemic mangrove in Australia). It is found on poorly consolidated muds on the margins of tidal rivers, particularly those that become brackish for a period of the year (Northern Territory Herbarium, 2015)	Unlikely –small areas of mangroves are present but are not likely to become brackish. It was not observed during the field survey.
Desmodium tiwiense (Melville Island Desmodium)	Near Threatened	1 record 2 km east of site	A trailing ground herb with a perennial rootstock and annual stems. It is endemic to the NT, being found in 'eucalypt savannah' and open forest, primarily in the Tiwi Islands but with 3 records from the mainland – one from 2006 located approximately 1.7 km east of the	Possible – suitable habitat (Eucalypt woodland) is present and common on site and is contiguous with habitat for a previous record from within 2 km. It was

Species	TPWC Act Status	Record Location	Discussion	Likelihood of Occurrence
			Project site (AVH 2017; Northern Territory Herbarium 2015).	not observed during the field survey (but an earlier fire had burnt out suitable habitat).
Operculina turpethum	Near Threatened	3 records on western boundary of site	A twining vine growing to 4 m or more, recorded from Queensland to WA but mostly found in South East Asia. In NT recorded from vine thicket beside mangroves, including from the rear of a dune on the Project site (but growing on the sand, not in vine thicket) (AVH 2017).	Possible – collected from the foredune grassland/forbland community on the coastal sand plain, on the far western edge of the Project site in 2000. It was not observed during the field survey (but an earlier fire had burnt out suitable habitat).
Pittosporum moluccanum	Near Threatened	2 records within 2 km north and south of site	A tree to 7 m tall growing in semi-deciduous vine thickets on stabilised coastal sand dunes or laterite ledges (Northern Territory Government 2015).	Possible – suitable areas of vine thicket on stabilised coastal sand dunes are present on site, and the species has been found twice within 2 km of the Project site, both to the north and south. It was not observed during the field survey.
Goodenia kakadu (Kakadu Goodenia)	Data deficient	1 record 7 km north east of site	Prostrate herb to 20 cm tall (Carolin 1992). Recorded from Gunn Point growing in shallow water, from a seasonally inundated swamp in the Shoal Bay Coastal Reserve near Howard Springs, and elsewhere from the Kimberly to the Gulf of Carpentaria (9 records in total) always in damp soil or shallow water (AVH 2017).	Unlikely – suitable habitat generally not present, except in the wetland area just outside the south eastern corner of the Project site. It was not observed during the field survey (but an earlier fire had burnt out suitable habitat).
Lindernia sp. Robyn's showy anthers	Data deficient	1 record 7 km west of site	A small annual herb recorded from seepage areas or at the base of cliffs, primarily further south in Kakadu National Park. Recorded 7 km west of the Project site in	Unlikely – suitable habitat generally not present, except in the wetland area just outside the south eastern corner of the Project site. It was not observed

Species	TPWC Act Status	Record Location	Discussion	Likelihood of Occurrence
			Melaleuca sp. closed forest (AVH 2017; Northern Territory Government 2015).	during the field survey (but an earlier fire had burnt out suitable habitat)
Stylidium tenerrimum	Data deficient	4 records 9 km south east of site	An annual herb to 30 cm tall, flowering/fruiting between April to August. Associated with sandy soils that remain damp after the wet season, and known to occur with *Pandanus sp., Melaleuca sp.* and *Grevillea pteridifolia* (Bean 2000).	Unlikely –suitable habitat generally not present, except in the wetland area just outside the south eastern corner of the Project site. It was not observed during the field survey (but an earlier fire had burnt out suitable habitat).

[1] TWPC Act = *Territory Parks and Wildlife Conservation Act 2000* (NT)

*Also listed under the Commonwealth EPBC Act

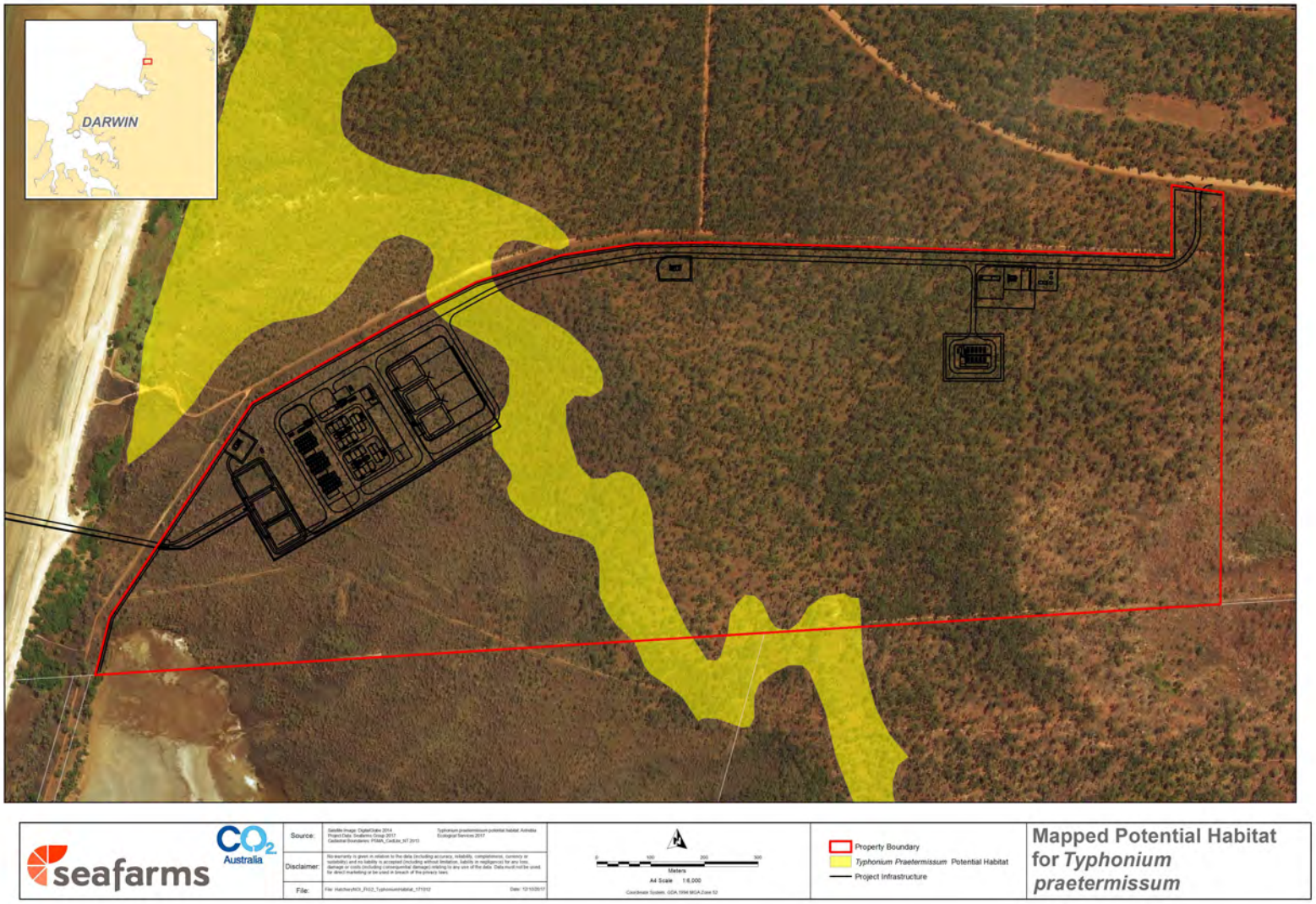

FIGURE 58 MAPPED POTENTIAL HABITAT FOR *TYPHONIUM PRAETERMISSUM*

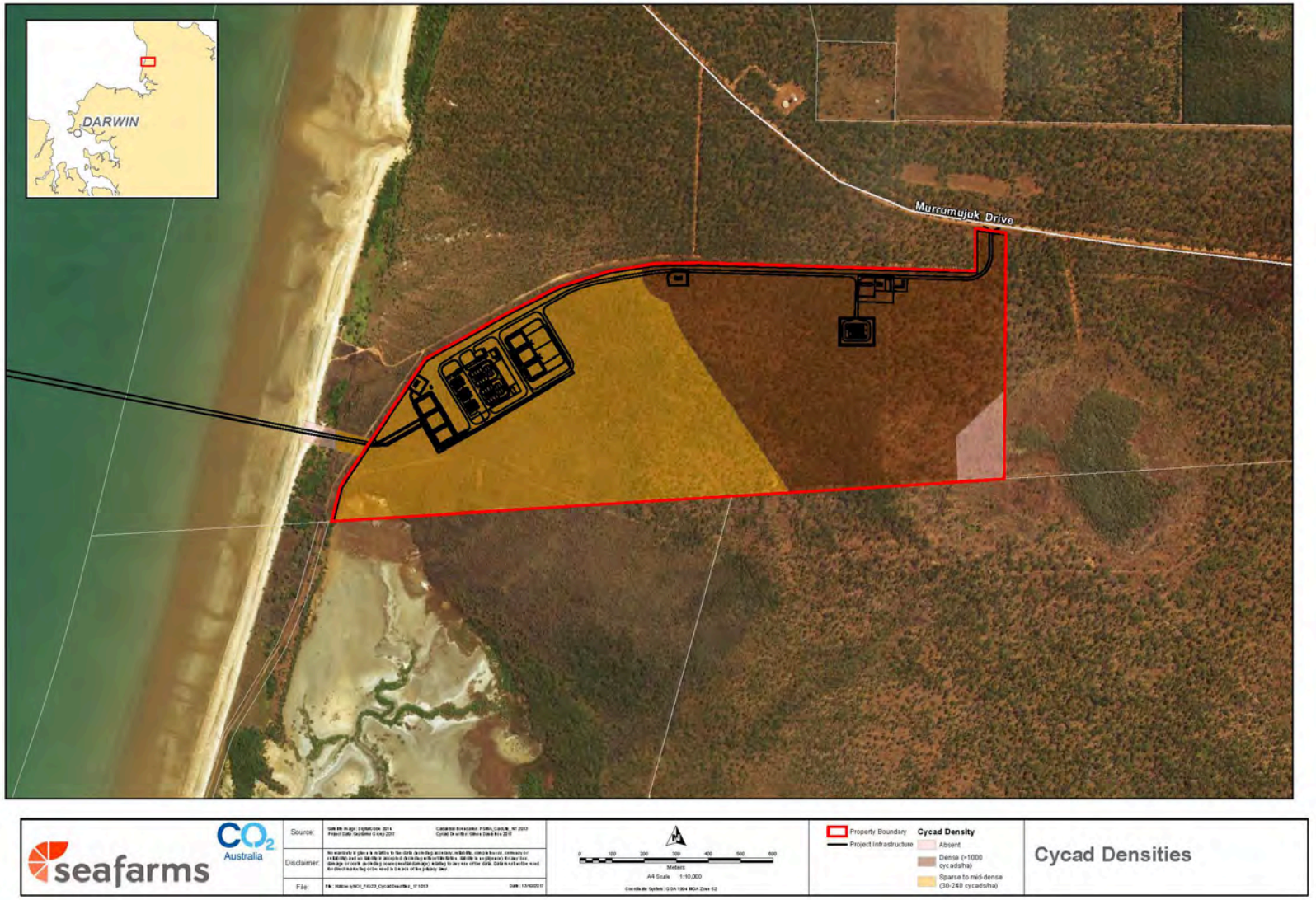

FIGURE 59 CYCAD DENSITIES

TABLE 30 CLASS B AND C DECLARED WEEDS RECORDED ON THE PROJECT SITE

Species	Description	Presence on the Project Site
Gamba grass (*Andropogon gayanus*)	Gamba grass is an African grass growing to four metres tall and capable of thriving in northern Australian savannah habitats. It is highly productive, developing a dense leaf canopy that greatly increases the fuel load available to fires when compared to fuel loads from native grasses. As a result, fires become hotter than the surrounding woodland are adapted to, and can kill woodland trees and other savannah components This alters the ecosystem over time (woodland becomes tall Gamba grass grassland) and severely decreases biodiversity (i.e. it is an increaser grass – it increases habitat suitability for itself as it becomes established).	Found in isolated clumps in three locations beside the immediate edge of the main track to Tree Point Conservation Park.
Goat's head burr (*Acanthospermum hispidulum*)	Goat's head burr is an erect annual herb to one metre tall. It is primarily a weed of disturbed areas – road sides and human settlements. It is known to invade crops and its spiny burr will degrade wool and cause a nuisance to recreational uses of bushland. It will also outcompete native species in open country (Smith 2002).	Only occasionally present on the Project site.
Hyptis (*Hyptis suaveolens*)	Hyptis is an upright annual or perennial herb capable of growing to two metres tall. It is primarily a weed of disturbed areas, being found beside roads and other areas of regular human disturbance. It is also a sure sign of overgrazing, becoming dominant as stock will not eat it (Northern Territory Government 2017). It has the capacity to severely decrease biodiversity, particularly in the ground layer.	Found on the coastal sand plain, where it is associated with areas of high human visitation/use, and in adjoining areas of low woodland on the run-off plain.
Mossman River grass (*Cenchrus echinatus*)	Mossman River grass is a short grass growing to approximately 50 cm tall. It has an exceptionally spiny seed head with spines that will penetrate clothes. On sheep farms it will foul wool and cause injuries to sheep – elsewhere, its main impact will be to deny areas of infestation to recreational users. It is commonly found in sandy soils, particularly beside beaches.	It is present on the foredune and associated swale, in foredune grassland/forbland, along the edges of monsoon vine thicket, and in the *M. dealbata* open woodland.

Species	Description	Presence on the Project Site
Perennial mission grass (*Cenchrus polystachyios*)	Perennial mission grass is an African grass growing to three metres tall, present in the Darwin area since the 1970s. As with gamba grass, it is an increaser species that is encouraged by regular burning. It reduces native biodiversity and occupies disturbed areas.	It is present, together with its non-declared but weedy relative *Cenchrus pedicellatus* (annual mission grass) on the coastal sand plain and beside the track leading to the Tree Point Conservation Park. It is particularly prevalent in foredune grassland/forbland and in the *M. dealbata* open woodland.
Spiny-headed sida (*Sida acuta*) and Flannel weed (*Sida cordifolia*)	Spiny-headed sida and the closely related flannel weed are herbs growing to one metre or slightly more. They are weeds of disturbed areas, becoming established in areas that are used heavily by humans or stock – in particular, around camp grounds and near water troughs and other places where humans or animals gather and degrade the landscape. They have awned capsules that attach to clothing, vehicles and animals, and so are easily spread (Smith 2002).	Both species were recorded in the swale on the coastal sand plain, beside vehicle tracks used to access the beach, and in areas used for camping beside the monsoon vine thicket and mangrove low closed forest.

11.3 ASSESSMENT OF POTENTIAL IMPACTS

11.3.1 Vegetation

The Project will involve the clearing 28.93 ha of vegetation while the remainder of the vegetation on the site (101.07 ha) will be retained. The area of vegetation proposed to be cleared by the Project is considered to be conservative as it includes a 25 m buffer around all infrastructure to allow for flexibility in the detailed design stage. It is highly likely that not all of the area within the 25 m buffer will be required to be cleared and as such the clearing area is likely to be smaller than 28.93 ha.

Approximately 45% of the clearing area occurs within *Eucalyptus tetrodonta* woodland to low woodland on the lateritic plain. This vegetation community consists of woodland dominated or co-dominated by *E. tetrodonta*, often with *Eucalyptus miniata* and is analogous with community 15 in the Litchfield Shire 1:100,000 vegetation mapping. This community is one of the most common in the NT with over 1.2 million hectares mapped by Wilson et al. (1990) (Department of Natural Resources, Environment and the Arts 2004). The community is widespread across the region, and the area to be cleared is less than 0.1% of the extent of the vegetation community that occurs within the Litchfield Shire area. The clearing of an estimated 12.84 ha of this vegetation type is not considered a significant impact or loss of biodiversity values.

The other two vegetation communities to be cleared by the Project, *Eucalyptus tectifica* and *Corymbia polysciada* low woodland/open woodland on gentle run-off slopes and deciduous mixed species low woodland/open woodland on lower run-off slopes are analogous with the same community, community 22, in the Litchfield Shire 1:100,000 vegetation mapping. The combined total area of these two communities within the footprint is less than 0.7% of the vegetation community that occurs within the Litchfield Shire area and is not considered to result in a significant impact or loss of biodiversity values.

The vegetation communities within the Project footprint and their analogous vegetation communities in the Litchfield Shire are provided in Table 31.

TABLE 31 VEGETATION COMMUNITIES WITHIN THE PROJECT FOOTPRINT

Vegetation Community	Area in Project footprint (ha)	Equivalent Community in Litchfield Shire 1:100,000 Mapping	Area of Community in the Litchfield Shire (ha)	Area to be Cleared as a Percentage of the Area in the Litchfield Shire
Eucalyptus tetrodonta woodland/low woodland on the lateritic plain	12.84	*Eucalyptus tetrodonta, E. miniata* woodland to low woodland, with mixed species mid stratum and grassland understorey	123,174	0.01%
Eucalyptus tectifica and *Corymbia polysciada* low woodland/open woodland on gentle run-off slopes	9.61	*Eucalyptus clavigera, E. polycarpa, E. tectifica* mixed species low woodland to very low open woodland. Understorey mixed species.	2,298	0.7%
Deciduous mixed species low woodland/open woodland on lower run-off slopes	6.48			

11.3.2 Threatened Flora

The desktop and field assessments described in Section 11.2 revealed that one threatened flora species listed under the TPWC Act does occur on site - *Cycas armstrongii*. An additional four species are considered possible to occur on site - *Typhonium praetermissum*, the Melville Island Desmodium (*Desmodium tiwiense*), *Operculina turpethum* and *Pittosporum moluccanum*.

An assessment of the potential impacts to each is given below.

11.3.2.1 *Cycas armstrongii*

Cycas armstrongii is a common species on site, and there may be as many as 80, 000 individuals over the entire site, with approximately 99% of these located in the Eucalyptus tetrodonta woodland on the laterite plain. This species is not evenly distributed across the site. Population densities are between 800-1,000/ha in the eastern half of the site but it is less common in the western half of the site. Avoidance of those parts of the site with higher densities of this species was a key consideration in planning the site layout (see Figure 59), hence infrastructure was concentrated into the western third of the site. However, to comply with the air quality and noise separation requirements for the incinerator and the generators, these facilities were required to be located in areas with comparatively higher densities of *C. armstrongii*.

Flora surveys undertaken to support this NOI indicate that between 2,775 and 3,469 individuals will need to be removed in the area shown as high density on Figure 59. The infrastructure in this location consists of the access road, site administration office, one manager's residence and incinerator and the generators. Between 351 to 2,810 individuals will need to be removed to facilitate the construction of all the other hatchery facilities, which are all located in the area shown as sparse to mid-dense on Figure 59.

Measures to mitigate this impact are given below in Section 11.4.1.2.

Operation of the facility is unlikely to pose any threat to this species. In fact, the weed and fire management regimes that will be implemented as part of the Project will likely have a positive impact upon this species, when compared with the current situation. Currently, the site shows evidence of increased fire regimes (likely as a result of inappropriate recreational use) and also has outbreaks of weeds that increase the fuel load, such as Gamba Grass and Perennial Mission Grass. Management of fire and these weeds will have a positive effect on *Cycas armstrongii* within the site.

11.3.2.2 *Typhonium praetermissum*

Suitable habitat is present on site and populations have been located in the Gunn Point area. Green and Cuff (2016) have mapped a corridor of potential habitat for this species through the middle of the Project site (see Figure 58). It was not observed during the field survey, but it is noted that the season was not correct for surveys for this species. Construction of the Project will result in the removal of 0.12 ha of habitat for this species. This represents 0.01% of potential habitat for the species available on the Project site and as such is not considered to be significant.

Operation of the facility is unlikely to pose any threat to this species. In fact, the weed and fire management regimes that will be implemented as part of the Project will likely have a positive impact upon this species, when compared with the current situation. Currently, the site shows evidence of increased fire regimes (likely as a result of inappropriate recreational use) and also has outbreaks of weeds that increase the fuel load, such as Gamba Grass and Perennial Mission Grass. Management of fire and these weeds will have a positive effect on the species within the site.

11.3.2.3 Melville Island Desmodium (*Desmodium tiwiense*)

Suitable habitat is present and common on site and is contiguous with habitat for a previous record from within 2 km. It was not observed during the field survey (but an earlier fire had burnt out suitable habitat). Potential habitat for this species is considered to be *Eucalyptus tetrodonta* woodland to low woodland on the lateritic plain, which is also habitat for *Cycas armstrongii*. As mentioned above, avoidance of those parts of the site with higher densities of *Cycas armstrongii* was a key consideration in planning the site layout. Construction of the Project will result in the removal of 12.84 ha of habitat for this species. This is not considered to be significant given habitat for this species is widespread across the region, and the area to be cleared is less than 0.1% of the extent of potential habitat for the species that occurs within the Litchfield Shire area.

Operation of the facility is unlikely to pose any threat to this species. In fact, the weed and fire management regimes that will be implemented as part of the Project will likely have a positive impact upon this species, when compared with the current situation. Currently, the site shows evidence of increased fire regimes (likely as a result of inappropriate recreational use) and also has outbreaks of weeds that increase the fuel load, such as Gamba Grass and Perennial Mission Grass. Management of fire and these weeds will have a positive effect on habitat for the species on site.

11.3.2.4 *Operculina turpethum*

This species was collected on the coastal sand dune immediately adjacent to the Project site in 2000. Potential habitat for this species exists along the coastal sand dune as well as the vine thicket/mangrove mosaic community. It was not observed during the field survey however an earlier fire had burnt out beach dune where it had been previously recorded. If it were to be present, it would not be affected by the Project, as there will be no impacts to the coastal sand dune and/or the vine thicket/mangrove mosaic community.

11.3.2.5 *Pittosporum moluccanum*

Suitable areas of habitat for the species in the vine thicket on stabilised coastal sand dunes are present on site, and the species has been found twice within 2 km of the Project site, both to the north and south. It was not observed during the field survey. As for the *Operculina turpethum*, if it were present on site, it would not be affected, as there will be no impacts to the vine thicket/mangrove mosaic community.

11.3.3 Weeds

In general, weeds are restricted to the areas being utilised by the public for recreation – outside of these areas, exotic species were almost completely absent (with the exception of hyptis - Hyptis suaveolens). Impacts from weeds are most serious on the foredune and swale area – here, perennial mission grass (*Cenchrus polystachyios*), Mossman River grass (*Cenchrus echinatus*) and spiny-headed sida (*Sida acuta*) are all prevalent (as observed in the wet season visit – these areas were thoroughly burnt at the time of the dry season survey). All weed species observed on site are declared Class B and C weeds in the Northern Territory.

Of particular concern is the presence of gamba grass (*Andropogon gayanus*) in isolated clumps on the immediate edge of tracks in the north of the Project site. It is highly productive, developing a dense leaf canopy that greatly increases the fuel load available to fires when compared to fuel loads from native grasses. As a result, fires become hotter than the surrounding woodland are adapted to, and can kill woodland trees and other savannah components This alters the ecosystem over time (woodland becomes tall Gamba grass grassland) and severely decreases biodiversity.

11.3.3.1 Construction

The movement of earthmoving machinery and other plant and construction materials to a site always involves a risk of weed introduction. In addition, the use of that machinery on site can contribute significantly to the spread of existing weeds within the site. However, if thorough weed hygiene measures are implemented, the

risks associated with these activities can be minimised. This includes careful weed wash-down of all plant and equipment moved to the construction site, and the requirement for contractors to complete legal declarations to the effect that their equipment is free of weed seeds. Weed wash-downs will be documented and evidence of this will be collected.

Where the soil seed bank on site already has a weedy component, further movement of those seeds within the site by earthmoving equipment can be impossible to avoid. In this case, monitoring of works areas post-construction will be undertaken and eradication of weeds observed in new areas will be completed at an appropriate time in the lifecycle of the weed (and as early as possible).

The influx of plant, materials and personnel during construction also has a significant risk of the introduction of new weeds, and this risk requires vigilance to avoid ongoing impacts.

11.3.3.2 Operation

The acquisition of the site by Seafarms will result in restriction of public access to the site, as the Seafarms biosecurity protocols forbid uncontrolled access by the public to the areas within the site boundary. A positive externality of this will be the reduction of impacts from recreational use (such as litter, human latrine sites, increased fire and weed dispersion) that are currently clearly evident, and were identified as threatening processes in both the flora and fauna assessments that were undertaken to support this NOI (see Appendix D and Appendix E respectively). Under the Northern Territory *Weed Management Act* (and, additionally for Gamba Grass, the 2014 NT Weed Management Plan for *Andropogon gayanus* [Gamba grass]), Seafarms will have a responsibility to manage the growth and spread of all Class B weeds. As such, the impacts of the Project in terms of weed management will be positive, and will have a flow on positive effect on vegetation community condition and fauna habitat.

11.4 MEASURES TO AVOID OR REDUCE IMPACTS

11.4.1.1 Vegetation Clearance

Upon finalisation of detailed design and vegetation clearing approval, as part of the Construction EMP site specific Vegetation Clearing Plans will be developed, with the extent of clearing and 'no go' areas clearly defined. Clearing activities will avoid damage to the roots, trunks and canopy of adjacent retained vegetation and the boundaries of clearing and 'no go' areas will be clearly pegged/flagged on the ground prior to clearing starting. Training for all personnel will include information on identifying these marked areas.

No lay down areas or materials storage will be located within areas of retained vegetation.

Given the relatively small area of the area to be cleared, clearing will not be staged. Construction is scheduled to take place from April 2019 to February 2020. Land clearing would occur at the beginning of this period and it is expected that the buildings would be constructed by the end of the dry season, with internal fit out occurring through the wet up until February 2020. Clearing in April or May is considered one of the optimal times to undertake clearing, as soils are moist (reducing the chance of wind erosion) but without a high likelihood of rain (reducing the chance of erosion as a result of rainfall). This will minimise the likelihood of erosion related impacts to vegetation adjacent to the footprint that will be retained. Cleared areas will be stabilised as much as practicable prior to wet season rains. The draft EMP for the project (Appendix B) provides measures for erosion and sediment control.

11.4.1.2 Threatened species

Avoidance of habitat for *Cycas armstrongii* was a key consideration in planning the site layout. Siting of infrastructure in areas mapped as having higher densities of this species was avoided, as much as practicable (Figure 59). Upon finalisation of detailed design, and once the exact numbers of *Cycas armstrongii* required to

be removed are known, an application for a permit to take or interfere with wildlife under the *Territory Parks and Wildlife Act 2006*, will be sought. The preferred option is to engage the services of the Larrakia Development Corporation (LDC) to salvage cycads from the site for sale to developers for landscaping. Seafarms are engaging with the LDC regarding this.

Targeted surveys for the other threatened species, *Typhonium praetermissum*, and *Desmodium tiwiense*, which have the potential to be present within the project footprint (and whose detection may have been compromised by fires prior to the flora surveys) are proposed prior to commencement of construction. If found to be present within the footprint, an application for a permit to take or interfere with wildlife under the *Territory Parks and Wildlife Act 2006*, will be sought. Both species are likely to be able to be translocated and this would be investigated further if the species are found to be present within the footprint.

11.4.1.3 Weed Management

A Weed Management Plan (WMP) for the construction and operation stages will be developed and implemented before construction activities commence. The control of gamba grass and perennial mission grass will be a focus of this WMP, including ensuring that vehicle movements to and from site do not spread these weeds further. This plan will include, but not be limited to, the following:

- vehicle and plant wash down procedures for the construction phase, and a requirement for all contractors bringing vehicles/plant onto site to complete Weed Declaration Forms, in which they formally declare that all required weed hygiene measures have been taken and that their vehicles/plant are free of weed material (in particular, weed seeds).
- During construction, weed monitoring will be conducted to ensure that high risk weeds have not been introduced.
- During the operational stage, weed monitoring will be undertaken within the Project footprint, particularly service corridors subject to road traffic, on an annual basis.

12 TERRESTRIAL AND MARINE FAUNA

12.1 METHODS

12.1.1 Conservation Significant Fauna and Pest Species

A Fauna Habitat Assessment was undertaken to support this NOI - the full report is provided at Appendix E.

12.1.1.1 Desktop Analysis

Desktop assessments of the following sources were undertaken to further assess the likelihood of threatened fauna species utilising the Project site:

- Commonwealth EPBC Act Protected Matters Search Tool - search encompassed all land within 15 km of the centre of the site
- Atlas of Living Australia search - search encompassed the area within 15 km of the centre of the site
- NT NRM Infonet
- NR Maps
- Fauna records for the Shoal Bay - Site of Conservation Significance #8
- Previous fauna surveys undertaken in the Project area and surrounds, including:
    - EcoOz (2001) Flora and fauna survey and preliminary environmental assessment, Sunrise Gas Project, Gunn Peninsula, Northern Territory.
    - Department of Infrastructure Planning and Environment Glyde Point Flora and Fauna Survey (GHD 2005)
    - URS (2003) Proposed Glyde Point Industrial Estate Marine Habitats Survey
    - Waterbird and shorebird record data sets relevant to the Shoal Bay area from the Parks and Wildlife Commission of the Northern Territory Technical Reports 73 and 76 (Chatto, 2003 and 2006)
    - The full details of the sources searched are given in Appendix E Fauna Habitat Assessment.

12.1.1.2 Field Assessment

A two day terrestrial habitat assessment of the site and surrounds was undertaken to support this NOI and the EPBC referral on 11 and 12 July 2017.

Site coverage by foot traverse was comprehensive with all habitats sampled. Both foot traverses and driving transects were undertaken within habitats adjacent and to the north, east and south of the site. As part of habitat suitability assessments on the site, information on the presence of hollow-bearing trees (live trees and stags) was collected along nine transects (80m wide strip transects).

On 11 July, foot searches were undertaken throughout the clay pan and wetland habitat to the near south of the site (within the Tree Point Conservation Area) within an hour before high tide for evidence of that habitat supporting a high tide roost for shorebirds. A seven kilometre section of beach was also inspected (during a slow driving transect) to assess evidence of shorebird high tide roosts. Searches for shorebirds utilising intertidal flats were implemented along the same seven kilometre section of beach during a slow vehicle transect within one hour of the nominated low tide.

12.1.1.3 Assessment of Likelihood of Occurrence of Conservation Significant Species at the Site

For each species identified within the databases and predictive models for the Gunn Point area, an assessment of the likelihood of site occurrence was undertaken. The conclusion in regard to site occurrence for each species was based on the known ecological requirements, presence of local records, and the presence and condition of suitable potentially habitat resources on the site.

The assessment of the likelihood of species occurrence within the site was based on the assignment of one of the following categories:

- Likely – where there is a medium to high probability of occurrence on the site. For example, where the species has been recorded as part of surveys within habitats within the local surrounding area and potentially suitable habitat is present within the site OR where the species has been recorded within the extent of desktop searches (as defined in the existing information review) and potentially suitable habitat is present within the site.
- Possible – where that part of the published modelled species' distribution (e.g. categorised as "may occur") incorporates the site and potentially suitable habitat may occur within the site, though there are no records within the extent of desktop searches (as defined in the existing information review) OR where insufficient information to categorise the species as likely to occur, or unlikely to occur. This category represents a highly conservative view of potential occurrence.
- Other – where there is a negligible probability of occurrence within the site (e.g. outside of known extent of occurrence or modelled distribution) OR there is no suitable habitat present within the site or immediately adjacent to the site.

Appendix E gives the full terrestrial Fauna Habitat Assessment report.

12.2 EXISTING ENVIRONMENT

12.2.1 Terrestrial Habitat

The site is dominated by sclerophyll woodland and open forest. *Eucalyptus tetradonta* is a dominant element of the tree canopy throughout the eastern two-thirds of the site. Both density and height of the tree canopy varies considerably. Generally, a higher abundance of taller and older trees were noted from the eastern third of the site, with woodland throughout other parts of the site characterised by a more open tree canopy and generally a lower height class. Understorey is relatively sparse in regard to shrubs and small trees (e.g. *Terminalia carpentariae* and *Pandanus spiralis*), though in parts, it is characterised by notable stands of the cycad *Cycas armstrongii*.

Eucalyptus tetrodonta woodland and open forest supported a comparatively higher density of hollow-bearing trees (live trees and stags) than other vegetation communities. Within the *E. tetrodonta* woodland and open forest, a higher density of hollow-bearing trees were observed within the eastern part of the site. Generally, ground timber (including hollow logs) and termitaria were present, whereas these habitat resources were sparse to absent within other parts of the site (western half and north-western parts). Woodland understorey was also variable, and thought to be linked to changes in topography and the frequency of fire.

Sclerophyll woodland and open forest dominates the erosional plain of the east, with low woodland, shrubland, vine thicket, and grassland present on the slopes and flats to the west of the eroding edge of the plain.

The western parts of the site support distinctly different fauna habitat characteristics in comparison to the woodland / open forest habitats dominating the eastern areas. Here low woodland occurs, either dominated by paperbarks (*Melaleuca viridiflora*) or bloodwoods (*Corymbia polysciada*). The tree canopy is comparatively lower than that observed within the eastern parts of the site (median height <10m versus 15-20m). Ground timber (including hollow logs) and termitaria were present, though sparsely distributed and typically absent within low paperbark woodland, vine thicket, and grassland/sedgeland communities on sandier soils within the western-most third of the site.

Along the western edge of the site, a low dune and swale variously supports mangroves and dry vine thicket communities. These elements intertwine and form a relatively narrow timbered band. During field work, the sandy beach exposed at high tide was approximately 60 m in width, and flats exposed a low tide were approximately 100-150 m in width.

12.2.2 Threatening Processes

There is evidence of a variety of impacts to fauna habitat values on the site. These can be summarised as follows:

- Fire – Evidence of the effects of fire was widespread across the site. There are indications that fire is more frequent and hotter within the western parts of the site (e.g. signs of old fire scars high up on trunks of canopy trees, and the paucity of ground timber and tree stags). The impact of a recent fire was evident across the northern part of the site and much of the eastern half of the site. Evidence indicates that the fire was of higher intensity within the north. It is considered quite possible that fires may more often emanate from unattended / poorly managed fires associated with camping along the beach and foredune areas.
- Invasive weeds – Small occurrences of Gamba grass (*Andropogon gayanus*) has been detected on the site and within the Gunn Point area (see Section 11.2.4). Gamba grass is a serious invasive weed with the capacity to dominate the natural ground cover and significantly increase fire intensity, which in turn can reduce habitat values of woodland/open forest for a wide variety of fauna.
- Invasive animals – Evidence of the occurrence of feral pigs was evident across the site. Habitats associated with depressions in the south-west and the parperbark wetland within the south-east exhibited recent evidence of pig damage. There was also evidence of Buffalos (*Bubalus bubalis*) within the Gunn Point area. Desktop searches revealed a number of feral species that have been previously recorded from the Gunn Point area including: cane toad (*Rhinella marina*), Asain house gecko (*Hemidactylus frenatus)*, house mouse (*Mus musculus*), black rat (*Rattus rattus*) and cats (*Felis catus*).
- Uncontrolled recreational uses – There is ample evidence that the beach and beach dune habitats are well used for recreational camping and four-wheel driving. Clearings for campsites and access tracks are prevalent throughout the dunes. Discarded rubbish is common. Beach driving appears to be common during both high and low tide conditions.

12.2.3 Marine and Intertidal Habitat

The adjacent marine environment to the Project site is Shoal Bay. Hope Inlet, at the mouth of the Howard River, lies to the south. Shoal Bay differs from most other bays in the Top End in that no large rivers (or freshwater coastal floodplains) are associated with it (DNREAS 2017). Extensive mud and sand flats are the major feature of Shoal Bay, with much of the bay exposed at low tide (DNREAS 2017). This is supported by the benthic habitat mapping undertaken to support the Ichthys Gas Field Development Project, which indicated

that the sediments of Shoal Bay are predominantly sand and mud, with the inferred habitat being classified as "soft-bottom benthos; sediment", with no macrobiota or reef communities present (see Figure 60).

In regard to the marine and intertidal habitats of the Shoal Bay SOCS, DNREAS (2017) notes the following:

- The Shoal Bay site lacks extensive sandy beaches and as a result, it is likely to be only used infrequently by marine turtles for nesting;
- No seabird breeding colonies are known from the Shoal Bay site;
- The Shoal Bay site lacks a large area of freshwater wetland and supports relatively low numbers of waterbirds;
- Sand and mud flats in Shoal Bay are an important feeding and roosting area for migratory shorebirds during their non-breeding season;
- Parts of the Shoal Bay site are degraded due to heavy disturbance by recreational users;
- Urbanisation is impacting on the Shoal Bay site, with local swamps being drained for urban development and further developments are proposed as Darwin continues to expand;
- Other management concerns include exotic plants and animals, frequent fires, and uncontrolled recreational use of the area.

12.2.4 Conservation Significant Fauna

Table 33 lists 44 conservation significant species listed under the TPWC that may occur around, or relate to the Project area. Table 33 also provides an assessment of the likelihood of occurrence of each conservation significant species. The likelihood of a species occurring on the Project area was assessed based on an analysis of threatened species records within the Project area, surrounds and the wider Gunn Peninsula area. Records of threatened species from the Project site surrounds are shown on Figure 61. Likelihood of a species occurring on the Project area was categorised into one of the following three categories:

- Likely - where there is a medium to high probability of occurrence on the site. For example, where the species has been recorded as part of surveys within habitats within the local surrounding area and potentially suitable habitat is present within the site OR where the species has been recorded within the extent of desktop searches (as defined in the existing information review) and potentially suitable habitat is present within the site[2].

[2] This category may include species for which there are historical but no recent records (due to inadequate survey effort), and for which there is suitable habitat within the site.

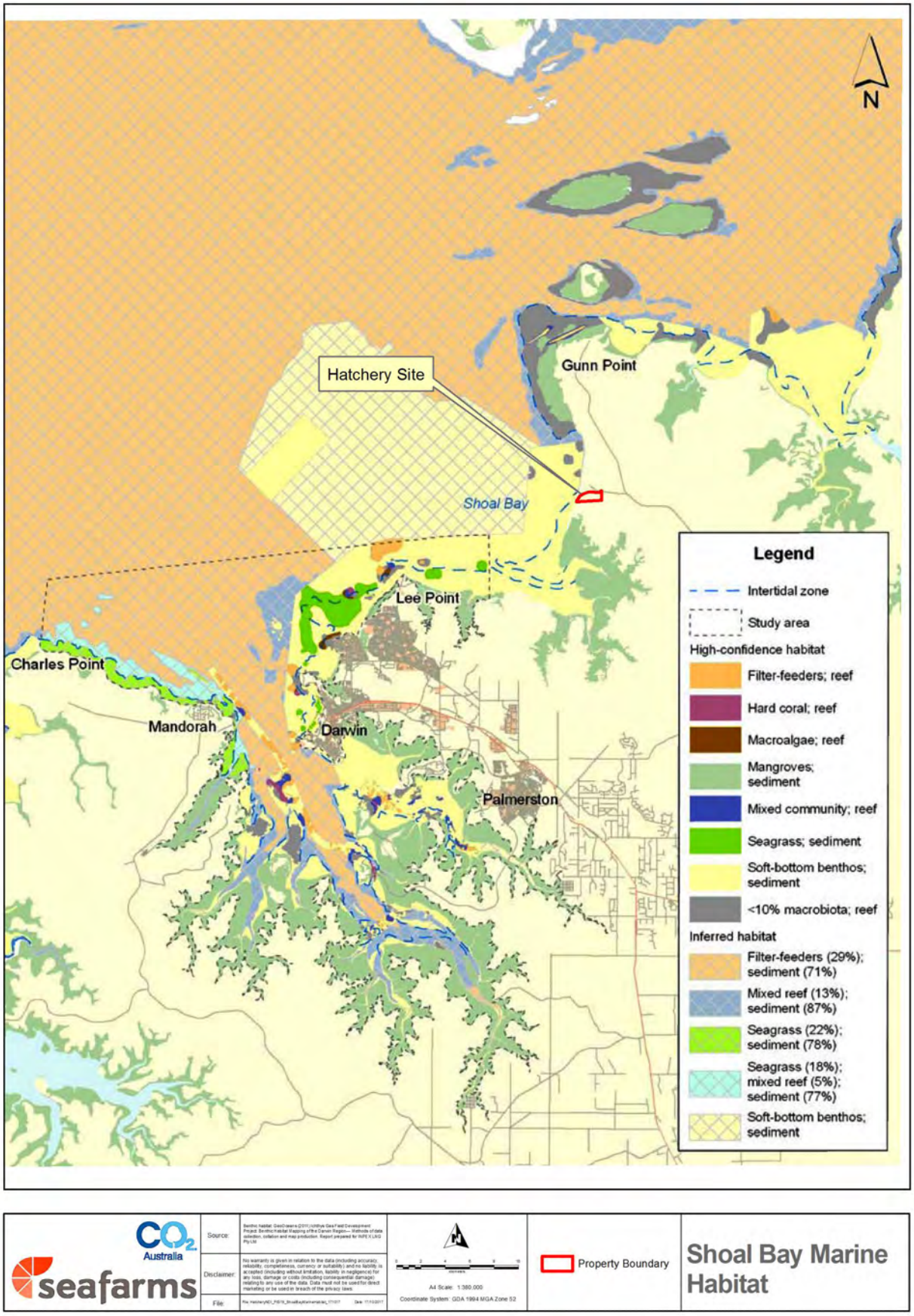

FIGURE 60 SHOAL BAY MARINE HABITAT

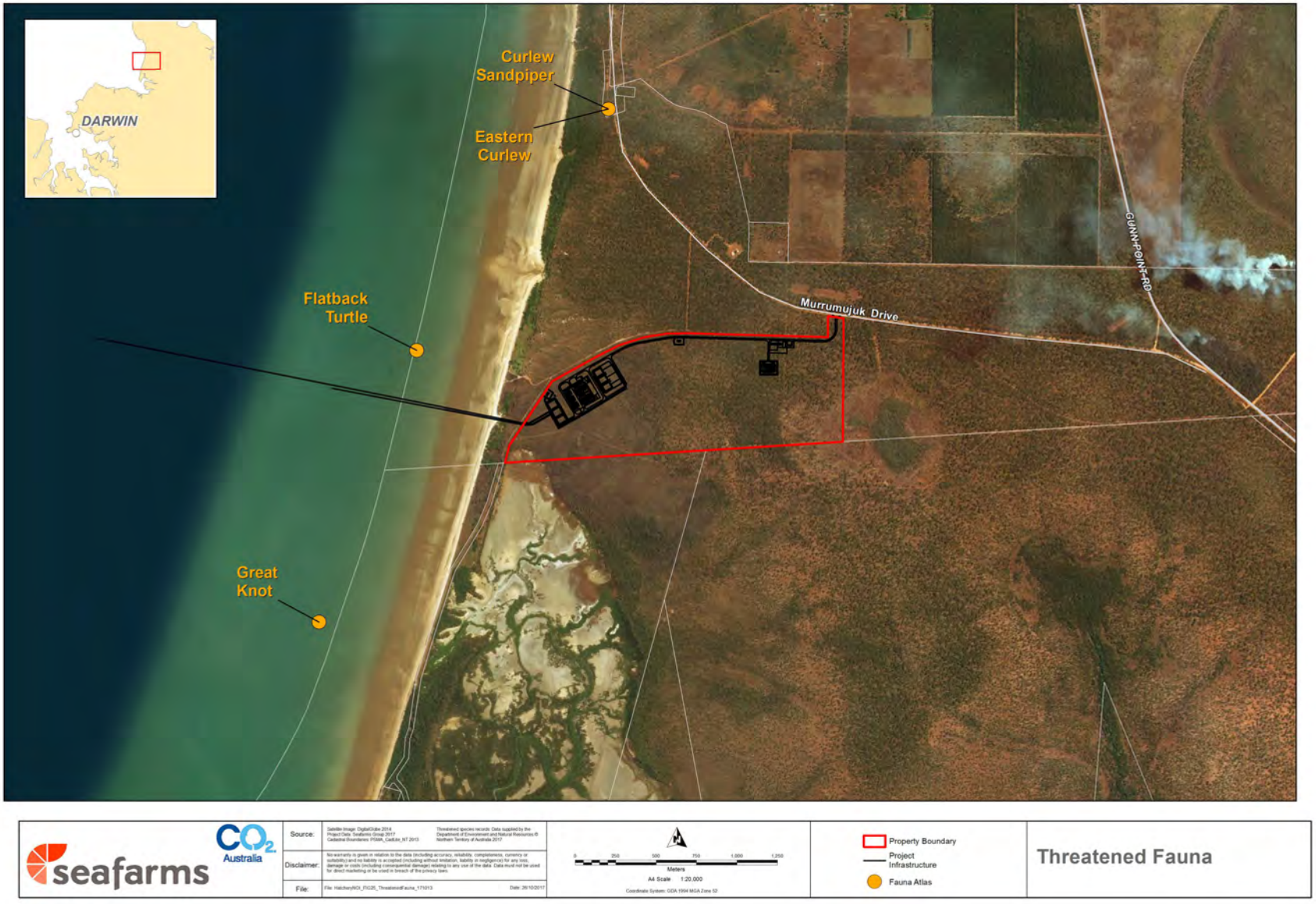

FIGURE 61 THREATENED FAUNA RECORDS

- Possible – where that part of the published modelled species' distribution (e.g. categorised as "may occur")[3] incorporates the site and potentially suitable habitat may occur within the site, though there are no records within the extent of desktop searches (as defined in the existing information review) OR where insufficient information to categorise the species as likely to occur, or unlikely to occur. This category represents a highly conservative view of potential occurrence.
- Other – where there is a negligible probability of occurrence within the site (e.g. outside of known extent of occurrence or modelled distribution) OR there is no, or insufficient, suitable habitat present within the site or immediately adjacent to the site[4]

Threatened and migratory fauna species that are listed under the EPBC Act that have the potential to occur on, or relate to Project area have been assessed as part of a referral to the Commonwealth Government, as described in Section 18.

12.2.5 Pest Species

GHD (2005) and EcoOz (2001) recorded a number of introduced fauna species in the area surrounding the Project including the black rat (*Rattus rattus*), house mouse (*Mus musculus*), feral pig (*Sus scrofa*), horse (*Equus cabalus*), cattle (*Bos taurus*) and Asian water buffalo (*Bubalus bubalis*).

During the recent fauna assessment undertaken to support this NOI the occurrence of feral pigs was evident across the site. Habitats associated with depressions in the south-west and the paperbark wetland within the south-east exhibited recent evidence of pig damage. There was also evidence of Asian water buffalo within the Gunn Point area.

At a larger scale, the pest species listed in Table 32 were returned from grid cells within which the NT NRM search was undertaken (i.e. the search area lies within a number of grid cells but the results returned are from the search area plus the full extent of the grid cell within which the search area occurs - see Figure 62) - as such the following records may relate to areas outside of the Project site and immediate surrounds.

TABLE 32 PEST SPECIES RECORDS FROM NT NRM MAPS

Common Name	Scientific Name
Cane Toad	*Rhinella marina*
Asian House Gecko	*Hemidactylus frenatus*
Flower-pot Blind Snake	*Ramphotyphlops braminus*
Rock Dove	*Columba livia*
Barbary Dove	*Streptopelia roseogrisea*
Common Starling	*Sturnus vulgaris*
House Sparrow	*Passer domesticus*

[3] 4 e.g. as published in DEWHA (2009b), SEWPaC (2011a) or as in Garnett et al. (2010) (minimum convex polygon that depicts extant taxon's extent of occurrence).

[4] This category could include species known from the project area historically, which are now considered unlikely to occur due to significant loss/degradation of habitat and/or other threatening processes (e.g., disease, predation by feral species).

Common Name	Scientific Name
Eurasian Tree Sparrow	*Passer montanus*
House Mouse	*Mus musculus*
Black Rat	*Rattus rattus*
Cat	*Felis catus*
Rabbit	*Oryctolagus cuniculus*
Horse	*Equus caballus*
Pig	*Sus scrofa*
Swamp Buffalo	*Bubalus bubalis*
Cattle	*Bos taurus*

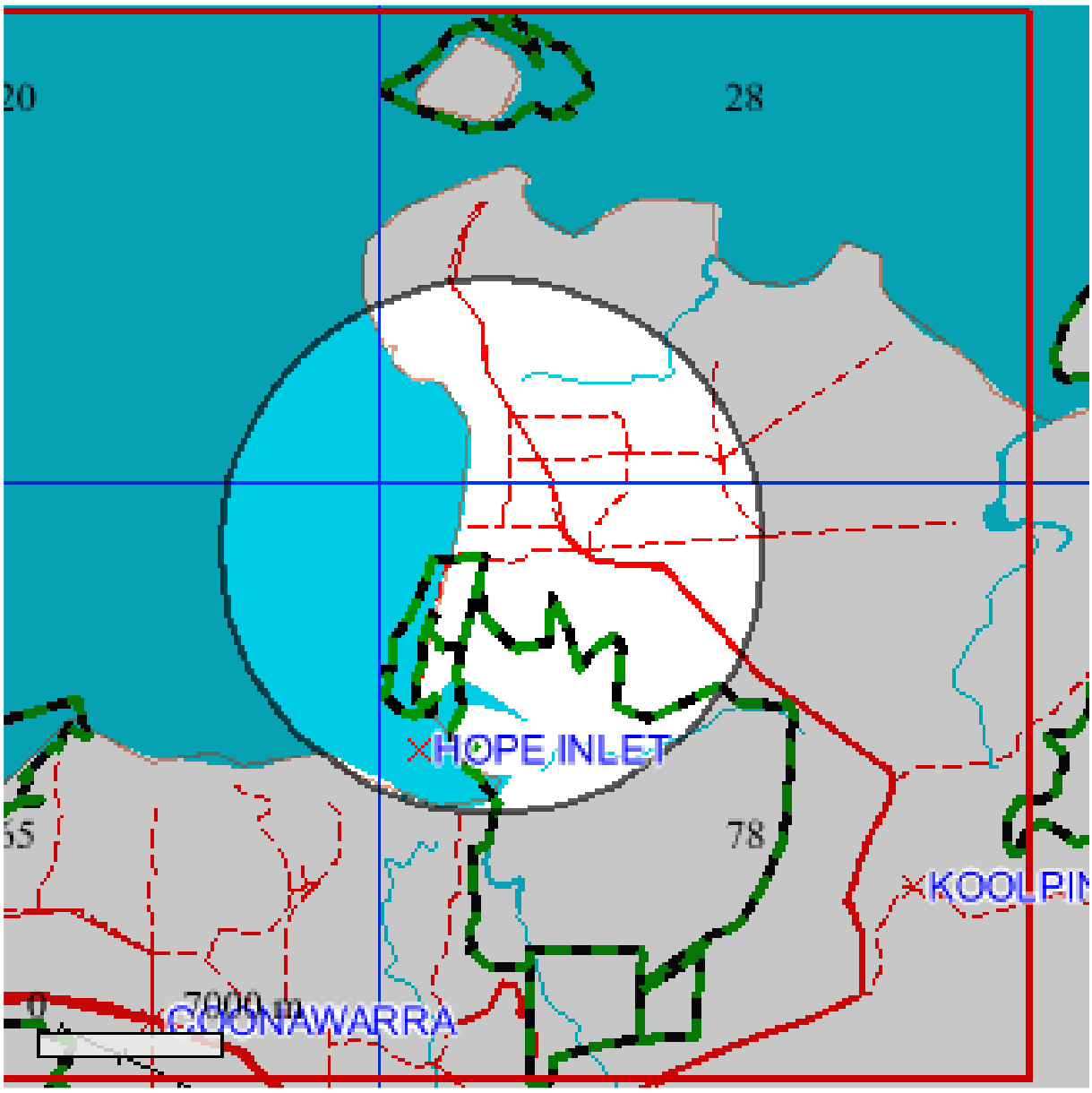

FIGURE 62 NT NRM REPORT PEST SPECIES SEARCH AREA

TABLE 33 THREATENED FAUNA SPECIES LISTED UNDER THE TPWC ACT

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Invertebrates								
Attacus wardi	Atlas Moth	-	V	-	•	-	-	**Potential Site Occurrence:** OTHER (negligible probability / highly degraded conditions & resources / recognised threats present & on-going / marginal habitat suitability) - **Ecology, Distribution & Threats:** The critical habitat is either dry or wet coastal monsoon forest, but they are predominantly known from drier monsoon forest, i.e coastal semi-deciduous monsoon vine-thicket. It is thought that a patch size of at least 8 hectares, but preferably greater than 20 hectares, is required to maintain a viable local population. The larval stages are associated with the pioneer species, *Croton habrophyllus*, growing on the edges of large patches of monsoon forest. Breeding colonies are very local in distribution, but adults may be seasonally abundant with a very limited flight period. Although this species is known from Gunn Point, and the Project site does contain habitat for this species, the patch of dry vine thicket (which is analogous with dry monsoon vine thicket) on the Project site is 1) considered degraded 2) is only 3.4 ha in size, and 3) the larval food plant, *Croton haprohyllus,* was not observed. As such, it is considered unlikely that there is a local population associated with the on-site habitat, given the requirement for patch sizes larger than 8 hectares, with an abundance of *Croton haprophyllus*. **Current Threats:** Inappropriate fire regimes, introduced African greasy weeds, which lead to modified and exacerbated fire regimes. **Sources:** Braby & Nielsen, 2011; Lane et al., 2010;

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Ogyris iphis doddi	Dodd's Azure Butterfly	-	E					**Potential Site Occurrence:** POSSIBLE (habitat conditions and resources available / habitat degraded / increased fire regimes/ presence of weed species that increase impacts of fire) **Ecology, Distribution & Threats:** Apparently restricted to the Top End of the Northern Territory. It is known only from Darwin and Melville Island. It is not clear if the apparent rarity is due to insufficient survey effort, or that the subspecies is in decline. Adults are rarely collected because they are relatively cryptic and difficult to sample due to their extreme localization and arboreal specialization on mistletoe food plants, which frequently grow in the canopy of eucalypts. The larvae shelter during the day in hollows or cracks in the haustorium of mistletoe where attendant ants have established a nest, and pupate in similar situations. The adults fly rapidly among the tree tops, but are rarely observed. **Potential Threats:** There is no evidence that any external factors have caused a decline in numbers or distribution of Dodd's Azure Butterfly. However, clearing of its preferred eucalypt forest habitat and increased fire regime potentially leading to declines in mistletoes in habitats on which they depend, may be threatening processes. **Sources:** Braby and Woinarski, 2006
Fish								

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Glyphis garricki	Northern River Shark, New Guinea River Shark	E	E	•	-	-	-	**Potential Site Occurrence:** POSSIBLE (modelled species' distribution indicates it "may occur"[5] /potentially suitable habitat but there are no records / insufficient information to categorise the species as likely to occur, or unlikely to occur). **Ecology, Distribution & Threats:** The northern river shark is believed to be endemic to Australia and southern New Guinea, with small and fragmented populations along the Northern Territory coast. Australian records of this species are from four rivers and estuaries in Northern Australia, and from marine waters north of 18°S. It is thought that rivers are nursery habitats. Neonates, juveniles and sub-adults (<135 cm total length) have been recorded in freshwater (Adelaide River), estuarine (Ord and King Rivers, South and East Alligator Rivers) and marine environments (King Sound). Adults (>140 cm total length) have only been recorded in marine environments (King Sound, Joseph Bonaparte Gulf, Western Australia and the Wessell Islands). The small amount of available data for this species suggests a preference for highly turbid, tidally influenced waters with fine muddy substrate. Northern river shark are likely to occur in upstream areas of estuaries in the dry season when salinity is tidally influenced, and to move downstream towards the estuary mouth in the wet season. **Potential Threats:** Fishing bycatch and habitat modification. **Sources:** Field, et al, 2008; Field et al. 2013; Pillans et al. 2009; Stevens et al. 2005; P. Kyne pers. comm. Charles Darwin University/NESP Marine Biodiversity Hub

[5] 4 e.g. as published in DEWHA (2009b), SEWPaC (2011a) or as in Garnett et al. (2010) (minimum convex polygon that depicts extant taxon's extent of occurrence).

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Glyphis glyphis	Speartooth Shark	CE	V	•	-	-	-	**Potential Site Occurrence:** POSSIBLE (modelled species' distribution indicates it "may occur"[6] /potentially suitable habitat but there are no records / insufficient information to categorise the species as likely to occur, or unlikely to occur). **Ecology, Distribution & Threats:** Speartooth shark have only been recorded from Australia and Papua New Guinea. The Australian records of the speartooth shark are confined to nine tropical rivers and estuaries in the Northern Territory and Queensland, north of 15°S. Speartooth shark are found in tropical tidal rivers and estuaries with turbid water and fine muddy substrate. In the Northern Territory, 93 records confirm speartooth shark in the tidal reaches of eight rivers, with the majority of records from the Adelaide River. This species has also recently been recorded in the Daly and Ord Rivers. The diet of speartooth shark is likely to consist primarily of teleost fishes and macroinvertebrates, with stomach contents including cherabin, burrowing gobies, gudgeons, benthic feeding jewfish and bony bream. **Potential Threats:** Fishing bycatch and habitat modification. **Sources:** Peverall et al. 2006; Pillans et al. 2009; P. Kyne pers. comm. Charles Darwin University/NESP Marine Biodiversity Hub

[6] 4 e.g. as published in DEWHA (2009b), SEWPaC (2011a) or as in Garnett et al. (2010) (minimum convex polygon that depicts extant taxon's extent of occurrence).

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Pristis clavata	Dwarf Sawfish, Queensland Sawfish	V, Mi	V	•	-	-	•	**Potential Site Occurrence:** LIKELY (species has been recorded as part of surveys within habitats within the local surrounding area and potentially suitable habitat is present within the footprint for the intake and discharge pipelines). **Ecology, Distribution & Threats:** The distribution of the dwarf sawfish is likely to be north from the Cape York Peninsula, Queensland, and across northern Australian waters to the Pilbara coast, Western Australia. In the Northern Territory, this species has been recorded in the Keep River, Victoria River, Buffalo Creek and Rapid Creek, and the South Alligator River catchments. Buffalo Creek drains into the west of Shoal Bay. Dwarf sawfish inhabit shallow (2-3 m), saline or brackish coastal waters and estuarine habitats, and do not utilise purely freshwater areas. Adults are likely to have a small home range (few square kilometres) and show site fidelity. Pupping is likely to occur in estuarine areas during the wet seasons and juveniles may remain in such habitats for several years. Adult dwarf sawfish move into marine waters after the wet season. Typically for sawfish, the dwarf sawfish feeds by stunning schooling fish with its toothed rostrum. Its main prey is pop-eye mullet. **Potential Threats:** Fishing pressure (commercial, recreational, Indigenous and unregulated illegal fishing) and habitat disturbance, particularly to river systems and estuaries. **Sources:** CoA, 2015; DoEE 2017a; Larson et al. 2012; Peverell 2005; Stevens et al. 2008; Thorburn et al. 2007

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Pristis pristis	Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish	V, Mi	V	•	-	-	-	**Potential Site Occurrence:** LIKELY (species has been recorded as part of surveys within habitats within the local surrounding area and potentially suitable habitat for adults is present within the footprint for the intake and discharge pipelines). **Ecology, Distribution & Threats:** In Australia, largetooth sawfish have been recorded within fresh and saline waters of numerous drainage from the Fitzroy River, Western Australia, to the western side of Cape York Peninsula, Queensland. In the Northern Territory, largetooth sawfish occur in the Keep, Victoria, Darwin, Adelaide, East and South Alligator, Daly, Goomadeer, Wearyan, McArthur and Robinson rivers. Largetooth sawfish generally inhabit sandy or muddy bottoms of shallow coastal waters, estuaries and river mouths, as well as the central and upper reaches of freshwater rivers and isolated waterholes. Largetooth sawfish are thought to pup in the estuary in the wet season with young moving upstream. Largetooth sawfish have an ontogenetic shift in habitat use with neonates and juveniles primarily occurring in the freshwater reaches of rivers and estuaries and adults being found in marine and estuarine environments. As such, it is unliley that juveniles and neonates would be found in the vicinity of the Project pipelines. **Potential Threats:** Fishing pressure (commercial, recreational, Indigenous and unregulated illegal fishing) and habitat disturbance, particularly to river systems and estuaries. **Sources:** CoA, 2015; DoEE 2017a; Larson et al. 2006; Peverell 2008; Peverell 2009

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Pristis zijsron	Green Sawfish, Dindagubba, Narrowsnout Sawfish	V, Mi	V	•	-	-	•	**Potential Site Occurrence:** POSSIBLE (species has been recorded as part of surveys within habitats within the local surrounding area and potentially suitable, but not preferred, habitat is present within the footprint for the intake and discharge pipelines). **Ecology, Distribution & Threats:** In Australia, green sawfish have historically been recorded from Broome, Western Australia, around northern Australia and down the east coast as far as Jervis Bay, New South Wales. Green sawfish have been collected from Buffalo Creek on the western side of Shoal Bay. They are considered likely to be more widely distributed in habitat characterised by muddy substrate and shallow waters. Green sawfish occur in inshore coastal environments including estuaries, river mouths, and embayments, along sandy and muddy beaches, as well as in offshore marine habitats. They are thought to be largely restricted to the inshore coastal fringe, with a strong association with mangroves and adjacent mudflats. Therefore even though they are known from other parts of Shoal Bay, as mangroves and adjacent mudflats do not occur in proximity to the they are considered possible, not likely to occur. Given this habitat is not found in proximity to the Project pipelines. **Potential Threats:** Fishing pressure (commercial, recreational, Indigenous and unregulated illegal fishing) and habitat disturbance, particularly to river systems and estuaries. **Sources:** CoA, 2015; Stirrat et al. 2006; Stevens et al. 2008
Terrestrial Reptiles								

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Acanthophis hawkei	Plains Death Adder	V	V	•	-	-	-	**Potential Site Occurrence:** OTHER (would not occur / no suitable habitat present) **Ecology, Distribution & Threats:** The exact distribution of the species is unclear. Suitable habitat consists of flat, treeless, cracking-soil riverine floodplains. Based on the presence of suitable habitat, the potential geographic range extends from Western QLD, across the north of the NT to north-east WA. Native frogs make up a large proportion of the species' diet. **Potential Threats:** The main identified threat is the introduced cane toad. Habitat modification due to over-grazing by cattle and inappropriate fire regimes are potential threats. **Sources:** Woinarski et. al. 2007; DE TSSC 2011a; & Cogger 2014.
Varanus panoptes	Yellow-spotted Monitor	-	V	-	•	•	-	**Potential Site Occurrence:** POSSIBLE (remnant habitat conditions and resources available / habitat degraded / fire & cane toads) **Ecology, Distribution & Threats:** A large ground-dwelling monitor occupying a variety of habitats, including coastal beaches, floodplains, grasslands and woodlands. Feeds mostly on insects and small, terrestrial vertebrates, though will also take other foods when available, such as eggs of marine and freshwater turtles. In the NT, it has been recorded across most of the Top End and the Gulf regions and south to about Katherine. **Potential Threats:** Principal threat in the NT is the arrival and spread of cane toads. **Sources:** Woinarski et. al. 2007; DLRM 2012b; Cogger 2014; & Doody et. al. 2015.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Varanus mertensi	Mertens` Water Monitor	-	V	-	-	•	-	**Potential Site Occurrence:** OTHER (would not occur / no suitable habitat present) **Ecology, Distribution & Threats:** Semi-aquatic monitor and is seldom far from water of coastal and inland rivers and wetlands. Widespread in the Northern Territory, occupying all of the Top End river systems. Known to feed on a wide variety of prey including fish, frogs, freshwater crabs, bird and turtle eggs, and carrion, though also insects and terrestrial vertebrates when available. **Potential Threats:** The principal threat in the NT is the arrival and spread of cane toads (poisoning). **Sources:** Griffiths & McKay 2007; Woinarski et. al. 2007; DLRM 2012c; & Doody et. al. 2015.
Varanus mitchelli	Mitchell`s Water Monitor	-	V	-	-	•	-	**Potential Site Occurrence:** OTHER (would not occur / no suitable habitat present) **Ecology, Distribution & Threats:** An aquatic monitor of wetlands across the northern parts of the NT and northern WA. Inhabits all of the Territory's northern river systems (except the southern Gulf). A strong swimmer and feeds largely on aquatic insects, fish, small lizards and frogs, though also bird's eggs when available. Principal threat in the NT is the arrival and spread of cane toads. **Sources:** Woinarski et. al. 2007; DLRM 2012d; Cogger 2014; & Doody et. al. 2015.
Amphibians								

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Uperoleia daviesae	Howard Springs Toadlet	-	V	-	-	•	-	**Potential Site Occurrence:** OTHER (would not occur / no suitable habitat present) **Ecology, Distribution & Threats:** Endemic to the NT. Confined to sandsheet heathland associated with alluvial plains, drainage lines and seepage zones within the Howard and Elizabeth River Catchments (close to Darwin). Within these areas, known from habitats of sandy soils with short vegetation that is inundated in the Wet season, or to adjacent melaleuca woodland areas. Habitats threatened by impacts associated with the expansion of peri-urban areas of Darwin. **Sources:** Woinarski et. al. 2007; DLRM 2012e; & Cogger 2014.
Marine Reptiles								
Caretta caretta	Loggerhead Turtle	E, Mi	V	•	-	-	-	**Potential Site Occurrence:** LIKELY (species has been recorded as part of surveys within habitats within the local surrounding area and potentially suitable habitat). **Ecology, Distribution & Threats:** There is no confirmed nesting of loggerhead turtles in the Northern Territory. However, feeding grounds generally occur from Fog Bay around to north-east Arnhem Land. Loggerheads have been reported as by-catch in inshore water during prawn trawls along the northern and eastern coasts of the NT. Potential threats: effects of climate change on habitat, resources, and biology/life history; ingestion of, and entanglement in, marine debris; biological effects of anthropogenic sources of chemicals and sediment; hunting and fishing bycatch; terrestrial predation upon eggs and hatchlings; light pollution; habitat modification due to coastal development, dredging and trawling; boat strike; marine noise; recreational activities; diseases and pathogens. **Sources:** Chatto, 1998; Chatto & Baker, 2008; CoA 2017; Robins et al. 2002.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle, Luth	E, Mi	CE	•	-	-	-	**Potential Site Occurrence:** OTHER (there is no suitable habitat present within the site or immediately adjacent to the site). **Ecology, Distribution & Threats:** The leatherback turtle spends much of its time in the open ocean, mainly venturing close to shore during the nesting season. There are very few nesting records for the leatherback turtle in the Northern Territory, and none from near the Project area (the closest being Point Danger on the Coberg Peninsula, more than 200 km away). Potential threats: effects of climate change on habitat, resources, and biology/life history; ingestion of, and entanglement in, marine debris; biological effects of anthropogenic sources of chemicals and sediment; hunting and fishing bycatch; terrestrial predation upon eggs and hatchlings; light pollution; habitat modification due to coastal development, dredging and trawling; boat strike; marine noise; recreational activities; diseases and pathogens. **Sources:** Benson et al. 2007; Chatto & Baker, 2008; CoA 2017; GBRMPA 2011; Lutz & Musick 1996

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Eretmochelys imbricata	Hawksbill Turtle	V, Mi	V	•	-	-	•	**Potential Site Occurrence:** LIKELY (species has been recorded as part of surveys within habitats within the local surrounding area and potentially suitable habitat). **Ecology, Distribution & Threats:** The hawksbill turtle is found in tropical, subtropical and temperate waters in all the oceans of the world, with nesting mainly confined to tropical beaches. Most hawksbill nesting in the Northern Territory occurs on islands (rather than mainland beaches) between north-east Arnhem Land and Groote Eylandt. There have been sightings of this species from around Darwin and Bynoe Harbour. Potential threats: effects of climate change on habitat, resources, and biology/life history; ingestion of, and entanglement in, marine debris; biological effects of anthropogenic sources of chemicals and sediment; hunting and fishing bycatch; terrestrial predation upon eggs and hatchlings; light pollution; habitat modification due to coastal development, dredging and trawling; boat strike; marine noise; recreational activities; diseases and pathogens. **Sources:** Chatto 1998); Chatto & Baker, 2008; CoA 2017; DoEE 2017a

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Lepidochelys olivacea	Olive Ridley Turtle, Pacific Ridley Turtle	E, Mi	V	•	-	-	•	**Potential Site Occurrence:** LIKELY (species has been recorded as part of surveys within habitats within the local surrounding area and potentially suitable habitat is present within the site). **Ecology, Distribution & Threats:** Olive ridley turtles occur in tropical and sub-tropical regions of the Pacific and Indian oceans. Their nesting range stretches from the western coastline of Cape York, Queensland to Port Keats, NT. They have mainly been recorded nesting on island beaches, but are also known from mainland beaches, and have even been recorded nesting at Casuarina Beach, in Darwin. Olive Ridley turtles generally forage over shallow benthic habitats, ranging in depths from several metres to over 100 m. They are typically not associated with coral reef habitat or shallow inshore seagrass and their diet consists of gastropod, bivalve molluscs, crabs, shrimp, tunicates, jellyfish, salps and algae. Potential threats: effects of climate change on habitat, resources, and biology/life history; ingestion of, and entanglement in, marine debris; biological effects of anthropogenic sources of chemicals and sediment; hunting and fishing bycatch; terrestrial predation upon eggs and hatchlings; light pollution; habitat modification due to coastal development, dredging and trawling; boat strike; marine noise; recreational activities; diseases and pathogens. **Sources:** Chatto & Baker 2008; CoA 2017; Conway 1994; DoEE, 2017a; Limpus 2008; Limpus & Roper 1977, Limpus et al. 1983; Whiting et al. 2005.
Birds								

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Calidris canutus	Red Knot, Knot	E, Mi	V	•	•	•	•	**Potential Site Occurrence:** LIKELY (potential occurrence on intertidal feeding habitat adjacent / beach subject to regular human disturbance / no suitable high tide roost habitat). **Ecology, Distribution & Threats:** Migratory, arriving in northern Australia between late August and early September, with departures to breeding grounds between late March and the end of April. Mainly inhabits intertidal mudflats, sandflats and sandy beaches of sheltered coasts, though also sandy ocean beaches or shallow pools on exposed rock platforms. Occasionally seen on terrestrial saline wetlands near the coast and on sewage ponds and saltworks. Within the NT, potentially the most important areas are the coast between the Daly River and the islands off Bynoe Harbour (particularly the Fog Bay area), the coast from Boucaut Bay to Buckingham Bay (including the Cadell Straits) and the coasts in the vicinity of the Roper River and Port McArthur. **Sources:** Higgins & Davies 1996; Chatto 2003 a&b; Geering et. al. 2007; & DE TSSC 2016c.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Calidris ferruginea	Curlew Sandpiper	CE, Mi	V	•	•	•	•	**Potential Site Occurrence:** LIKELY (potential occurrence on intertidal feeding habitat adjacent / beach subject to regular human disturbance / no suitable high tide roost habitat). **Ecology, Distribution & Threats:** Mainly on intertidal mudflats in sheltered coastal areas, including estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes, lagoons, and sewage farms near the coast. Also recorded less often on inland ephemeral and permanent lakes, dams. Occurs on both fresh and brackish non-tidal habitats. Within the NT, areas of importance include Fog Bay, Chambers Bay and the Port McArthur areas. Migratory, arriving in northern Australia between late August and early September, with departures to breeding grounds between late March and the end of April. **Sources:** Higgins & Davies 1996; Chatto 2003 a&b; Geering et. al. 2007; & DE TSSC 2016de.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Calidris tenuirostris	Great Knot	CE, Mi	V	•	•	•	•	**Potential Site Occurrence:** Likely (potential occurrence on intertidal feeding habitat adjacent / beach subject to regular human disturbance / no suitable high tide roost habitat). **Ecology, Distribution & Threats:** Prefers sheltered coastal habitats with large intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Occasionally occur at swamps near the coast, salt lakes and non-tidal lagoons. Migratory, arriving in northern Australia between late August and November, with departures to breeding grounds between March to April. A significant proportion of the population apparently remain in northern Australia. Within the NT, the most significant areas are along the coast from the Daly River to Murgenella Creek (particularly the Fog Bay area), the coast from Junction to Buckingham Bays, and the coast from Port McArthur to the Roper River. **Sources:** Higgins & Davies 1996; Chatto 2003 a&b; Geering et. al. 2007; & DE TSSC 2016d.
Charadrius leschenaultii	Greater Sand Plover, Large Sand Plover	V, Mi	V	•	•	•	•	**Potential Site Occurrence:** Likely (potential occurrence on intertidal feeding habitat adjacent / beach subject to regular human disturbance / no suitable high tide roost habitat). **Ecology, Distribution & Threats:** Migratory, arriving along the Top End coastline in late July with departures to breeding grounds late February and April. Almost entirely coastal, inhabiting littoral and estuarine habitats where it occurs on sheltered sandy, shelly or muddy beaches, large intertidal mudflats, sandbanks, salt-marshes, estuaries, coral reefs, and tidal lagoons near the coast. The most significant areas within the Top End include Joseph Bonaparte Gulf, the coast from Anson Bay to Murgenella Creek, the northern Arnhem coast, and the Port McArthur area. **Sources:** Higgins & Davies 1996; Chatto 2003a; Geering et. al. 2007; & DE TSSC 2016df.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Charadrius mongolus	Lesser Sand Plover, Mongolian Plover	E, Mi	V	•	•	•	•	**Potential Site Occurrence:** Likely (potential occurrence on intertidal feeding habitat adjacent / beach subject to regular human disturbance / no suitable high tide roost habitat). **Ecology, Distribution & Threats:** Migratory, arriving along the Top End coastline in late July with departures to breeding grounds late February and April. Almost strictly coastal, preferring sandy beaches, sand-flats, and mudflats of coastal bays and estuaries, occasionally frequenting mangrove mudflats. Mainly feeds on extensive, freshly-exposed areas of intertidal sandflats and mudflats in estuaries or beaches, or in shallow ponds in saltworks. Recorded from most of the NT coastline, with the most significant areas regarded as the coast from Anson Bay to Murgenella Creek, the northern Arnhem coast, Blue Mud Bay and the Port McArthur area. **Sources:** Higgins & Davies 1996; Chatto 2003a; Geering et. al. 2007; & DE TSSC 2016g.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Epthianura crocea tunneyi	Alligator Rivers Yellow Chat, Yellow Chat (Alligator Rivers)	E	E	•	-	•	-	**Potential Site Occurrence:** Other (would not occur / no suitable habitat present) Ecology, Distribution & Threats: Two subspecies occur within the NT, however, subspecies Epthianura crocea tunneyi is restricted to a small geographic area which comprises floodplains between the Adelaide River to the East Alligator River. Within this area it is known from only a small number of sites. Most records of the subspecies derive from tall grasslands and samphire shrublands (on coastal saltpans) associated with floodplain depressions and channels, and concentrating around wetter areas at the end of the dry season. **Current and potential threats:** alteration of preferred floodplain habitats by invasive exotic plant species (notably by Mimosa pigra, Brachiaria mutica and *Andropogon gayanus*); and vegetation change due to grazing by buffalo and cattle, by wallowing and rooting by pigs; and by altered fire regimes. **Sources:** Armstrong 2004; Woinarski et al 2007; Garnett et al. 2011; & DE TSSC 2016i.
Erythrotriorchis radiatus	Red Goshawk	V	V	•	•	-	•	**Potential Site Occurrence:** Possible (remnant habitat conditions and resources available / habitat degraded / fire impacts) **Ecology, Distribution & Threats:** Patchy, widespread distribution across coastal and sub-coastal regions of northern and eastern Australia, with the NT considered to be a stronghold for the species. Maintains a very large home range (e.g. >120km2) across open forest and woodland, and favouring such habitats associated with river systems. Considered to be monogamous and the same territories may be occupied year after year. Breeding generally occurs in the dry season with very tall E. tetradonta being a favoured nest site. **Sources:** Aumann & Baker-Gabb 1991; Marchant & Higgins 1993; Woinarski et. al. 2007; Garnett et al. 2011; DERM 2012; DLRM 2012f; & DE TSSC 2015g.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Erythrura gouldiae	Gouldian Finch	E	V	•	-	•	-	**Potential Site Occurrence:** Other (would not occur / no suitable habitat present) **Ecology, Distribution & Threats:** Obligate cavity-nesting grassfinch. Granivorous, with a rather specialised diet according to wet or dry season. Regular seasonal shifts in habitat, from breeding areas in hill woodland in the dry season to adjacent lowlands throughout much of the wet season, are in response to seasonal changes in food availability. Known breeding habitat in the NT and WA is characterised by rocky hills with hollow-bearing *Eucalyptus brevifolia, E. tintinnans* or *Corymbia dichromophloia*, and within two to four kilometres of small waterholes or springs that persist throughout the dry season. Formerly ranged across the Top End, though now only reliably recorded at a small number of sites in the Ord Victoria Plains, Victoria Bonaparte, Pine Creek, Central Kimberley, Northern Kimberley, and Dampierland Bioregions of the NT and WA. **Sources:** Tidemann et al. 1999; Dostine & Franklin 2002; O'Malley 2006; Garnett et al. 2011; & DE TSSC 2016h.
Falco hypoleucos	Grey Falcon	-	V	-	-	•	-	Potential Site Occurrence: Other (would not occur / no suitable habitat present) Ecology, Distribution & Threats: More commonly associated with open country and wooded habitats of the arid and semi-arid zones, though occasionally recorded near the coast in open woodland, lightly timbered plains and grasslands. Sporadic records on the periphery of its range are usually during or after inland drought. The majority of records from the NT are from the southern half (mainly south of 20ºS). Sources: Marchant & Higgins 1993; Woinarski et. al. 2007; DLRM 2012g; & Schoenjahn 2013.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Geophaps smithii smithii	Partridge Pigeon (eastern)	V	V	•	-	•	-	**Potential Site Occurrence:** Possible (remnant habitat conditions and resources available / habitat degraded / fire & invasive grasses) **Ecology, Distribution & Threats:** A ground-dwelling species whose diet comprises seeds of mostly grasses, though also from Acacia and other woody plants. Considered to be relatively sedentary and within habitats in proximity to water, though known to make local-scale movements (up to 5 to 10 km) in response to seasonal variations in water and food availability. As a ground-nesting species (nesting during the dry season and preferentially selecting sites within relatively dense grass), it is vulnerable to a variety of threats, including fire, though may be disadvantaged by the absence of fire which leads to development of structurally/floristically unsuitable feeding habitat. Previously recorded across the Top End and far east Kimberley though now recorded only in sub-coastal parts, from Yinberrie Hills in the south, Litchfield National Park in the west, and Arnhem Land to the east. **Sources:** Fraser et al. 2003; Woinarski 2004; Woinarski et al 2007; DLRM 2012h; & DE TSSC 2015h.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Limosa lapponica baueri	Bar-tailed Godwit (baueri)	V, Mi	V*	•	•	•	•	**Potential Site Occurrence:** Likely (potential occurrence on intertidal feeding habitat adjacent / beach subject to regular human disturbance / no suitable high tide roost habitat). **Ecology, Distribution & Threats:** Mainly coastal, occurring on large intertidal sandflats and sandbanks, and less often on mudflats of estuaries, harbours, and bays. Within the Northern Territory, rarely far from the coast. During the non-breeding period, the distribution of *L. l. baueri* is predominately New Zealand, northern and eastern Australia. Migratory, arriving generally in northern Australia in August, with departures to breeding grounds between mid-March to mid-April. **Sources:** Higgins & Davies 1996; Chatto 2003a; Geering et. al. 2007; & DE TSSC 2016j.
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri)	CE, Mi	V*	•	-	-	-	**Potential Site Occurrence:** Possible (potential occurrence on intertidal feeding habitat adjacent / beach subject to regular human disturbance / no suitable high tide roost habitat). **Ecology, Distribution & Threats:** The two subspecies (baueri and menzbieri) in the East Asian – Australasian Flyway (EAAF) both occur in Australia, though L. l. menzbieri spends the non-breeding period mostly in the north of Western Australia. L. l. menzbieri usually forages near the edge of water or in shallow water, mainly in tidal estuaries and harbours. Prefers exposed sandy or soft mud substrates on intertidal flats, banks and beaches. Known to arrive along the North Australian coastline from August onwards, with departures to breeding grounds starting early April. **Sources:** Higgins & Davies 1996; Chatto 2003a; Geering et. al. 2007; & DE TSSC 2016k.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	CE, Mi	V	•	•	•	•	**Potential Site Occurrence:** Likely (potential occurrence on intertidal feeding habitat adjacent / beach subject to regular human disturbance / no suitable high tide roost habitat). **Ecology, Distribution & Threats:** Most commonly associated with coastal habitats with soft sheltered intertidal sandflats or mudflats along coasts, especially estuaries, bays, harbours, inlets, though also coastal lagoons. Rarely occur on near-coastal lakes or in grassy areas. Migratory, arriving in northern Australia as early as July, with maximum arrival recorded during the latter half of August, with departures to breeding grounds between late February and March-April. More important areas within the NT include the coast either side of Darwin, the Millingimbi to Buckingham Bay area, Roper and Limmen Bight River mouths and the Port McArthur area of the Gulf of Carpentaria. **Sources:** Higgins & Davies 1996; Chatto 2003a; Geering et. al. 2007; & DE TSSC 2015i.
Limnodromus semipalmatus	Asian Dowitcher	Mi	V	-	-	•	-	**Potential Site Occurrence:** Possible (potential occurrence on intertidal feeding habitat adjacent / beach subject to regular human disturbance / no suitable high tide roost habitat). **Ecology, Distribution & Threats:** Typically solitary or in small groups on intertidal mudflats, often in areas of soft mud near sea-edge. Migratory, generally arriving in northern Australia from August onwards, with departures to breeding grounds from late April. In the NT, typically reported in small numbers in the Darwin region, central coastal Arnhem Land, Blue Mud Bay and the Port McArthur region. **Sources:** Higgins & Davies 1996; Chatto 2003a; Geering et. al. 2007; & DLRM 2012i.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Rostratula australis	Australian Painted Snipe	E	V	•	-	-	-	**Potential Site Occurrence:** Other (would not occur / no suitable habitat present) **Ecology, Distribution & Threats:** Regarded as crepuscular, possibly nocturnal, feeding at the water's edge and on adjacent wet soils for seeds and invertebrates, including insects, worms, and molluscs. Known to occur in shallow, vegetated freshwater (occasionally brackish) wetlands, both ephemeral and permanent, and generally with a good cover of grasses, rushes and reeds, low scrub, and/or Muehlenbeckia spp. (lignum). Primary threat is loss and degradation of wetland habitat, especially shallow ephemeral wetlands, through drainage and the diversion of water for agriculture and reservoirs. Other threats include grazing and associated trampling of wetland vegetation by cattle (particularly where grazing is concentrated around wetlands during the dry season). **Sources:** Higgins & Davies 1996; Chatto 2003a; Geering et. al. 2007; DE TSSC 2013; & DLRM 2012j.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Tyto novaehollandiae kimberli	Masked Owl (northern)	V	V	•	-	•	-	**Potential Site Occurrence:** POSSIBLE (remnant habitat conditions and resources available / habitat degraded / fire) **Ecology, Distribution & Threats:** Occurs mainly in tall eucalypt open forest (especially those dominated by *E. tetrodonta* and *E. miniata*), though also known to roost in monsoonal forest and forage in more open habitats, including grasslands. Small to medium-sized mammals (up to the size of possums) are thought to comprise the majority of the diet. Typically roosts (and nests) in tree hollows. Reasons for decline not known, though probable causes include fire regimes which reduce the availability of large trees and hollows, and declines in small and medium-sized mammals. The distributional range is poorly understood, though generally accepted as extending across the Kimberley region, across the Top End, and east to the north-east part of QLD. **Sources:** Higgins 1999; Woinarski 2004; Woinarski et al. 2007; Garnet et al. 2011; DLRM 2012k; & DE TSSC 2015.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Terrestrial Mammals								
Antechinus bellus	Fawn Antechinus	V	E	•	-	-	-	**Potential Site Occurrence:** Other (negligible probability / highly degraded conditions & resources / recognised threats present & on-going / marginal habitat suitability) **Ecology, Distribution & Threats:** Occurs mostly in open forests and woodlands dominated by Darwin woollybutt (*Eucalyptus miniata*) and/or Darwin stringybark (*E. tetrodonta*), particularly where these forests have a relatively dense shrubby understorey (cf. habitat subject to frequent &/or fires). Insectivorous, and shelters in tree hollows and fallen logs. **Current Threats:** Predation by feral cats; inappropriate fire regimes; and habitat loss and fragmentation. **Potential threats:** Exotic invasive grasses; cane toads (*Bufo marinus*); and disease from introduced species such as black rats (*Rattus rattus*) and feral cats. Known to occur in Litchfield and Kakadu National Parks to near south and east of site. **Sources:** Woinarski et. al. 2007; Young 2012; Woinarski et. al. 2012; & DE TSSC 2015a.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Conilurus penicillatus	Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma	V	E	•	-	•	-	**Potential Site Occurrence:** Other (negligible probability / highly degraded conditions & resources / recognised threats present & on-going / marginal habitat suitability) **Ecology, Distribution & Threats:** Occurs mostly in open forests and woodlands dominated by *Eucalyptus miniata* and/or *E. tetrodonta* which have not been exposed to recent severe fires. Shelters in tree hollows and fallen logs. **Current threats:** high frequency of extensive and intensive fires; and habitat loss. Potential threats: competition with introduced rodents; and invasive weeds. Known to occur on Groote Eylandt, Cobourg Peninsula, Kakadu National Park (last recorded in 2008). **Sources:** Woinarski et. al. 2007; Woinarski et. al. 2012; & DE TSSC 2016a.
Dasyurus hallucatus	Northern Quoll, Digul	E	CE	•	•	•	•	**Potential Site Occurrence:** Possible (remnant habitat conditions and resources available / habitat degraded / fire & cane toads) **Ecology, Distribution & Threats:** Restricted to the Top End where habitat comprises rocky areas and tall open coastal eucalypt forests, with prime habitat associated with sandstone escarpment. Decline in the NT has been linked to several threatening processes, including impacts of feral cats and cane toads, disease, and/or changed fire regimes. **Sources:** Oakwood 2003; Hill & Ward 2010; Woinarski et. al. 2012; & DE 2017a.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Isoodon auratus auratus	Golden Bandicoot	V	E	-	-	•	-	**Potential Site Occurrence:** Other (negligible probability / highly degraded conditions & resources / recognised threats present & on-going / marginal habitat suitability) **Ecology, Distribution & Threats:** Not known to occur on mainland NT, though known to occur following recent introductions to Guluwuru (2007) and Raragala (2008-09) Islands in the Wessel group. **Current threats:** predation by feral cats; and frequent extensive and hot fires. Potential threats: competition with and/or predation by introduced rodents; and invasive weeds. **Sources:** Woinarski et. al. 2007; Woinarski et. al. 2012; & DE TSSC 2015b.
Mesembriomys gouldii gouldii	Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul	E	V	•	•	•	-	**Potential Site Occurrence:** Possible (remnant habitat conditions and resources available / habitat degraded / fire) **Ecology, Distribution & Threats:** Formerly restricted to forests and woodlands of the north Kimberley and mainland Northern Territory. Recent marked declines reported for the Kakadu area and more broadly across the Top End. Occurs mostly in open forests and woodlands dominated by *Eucalyptus miniata* and/or *E. tetrodonta*, particularly where these forests have a relatively dense shrubby understorey (cf. habitat subject to frequent &/or fires). Shelters in tree hollows and fallen logs. **Current and Potential Threats:** Inappropriate fire regimes; predation by feral cats or wild dogs; habitat loss; habitat change due to exotic invasive grasses; and poisoning by cane toads. **Sources:** Woinarski et. al. 2007; Woinarski et. al. 2012; & DE TSSC 2015c.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Trichosurus vulpecula vulpecula	Common Brushtail Possum (southern)	-	E	-	-	•	-	**Potential Site Occurrence:** Other (would not occur / beyond known range) **Ecology, Distribution & Threats:** Two subspecies occur in the NT, with the subspecies *T. v. vulpecula* occurring as isolated populations in the southern NT. The subspecies *T. v. arnhemens* occurs in the across the monsoon tropics of the Top End of the NT and in the Kimberley, WA. T. v. arnhemens remains locally common. **Sources:** Woinarski et. al. 2007; & Woinarski et. al. 2012.
Petrogale concinna canescens	Nabarlek (Top End)	E	V	•	-	-	-	**Potential Site Occurrence:** Other (would not occur / no suitable habitat present) **Ecology, Distribution & Threats:** Restricted to the monsoonal tropics where it has been recorded from a series of isolated rocky sites from the Daly River in the west to the East Alligator River area. Species inhabits rugged rocky areas, typically dominated by sandstones but occasionally by granites, seeking shelter in caves in cliffs and rock piles during the day, and emerging at night to feed. **Current and Potential Threats:** Predation by feral cats; inappropriate fire regimes; habitat loss & fragmentation; habitat degradation due to exotic invasive grasses and/or by livestock and feral herbivores; and human interference. Known populations within Kakadu and Litchfield National Parks. **Sources:** Woinarski et. al. 2007; Woinarski et. al. 2012; & DE TSSC 2015d.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Phascogale pirata	Northern Brush-tailed Phascogale	V	E	•	-	-	-	**Potential Site Occurrence:** Possible (remnant habitat conditions and resources available / habitat degraded / fire & cane toads) **Ecology, Distribution & Threats:** Most records from open forests dominated by *Eucalyptus miniata* and/or *E. tetrodonta*. Shelters in tree hollows during the day. Current and potential threats: predation by feral cats; inappropriate fire regimes; habitat loss & fragmentation. Restricted to eucalypt forests in the NT top end and from Melville Island (Tiwi group) and West Island, Cobourg Peninsula and Gove Peninsula. Almost all other records are concentrated in a restricted area bounded by Kakadu, Katherine and Litchfield National Parks. **Sources:** Woinarski et. al. 2007; Woinarski et. al. 2012; & DE TSSC 2015e.
Xeromys myoides	Water Mouse, False Water Rat, Yirrkoo	V	-	•	-	-	-	**Potential Site Occurrence:** Other (would not occur / no suitable habitat present) **Ecology, Distribution & Threats:** A ground-dwelling, nocturnal predator of invertebrates (e.g. grapsid crabs, pulmonates and molluscs) on intertidal flats within mangrove wetlands and adjacent supralittoral habitats (e.g. sedge swamps and saline grasslands). Known to shelter and “nest” within either burrows or substantial earthen mounds - supralittoral zone, though also around the base of a hollow mangrove tree trunk. **Sources:** Woinarski et. al. 2007; DEWHA 2009a; DERM 2010; & Woinarski et. al. 2012.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Macroderma gigas	Ghost Bat	V	NT	•	-	•	-	**Potential Site Occurrence:** Other (would not occur / no suitable habitat present) **Ecology, Distribution & Threats:** Recorded from a broad range of habitats, though distribution is influenced by the availability of cavernous roosts, including caves, rock crevices and disused mines. Roost sites used permanently are generally deep natural caves or disused mines with a relatively stable temperature and a moderate to high relative humidity. One of the largest known colonies occurs in a series of gold mine workings at Pine Creek, NT. Current and potential threats: degradation of largest known colony near Pine Creek; human disturbance at roost/maternity sites; and poisoning by cane toads. **Sources:** Schulz & Thomson 2007; Woinarski et. al. 2012; & DE TSSC 2016b.
Saccolaimus saccolaimus	Bare-rumped Sheath-tailed Bat	V	-	•	•	•	-	**Potential Site Occurrence:** Possible (remnant habitat conditions and resources available /habitat degraded/fire impacts on tree hollow production) **Ecology, Distribution & Threats:** Based only a restricted sample of records, it is thought to occur within woodlands and forests extending from coastal and adjacent inland areas throughout the Top End. Records derive from tall open eucalypt forest of *Eucalyptus tetrodonta* and *E. miniata*, Pandanus woodland fringing the South Alligator River, and in grassy beach dunes with Melaleuca and Acacia adjacent to open eucalypt forest. Roosting ecology poorly known - all confirmed roosting records are from deep tree hollows in, mostly large trees, being *Eucalyptus platyphylla* (reported as *E. alba*), *E. miniata* and *E. tetrodonta*. Hollows in these tree species have also been used as maternity roosts. Such roosts are susceptible to damage by termites and by fire. **Sources:** Milne et. al. 2009; Milne et. al. 2011; Woinarski et. al. 2012; & DE 2017b.

Scientific Name	Common Name	EPBC Act Status	TPWC Act Status	Source				Potential for Occurrence at Site and Species Profile
				1	2	3	4	
Rattus tunneyi	Pale Field-rat	-	V	-	-	●	-	**Potential Site Occurrence:** Other (would not occur / no suitable habitat present) **Ecology, Distribution & Threats:** Once regarded as a widespread and abundant species which formed loose colonies associated with dense vegetation along creeks, though there are records from hill slopes with stony substrates. Nocturnal, mainly herbivorous, and has a marked breeding season between January and August. Data for a variety of monitored sites (e.g. Kakadu and Litchfield National Parks) show recent severe declines in populations of these former strongholds. Declines have been recorded since the early 2000s with no clear explanation, though impacts related to feral cats and changed fire regimes are currently being studied. **Sources:** Woinarski et. al. 2007; DLRM 2012a; & Woinarski et. al. 2012.

Table Notes:

Status: Territory TPWCA / Commonwealth EPBCA. CE = Critically Endangered; E: Endangered; V = Vulnerable; NT = Near Threatened and M = Migratory.

Information Sources: 1 = EPBC Act Protected Matters Report (20km search area centred on site; 2 = NT NRM records based on a 15km search area centred on site; 3 = NT NTM records within grid cell(s) in which 15km search area occurs; 4 = Records within 15km of the site listed by other sources (e.g. Atlas of Living Australia, NT Fauna Atlas, Birdlife Australia, GHD (2005), URS (2003) etc.) EcoOz (2001). ^

Symbols: ● = Recorded; - = Not recorded; * = Under the TPWC Act these subspecies are grouped together and listed as *Limosa lapponica*.

12.3 POTENTIAL IMPACTS

12.3.1 Terrestrial Habitat

The terrestrial habitat to be cleared to facilitate the project is not considered to be unique or critical habitat for any of these species. As described in Section 12.2.2, the site has been subject to degrading processes, particularly as result of the past fire regime, uncontrolled recreational use, and invasive pest and weed species. This is more pronounced in the western third of the site, closer to the beach.

The habitats in the eastern parts of the site (i.e. outside of the main part of the project footprint) were found to have more resources for fauna species than the western parts of the project site. As such, the majority of the Project infrastructure was preferentially sited in areas of degraded habitat in the western third of the site to minimise impacts to flora and fauna values.

The clearing will be restricted to those areas required to be cleared to facilitate the Project footprint only (i.e. only the footprint of the infrastructure and the required firebreaks will be cleared – the rest of the site will remain vegetated). The areas to be cleared for the project infrastructure are unlikely to be important habitat for any of threatened fauna species that may utilise the site and the removal of 28.93 ha of habitat that would largely be considered marginal for these species is unlikely to result in a significant impact to any species.

Outside of the area required to be cleared to enable the construction of infrastructure, the remainder of the vegetation on the site (101.07 ha) will be retained. The area of vegetation proposed to be cleared by the Project is considered to be conservative as it includes a 25 m buffer around all infrastructure to allow for flexibility in the detailed design stage. It is highly likely that not all of the area within the 25 m buffer will be required to be cleared and as such the clearing area is likely to be smaller than 28.93 ha.

The vegetation to be cleared is widespread in the local area and is not considered to represent unique, or critical habitat for any threatened species that may utilise the site. This, combined with the small extent of the proposed development footprint, the proposed location of the footprint elements, and the nature of the operations indicates that, with the incorporation of the management practices set out in Section 12.4, means there will be no significant impact to fauna habitat values on, or adjacent to the site.

12.3.2 Marine Habitat

The area of marine habitat to be impacted by the Project is relatively small, comprising only the intake and outfall pipelines. This area is classified as "soft-bottom benthos; sediment", with no macrobiota or reef communities present (GeoOceans 2011; see Figure 60) and does not contain any unique habitat values, being well represented locally and affecting only a very small proportion of Shoal Bay. As such there is not considered to be any potential for the pipelines to significantly impact upon marine habitat in Shoal Bay.

As explained in Section 9.3.3, the quality of the water to be affected by the discharge from the proposed Project will be within the Water Quality Objectives for Darwin Harbour, and as such, by definition, will not pose a significant risk to the environmental values of the receiving waters.

12.3.3 Threatened Fauna

The Assessment of the Likelihood of Occurrence for conservation significant species revealed that 18 species were categorised as 'other'; meaning that there is considered to be a negligible probability of occurrence of those species within the site, as the site is either outside of known extent of occurrence or modelled distribution of that species, or there is no suitable habitat present within the site or immediately adjacent to the site.

Thirteen species were considered likely to occur, with a further 13 species considered possible to occur. The potential impacts of construction and operation to these species, should they occur, on or around the Project footprint, are discussed below.

12.3.3.1 Insects

One insect species of conservation significance, Dodd's Azure Butterfly (*Ogyris iphis doddi*), is considered possible to occur on site.

There is no evidence that any external factors have caused a decline in numbers or distribution of Dodd's Azure Butterfly. However, clearing of its preferred eucalypt forest habitat and increased fire regime potentially leading to declines in mistletoes in habitats on which *Ogyris iphis doddi* and related species depend, may be threatening processes (Braby and Woinarski, 2006).

Threatening process for this species are inappropriate fire regimes, especially those that perpetuate fires that penetrate forest edges and destroy cocoons of diapausing pupae in the dry season; and introduced African greasy weeds, which lead to modified and exacerbated fire regimes. The Project will not lead to any increases in fire regime. Formulation of bushfire management practices will be a requirement of the operation of the Project. Formulation of the fire management processes will take into account ecological considerations. Given the above, the management of fire is considered to be a positive externality of the Project.

The Project will require the clearing of a maximum of 28.93 ha of eucalypt forest vegetation. 101.07 ha of vegetation on the Project site will be retained, and the vegetation type to be cleared is widespread in the area (Section 11.3.1) and given the relatively low level of clearing required, it is considered unlikely that removal of vegetation to facilitate the Project would constitute a potential significant impact to Dodd's Azure Butterfly, should it occur in the area. The Project will not lead to any increases in fire regime. Rather the management of fire on the site, along with the control of introduced weeds that contribute significantly to fuel loads, is considered likely to have a positive effect upon the ecological values of the site.

12.3.3.2 Fish and Marine Reptiles

The dwarf sawfish (*Pristis clavata*) was ranked as likely to occur in the vicinity of the Project, although the area to be affected by the proposed action would not constitute critical habitat for this species. The green sawfish (*P. zijsron*) was ranked as possible to occur, as it has a preference for habitats with muddy substrate and is thought to be largely restricted to the inshore coastal fringe, with a strong association with mangroves and adjacent mudflats – these habitats are not present in the vicinity of the area to be affected by the Project. Both the green and the dwarf sawfish are known from Buffalo Creek, which drains into the western side of Shoal Bay. The largetooth sawfish (*P. pristis*) has similar habitat requirements to the dwarf sawfish species so it was also assessed as likely to occur, although it has not been recorded from the surrounding area.

The main threatening processes for sawfish in Australia are fishing (targeted and incidental capture) and habitat degradation (Cavanagh et al. 2003). The proposed action will not increase these activities. It should be noted that the records from Buffalo Creek were from an area where the existing water quality is known to be poor due to discharge from the Leanyer Sanderson Wastewater Treatment Plant.

The northern river shark (*Glyphis garricki*) and the speartooth shark (*G. glyphis*) are considered possible to occur in the waters surrounding the Project site. Both have been recorded in the Adelaide River, to the east of the Project site, and also from other NT rivers to the west.

Key threatening processes to these species include commercial and recreational fishing activities. The proposed action will not increase these activities.

The Loggerhead, Hawksbill and Olive Ridley are considered likely to occur in Shoal Bay. The Conservation Values Atlas (DoEE, 2017b), which maps biologically important areas (e.g. foraging, mating, nesting and interesting) for listed species does not map Shoal Bay as a biologically important area for any of these species (DoEE, 2017b).

Nesting beaches for these species are absent from Shoal Bay, however, three Olive Ridley nests have been recorded (since the 1990's) from Casuarina Beach, a Darwin Beach approximately 18 km away that is more significant for flatback turtle nesting.

The potential impacts of construction and operation of the facility to conservation significant fish and marine turtle species are:

- Changes in water quality during construction (elevated turbidity)
- Entrainment or impingement in the intake pipe
- Changes in water quality as a result of the discharge of the aquaculture water
- Spills or leaks of hydrocarbons during construction
- Changes to the marine ecology as a result of escape of prawn stock
- Changes to the marine ecology through the spread of disease
- Increased noise during construction and operation
- Light spill to the marine environment (marine turtles only)

These are addressed below.

12.3.3.2.1 Changes in Water Quality during Construction

During construction of the intake and outfall pipelines there is the potential for the construction activities to create minor elevations in turbidity through disturbance of the sea bed. However, the area to be disturbed is small relative to the scale of Shoal Bay, and the disturbance will be localised, short term and temporary in nature.

The species that may be influenced by elevated turbidity are highly mobile and are expected to move away from disturbance areas such that they are not detrimentally affected. They are also expected to return to the area following cessation of disturbances; this is supported by evidence collected under the Ichthys nearshore environmental monitoring program (Cardno 2015) for a large scale dredging and pile driving program in the Darwin region - that project was of a much larger scale than this Project. Monitoring results found no indication that dredging activities (which would elevate turbidity far more than the activities proposed for the construction of the marine infrastructure as part of this Project) affected turtle distribution or population sizes (Cardno 2015). Furthermore, the aquatic flora and fauna present in the environment surrounding the Project area would be habituated to periods of high turbidity that occur naturally in Shoal Bay. As such it is considered highly unlikely that any of the conservation significant marine species that may possibly occur in Shoal Bay would be significantly impacted by any localised spikes in turbidity as a result of construction activities.

Management controls for unplanned construction inputs from land-based erosion (including during extreme weather events) have been nominated in Section 6.3.1.

12.3.3.2.2 Entrainment or impingement in the intake pipe

The proposed seawater intake may entrain or impinge aquatic fauna, including fishes and invertebrates. Entrainment is the voluntary or involuntary movement into the intake infrastructure of aquatic organisms small enough to pass through the particular size and shape of intake screens, while impingement is the involuntary retention of aquatic organisms on the screen. Entrainment and impingement can cause mortality or injury to aquatic fauna, with egg and larval stages most susceptible.

Involuntary entrainment and impingement of aquatic fauna may occur when the velocity at which water drawn into the seawater intake pump station exceeds the swimming capability of the species. Published data suggests most fish can swim against currents of 0.4 m/s and all fish can swim against currents of 0.1 m/s (Boys et al. 2012; and see also Section 3.19.18 of PSD, 2016).

While there is limited data available on the swimming abilities of most threatened species potentially occurring within the vicinity of the intake, juveniles of these species are relatively large (e.g. sawfish pups > 65 cm and river shark > 50 cm) and therefore are likely to have a relatively strong swimming ability. Flatback turtle hatchlings (approximately 6 cm at emergence) can have a swimming speed of >1 m/s, but generally only for short periods of time and they require periodic oxygen replenishment (Salmon et al. 2010). Turtle hatchlings however are unlikely to be in the vicinity of the intake given they generally disperse seaward following emergence from nesting beaches (Hamann et al. 2011).

The intake point will be fitted with a screen covered with mesh sized at 100 mm or less to limit the potential to intake marine fauna. In times of pumping, the velocity of seawater intake at the mesh screen will be less than 0.25 m/sec - suggesting that most fish will be able to swim away from this area (i.e. the velocity at the screen is less than the 0.4 m/s velocity that most fish can swim against). Calculations undertaken reveal that within one metre of the mesh screen, the intake velocity will drop to less than 1 m/sec - which is within the swimming ability of all fish (Boys et al. 2012), and the speed of currents within Shoal Bay during spring tides (Appendix A in Water Technology 2017 which is Appendix C). As such, there is a considered to be a negligible potential to impinge or entrain sawfish, river sharks and marine turtles.

Also of note is that the seawater intake pump will only operate between mid to high tide daily meaning that there will be a large proportion of each day when no fauna will be exposed to any entrainment and impingement risks.

Consequently, with the relatively low velocity expected at the screen, and the inclusion of the screen over the intake point as described above, there are not expected to be any significant impacts to conservation significant fish and marine turtle species as a result of the operation of the intake pumps.

12.3.3.2.3 Changes in water quality as a result of the discharge of the aquaculture water

The aquaculture water will be discharged proportional to the intake of water. The discharged water will have elevated nutrients, derived from the feeding of the prawns, relative to the intake water. As such, nutrients and algae (which is a food source) will leave the facility in the form of uneaten prawn feed residues and prawn excreta (faeces and moults).

The increased nutrients and algae in the discharge water may impact upon the aquatic ecology of the receiving environment through increasing primary production, denitrification, zooplankton and juvenile fish feeding biomass near the discharge. However, as explained in Section 9.3.3, the increased nutrients as a result of the Project will be relatively minor and, at the point of discharge the water will be within the range considered acceptable under the Water Quality Guidelines for Darwin Harbour. As such none of these potential increases are likely to lead to significant impacts to any conservation significant fish species. It should also be noted that the closest records of sawfish species to the proposed discharge are from and areas of Buffalo Creek where the

existing water quality is known to be poor due to discharge from the Leanyer Sanderson Wastewater Treatment Plant.

There will be no release of any elements that do not occur naturally in the local environment i.e. no anti-parasitic or anti-fouling agents will be released. Whilst it is proposed to use hydrogen peroxide to disinfect the water prior to discharge (Section 3.3.3.4), hydrogen peroxide occurs naturally in the environment, and is not considered to pose a significant risk to environmental values at levels below 0.7 mg/L (Schmidt et al. 2006). Concentrations of H_2O_2 will be measured at the point of release and water will not be released until levels under 0.7 mg/L are achieved.

12.3.3.2.4 Spills or leaks of hydrocarbons during construction

Spill or leaks of hydrocarbons or other contaminants such as chemicals from construction vessels or vehicles are considered a very low risk and will be controlled via operational procedures and environmental management plans required to detect and respond to any unplanned accidental releases to ameliorate impact to the environment.

Additionally, a hazardous materials management strategy (as detailed in the Environmental Management Plan in Appendix B) will be implemented as part of the Project. This contains procedures and protocols for the transport, storage, use and disposal of hydrocarbons and other chemical as well as response procedures in the event of a spill or leak.

12.3.3.2.5 Changes to the marine ecology as a result of escape of prawn stock

The likelihood of accidental escape of prawns from these facilities is considered negligible. To ensure the accidental escape of prawns from the Stage 1 Hatchery does not occur the outlets on the tanks are screened with a mesh sized at 350, 500, 700 or 1000 microns, as appropriate. In the unlikely event that any PL's were to get flushed into the settlement pond, this would present a harsh environment for such young prawns in which any escaped PLs are unlikely to survive. It should be noted that regardless of the extremely low probability of escape, the consequence of prawn escapes is insignificant: the species are local, found across waters in the Top End and they will be of known health status (Specific Pathogen Free) and of high health.

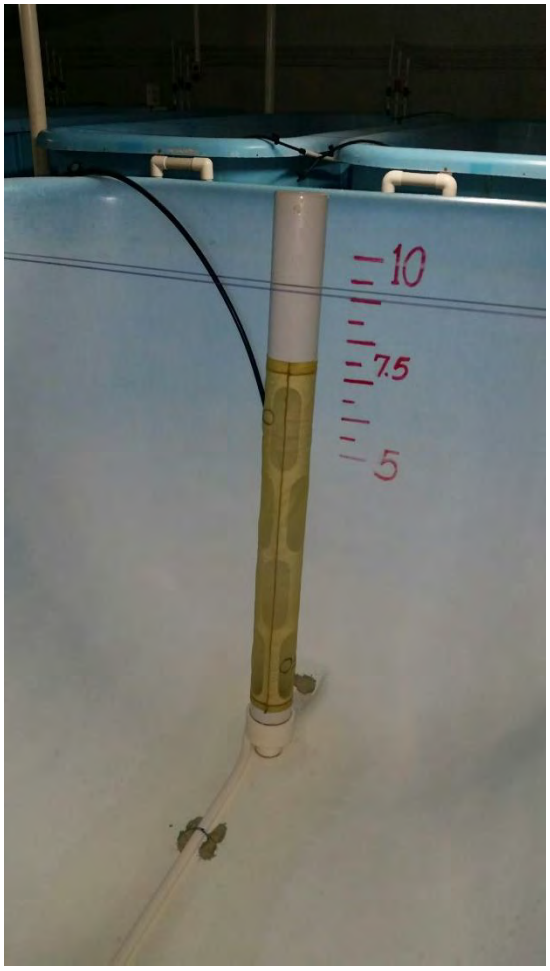

FIGURE 63 SCREENING OF OUTLETS ON HATCHERY TANKS

12.3.3.2.6 Changes to the marine ecology through the spread of disease

Domesticated Prawn Stock

There are a number of potential diseases that have the potential to spread from domesticated prawn stock to aquatic fauna in the estuarine environment. However, these diseases are all endemic and exist in the wild prawn populations of Darwin Harbour. Outbreaks of exotic diseases are not considered a risk given Australia's geographic isolation and restrictions on the importation of prawns and prawn products.

An assessment of the potential risk that these endemic diseases pose to the wild prawn populations of the receiving waters for PSD was undertaken by Panaquatic Health Solutions Pty Ltd (Panaquatic) and is included in Appendix F. Panaquatic conclude that the risk of diseases being spread from prawn stock to aquatic fauna in the marine environment was very low given:

- The Stage 1 Hatchery will be stocked with post-larvae that are bred from Specific Pathogen Free (SPF) prawn stock. SPF prawns are a domesticated and selectively bred population of prawns that have been screened for a suite of known pathogens. Consequently, if the prawns in the Stage 1 Hatchery are free of disease in the first place, there is no risk of the disease being released to the external environment.
- A biosecurity plan has been developed for the Project to minimise the potential for the introduction and spread of diseases through pathways such as the movement of staff and equipment. This includes

development of biosecurity zones and restricting movements of people and equipment between these zones.

- A health monitoring and surveillance program will be implemented as part of the biosecurity plan to rapidly identify any disease, should such a disease be introduced to the Stage 1 Hatchery. If a disease is identified, immediate steps will be taken to contain the disease to the tank in which it has been identified.

In addition, in the unlikely event that a disease was transmitted to the external environment, the following steps would need to occur in order for that disease to spread to a wild prawn population and/or other aquatic fauna:

1. Wild prawns or aquatic fauna that are susceptible to the disease must be present in the receiving environment.

2. The disease must persist long enough in the environment to come into contact with the susceptible animals.

3. Susceptible animals must be exposed to sufficient quantities of the disease so that they become infected and develop the disease.

4. The diseased animals must then shed sufficient quantities of the disease to infect other wild prawns.

Based on the number of steps required in order for a disease to be transmitted and the likelihood of each of these steps occurring, the risk of a disease from the grow-out facility impacting on a wild prawns and/or other aquatic fauna is concluded to be very low.

Altered Water Quality Conditions

Altered nutrient and turbidity water quality conditions in the estuarine environment has the potential to detrimentally affect the health of aquatic vertebrate fauna (Brodie et al. 2014, Palmer and Peterson 2014). Diseases such as fibropapillomatosis in turtles and pox-like fungal infections of dolphins have been related to poor water quality conditions. Increased sediment or nutrient loads may increase exposure of species to biotoxins bound to sediments or associated with nutrients or indirectly alter dietary and habitat quality affecting foraging and reproductive success (Santos et al. 2010, Van Houtan et al. 2010, Bearzi et.al 2009).

As discussed in Section 9.3.3, the modelling indicates that the Project discharge will disperse quickly in the receiving environment and that the Water Quality Objectives for Darwin Harbour will not be exceeded. Given this, and that the habitat to be affected is both widespread in the surrounding areas and is not unique or critical for any species, hence is unlikely to be preferential utilised over surrounding areas, it is unlikely that the discharge of waste water will lead to detrimental health impacts to any marine vertebrate population.

12.3.3.2.7 Increased noise during construction and operation

Underwater noise and vibration are likely to occur during construction of the intake and outfall pipelines, particularly during pile driving works which are required for intake structure (see Section 3.8.3). The construction vessel(s) will also generate through-hull noise associated with engine and propulsion systems, and propeller tip vortex cavitation noise. The vessel(s) are expected to produce similar noise emissions to other marine vessels that frequent Shoal Bay (e.g. recreational vessels, etc.). Operational noise may also occur from the operation of the pump systems for the intake and outfall pipelines and during routine maintenance procedures such as pigging (cleaning) the pipelines, however, again, these are expected to be no louder that noise emissions from recreational vessels that frequent Shoal Bay.

The most likely impact resulting from underwater noise emitted during the construction and operation of the Project are changes in the behaviour of aquatic fauna. Aquatic fauna in the vicinity of the pipelines may vacate

or avoid the area following commencement of underwater works such as pile driving. Any behavioural change caused by noise from the Project is likely to be localised and temporary with aquatic fauna expected to resume normal behavioural patterns in the waters surrounding the Project within a short time-frame. This is supported by the findings of the Ichthys nearshore environmental monitoring program (Brooks and Pollock 2015). Construction activities for that project included pile driving, albeit on a much larger scale than what is required for this Project.

12.3.3.2.8 Light Spill to the Marine Environment

Construction and operational lighting has the potential to affect marine turtles by altering use of visual cues for orientation, navigation or other purposes. However, given that turtles do not nest within the Project area or adjacent habitats (the nearest nesting beach is located around 18 km from the Project area), it is unlikely the artificial light will interfere with the breeding success and population longevity of marine turtles.

The environmental risks are considered to be as low as reasonably practicable as the lighting will be short lived during construction, and managed to the requirements for occupational safety regulations. Construction will occur during daylight hours only, but it is likely that some construction lighting will be required across the Project site 24 hours a day 7 days a week to manage safety on site.

Outdoor operational lighting will be minimal, designed to be 'turtle friendly' by being low profile (i.e. mounted as low to ground as possible, on fencing or buildings, not pole mounted), directed away from the marine environment, or shielded where that is not possible, and on timers or sensors. The Hatchery buildings will have minimal wall mounted lighting to add in navigation at night which are switched by light sensor or manually. Detailed design (at which time the specific lighting details will be documented) will consider the best available turtle friendly low wattage lighting that is practical for safety (for example, red or amber LEDs, which are best for turtles, may not be considered practical from a workplace health and safety perspective). The managers' houses will have decks with lighting on manual switches. However, the managers houses will be 300 m and 1,000 m from the beach and vegetation will be retained between the houses and the beach (see Figure 5).

Importantly, it is not proposed to clear any of the monsoon vine thicket or any other dune vegetation, nor any other vegetation types between the building footprints and the beach (Figure 57). The retention of this vegetation will act as a screen between light sources from the facility and the beach. As such, potential impacts associated with light disturbance to marine turtle species are considered to be minimal.

12.3.3.3 Terrestrial Reptiles

One terrestrial reptile of conservation significance, the floodplain monitor (*Varanus panoptes*), was rated as possibly occurring on site. This species is known to occupy a variety of habitats, including coastal beaches, floodplains, grasslands and woodlands. The principal threat to this species in the NT is the arrival and spread of cane toads. The proposed action will not cause any increase in cane toad abundance. As such, the only potential impact to this species is the removal of habitat required for the buildings. Given the widespread nature of the potential habitat for this species that will remain on-site, and the large extent that exists throughout the wider Gunn Point area, there is considered unlikely to be any significant impact to this species as a result of the proposed action.

12.3.3.4 Terrestrial Mammals

Three terrestrial mammal species and one avian mammal species were considered possible to occur on site. They are:

- Northern Quoll (*Dasyurus hallucatus*)

- Black-footed Tree-rat (Kimberley and mainland Northern Territory subspecies) (*Mesembriomys gouldii gouldii*)
- Northern Brush-tailed Phascogale (*Phascogale pirata*)
- Bare-rumped Sheath-tailed Bat (*Saccolaimus saccolaimus*)

As described in Section 12.2.2, the site has been subject to degrading processes, particularly as result of the past fire regime. Loss of habitat resources (e.g. tree hollows) and conditions as result of inappropriate fire regimes, habitat degradation due to exotic invasive grasses and/or feral animals, and human interference, are regarded a key threats to these mammal species. The proposed action will not exacerbate any of these threatening processes.

The habitats in the eastern parts of the site (i.e. outside of the main part of the Project footprint) were found to have more resources for these species than the western parts of the Project site, having a comparatively higher density of hollow-bearing trees; ground timber (including hollow logs) and termitaria; and evidence of lower fire frequency. As such, the majority of the Project infrastructure was preferentially sited in areas of degraded habitat in the western third of the site to minimise impacts to flora and fauna values.

Operation of the facility is unlikely to pose any threat to any of these species. In fact, the weed and fire management regimes that will be implemented as part of the Project will likely have a positive impact upon habitat for these species, when compared with the current situation.

As such, construction and operation of the Stage 1 Hatchery is considered unlikely to result in a significant impact to any terrestrial mammal species.

12.3.3.5 Avifauna

12.3.3.5.1 Terrestrial birds

Three avifauna species, red goshawk (*Erythrotriorchis radiatus*), partridge pigeon (eastern subspecies - *Geophaps smithii smithii*), and masked owl (northern subpecies - *Tyto novaehollandiae kimberli*) were assessed as possible to occur on site.

The habitat to be cleared to facilitate the Project is not considered to be unique or critical habitat for any of these species. As described in Section 12.2.2, the site has been subject to degrading processes, particularly as result of the past fire regime. As for the mammal species described above, loss of habitat resources (e.g. tree hollows) and conditions as result of inappropriate fire regimes, habitat degradation due to exotic invasive grasses and/or feral animals, and human interference, are regarded a key threats to these avian species. The proposed action will not exacerbate any of these threatening processes.

Operation of the facility is unlikely to pose any threat to any of these species. In fact, the weed and fire management regimes that will be implemented as part of the Project will likely have a positive impact upon habitat for these species, when compared with the current situation.

As such, construction and operation of the Stage 1 Hatchery is considered unlikely to result in a significant impact to any terrestrial avian species.

12.3.3.5.2 Shorebirds

Nine migratory shorebirds species were considered possible or likely to occur on the site or within the local surrounds. Observations during the field investigations indicated that there was a paucity of shorebirds using the intertidal flats along the beach, thought possibly due to a lower bio-productivity of the intertidal flats (low abundance of invertebrates associated with coarser sandy substrates) and/or the manifest effects of regular

human disturbance (people, dogs, and of-road vehicles). Searches of beach and claypan habitats did not reveal evidence of any high-tide roosts.

The Project will have a minimal impact upon the intertidal zone and impacts will be restricted to those required for construction of the intake and outfall pipelines. The nutrients contained in the aquaculture water to be discharged in to the marine environment will be within levels considered acceptable under the Darwin Harbour Water Quality Objectives. As such there will not be any significant impact to feeding resources or habitat for migratory shorebirds in Shoal Bay.

12.4 MEASURES TO AVOID OR REDUCE IMPACTS

12.4.1 Threatened Fauna

12.4.1.1 Terrestrial Fauna and Avifauna

Flora and fauna surveys were undertaken to determine the areas of the site with comparatively lower values for both threatened and non-threatened fauna. The results revealed that the western third of the site supports comparatively lower values, and as such development has been concentrated as much as possible, into this area of the site to ensure impacts on this species are minimised. To further minimise impacts to terrestrial fauna, the following measures will be undertaken:

- A Weed Management Plan will be implemented prior to construction. The control of gamba grass and perennial mission grass will be a focus of this WMP.
- A fauna spotter will be present on site during clearing activities. If conservation significant fauna are identified within the Project footprint, mitigation measures, including relocation of the fauna if appropriate, will be developed in consultation with the NT DERM.
- Formulation of bushfire management practices (as required under the *Bushfire Act 2009*) will also take into account measures to optimise burns in a way that least impacts habitat.
- A Fauna Management Plan will be developed to provide for the protection of fauna during construction and operation of the facility.
- The boundary of the site will be fenced with standard rural cattle fencing to exclude feral animals.
- In regards to rodents and feral cats the Fauna Management Plan will include:
    - An on-going, rodent baiting program around built facilities
    - Measures to minimise available food sources for introduced rodents around buildings
    - An on-going cat baiting program around built facilities using proprietary baits such as Curiosity® with the toxin PAPP (para-aminopropriophenone).

12.4.1.2 Marine

Numerical modelling has shown that during operation, the impact of the discharge on the receiving waters will be minimal and the quality of water within the receiving environment will be well within levels considered acceptable under the Water Quality Guidelines for Darwin Harbour. The mitigation measures specified above for coastal features, processes and water quality (Section 9.4) are also relevant to marine fauna. In addition, the following actions will be considered to alleviate the potential impact of the Project on threatened fauna and their habitat in Shoal Bay:

- Intake pipes will be screened to avoid entrapment or entrainment

- Implementation of vessel speed limits in the construction zone and implementation of marine megafauna observation zone (150 m) and marine megafauna exclusion zone (50 m)
- Notwithstanding that only minimal lighting is required for the construction and operation of the Project, in accordance with the Environmental Assessment Guideline for Protecting Marine Turtles from Light Impacts (WAEPA 2010), the proponent will limit lighting to only that which is essential. Lighting will be installed low in the vertical plane and will use the lowest intensity practicable. Detailed design will consider the following:
    - light fixtures that are mounted low down, shielded and aligned to direct light onto the target area only
    - turn lights on only when they are needed
    - directional, achieving no spill to the marine environment
    - Automated controls (e.g. timers and motion detectors) to be used as appropriate to minimise lighting
    - Designing ground-level path lighting for use where practicable.
- Construction vessels used to be certified as free of marine fouling.