EcOz Environmental Consultants

Statement of Effect

Animal Husbandry Facility (aquaculture)

Tasmanian Seafoods Pty Ltd

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1 Context

1.1 Background

Tasmanian Seafoods Pty Ltd propose to construct an intensive animal husbandry facility (aquaculture) for Trepang (Sea Cucumber). Juveniles will be bred at the hatchery in a series of tanks, and later transferred to ponds and approved sea ranching locations for growing out and harvest. The hatchery and nursery will comprise tanks, raceway ponds and associated buildings, along with a salt water intake and outlet for replenishment of water within the culture units.

This document provides an assessment of the potential environmental impact of the proposal, along with appropriate mitigation measures to manage any impact, consistent with the requirements of the *NT Planning Act* and *NT Planning Scheme.*

1.2 Project location

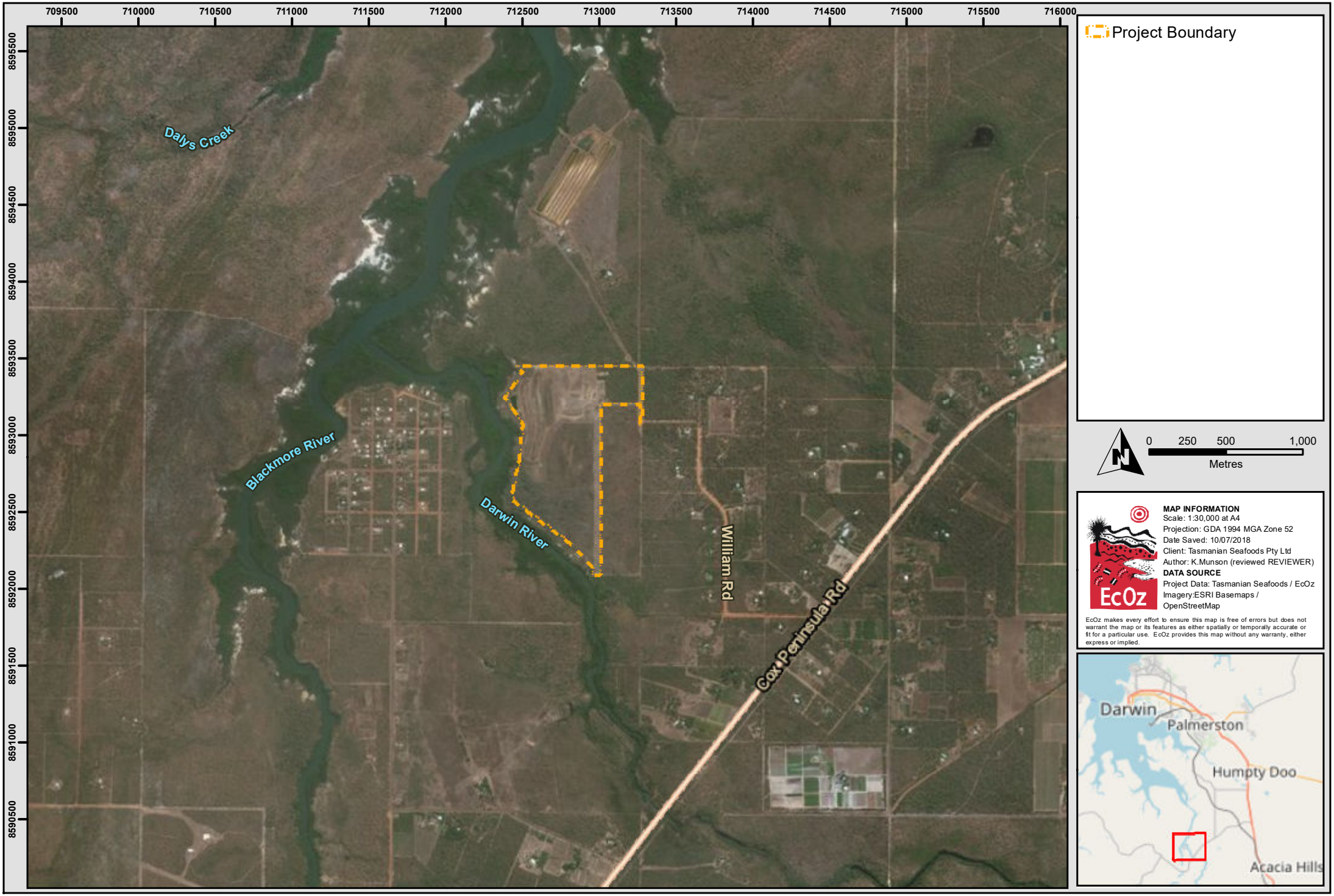
The project area is located at William Rd., Berry Springs within Section 2413, Hundred of Cavenagh. The site is within the Rural Town Planning Zone (Figure 1-1). The property size is 68 ha with the total area of land to be utilised by the aquaculture hatchery facility approximately 17 ha. There are existing ponds and infrastructure on the site that was originally developed for prawn aquaculture. The project area is largely comprised of flat topography, sloping gently to the West. The western and southern boundaries are bordered by mangroves and Darwin River.

1.3 Legislation & planning requirements

This Statement of Effect has been prepared to accompany a Development Application made under Section 46 of the NT Planning Act. It specifically addresses 46(3)(e) of the Planning Act (Table 1-1). NT Planning Scheme Clauses 10.2.3 and 10.3 have not been addressed as there are no plans to clear further vegetation than has previously been cleared at the site.

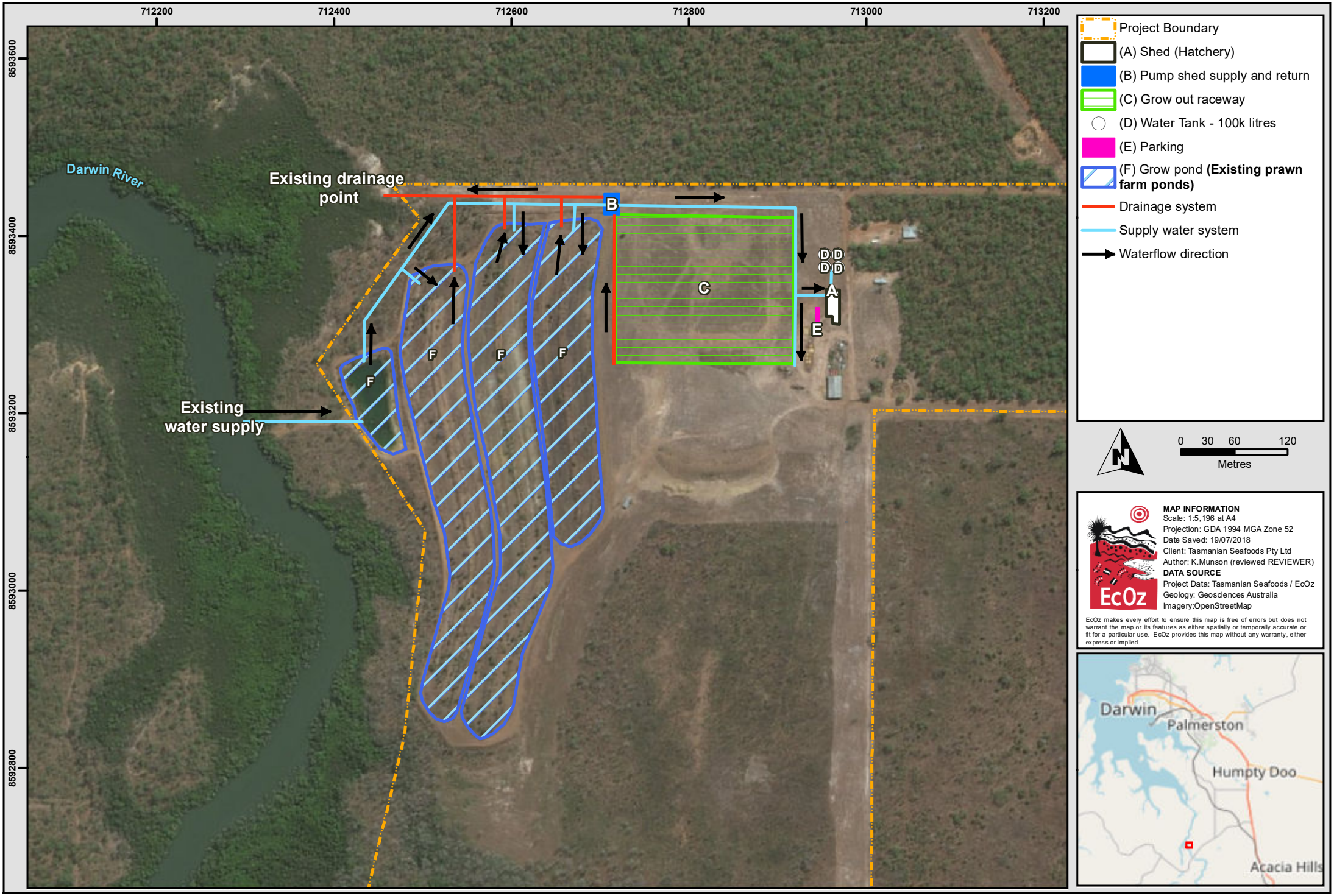
Table 1-1. NT Legislation and planning requirements

NT Planning Act	
46(3)(e)	Provide a description of the physical characteristics of the land and a detailed assessment demonstrating the lands suitability for the purposes of the proposed development and the effect of development on that land and other land



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ18116 - Sea Cucumber Hatchery Berry Springs\01 Project Files\Figure 1. Map showing project location.mxd

Figure 1-1. Map showing project location



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ18116 - Sea Cucumber Hatchery Berry Springs\01 Project Files\Figure 2-1. Map of sea cucumber hatchery layout and water flow diagram.mxd

Figure 2-1. Map of sea cucumber hatchery layout and water flow diagram

2 Project Description

2.1 Overview

The aquaculture breeding facility is proposed to be constructed over 17 ha and involve the following:

- Sheds and office facilities
- Stock ponds
- Pump sheds (supply & return)
- Intake and offtake pipelines
- Substation
- Toilet & ablution block (septic)
- Grow out ponds and raceways
- Water tanks
- Parking area
- Access from William Rd.

The hatchery will comprise tanks, earthen ponds and associated buildings, along with a salt water intake and outlet for replenishment of water within the breeding tanks (Figure 2-1). The intake and offtake pipes will be connected to existing ponds and water infrastructure. The project requires no clearing of vegetation as the land was cleared prior to 2004 for an aquaculture farm. There will be a vegetation buffer retained between William Road and the development.

2.2 Farming system

The species farmed is *Holothuria scabra*, also known as Sandfish, which in the wild inhabits soft sediments and seagrass beds in shallow waters (<20 m deep) across the Top End coastline.

The sea cucumber farming system to be implemented is well-tested and based on more than 13 years of research and development by Tasmanian Seafoods. This has included pilot-scale brood stock, hatchery and nursery trials at the Darwin Aquaculture Centre (DAC), and sea ranching trials at Umbakumba, Groote Eylandt and Warruwi, South Goulburn Island in the Northern Territory (NT). Brood stock, nursery and grow-out trials were also undertaken between November 2011 and August 2013 at an aquaculture facility owned by Paspaley Pearling Company.

The farming system involves:

- Collection of wild brood stock from selected locations within NT coastal waters.
- Brood stock maintenance: brood stock is conditioned in ponds and induced to spawn.
- Hatchery production: fertilised eggs are hatched and the larvae reared in tanks and fed live microalgae for 11-14 days whilst in their planktonic phase.
- Nursery production: once they reach their settlement phase, juveniles are transferred to a nursery system where they are grown out in raceway tanks for approximately six weeks to reach a size of 1 g (average 25 mm; up to 50 mm). The raceways have a sandy substrate on which the juveniles live and forage for benthic algae and other organic detritus.
- Sea ranching: once large enough, juveniles are transported to approved sea ranching sites across the Top End (Groote Eylandt, Coburg Peninsula, South Goulburn Island) and monitored throughout their 18-month grow-out period before harvesting.

3 Environmental Context

The project is located on land adjoining the Darwin River near the township of Southport in the Northern Territory. The project area is approximately 1 km from the confluence of Darwin River and Blackmore River. Both Rivers are tidal and feed in to Darwin Harbour. The land is flat with gentle slopes of around 1 %. The project boundary is approximately 68 ha, of which 40 ha has previously been cleared for use as an aquaculture (prawn) farm. Historic aerial imagery (Google Earth Pro 2017) indicates selective clearing taking place prior to 2004. Subsequent to clearing taking place, regrowth has established within some of the cleared area.

3.1 Climate

The project area is located within the monsoon tropics and is subject to high rainfall during the annual wet season from October to April. The annual dry season brings cooler dry conditions and occurs between May and October (see Figure 3-1). The mean annual rainfall recorded at nearby Territory Wildlife Park is 1,821.5 mm. Annual average pan evaporation is 2,400 mm at the Darwin Airport, with little variation in average monthly evaporation occurring over the year (175 mm to 200 mm).

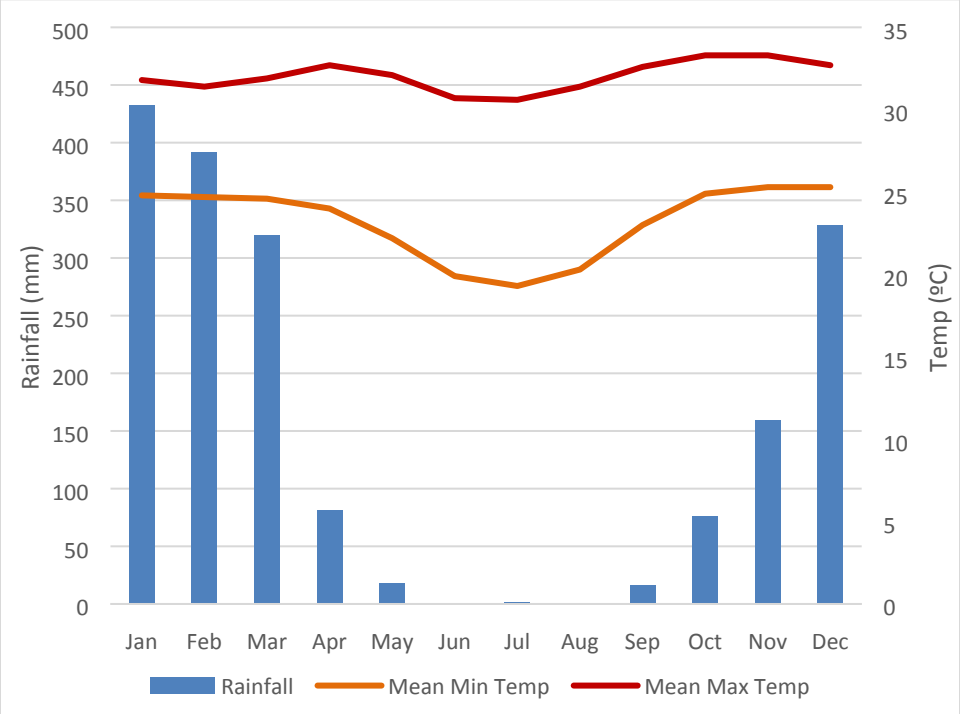


Figure 3-1. Graph of mean monthly climate statistics for the project area

Climate data was obtained from the Bureau of Meteorology, rainfall data from Territory Wildlife Park (Station number 014264) and temperature data from Darwin Airport (Station number 014015).

3.2 Topography

The project area is generally flat with a slight slope near the Darwin River riverbank.

3.3 Soils and geology

The project area consists of undifferentiated unconsolidated alluvial, colluvial and residual deposits: sand, soil, silt, gravel, sheetwash, talus, duricrust (NT Geological Survey 1983) – see Figure 3-3**.**

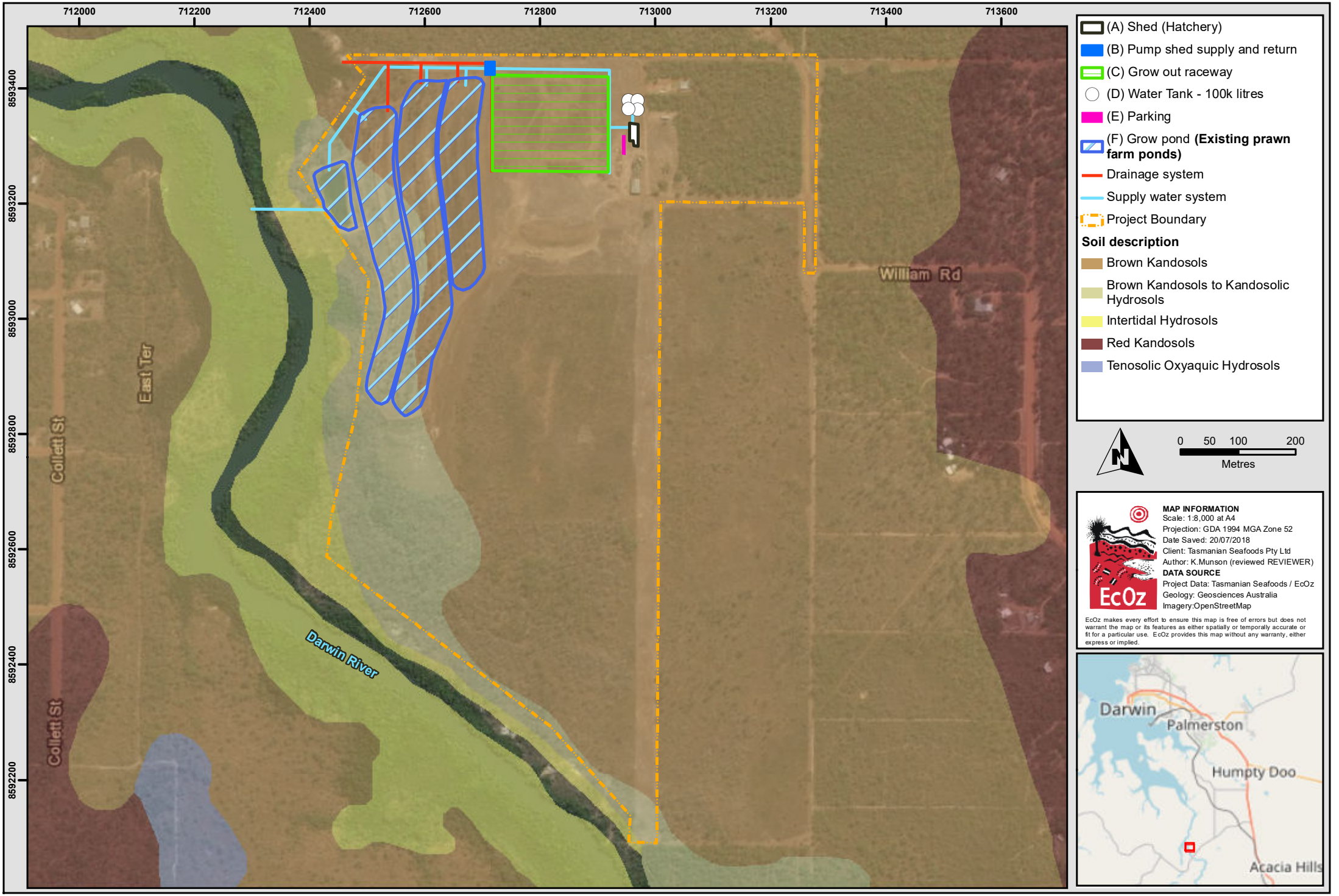
Soil types on the project area consist mainly of Brown Kandosols with some Brown Kandosols to Kandosolic Hydrosols along the south and western boundaries. The key characteristics are presented in Table 3-1 and shown in Figure 3-2.

Table 3-1. Soil types within the project area, as per Isbell (1996)

Soil type	Key characteristics	Drainage
Kandosol	• Lacks strong texture contrast, • B2 horizons in which the major part is massive or has only a weak grade of structure. • B2 horizons in which the major part is massive or has only a weak grade of structure. • Do not have a tenic B horizon. • Do not have clear or abrupt textural B horizons. • Are not calcareous throughout the solum, or below the A1 or Ap horizon or to a depth of 0.2m if the A1 horizon is only weakly developed.	Well-drained
Hydrosols	• Seasonally or permanently saturated (wet), with or without reducing conditions during saturation, which results in a range of mottling and signs of saturation. • Can be associated with acid sulfate soils	Very poorly drained, saturated for a least 2-3 months of each year

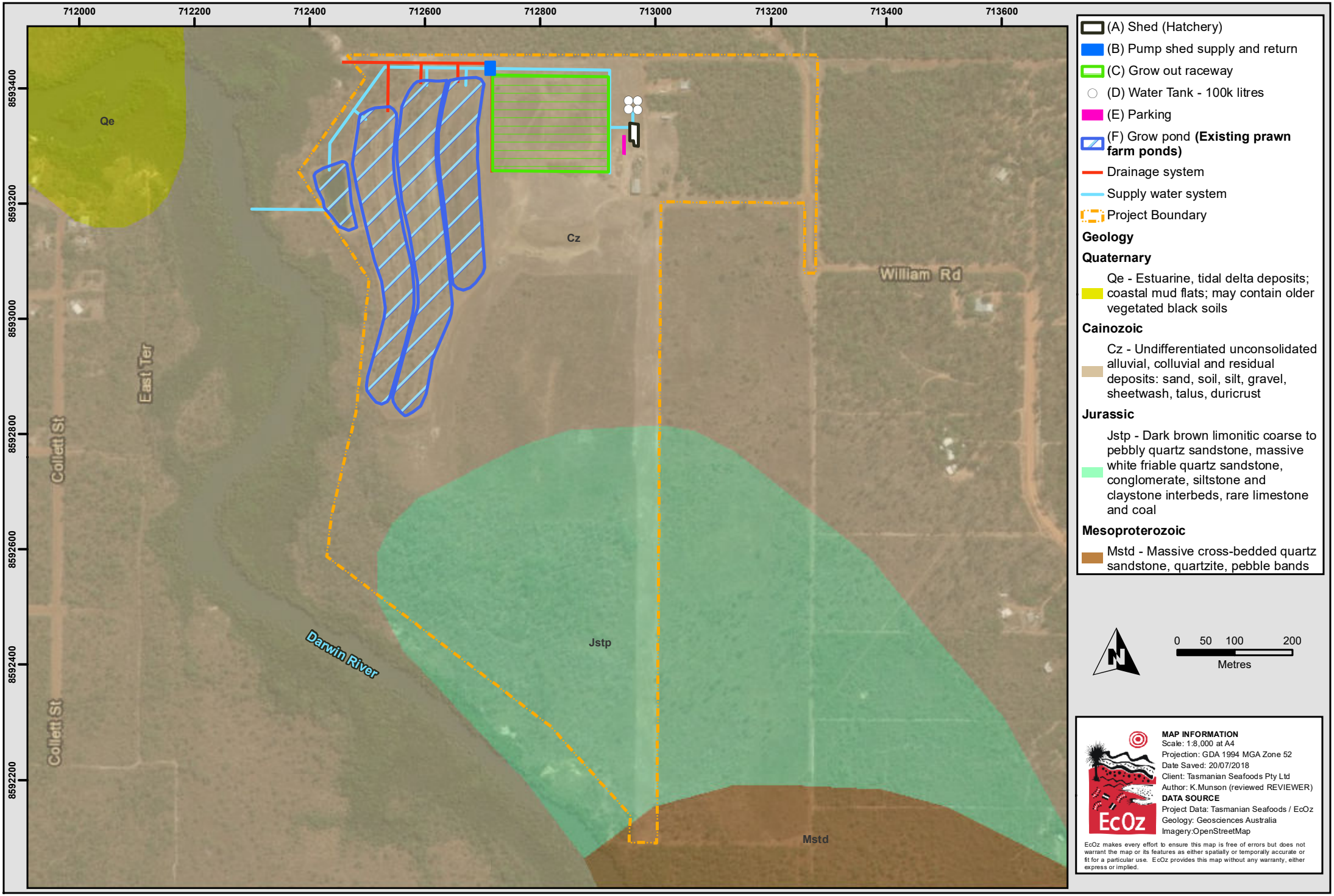
3.3.1 Acid sulfate soils

The *Greater Darwin Region 1:50,000 Acid Sulfate Soils Map* (Sheet 5073-2) illustrates acid sulfate soils (ASS) for the Darwin region. The majority of ASS in the Darwin region is associated with tidal zones around the Darwin Harbour. The project area falls within area of rocky ridge surrounded by estuarine fringes within the Darwin Harbour. Minor areas of tidally-affected estuarine fringes are mapped on the eastern and southern sides of the project area. These small areas within the project boundary have a moderate risk of acid sulfate soils occurring within the upper 1 m of soil (see Figure 3-4), with the vast majority of site falling outside of any mapped ASS risk areas.



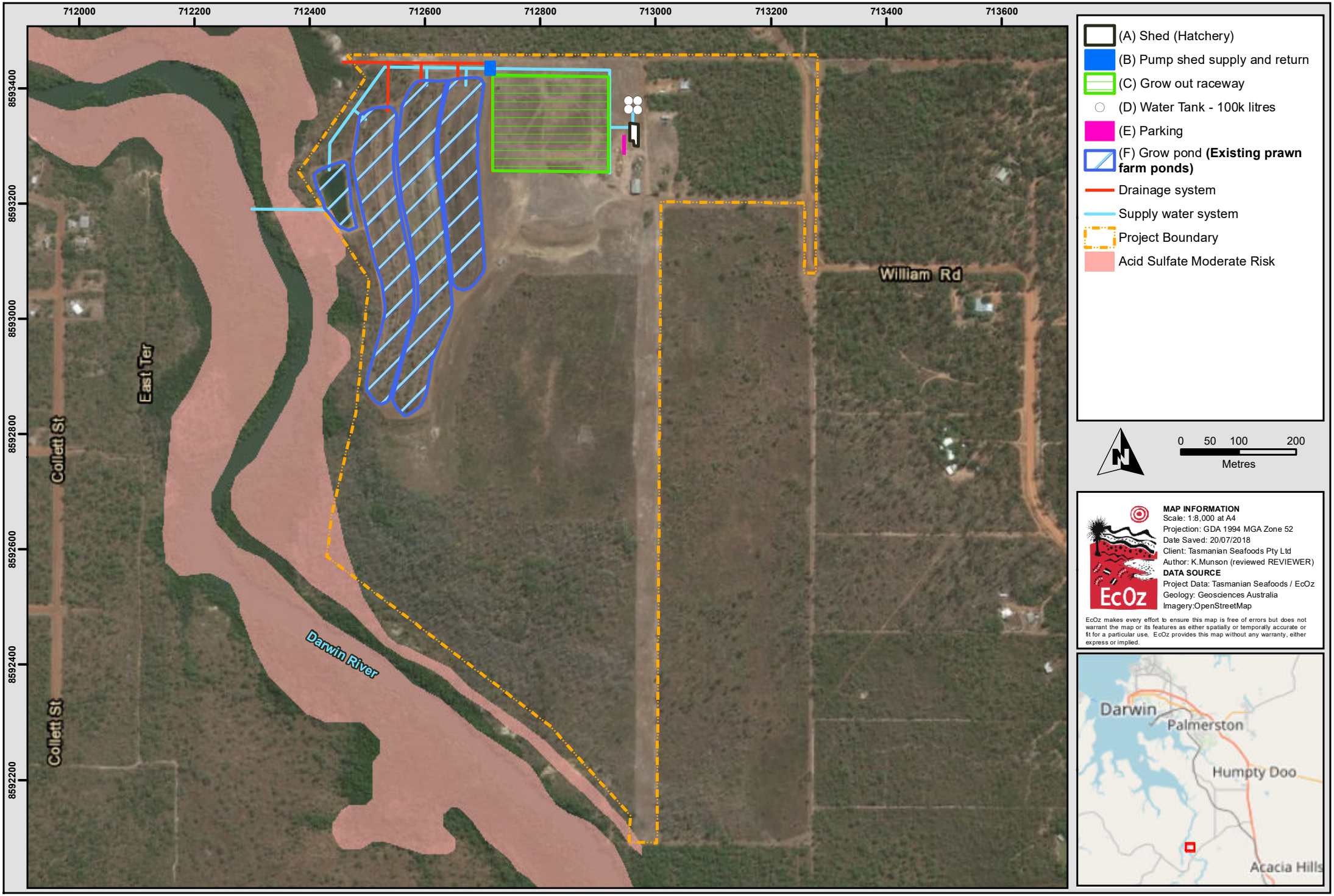
Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ18116 - Sea Cucumber Hatchery Berry Springs\01 Project Files\Figure 3-2. Map showing project topography and soils.mxd

Figure 3-2. Map showing project soils



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ18116 - Sea Cucumber Hatchery Berry Springs\01 Project Files\Figure 3-3. Map showing project geology.mxd

Figure 3-3. Map showing project geology.pdf



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ18116 - Sea Cucumber Hatchery Berry Springs\01 Project Files\Figure 3-4. Map showing acid sulfate soil risk.mxd

Figure 3-3. Map showing acid sulfate soil risk

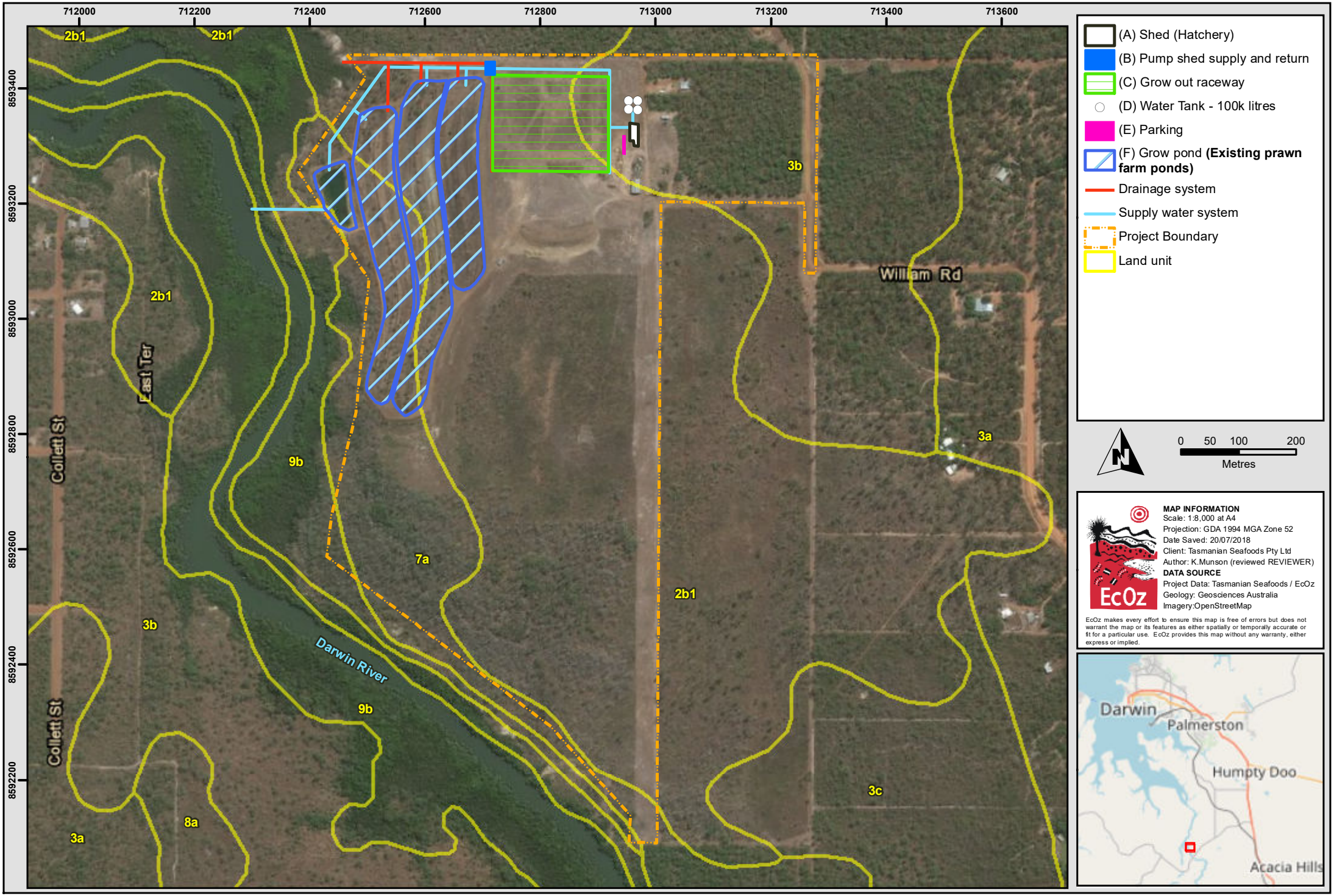
3.4 Land units

3.4.1 Land unit descriptions

Land units for the Greater Darwin area have been mapped at 1:25,000 (Fogarty et al. 1984) and cover the project area. Those land units relevant to the project area are summarised in Table 3-2 and shown in Figure 3-5

Table 3-2. Descriptions of the existing land units within the project area

Land unit	Vegetation types	Landform	Drainage	Soil	Area (ha)
2b1	Open Woodland of *E. miniata, E. tetrodonta, C. foelscheana, E. tectifica* over *Sorghum spp.*	Sideslopes	Very rapid	Brown kandosols	45.04
3b	Woodland of *E. miniata, E. tetrodonta* over *Sorghum spp.*	Flat to gently undulating upland surface	Very rapid	Brown Kandosols	10.03
7a	Open Woodland of *E. miniata, Erythrophleum chlorostachys* over *Sorghum plumosum, Themeda triandra*	Fringes and levees of major stream channels	Tidally inundated / Poorly drained	Brown kandosols to Kandosolic Hyrdrosols	12.82



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ18116 - Sea Cucumber Hatchery Berry Springs\01 Project Files\Figure 3-5. Map showing project land unitsb.mxd

Figure 3-5. Map showing project land units

3.5 Threatened species

3.5.1 Likelihood of occurrence

The development of the project area will require significant earthworks during the construction stage, with potential risk of sedimentation impacting upon Darwin River (without implementation of appropriate mitigation measures). Similarly, there is potential impact upon Darwin River during the operational phase associated with the discharge of aquaculture pond water. Therefore, in determining a threatened species 'likelihood of occurrence' assessment, the study area is both the project area and the waters of Darwin River downstream to where it reaches Darwin Harbour.

There are no specific threatened species records for the project area. This is not surprising; given its small size there is a low likelihood that any surveys have been undertaken there.

The study area straddles two bioregions, but is more appropriately assigned to Darwin Coastal bioregion – within which 70 threatened flora and fauna species are known to occur. Based on the large proportion of the site that has been previously disturbed, the land unit descriptions in Section 3.4, and each threatened species particular ecological requirements – most threatened species are considered very unlikely to occur within the study area, due to one or more of the following factors:

- There is no or insufficient suitable habitat to support the species
- The species is only an occasional visitor to the area
- The species is considered to be locally-extinct.

Therefore, those species have been discarded from further assessment. The remaining species have a medium or high chance of occurring within the study area – see Table 3-3 – as per the following criterion:

- HIGH – it is expected that this species will be within the study area because of the presence of suitable habitat, and/or there are recent proximate records (i.e. post-2000).
- MEDIUM – this species may live within the study area because there is suitable habitat; however, there is evidence that lowers its likelihood of occurrence (i.e. known range contraction of the species in the region, no recent records with the search area, substantial loss of habitat within the project area since previous records, species is naturally-rare or occurs at a low density etc.).

Table 3-3. Threatened species with a high or medium likelihood of occurring within the study area

Species	Status		Habitat description	Likelihood of occurrence
	Cth	NT		
TERRESTRIAL REPTILES				
Floodplain Monitor (*Varanus panoptes*)	-	VU	Occurs in broad range of habitats – from coastal beaches to savannah woodlands.	**MEDIUM** Suitable habitat occurs within the project area and surrounds, and there are records in greater Darwin. However, numbers have significantly reduced since the arrival and establishment of Cane Toads. Close to Darwin, persistence is generally in coastal areas (unsuitable for Cane Toads) or in areas protected by development from Cane Toads.
BIRDS				
Partridge Pigeon (eastern sub-species)	VU	VU	Open forests and woodlands with an understorey of grasses. Prefers woodland dominated by *Eucalyptus tetrodonta* and *E. miniata*. The ideal	**MEDIUM or HIGH** This species may be found in the land units assigned to the project area, but as the quality of habitat within the site

Species	Status		Habitat description	Likelihood of occurrence
	Cth	NT		
(*Geophaps smithii smithii*)			fire regime appears to be fine-scale patchiness, where burnt and unburnt areas are juxtaposed at the scale of an individual's home-range.	has not been assessed (i.e. level of weed infestation, regrowth etc.), it is difficult to determine how likely this species is to occur.
Eastern Curlew (*Numenius madagascariensis*)	CR	VU	Coastal and estuarine with tidal mudflats. May roost during high tide on nearby beaches. May also be found at near-coastal swamps and lakes (apart from Red and Great Knot). Mostly widespread around the northern Australian coast, less common in the south, with few inland records. Eastern Curlew is uncommon across. Every year these species breed in the northern hemisphere in the summer, and migrate to Australia for the southern hemisphere summer. Some birds remain in Australia during the winter.	**MEDIUM** The distribution and habits of shorebirds within the Darwin region is well known because of long-term monitoring programs. There are small patches of mudflats within the study area within which, at times, individual shorebirds may occur; however, those mudflats are not known to be important foraging sites or support significant numbers of shorebirds.
Curlew Sandpiper (*Calidris ferruginea*)	CR	VU		
Bar-tailed Godwit (*Limosa lapponica baueri*)	VU	VU		
Bar-tailed Godwit (*Limosa lapponica menzbieri*)	CR	VU		
Great Knot (*Calidris tenuirostris*)	CR	VU		
Greater Sand Plover (*Charadrius leschenaultii*)	VU	VU		
Lesser Sand Plover (*Charadrius mongolus*)	EN	VU		
Red Knot (*Calidris canutus*)	EN	VU		
Asian Dowitcher (*Limnodromus semipalmatus*)	-	VU		
SAWFISH				
Dwarf Sawfish (*Pristis clavata*)	VU	VU	Tropical marine and estuarine waters, entering estuarine or fresh waters to breed during the wet season and moving into marine waters following the Wet season.	**HIGH** There is suitable breeding and nursery habitat for these species in the estuarine waters of the Darwin River. There are no records of these species from Darwin Harbour; however, detectability of these species is very low and they are considered possible in all Top End river systems.
Green Sawfish (*Pristis zijsron*)	VU	VU		
Large-tooth Sawfish (*Pristis pristis* – Cth) Freshwater Sawfish (*Pristis microdon* – NT)	VU	VU		
MAMMALS				
Pale Field-rat (*Rattus tunneyi*)	-	VU	Historically occurred in a wide range of habitats, but now primarily found in dense vegetation along creeks.	**MEDIUM or HIGH** These species may be found in the land units assigned to the project area, but as the quality of habitat within the site has not been assessed (i.e. level of weed infestation, regrowth etc.), it is difficult to predict how likely these species are to occur.
Black-footed Tree-rat (Kimberley and Mainland NT sub-species) *Mesembriomys gouldii gouldii*	EN	VU	Woodlands and open forests with large trees and a moderately diverse mid-storey in near-coastal areas. Thought to be more prevalent in woodlands with infrequent and low intensity fires.	

Status key: - = Not Listed, CR = Critically Endangered, EN = Endangered, VU = Vulnerable

3.5.2 Potential for significant impact

There are threatened species with a medium or high chance of occurring within or proximately downstream of the project area. By far the most likely way that most of these species could be impacted upon by project activities is through a reduction in surface water quality compromising their estuarine habitat. If the post-development quality of run-off and process water leaving the project area is not significantly different to the pre-development quality, then it is considered unlikely that any estuarine threatened species will be significantly impacted upon. Sections 4 and 6 detail the environmental impact management measures that will be employed to minimise impacts on surface water quality.

The quality of remnant woodland within the project area is unknown, and so it is difficult to predict whether or not certain potential threatened species are present. However, as the project does not involve any additional land clearing, project activities are unlikely to impact upon any extant terrestrial threatened species in surrounding areas.

3.6 Historic and cultural heritage

3.6.1 Archaeological sites

There have been no previous archaeological surveys undertaken within the project area to the knowledge of Tasmanian Seafoods.

3.7 Water quality

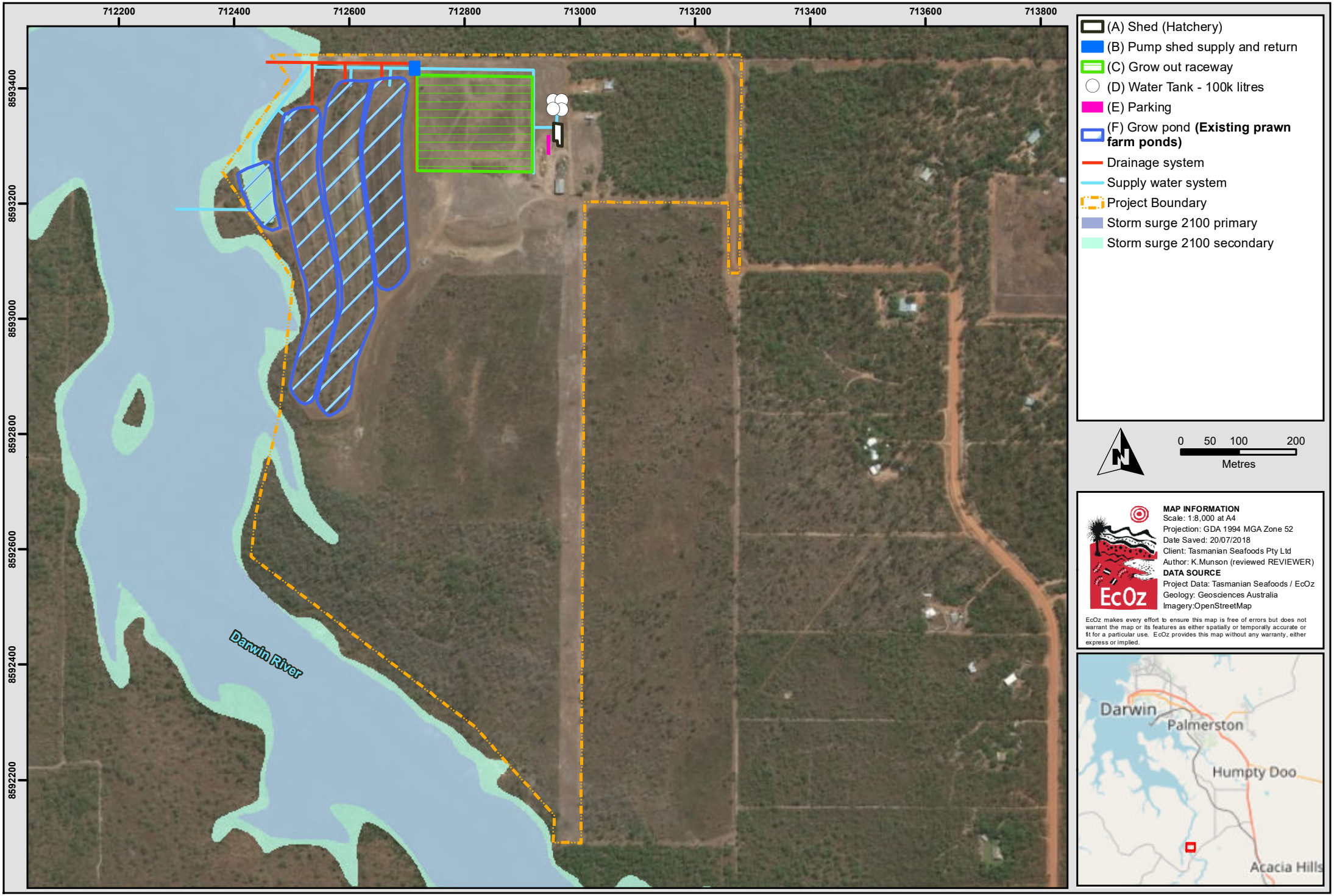
Given the immediate proximity of the project area to the Darwin Harbour, potential adverse impacts to the marine water quality must be considered. The water quality of Darwin Harbour is regularly monitored at a number of locations, and so a good baseline is available for assessing whether stormwater run-off or water used in farming operations are causing a reduction in the receiving environment's water quality. The project will employ a suite of stormwater management measures during construction and operation (Section 6.2.3) and will adopt a robust water quality monitoring regime (discussed in detail in Section 4).

In addition, Section 4.2 describes the likely, post-use quality of sea water that is used in the farming system and then released back into the harbour and concludes that there will be little change in quality.

For the operational phase, the aquaculture facility will be operated by a maximum of eight people with the use of two toilets. The standard design wastewater flow is estimated at 150 L/person/day in urban and rural areas. This will result in a projected daily effluent load of around 1200 L /day. Effluent (sewerage sludge and residues) will be collected by an appropriately licensed waste contractor.

3.8 Storm surge

In its current state, the project area includes zones within the storm surge zone (Figure 3-6); around 5 % of the project area falls within the 2100 secondary storm surge zone, and 1 % within the 2100 primary storm surge zone. The aquaculture facility will be designed and constructed to address adverse impact resulting from storm surge, including the use of building foundation pads and concrete lined ponds. The aquacultured species is native to Darwin Harbour and therefore loss of stock is not considered an environmental issue.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ18116 - Sea Cucumber Hatchery Berry Springs\01 Project Files\Figure 3-6. Map showing storm surge risk.mxd

Figure 3-5. Map showing storm surge risk

3.9 Groundwater

There are two known production bores located within the project area, RN029384 and RN033415. Bore RN033415 on Section 2413, Hundred of Cavenagh has a licence to extract up to 80 ML/year for Aquaculture purposes and 45 ML/year for agricultural uses. It has a yield of 10L/s

Tasmanian Seafoods estimate that approximately 2 kL/day of freshwater will be used for washing down equipment and for domestic purposes.

It is expected that the water system for the aquaculture facility will be a flow-through system for the majority of the year and will not require fresh water. If the raceway system is being recirculated, then approximately 45 kL/day of fresh water will be used to account for evaporation.

At these rates of usage, the ongoing water requirements of the aquaculture facility will fall well within the extraction licence allowance of 80 ML/year..

3.10 Biting insects

The project area is within naturally-occurring biting insect breeding areas with potential to expose people to the public health and amenity issues associated with biting insects. For the operational phase, establishment of a stormwater drainage system that eliminates the potential to create new biting insect breeding will be paramount.

During construction, the following will occur:

- Undertake earthworks so as to avoid the creation of pooling water
- Remove materials that may hold water (e.g. drums/pipes)
- Inspect laydowns weekly for pooling water (during wet season).

3.11 Dust, noise & air quality

Air quality within the project area is commensurate with that of the greater Darwin airshed; there is no industry or environmental factors proximate to the project area to give effect otherwise.

The final form of proposed development will include paved, landscaped and hardstand areas which will minimise dust generation during the operational phase. During the construction phase, dust will be managed through the implementation of the ESCP which will include restricted activities during windy weather and use of dust suppression (e.g. water carts).

Noise during construction will be managed through selection of appropriate construction equipment and restricted construction working hours.

Requirements for dust, noise and air quality will be documented within the CEMP.

4 Water Quality Impact Assessment

4.1 Water management and quality

The proposed facility will include four existing grow-out ponds, and 24 raceways (each 5 m x 200 m) for nursery production and broodstock maintenance (Figure 2-1). There is provision for a new hatchery at the site, however the DAC hatchery will continue to be used as the primary hatchery and juveniles will be transferred from DAC to the new farm.

The farm will be a flow-through system where water is pumped from existing ponds on the property that are fed from Darwin River into storage tanks (four tanks; total combined capacity 100 kL), which feed the brood stock ponds and raceways. After flowing through the ponds and raceways, the water is returned to existing drainage channel and eventually to the river.

On average, around 1 ML of water may be extracted from Darwin River, and 1 ML returned (discharged) each day.

There is minimal change to water quality as it flows through the raceways and ponds, and discharge water quality is very similar to that originally extracted from the Harbour. This is because:

- Sea cucumber do not require any feeding, and there are no external nutrient inputs added the water from animal feed. Small amounts of organic fertiliser may at times be applied to maintain a low benthic algal production in the raceways.
- The stocking density is very low for sea cucumber culture (200 grams/m^2). Therefore, the excrement from the sea cucumbers is negligible and water treatment is not required prior to discharge.
- Water pumped from the intake point flows through the farm. Twenty percent of the water will be replaced each day with the remainder being stored in existing ponds.

4.2 Water quality testing

As an indication of incoming and outgoing water quality to and from the sea cucumber farm, water quality test results from the pilot-scale trial sites (i.e. DAC nursery raceways and Paspaley brood stock and nursery ponds) are presented in Table 4-1.

The incoming Darwin Harbour water to both the DAC and Paspaley facility is very similar to that of the proposed farm. The incoming water to DAC is from Darwin Harbour off Channel Island, and for the Paspaley facility from Middle Arm

The Paspaley facility was previously used for barramundi and prawn aquaculture. Tasmanian Seafoods utilised the existing pond system for supporting brood stock and juvenile sea cucumbers. Figure 4-2shows the water intake point, nursery and brood stock ponds, settlement pond and discharge point. The Paspaley facility water quality data was collected as a condition of the operation's Waste Discharge Licence (WDL 173-01).

Water quality monitoring of the parameters listed in Table 4-1 was required quarterly at three points (shown in Figure 4-1):

- TSF Discharge – located at the outlet of the final settlement pond, at the landward extent of the mangroves.
- TSF 1 – located at the seaward extent of the mangroves, around 850 m downstream of TSF Discharge.
- TSF 3 – located around 1 km out into the harbour from TSF 1.

TSF Discharge was sampled on foot, whereas TSF 1 and TSF 3 were sampled from a boat.

Data is only available for the period the facility was used for sea cucumber pilot trials between November 2011 and August 2013.

As specified in WDL 173-01, the water quality of the receiving Darwin Harbour environment, represented by TSF 1 and TSF 3, must comply with the *Water Quality Objectives for the Darwin Harbour Region* (NRETAS 2010); specifically, the objectives set for the Blackmore River.

In regards to the DAC, brood stock, hatchery, and nursery trials have been on-going since 2004, however, water quality testing has not been required as the DAC does not have reporting responsibilities under a waste discharge licence. Water quality samples were collected on 21 December 2016 to inform this water quality assessment (data included in Table 4-1). A sample was collected of the incoming water and outgoing water of one of the nursery raceways (see Figure 4-2**).** Laboratory documentation is provided in Appendix A.

The incoming water is pumped direct from the Harbour and passed through a 20-micron sand filter before release into the raceways. No feed or fertiliser to promote algae growth is normally required and the juvenile sea cucumbers gain their nutrition from the benthic algae and other organic detritus in the sandy substrate of the raceways.

4.2.1 Water quality results discussion

Water quality results in Table 4-1 are compared to the NRETAS 2010 *Water Quality Objectives for the Darwin Harbour Region – Blackmore River*.

Paspaley Facility

For the Paspaley facility, the TSF Discharge, TSF 1 and TSF3 sites (Figure 4-2) largely complied throughout the monitoring period in regards to the water quality objectives for pH, dissolved oxygen, total phosphorus (TP) and filterable reactive phosphorus (FRP).

Chlorophyll-a levels were often elevated in the TSF Discharge, but this did not transfer to the Harbour water quality, with TSF 1 and TSF 3 chlorophyll-a levels always below the objective. It is important to note that the elevated chlorophyll-a levels in the TSF Discharge water at the Paspaley facility results from the previous use of the ponds for barramundi and prawn aquaculture and is not related to the sea cucumber trials. The previous operation left the bottom of the ponds with a high amount of nutrients so the final settlement pond always had a dense algae bloom.

Total Nitrogen (TN) levels were elevated in the TSF Discharge water on three occasions during the reporting period (Nov 2011, Nov 2012 and Mar 2013). This did not equate to higher TN levels at the Harbour sites in November 2011; but did in November 2012 and March 2013. In November 2012, the inner Harbour site TSF 1 (closer to the discharge point) complied with the objectives but the outer Harbour site TSF 3 was above, indicating the TN concentration at this site likely reflected the wider Harbour water and not the discharge.

Nitrate + Nitrite (NO_x) concentrations were elevated in the TSF Discharge on three occasions (Nov 2011, May 2012, and Mar 2013). This did not equate to higher NO_x concentrations at the Harbour sites in November 2011, but did in March 2013. In May 2012, the inner Harbour site TSF 1 complied with the objectives, but the outer Harbour site TSF 3 was slightly above. Similarly to TN, this indicates the NO_x concentration at this site reflected the wider Harbour water and not the discharge. This was similarly the case in March 2012, where the Harbour sites exceeded the objective but the discharge water actually complied.

Ammonia (NH_3) concentrations were elevated in the TSF Discharge on six occasions. However, four of these (Nov 2011, May 2012, Aug 2012 and Mar 2013) did not equate to higher NH_3 concentrations at the Harbour sites. The other two occasions (Mar 2012 and Nov 2012), the TSF 3 site was higher in

concentration than the TSF1 site, and in Mar 2012, the TSF 3 site was also higher than the actual discharge. Given this, it appears that NH_3 concentrations can be elevated in the Harbour regardless of the discharge. This is further evidenced in August 2013, when NH_3 was elevated at TSF 3 despite there being no discharge.

The variability of background NO_x and NH_3 concentrations in the Harbour is demonstrated in the water quality data collected by the NT Government Aquatic Health Unit for the annual *Darwin Harbour Region Report Cards*. As an example, the data collected for the 2015 report card (see Fortune and Patterson 2016) shows that for the Blackmore River Estuary, NO_x concentrations ranged between 0.003 and 0.124 mg/L, and NH_3 concentrations between 0.005 and 0.037 mg/L. All concentrations recorded at TSF1 and TSF3 are within these ranges.

Similarly, all TN concentrations measured at TSF 1 and TSF 3 largely fall within the range recorded by Fortune and Patterson (2016); 0.08 to 0.48 mg/L.

Paspaley Facility Water Quality Conclusions

In conclusion, the water quality data indicates the discharge from the sea cucumber farm trials did not impact the Harbour water quality (TSF1 and TSF3). Chlorophyll-a was elevated in the discharge water, however this was not transferred to the Harbour; noting the discharge water flows through an 850 m-wide band of mangroves prior to reaching the Harbour. Also, the elevated chlorophyll-a is not associated with the sea cucumber trials but a result of pre-existing nutrients in the pond substrate from barramundi and prawn operations causing algae blooms in the final sediment pond. The proposed sea cucumber farm is expected to have negligible chlorophyll-a concentrations in discharge water as all algae will be benthic and not suspended or able to flow out with the discharge water. The juvenile sea cucumbers feed on benthic algae in the sandy raceway substrate and suspended algae is undesirable.

Nitrogen species (TN, NO_x, NH_3) were at times elevated in the TSF Discharge, although this did not always correspond to elevated nitrogen in the Harbour. Also, sometimes nitrogen concentrations distant to the discharge (TSF 3) were higher than the site closer to the discharge (TSF 1), or higher than the actual discharge itself. On one occasion when there was no discharge occurring, NH_3 was elevated at TSF 3. This suggests that nitrogen can be elevated in the Harbour for reasons other than discharge from the farm. This is further supported by the NT Government data collected for the on-going annual *Darwin Harbour Region Report Cards* (see for example Fortune and Patterson 2016).

DAC

For the DAC nursery raceway tested 21 December 2016, there was little difference between the incoming (representing Harbour water) and outgoing water quality regarding temperature, pH, dissolved oxygen, salinity and chlorophyll-a.

The low chlorophyll-a in the outgoing water demonstrates the point made in the section above, where unlike the Paspaley facility ponds, the proposed sea cucumber farm is expected to have negligible chlorophyll-a concentrations in discharge water as all algae will be benthic and not suspended or able to flow out with the discharge water.

FRP, NH_3 and NO_x concentrations were lower in the outgoing water compared to the incoming water, indicating the removal of these nutrients within the raceway resulting in water quality improvement.

TN and TP concentrations increased in the outgoing water. In relation to TN, this increase is likely due to the addition of organic nitrogen. The concentration of Total Kjeldahl Nitrogen (TKN) in the outgoing water was 0.8 mg/L (not shown in Table 4-1 but provided in Appendix A). TKN is the sum of NH_3 and organic nitrogen, therefore organic nitrogen = 0.63 mg/L. No feed, fertilisers or other additives have been added to the water, therefore the organic nitrogen is likely sea cucumber excrement and organic detritus from the sandy substrate disturbed and suspended into the water by sea cucumber activity and rapid water flow down the raceway.

Similarly, the increase in TP in outgoing water is likely from the disturbance and suspension of organic detritus (particulate P) from the sandy substrate into the water column given the dissolved form of P (measured as FRP) was relatively low.

Importantly to note is that the dissolved inorganic nutrient forms that decreased through the raceways are those more likely to cause water quality issues. FRP, NH_3 and NO_x are more readily available for plant uptake and more likely to cause algal blooms; whereas organic N and particulate P are less available and less likely to cause water quality degradation. Further evidence of this is the low chlorophyll-a and biological oxygen demand (BOD) determined for the outgoing water. BOD is not shown in Table 4-1 but was <2 mg/L (see Appendix A).

DAC Water Quality Conclusions

In conclusion, water quality was improved after flowing through the nursery raceway in regards to dissolved inorganic nitrogen (NH_3 and NO_x) and dissolved phosphorus (FRP). Organic nitrogen and particulate P increased in the raceway likely due to sea cucumber excrement and organic detritus from the sandy substrate disturbed and suspended into the water by sea cucumber activity and rapid water flow down the raceway.

Of note in regards to the proposed sea cucumber farm is that the DAC raceways are highly stocked in comparison to the density of sea cucumbers planned for the proposed farm. As such, the outgoing TN and TP concentrations will be less.

Additionally, the nutrient species that showed a decrease in concentration through the nursery are the species of most concern for water quality given these are the most available for plant uptake and potential for algal blooms. Organic N and particulate P are less available. Further evidence of the low availability of nutrients in the outgoing water is the concentration of chlorophyll-a and BOD, which were both below detection limits.

Table 4-1. Water quality test results for pilot trial sites

Concentrations compared to Water Quality Objectives for the Darwin Harbour Region – Blackmore River, Table 8 and Table 9 in NRETAS 2010. Concentrations outside the objectives highlighted in red.

Date	Site	NH_3-N	NOx-N	TN	Filt. Reactive P	TP	Chl-a	Temp.	pH	Diss. Oxy.	Salinity
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/m³	°C	pH units	%sat	ppt
Water Quality Objectives Darwin Harbour - Blackmore River		0.020	0.020	0.30	0.010	0.030	4	-	6.5-8.5	80-100	-
Pilot trial – Paspaley site – Water Quality Reporting as required under WDL173-01											
29/11/2011	TSF 1	0.010	0.005	0.12	<0.005	0.015	4	29.8	7.87	89	34
29/11/2011	TSF 3	0.015	<0.005	<0.165	<0.005	0.010	3	29.5	7.85	87	33
29/11/2011	TSF Discharge	0.100	0.035	0.65	<0.005	0.030	18	30.1	8.16	85	33
30/03/2012	TSF 1	0.020	0.035	0.07	0.005	0.015	2	30.6	7.89	110	29
30/03/2012	TSF 3	0.030	0.030	0.17	0.005	0.015	2	30.5	7.89	110	29
30/03/2012	TSF Discharge	0.025	<0.050	<0.495	<0.005	0.020	14	30.8	7.98	94	22
29/05/2012	TSF 1	0.020	<0.005	<0.035	<0.005	0.015	<1	23.5	7.64	96	36
29/05/2012	TSF 3	0.010	0.025	0.10	<0.005	0.010	1	23.2	7.66	95	36
29/05/2012	TSF Discharge	0.040	0.025	0.20	<0.005	0.020	3	22.1	7.70	93	34
23/08/2012	TSF 1	0.015	0.010	0.09	<0.005	0.005	1	26.4	7.84	93	37
23/08/2012	TSF 3	0.020	0.015	0.11	<0.005	0.005	1	26.2	7.88	98	37
23/08/2012	TSF Discharge	0.050	0.020	0.19	<0.005	0.010	5	26.5	7.91	93	39
19/11/2012	TSF 1	0.025	0.020	0.26	0.005	0.015	2	32.6	7.70	88	36
19/11/2012	TSF 3	0.035	0.020	0.49	0.010	0.025	2	32.7	7.72	98	36
19/11/2012	TSF Discharge	0.080	0.015	0.41	<0.005	0.020	5	32.4	7.95	87	38
4/03/2013	TSF 1	0.015	0.045	0.39	0.010	0.020	4	27.8	7.76	83	33
4/03/2013	TSF 3	0.010	0.045	0.30	0.010	0.020	2	27.8	7.81	83	33
4/03/2013	TSF Discharge	0.125	0.055	0.54	< 0.005	0.010	5	27.7	7.72	87	23
17/05/2013	TSF 1	0.020	0.010	0.17	<0.005	0.010	2	30.4	7.83	95	35
17/05/2013	TSF 3	0.025	0.010	0.14	<0.005	0.005	1	30.4	7.86	96	35
17/05/2013	TSF Discharge	0.015	0.015	0.17	<0.005	0.030	41	30.4	8.17	92	32
13/08/2013	TSF 1	0.015	0.010	0.08	0.005	0.020	<1	24.8	7.90	96	37
13/08/2013	TSF 3	0.025	0.015	0.14	0.005	0.020	<1	24.8	7.92	97	37
13/08/2013	TSF Discharge	No water discharged this month due to pump replacement. No sample collected.									
Pilot trial - Darwin Aquaculture Centre – recent water quality testing of nursery raceways											
21/12/2016	Incoming	0.200	0.040	<0.50	0.007	<0.050	<1	29.4	7.71	92	26
21/12/2016	Outgoing	0.170	0.020	0.80	0.004	0.070	<1	27.9	7.89	90	26

Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ16150 - Tasmanian Seafoods Sea Cucumber\01 Project Files\Figure 4-3. Paspaley aquaculture facility layout and location of Waste Discharge Licence water quality monitoring points.mxd

Figure 4-1. Paspaley aquaculture facility layout and location of Waste Discharge Licence water quality monitoring points

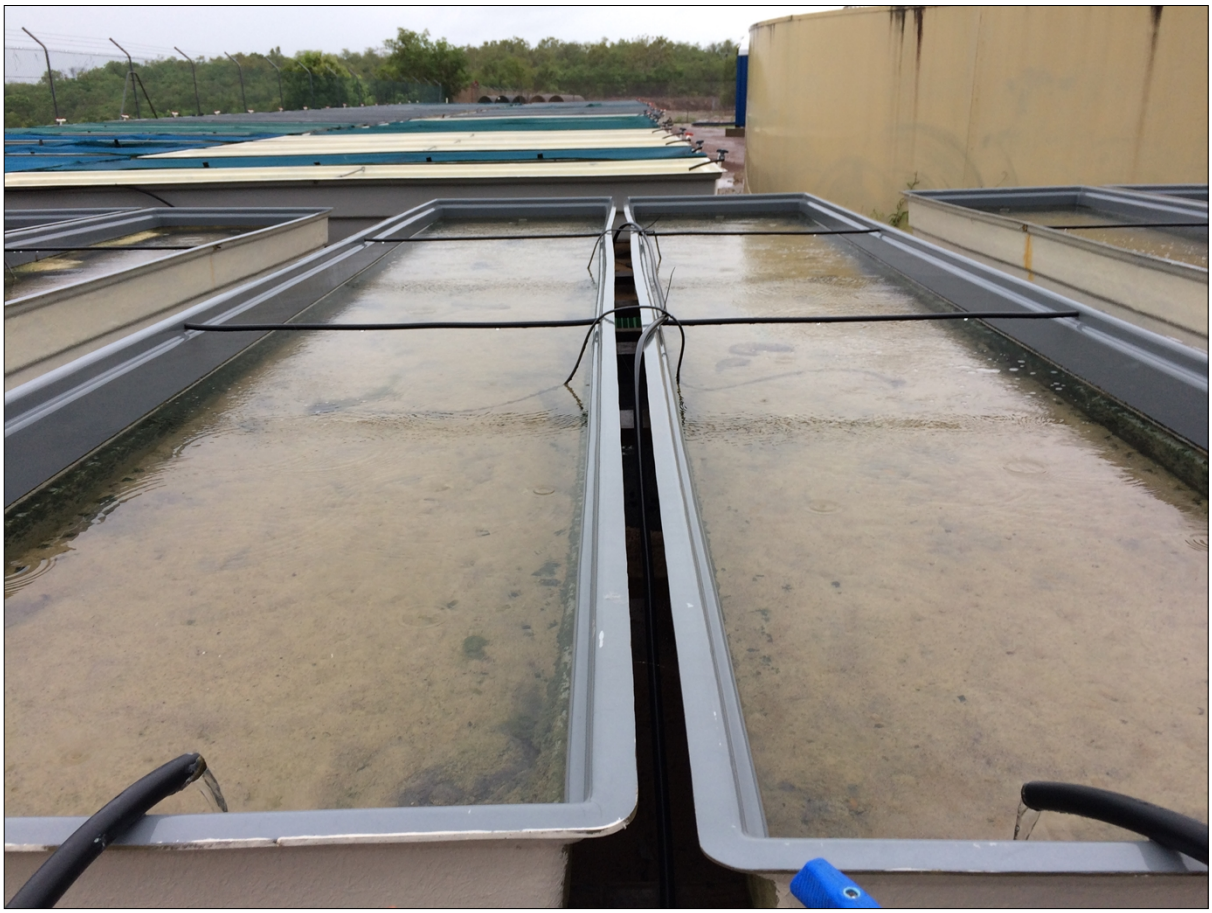


Figure 4-2. Photo of nursery raceways at DAC

4.3 Water quality impact assessment

The potential impact of discharge from the proposed sea cucumber farm on Darwin River water quality is assessed as low for the following reasons:

- The quality of discharge water is very similar to that originally extracted from the river as evidenced by the water quality testing results (Section 4).
- Sea cucumber do not require any feeding, and there are no external nutrient inputs added the water from animal feed. Small amounts of organic fertiliser may at times be applied to maintain a low benthic algal production in the raceways.
- The stocking density is very low for sea cucumber culture (200 grams/m2). Therefore, the excrement from the sea cucumbers is negligible.
- For some dissolved nutrient species (FRP, NH_3 and NO_x) there was an improvement in water quality (i.e. decreased concentration) after flowing through the DAC nursery.
- Where nutrient species increased (organic nitrogen, particulate P), this is not expected to the same extent at the proposed farm given the lower stocking density.
- Additionally, the nutrient species that showed a decrease in concentration through the nursery (NH_3, NO_x, FRP) are the species of most concern for water quality given these are the most available for plant uptake and potential for algal blooms. Organic N and particulate P are less

available. Further evidence of the low availability of nutrients in the outgoing water is the concentration of chlorophyll-a and BOD, which were both below detection limits.

- The concentration of nutrients in discharge water is certainly expected to be within the current baseline range of concentrations as recorded in the NT Government's long-term Darwin Harbour monitoring program.
- The water quality monitoring plan outlined in Section 4.4 below will be implemented and will allow early detection of any emerging discharge water quality issues.

4.4 Water quality monitoring plan

4.4.1 Water quality monitoring sites

- Site 1. Incoming water
- Site 2. Discharge water
- Site 3. Tidal inlet receiving discharge water – via boat – a point in the centre of the river around 100 m downstream of where discharge enters the inlet.

4.4.2 Water quality parameters

- Physical parameters: temperature, pH, electrical conductivity (EC), salinity
- Laboratory parameters: nutrients (TN, TP, NO_x, NH_3, TKN, FRP), total suspended solids (TSS), chlorophyll-a, BOD.

4.4.3 Sampling frequency

Monthly for first 6 months then quarterly depending on results.

4.4.4 Water quality assessment criteria

Water Quality Objectives for the Darwin Harbour Region – Blackmore River, Table 8 and Table 9 in NRETAS 2010.

5 Risk Assessment

The risk assessment process involves identification of environmental aspects and impacts, and is systematic and consistent with international best practice standard methodologies, including:

- *AS/NZS ISO 31000:2009: Risk management - Principles and Guidelines (Standard).*
- *HB 203:2006: Environmental risk management - Principles and Process (Guide).*
- *HB 158:2010: Delivering assurance based on ISO 31000:2009 - Risk management - Principles and Guidelines (Guide).*

Environmental aspects are defined as the elements of an organisations activities, products or services that can interact with the environment (e.g. vegetation clearing, use of machinery, excavation activities). Environmental impacts are any change to the environment, whether adverse or beneficial, wholly or partially resulting from the organisation's environmental aspects.

Identifying the environmental aspects and impacts relevant to the construction and operation of the aquaculture facility allows an assessment of the environmental risk to be completed, using a standard consequence and likelihood matrix. Management or mitigation measures can be assigned to each aspect, with a residual risk calculated based on the resulting potential impacts. Environmental management activities can then be prioritised according to risk.

The ranking for event consequence is shown in Table 5-1. The likelihood of an event occurring provides a measure of the known or anticipated frequency of occurrences is shown in Table 5-2. Combining likelihood with consequence provides guidance on risk levels of each aspect and enables key risk to be identified and management strategies to be prioritised (Table 5-3). The risk assessment for the various aspects of the operation of the animal husbandry facility is provided in Table 5-4.

Table 5-1. Consequence ranking

Consequence		
1	**Insignificant**	No/low measurable impact on the environment.
2	**Minor**	Some minor, temporary environmental impact
3	**Moderate**	Contained temporary or permanent minor, localised environmental damage
4	**Major**	Severe environmental damage.
5	**Catastrophic**	Environmental disaster

Table 5-2. Qualitative measures of likelihood

Probability/Likelihood			Likelihood criteria
A	**Rare**	Will occur only in exceptional circumstances	0-1%
B	**Unlikely**	Could occur at some time.	1-10%
C	**Moderate**	Might possibly occur at some time.	11-50%
D	**Likely**	Will probably occur in most circumstances.	51-90%
E	**Almost Certain**	Expected to occur in most circumstances.	91-100%

Table 5-3. Risk rankings from combined consequence to likelihood

Likelihood	Consequence 1	2	3	4	5
A	1	3	6	10	15
B	2	5	9	14	19
C	4	8	13	18	22
D	7	12	17	21	24
E	11	16	20	23	25

Red	extreme risk	intolerable
Orange	high risk	intolerable or tolerable
Yellow	medium risk	tolerable or acceptable
Green	low risk	acceptable

Table 5-4. Risk assessment

Aspect	Impact	Inherent risk	Mitigation/Control	Residual Risk
Waste management: storage, transport and disposal	• Contamination of land, groundwater, surface water and the marine environment • Toxic effects on marine biota • Odours • Increased fire risk • Risk to human health • Reduced visual amenity • Contamination of recyclables • Attracting fauna & insects	8 (Medium)	• Training and induction of site personnel re: waste management • Ensure the work site remains tidy and all rubbish is disposed of appropriately • Waste materials will be re-used and recycled where possible. • No burial or incineration of waste will be conducted. • Designated collection facilities, including rubbish bins, skips and recycling bins will be located around site • Waste receptacles to be covered for food waste items • Segregation of waste streams • Hazardous waste storage areas are perimeter-bunded and covered • Spill kits available on site • Identification and appropriate handling of prescribed waste products (including Listed Waste) • Dispose of non-hazardous solid waste at a designated waste disposal facility (unless the waste can be re-used or recycled) • Engage a licensed contractor to collect and dispose of liquid waste • Regular site inspections	5 (Low)
Waste management: on-site generation and storage of raw sewage at ablutions facilities	Spills or leaks of raw sewage resulting in: • Contamination of soils, groundwater, surface water and marine environment • Odours	8 (medium)	• Design and installation of ablution facilities as per Australian Standard by licensed plumber • Regular disposal/servicing by a licensed contractor • Spill kits available on site • Training of staff in spill response	5 (Low)
Hazardous substances: storage, transport and	• Pollution of the marine environment and waterways	8 (Medium)	• Training and education to be provided to personnel via site induction • Centralised storage of hazardous	5 (Low)

usage	• Odours
	• Fire risk
	• Ground contamination
	• Groundwater pollution
			substances
			• Hazardous substances to be stored in appropriate containers, including secondary containment (e.g. bunded areas)
			• Hazardous substances to be segregated where required
			• Hazardous waste receptacles to be clearly labelled
			• Engage licensed professional for the handling and removal of hazardous waste
			• Spill kits to be located within storage and usage areas
			• Safety Data Sheets to be readily available
			• Follow the spill response procedure:
			  ○ Control and contain
			  ○ Communicate
			  ○ Clean-up
			• All contaminated waste to be disposed of in the correct contaminated waste bin
			• Darwin Depot Emergency Response Plan
			• Corporate Emergency Response and Recovery Plan (for major incidents)	

Hazardous substances: refuelling	• Soil, surface water and groundwater pollution
	• Pollution of the marine environment and Darwin Harbour
	• Odours
	• Fire risk
		8 (Medium)	• Refuelling operations to be undertaken consistent with refuelling procedure.
			• Refuelling to be performed by trained, competent and authorised refuelling operator(s)
			• Refuelling operation to be manned at all times
			• All light vehicle refuelling to occur off site
			• Drip trays/bunds to be used during refuelling process to prevent spills to ground
			• Safety data sheets to be readily available in area where hazardous substances are used
			• Refuelling equipment to be fitted with auto shut-off fuel nozzles
			• Identify high risk areas and limit vehicle movements
			• Secondary containment of hazardous substances (e.g. double skinned tanks)
			• Site induction/training to include spill prevention and response
			• Complete regular vehicle maintenance as per manufacturers requirements.
			• Undertake pre-start checks
			• Inspect work areas for spills
			• Chemicals and hazardous substances to be stored in containers which are fit for purpose
			• Spill kits to be made available in work area
			• Follow the spill response procedure:
			  ○ Control and Contain
			  ○ Communicate
			  ○ Clean-up
			• All contaminated waste to be disposed of in the correct contaminated waste bin
			• Regular monitoring and maintenance of machinery and equipment to be undertaken.
			• Site Emergency Response Plan
				5 (Low)

Storage and operation of	• Greenhouse gas emissions from	8 (Medium)	• Maintain vehicles and machinery in good working order.	5 (Low)

machinery and vehicles	machinery use		• Operate machines in an efficient manner. • Avoid use of machinery when not required.	
Vehicle washdown	• Discharge of contaminated washdown water to marine environment	8 (Medium)	• Washdown of vehicles and equipment to be undertaken within dedicated washdown facility • Washdown facility to include oil-water separator • Washdown facility to be managed and maintained to ensure no discharge of contaminants to watercourse and/or marine environment	5 (Low)
Onshore and intertidal zone earthworks and construction activities	Uncontrolled release of dangerous goods or hazardous substances resulting in: • Soil, surface water and groundwater pollution • Pollution of the marine environment and Darwin Harbour • Odours • Effects on flora and fauna	8 (Medium)	• Appropriate storage and handling of hazardous substances • Training and induction of site personnel (emergency & spill response) • Maintain dangerous goods register, including SDS's • Development and implementation of ESCP • Spill kits to be available • No storage of dangerous goods/hazardous substances within 30m of a watercourse or tidal areas • Water quality impact monitoring to be undertaken beyond the site • Construction to utilise low tides to minimise tidal exposure • Encapsulation/containment of abrasive blasting, spray painting etc.	5 (Low)
Onshore and intertidal zone earthworks and construction activities	Disturbance of sediments and displacement of ASS/PASS leading to: • Oxidation of ASS and generation of sulphuric acid • Potential acidification and heavy metal contamination of soil, surface water, groundwater and marine environment • Impacts to flora and fauna due to lowering of ph.	9 (Medium)	• Development of CEMP • ESCP to be developed and implemented prior to commencement of work activities • Identification of ASS areas prior to commencement of works • No soil disturbance works to be undertaken within mapped ASS risk areas • Training and induction of site personnel	6 (Low)
Onshore and intertidal zone earthworks and construction activities	Erosion and discharge of sediment to marine environment resulting in: • Increased nutrients to receiving waters • Reduced environmental health • Smothering of vegetation and invertebrate fauna	8 (Medium)	• ESCP to be developed and implemented prior to commencement of work activities (in accordance with IECA guidelines) • Water quality impact monitoring to be undertaken beyond the site (pH, turbidity, hydrocarbons etc.) • Disturbed areas to be rehabilitated following completion of works •	5 (Low)
Surface water (construction and operational)	Erosion and discharge of sediment to marine environment resulting in: • Increased nutrients to receiving waters • Reduced environmental health • Smothering of vegetation and	8 (Medium)	• ESCP to be developed and implemented prior to commencement of work activities (in accordance with IECA guidelines) • Site induction/training to include awareness of stormwater management (including erosion and sediment control) • Ensure erosion protection in place for susceptible areas (e.g. hardstand, vegetation, rock/concrete cover)	5 (Low)

	invertebrate fauna soil erosion
	• Discharge of sediment to marine environment
	• Discharge of hydrocarbons
			• Install appropriate sediment control measures for areas of 'dirty' site runoff.
			• Storage areas for hazardous substances (including fuel) to be isolated from site stormwater runoff (e.g. bunded)
			• Follow the spill response procedure:
			  ○ Control and contain
			  ○ Communicate
			  ○ Clean-up
			• All contaminated waste to be disposed of in the correct contaminated waste bin
			• Daily visual inspections of site erosion & sediment controls and outlet points	

Dewatering of construction water	Contamination of soil, surface water, groundwater and marine environment	8 (Medium)	• Construction water to be contained for testing and treatment (as required). Provision for treatment to be provided. • Construction water to meet water quality performance criteria prior to discharge • Identification of ASS/PASS areas • Identification and protection of construction water discharge areas • Engage a licensed contractor to collect and dispose of liquid waste (as required)	3 (Low)
Concrete works	Contamination of soil, surface water, groundwater and marine environment	8 (Medium)	• Development and implementation of ESCP • Provision of dedicated concrete washout area • Works scheduled to avoid wet season • Return unused concrete to batch plant • Wastewater from washdown of concrete trucks/equipment not to enter environment	3 (Low)
Noise, vibration & dust	Noise, vibration and dust causing: • Nuisance and disturbance to local community • Displacement of fauna • Impacts to marine megafauna	8 (Medium)	• Training and induction of site personnel • Restrict operating hours to avoid impacts on surrounding community • High noise level activities should be scheduled to occur on weekdays where possible. • Limit vehicle speeds to minimise dust generation. • Maintain vehicles and machinery in good working order. • Throttle down or shut off plant used intermittently when not in use. • Water down area if needed to minimise dust emissions. • Operate machinery in a manner that reduces noise and dust emissions (according to manufacturer's instructions). • Ensure machinery is equipped with noise and dust minimising devices where possible. • Monitor noise levels through regular HSEQ inspections and observations • Comply with Australian Standard for managing noise on construction sites • Work within approved hours • Noise monitoring	5 (Low)
Biting insects	Excavation and pooling of water around site and office environments encouraging biting midge and mosquito breeding	16 (High)	• Minimise pooling of water • Insect repellent • PPE • Dewatering • Drainage design	8 (Medium)
Weeds and	Introduction of invasive	8 (Medium)	• Regular inspections of vehicles	5 (Low)

pests	species to protected areas/sites		• Wash down of identified equipment, containers, vehicles and mobile plant • Weed survey and identification of weed areas • Control of weeds as required	
Critical weather	Spills, littering and/or degrading of debris as a result of poor storage	8 (Medium)	• Critical weather event procedure to be communicated to all personnel • Removal/securing of degradable waste and materials prior to critical weather event • Refer Corporate Emergency Response and Recovery Plan	5 (Low)
General operations	Fire and subsequent loss of flora and fauna	8 (Medium)	• Ensure personnel are trained in fire awareness, emergency response procedures and use of fire-fighting equipment. • Clear all flammable material from potential ignition sources • Cleared vegetation to be mulched and stockpiled for reuse (or disposal) • Hot works activities to be shielded to restrict airborne sparks • Provide and maintain appropriate fire-fighting equipment • Use diesel vehicles where possible to minimise the potential for fire ignition. • Immediately notify emergency services in the event of an uncontrolled fire	5 (Low)

6 Environmental impact management

6.1 Consideration of key potential environmental impacts

Previous sections of this document have identified and discussed potential environmental impacts associated with construction and operation of the proposed aquaculture facility. The Risk Assessment in Section 5 provides a summary of potential risks and associated mitigation measures. The key potential environmental impacts are associated with water quality; and potential biting insect habitat.

6.2 Mitigation Measures

6.2.1 Engineering and design

The existing landform, geology and drainage characteristics of the project area requires careful consideration during the planning and design phase of the aquaculture facility. Engineering and design will be carried out to minimise impacts associated with natural constraints including potential acid sulfate soils, proximity to storm surge zones and presence of culturally significant areas.

6.2.2 Construction Environmental Management Plan

The construction of the project will be guided by a Construction Environmental Management Plan (CEMP). The CEMP will identify potential adverse environmental effects and cover the environmental protection practices, resources, responsibilities, approvals and sequence of activities associated with construction of the proposed facility.

As a minimum, the CEMP will include:

- Details of how the environment will be protected for construction activities
- Assignment of responsibility for environmental controls
- Conditions of approvals, licences and permits to meet statutory requirements; and
- Details of potential environmental impacts and operational control measures which are to be implemented.

The CEMP will address the following:

- Erosion and sediment control
- Water quality
- Noise and vibration
- Soil disturbance
- Acid sulfate soils
- Air pollution
- Flora and fauna disturbance
- Waste management
- Cultural heritage
- Biting insect management
- Dangerous goods management
- Community consultation
- Details of how the environment will be protected during construction activities
- Locations of environmental controls and environmentally-sensitive areas.

6.2.3 Water quality management & monitoring

As discussed in Section 4, it is anticipated that there will be minimal change to water quality as it flows through the proposed aquaculture raceways and ponds, as demonstrated by the results from the pilot-scale trial sites (i.e. DAC nursery raceways and Paspaley brood stock and nursery ponds), presented in Table 4-1.

Stormwater

The proposed development will include provisions for the management of stormwater, during both the construction phase and operational phase. The main impacts to stormwater during these phases are detailed below.

Construction activities have the potential to:

- Increase the quantity and peak discharge of surface water run-off due to surface compaction and an increase in the proportion of impervious surfaces.
- Increase sediment loads in surface water run-off due to earthworks and soil disturbance.
- Facilitate the transport of contaminants off-site via surface water flows (particularly in sediment).
- Lead to an uncontrolled release of fuels, chemicals and hazardous substances transported, stored and used during construction.
- During the operational phase, there is the potential for:
- An alteration in the volume of surface water leaving the project area due to stormwater management design.

The management of these impacts will be through implementation of the certified ESCP during construction (Section 6.2.4) and implementation of the stormwater drainage design during the operational phase of the development.

6.2.4 Erosion & Sediment Control Plan

An Erosion and Sediment Control Plan (ESCP) will be prepared to assist and guide the appropriate planning and implementation of erosion and sediment control measures during the construction stages of the proposed development. The ESCP will be developed in accordance with the following best practice guidelines:

- *Best Practice Erosion and Sediment Control* (IECA, 2008)
- *Standards Specifications for Environmental Management* (Department of Infrastructure, 2013)

The ESCP will include a program of implementation, including specific design and implementation of measures, to reflect construction staging as the development evolves. The ESCP will include the following items:

- Staging of works
- Layout and staging to minimise land clearing
- Timing of works
- Method and sequence of operations
- Identification of access restrictions and no-go areas
- Management of existing drainage features and topography
- Incorporation of recommendations to manage potential biting insect habitat
- Design, location and management of structural drainage, erosion and sediment controls
- Specific management practices (e.g. ingress and egress of construction traffic, stockpile management, ancillary areas etc.)
- Monitoring, maintenance and rehabilitation activities

- Groundcover management
- Specific key controls
- Responsibility for implementation, monitoring and management
- Identification of areas where land clearing or disturbance will not be required

7 Conclusion

Tasmanian Seafoods Pty Ltd propose to construct an aquaculture facility within an area situated next to Darwin River, on William Road, Berry Springs. The project area has previously been developed as an aquaculture farm with over 40 of 68 hectares having previously been cleared.

The key issues (and mitigation measures) in managing potential environmental impacts associated with construction and operation of the aquaculture facility are listed below:

- During the operational phase of the proposed development, the potential impact of discharge from the proposed aquaculture facility on Darwin Harbour water quality is assessed as low (as demonstrated by the results from the pilot-scale trial sites).
- Aquaculture pond discharge will be managed through an approved Waste Discharge Licence. A Water Quality Management Plan will be implemented to maintain ongoing monitoring of pond discharge.
- Construction activities will be guided by the implementation of a Construction Environment Management Plan (CEMP).
- The CEMP will include a certified Erosion & Sediment Control Plan, consistent with the requirements of IECA (2008).
- Assuming no significant reduction in run-off and surface water quality from the project area, there are no threatened species that are likely to be significantly impacted upon by project construction or operation.

8 Acronyms & References

8.1 Acronyms

AAPA	Aboriginal Areas Protection Authority
ARI	Average Recurrence Interval
ASS	Acid Sulfate Soils
BOD	Biological Oxygen Demand
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
DAC	Darwin Aquaculture Centre
DO	Dissolved Oxygen
EC	Electrical Conductivity
ESCP	Erosion and Sediment Control Plan
FRP	Dissolved Phosphorus
IECA	International Erosion Control Association
LCA	Land Capability Assessment
LSA	Land Suitability Assessment
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids

8.2 References

Department of Infrastructure (DOI) 2013, *Standard Specification for Environmental Management, Specification Services*, Department of Infrastructure, Northern Territory Government, Palmerston.

Department of Lands, Planning and the Environment (DLPE) 2013, *Northern Territory Land Suitability Guidelines,* Northern Territory Government, Darwin.

Department of Natural Resources, Environment, The Arts and Sport (NRETAS) 2010*, Land Clearing Guidelines*, Department of Natural Resources, Environment, the Arts and Sport, NT Government, Darwin.

Department of Natural Resources, Environment, The Arts and Sport (NRETAS) 2010, *Water Quality Objectives for the Darwin Harbour Region – Background Document*, Aquatic Health Unit, Department of Natural Resources, Environment, the Arts and Sport, NT Government, Darwin.

Fogarty, P, Lynch, B and Wood, B 1984, *The Land Resources of the Elizabeth, Darwin and Blackmore Rivers,* Conservation Commission of the Northern Territory, Darwin.

Fortune, J and Patterson, R 2016, *Darwin Harbour Region 2015 Report Card Water Quality Supplement,* Report No. 4/2016D, Aquatic Health Unit, Department of Land Resource Management, NT Government, Palmerston.

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IECA 2008, *Best Practice Erosion & Sediment Control*. International Erosion Control Association (Australasia), Picton NSW.

Isbell 1996, The Australian Soil Classification First Edition, interactive version of first addition, CSIRO Publishing, accessed 29/09/2016, http://www.clw.csiro.au/aclep/asc_re_on_line/soilhome.htm

Northern Territory Department of Health (DoH) 2013, Guidelines for Land Capability Assessment for Onsite Wastewater Management, NT Government, Darwin, NT.

Northern Territory Geological Survey 1983, *Australia 1:100 000 geological series; sheet 5073 (map)*. Northern Territory Geological Survey. Darwin, NT.

Whitehead & Associates, 2005, *Technical Guideline, Design, Installation and Operation of Mound Systems for Onsite Effluent Management*.

Appendix A Laboratory Documentation

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 4971 9600 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 24 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

ORANGE 4/13 Geary Place North Orange NSW 2800 Ph: 02 4423 2063 E: orange@alsglobal.com

WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: EcOz Environmental	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☑ Standard TAT (List due date):	
OFFICE: Darwin		☐ Non Standard or urgent TAT (List due date):	
PROJECT: EZ16150 Tasmanian Seafoods Sea Cucumber - Dec 2016	ALS QUOTE NO.: SY/476/16 V2	COC SEQUENCE NUMBER (Circle)	
ORDER NUMBER:		COC: 1 2 3 4 5 6 7	
PROJECT MANAGER: Emma Smith	CONTACT PH: 08 8981 1100	OF: 1 2 3 4 5 6 7	
SAMPLER: Ben Kelly	SAMPLER MOBILE: 0430835540	RELINQUISHED BY:	RECEIVED BY: Lana - ALS
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 21.12.16	DATE/TIME: 21.12.16 1033
Email Reports to: emma.smith@ecoz.com.au,		RELINQUISHED BY:	RECEIVED BY:
Email Invoice to: lyndall.ryan@ecoz.com.au, emma.smith@ecoz.com.au		DATE/TIME:	DATE/TIME: 22/12/16 15:15

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).					Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	Chlorophyll-a	BOD	Suspended Solids (High Level)	Phosphorus - Reactive as P - ULTRATRACE	NT-8 Total Nitrogen, TKN, NOx, NO2, NO3, NH3, Total Phosphorus	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	Incoming	21/12 9:30	W	P, SP	4	✓	✓	✓	✓	✓	LAB OF ORIGIN: DARWIN
2	Outgoing	"	W	W	4	✓	✓	✓	✓	✓	
				TOTAL	8	2	2	2	2	2	ES1629410

Environmental Division
Sydney
Work Order Reference
ES1629410

Telephone : +61-2-8784 8555

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES1629410**

Client	: **ECOZ ENVIRONMENTAL SERVICES**	Laboratory	: Environmental Division Sydney
Contact	: MS EMMA SMITH	Contact	: Customer Services ES
Address	: PO BOX 381 DARWIN NT, AUSTRALIA 0801	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: emma.smith@ecoz.com.au	E-mail	: ALSEnviro.Sydney@alsglobal.com
Telephone	: +61 08 89811100	Telephone	: +61-2-8784 8555
Facsimile	: +61 08 89811102	Facsimile	: +61-2-8784 8500
Project	: EZ16150 Tasmanian Seafoods Sea Cucumber - Dec 2016	Page	: 1 of 2
Order number	: ----	Quote number	: ES2016ECOZENV0004 (SY/476/16 V2)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: BEN KELLY		

Dates

Date Samples Received	: 22-Dec-2016 15:15	Issue Date	: 22-Dec-2016
Client Requested Due Date	: 04-Jan-2017	Scheduled Reporting Date	: **04-Jan-2017**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 2	Temperature	: 12.6 - Ice present
Receipt Detail	:	No. of samples received / analysed	: 2 / 2

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA025H Suspended Solids (High Level)	WATER - EK271A-CM Reactive Phosphorus (Ultra-trace by Flow	WATER - EP008 Chlorophyll a	WATER - EP030 BOD	WATER - NT-08 Total Nitrogen + NO2 + NO3 + NH3 + Total P
ES1629410-001	21-Dec-2016 09:30	Incoming	✓	✓	✓	✓	✓
ES1629410-002	21-Dec-2016 09:30	Outgoing	✓	✓	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

EMMA SMITH

- *AU Certificate of Analysis - NATA (COA)	Email	emma.smith@ecoz.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	emma.smith@ecoz.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	emma.smith@ecoz.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	emma.smith@ecoz.com.au
- A4 - AU Tax Invoice (INV)	Email	emma.smith@ecoz.com.au
- Chain of Custody (CoC) (COC)	Email	emma.smith@ecoz.com.au
- EDI Format - ENMRG (ENMRG)	Email	emma.smith@ecoz.com.au
- EDI Format - ESDAT (ESDAT)	Email	emma.smith@ecoz.com.au

LYNDALL RYAN

- A4 - AU Tax Invoice (INV)	Email	Lyndall.ryan@ecoz.com.au

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1629410**	Page	: 1 of 3
Client	: **ECOZ ENVIRONMENTAL SERVICES**	Laboratory	: Environmental Division Sydney
Contact	: MS EMMA SMITH	Contact	: Customer Services ES
Address	: PO BOX 381 DARWIN NT, AUSTRALIA 0801	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 08 89811100	Telephone	: +61-2-8784 8555
Project	: EZ16150 Tasmanian Seafoods Sea Cucumber - Dec 2016	Date Samples Received	: 22-Dec-2016 15:15
Order number	: ----	Date Analysis Commenced	: 22-Dec-2016
C-O-C number	: ----	Issue Date	: 03-Jan-2017 11:50
Sampler	: BEN KELLY		
Site	: ----		
Quote number	: SY/476/16 V2		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK061G/EK067G: LOR raised for TKN and Total P on sample No 1 due to sample matrix.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Incoming	Outgoing	----	----	----
				Client sampling date / time	21-Dec-2016 09:30	21-Dec-2016 09:30	----	----	----
Compound	CAS Number	LOR	Unit		ES1629410-001	ES1629410-002	--------	--------	--------
					Result	Result	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	<5	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.20**	**0.17**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.04**	**0.02**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	**0.02**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.5	**0.8**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		<0.5	**0.8**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.05	**0.07**	----	----	----
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		**0.007**	**0.004**	----	----	----
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<1	----	----	----
EP030: Biochemical Oxygen Demand (BOD)									
Biochemical Oxygen Demand	----	2	mg/L		<2	<2	----	----	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1629410**	Page	: 1 of 4
Client	: **ECOZ ENVIRONMENTAL SERVICES**	Laboratory	: Environmental Division Sydney
Contact	: MS EMMA SMITH	Contact	: Customer Services ES
Address	: PO BOX 381 DARWIN NT, AUSTRALIA 0801	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 08 89811100	Telephone	: +61-2-8784 8555
Project	: EZ16150 Tasmanian Seafoods Sea Cucumber - Dec 2016	Date Samples Received	: 22-Dec-2016
Order number	: ----	Date Analysis Commenced	: 22-Dec-2016
C-O-C number	: ----	Issue Date	: 03-Jan-2017
Sampler	: BEN KELLY		
Site	: ----		
Quote number	: SY/476/16 V2		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 705335)									
ES1629401-002	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	<5	<5	0.00	No Limit
ES1629558-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	<5	<5	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 707416)									
ES1629410-001	Incoming	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.20	0.21	0.00	0% - 20%
ES1629575-004	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.02	0.04	75.5	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 703861)									
ES1629562-002	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
ES1629530-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	0.03	0.03	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 707417)									
ES1629410-001	Incoming	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.04	0.03	0.00	No Limit
ES1629575-004	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.02	0.01	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 707413)									
ES1629410-001	Incoming	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.5	<0.5	0.00	No Limit
ES1629575-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	0.8	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 707412)									
ES1629410-001	Incoming	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.05	<0.05	0.00	No Limit
ES1629575-002	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.09	0.08	0.00	No Limit
EK271A: Reactive Phosphorus (QC Lot: 704081)									
ES1629471-001	Anonymous	EK271A-CM: Reactive Phosphorus as P	14265-44-2	0.001	mg/L	0.002	0.002	0.00	No Limit
EP030: Biochemical Oxygen Demand (BOD) (QC Lot: 703629)									
ES1629410-001	Incoming	EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	<2	0.00	No Limit
ES1629533-012	Anonymous	EP030: Biochemical Oxygen Demand	----	2	mg/L	163	157	3.75	0% - 20%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 705335)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	96.3	83	129
				<5	1000 mg/L	107	82	110
EK055G: Ammonia as N by Discrete Analyser (QCLot: 707416)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	102	90	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 703861)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	98.2	82	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 707417)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	98.5	91	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 707413)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	92.7	69	101
				<0.1	1 mg/L	81.2	70	118
				<0.1	5 mg/L	99.1	74	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 707412)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	90.7	71	101
				<0.01	0.442 mg/L	78.1	72	108
				<0.01	1 mg/L	99.5	78	118
EK271A: Reactive Phosphorus (QCLot: 704081)								
EK271A-CM: Reactive Phosphorus as P	14265-44-2	0.001	mg/L	<0.001	0.1 mg/L	99.6	78	120
EP008: Chlorophyll (QCLot: 703784)								
EP008: Chlorophyll a	----	1	mg/m³	<1	20 mg/m³	90.0	70	130
EP030: Biochemical Oxygen Demand (BOD) (QCLot: 703629)								
EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	200 mg/L	93.5	74	112

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK055G: Ammonia as N by Discrete Analyser (QCLot: 707416)							
ES1629410-001	Incoming	EK055G: Ammonia as N	7664-41-7	1 mg/L	115	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 703861)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EK057G: Nitrite as N by Discrete Analyser (QCLot: 703861) - continued							
ES1629530-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	106	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 707417)							
ES1629410-001	Incoming	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	93.9	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 707413)							
ES1629410-002	Outgoing	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	93.9	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 707412)							
ES1629410-002	Outgoing	EK067G: Total Phosphorus as P	----	1 mg/L	97.3	70	130
EK271A: Reactive Phosphorus (QCLot: 704081)							
ES1629471-001	Anonymous	EK271A-CM: Reactive Phosphorus as P	14265-44-2	0.1 mg/L	106	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1629410**	Page	: 1 of 5
Client	: **ECOZ ENVIRONMENTAL SERVICES**	Laboratory	: Environmental Division Sydney
Contact	: MS EMMA SMITH	Telephone	: +61-2-8784 8555
Project	: EZ16150 Tasmanian Seafoods Sea Cucumber - Dec 2016	Date Samples Received	: 22-Dec-2016
Site	: ----	Issue Date	: 03-Jan-2017
Sampler	: BEN KELLY	No. of samples received	: 2
Order number	: ----	No. of samples analysed	: 2

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H)							
Incoming, Outgoing	**21-Dec-2016**	**----**	----	----	**24-Dec-2016**	28-Dec-2016	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
Incoming, Outgoing	**21-Dec-2016**	**----**	----	----	**29-Dec-2016**	18-Jan-2017	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
Incoming, Outgoing	**21-Dec-2016**	**----**	----	----	**22-Dec-2016**	23-Dec-2016	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
Incoming, Outgoing	**21-Dec-2016**	**----**	----	----	**29-Dec-2016**	18-Jan-2017	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
Incoming, Outgoing	**21-Dec-2016**	**29-Dec-2016**	18-Jan-2017	✓	**29-Dec-2016**	18-Jan-2017	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
Incoming, Outgoing	**21-Dec-2016**	**29-Dec-2016**	18-Jan-2017	✓	**29-Dec-2016**	18-Jan-2017	✓
EK271A: Reactive Phosphorus							
Clear Plastic - Filtered & Frozen (AS/ISO) - UT Nu (EK271A-CM)							
Incoming, Outgoing	**21-Dec-2016**	**----**	----	----	**23-Dec-2016**	18-Jan-2017	✓
EP008: Chlorophyll a & Pheophytin a							
White Plastic Bottle - Unpreserved (EP008)							
Incoming, Outgoing	**21-Dec-2016**	**----**	----	----	**22-Dec-2016**	23-Dec-2016	✓
EP030: Biochemical Oxygen Demand (BOD)							
Clear Plastic Bottle - Natural (EP030)							
Incoming, Outgoing	**21-Dec-2016**	**----**	----	----	**22-Dec-2016**	23-Dec-2016	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace for Catchment M	EK271A-CM	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace for Catchment M	EK271A-CM	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace for Catchment M	EK271A-CM	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace for Catchment M	EK271A-CM	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P - Ultra-Trace for Catchment M	EK271A-CM	WATER	In house: Referenced to APHA 4500-P E Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by FIA. This method is compliant with NEPM (2013) Schedule B(3)
Chlorophyll a and Pheophytin a	EP008	WATER	In house: Referenced to APHA 10200 H. The pigments are extracted into aqueous acetone. The optical density of the extract before and after acidification at both 664 nm and 665 nm is determined spectrometrically.
Biochemical Oxygen Demand (BOD)	EP030	WATER	In house: Referenced to APHA 5210 B. The 5-Day BOD test provides an empirical measure of the oxygen consumption capacity of a given water. A portion of the sample is diluted into oxygenated, nutrient rich water, and a seed added to begin biological decay. The initial dissolved oxygen content is measured, then the bottle is sealed and incubated for five days. The remaining dissolved oxygen is measured, and from the difference, the demand for oxygen, by biological decay, is determined. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

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