Cossill & Webley
CONSULTING ENGINEERS

Ningaloo Lighthouse Resort
Engineering Servicing Report
November 2020

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Contents

1. INTRODUCTION

The following report has been prepared by Cossill & Webley, Consulting Engineers (CW) and summarises civil engineering and future servicing considerations of the proposed tourism development of the Ningaloo Lighthouse Resort (referred to herein as the Site). The report has been prepared to support the Development Application (DA) submission.

The Site fronts the Indian Ocean to the north and is surrounded by undeveloped land parcels, approximate 14km north of the Exmouth Town Site. Access to the site is off existing Yardie Creek Road.

This report has been prepared based on civil engineering infrastructure requirements to service the proposed DA and covers siteworks, sewerage, water reticulation, power supply, stormwater drainage and utility services.

Details included in this report are largely based on preliminary advice from various service authorities, and is subject to change once formal submissions have been made to those service authorities.

The Site is identified by the red boundary presented below in Figure 1.

Figure 1 - Site Plan (MNG Access, 2019)

2. SITE DESCRIPTION

The Site contains the existing Ningaloo Lighthouse Caravan Park, is approximately 45.54 hectares in area, located 14km north of the Exmouth. The northern boundary of the Site is adjacent to the existing Yardie Creek Road, which extends to the west and south to Yardie Creek, and to the east connects into Murat Road, and onwards to Exmouth. Yardie Creek Road separates the Site from the Indian Ocean.

The Site is covered in native coastal heath vegetation, with evidence of rock outcrops at the surface in the north and west portion of the Site, and a significant creek line running through the centre of the Site. The Vlamingh Head Lighthouse sits prominently above the Site, immediately to the west.

The Site is capable of accommodating further tourism development in accordance with an approved Local Structure Plan.

2.1 Geology

Douglas Partners have carried out a preliminary investigation of the Site. They indicate that the Site is generally characterised by Vlamingh Sandstone (Tv). There are rocky outcrops through the Site, of the Pilgramunna Formation (Tp) – which is high to very high strength calcarenite and calcilutite and grey coralgal limestone. The Tp is the predominant site classification to the west, beneath the prominent Lighthouse Location. This is presented below in Figure 2.

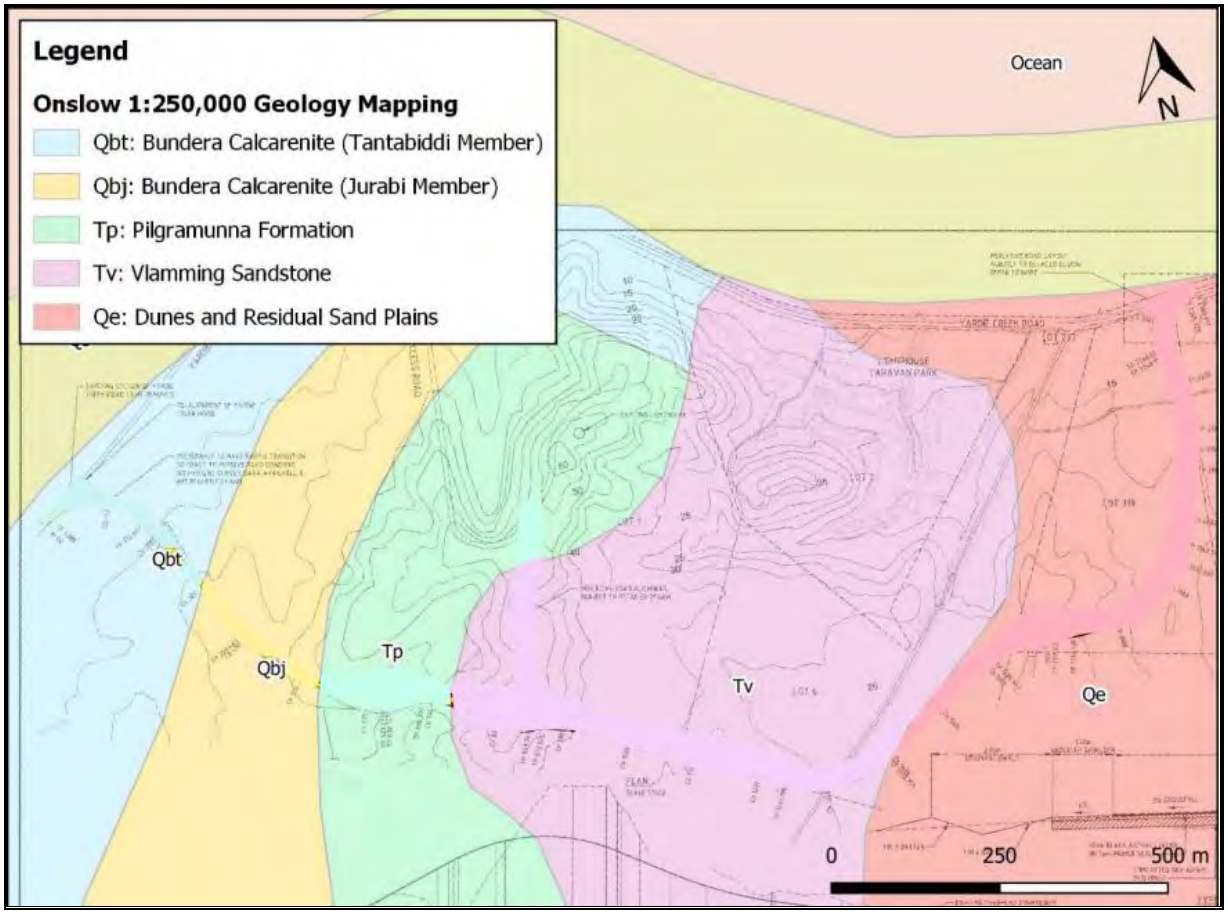

Figure 2 – Douglas Partners simplified version of the AUSGIN Geoscience Portal

2.2 Landform

Based on survey level information, the Site ranges in elevation from RL 10m AHD at the northern edge of the Site, adjacent to Yardie Creek Road, to RL 35m AHD at the south west extent of the site and at the outcrop in the centre of the Site as presented below in Appendix B. The Lighthouse is located at RL63m.

The existing topography is typical of coastal area along the Ningaloo Coast, both in terms of geomorphology and vegetation characteristics. It is proposed that future development of the Site will respond to, and incorporate the existing landform where possible. Primarily, this will be achieved through the limiting vegetation clearing and other environmental impacts wherever possible.

Remnant vegetation occurs across the vast majority of the Site, characterised by low shrub land vegetation.

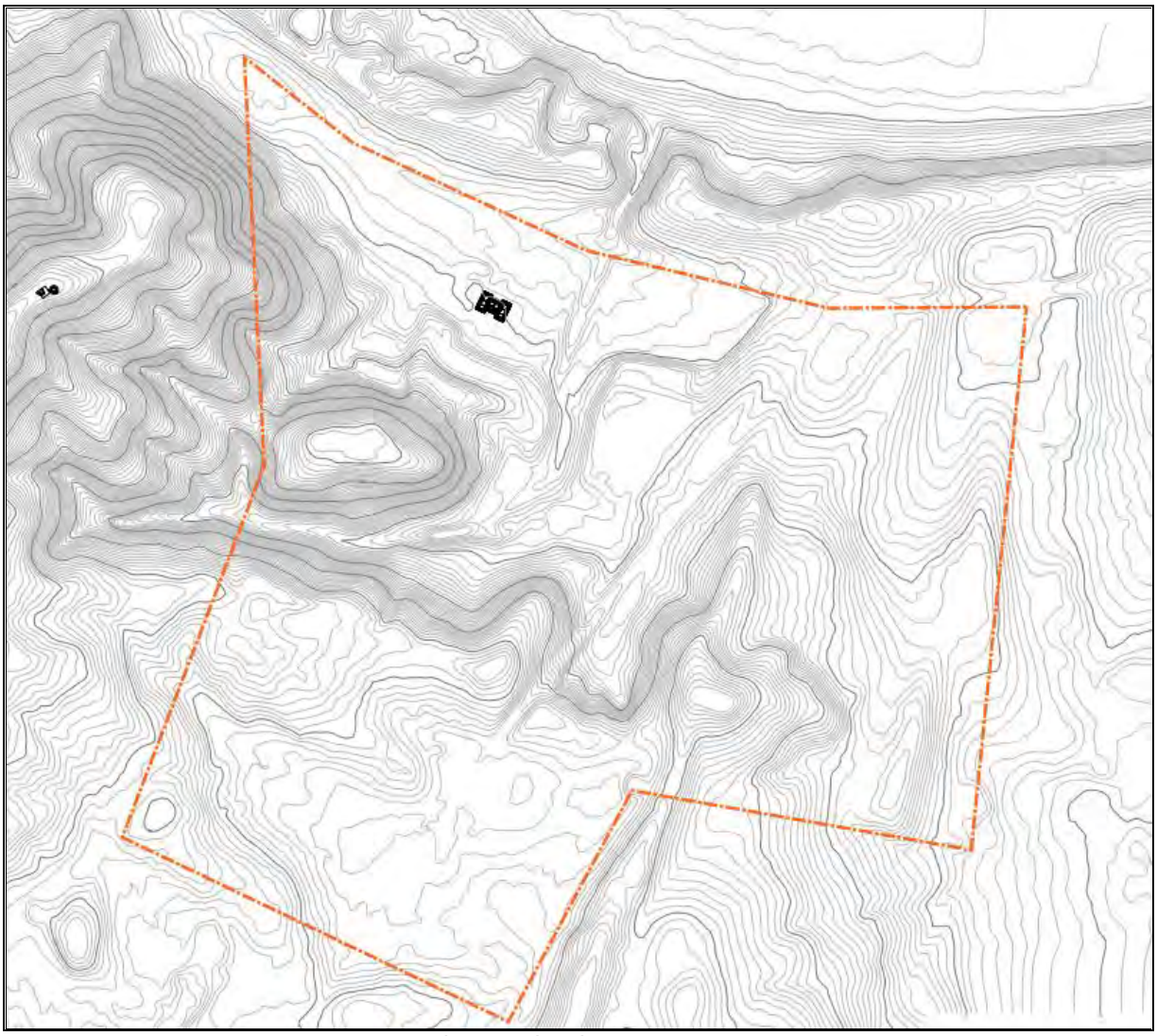

Figure 3 - Elevation 1m Contours

2.3 Groundwater

The Site is beyond the extent of the Department of Water's Perth Groundwater Atlas. However, existing groundwater bores onsite indicate that groundwater is likely to be below 1m AHD. The sands on site are free drainage, and the site is located close to the ocean. The groundwater on site has high levels of saline (from 5,000 to 10,000mg/l).

As such we do not anticipate that the presence of groundwater will constrain development.

2.4 Acid Sulphate Soils

No data is available from the Department of Water and Environmental Regulation regarding potential for acid sulphate soils (ASS) for the proposed Site. However we do not anticipate ASS will be present, and don't consider this issue will be a constraint to development.

3. EARTHWORKS

A site responsive earthworks approach is proposed to integrate development into the existing undulating landform. The general intent is to minimise the extent of site re-contouring and clearing, whilst ensuring drainage, roadworks and sewer reticulation requirements are met.

As a general principle it is proposed to construct just sufficient earthworks for the purpose of constructing roads with suitable gradients and cross fall, and sufficient earthworks across each of the development precincts such that the precinct can be developed for their intended use. We anticipate clearing will be kept to a minimum, and development will be integrated into the existing topography as far as practical.

4. ROADS AND FOOTPATHS

It is proposed to construct a main access road along the eastern boundary of the site, from Yardie Creek Road up to the proposed Caravan Site and Fuel Station. All service infrastructure upgrades will also be accessed via this road, and they will be located at the southern extent of the site, near the Fuel Station Site. This access road will be designed and constructed to the same standard as Yardie Creek Road, with the engineering design to comply with the requirements of the Shire of Exmouth as a potential Yardie Creek Road alternative route.

The existing Yardie Creek Road along the northern boundary of the Site has the potential to be modified to a low speed environment through design, subject to separate approval processes from the Shire of Exmouth and Main Roads WA. This will enable patrons of the Resort safe access to the beach, north of Yardie Creek Road, and create a safer and quieter frontage for the resort.

All internal roads through the Site will be sealed and built to a rural standard with table drains throughout. Kerbing may be incorporated on steeper road sections as required.

Though the Site is undulating, preliminary design indicates the majority of roads can be constructed with a longitudinal gradient of less than 4%. The undulating nature of the site does not present a material constraint to development. The steeper road sections (8%) are leading up to the Villa's on the outcrop at the western edge of the site, and the access to the Caravan Park, through the centre of the site.

5. STORMWATER DRAINAGE

The low-density nature of the development and the existing environmental characteristics of the Site (highly permeable sand and significant depth to groundwater) allow for development to occur with minimal need for constructed stormwater management infrastructure. Stormwater drainage collected from new roads and building developments will be disposed by means of swales, both roadside and natural through the site. Infiltration and groundwater recharge at source will be in the form of roadside swales or table drains and infiltration areas (generally associated with naturally occurring low points).

Appendix A contains a series of sketches which outline the crest within the site, and the valleys, and indicate where the natural water paths occur. The site is dominated by the Central Swale, which captures much of the water from the highlands to the south and west, and naturally flows north into the Indian Ocean. Roadside swales are proposed

to be directed to natural low points, into the Central Swale, avoiding key development areas of the Site.

The underlying soils are conducive to infiltration and collected water is unlikely to pond for extended periods of time. We do not propose to dispose of stormwater directly into the foreshore area apart from periods of high storm intensity, where the Central Swale will be used as point of discharge, underneath Yardie Creek Road. Please see below the Central Swale location in Figure 4.

Figure 4 - Overland Stormwater Swale Paths

Subsoil drainage will not be required due to the significant clearance from proposed finished surface levels to the groundwater level.

6. WATER RETICULATION

Potable water requirements for the Resort (kitchens, showers and dishwashers) will be sourced from groundwater under abstraction licence from the Department of Water and Environment Regulation (DWER).

The existing Caravan Park is serviced with potable water via the Department of Defence bore fields, located 7km due east of the site, in addition to private bores on site. The water is treated through a reverse osmosis unit and stored in a 100,000l tank on site and a series of 13 smaller tanks (32,000l poly tanks). The Ningaloo Caravan Park has a groundwater licence allocation of 32,000KL/annum from DWER, of which the current scheme abstraction utilises 12,551KL/annum.

The existing supply agreement with the Department of Defence will not be continued, and the saline levels from the existing bores on site are too high. The proposed supply of bore water for potable water is via a new bore field, installing a number of bores, and located approximately 2km to the south, as per Figure 5 below. The bore field is expected to have a peak flow of 259kl/day. With an allowance of 30% reject stream through the RO plant, this flow will be sufficient to supply the peak potable water requirement of 181KL/day, based on 250l/person/day and peak occupancy of 726 people. The Water Balance Equation is shown in Appendix G.

The long term water requirement of the development is based on an average water use of 250l/person/day, and an average occupancy of 448 persons per day (with a maximum of 726 person) as per the attached Occupancy Schedule (attached Appendix B). Based on the type of development proposed and estimated occupancy of the Resort, we anticipate that the development requires the existing groundwater licence to be increased to approximately 72 ML of potable water per annum, from the current 32ML. This is covered in detail in the Penningtonscott Report within Appendix I.

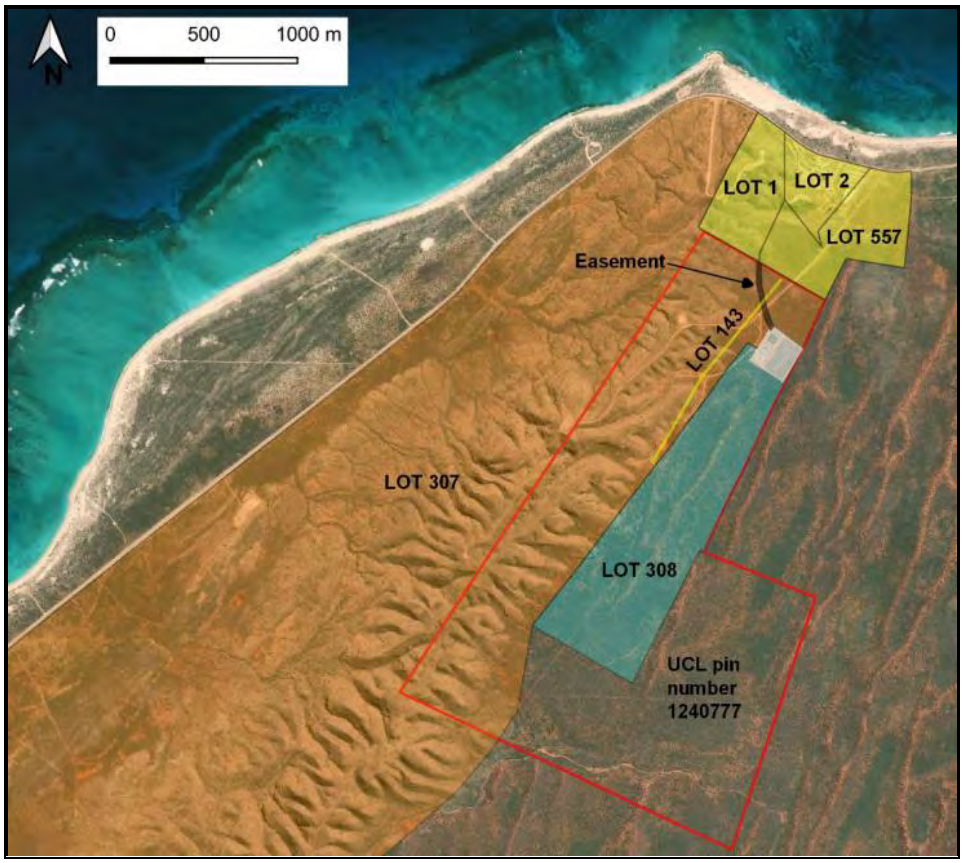

Figure 5 - Proposed Bore Field

Given the abstracted groundwater will have Total Dissolved Solids (TDS) above the minimum parameters of the Australian Drinking water Guidelines of 500 mg/L, the treatment approach will entail reverse osmosis (RO) in addition to standard disinfection.

Given that the potable water treatment plant will require separate State regulatory approvals, the proponent anticipates that approval for the plant from relevant State regulators will be a condition of the Resort Development Application.

Specifically, the potable water treatment plant will require the following approvals:

- Drinking Water Quality Management Plan (DoH)
- Drinking Water Source Protection Plan (DWER)
- Operating Strategy (DWER)
- Groundwater Abstraction Licence (DWER)
- Service Provider Licence (Economic Regulation Authority)

A Water Balance (Appendix G) has been provided with this Development Application which outlines potable water demand, on a daily basis. The full report of the Bore Field Revied, carried out by Pennington Scott, is attached in Appendix I.

Hydraulic Design Australia (Appendix C) propose a series of new tanks to store the water at the higher levels of the site. The tanks will be located on a hill at or above RL 42mAHD, The water reticulation will be pressurised through a pump room to ensure both potable water supply, and reticulation treated water can be supplied at adequate pressures and flows to service the entire development. Infrastructure required may include a 6 new on-ground storage tank for potable water, with a total capacity of 1,800KL (8 days storage at peak demand). We also propose 2 300KL storage tanks dedicated to Fire Fighting, and will contain potable water.

Section 7 below outlines the treatment process for Waste Water – note there will be a single 300KL tank which is dedicated to irrigation purposes, and contains water treated as below. This water will be reticulated through the site, and used for irrigation of the landscape areas, and plumbed into the buildings for flushing toilets.

Reticulated potable and non-potable water will be supplied to all new development sites and lots via a network of pipes (blue and purple) that are supplied from the on-ground storage tanks.

7. WASTEWATER RETICULATION AND DISPOSAL

The Ningaloo Caravan Park has an outdated waste water treatment system, which disposes all of the treated effluent into evaporation ponds to the south of the Site. This system is not up to current environmental standards, creates odour (and associated buffer) issues and would not be suitable for the development. The proposed Resort is to be finished to a high standard, including irrigated areas which will require significant amounts of water. Water is a scarce resource in the area, and hence an alternative water supply solution is required.

There are a number of options open to the developer with respect to the disposal of wastewater from the proposed Ningaloo Lighthouse Resort development. These include:

- Aerobic treatment units (ATU's);
- A locally sited wastewater treatment plant which uses membrane bio-reactor (MBR) or Sequential Batch Reactor (SBR) plant technology;
- Settlement and evaporation ponds;
- A combination of the above.

Following a review of economic and environmental benefits, the development proposes to process all wastewater produced from the development in a fit-for-purpose on-site recycled water plant. The proposed technology for the development is a Membrane Bioreactor (MBR) followed by ultra-violet (UV) and chlorine disinfections.

Wastewater servicing for Ningaloo Resort will entail the collection of blackwater and greywater (collectively, "wastewater") from within the resort for treatment and reuse. The wastewater will be gravity fed to a series pumping stations in the site, from where it will then be pumped to the wastewater treatment site in the south of the site (refer Site Layout – Appendix F for the overall Resort).

The area required for the wastewater treatment facility is also identified in the Site Layout drawing. The design and operational philosophy for the wastewater scheme is based on treatment to a fit-for-purpose standard which will facilitate reuse of the treated wastewater (recycled water) for open space irrigation and internal application for toilet flushing.

The treatment approach involves membrane technology, coupled with biological and chemical processes, which will achieve a quality of water which will meet public health and environmental standards. It is relevant to note that the wastewater collection, treatment and reuse scheme will be similar to the scheme recently implemented at Monkey Mia, in the Shire of Shark Bay. That scheme has been assessed and approved by the Department of Environment and Water Regulation (DWER) and the Department of Health (DoH). The Ningaloo Resort will similarly require a number of Local/State regulatory approvals prior to implementation and operation.

Pertinently, the wastewater scheme will require separate approval from the Shire of Exmouth via the submission from the proponent of an "*Application to Construct or Install an Apparatus for the Treatment of Sewage*". This application will provide detailed plans/schematics/overview of the proposed wastewater scheme. The proponent

anticipates that the approval for the Ningaloo Resort Development Applications will include a condition requiring submission and approval for the aforementioned approval.

It is also noted that in addition to the Shire's approval for and "*Application to Construct or Install an Apparatus for the Treatment of Sewage*", which may also require DoH approval, the scheme will require the following State regulatory approvals:

- Works Approval under Part V of the Environmental Protection Act 1986 (DWER)
- Recycled Water Quality Management Plan (DoH)
- Operating Licence (DWER)
- Water Service Provider Licence (Economic Regulation Authority)

The Water Balance (Appendix G) has been provided with this Development Application which outlines wastewater generation and treated wastewater (recycled water) reuse, on a monthly basis. All waste water generated by the treatment plant will be used for irrigation of the site. There will be an underlying irrigation demand, which can be topped up with bore water when occupancy falls below a critical level (which will be associated with less bore water demand for potable supply). For disposal of the treated waste water in peak occupancy, additional drippers will be located within roadside swales and natural swales. The vegetation in these swales will be designed to benefit from this water, however not rely on it for survival. This water will infiltrate into the sandy soils (Tv), and ultimately flow through the swales, greening the central swale, and being naturally treated, as it flows towards the central swale.

Images and preliminary details of the type of Waste Water Treatment facility which is proposed at the Site is enclosed in Appendix H.

8. CONSTRUCTION WATER REQUIREMENTS

It is anticipated that construction water will be required at each stage of development to facilitate the civil and building works, including dust suppression.

High level estimates assume this demand is likely to be in the order of 25,000KL, which is proposed to be supplied via groundwater. This would be a temporary water use, and would be applied for separately at the detailed design stage.

9. POWER

The Site lies in close proximity to 11kV overhead power line distribution network and is supplied with power from the main generation at the Exmouth Town Site.

The anticipated load for the development is 1500Amp, with the development able to be serviced from the 11kV overhead power lines which currently run through the site. The details of the power requirement are in the attached 3E Power Report (Appendix D).

The overhead lines will need to be removed from the site, and relocated to an underground HV network adjacent to the proposed eastern Access Road. This detail is shown attached in Appendix E.

The existing aerial Transformer will not be sufficient to meet the demands of the proposed resort development. As the development develops there will be a requirement to remove the existing transformer and replace with a ground mounted substation, located close to the relocated underground HV system. The proposed substation will have two transformers, each with a supply capacity of 630KVA.

With increased demand on the existing network it may be necessary for network reinforcement and/or network reconfiguration review to be undertaken. Horizon Power has advised the dynamic nature of their network makes it difficult to confirm exactly what reinforcement requirements will be required and when. In response to these

additional power requirements the development proposes to implement renewable energy generation alternatives. These may include Photo Voltaic Cells and future power storage, subject to economic viability.

Underground power will be provided to all new sites and via a network of cables. These works will be designed at the time of development.

10. GAS SUPPLY

It is proposed to provide reticulated gas within the development, to all units, supplied via an on-site storage tanks. These will have a capacity of 6,375litres (the same size tanks as the existing facility) and there will be a primary tank and a secondary back-up tank supply. Reticulation gas will be used for water heating throughout the proposed development.

11. TELECOMMUNICATIONS

We anticipate the Site will be serviced via an extension of the existing NBN network. Under the current NBN scheme, the developer is required to enter into an agreement to provide infrastructure which is handed over free of charge to NBN Co upon completion. The installation of the communication service to the resort would be funded through NBN, with developers responsible for funding the internal pit and pipe and a contribution to the backhaul costs (through existing network or via satellite receiver).

Capacity of the existing NBN Co and any potential backhaul costs will be finalised through the submission of a formal application with NBN.

12. IMPLEMENTATION & STAGING

It is anticipated the Site will be developed in one stage, duration of which will be determined in detailed design.

The provision of engineering infrastructure will be required as an early part of the construction process, followed be development of the built form.

13. CONCLUSION

As outlined in this report, the Site is capable of being serviced with key infrastructure including potable water supply, wastewater and power. Infrastructure upgrades to the Site will be required to facilitate the development with the scope of the infrastructure being staged to address demand growth requirements.

APPENDIX A

LEGEND

- EXISTING CONTOURS (5m)
- EXISTING CONTOURS (1m)
- EXISTING RIDGES
- EXISTING VALLEY FLOWS
- PROPOSED FLOW DIVERSION

DETAIL AREA PLAN 'C'

DETAIL AREA PLAN 'B'

DETAIL AREA PLAN 'A'

1:2500 0m 50 100 150m

REV	DATE	DRN	CKD	APP	AMENDMENT
C	30.10.20	MI	-	-	DRAWINGS REVISED TO REFLECT UPDATED LAYOUT
B	03.09.19	ARH		M. WALLIS	DETAIL AREA PLAN 'C' MOVED
A	22.08.19	ARH		M. WALLIS	ISSUED FOR INFORMATION

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CLIENT: MINDEROO

APPROVED: MARK WALLIS

DESIGNED: ARH

SCALE: 1:2500

PROJECT: NINGALOO LIGHTHOUSE CARAVAN PARK

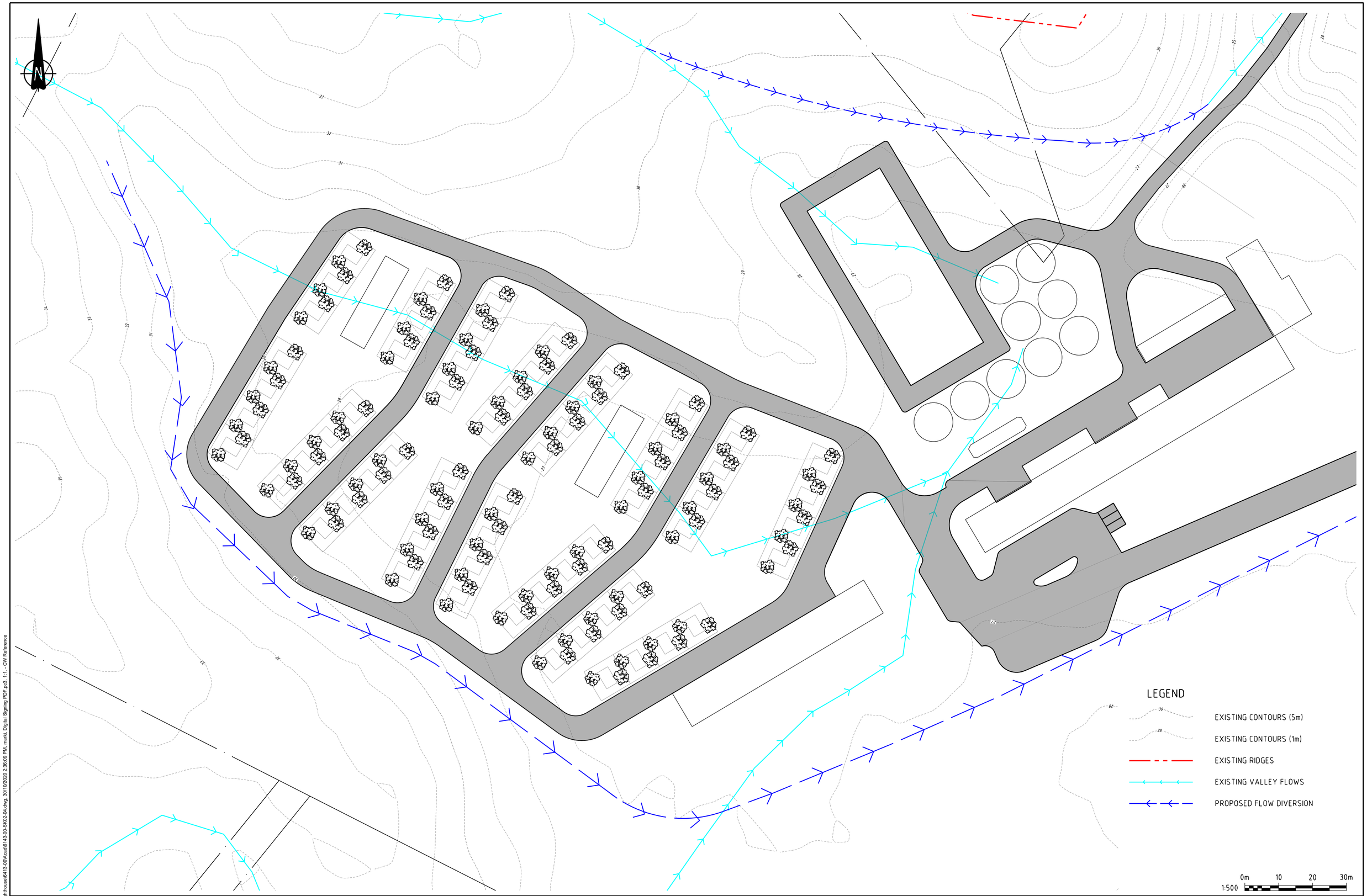
TITLE: SITE PLAN

WAPC No.

DRAWING No.: 6143-00-SK01

REVISION: C

ORIGINAL SIZE: A1



REV	DATE	DRN	CKD	APP	AMENDMENT
B	30.10.20	MI	-	-	DRAWINGS REVISED TO REFLECT UPDATED LAYOUT
A	22.08.19	ARH		M WALLIS	ISSUED FOR INFORMATION

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CLIENT: MINDEROO

APPROVED: MARK WALLIS

DESIGNED: ARH

SCALE: 1:500

PROJECT: NINGALOO LIGHTHOUSE CARAVAN PARK

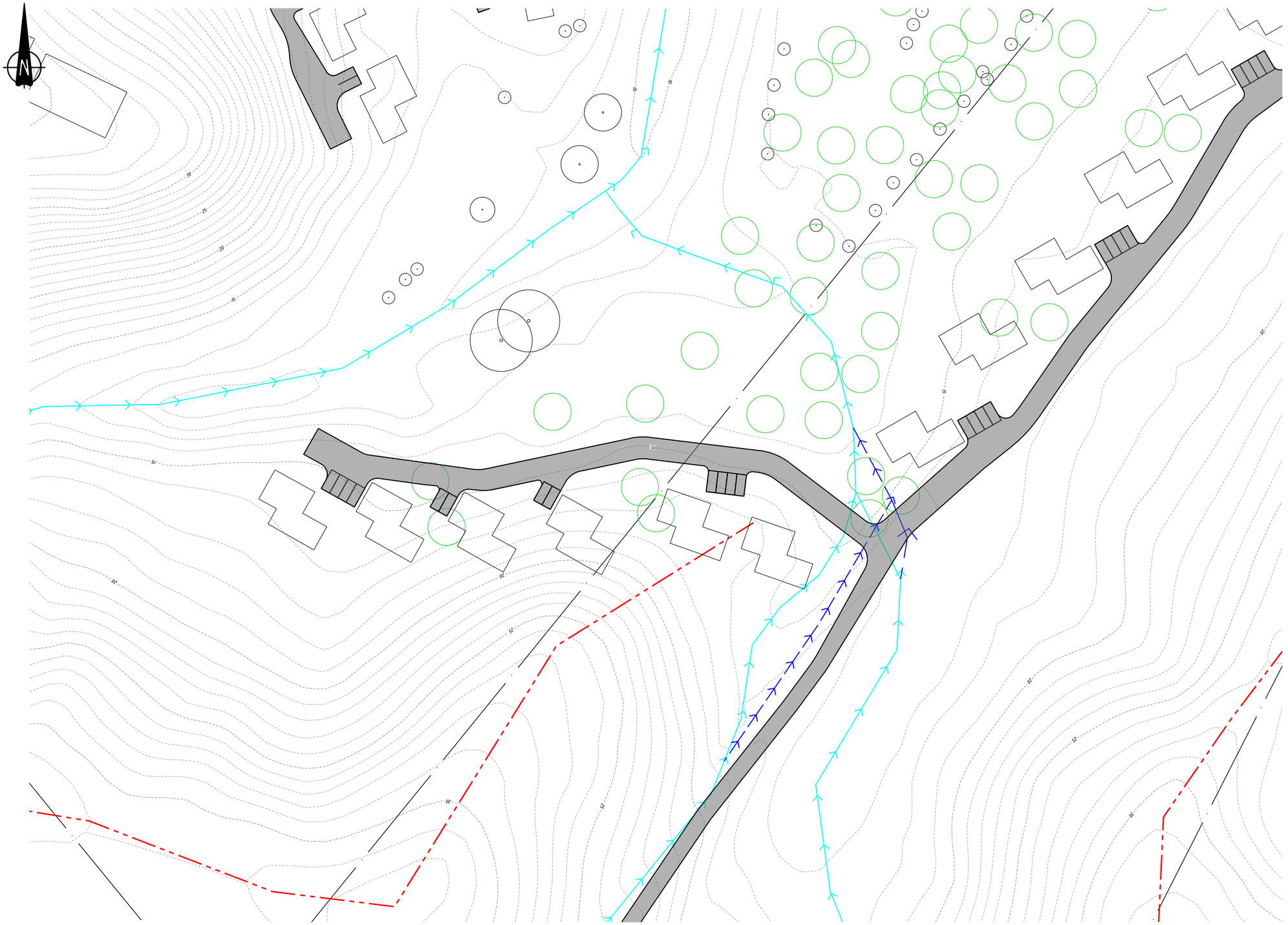
TITLE: DETAILED AREA PLAN 'A'

WAPC No.

DRAWING No.: 6143-00-SK02

REVISION: B

ORIGINAL SIZE: A1



0m 10 20 30m
1:500

REV	DATE	DRN	CKD	APP	AMENDMENT
B	30.10.20	MI	-	-	DRAWINGS REVISED TO REFLECT UPDATED LAYOUT
A	22.08.19	ARH		M. WALLIS	ISSUED FOR INFORMATION

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CLIENT: MINDEROO

APPROVED: MARK WALLIS

DESIGNED: ARH

SCALE: 1:500

PROJECT: NINGALOO LIGHTHOUSE CARAVAN PARK

TITLE: DETAILED AREA PLAN 'B'

WAPC No.

DRAWING No.: 6143-00-SK03

REVISION: B

ORIGINAL SIZE: A1

N

LEGEND

- EXISTING CONTOURS (5m)
- EXISTING CONTOURS (1m)
- EXISTING RIDGES
- EXISTING VALLEY FLOWS
- PROPOSED FLOW DIVERSION

0m 10 20 30m
1:500

REV	DATE	DRN	CKD	APP	AMENDMENT
C	30.10.20	MI	-	-	DRAWINGS REVISED TO REFLECT UPDATED LAYOUT
B	03.09.19	ARH		M. WALLIS	DETAIL LOCATION UPDATED
A	22.08.19	ARH		M. WALLIS	ISSUED FOR INFORMATION

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CLIENT: MINDEROO

PROJECT: NINGALOO LIGHTHOUSE CARAVAN PARK

TITLE: DETAILED AREA PLAN 'C'

APPROVED: MARK WALLIS

DESIGNED: ARH

SCALE: 1:500

WAPC No.

DRAWING No.: 6143-00-SK04

REVISION: C

ORIGINAL SIZE: A1

APPENDIX B

NINGALOO LIGHTHOUSE RESORT - ESTIMATED OCCUPANCY SCHEDULE

Oct-20

Occupancy	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Average
Chalets & Bungalows	18%	49%	88%	81%	87%	98%	91%	74%	56%	35%	55%	42%	65%
Caravan Park Sites	19%	18%	52%	39%	59%	89%	77%	49%	38%	21%	31%	21%	43%
Average	19%	34%	70%	60%	73%	94%	84%	62%	47%	28%	43%	32%	54%
Guests	123	223	466	400	486	623	559	410	313	186	286	210	357
Vistors	6	10	21	18	22	28	25	18	14	8	13	9	16
Staff	75	75	75	75	75	75	75	75	75	75	75	75	75
Total	204	308	562	493	583	726	660	503	402	270	374	294	448

Room Type	# Keys	Base Guests	Max Guests
Hotel	60	120	120
Dual Key Villa (base key)	30	60	102
Dual Key Villa (add key)	30	60	60
Upgraded Villa (Base key)	4	16	16
Upgraded Villa (add key)	4	8	8
Small Eco Tent	14	28	28
Large Eco Tent	14	28	28
Lodge	28	56	56
Caravan	62	186	248
Total	246	562	666

Max Vistors
30

Average	
54%	
448	*people per day*

APPENDIX C

Hydraulics Design Australia

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web: www.hdawa.com.au

27th November 2020

Mr. Mark Wallis
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EXMOUTH LIGHTHOUSE PROJECT
AMENDED HYDRAULICS SITE SERVICES DESIGN REPORT

Potable Water

The Water Corporation have established a daily average water consumption of 337 litres per person for Perth for 2017-2018 which includes cistern flushing and landscape irrigation.

Based on recycled water used for cistern flushing throughout and a separate water consumption allowance for landscape irrigation, we recommend 250 litres of daily water consumption allowance per person for Exmouth Lighthouse project.

We estimate a total potable water consumption of 223kL during peak occupation periods based on;

- 250L x 726 guests/staff/visitors = 181kL potable water consumption per day.
- 25kL per day for landscape irrigation
- 15kL pool water make up for peak occupation periods (to be confirmed by Pool Consultant)

Potable water storage will be required to buffer the daily water consumption requirements against the available bore/treatment tank replenishment flow rate during peak occupation periods. Potable water storage will also be required to provide a potable water reserve to accommodate periods of bore and/or water treatment plant maintenance.

The Pennington Scott Technical Memorandum dated 10th November 2020 recommends an upgrade of the water bores to supply up to 259kL /day based on 726 guests at 250L of potable water per guest each day. The Peritas Ningaloo Lighthouse Caravan Park Services and Infrastructure Due Diligence Report dated 26th April 2017 indicates a bore water allocation of 32,000kL per annum for the Lighthouse Caravan Park and an annual water consumption of 12,551kL.

The Ningaloo Lighthouse Caravan Park has approximately 350kL of potable water storage contained within various water storage tanks located throughout the site.

We recommend a potable water storage capacity of 1,800kL litres contained within 6 x 300kL potable water storage tanks to accommodate an 8 day supply during peak occupation periods. The potable water storage capacity will be adjusted to reflect final bore yield and treated water infill flow rate.

Picture of 2,000kL total water storage comprising 4 x 500kL tanks measuring 18.4m diameter x 2.31m wall height.

Two electric driven potable water pressure pump sets will be installed within a Pump to supply potable water throughout the site via a ring main. Pressure vessels will be installed at the highest point of the piping system to

minimize water pressure surges. Each building will be fitted with an adjustable pressure reduction valves (installed in duplicate) to balance the supply pressures throughout and minimize water consumption. We recommend that the water pressure pumps are supplied back up electrical supply from a site generator.

We recommend that the potable water service is reticulated throughout the site utilizing uPVC pipes. We recommend the reticulation of potable water throughout the buildings utilizing PEX pipes.

PE pipes and fittings are not recommended for installation within the north west by the manufacturers. Metal pipes and fittings may be susceptible to corrosion and calcium build up.

Copper or stainless steel pipes are required to be installed in exposed locations above ground level and immediately downstream of water heaters. Stainless steel pipes are not recommended where elevated levels of chlorine may be present within the water.

We recommend the use of electronic gas instantaneous water heaters to supply hot water throughout the proposed resort buildings with an anti-scaling maintenance regime adopted to maximize the water heater life (subject to final treated water quality).

Landscape Irrigation

Water used to irrigate landscaped areas within the central facilities area could be drawn from the potable water tanks to ensure odour free clean potable water is distributed via above ground sprinkler systems.

An additional dedicated 300kL landscape irrigation tank could be installed to receive treated grey water with treated bore water top up to supplement the landscape irrigation in areas suitable for sub-surface irrigation (dripper irrigation system installed 150mm below ground level).

Fire Service

The Exmouth Lighthouse project will require the installation of a fire pressure pump set and fire water storage tanks to supply fire hydrants, fire hose reels and for bush firefighting requirements. Class 2, 3, 5 & 9 buildings (1 or 2 storeys contained) with fire compartment floor areas >1,000m^2 and ≤5,000m^2 require a minimum of 2 hydrants to operate simultaneously at a flow rate of 5 litres/second per hydrant (10 litres/second total) whilst maintaining a residual pressure of 700kPa within the fire piping system. The fire water storage tanks require hard suction connections (Storz connections) capable of supplying 20 litres/second suction flow rate for boosting the fire service system pressure via the DFES appliance. The fire water storage tanks are required to maintain a minimum of 4 hours of fire water at the minimum flow rate of 20 litres/second in addition to the static fire water storage requirements for bush firefighting. Two 300kL capacity fire water storage tanks will be required to be installed adjacent to the potable water tanks. An additional 50kL fire water storage tank with hard suction connection is required to be installed within the vicinity of the central facilities refuge area in accordance with the Bush Firefighting recommendations. A 7m x 5m Fire Pump Room is required adjacent to the fire water storage tanks to house a dual diesel driven fire pump set.

Fire hydrants will be located throughout the site to provide coverage of the internal areas of all buildings from a 60m long hose emanating from the hydrant and a 10m long water spray. The hydrants are required to be located a minimum of 10m clear of buildings or on a 3m high x 4m wide 90/90/90 fire rated wall to provide protected access to DFES personnel. A fire booster assembly will be installed within site of the main access point to the resort administration building or at an alternative location to be agreed (to minimize tank suction pipe length).

We recommend that fire hose reels and/or fire extinguishers are installed throughout the site for staff and occupant use in the event of a small fire, prior to DFES attendance. Fire hose reels shall be located throughout the site to provide coverage of the internal areas of all buildings from a 36m long hose and a 4m long water spray.

The bore water will require treatment for fire water use prior to storage. The treated bore water supply is required to replenish the fire hydrant water storage component within the storage tanks within 24 hours. Refer to attached DFES GL-06 for water quality requirements.

DFES will require a hydrological report for assessment where bore water is utilized for fire fighting water. Refer to attached DFES GL-06 for bore water use requirements.

Refer to attached GL-11 for DFES site planning requirements.

We recommend that the fire service is reticulated throughout the site utilizing uPVC (blue-brute) pipes with rislan coated ductile iron fittings and concrete thrust and anchor blocks.

PE pipes and fittings are not recommended for installation within the north west by the manufacturers.

Galvanized steel pipes are required to be installed in exposed locations above ground level.

Gas Service

The Exmouth Caravan Park incorporates a 6,375 litre bulk liquid petroleum gas storage tank located adjacent to the refuelling area. The bulk LPG tank is utilized to refill smaller LPG bottles located on buildings throughout the site.

We recommend that the existing LPG tank be relocated to the proposed new refuelling area and an additional 6,375 litre LPG tank be installed adjacent to the relocated LPG tank to accommodate the proposed resort increased gas requirements.

We recommend that LPG will be reticulated around the site to supply gas for water heating and cooking via a PVC inground piping system at 70kPa. Second stage regulators will be installed on each building to reduce the gas pressure suitable for appliance use. PVC pipes are not permitted for use where gas pressures exceed 70kPa.

PE pipes and fittings are not recommended for installation within the north west by the manufacturers.

Copper LPG pipes are required to be installed above ground level and within and under buildings. Copper LPG pipes are required to be installed between the LPG tanks and first stage regulators.

Sewerage

We estimate that 90% of guest/staff water consumption will be discharged to sewer.

We estimate the following waste water discharges per person per day;

- Grey water 240 litres
- Black water 60 litres
- Consumption 40 litres (not discharged to drain)

We estimate 174kL of grey water and 44kL of black water will be discharged daily during times of peak occupancy based on 726 guests/staff/visitors. Or a combined sewerage discharge of 218kL discharged daily during times of peak occupancy.

A property sewer drainage system will be installed throughout the resort to gravity drain to sewer pump stations utilizing the site topography. Access points will be installed where required to provide for ease of maintenance.

The sewer pump stations will discharge to the sewerage treatment systems via PVC rising mains.

Yours sincerely,

Quentin Oma

Director

Encl.

APPENDIX D

PROJECT:

NINGALOO LIGHTHOUSE RESORT, EXMOUTH

SERVICING REPORT FOR:

SITE ELECTRICAL SERVICES

DOCUMENT NO: 3E19074-R-01

Document History and Status

Revision	Date issued	Author	Reviewed by	Approved by	Revision Description
A	28/08/2019	TJS	VH	DLJ	For Information
B	28/08/2019	TJS	VH	DLJ	For Information
C	09/09/2019	TJS	VH	DLJ	For Information
D	27/09/2019	TJS	VH	DLJ	For Information
E	29/10/2020	TJS	VH	DL	For information

SECTION 1 EXISTING POWER NETWORK DISTRIBUTION

1.1 GENERAL

The greater Exmouth area is currently supplied by various High Voltage (HV) spur lines, of 11kV and 33kV network, with the main generation located close to the Exmouth Town Site. This generation site provides a current load of 5.9MW to the surrounding area, and is comprised of 7 x 1MW Dual Fuel CNG/LPG generators and 3 x 20kW Wind Turbines. This system was built in 2003.

Based on information obtained from an existing site assessment report prepared in 2017, the site is fed by a 200kVA pole top transformer, which is connected off an 11kV overhead aerial line.

The meter data from the report also indicates that the park operates at about 50% the capacity of the transformer, based on low occupancy of the park. Extrapolating from this data, if the park were at full occupancy the transformer would be at full capacity. The current pole top transformer is thus sized to cater for the current site maximum demand only.

There is additional generation on site in the form of two backup generators, a 110kVA and 200kVA Generating Units.

See Appendix 3.1 for Horizon Power DBYD Aerial Plan

SECTION 2 POWER SUPPLY SCENARIO

2.1 LIKELY LOAD

Based on the likely development accommodation yield (Appendix 3.2) and approximate mechanical electrical loads for key buildings and accommodation types (Table 1), we have completed a general AS3000 load calculation for the overall site. Additional likely loads have been included within the assessment.

Building	Phases	Amps
Admin/Recep/Surf Shop	3	80
Rec Centre	1	15
Fuel Station	3	25
Services/BOH	1	40
Powell House	3	50
Spa	1	25
F&B Pavilion	3	50
Restaurant BOH Facilities	3	50
Hotel	3	100
Standard Villa	1	18
Std Villa + Bunk	1	22
Lodge	1	30
Luxe Villas	1	35
Staff Accommodation	3	60

Table 1. General Mechanical Electrical Loads

The load calculation for the accommodation and services portion of the site is approximately 1250A 3-phase, and makes allowance for load diversity. Additional loads at the Waste Water treatment plant (150A 3-Phase) and Water Pump Station (100A 3-Phase) increase the load demand on site to above 1500A.

Based on a load requirement of 1500A we would expect the installation of a 2 x 630kVA transformers. In addition to the transformers, a switchgear unit will also need to be installed, which provides the protection for the equipment.

The load estimate does not take into account any on site generation either in the form of renewable or non-renewable systems.

2.2 LIKELY POWER SUPPLY SCENARIO

The calculated site load will require the upgrade of the existing point of connection, which will result in the existing 200kVA aerial transformer being removed, and replaced by a ground mount substation.

In addition to the above works, as the existing aerial line is located within the proposed development area, it will need to be relocated. The access road to the south of the site is being realigned as part of these works, thus the new aerial line can be located adjacent to this access way. All works associated with the existing Horizon Power infrastructure will need to be costed, and constructed by Horizon Power.

The new substation should be located as close to the re-aligned aerial network as possible, to minimise the cost of new cabling to interconnect the substation to the aerial line. New on site generation (non-renewable) is to be installed as a requirement to feed the onsite firefighting system. This unit should also be located as close to the substation as possible. This would allow a better interface between the grid and the onsite generation. The Site Main Switchboard could be constructed as to compartmentalise the supplies, so that the generator is able to provide power to essential services in the event of mains power failure.

Any installed renewable energy systems on site, if incorporated with energy storage could be utilised to off-set the overall site energy demand. By reducing the energy demand, it may be possible to reduce the size of the installed network connected equipment.

The existing generators could be left in key locations for localised emergency power.

Appendix 3.3 for the HV Concept

Appendix 3.4 for Substation Land requirement

2.3 RENEWABLE ENERGY AND ON-SITE GENERATION

The integration of renewable generation into this electrical network should be considered, and optimised to offset as much of the localised energy needs as possible. This will benefit the development in the potential savings through reduced infrastructure, and reduced ongoing energy costs.

The additional Solar PV/Wind Turbines (plus energy storage) could be used to reduce the size of the substation, from multiple transformers to a single 1MVA unit. The cost difference between 2 x 630kVA transformers and a single substation is approximately $30k. The cost saving in the network impact of installing a larger system would be great, as larger connected capacity may result in additional network reinforcement costs. The land requirement for the double transformer layout is larger than the single layout.

The determining factor in the connection size is peak demand of the site, which is general the evening, after sun set. As during the day Solar PV will off-set some of the daytime energy needs, and late in the evenings the network connection can cover the baseload.

During peak times is when the network connection limit will more than likely be breached. To offset this, some form of energy storage should be considered. With the energy storage in the form of Lithium Ion Batteries or Vanadium Flow Systems. With an approximate 200kWh Lithium Ion system costing in around $300-350k installed on site.

Horizon Power has unofficially confirmed that a load of up to 630kVA can be connected without having to complete a line upgrade, but may require some localised network changes. The capacity of the line is unreserved, and will require a connection application to be submitted to lock it away for the development.

The land requirement for the additional back-up generator would be approximately 4m x 9m. This compound could also contain the Site Main Switchboard, which would be the interface point between the private network, substation and generator.

Appendix 3.5 Generator Compound Requirement

2.4 HORIZON POWER AND CONNECTION REQUIREMENTS

Horizon Power has provided general information regarding the capacity of the network, and the potential to connect additional load. A full network study upon connection request will need to be conducted to confirm that the additional load can be connected and confirm upgrade availability. Without a network connection application the spare capacity in that feeder is available to any other developer that may want to connect to the network prior to this development.

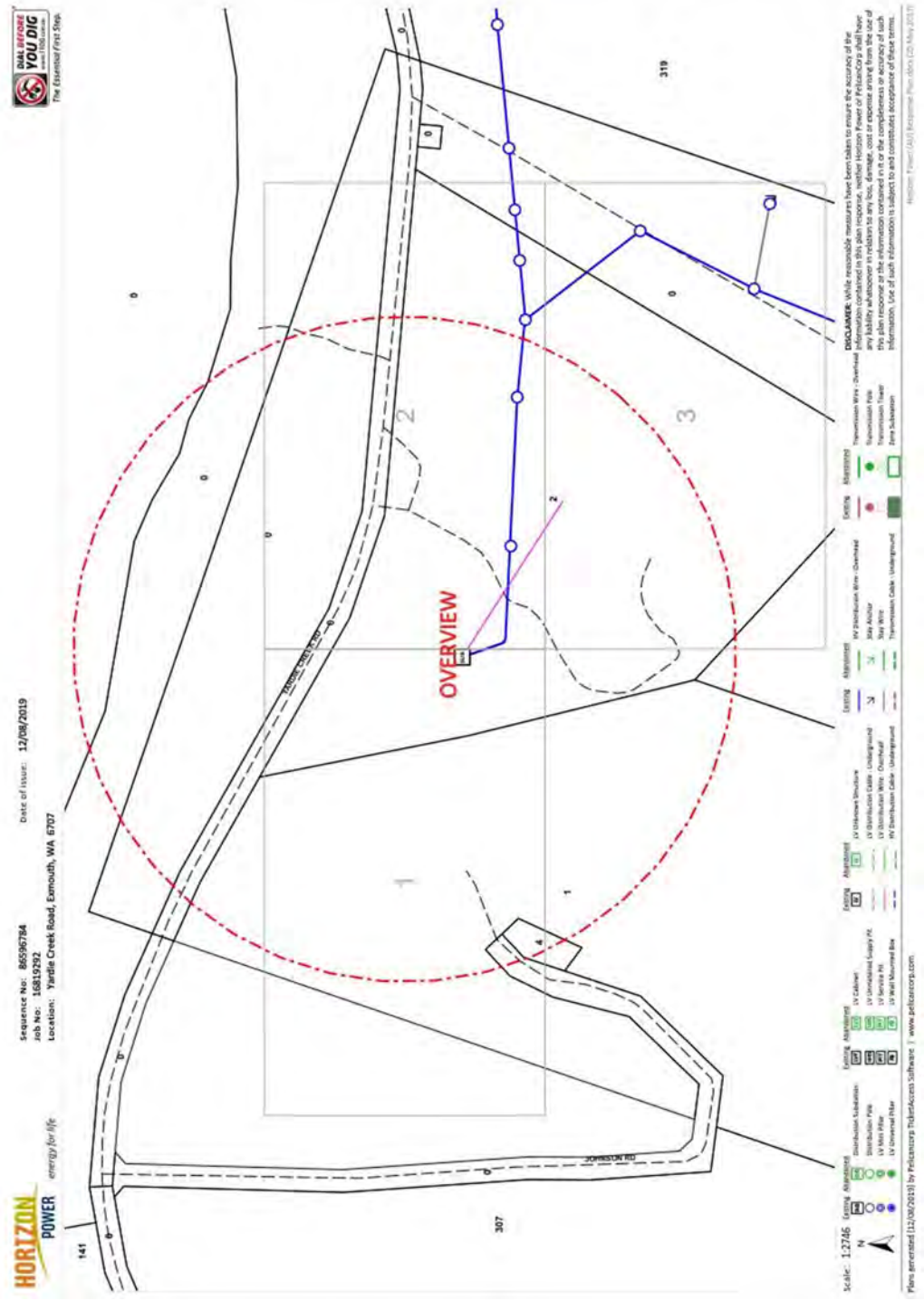
The full network study and assessment by Horizon Power on that network connection will cost $6,100 + GST to Horizon Power.

Based on the current network upgrade strategies that Horizon Power are implementing at edge of grid sites, they may provide a solution within which they own and operate any of the additional generation on site, and enter into a Power Purchase Agreement with the developer for the provision of energy.

Other than Horizon Power, there are a number of private renewable energy companies that are willing to offer PPA's for the installation of renewable assets. This could be investigated further, and reduce the capital cost of this upgrade.

SECTION 3 Appendix

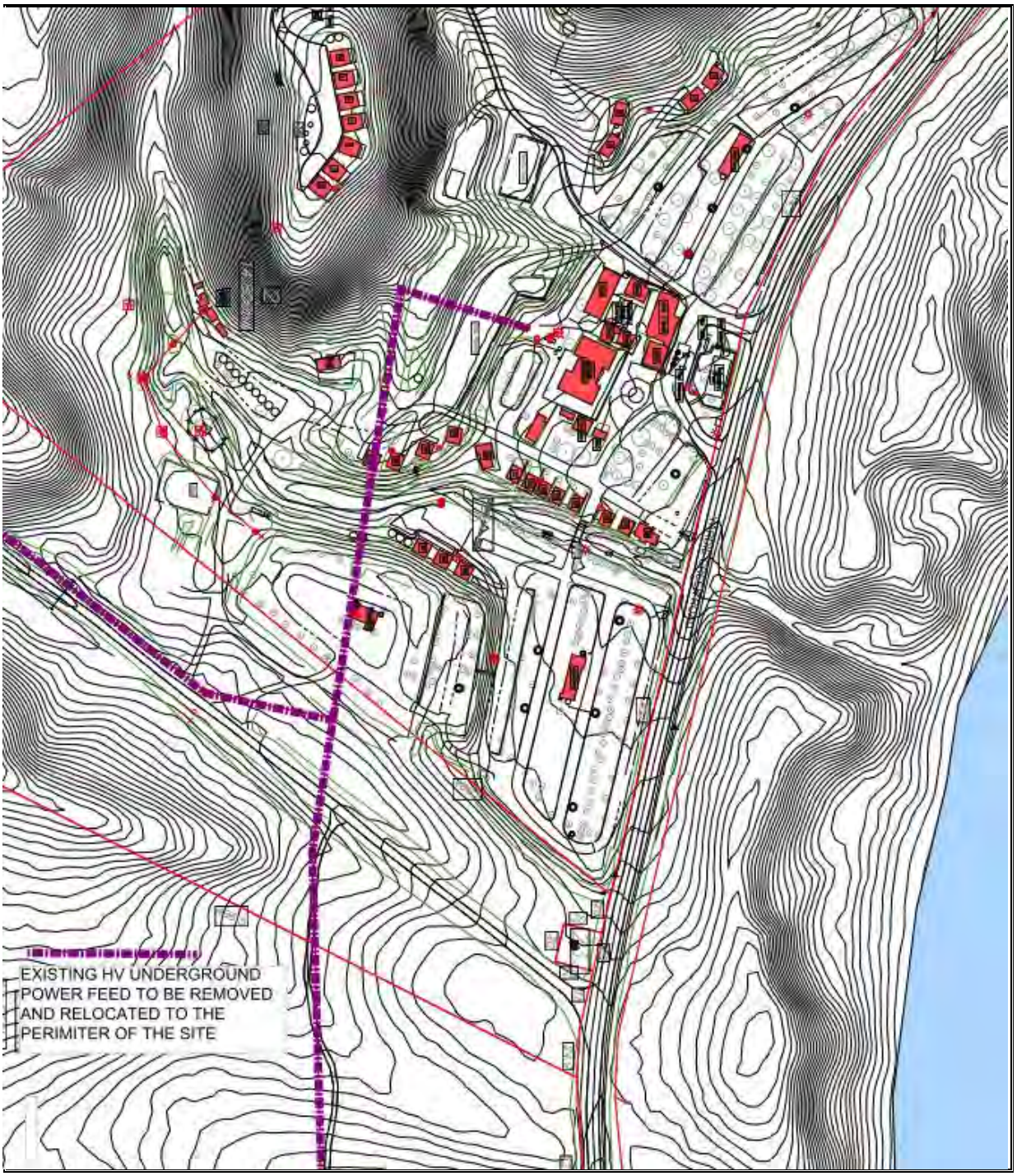
3.1 Horizon Power DBYD



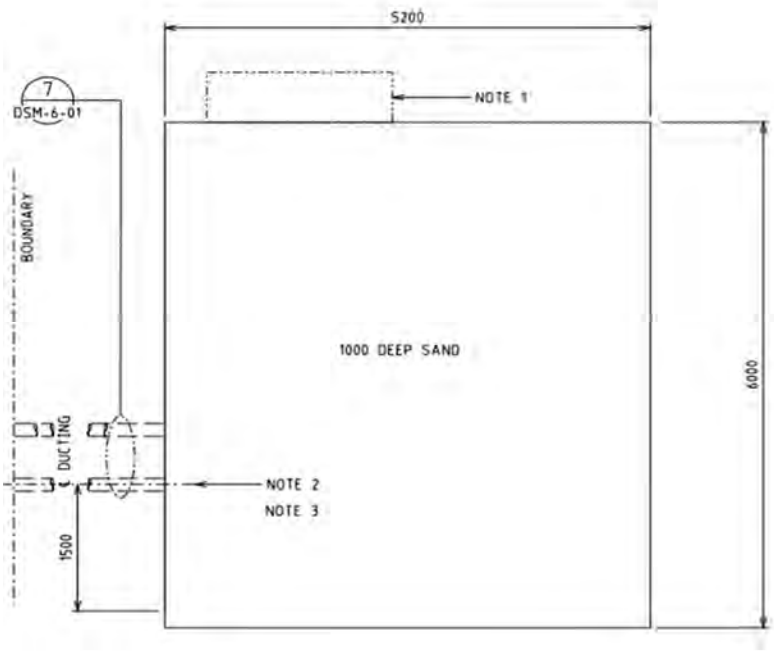
3.2 Development Yield

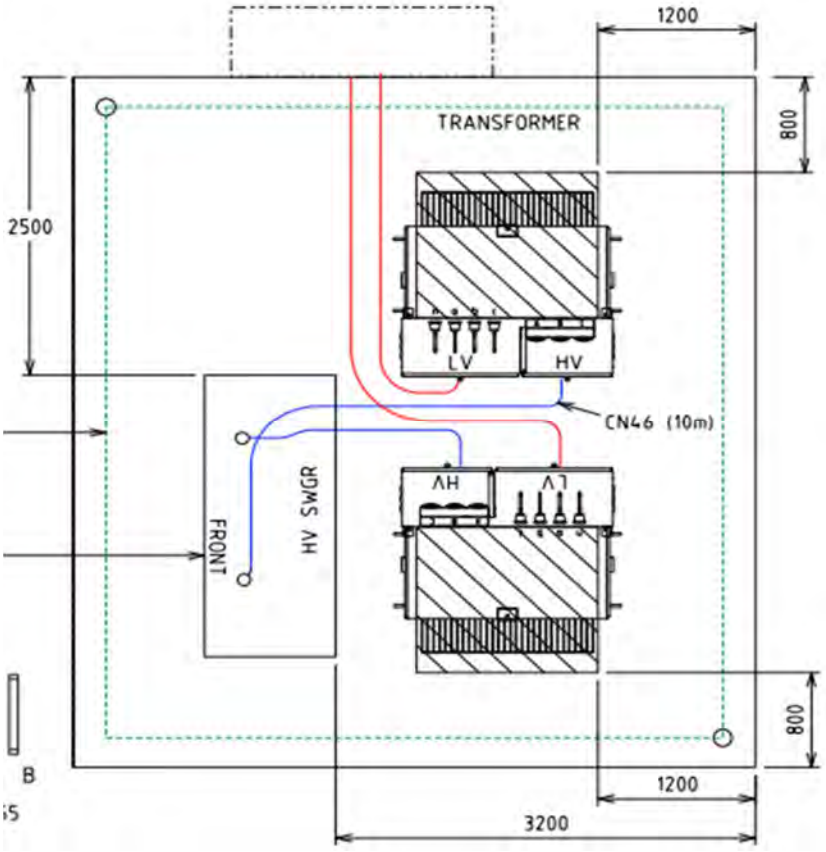
	LEGEND	YIELD	KEYS
TC	TENNIS COURTS	2	-
H	HOTEL	60	60
V	VILLAS	30	60
SV	SUNSET VILLAS	4	8
SPA	SPA - 2 TREATMENT ROOMS/ GYM	1	-
SP	SWIMMING POOLS	4	-
PH	POWELL HOUSE/ RECEPTION AND FUNCTION FACILITIES	1	-
FB	FOOD & BEVERAGE/ REC CENTRE & FUNCTION	1	-
PG	PLAYGROUND	2	-
L	LODGES	7	28
T	ON-SITE TENTS	28	28
A	ABLUTION BLOCKS	3	-
R	RETAIL/ SURF SHOP/ BAR	1	-
GM	GENERAL MANAGERS ACCOMMODATION	1	1
C	CARAVAN SITE	62	62
SF	SERVICES FACILITIES	1	-
PS	PETROL STATION	1	-
BS	BOAT STORAGE	1	-
W	WATER TANKS	9	-
WT	WATER & SEWERAGE TREATMENT FACILITIES	1	-
SA	STAFF ACCOMMODATION	6	6

3.3 HV Concept

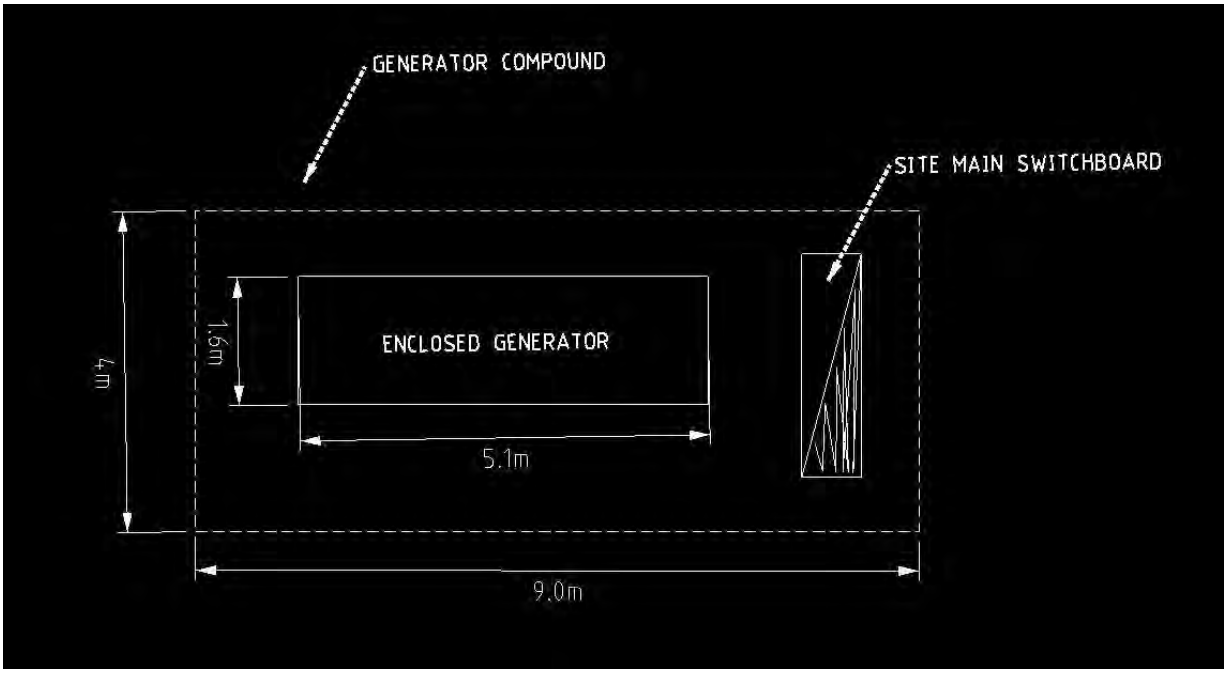


3.4 Substation Site Details





3.5 Generator Site Requirement



APPENDIX E

LEGEND

- PROPOSED UNDERGROUND HV
- EXISTING UNDERGROUND HV (TO BE REMOVED)
- EXISTING HV FEEDER

LOT 1
LOT 2
LOT 6
LOT 307
LOT 319

POWER FEED FROM EXMOUTH

POWER FEED FROM EXMOUTH

SITE FOR SUBSTATION AND GENERATOR

UNDERGROUND HV ALONG ROAD ACCESS TO CARAVAN PARK

HV NETWORK FEEDER HEADING SOUTH

0m 50 100 150m
1:2500

REV	DATE	DRN	CKD	APP	AMENDMENT
B	27.09.19	AMP	-		BASE FILE 'SITE MASTER PLAN' UPDATED
A	03.09.19	ARH	MW	M. WALLIS	ISSUED FOR INFORMATION

Cossill & Webley CONSULTING ENGINEERS

Mailing Address
PO Box 680
Subiaco WA 6904

Street Address
B12 (Level 2) 431 Roberts Road
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CLIENT: MINDEROO

PROJECT: NINGALOO LIGHTHOUSE RESORT

TITLE: HV NETWORK

APPROVED

DESIGNED: ARH

SCALE: 1:2500

WAPC No.

DRAWING No.: 6143-00-SK05

REVISION: B

ORIGINAL SIZE: A1

P:\6413 Exmouth Lighthouse\6413-00\Acad\6143-00-SK05 HV Power.dwg, 27/09/2019 11:47:56 AM, andrewp, Digital Signing PDF.pc3, 1:1, - CW Reference

APPENDIX F

NOTES / LEGEND / MATERIAL

PRINT IN COLOUR

ISSUE	DATE	AMENDMENT	CHECKED
A	27.09.19	ISSUED FOR DA	KHA
B	07.11.19	ISSUED FOR DA (REV.)	KHA
C	08.09.20	AMENDMENT TO CLIENT REQUEST	KHA
D	30.10.20	ISSUED FOR DA	KHA

STATUS

DA SUBMISSION

CLIENT

NORTHWEST RESORTS PTY LTD

ARCHITECT

Kerry Hill Architects Pty Ltd
30 Mouat St, Fremantle, WA 6160
T:+618 93364545 F:+618 93364546
admin_perth@kerryhillarchitects.com

PROJECT	REF
NINGALOO LIGHTHOUSE RESORT	562

ADDRESS

LOTS 2 & 557 YARDIE CREEK ROAD, NORTH WEST CAPE

DRAWN	NORTH	SCALE @ A1/A3
KHA		1:2000/1:4000

CHECKED	APPROVED
KHA	KHA

DRAWING TITLE

SITE MASTER PLAN

-

DRAWING NUMBER	ISSUE	DATE
A0003	D	30.10.20

APPENDIX G

Water Balance

Potable Water

		per day		
Bore Water Supply (max)		259	KL	
30% reject stream		77.7	KL	
useable potable water		181.3	KL	
max annual extracition (full capacity)		94535	KL	
Bore Water Supply (average)		160	KL	
30% reject stream		48	KL	
useable potable water		112	KL	
average annual exactraction		58400	KL	
licence application		72000	KL	allowance for 25% growth
Potable Water Demand				
Peak	726	182	KL	250 L/person/day
Median	448	112	KL	

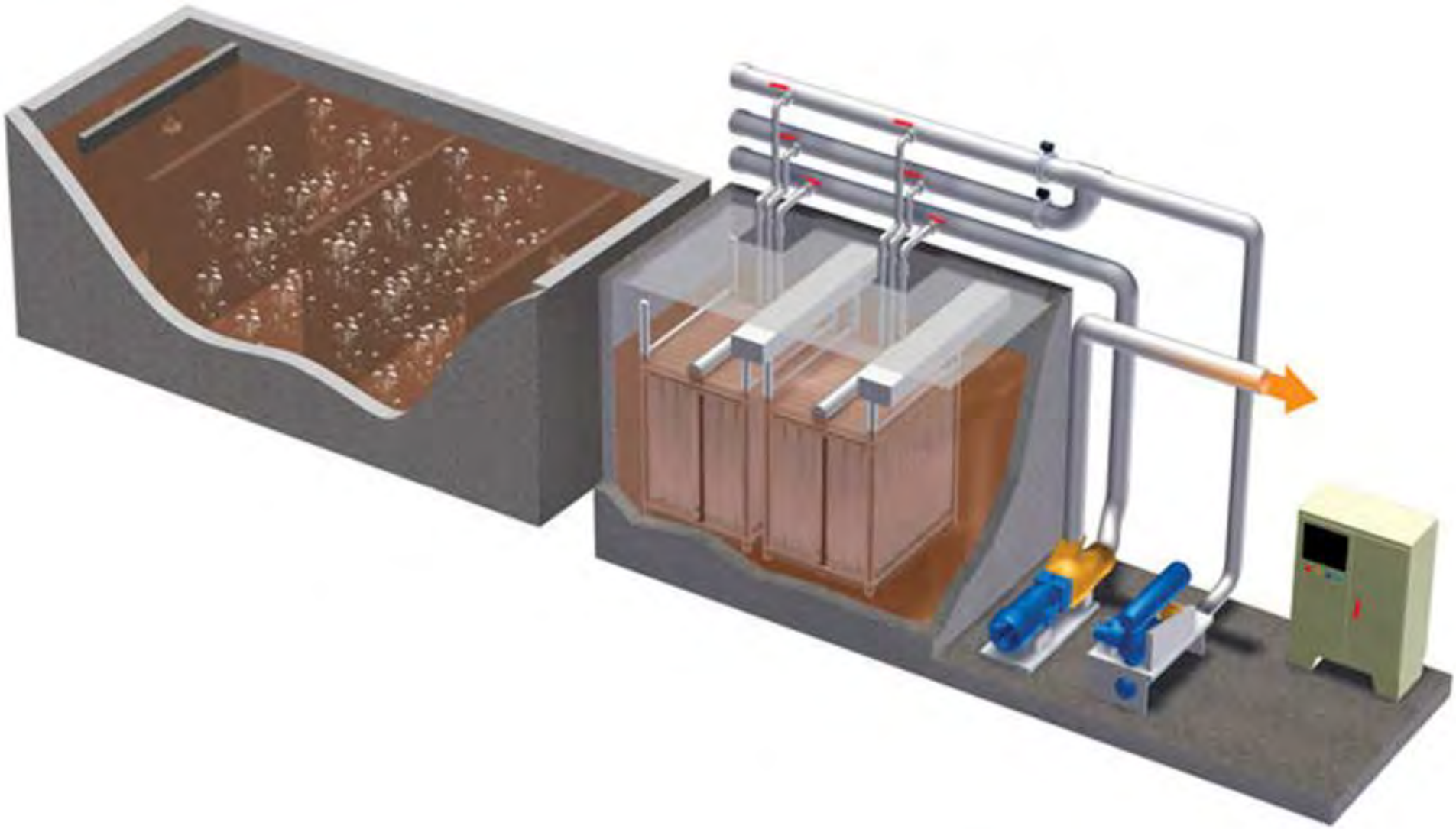
Non Potable Water

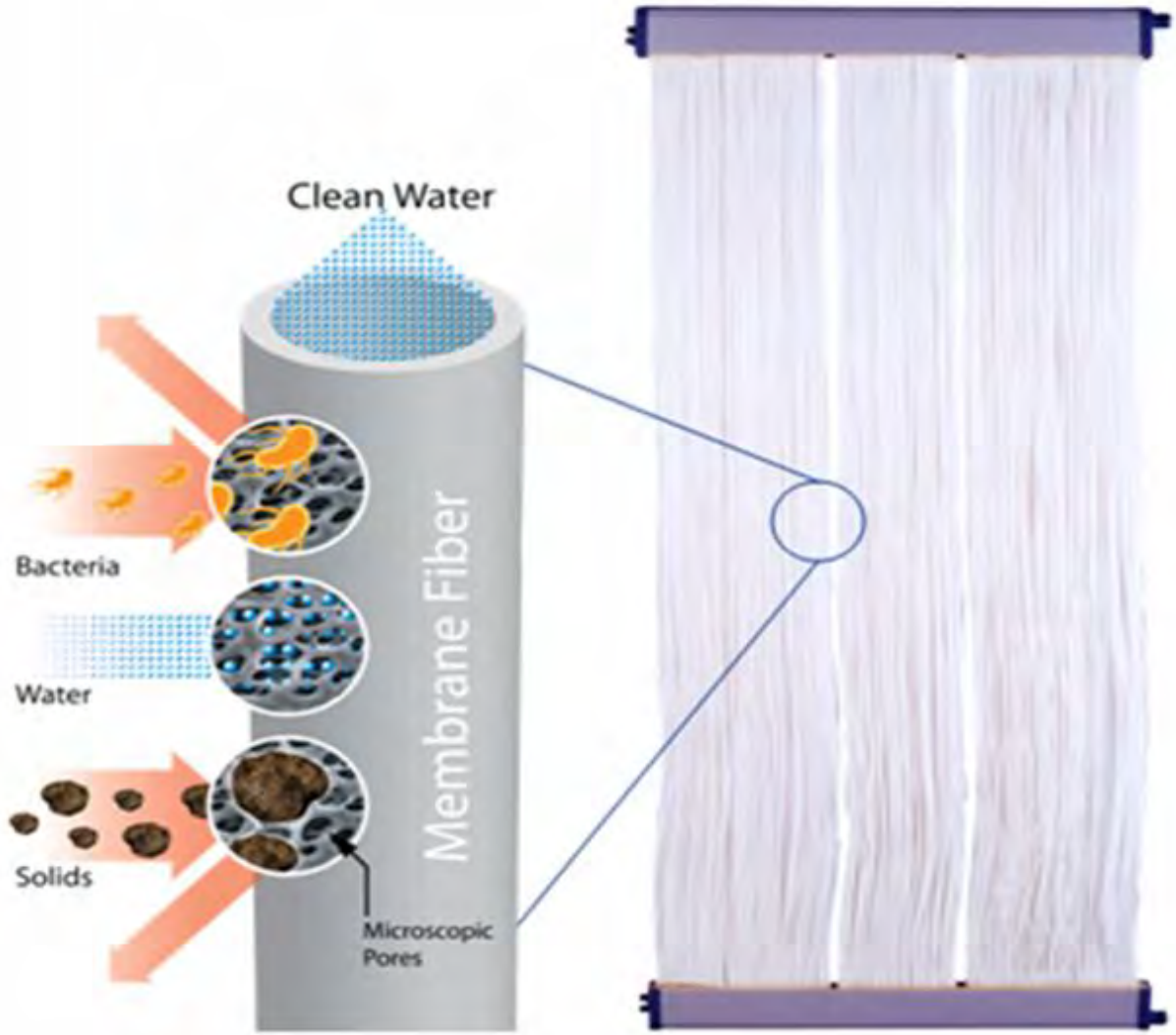
Grey Water Produced				
Peak	726	174	KL	240 L/person/day
Median	448	108	KL	
Grey Water Requirement				
Toilet Flushing	726	44	KL	60 L/person grey water reuse
Irrigation		25	KL	25 ML/ha/year. based on 3,000m2 irrigation
TOTAL NOT POTABLE REQUIREMENT (PEAK)		69	KL	

Storage Requirements

Tanks		
Potable Supply	300KL	6 tanks
Irrigation	300KL	1 tank
Fire	300KL	2 tanks

APPENDIX H




Clean Water
Bacteria
Water
Solids
Membrane Fiber
Microscopic
Pores

APPENDIX I

Northwest Resorts Pty Ltd

H2 Hydrogeological Report

Lighthouse Holiday Park Redevelopment

penningtonscott
securing your water future

Northwest Resorts Pty Ltd

H2 Hydrogeological Report

Lighthouse Holiday Park Redevelopment

2255 | Rev 1

10 November 2020

Pennington Scott ABN 76 747 052 070

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REVISION	ISSUED	DESCRIPTION
Rev 0	6 Nov. 2020	Issued to client for review
Rev 1	10 Nov. 2020	Re-issued to client

EXECUTIVE SUMMARY

Northwest Resorts Pty Ltd (the **Proponent**) purchased the Ningaloo Lighthouse Holiday Park in late 2018 and is seeking to redevelop it into an eco-resort in 2021. The Proponent currently holds groundwater licence GWL153728 to take 32,000 kL/year from the Exmouth North Saline Resource but is seeking to increase the saline water allocation to 72,000 kL/year to produce 50,000 kL/year of potable water. The borefield would provide up to 259 kL/day during the peak tourist season (1 April to 31 October) and 108 kL/day during the low season (1 November to 31 March).

At the time of the purchase, Lighthouse had four (4) existing equipped water bores on Lot 2, plus was receiving makeup water from the Department of Defence. In August 2020 the Department of Water and Environmental Regulation granted the Proponent a 26D permit CAW204525(1) to explore and develop seven (7) additional water bores in the Work Area along the eastern edge of the Cape Range, so that the Project could become fully self-sufficient for water. The new bores were completed between August and September 2020 and as part of the hydrogeological investigations, all bores were pump tested for 48hrs at 0.5 L/s which water quality parameters were monitored during the tests.

The hydrogeological investigations reveal that the Tulki Limestone beneath the Property is a saline groundwater resource, with better quality brackish to saline groundwater (3,000 to 14,000 mg/L) at the water table, becoming more saline with depth. The highest measured salinity on the property was 24,000 mg/L from about 30 m below the water table, which is still less saline than seawater as measured at Exmouth during the program, being 33,200 mg/L. All bores are screened a few metres beneath the water table such that they skim only the better-quality groundwater from the top of the water table.

Seasonal borefield abstraction in the high season is likely cause groundwater salinity in the immediate borefield vicinity to increase marginally as better-quality groundwater is sipped from the water table. However, water quality would recover over the wetter season, when abstraction rates are minimal and when natural recharge over the Cape Range is at its highest.

Groundwater abstraction over the high season is likely to cause a maximum discernible drawdown impact extending up to 370 m from the borefield, with the highest drawdown in each production bore ranging from 0.4 to 0.6 m.

The perceived environmental and social impacts that could may arise from the expansion of the Project borefield are as follows:

- **Groundwater dependent ecosystems** - Bennelongia (environmental consultants) have been engaged to conduct a subterranean fauna study of the Project borefield, which will comprise a comprehensive desktop study and a field sampling program in accordance with the Environmental Protection Agency guidance documents. Sampling prior to this report has not been possible because the bores were only completed in late September 2020, and in line with EPA requirements, subterranean fauna sampling should ideally be undertaken 3 months post disturbance. Notwithstanding the above, the BoM database reveals the presence of the ‘Cape Range Subterranean Waterways’, located approximately 4 to 5 km northeast of the Project;

- **Other groundwater users** – the Project would have no impact on other groundwater users because there are no other users within the drawdown impact area; indeed, the nearest third-party bore is more than 5 km away from the Project; and
- **Aboriginal Heritage** – the Project would have no unacceptable impacts on aboriginal heritage values because there are no sites with water significance within the drawdown impact area; the nearest site of water significance is 3 km away and the Proponent has agreed to engage regularly with the Gnulli Group with respect to groundwater abstraction and protection of this site; and the Proponent has implemented a management plan to avoid impacts to one identified artifact site within in the borefield area.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIX

1. BACKGROUND

Northwest Resorts Pty Ltd (**the Proponent**), a wholly owned subsidiary of Tattarang Pty Ltd, purchased the Ningaloo Lighthouse Holiday Park (**the Property**) in late 2018 with a view to redevelop the Property into an eco-resort, catering for a peak load of 651 guests and visitors during the main tourist season (1 Apr. to 31 Oct.), and up to 299 guests and visitors during the low season (**the Project**).

The Property is located 13 km north of Exmouth, Western Australia, comprising freehold land over Lot 2 (P 014686 2), Lot 1 (P 014686 1) and Lot 557 (DP 412260) Yardie Creek Road, leasehold land over parcel LGE N657592, and an easement over land LAA 144(307) L826505. Also included for the Project's development is access to Unallocated Crown Land (**UCL**) for water exploration, approved under a Section 91 of the *Land Administration Act 1997* (**LAA**) comprising Lot 307 and 308 on Deposited Plan 40825 and a portion of UCL pin number 1240777. **Figure 1-1** illustrates all land pertaining to, and associated with, the Property and the Project.

The annual potable water demand for the Project is anticipated to be 50,000 kL/year based on water usage of 250 L per guest per day. The raw saline groundwater must be treated through an onsite reverse osmosis (**RO**) plant to produce potable water, with a 30% reject stream. Thus, the Project would require 72,000 kL/year of saline groundwater to produce 50,000 kL/year of potable water.

The Proponent currently holds groundwater licence (**GWL**) GWL153728 to take 32,000 kL/year from the Exmouth North Saline Resource, granted under *Section 5C of the Rights in Water and Irrigation Act 1914* (**RWIA**). The Proponent has applied to the Department of Water and Environmental Regulation (**DWER**) to increase the current allocation to 72,000 kL/year, and in support of the application, the Proponent has constructed a new borefield on the eastern side of the Cape Range, approximately 2 km south of the existing holiday park.

Pennington Scott (groundwater consultants) were engaged to develop the new borefield and prepare an H2 hydrogeological assessment in accordance with DWER's Operational Policy 5.12.

The contained document represents the interpretive H2 hydrogeological report, prepared in accordance with the Department of Water and Environmental Regulation's Operational Policy No. 5.12 (DWER, 2009), in support of Northwest Resorts Pty Ltd application to DWER to increase the allocation limit on 5C groundwater licence GWL153728 from 32,000 kL/year to 72,000 kL/year.

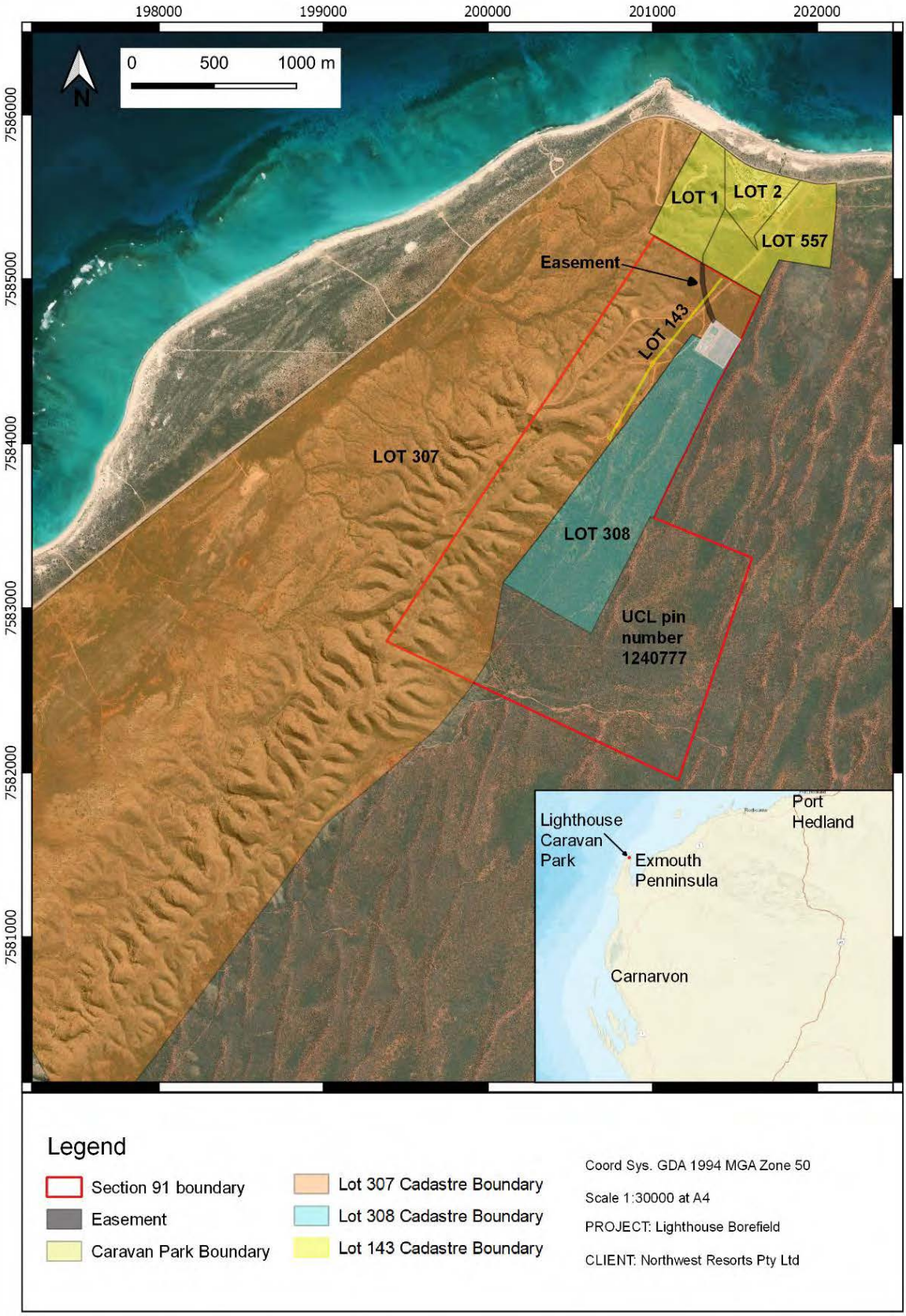

Figure 1-1: Lighthouse Holiday Park location map and land parcels

2. HYDROGEOLOGICAL SETTING

2.1 Climate

Exmouth endures a semi-arid climate with daytime temperatures often reaching above 40ºC in summer and reduce to 25ºC in winter. Rainfall mostly occurs between January to July and is usually dry between August to December.

The Bureau of Meteorology has been recording climate data at the Learmonth Airport (weather station number 5007) since 1945. The long-term annual average rainfall recorded from the Learmonth Airport is 253.5 mm, but records have shown that up to 361 mm has previously fallen in one month - January. In the 2019-2020 FY period, a total of 83.1 mm of rainfall was recorded. Evaporation rates are high, with the annual average pan evaporation of approximately 3000 mm/year. **Figure 2-1** illustrates the 2019-2020 rainfall with the long-term monthly average rainfall and evaporation as recorded from the Learmonth Airport.

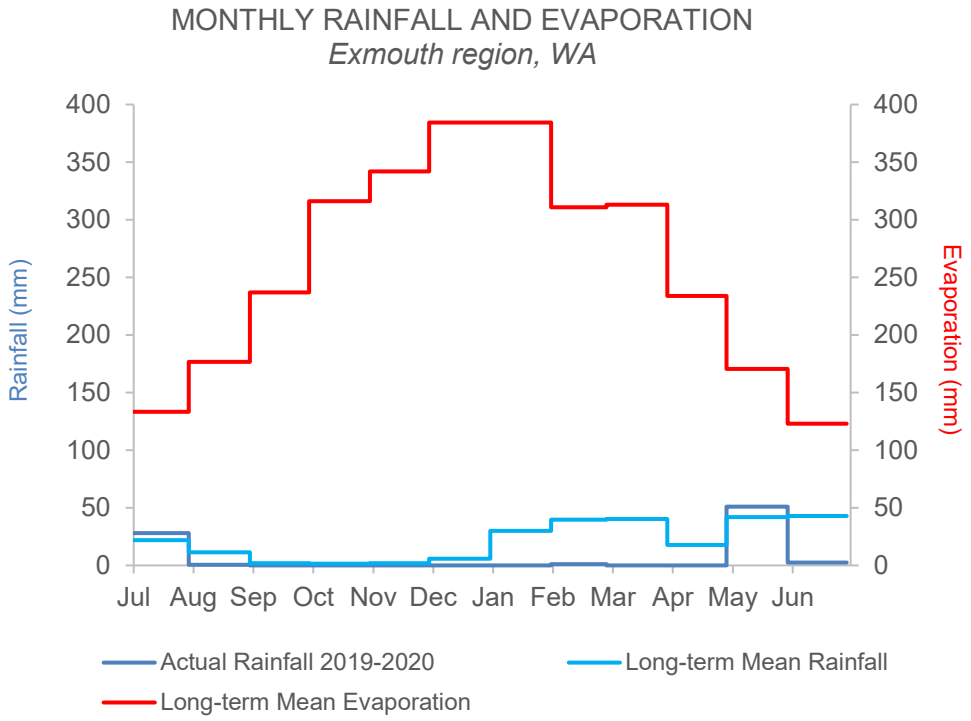

Figure 2-1: Climate statistics from the Learmonth Airport (#5007)

2.2 Geology

The Property lies within the Northern Carnarvon Basin with rock types from the Cape Range Group originating from sediment deposition in the mid-to-late Cenozoic era. The broader area was mapped by the Geological Survey of Western Australia (Van De Graff et al., 1982) who defined the stratigraphy of the Cape Range Group. **Table 2-1** shows the stratigraphy which comprises (in ascending order) the Mandu Calcarenite, the Tulki Limestone, the Trealla Limestone, the Pilgramunna Formation and the Vlamingh Sandstone.

Table 2-1: Stratigraphy of the Cape Range Group

Age		Group	Formation	Lithology
Neogene	Miocene	Cape Range Group	Vlamingh Sandstone	Well-sorted, medium-grained quartzose calcarenite with large-scale (12m) steep cross-bedding
			Pilgramunna Formation	Quartzose calcarenite and coralgal limestone, fine to very coarse-grained
			Trealla Limestone	Pure white calcirudite to calcisiltite, with coralgal limestone; thin to massive bedded with sharp edged karst features common; fossiliferous
			Tulki Limestone	Reddish to yellowish, marly, foraminiferal, calcarenitic packstone; fossiliferous
	Oligocene to Miocene		Mandu Calcarenite	White, chalky calcarenite to calcilutite; rare flint nodules; fossiliferous

The Cape Range is a north-south striking elevated gentle anticline comprising the Tulki Limestone over Mandu Calcarenite at depth, the Cape Range dips gently to the east and west. On the eastern side of the Cape Range, the Tulki Limestone is overlain by a veneer of red brown sandy loam soil.

Figure 2-2 illustrates drill samples from the northern and southern extents of the recent drilling and bore construction program. This shows that the Tulki Limestone appears to have three distinctive horizons over the Property, being:

- An upper 3 to 20-27 m of hard indurated limestone in the northern and southern extents;
- A lower zone of weakly cemented to loose “running” medium quartz SAND with clay and/or silt, seen in the northern extent; or,
- A lower zone of indurated limestone with non-carbonate SAND filled karsts seen in the southern extent.

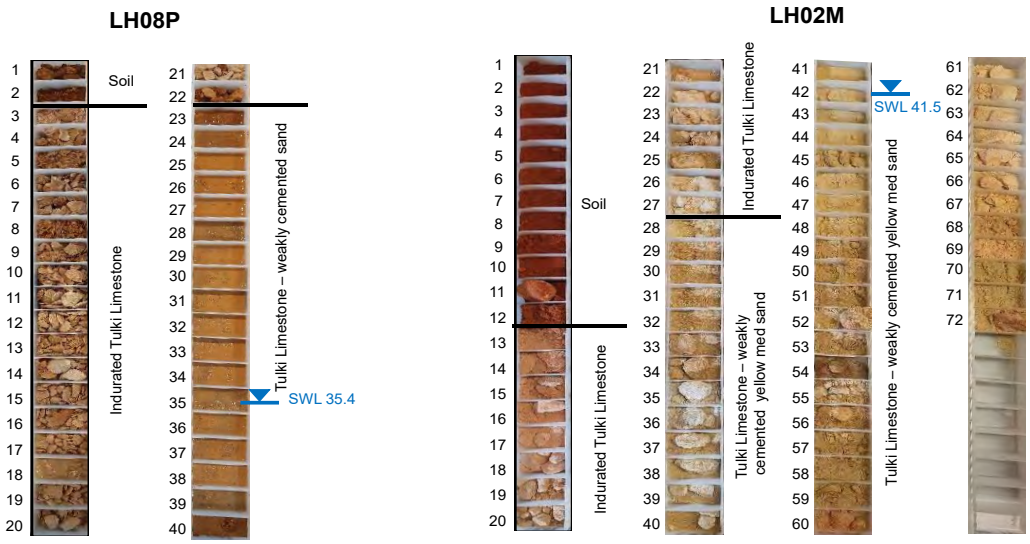

Figure 2-2: Chip trays with drill samples from the northern and southern areas of the borefield; LH08P from the north, LH02M from the south.

2.3 Hydrogeology

The water table elevation ranges from a few meters above sea level in areas around the coastline and can rise inland up to 15 m above sea level in the central part of the Exmouth Peninsular (Water Corporation, 1997).

The water table beneath the Property is relatively deep, intersected at 30 to 50 m below ground level. While the Tulki Limestone is known to have karstic dissolution features (Water Corporation, 1997), groundwater occurrence in the new bores (see **Section 5.1**) was intersected beneath the indurated limestone within the loose medium sand. Here, groundwater permeability and storage are developed within the primary interstitial pore spaces.

Groundwater salinity beneath the Property appears to be stratified with a lens of better quality brackish to saline groundwater (3,000 to 14,000 mg/L TDS) at the watertable, becoming steadily more saline with depth. The highest recorded groundwater salinity was 24,000 mg/L TDS at 72 m depth (30 m below the water table) in bore LH02M. Seawater salinity was measured at the Exmouth coast at during the program at 33,200 mg/L TDS.

From these results, the saltwater interface is extrapolated to be more than 50 m below the water table in the borefield area. While no fresh water lense was encountered in the borefield (i.e. groundwater with a potable salinity of less than 1,000 mg/L TDS), the shallow groundwater within the transition zone nonetheless offers an ideal low salinity resource suitable for feed water for an RO treatment plant.

3. ABORIGINAL HERITAGE SURVEY

Hydrogeological field work was undertaken on the Property on the eastern side of the Cape Range, an area that has cultural heritage significance to the Gnulli Native Title group (**the Gnulli Group**). In accordance with the indigenous land use agreement (**ILUA**) between the Proponent and the Gnulli Group, the Proponent engaged the Yamatji Marlpa Aboriginal Corporation (**YMAC**), who are representatives of Gnulli Group, to undertake a heritage survey over the proposed drill pads and access tracks (referred to as the **Work Area**). The survey was completed between 10 and 13 December 2019.

The heritage survey is included in **Appendix A** and the key findings are summarised as follows:

- One artifact scatter location (Section 91 Water Bores Avoidance Area One) was identified on the existing main access track leading into the Work Area;
- One registered heritage site (DPLH ID 10381 Vlamingh Head) was reassessed and found to have continuing cultural significance for the Baiyungu people; and
- The importance of groundwater to the sacred narratives of the Cape Range region were recognised.

To avoid disturbing the artifact scatter location on the main access track, the Gnulli Group surveyed an alternative deviation (refer to **Figure 4-1**). The Proponent obtained a clearing permit (CPS/8913-1) and constructed the alternative track during the hydrogeological investigation program.

4. FLORA AND FAUNA SURVEY / CLEARING PERMIT

Flora and fauna in Western Australia are protected by various legislative measures, including:

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) – Australian Government;
- Biodiversity Conservation Act 2016 (BC Act) – State;
- Environmental Protection Act 1986 (EP Act) – State; and
- Biosecurity and Agriculture Management Act 2007 (BAM Act) – State.

The Property is located within an environmentally sensitive area (**ESA**) declared by the Minister for Environment under the *Environmental Protection Act 1986,* with known locations of priority flora and fauna species (**Figure 4-1**).

For this reason, environment consultants, Strategen JBS&G, were engaged to undertake an ecological survey for flora and fauna within the Work Area; the survey was completed on 19 June 2020. The survey is included in **Appendix B** and key findings are summarised as follows:

- Three native vegetation types were mapped within the Work Area;
- No threatened or priority ecological communities were recorded within the Work Area;
- No other significant vegetation was mapped within the Work Area; and
- Two Priority flora species (P2 and P4) were recorded within the Work Area.

The survey concluded that the P2 species were located directly adjacent to previously cleared tracks and concluded *"that clearing activities are unlikely to have indirect impacts on this species"*. A risk management plan was developed to deviate the proposed clearing around the P2 species to minimise any disturbance. A clearing permit was approved under CPS 8913/1. **Figure 4-1** illustrates the actual cleared tracks and avoidance of the P2 species.

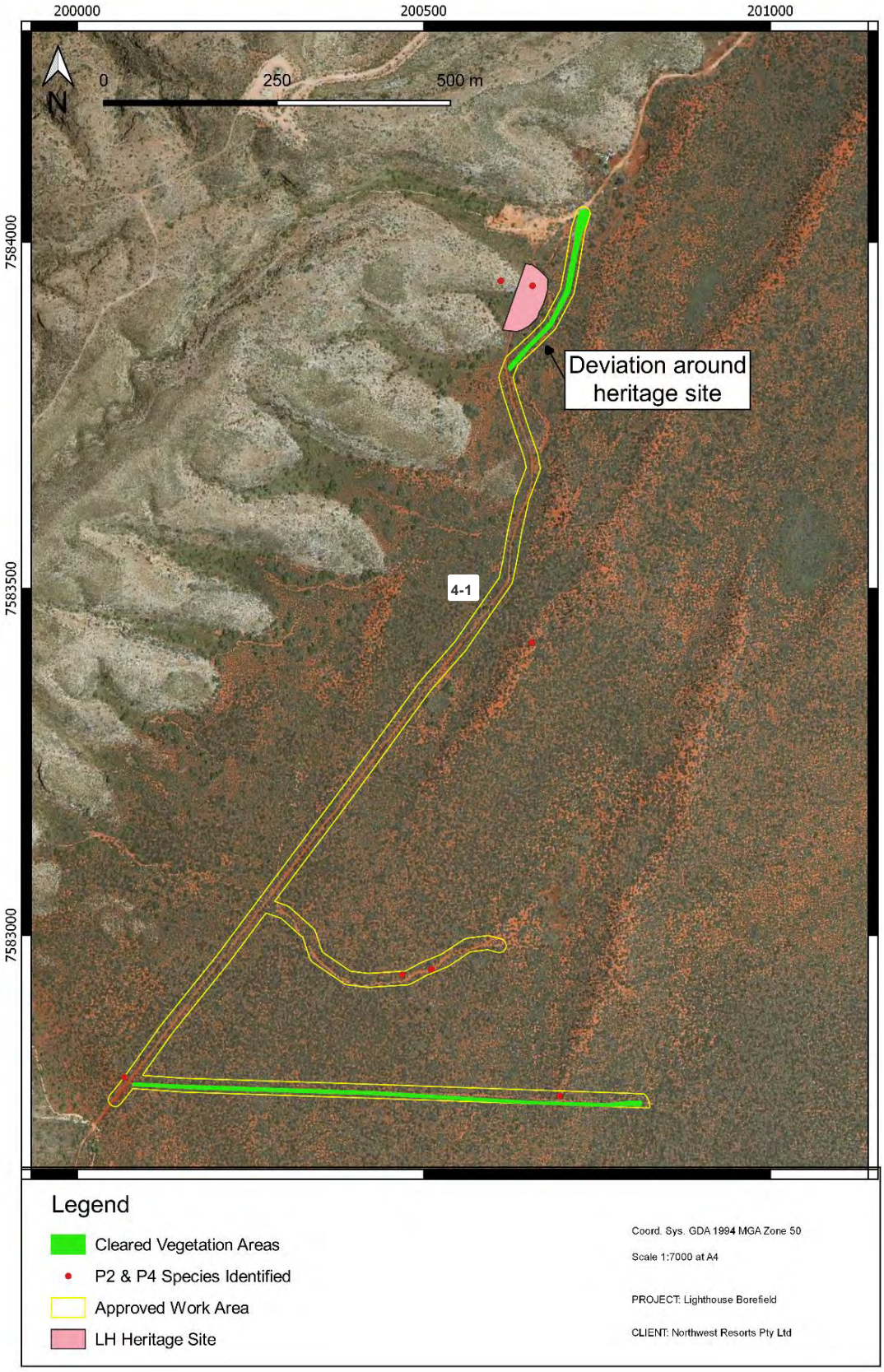

Figure 4-1: Work area and cleared deviations around the P2 species

5. HYDROGEOLOGICAL FIELD PROGRAM

The prime objective of the new borefield is to produce feed water for the RO plant at as low salinity as possible. For this purpose, the borefield is designed as a low yield "groundwater sipping" borefield, where a small volume of abstraction is spread over multiple bores to minimise the drawdown impacts.

DWER granted the Proponent Section 26D permit CAW204525(1) under the RIWA to drill exploration and production water bores on the Property. Given the paucity of available hydrogeological information leading into the field program, the hydrogeological investigation was divided into two stages:

- **Stage 1: Exploration / Monitoring Program** – This initial exploration phase was conducted over the Work Area to locate the most prospective borefield area in terms of yield and water quality. This phase was conducted using a combination of percussion rotary air blast **(RAB)** and reverse circulation **(RC)** drilling methods, which provided air lift yields and water quality variations with depth. A total of eight (8) monitoring bores were constructed during this program; seven (7) within the original Work Area and one (1) within leasehold Lot 143; and
- **Stage 2: Production Bore Program** – Air drilling techniques were unsuitable for larger diameter bore construction due to collapsing subsurface conditions encountered during the exploration program. Thus, a follow-up production bore drilling program was completed using a mud rotary drilling method. A total of seven (7) production bores were installed to target depths of 3 to 4 m below the prevailing water table (as identified during the exploration program); four (4) bores were constructed within the Work Area and three (3) bores were constructed to reinstate old bores on existing drill pads but were outside of the original Work Area.

The following sections further detail each component of the hydrogeological field program.

5.1 Drilling and Bore Construction

An exploratory drilling and bore construction program were conducted in August and September 2020 with drilling contractor Harrington Drilling engaged to undertake the drilling. A total of eight (8) monitoring bores and seven (7) production bores were constructed. **Figure 5-1** illustrates the bore locations and **Table 5-1** summarises all bore construction details. Bore completion logs are included in **Appendix C**.

The bore construction procedure was in accordance with the *Minimum Construction Requirements for Water Bores in Australia, February 2012*, and all field operations were under the direct supervision of a Pennington Scott senior hydrogeologist. Bores were constructed under the following protocols:

Stage 1 Exploration Monitoring Bore Construction

- Temporary 155 mm I.D. PN9 surface casing was installed to 6 m;
- A pilot hole was drilled with a 150 mm or 128 mm drill bit; final depths determined by water quality (see following point);

- Drill return samples were laid out in 1 m intervals and logged by a senior hydrogeologist to the Australian Standard AS1728-1993. Airlift yields and EC were recorded at 1-3 m intervals upon the intersection of the watertable, and the hole was terminated at either EC >18,000 uS/cm or at 120m, whichever came first;
- The hole was cased to full depth with 55.2 or 53.7 mm I.D. (PN9 or PN12) uPVC casing, with machine slotted liners (1 mm aperture) over the bottom 12 m of the hole;
- Temporary surface casing was removed;
- All bores were developed for 30-60 minutes; drilling muds were not used during drilling; and,
- A concrete plinth was installed at surface and a lockable steel headworks was installed over bore.

Stage 2 Production Bore Construction

Production bores were sited within 20-30 m of a prospective exploration bore as follows:

- Stainless steel surface casing (263.5mm I.D. / 273.1mm O.D.) was installed to depths determined by the drilling contractor according to subsurface conditions; surface casing was fully cement grouted;
- A 250 mm pilot hole was drilled to depths of 3-4 m below the water table as determined from the exploration bore;
- Drill return samples were laid out in 1 m intervals and logged by a senior hydrogeologist to the Australian Standard AS1728-1993;
- A downhole geophysical survey was undertaken prior to casing of the hole;
- The hole was cased to full depth with 154 mm I.D. / 168mm O.D. (6") PN9 uPVC casing, with machine slotted liners (1 mm aperture) set between 2 to 4 m below the water table and a 1 m blank pump sump beneath the screened interval;
- Where required, over-drilling was backfilled with bentonite pellets, and the annulus around the pump sump was also backfilled with bentonite pellets;
- The annulus was backfilled with either 1.6 - 3.2 mm or 3.2 – 6.4 mm graded gravel to 6 m below surface;
- Cement grout with 5% bentonite filled the annulus from 6 m to ground level.
- All bores were developed for 3 – 8 hours; airlifting was difficult due to little saturated thickness in each bore and final bore development was invariably completed by pumping during the pump test; and,
- A concrete plinth was installed at surface and a lockable steel headworks was installed over bore.

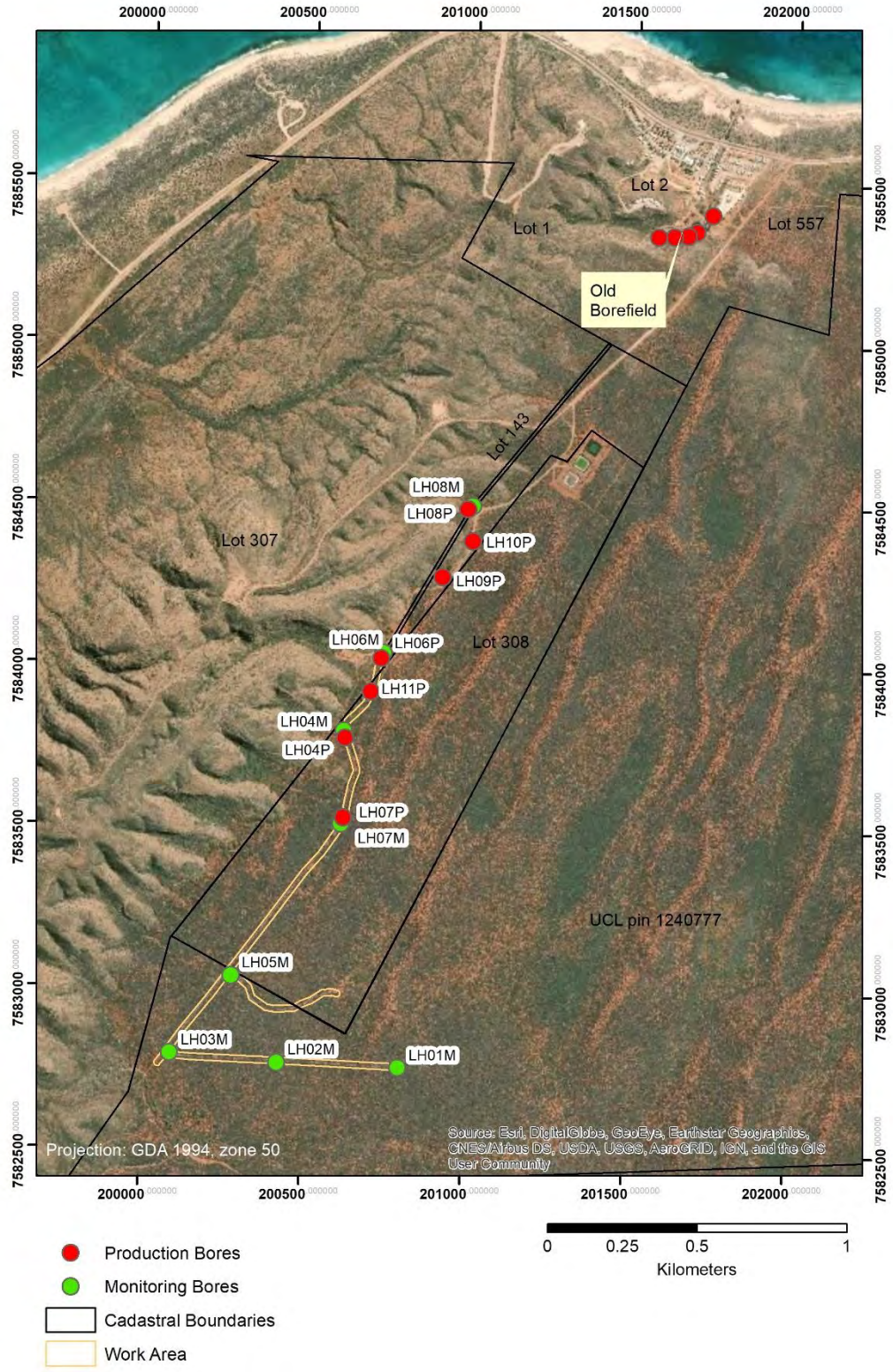

Figure 5-1: Location of monitoring and production bores within the Lighthouse borefield

Table 5-1: Bore construction summary details

Bore	Easting GDA '94	Northing GDA '94	Bore Type	Constructio n Date	Depth (m)	Blank casing (m)	Slotted casing (m)	SWL (mbtoc)	CRT Pump Rate (L/s)	EC (mS/cm)
LH01M	200801	7582754	Monitoring	20/08/2020	54	0 - 41.5	41.5 – 53.5	30.83	0.5	30.3
LH02M	200425	7582770	Monitoring	20/08/2020	72	0 - 41	41 - 71	41.47	0.5	40.6
LH03M	200092	7582795	Monitoring	21/08/2020	66	0 – 50.5	50.5 – 65.6	50.90	0.5	28.6
LH04M	200616	7583798	Monitoring	22/08/2020	56	0 - 41	41- 53	43.14	0.5	23.1
LH05M	200277	7583036	Monitoring	22/08/2020	60	0 - 47	47 - 59	47.59	0.5	32.4
LH06M	200735	7584041	Monitoring	23/08/2020	54	0 – 41	41 – 53	39.22	0.5	40.6
LH07M	200611	7583511	Monitoring	16/08/2020	65	0 – 41	41 - 59	46.34	0.5	29.8
LH08M	201004	7584498	Monitoring	24/08/2020	48	0 - 36	36 - 48	35.39	0.5	36.1
LH04P	200620	7583776	Production	03/09/2020	47.8	0 – 43.5, 46.5 – 47.5	43.5 – 46.5	43.31	0.5	15.84
LH06P	200728	7584023	Production	25/08/2020	44	0 – 37.7	37.7 – 43.7	38.26	0.5	17.16
LH07P	200619	7583530	Production	02/09/2020	50.7	0 – 46.32	46.32 – 50.32	46.42	0.5	22.2
LH08P	200990	7584487	Production	12/09/2020	39.9	0 – 35.6	35.6 – 38.6	35.39	0.5	2.1
LH09P	200914	7584277	Production	12/09/2020	41.8	0 – 37.5, 40.5 – 41.5	37.5 – 40.5	37.71	0.5	6.4
LH10P	201006	7584389	Production	20/09/2020	39.5	0 – 36.15, 38.15 – 39.15	36.15 – 38.15	36.23	0.5	2.94
LH11P	200697	7583921	Production	23/09/2020	44.6	0 – 41.34, 43.34 – 44.34	41.34 – 43.34	41.43	0.5	7.55

5.2 Pump Testing

Given the bore constructions were designed for 'groundwater sipping' to minimise water quality variations, the pump testing differed from other hydrogeological investigations insofar as each bore was pumped at a constant rate of 0.5 L/s for 48-hours. Monitoring bores were monitored for changes in water level, temperature, salinity and pH over time using a combination of manual readings and automated data loggers.

Drawdown levels during the constant rate tests were too low for conventional pump test analysis. Instead, **Table 5-2** shows aquifer permeability (hydraulic conductivity) parameters estimated from the Cooper Jacob distance drawdown method using observation bore levels. Reference to the table shows that hydraulic conductivity varies between 12 and 90 m/day, with an average of 80 m/day.

Table 5-2: Cooper Jacob analysis of pump tests

Bore ID	Q (L/s)	Obs radius	Final drawdown (m)		Delta S	T	Screen length	K
		m	Prod Bore	Obs Bore	m	m2/day	m	m/day
LH04P	43.2	22	0.74	0	0.21	37	3	12
LH06P	43.2	20	0.13	0.08	0.01	542	6	90
LH07P	43.2	21	0.3	0.23	0.02	389	4	97
LH08P	43.2	14	0.22	0.06	0.05	162	3	54
LH09P	43.2	20	0.41	0.18	0.07	118	3	39
LH10P	43.2	20	0.46	0.03	0.13	63	2	32
LH11P	43.2	-	0.69	-	0		2	

The manually recorded salinity, pH, temperature and water level measurements taken during the test are plotted in **Appendix D.** Reference to these plots show the following:

- Groundwater temperatures were variable between each bore ranging from 27.8 to 32ºC, but temperatures remained more or less constant in each bore during the test;
- Salinity levels gradually increased over time across all bores, but not significantly;
- pH remained between 6.5 and 7.5;
- Observation bores were at a distance of 20 – 25 m from the pumped bore and observations show the maximum drawdown was 0.23 m at 48-hours; and,
- Given the water table is deep, it was not possible to gate back the flow to a constant low rate of 0.5 L/s at the start of each test, and therefore, it was necessary to start with a higher rate (up to 6 L/s) while pumping filled the column and water reached the gate valve. This resulted in an initial deeper drawdown in each test, followed by a recovery. Nonetheless, the maximum final drawdown in all pumping bores was less than 0.74 m (refer to **Table 6-1**).

5.3 Laboratory Water Quality Analyses

At the end of each 48-hour pump test, a water sample was collected and sent for laboratory analysis to test for pH, electrical conductivity (**EC**), total dissolved solids (**TDS**), ionic balance, turbidity, true colour, major ions, selected nutrients and metals (**Appendix E**); a total of seven (7) samples were collected and laboratory tested.

Table 5-3 summarises laboratory EC, TDS and pH measurements from each production bore. The salinity in the seven production water bores varies from 3,000 to 14,000 mg/L TDS, being equivalent to 4,900 to 21,300 uS/cm. **Figure 5-2** plots the relationship between EC vs TDS, which illustrates a linear relationship of 1 uS/cm equivalent to 0.61 mg/L.

Table 5-3: Laboratory EC, pH and TDS measurements

Bore Number	pH	EC (µS/cm)	TDS (mg/L by evap.)
LH04P	7.3	15,200	9,400
LH06P	7.4	11,600	7,000
LH07P	7.3	21,300	14,000
LH08P	7.3	4,900	2,900
LH09P	7.4	8,070	4,700
LH010P	7.3	7,250	4,400
LH011P	7.3	10,200	6,300

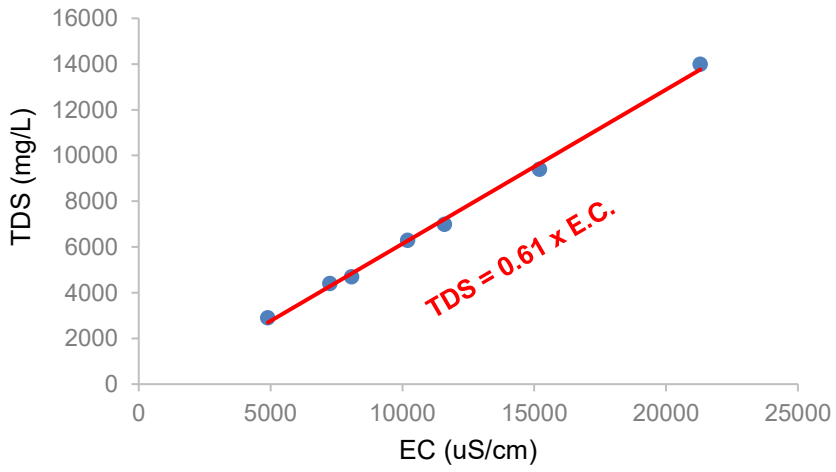

Figure 5-2: Relationship between EC and TDS

6. BOREFIELD DEVELOPMENT PLAN

Figure 5-1 shows the Project borefield, which comprises a total of eleven (11) production water bores, including four (4) equipped existing bores on Lot 2, plus seven (7) new production bores constructed within the Work Area on the east side of the Cape Range. The proposed borefield development plan would be as follows:

- All existing and new bores would deliver raw groundwater to the main raw water storage tank farm on Lot 2 of the Lighthouse Resort via two collector mains. Water from the tank farm would in turn feed the RO water treatment plant;
- All bores would be equipped to deliver nominal yields of 0.5 L/sec;
- A float control on the raw water tank would send automatic calls to turn on/off each bore pump, with bore calls being rotated on a roster system, with the total number of bores activated at any one time being dependant on the drawdown water level in the tank farm;
- During the seven-month peak tourist season (1 April to 31 October), the borefield would be operated to deliver a peak capacity of 259 kL/day to provide 181 kL/day of potable water; and
- During the low season (1 November to 30 March), the borefield would be operated to deliver an average of 108 kL/day to provide 73 kL/day of potable water.

7. ENVIRONMENTAL IMPACT ASSESSMENT

The Project borefield has increased from the four (4) equipped bores on Lot 2, to a total of eleven (11) equipped bores including the addition of the seven (7) new bores along the eastern edge of the Cape Range.

The borefield would be used to provide a base load of 292 kL/day, and a peak of 520 kL/day during the high tourist season (1 April to 31 October) each year and would be rested over the off-season, which coincides with the northern wet season.

Saline groundwater abstraction for the Project would be increase from 32,000 kL/year to 75,000 kL/year after completion of the Project.

Using the Cooper Jacob Method, the maximum possible extent of drawdown impact around the borefield is calculated to be 370 m from the bores, with a maximum drawdown at each production bore ranging from 0.4 to 0.6 m based the assumption that each bore is continuously pumped at the peak rate of 0.5 L/s for the entire high season (210 days); and that the aquifer has an average transmissivity of 80 m2/day and specific yield of 20%.

The brackish to saline water quality in the immediate vicinity of the production bores (3,000 to 14,000 mg/L) is expected over the course of the high season as better-quality groundwater is sipped from the water table. However, the water quality will replenish seasonally with mixing of seasonal recharge from the Cape Range.

The perceived environmental and social impacts that could potentially arise from the expansion of the Project borefield are as follows:

- Environmental values – groundwater dependent ecosystems;
- Economic values – other groundwater users; and
- Social values – Aboriginal heritage.

The following sections discuss these potential impacts.

7.1 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (**GDE**) are biological assemblages that use available groundwater, or surface expressions of groundwater, either opportunistically or as their primary water source. GDEs are classified into three board categories, aquatic (e.g. wetlands), terrestrial (e.g. woodlands) and subterranean fauna (e.g. stygofauna), all of which have water requirements associated with water quality and quantity. In general, groundwater abstraction has the potential to adversely impact the health and diversity of GDEs that occur with the drawdown zone caused by continued abstraction.

Several open source databases were reviewed to identify the existence of GDEs within 5 km of the new borefield. The Australian National Map database was reviewed to identify RAMSAR listed wetlands i.e. nationally important aquatic GDEs, and the Bureau of Meteorology (**BoM**) and the Department of Biodiversity, Conservation and Attractions (**DBCA**) databases were reviewed for all GDE types.

7.1.1 Aquatic and terrestrial GDEs

A review of these databases shows that there are no RAMSAR listed wetlands or terrestrial GDEs within the drawdown impact area and indeed no listed wetlands within a 5 km radius of the Project. Therefore, there will be no impact on these GDE types.

7.1.2 Subterranean GDEs

Stygofauna, as opposed to troglofaunal, is recognised as the being the most likely subterranean fauna to be affected by groundwater change.

Bennelongia (environmental consultants) have been engaged to conduct a subterranean fauna study of the Project borefield comprising a comprehensive desktop study and a field sampling program in accordance with the Environmental Protection Agency (**EPA**) guidance documents. Sampling prior to this report has not been possible due to the construction of bores having only recently been completed in late September 2020, and in line with EPA requirements, stygofauna sampling is to be undertaken 3 months post disturbance i.e. drilling.

Notwithstanding the above, the BoM database reveals the presence of the ‘Cape Range Subterranean Waterways’, located approximately 4 to 5 km northeast of the Project (**Figure 7-1**), beneath the North West Cape radio transmission aerial.

7.2 Other Groundwater Users

Figure 7-1 shows the location of all licenced water bores within the vicinity of the Project. Reference to this figure shows that there are no third party bores within the projected drawdown impact area around the borefield.

The closest registered bore for general water usage is greater than 5.5 km from the Project’s borefield (registered as a stock and domestic bore) and the closet borefield for water supply is the Department of Defence (DoD) borefield, located more than 6 km from the Project.

In summary, the Project will have no impact on third party groundwater users.

7.3 Aboriginal Heritage Sites

The Exmouth region is known for its Aboriginal heritage significance, particularly across the Cape Range where heritage sites are registered. Where Aboriginal heritage sites are associated with the occurrence of water i.e. waterholes, groundwater abstraction has the potential to adversely impact the water related site by reducing groundwater flow to the waterhole.

Figure 7-1 shows the location of all registered sites of aboriginal heritage within the vicinity of the Project. Reference to the figure shows that:

- The nearest heritage site with water significance is located about 3 km southwest of the new borefield. This site is described as a water-source site within the Cape Range, but the site has not been visited during the current investigations;
- One Registered Aboriginal heritage site, Vlamingh Head (DPLH site ID 10381 – ceremonial), is located immediately over the Lighthouse Holiday Park which includes the four existing bores on Lot 2, but does not include the seven new bores. This blanket site is described as being culturally sensitive containing sacred places of ceremonial and mythological significance. The actual locations of sites are not publicly available; and,
- In addition to a review of the registered sites, the Proponent also engaged an Aboriginal heritage survey of the investigation area in late 2019, comprising desktop and field study by representatives from the Gnulli Group. During the survey, one artifact site was recognised (but not formally registered) of which for, a mitigation plan was developed to avoid the site by clearing a new access track (**refer to Section 3**).

In summary, there are no heritage sites with water significance within the potential drawdown impact area around the borefield. The nearest site of water significance is 3 km away from the borefield and the Proponent has agreed to engage regularly with the Gnulli Group with respect to groundwater abstraction and protection of this site. The Proponent has implemented a management plan to avoid impact on one identified artifact site in the borefield area.

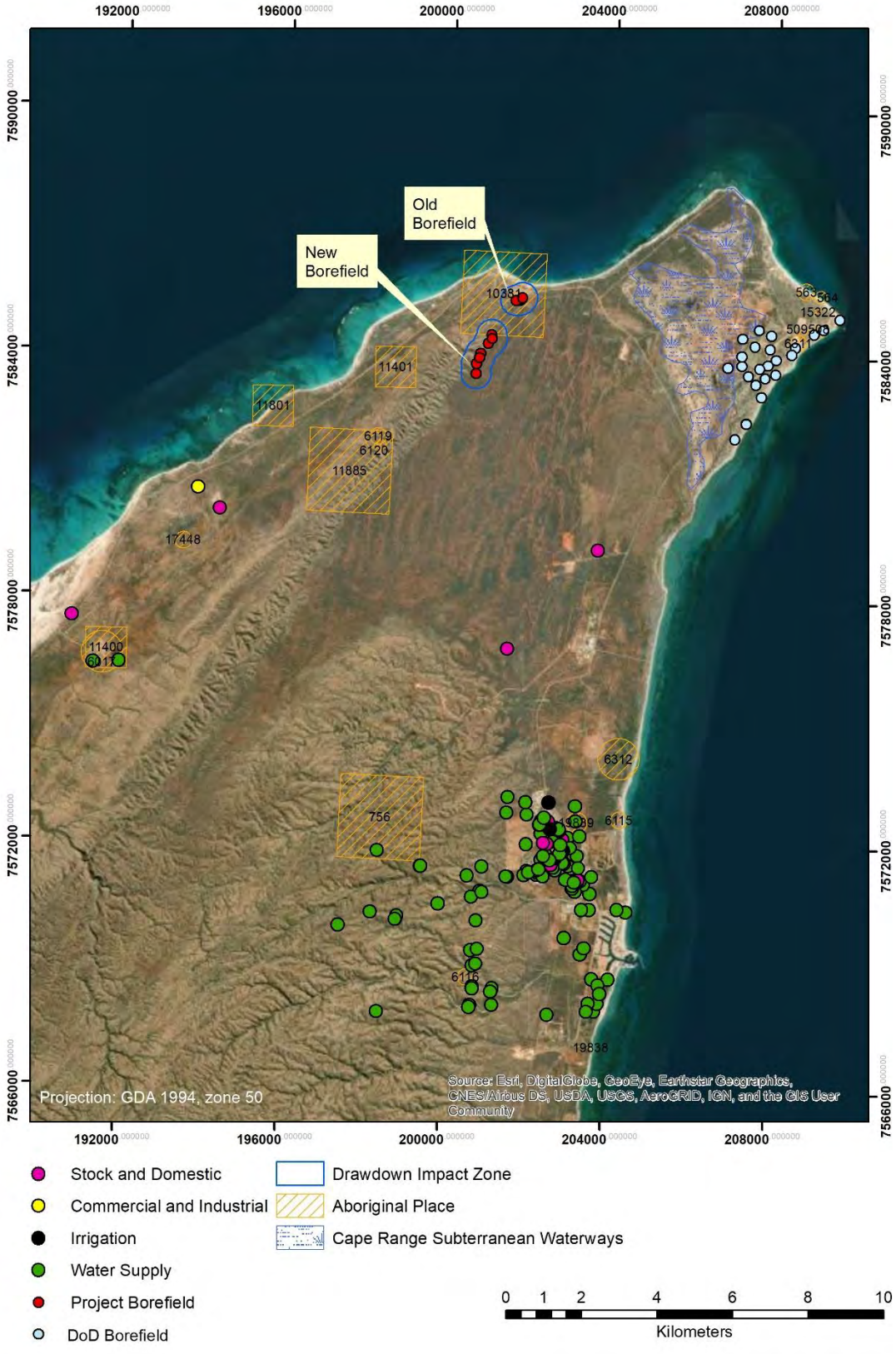

Figure 7-1: Project borefield with GDEs, other water bores and Aboriginal heritage sites

8. CONCLUSION

Northwest Resorts Pty Ltd (the **Proponent**) purchased the Ningaloo Lighthouse Holiday Park in late 2018 and is seeking to redevelop it into an eco-resort in 2021. The Proponent currently holds groundwater licence GWL153728 to take 32,000 kL/year from the Exmouth North Saline Resource but is seeking to increase the saline water allocation to 72,000 kL/year to produce 50,000 kL/year of potable water. The borefield would provide up to 259 kL/day during the peak tourist season (1 April to 31 October) and 108 kL/day during the low season (1 November to 31 March).

At the time of the purchase, Lighthouse had four (4) existing equipped water bores on Lot 2, plus was receiving makeup water from the Department of Defence. In August 2020 the Department of Water and Environmental Regulation granted the Proponent a 26D permit CAW204525(1) to explore and develop seven (7) additional water bores in the Work Area along the eastern edge of the Cape Range, so that the Project could become fully self-sufficient for water. The new bores were completed between August and September 2020 and as part of the hydrogeological investigations, all bores were pump tested for 48hrs at 0.5 L/s which water quality parameters were monitored during the tests.

The hydrogeological investigations reveal that the Tulki Limestone beneath the Property is a saline groundwater resource, with better quality brackish to saline groundwater (3,000 to 14,000 mg/L) at the water table, becoming more saline with depth. The highest measured salinity on the property was 24,000 mg/L from about 30 m below the water table, which is still less saline than seawater as measured at Exmouth during the program, being 33,200 mg/L. All bores are screened a few metres beneath the water table such that they skim only the better-quality groundwater from the top of the water table.

Seasonal borefield abstraction in the high season is likely cause groundwater salinity in the immediate borefield vicinity to increase marginally as better-quality groundwater is sipped from the water table. However, water quality would recover over the wetter season, when abstraction rates are minimal and when natural recharge over the Cape Range is at its highest.

Groundwater abstraction over the high season is likely to cause a maximum discernible drawdown impact extending up to 370 m from the borefield, with the highest drawdown in each production bore ranging from 0.4 to 0.6 m.

The perceived environmental and social impacts that could may arise from the expansion of the Project borefield are as follows:

- **Groundwater dependent ecosystems** - Bennelongia (environmental consultants) have been engaged to conduct a subterranean fauna study of the Project borefield, which will comprise a comprehensive desktop study and a field sampling program in accordance with the Environmental Protection Agency guidance documents. Sampling prior to this report has not been possible because the bores were only completed in late September 2020, and in line with EPA requirements, subterranean fauna sampling should ideally be undertaken 3 months post disturbance. Notwithstanding the above, the BoM database reveals the presence of the ‘Cape Range Subterranean Waterways’, located approximately 4 to 5 km northeast of the Project;

- **Other groundwater users** – the Project would have no impact on other groundwater users because there are no other users within the drawdown impact area; indeed, the nearest third-party bore is more than 5 km away from the Project; and
- **Aboriginal Heritage** – the Project would have no unacceptable impacts on aboriginal heritage values because there are no sites with water significance within the drawdown impact area; the nearest site of water significance is 3 km away and the Proponent has agreed to engage regularly with the Gnulli Group with respect to groundwater abstraction and protection of this site; and the Proponent has implemented a management plan to avoid impacts to one identified artifact site within in the borefield area.

Appendix A

Aboriginal Heritage Survey

Yamatji Marlpa
ABORIGINAL CORPORATION

KNOWLEDGE PARTNERSHIPS

Final report regarding the archaeological and ethnographic work program clearance heritage survey of the Ningaloo Lighthouse Holiday Park section 91 water bores undertaken by the Gnulli representatives and Yamatji Marlpa Aboriginal Corporation for Northwest Resorts

December 2019

Authors: Stephen Morgan and Sally McGann

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Spatial data and GIS

Geographic co-ordinates in this report were obtained using a hand-held Garmin Global Positioning System device. The manufacturer states that these devices are accurate to within +/- 5 m. Geographic co-ordinates in this report are based on the GDA 94 coordinate system, [Zone 50].

Contents

Tables

Maps

Plates

1 Acknowledgements

Yamatji Marlpa Aboriginal Corporation (YMAC) would like to thank the following people who helped prepare or participated in the archaeological and ethnographic heritage survey from 10 December to 13 December 2019.

Gnulli representatives	
Delton Dickerson	William Shea
Gavin Parfitt	Jermaine Baron
Robert Walgar	Gavin Walgar

Northwest Resorts representatives	
Damien Lafrentz	Horizon Heritage
Sam Rizzo	Minderoo Group
Don Scott	Pennington-Scott

Yamatji Marlpa Aboriginal Corporation representatives	
Stephen Morgan	Senior Anthropologist
Sally McGann	Archaeologist

Plate 1: Team photo L-R Robert Walgar, William Shea, Gavin Walgar, Gavin Parfitt, Jermaine Baron, Dalton Dickerson, Stephen Morgan.

2 Executive summary

This document provides Northwest Resorts (NWR) with the final results of the archaeological and ethnographic work program clearance (WPC) survey completed on the Gnulli native title claim (WC1997/028) between 10 December and 13 December 2019.

The survey was undertaken in response to the heritage notice of 30 October 2019 in which NWR requested an archaeological and ethnographic WPC heritage survey of their proposed section 91 water bores. The project area and the completion status at the end of the survey is summarised in table 1 below.

The survey was undertaken with the full involvement of the Gnulli representatives who are descendants of Aboriginal people from the Cape Range area. These representatives were nominated by the native title group based on the most current selection processes endorsed by the appropriate native title group committee.

Table 1: Project Areas

Name / ID	Size	Completion Status	Request
Water Bores	5.95 ha	Partially complete	Archaeological and anthropological work program clearance survey

2.1 Summary of results

- **Water Bores and the associated access track** as defined in the original request are **partially clear** for the stated works to proceed. The eastern end of the southern access track was truncated to end at Water Bore target number LH 001 at the request of the proponent and the northern end of the access track has been amended in order to avoid a heritage site. Map 3 depicts the cleared areas;
- **One** heritage place (Section 91 Water Bores Avoidance Area One) was identified;
- The Work Program Clearance level recording of Section 91 Water Bores Avoidance Area One is insufficient for the submission of a Heritage Information Submission Form (HISF) to DPLH.

The results of the archaeological and anthropological heritage survey are presented in section 7 and map 3. Detailed recommendations and heritage considerations are presented in section 8.

3 Introduction

NWR intends to use land contained within the Gnulli determination area (WC1997/028) for new water bores and an associated access track to draw groundwater to supply the Ningaloo Lighthouse Holiday Park.

To meet their obligations under the heritage agreement and the *Aboriginal Heritage Act 1972* (AHA), NWR contacted YMAC as the heritage service provider of the Gnulli native title group to request an archaeological and ethnographic WPC heritage survey over their proposed section 91 water bores project area.

The archaeological and anthropological heritage survey was conducted within Temporary Reserve TR 70/2614.

Map 1 below, generated with information provided by NWR, outlines the location of the survey areas.

Map 1: Section 91 water bores and access track

4 Desktop research

Prior to undertaking the fieldwork the heritage team completed desktop research of the proposed section 91 water bores. The spatial data was entered into the Department of Planning, Lands, and Heritage's (DPLH) Aboriginal Heritage Enquiry System (AHIS) to identify any Registered Aboriginal sites, other heritage places (OHPs), prior surveys and associated reports relevant to the project area. Where applicable, unpublished heritage reports and relevant academic resources were also consulted. These site files and reports were requested from the DPLH and reviewed prior to mobilisation. The summaries of these reports are presented in section 6 below.

Registered Aboriginal sites are sites that have been reported to the DPLH and assessed by the Aboriginal Cultural Materials Committee (ACMC) as meeting the criteria of a site under section 5 and section 39 of the AHA. These sites are added to the permanent register of Aboriginal sites.

There are two types of OHPs, lodged OHPs and 'not a site' OHPs:

- Lodged OHPs are sites that have been reported to the DPLH but have not yet been assessed by the ACMC. While they are pending assessment they are entered onto the temporary register and appear on the public database; and
- 'Not a site' OHPs are either sites that have met the criteria of the AHA but have been so disturbed that the heritage values are no longer present or places that have been assessed by the ACMC and were found not to meet the criteria of the AHA.

The AHIS search identified no Registered heritages sites or OHPs within the project area. There is one registered Aboriginal site *within the vicinity* of the water bores and associated access track (see map 2). Vlaming Head *(DPLH ID 10381)* is a place of sacred importance (Randolph *et al* 1986) that has a closed or obscured boundary on the DPLH public database because of cultural sensitivity. This site is linked to other sites of spiritual and ceremonial importance in the Cape Range National Park and as far south as Carnarvon.

The Cape Range area is an archaeologically rich region with over 35,000 years of human occupation (DPLH ID 6120 Pap Hill 2; Morse 1993:240; Przywolnik 1998). In the vicinity of the current survey area are a number of different site types. Shell middens have been located on the coast on the west side of the Cape and in the ranges are rock shelters with engravings, paintings, grinding patches and archaeologically significant deposit (Przywolnik 1998:4; Turner 1985:12). Larger sites are typically located in areas adjacent to a range of resources such as that found near freshwater creeks and mangrove communities, which provide both aquatic and terrestrial fauna (Murphy *et al* 1995:9). Fewer sites have been recorded on the eastern side of the peninsula but this may be the result of less systematic inspections on this side of the cape (Morse *et al* 1990:2).

In 1984 Morse and Kee conducted a survey for sites within the proposed Ningaloo Marine Park (Morse *et al* 1984) on the western margin of North West Cape. They identified 92 Aboriginal heritage sites and estimated that at least 80% of the sites are, or were, threatened by recreational use of the area (Morse 1984:1).

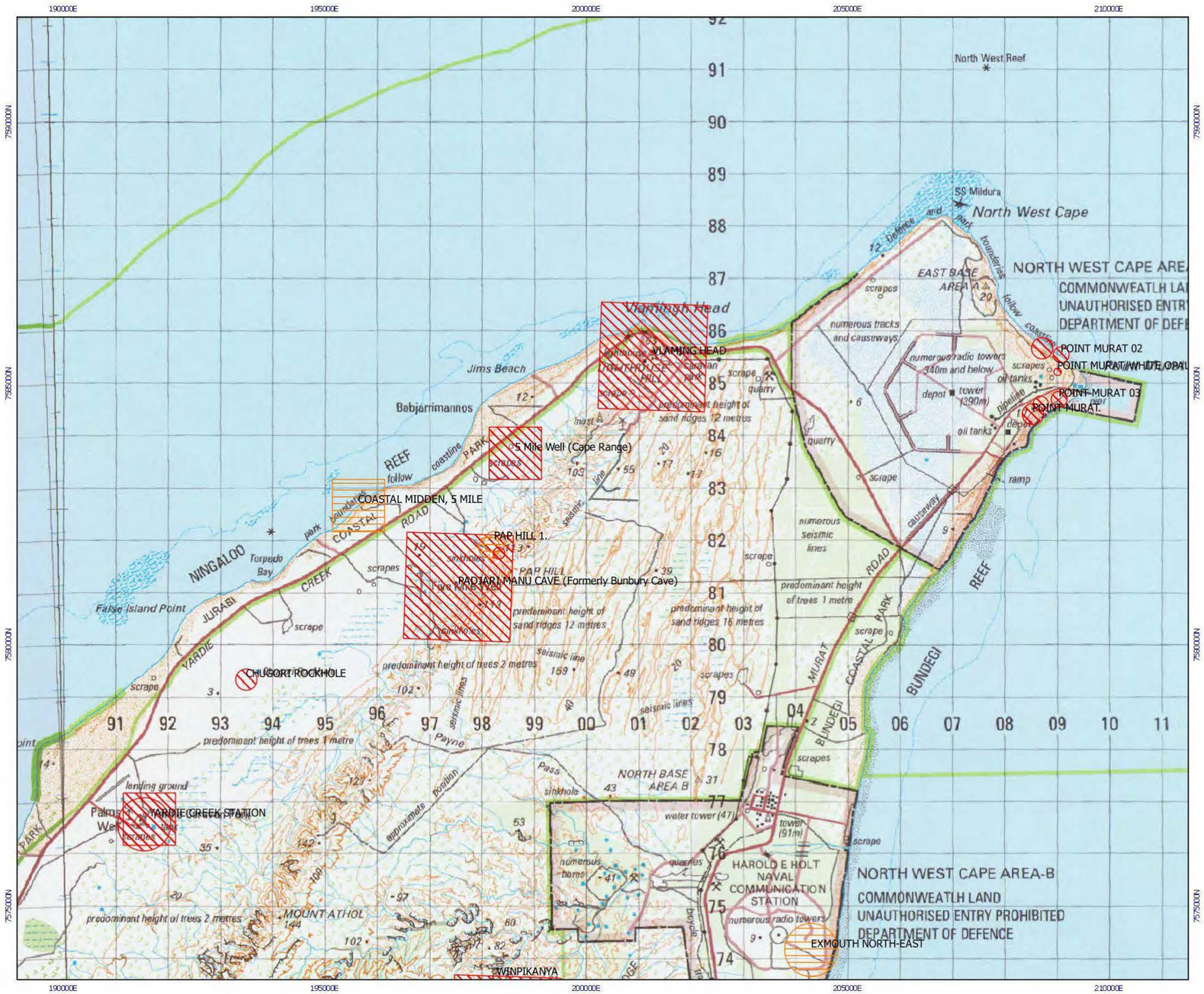
The site file for Vlaming Head (*DPLH ID 10381*) contains an ethnographic background relevant to the survey area and provides a deeper understanding of the cultural landscape. Prepared

by the consultant anthropologist Guy Wright (1990) the area of the proposal at Vlaming Head "is within the area identified by Tindale (1974) as the land traditionally occupied by the northern neighbors of the Baijungu linguistic unit. According to Tindale, the Baiyungu people inhabited an area roughly between Point Cloates and Quobba Point and inland to approximately Mia Mia. To their north were the Jinigudira and to the south the Maia. Probably during the latter portion of the 19th Century the Jinigudira were devastated by an epidemic likely introduced by pearlers and others working in the Exmouth Gulf area. (Jan) Turner (ref.1985) quotes an elderly man in 1985 from Onslow who described the sickness: "(It) began with the dogs, just like distemper, with shaking all over. Shake, Shake, they died. The Old People tried to nurse them and they died too. Whole families died. Skeletons everywhere Cardabia."

The epidemic undoubtedly affected the Baijungu, the direct neighbours of the Jinigudira. Cardabia Station where members of the Gnulli Native Title group reside is only a couple of kilometres from Coral Bay and there are seven burial sites between Gnaraloo Bay and Point Maud. A blowout on the southern side of Point Maud is locally referred to as "Skelly Beach."

Regardless of whether the human remains are the result of the sickness that decimated the local population in the 1800s or are considerably older, the sand dunes of the coast and Exmouth region have proved to be preferred burial places. The possibility of finding human remains in the vicinity of the project area would be reasonably high especially in the coastal dunes and sand ridges east of Cape Range. For obvious reasons, and in light of the tragic history of the area, the current generation of Aboriginal heritage custodians are keen to ensure that the resting places of their ancestors are left undisturbed.

Map 2: Recorded cultural heritage sites in the vicinity of Vlamingh Head.



Cultural Heritage Sites recorded with DPLH in the vicinity of Vlamingh Head

1:70,000 (A3)

0 0.5 1 1.5 2 2.5 km

Geographic Projection
Datum: GDA94

Produced by smcgann,
Yamatji Marlpa Aboriginal Corporation

Yamatji Marlpa
ABORIGINAL CORPORATION

Job Ref:
Produced at 04:09 PM on January 15, 2020

4.1 Summary of DPLH registered Aboriginal sites

4.1.1 Vlaming Head (DPLH site ID 10381- ceremonial)

The DPLH records this cultural place where Aboriginal people have attributed significant meaning to the limestone ridge of Cape Range which ends at its northern most point with Vlaming Head as it is known now. Aboriginal people called this place Padjari Manu after the name for the hill kangaroo Padjaru that inhabit its caves, rockshelters and waterholes. This sacred place is now a registered site under Section 5(b) of the Aboriginal Heritage Act.

The DPLH site boundary, which appears on the public database as a two kilometre square polygon, overlaps the Ningaloo Lighthouse Holiday Park but not the proposed bore field. However, the actual boundary is masked as the site is culturally sensitive.

A number of Aboriginal sites have been recorded within 10 kilometres of Vlaming Head including rockshelters at Pap Hill which have been dated to 35,320BP Przywolnik (1998) and a rockshelter Padjari Manu (formerly called Bunbury Cave) where a shell necklace was found Randolph (1985).

4.2 Summary of relevant heritage survey reports

4.2.1 DPLH report ID N/A – Anderson and Smith 2019

This is a report of heritage work for the University of Western Australia which included a consultation for an application under Regulation 10 of the AHA and a work program clearance survey of the Vlaming Head ceremonial site (*DPLH site # 10381*). Those consulted, including descendants of the original informants, reiterated the importance of the *DPLH ID 10381 Vlaming Head* site. They concluded that the UWA oceanographic monitoring stations are compatible with the spiritual substance of the site and provided support for the research.

4.2.2 DPLH report ID # 101900 - Przywolnik 1998

This is a report of an archaeological survey for an area of infrastructure, sewerage evaporation ponds specifically, that is directly related to the Ningaloo Lighthouse Holiday Park. It is also the survey conducted closest to the current project areas. The survey only covered an area of 300 m x 300 m but it is one of the few surveys conducted in the elevated sand plains in the centre of the peninsula and is therefore relevant to the current studies. Przywolnik reported that cultural material had been found in red dune deposits similar to that found in the project area, but that these were approximately 1.5 km to the north and closer to the resources of the coast.

Bush tucker such as desert walnuts and potato bush were noted in the survey area and along with acacia seeds had been found in archaeological sites on the Cape Range peninsula. She concluded that the inland areas appeared to have been used for gathering plant foods and hunting terrestrial fauna. One isolated artefact was found within the survey area.

4.2.3 DPLH report ID 17613 - Randolph and Wallam 1986

This is a report of a targeted assessment of specific sites at North West Cape. The authors relate information relevant to the spiritual values of *DPLH ID 10381 Vlaming Head* and other sites in the area. The report also provides recommendations for the management of the sites

in relation to tourists visiting the region. This consultation was not exhaustive by the standards of today and should be revisited before any of the recommendations are implemented.

4.2.4 DPLH report ID 102133 - Turner 1985

This report was prepared for the Aboriginal people of Carnarvon and Onslow and the Western Australian Museum. It outlines a survey for archaeological sites in the Cape Range National Park that were threatened by vehicle and human/tourist impact. Twelve sites were identified and recorded as a result of the fieldwork. The report contains historical renderings of rafts used in the Exmouth Gulf area by the inhabitants in the contact period. It also features a map of the peninsula depicting the Aboriginal names for places and water sources. *DPLH ID 10381 Vlaming Head* is described in the report and the relationship between the site and the cape ranges is explained.

5 Survey areas

The project area is located 17 km northwest of Exmouth at Vlamingh Head. It includes water bore targets and an associated access track. If successful the groundwater will be used to provide water for the proposed holiday park.

Spatial information reveals the cultural topography for the area is dominated by two landforms: sand ridges up to 12 metres high east of the limestone ridge called Cape Range. The general area also contains evidence of previous disturbance such as multiple access tracks, numerous bores, windmills and wells, small mines and sewerage treatment ponds for the holiday park.

5.1 Section 91 Water Bores and Access Track

The proposed bore field is approximately two km south of the existing holiday park and access is gained to the area via a surviving dirt track. It is intended that this track and the proposed tracks linking the individual bore targets will be upgraded prior to the drilling project. Although it appears that the drill targets on the east west lines are on previously existing tracks, these alignments are overgrown and poorly defined. The north south running track is in better condition and was easily navigated in 4WD vehicles.

Seven drill targets and 2.77 km of vehicle track comprised the planned water bore survey. The proposed track upgrade corridor as defined is 20 m wide and is centred on the existing alignments. During the survey the eastern end of the southern access track was truncated to end at Water Bore target number LH 001 at the request of the proponent. Prior to the survey each bore target was given a 20 m radius to allow for clearing and the establishment of a drill pad but this radius was increased to 25 metres following a discussion on site regarding the drilling process.

The proposed water bores are located on the Tulki limestone above an aquifer from which NWR intend to draw groundwater. This fresh groundwater is thickest or deepest towards the centre of the peninsula and in order to gain access to this level of water the bores are located inland. In these areas the surface of the landscape consists of red dunes and elevated sandplains. To the west are the limestone ranges and the nearest stretch of coastline is adjacent to the holiday park, 2.5 km to the north. The vegetation consists of spinifex (*triodia sp*), shrubs and small trees (*Banksia sp*).

Plate 2: Looking east along the southern water bore access track.

6 Survey methodology

On the first day of the heritage survey the heritage team facilitated a detailed pre-survey brief. During the brief the heritage team discussed the scope of works, proposed use of the land, and the WPC heritage survey methodologies. The Gnulli representatives had the opportunity to discuss, contribute to, and comment upon the proposed survey methodology and gave their consent to the WPC methodology. Field briefings were completed every morning to ensure ongoing consent and engagement with the project.

At the end of the fieldwork program the heritage team facilitated a debrief meeting. During the debrief meeting the team discussed the results of the survey, sought feedback, and collected recommendations and considerations for the sites and project area from the Gnulli.

WORK PROGRAM CLEARANCE

The archaeological and anthropological heritage survey within the **water bore target areas and access track** was undertaken to a work program clearance heritage standard. These types of survey usually occur in the very early stages of project planning and exploration. WPC surveys occur when the proponent has identified the preferred location of the work program, usually a drill program. When heritage places are identified they are given a boundary and delineated as not clear. The consultant will then endeavour to provide an appropriate deviation around the site to allow the work program to continue.

The minimum recording standards for YMAC WPC surveys are:

- Pedestrian transects at a spacing of no greater than 20 m;
- If spacing of greater than 20 m is required for safety reasons, this must be discussed with and agreed to by the Traditional Owner representatives. It is expected that this will be noted in the report where it occurs along with an explanation of why the increased spacing was deemed necessary, accompanying photographs of the terrain and the names of the Traditional Owner representatives that endorsed the change of methodology;
- Recording of outer lines or central lines using tracks on hand held global positioning system (GPS) devices with a minimum accuracy of +/- 5 m;
- The conduct of intensively spaced pedestrian transects to determine the extent of heritage values of any identified sites;
- Accurate delineation of a boundary with a suitable buffer to account for GPS accuracy;
- On WPC surveys a deviation may be required by the proponent, these should provide a sufficient buffer around any heritage places;
- Flagging of the boundary using pink and black heritage tape. Please note that some Traditional Owner representatives may request that sites are not flagged to reduce visibility and potential visitation by non-authorised persons. In this instance, the wishes of the Traditional Owner representatives supersede this standard;
- Recording of survey progress by archaeologist / anthropologist using a field notebook; and
- An appropriate photographic record of the survey.

6.1 Archaeological survey

Water bore target areas and access track

All of the survey areas were subject to a pedestrian inspection using a hand held GPS unit (Garmin GPS Map Datum WGS84 Zone 50) to follow the spatial data provided by the proponent. The access track survey corridor is 20 m wide and the entirety of this corridor was walked by the archaeologist and between two and six Gnulli representatives. Because there is an existing track that will be upgraded, the survey team flanked this alignment.

Each of the seven water bore target sites were inspected as part of the track survey. When the party reached a water bore pad the individuals spread out to cover the 50 m wide area.

6.2 Anthropological survey

During the archaeological component of the survey, the YMAC anthropological consultant participated and observed the Gnulli participants walking transects and locating artefactual material. The anthropologist discussed and recorded ethnographic comment and observations in a field notebook at the respective project areas and potential impact of proposed DBCA works with the Gnulli participants. This information and data was later analysed and conclusions drawn to formulate appropriate recommendations for cultural heritage management. Maps of the survey area were made available to the Gnulli participants during the fieldwork as an aid to contextualise the surrounding cultural landscapes. Spatial data of survey tracks and waypoints was captured in the field using a handheld Garmin GPS map 60Cx unit and the field action was captured with a Lumix digital camera.

On the 11th December 2019 Gnulli participants travelled with the YMAC consultants and met NWR representatives at the existing Ningaloo Lighthouse Holiday Park. The survey team consisted of six Gnulli participants, two YMAC heritage consultants and three proponent representatives. After a discussion of the proposed developments the group decided that the heritage survey would commence with the visit to the proposed bore field area. The YMAC anthropologist participated in the archaeological survey walking over the bore field project area discussing cultural issues with the Gnulli participants.

The survey team travelled in 4WD vehicles along existing tracks south of the holiday park to the location of proposed bore drill pad LH003 where the survey team inspected the access to LH001 approximately 700 metres east. There were no finds of artefactual material and no cultural issues were raised by the Gnulli participants. The survey team travelled north along the existing tracks to inspect the remaining four drill pads and access with similar findings except where artefactual material was found at Section 91 Water Bores Avoidance Area One.

Plate 3: Looking west at Section 91 Water Bores Avoidance Area One

This cultural material will be avoided by deviating the access track to the east. There was general ethnographic comment made about the effect of drilling into the water below the surface and the potential impact on nearby water-sources traditionally used by Aboriginal people. Concerns were raised in May 2019 by YMAC that pumping of groundwater may adversely impact water holes 3km south-west of the borefield (ref. Technical Memorandum 2019). The memo authors concluded that the pumping rates would be too low to affect water holes on the other side of the ridge. Further concerns were raised by the Gnulli participants about unauthorised camping and trespass which has left campsite fireplaces and rubbish in the area.

The survey concluded with a discussion about the proposed development and its potential impact on the cultural heritage values of Vlaming Head. The Gnulli representatives stated that the Baiyungu have an obligation and a right under native title and heritage to be respected and recognized as the custodians of this place and story and wish to work together with proponents and visitors to protect and care for this place, raise awareness of Inagudura culture and control unauthorised access that might damage the place and upset the ancestors. The Gnulli representatives commented that these same ancestors protected and cared for the survivors of the shipwrecked barque, Stefano in 1875 and guided them back to their community.

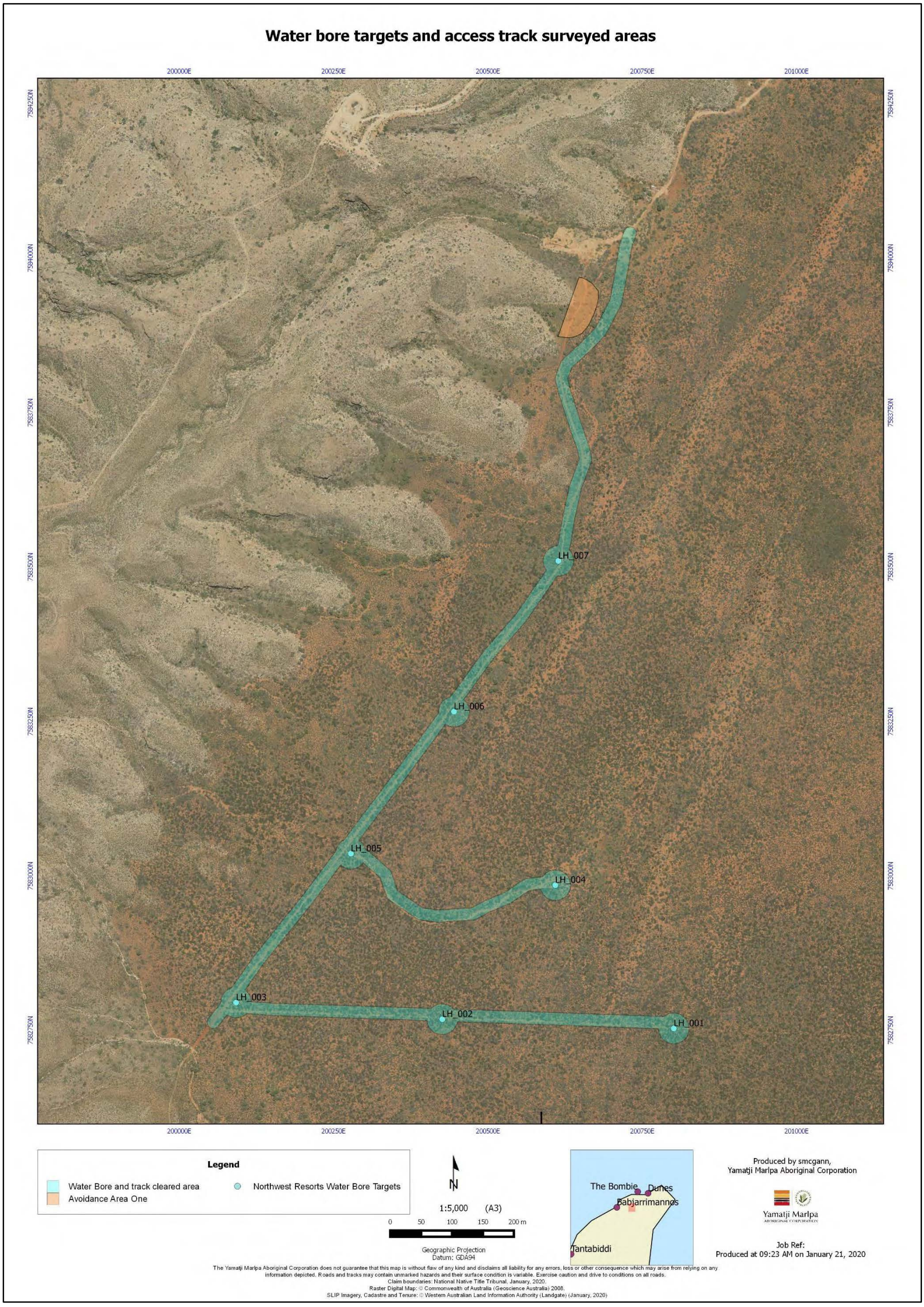
7 Results

This section details the final results of the archaeological and ethnographic heritage survey and consultation of the proposed section 91 water bores for NWR. The results are summarised in Table 2 and Map 3 below. The spatial data has been provided with the preliminary advice. A summary of the heritage place recorded to WPC standard is presented below.

Table 2: Summary of results from GNU680-1 water bores and access track survey.

Scope # / Name	Completion status	Heritage places / areas	DPLH Registered Aboriginal sites	DPLH other heritage places	Newly identified Aboriginal sites
Water Bores	Partially complete	One not clear area	N/A	N/A	Section 91 Water Bores Avoidance Area One

Map 3: Water bore targets and access track surveyed areas.



7.1 Newly identified heritage sites

One cultural heritage site was identified within the proposed section 91 water bores access alignment and was recorded to WPC level. An alternate alignment for the proposed water bore track was defined in order to avoid and protect the area of cultural material. The alternate route was placed to avoid both the site and a longitudinal sand dune to the east. It reconnects to the northern end of the proposed alignment within a disturbed quarry area.

7.1.1 Section 91 Water Bores Avoidance Area One – artefact scatter

This is a scatter of stone artefacts that was revealed in a section of the existing track. It is located at the northern end of the proposed alignment where the track skirts the eastern end of the ranges. North of this the track descends into the existing quarry area.

Site boundary

The site boundary was defined to encompass all visible artefacts within the track area and on the undisturbed sand plain above. A suitable buffer to account for GPS accuracy was included on the southern, northern and eastern sides. The western boundary of the site was not assessed during this survey and it is assumed that it extends into the limestone range and the drainage valley beyond the area currently defined for the scatter. This section of the border is depicted as a straight line and is not indicative of a proved boundary. As it is delineated the boundary will be sufficient as the current activity will be within the existing access track and to the east of the site. If any work is proposed to the west of the site the boundary will have to be revisited as it is possible that it extends westward into the ranges.

Environmental context

The cultural material is situated at the southern margin of the entrance to a drainage valley within the ranges. This is a well-defined drainage line that cuts through the ranges and empties onto the sandplain at this point. It is probable that the water descending through this valley runs onto the track and has created the washout where the cultural material was identified. In this section of the track the soil has washed away revealing limestone from the ranges beneath.

The area immediately surrounding this section of the track appears to be better watered as there are more trees, including *Eucalypt* species, than on the surrounding sand plain. Spinifex dominates the vegetation on the plain between the ranges and the sand dune to the east.

Description

The scatter consists of quartzite and silcrete flakes and one rotated quartzite core. None of the flakes are primary flakes although most are broken, which may be due to damage from vehicles using the track. The highest density encountered during recording was three artefacts per square metre, although this was within the track and it is possible that the concentration was due to damage from vehicles and water scouring. One transversally broken flake was found on the plain above the track but it is possible that there are more present that are obscured by vegetation.

These are the remains of an occupation site located near the resources of both the ranges and the plain and the water that drains seasonally through the valley. Freshwater would have

drained past the site during the wet season and game and plant resources (see Przywolnik 1998:9) would have been available in both the ranges above and on the plain to the east.

On the western coastal side of the ranges, larger sites are typically found in areas adjacent to freshwater creeks and the resources of the mangrove communities (Murphy *et al* 1995:9). On the eastern side of the ranges fewer sites have been recorded and this could be due to less resources available on the plain but may also be the result of less surveys conducted in this area (Morse *et al* 1990:2). Certainly during this survey no cultural material was encountered on the plains and dunes to the east of the ranges.

Site condition

The site is bisected by an existing track, which has cut into the sand plain and attracted water erosion from seasonal rainfall draining from the ranges. This disturbance has had an impact on a section of the site, but not all of it, and has served to reveal or deposit some artefacts that might have been obscured by sediment. The track is in current use for access to the bore field and other areas to the south.

As a result of this recording, NWR plan to move the alignment of the track to the east to avoid the site. If this occurs and the new alignment becomes the preferred track then the sand plain and vegetation should reclaim the area of the site that is within the track. To this end it would be preferable that access to this section of the track is blocked with windrows or similar, and only the new track be used. The area of the track within the site should not be subject to rehabilitation efforts as this will cause more disturbance.

Importance and significance

Section 91 Water Bores Avoidance Area One is important and significant under section 39(2b) of the AHA. The Gnulli representatives present during the recording of the site were adamant that the site be protected as evidence of the activities of their ancestors. Gavin Parfitt and William Shea were walking the transect that intersected with the site and identified the first artefacts. These were thought to be isolated but it transpired that the artefacts are part of a larger scatter. Gavin was concerned that measures are implemented for the protection of the site and Dalton Dickerson expressed concern that potential sub surface deposits surrounding the track be preserved.

Section 91 Water Bores Avoidance Area One is important and significant under section 39(2c). Artefact scatters are a relatively common site type within the Exmouth region. Of the Registered sites identified within the Shire of Exmouth 20% are artefact scatters and a further 59% of the recorded sites have an artefact scatter component. The majority of these sites, however, have been recorded within the ranges or on the west side of the peninsula adjacent to the resources of the coast (Morse *et al* 1984:8; Murphy *et al* 1995:9; Morse *et al* 1990:2). The presence of a habitation site within an area that is not in proximity to the coast and is not within the ranges, has the potential to answer questions about the past use of the plain within the cape area (Przywolnik 1998:9).

Plate 4: Looking north toward Section 91 Water Bores Avoidance Area One.

Plate 5: Looking south over the track through Section 91 Water Bores Avoidance Area One. A limestone base is visible in the lower surface of the track.

Plate 6: Section 91 Water Bores Avoidance Area One artefact one

Plate 7: Section 91 Water Bores Avoidance Area One artefact two

Plate 8: Section 91 Water Bores Avoidance Area One artefact three

7.2 Reassessed heritage sites

One previously recorded heritage site was the subject of the ethnographic consultation. *ID 10381 Vlaming Head* is not within the Section 91 area but those consulted were concerned about indirect disturbance to the site from the water bores.

7.2.1 ID 10381 Vlaming Head – site of sacred, ceremonial and ritual importance

During the survey the Gnulli representatives reiterated the spiritual significance of Vlaming Head and the protective powers of the place. Vlaming Head is where the northernmost tip of the ranges reaches the ocean. Access to power is gained at this location to protect the cape region from cyclones and related disasters.

The continuing expression of this story is very important to the surrounding cultural landscape, the Gnulli people and to their culture. Given the extreme power attributed to the site at Vlaming Head, fears are held by the representatives for the safety of the area and their people if the importance of the site is not observed. As the groundwater is important in the sacred narratives, the Gnulli representatives raised concerns regarding the drawing of water from bores on the Cape

The Gnulli representatives stated that the Baiyungu have an obligation and a right under Aboriginal traditional law to be respected and recognized as the custodians of this place and mythological story and wish to work together with visitors to protect and care for this place,

raise awareness of Inagudura culture and control unauthorised access that might damage the place and upset the ancestors.

7.3 Summary of Surveys

- **One** heritage place (Section 91 Water Bores Avoidance Area One) was identified;
- **One** Registered heritage site (*DPLH ID 10381 Vlaming Head*) was reassessed and found to have continuing cultural significance for the Baiyungu people;
- Given the importance of the groundwater in the sacred narratives of the region, the Gnulli representatives raised concerns regarding the drawing of water from bores on the Cape;
- Gnulli representatives requested that the proponent meet with elders and senior members of the (soon to be formalised) Baiyungu Prescribed Body Corporate (PBC) who were unable to attend the heritage survey to discuss mitigative strategies and the ongoing relationship with the relevant native title holders.

8 Recommendations and considerations

An archaeological and ethnographic WPC heritage survey of the proposed section 91 water bores for NWR is now complete. The proposed works are partially cleared to proceed subject to the following **recommendations**:

1. **One** heritage place, *Section 91 Water Bores Avoidance Area One*, was identified within the **water bore access track survey area** and a deviation to avoid the site was identified and inspected for cultural material;
2. The work program clearance level recording of *Section 91 Water Bores Avoidance Area One* is insufficient for the submission of an HISF to DPLH.
3. **It is advised** that if human remains, skeletal materials that may be human, or materials that may belong to a human grave are discovered during activity within the cleared survey areas, NWR must follow the DPLH procedures and stop work immediately, and the materials and the area around them must be left undisturbed. The Western Australian Police must be informed immediately as well as Gnulli traditional owners, through their representative, YMAC, as soon as practicable.
4. **It is recommended** that NWR employees and contractors executing the proposed works be informed of the contents of this report and their obligations under the AHA.
5. **It is recommended** that NWR maintain discussions with the Gnulli people, regarding any future matters that may arise in relation to the areas surveyed, including any further proposed excavation or ground disturbance activities or access to uncleared proximate areas.

The following concerns were also raised during the heritage survey:

- The Gnulli representatives raised concerns regarding the drawing of water from bores on the Cape and would prefer that NWR implements a desalination process for their water use at the site.

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DPLH site files

DPLH SITE ID 10381 Vlaming Head

Appendix 1 – acronyms

Acronym	Description
ACMC	The Aboriginal Cultural Materials Committee.
AHA	The *Aboriginal Heritage Act 1972*.
AHIS	The Aboriginal Heritage Inquiry System. The AHIS is used to search the DPLH's Register of Aboriginal Sites which records the location and other information concerning registered Aboriginal sites and other heritage places that have been reported to the DPLH.
DPLH	The Department of Planning Lands and Heritage.
GIS	Geographical Information systems.
Gnulli representatives	Representatives of the Gnulli native title claimants / holders. These representatives are selected by the native title group via the most up to date selection process endorsed by the relevant committee of the Gnulli.
Heritage survey	A survey undertaken by representatives of the native title group in conjunction with suitably qualified heritage professionals (e.g. archaeologists and / or anthropologists), for the purpose of identifying and recording heritage sites and areas within a defined project area.
ILUA	Indigenous Land Use Agreement.
LAA	Land Access Agreement.
OHPs	Other heritage places. There are two types of OHPS, lodged OHPs and 'not a site' OHPs lodged OHPS are sites that have been reported to the DPLH but have not yet been assessed by the ACMC. While they are pending assessment they are entered onto the temporary register. 'Not a site' OHPs are sites which have been submitted to the DPLH and assessed by the ACMC as not meeting the criteria of a site under the AHA.
NWR	Northwest Resorts
SID	Site Identification.
WAC	Work area clearance.
WPC	Work program clearance.
YMAC	Yamatji Marlpa Aboriginal Corporation.

Appendix B

Ecological Flora and Fauna Survey

Name:	Daniel Griffin	Date:	19 June 2020
Company:	Minderoo	Job/Doc. No.:	JBS&G58909-130,188
Email:	dgriffin@mindaroo.com.au	Inquiries:	Tristan Sleigh

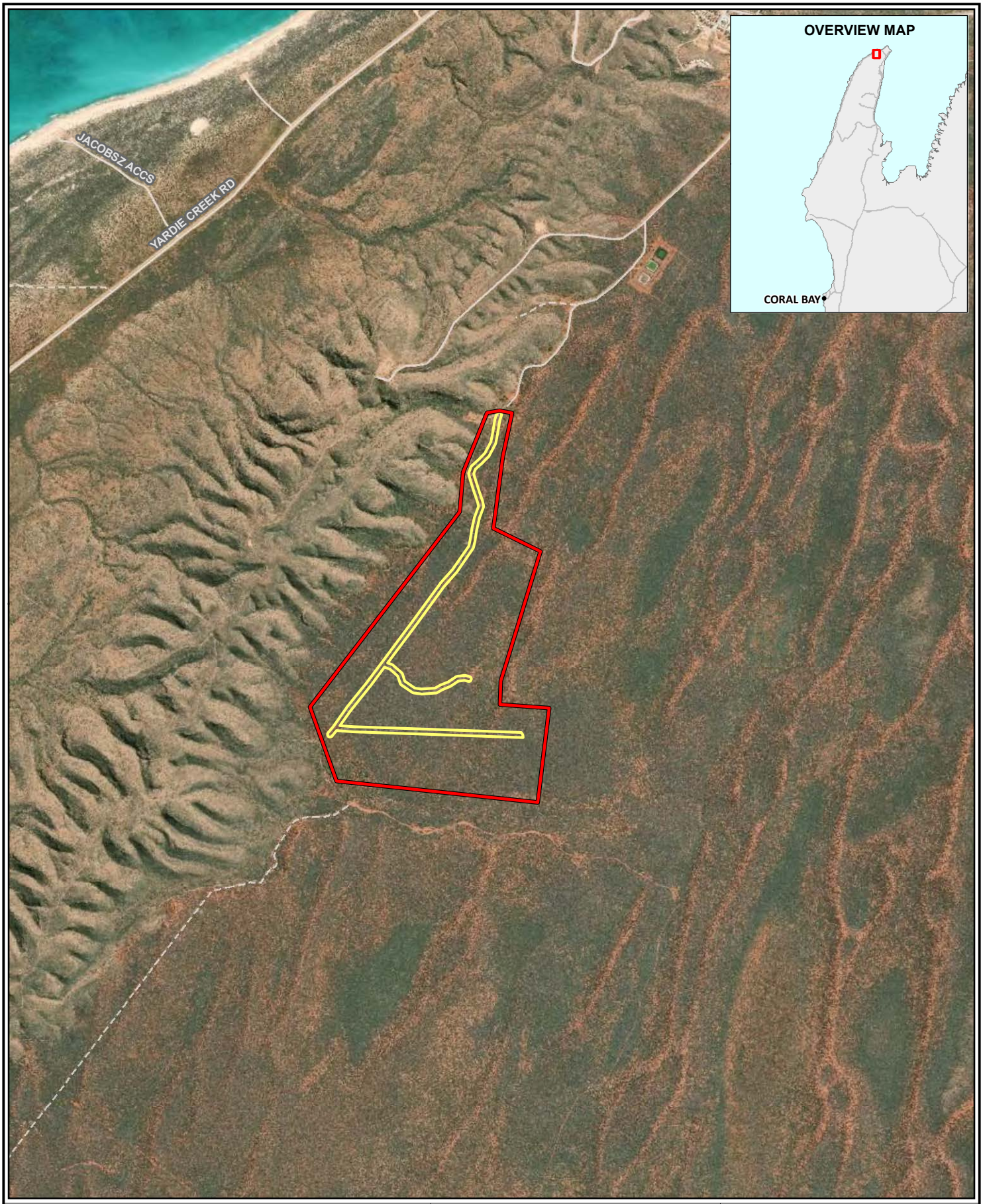
Exmouth Lighthouse Resort Borefield – Ecological Survey Report

1. Introduction and Scope

North West Resorts Pty Ltd (the Client) are progressing their development of the Exmouth Lighthouse Resort. To support this development, a borefield is required to be constructed. To enable the construction, vegetation clearing is required for both the bore sites and access tracks.

The Client has engaged Strategen JBS&G to undertake a flora and vegetation survey within the proposed borefield area (Figure 1). Specifically, the outcomes of the work will to support the Native Vegetation Clearing Permit Application to be submitted under Part V of the Environmental Protection Act 1986 (EP Act).

This memorandum presents the findings of the ecological survey.



Legend

- Survey area
- Proposed clearing area
- Minor road
- Track

Scale 1:20,000 at A4 (0 200 400 metres)		**Lighthouse Resort Exmouth**
Coord. Sys. GDA 1994 MGA Zone 50		**SURVEY AREA**
Job No: 58909		
Client: Minderoo		**FIGURE 1**
Version: A	Date: 16-Jun-2020	strategen JBS&G
Drawn By: cthatcher	Checked By: TS	

File Name: \\008pmpmr004v001.jbsg.aust\JBS Perth\Projects\1)Open\Minderoo\58909 Exmouth Lighthouse Resort F+V Survey\GIS\Maps\M01_Rev_A\58909_01_SurveyArea.mxd
Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

2. Context

2.1 Legislative context

Flora and fauna in WA are protected formally and informally by various legislative measures, which are as follows:

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) – Australian Government
- Biodiversity Conservation Act 2016 (BC Act) – State
- Environmental Protection Act 1986 (EP Act) – State
- Biosecurity and Agriculture Management Act 2007 (BAM Act) – State.

A short description of each legislative measure is given below.

2.1.1 EPBC Act

The EPBC Act aims to protect Matters of National Environmental Significance (MNES). Under the EPBC Act, the Commonwealth Department of the Environment and Energy (DEE) lists protected species and Threatened Ecological Communities (TECs) by criteria set out in the Act. Species are conservation significant if they are listed as Threatened (i.e. Critically Endangered, Endangered and Vulnerable) or Migratory.

2.1.2 BC Act

DBCA lists taxa (flora and fauna) under the provisions of the BC Act as protected and are classified as according to their need for protection. The BC Act makes it an offence to 'take' threatened species without an appropriate licence. There are financial penalties for contravening the BC Act.

2.1.3 EP Act

Threatened flora, fauna (and significant habitat necessary for the maintenance of indigenous fauna) and Threatened Ecological Communities (TECs) are given special consideration in environmental impact assessments and have special status as Environmentally Sensitive Areas (ESAs) under the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Exemptions for a clearing permit do not apply in an ESA.

2.1.4 BAM Act

The BAM Act provides for management and control of listed organisms, including introduced flora species (weeds). Species listed as declared pests under the BAM Act are classified under three categories:

- C1 Exclusion: Pests assigned under this category are not established in Western Australia, and control measures are to be taken to prevent them entering and establishing in the State.
- C2 Eradication: Pests assigned under this category are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
- C3 Management: Pests assigned under this category are established in Western Australia, but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area that is currently free of that pest.

Under the BAM Act, land managers are required to manage populations of declared pests as outlined under the relevant category.

3. Survey Methods

3.1 Desktop assessment

Database searches were undertaken to produce a list of vascular flora, vertebrate fauna, and Threatened and Priority ecological communities previously recorded within, and nearby the Survey Area – with an emphasis on species and communities of conservation significance and introduced species (Table 1). Database searches were conducted within a 40km buffer of the Survey Area to ensure an accurate representation of the surrounding ecosystem was captured.

Table 1: Database searches conducted for the desktop assessment

Custodian	Database	Taxonomic group	Buffer
DBCA	NatureMap	Flora and Fauna	40km
DAWE	Protected Matters Search Report	Flora and Fauna, Ecological Communities	40km
DBCA	Threatened and Priority Flora	Flora	40km
DBCA	Threatened and Priority Ecological Communities	Ecological Communities	40km

3.2 Field assessment

3.2.1 Flora and vegetation

The field survey of the Exmouth Lighthouse Resort Borefield was conducted by one ecologist from Strategen JBS&G on 13 June 2020. The survey was conducted in accordance with guidelines provided in *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessmen*t (EPA 2016) and is suitable to support native vegetation clearing permits.

A reconnaissance flora and vegetation survey was conducted across the site, with a targeted flora survey within areas likely to support conservation significant flora species.

Flora and vegetation was described and sampled systematically at each survey site (relevé) and additional opportunistic collecting were undertaken wherever previously unrecorded plants were observed. At each site, the following floristic and environmental parameters was noted:

- GPS location.
- Topography.
- Soil type and colour.
- Outcropping rocks and their type.
- Percentage cover and average height of each vegetation stratum.

For each vascular plant species, the average height, number of plants and percent cover was recorded. Between relevé locations, opportunistic observations were also recorded. These observations included:

- Changes in vegetation structure and composition.
- Changes in vegetation condition.
- Taxa not previously recorded.
- Flora of conservation significance.
- Significant weed populations.

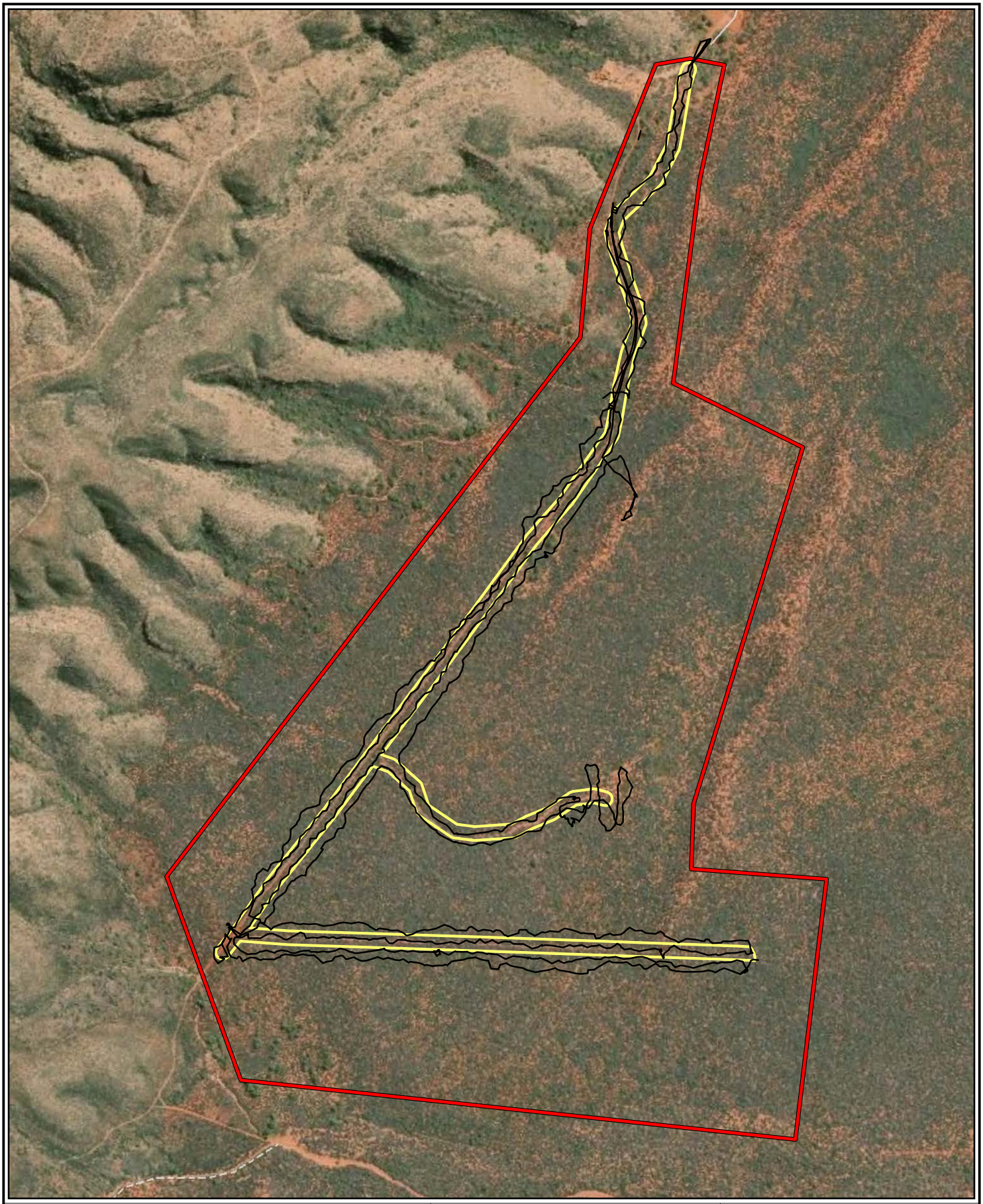
All plant specimens collected during the field surveys were identified using appropriate reference material or through comparisons with pressed specimens housed at the Western Australian

Herbarium where necessary. Nomenclature of the species recorded is in accordance with Western Australian Herbarium (1998-).

Data was grouped into a species by site matrix to delineate individual vegetation types (VTs) present within the survey area. Aerial photography interpretation and field notes taken during the survey will then be used to develop VT mapping polygon boundaries over the survey area. These polygon boundaries will then be digitised using Geographic Information System (GIS) software.

Vegetation condition was recorded at all quadrats, and also opportunistically within the survey area during the field assessment where required. Vegetation condition was described based on the scale developed by Trudgen (1988) and modified and adapted as presented in the Technical Guidance (EPA 2016). Vegetation condition polygon boundaries were developed using this information in conjunction with aerial photography interpretation and digitised as for vegetation type mapping polygon boundaries.

The targeted survey traversed habitat within and adjacent to the clearing application area with potential to support conservation significant flora species. Any conservation species identified were recorded population density and extent mapped. Tracks recorded during the survey are shown in Figure 2.



Legend

- Survey area
- Proposed clearing area
- Survey tracks
- Minor road
- Track

Scale 1:7,250 at A4

0 50 100
metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58909

Client: Minderoo

Version: A | Date: 16-Jun-2020

Drawn By: cthatcher | Checked By: TS

Lighthouse Resort Exmouth

SURVEY EFFORT

FIGURE 6

strategen JBS&G

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Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

4. Results

4.1 Desktop Assessment

4.1.1 Landsystems

The project area occurs within the Range System and can be described as 'Dissected limestone plateaux, hills and ridges with gorges and steep stony slopes supporting hard spinifex, sparse shrubs and eucalypts.'

4.1.2 Vegetation

Vegetation occurring within the region was initially mapped at a broad scale (1: 1 000 000) by Beard during the 1970s. This dataset formed the basis of several regional mapping systems, including the biogeographical region dataset (Interim Biogeographic Regionalisation for Australia) for Western Australia (Department of the Environment and Energy, 2017), physiographic regions defined by Beard (1981).

4.1.2.1 Beard (1990) Botanical Subdistrict

The Survey Area occurs within the Carnarvon Botanical District of the Eremaean Province which is characterised by Acacia scrub and low woodland moving to tree and shrub steppe in the north (Beard 1990).

4.1.2.2 IBRA subregion

IBRA describes a system of 89 'biogeographic regions' (bioregions) and 419 subregions covering the entirety of the Australian continent (DEE 2017). Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna.

The Survey Area occurs within the Cape Range IBRA subregion which within the project area is dominated by Acacia shrublands over Triodia on limestone (*Acacia stuartii* or A. *bivenosa*) and red dune fields (Kendrick and Mau 2002).

4.1.2.3 Vegetation association mapping

The Survey Area comprises one vegetation association (Shepheard et al. 2001). Percentage remaining of the vegetation association is provided in Table 2 (GoWA 2019a). Within the local area (10km radius), 71% of the pre-European vegetation extent remains. This excludes native vegetation still present contained within areas of Commonwealth Land.

Table 2: Vegetation associations within the Survey Area

Vegetation Association	Description	Current Extent	Percent remaining in IBRA Region	Percent remaining within local area (10km)
662	Hummock grassland; shrub steppe; mixed acacia scrub & dwarf scrub with soft spinifex & *Triodia basedowii*	282,125.59	99.64%	95%

4.1.2.4 Threatened and Priority Ecological Communities

Searches of the EPBC Act PMST and the DBCA TEC/PEC databases identified one TEC within the project footprint, the Camerons Cave Troglobitic Community listed as a Critically Endangered TEC by DBCA.

Camerons Cave troglobitic community (obligatory cave inhabitants) is known only from Camerons Cave on the Cape Range peninsula. The community contains a unique assemblage of species, at least eight of which are known only from this location. Based on potential habitat, this community highly unlikely to occur within the project area.

4.1.3 Flora

A desktop survey for Threatened and Priority flora that may potentially occur within the Survey Area was undertaken using NatureMap (Parks and Wildlife 2007-), the Western Australian Herbarium (Western Australian Herbarium 1998-), and the DAWE Protected Matters Search Tool (DEE 2017c) (Figure 3; Attachment A).

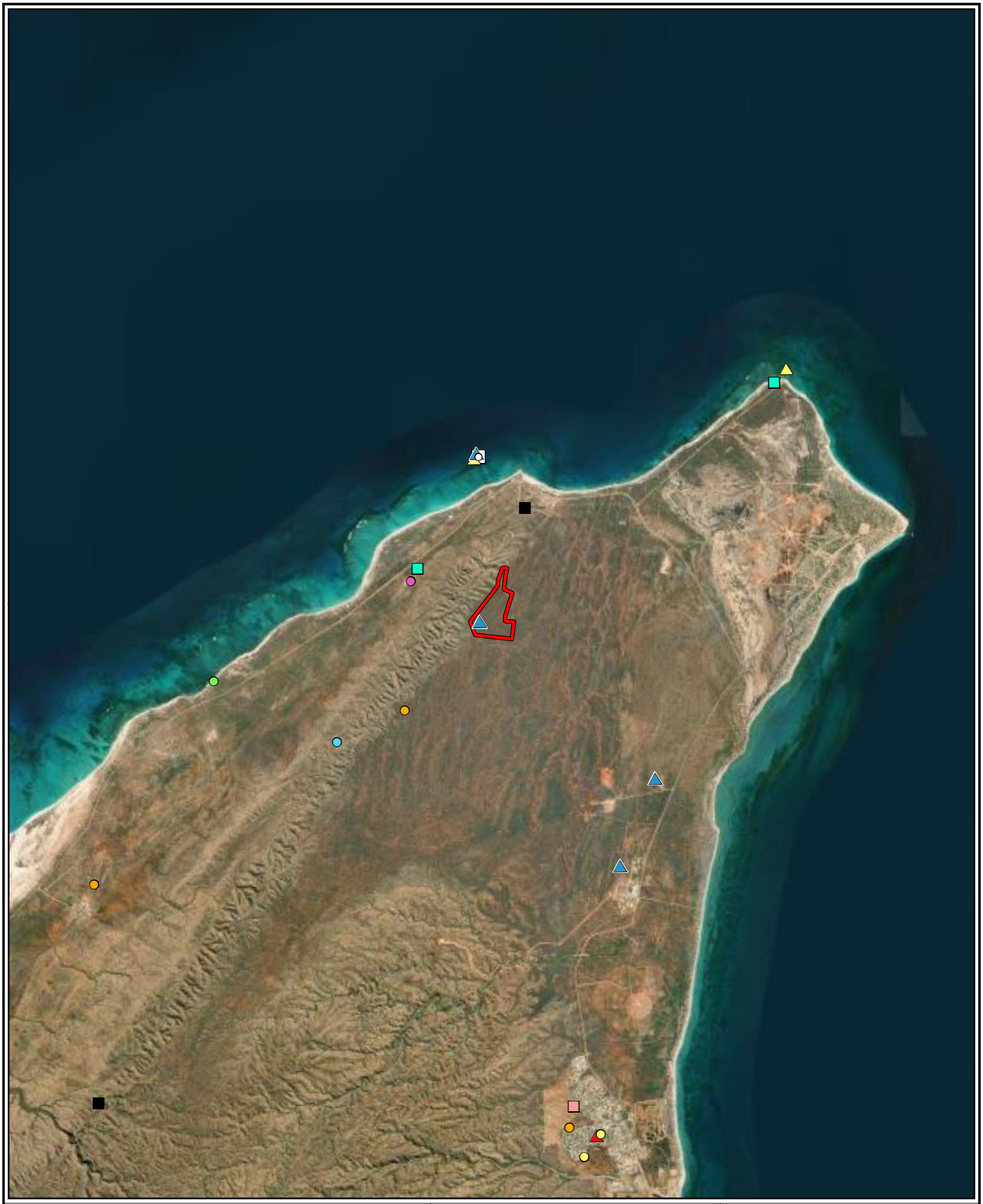
Table 3 shows the Threatened and Priority flora potentially occurring within the Survey Area. The desktop assessment identified 17 Priority flora species that have been recorded in the local area. Of these, based on general habitat requirements (Table 3), four Priority 2, three Priority 3 and one Priority 4 flora species are considered to have potential to occur within the Survey Area:

- *Brachychiton obtusilobus* (P4).
- *Corchorus congener* (P3)
- *Daviesia pleurophylla* (P2)
- *Eremophila occidens* (P2)
- *Phyllanthus fuernrohrii* (P3)
- *Stackhousia umbellata* (P3)
- *Tephrosia* sp. North West Cape (G. Marsh 81) (P2)
- *Verticordia serotina* (P2).

Table 3: Threatened and Priority flora potentially occurring within the Survey Area

Taxa	Conservation status		Known habitat	Potential to occur (based on desktop assessment)	Potential to occur (post field assessment)
	EPBC Act	BC Act			
Acanthocarpus rupestris	nil	P2	Slopes and gullies. Red sand/ limestone	Unlikely based on habitat.	Highly unlikely
Calandrinia sp. Cape Range (F. Obbens FO 10/18)	nil	P2	Slopes and gullies. Skeletal limestone soil. On Red brown sandy clay loam in cracks between rock over limestone.	Unlikely based on habitat.	Highly unlikely
Daviesia pleurophylla	nil	P2	Sand dunes	Recorded	Recorded
Eremophila occidens	nil	P2	Orange/brown sand. Limestone ranges, dunes.	Likely based on habitat	Unlikely
Harnieria kempeana subsp. *rhadinophylla*	nil	P2	Amongst limestone rocks, creek banks.	Unlikely based on habitat	Highly unlikely
Tephrosia sp. North West Cape (G. Marsh 81)	nil	P2	orange-red to brown soil with limestone fragments, over limestone	Possible based on habitat	Unlikely
Tinospora esiangkara	nil	P2	Pebbly orange-brown calcareous loam. Limestone outcrops or ridges, near creek bank.	Unlikely based on habitat	Highly unlikely
Verticordia serotina	nil	P2	Red sand. Sand dunes.	Likely based on habitat	Unlikely
Acacia alexandri	nil	P3	Limestone. Stony creeks, steep rocky slopes.	Unlikely based on habitat	Highly unlikely

Acacia startii	nil	P3	Calcareous loam with limestone pebbles. Stony hills & watercourses.	Unlikely based on habitat	Highly unlikely
Corchorus congener	nil	P3	Sand, red sandy loam with limestone. Sand dunes, plains.	Likely based on habitat	Unlikely
Eremophila forrestii subsp. *capensis*	nil	P3	Brown rocky soils, limestone. Ridges.	Unlikely based on habitat	Highly unlikely
Grevillea calcicola	nil	P3	Limestone hilltops.	Unlikely based on habitat	Highly unlikely
Phyllanthus fuernrohrii	nil	P3	Sandy soils on limestone.	Possible based on habitat	Unlikely
Stackhousia umbellata	nil	P3	Sandy soils on limestone.	Possible based on habitat	Unlikely
Brachychiton obtusilobus	nil	P4	Rocky limestone ranges, gorges, occasionally sandplains.	Possible based on habitat	Recorded
Eremophila youngii subsp. *lepidota*	nil	P4	Stony red sandy loam. Flats plains, floodplains, sometimes semi-saline, clay flats.	Unlikely based on habitat	Highly unlikely



Legend

- Survey area

Priority flora (DBCA)

- *Acacia alexandri*
- *Acacia ryaniana*
- *Brachychiton obtusilobus*
- *Calandrinia* sp. Cape Range (F. Obbens FO 10/18)
- *Corchorus congener*
- *Cucumis* sp. Barrow Island (D.W. Goodall 1264)
- *Daviesia pleurophylla*
- *Eremophila forrestii* subsp. *capensis*
- *Eremophila youngii* subsp. *lepidota*
- *Grevillea calcicola*
- *Phyllanthus fuernrohrii*
- *Stackhousia umbellata*
- *Tephrosia* sp. North West Cape (G. Marsh 81)

Scale 1:110,000 at A4

0 1 2 Kilometres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58909

Client: Minderoo

Version: A | Date: 16-Jun-2020

Drawn By: cthatcher | Checked By: TS

Lighthouse Resort Exmouth

CONSERVATION SIGNIFICANT FLORA AND COMMUNITIES

FIGURE 2

strategen JBS&G

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Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

4.1.4 Vertebrate Terrestrial Fauna

A desktop survey for Threatened and Priority fauna that may potentially occur within the Survey Area was undertaken using NatureMap (Parks and Wildlife 2007 and the DAWE Protected Matters Search Tool (Attachment A).

Table 4 shows the Threatened and Priority fauna potentially occurring within the Survey Area. The desktop assessment identified nine Threatened and two Priority fauna species that have been recorded in the local area. Of these, based on general habitat requirements, no conservation significant fauna species are considered to potentially occur within the clearing application area.

Table 4: Threatened and Priority fauna potentially occurring within the Survey Area

Taxa	Conservation status		Known habitat	Potential to occur
	EPBC Act	BC Act		
Anilios splendidus	nil	P2	Heath over limestone (Parks and Wildlife 2007)	Unlikely based on habitat.
Aprasia rostrata	nil	P3	Highly calcareous sandstone, the higher parts are rocky with other areas consisting of flat, dried mud, like the bed of a dried-up lake	Unlikely based on habitat.
Calidris ferruginea	CR	T	Intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms.	Unlikely based on habitat.
Charadrius leschenaultii	VU	T	Feeding habitat occurs from the surface of wet sand or mud on open intertidal flats of sheltered embayments, lagoons or estuaries. Roosts occur on sand-spits and banks on beaches or in tidal lagoons.	Unlikely based on habitat.
Charadrius mongolus	EN	T	Occurs in coastal littoral and estuarine environments. It inhabits large intertidal sandflats or mudflats in sheltered bays, harbours and estuaries, and occasionally sandy ocean beaches, coral reefs, wave-cut rock platforms and rocky outcrops.	Unlikely based on habitat.
Diplodactylus capensis	nil	T	Limestone hills with spinifex and low shrubs and trees.	Unlikely based on habitat.
Falco peregrinus	nil	S	Areas with granite outcrops and cliffs which are its preferred breeding habitat.	Unlikely based on habitat.
Numenius madagascariensis	CR	T	Occurs in sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass.	Unlikely based on habitat.
Ophisternon candidum	VU	T	inhabits subterranean caves, fissures and wells and is one of only two vertebrate animals known from Australasia that are restricted to either caves or groundwater.	Unlikely based on habitat.
Petrogale lateralis subsp. lateralis	EN	T	Shelter under deep shade in rocky areas such as caves, cliffs, screes and rockpiles, and emerge at dusk to feed on grasses, forbs, shrubs and occasionally seeds and fruits.	Unlikely based on habitat.
Rhinonicteris aurantia	VU	T	Roosts require caves in ironstone and siliceous formations. Foraging occurs near large watercourses, around rocky outcrop, gullies, gorges and over pools	Unlikely based on habitat.

4.2 Field survey results

All plants collected were taken under flora collecting permits listed in Table 5, pursuant to Regulation 62 of the Biodiversity Conservation Regulations 2018.

Table 5: Personnel

Name	Role	Flora collection permit
Tristan Sleigh Senior Botanist	Planning, fieldwork, plant identification, data interpretation and report preparation.	FB62000128 (exp 08 Apr 2022)

4.2.1 Flora

A total of seven relevés were conducted during the survey resulting in identification of 31 taxa from 11 families and 21 genera (Attachment B)).

The most commonly recorded family was Fabaceae, which accounted for 32% of all taxa collected in the survey area, constituting 10 taxa and four genera.

One of the 31 taxa could not be confirmed: *Eremophila* ?*latrobei* subsp. g*labra*. The lack of reproductive structure prevented confirmation of identification. This specimens is not considered to be a conservation significant taxa.

4.2.1.1 Conservation significant flora

Within survey area, two Priority flora species were recorded; *Daviesia pleurophylla* (P2) and *Brachychiton obtusilobus* (P2). Their locations and numbers recorded within the Survey area are presented in Table 6 and shown in Figure 4.

Table 6: Priority Flora Species Locations

taxa	Population size	mE (MGA50)	mN (MGA50)	Comments
Brachychiton obtusilobus (P4)	1	200657	7583937	Located on eastern edge of existing track
Brachychiton obtusilobus (P4)	2	200611	7583944	Limestone hill
Daviesia pleurophylla (P2)	12 (4 within proposed clearing application area)	200696	7582768	All individuals located north of existing track
Daviesia pleurophylla (P2)	1 (1 within proposed application clearing area)	200511	7582951	All individuals located north of existing track
Daviesia pleurophylla (P2)	5 (2 within proposed application clearing area)	200469	7582943	All individuals located north of existing track
Daviesia pleurophylla (P2)	22 (6 with proposed application clearing area)	200068	7582795	All individuals located west of existing track
Daviesia pleurophylla (P2)	18	200656	7583422	Dune crest

4.2.2 Vegetation

Within the Survey area, three vegetation types were recorded and mapped (Figure 4). The most dominant vegetation type recorded was type VT1 (61.33 ha which is 92.3% of the entire Survey area. This vegetation type can be described as open low shrubland of *Grevillea stenobotrya* and *Banksia ashbyi* over hummock grassland of *Triodia angusta*. Photographs of each vegetation type are provided in Attachment C.

Table 7: Description of vegetation types mapped within the Survey Area

Code	Vegetation types	Dominant Landform	Veg Cond	Area (ha)	% survey area	Area within application area (ha)
VT1	*Grevillea stenobotrya* and *Banksia ashbyi* open low shrubland over *Triodia angusta* hummock grassland	Dune swale and crest	Excellent; Very Good; Degraded	61.33	92.32	4.14
VT2	*Corymbia hamersleyana* open low woodland over *Grevillea stenobotrya* and *Acacia bivenosa* open shrubland over *Triodia angusta* hummock grassland.	Dune swale	Excellent; Very Good	4.21	6.33	0.61
VT3	*Acacia bivenosa* and *Melaleuca cardiophylla* low open shrubland over *Triodia wiseana* and *Triodia basedowii* open hummock grassland.	Low limestone hill	Excellent; Very Good	0.18	0.27	0.00
Cleared	No vegetation present	n/a	n/a	0.72	1.08	0.56
Total				**66.43**	**100**	**5.31**

None of the vegetation associations mapped and described are listed as Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs).

4.2.2.1 Vegetation Condition

The average vegetation condition across the Survey area was Excellent (excluding existing tracks) (Figure 5). A few small areas within the survey area were considered to be in a Degraded condition due to historical disturbance. These areas had reduced vegetation cover consistent with partial clearing. Overall, 95% of the Survey area was in excellent condition.

4.2.3 Introduced and exotic taxa

No introduced or exotic flora were found within the relevés within the Survey area.

Legend

- Proposed clearing area

Vegetation type
- VT1
- VT2
- VT3
- Cleared

Conservation significant flora
- *Brachychiton obtusilobus*
- *Daviesia pleurophylla*

Scale 1:6,500 at A4 (0 50 100 metres)	**Lighthouse Resort Exmouth**
Coord. Sys. GDA 1994 MGA Zone 50	**VEGETATION TYPES**
Job No: 58909	
Client: Minderoo	**FIGURE 4**
Version: A / Date: 16-Jun-2020	strategen JBS&G
Drawn By: cthatcher / Checked By: TS	

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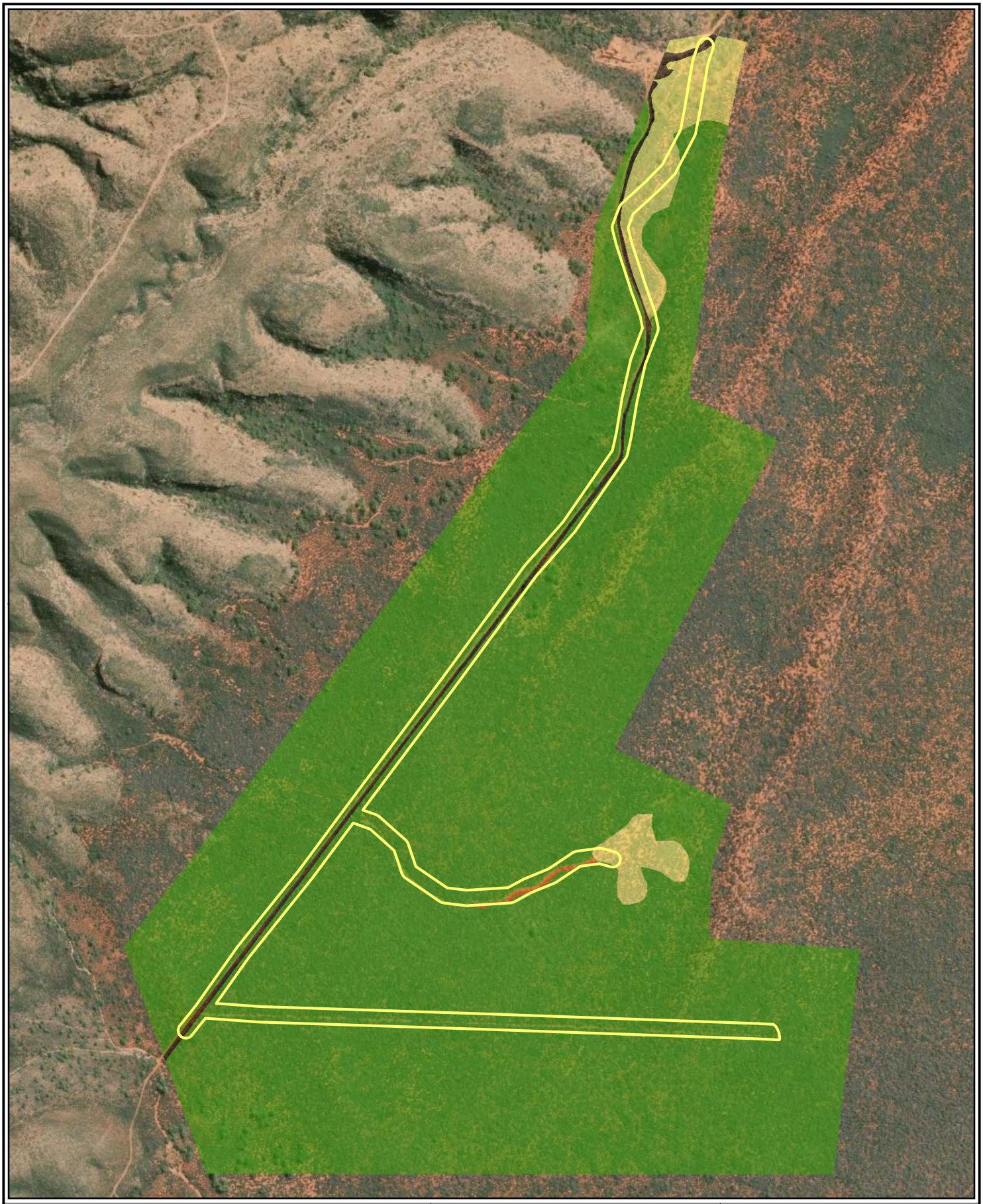
Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

- Proposed clearing area

Vegetation condition

- Excellent
- Very good
- Degraded
- N/A

Scale 1:6,500 at A4 (0 50 100 metres)	**Lighthouse Resort Exmouth**
Coord. Sys. GDA 1994 MGA Zone 50	**VEGETATION CONDITION**
Job No: 58909	
Client: Minderoo	**FIGURE 5**
Version: A — Date: 16-Jun-2020	strategen JBS&G
Drawn By: cthatcher — Checked By: TS	

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Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

5. Discussion

The overall vegetation condition within the survey area was considered to be in excellent condition (with the exception of the cleared areas shown in (Figure 4). The vegetation within the survey area is consistent with the regional vegetation mapping (Shepheard 2001), and is considered to be well represented both locally and regionally. Only a small percentage of taxa were in flower at the time the survey was conducted, but most taxa were identifiable based on vegetative features. While this impacted the identification of some species, it did not affect the overall outcome of the reconnaissance survey, and did not prevent the identification of any conservation significant flora species.

Two priority flora species were recoded within the Survey area. *Daviesia pleurophylla* (P2) was recorded at five locations within the Survey area, with a total of 58 individuals. Of these 13 (from four locations) are contained within the clearing application area. *Daviesia pleurophylla* is known from 6 previous records over a range of 73km. One of these records is shown to be occurring within the clearing application area. This location was searched, and no specimens were located. This record is 148 m to the east of a population recorded during the current survey. Based on location and associated vegetation descriptions, this is likely to represent the same occurrence.

Daviesia pleurophylla occurs on dune crests on red sand (FloraBase 2007-). This habitat is well represented locally with approximately 3,600ha of this vegetation association occurring within a 10km radius of the survey area. Based on the large extent of suitable habitat it is likely that this species is present in other areas. No population number data is publicly available for the known populations of *Daviesia pleurophylla*, preventing the assessment of impacts to total species numbers. The clearing application area intersects 22% of the local population of *Daviesia pleurophylla*. Of the five local populations recorded, four occur directly adjacent to previous clearing (tracks). This suggests that clearing activities are unlikely to have indirect impacts on this species.

Brachychiton obtusilobus (P4) was recorded at two locations during the survey, with a total of three individuals. This species was not recorded within the clearing application area. Given this, no impact to this species from the proposed clearing will occur.

6. Conclusion

The key results and outcomes of the flora and vegetation survey were:

- Three native vegetation types were mapped within the Survey area.
- no TECs or PECs were recorded within the Survey area
- no other significant vegetation was mapped within the survey area
- two Priority flora species were recorded within the Survey area
    - 22% of the local population of *Daviesia pleurophylla* is located within the clearing permit application area.

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Attachment A: Database Searches

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 03/06/2020

Origin	Native
Conservation Status	Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	114° 04' 40" E,21° 54' 47" S
Buffer	40km
Group By	Kingdom

Kingdom	Species	Records
Animalia	88	2796
Plantae	23	135
TOTAL	**111**	**2931**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Animalia					
1.	41323	*Actitis hypoleucos (Common Sandpiper)*		IA	
2.	25350	*Aipysurus apraefrontalis (Short-nosed Seasnake)*		T	
3.	44647	*Anilios splendidus (splendid blind snake (North West Cape), blind snake (Milyering Well))*		P2	Y
4.	25634	*Anous stolidus (Common Noddy)*		IA	
5.	24992	*Aprasia rostrata (Ningaloo worm-lizard, Monte Bello Worm-lizard)*		P3	
6.	48573	*Ardenna pacifica (Wedge-tailed Shearwater)*		IA	
7.	25736	*Arenaria interpres (Ruddy Turnstone)*		IA	
8.	33905	*Bamazomus subsolanus (Eastern Cape Range Bamazomus)*		T	Y
9.	33906	*Bamazomus vespertinus (Western Cape Range Bamazomus)*		T	Y
10.	24161	*Bettongia lesueur subsp. graii (Boodie (inland), Burrowing Bettong (inland))*		X	
11.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
12.	24780	*Calidris alba (Sanderling)*		IA	
13.	24784	*Calidris ferruginea (Curlew Sandpiper)*		T	
14.	24788	*Calidris ruficollis (Red-necked Stint)*		IA	
15.	24789	*Calidris subminuta (Long-toed Stint)*		IA	
16.	24790	*Calidris tenuirostris (Great Knot)*		T	
17.	34034	*Carcharias taurus (Grey Nurse Shark)*		T	
18.	34031	*Carcharodon carcharias (Great White Shark)*		T	
19.	25335	*Caretta caretta (Loggerhead Turtle)*		T	
20.	25575	*Charadrius leschenaultii (Greater Sand Plover)*		T	
21.	25576	*Charadrius mongolus (Lesser Sand Plover)*		T	
22.	24378	*Charadrius veredus (Oriental Plover)*		IA	
23.	25336	*Chelonia mydas (Green Turtle)*		T	
24.	41332	*Chlidonias leucopterus (White-winged Black Tern, white-winged tern)*		IA	
25.	25346	*Dermochelys coriacea (Leatherback Turtle)*		T	
26.	34146	*Diplodactylus capensis (Cape Range Stone Gecko)*		P2	Y
27.	33907	*Draculoides brooksi (Northern Cape Range Draculoides)*		T	Y
28.	33909	*Draculoides julianneae (Western Cape Range Draculoides)*		T	Y
29.	24084	*Dugong dugon (Dugong)*		S	
30.	25473	*Eretmochelys imbricata (Hawksbill Turtle)*		T	
31.	25342	*Eretmochelys imbricata subsp. bissa (Hawksbill Turtle)*		T	
32.	24043	*Eubalaena australis (Southern Right Whale)*		T	
33.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
34.	24793	*Gallinago stenura (Pin-tailed Snipe)*		IA	
35.	47954	*Gelochelidon nilotica (Gull-billed Tern)*		IA	
36.	24481	*Glareola maldivarum (Oriental Pratincole)*		IA	
37.	48587	*Hydroprogne caspia (Caspian Tern)*		IA	
38.	34145	*Indohya damocles (Cameron's Cave Pseudoscorpion)*		T	Y
39.	24218	*Leporillus apicalis (Lesser Stick-nest Rat)*		X	
40.	25120	*Lerista allochira (Cape Range Slider)*		P3	
41.	25739	*Limicola falcinellus (Broad-billed Sandpiper)*		IA	

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
42.	30932	*Limosa lapponica (Bar-tailed Godwit)*		IA	
43.	25741	*Limosa limosa (Black-tailed Godwit)*		IA	
44.	24051	*Megaptera novaeangliae (Humpback Whale)*		S	
45.	24222	*Mesembriomys macrurus (Golden-backed Tree-rat)*		P4	
46.	34025	*Milyeringa veritas (Cave Gudgeon, Blind Gudgeon)*		T	
47.	25344	*Natator depressus (Flatback Turtle)*		T	
48.	33985	*Nocticola flabella (Cape Range delicate cockroach, Cape Range Blind Cockroach)*		P4	Y
49.	24798	*Numenius madagascariensis (Eastern Curlew)*		T	
50.	24799	*Numenius minutus (Little Curlew, Little Whimbrel)*		IA	
51.	25742	*Numenius phaeopus (Whimbrel)*		IA	
52.	24497	*Oceanites oceanicus (Wilson's Storm-petrel)*		IA	
53.	41347	*Onychoprion anaethetus (Bridled Tern)*		IA	
54.	34038	*Ophisternon candidum (Blind Cave Eel)*		T	
55.	24060	*Orcaella heinsohni (Australian Snubfin Dolphin)*		P4	
56.	48591	*Pandion cristatus (Osprey, Eastern Osprey)*		IA	
57.	24142	*Petrogale lateralis subsp. lateralis (Black-flanked Rock-wallaby, Black-footed Rock-wallaby)*		T	
58.	24662	*Phaethon lepturus (White-tailed Tropicbird)*		IA	
59.	24663	*Phaethon rubricauda (Red-tailed Tropicbird)*		P4	
60.	24098	*Phascogale calura (Red-tailed Phascogale, Kenngoor)*		S	
61.	24382	*Pluvialis fulva (Pacific Golden Plover)*		IA	
62.	24383	*Pluvialis squatarola (Grey Plover)*		IA	
63.	34037	*Pristis zijsron (Green Sawfish)*		T	
64.	24233	*Pseudomys chapmani (Western Pebble-mound Mouse, Ngadji)*		P4	
65.	24236	*Pseudomys fieldi (Shark Bay Mouse, Djoongari)*		T	
66.	24715	*Puffinus huttoni (Hutton's Shearwater)*		T	
67.	24716	*Puffinus pacificus (Wedge-tailed Shearwater)*		IA	
68.	42358	*Rhincodon typus (Whale Shark)*		S	
69.	43368	*Rhinonicteris aurantia (Orange Leaf-nosed bat)*		P4	
70.	24115	*Sminthopsis longicaudata (Long-tailed Dunnart)*		P4	
71.	48107	*Sousa sahulensis (Australian humpback dolphin)*		P4	
72.	25640	*Sterna dougallii (Roseate Tern)*		IA	
73.	25642	*Sterna hirundo (Common Tern)*		IA	
74.	48593	*Sternula albifrons (Little Tern)*		IA	
75.	48595	*Sternula nereis subsp. nereis (Fairy Tern)*		T	
76.	33963	*Stygiocaris lancifera (Lance-beaked Cave Shrimp)*		T	
77.	33964	*Stygiocaris stylifera (Spear-beaked Cave Shrimp)*		P4	
78.	33967	*Stygiochiropus isolatus (a stygiochiropus millipede (Cape Range), millipede)*		T	Y
79.	33968	*Stygiochiropus peculiaris (Cameron's Cave Millipede)*		T	Y
80.	33969	*Stygiochiropus sympatricus (a stygiochiropus millipede (Cape Range), millipede)*		T	Y
81.	34007	*Thalassarche chlororhynchos (Atlantic Yellow-nosed Albatross)*		T	
82.	48597	*Thalasseus bergii (Crested Tern)*		IA	
83.	24803	*Tringa brevipes (Grey-tailed Tattler)*		P4	
84.	24806	*Tringa glareola (Wood Sandpiper)*		IA	
85.	24808	*Tringa nebularia (Common Greenshank, greenshank)*		IA	
86.	24809	*Tringa stagnatilis (Marsh Sandpiper, little greenshank)*		IA	
87.	41351	*Xenus cinereus (Terek Sandpiper)*		IA	
88.	24249	*Zyzomys pedunculatus (Central Rock-rat, Antina)*		T	
Plantae					
89.	13074	*Acacia alexandri*		P3	
90.	13071	*Acacia ryaniana*		P2	
91.	13076	*Acacia startii*		P3	
92.	1210	*Acanthocarpus rupestris*		P2	
93.	12714	*Brachychiton obtusilobus*		P4	
94.	49022	*Calandrinia sp. Cape Range (F. Obbens FO 10/18)*		P2	
95.	49009	*Calytrix sp. Learmonth (S. Fox EMopp 1)*		P1	Y
96.	18411	*Corchorus congener*		P3	
97.	1491	*Crinum flaccidum (Native Crinum)*		P2	
98.	14375	*Daviesia pleurophylla*		P2	
99.	29715	*Eremophila forrestii subsp. capensis*		P3	
100.	15032	*Eremophila occidens*		P2	
101.	16040	*Eremophila youngii subsp. lepidota*		P4	
102.	1972	*Grevillea calcicola*		P3	
103.	12832	*Gymnanthera cunninghamii*		P3	
104.	17327	*Harnieria kempeana subsp. rhadinophylla*		P2	Y
105.	16	*Helminthostachys zeylanica*		P3	
106.	19	*Lygodium flexuosum*		P3	
107.	4677	*Phyllanthus fuernrohrii (Sand Sponge)*		P3	
108.	4736	*Stackhousia umbellata*		P3	
109.	46053	*Tephrosia sp. North West Cape (G. Marsh 81)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
				P2	
110.	17345	*Tinospora esiangkara*		P2	Y
111.	12457	*Verticordia serotina*		P2	

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Australian Government
Department of the Environment and Energy

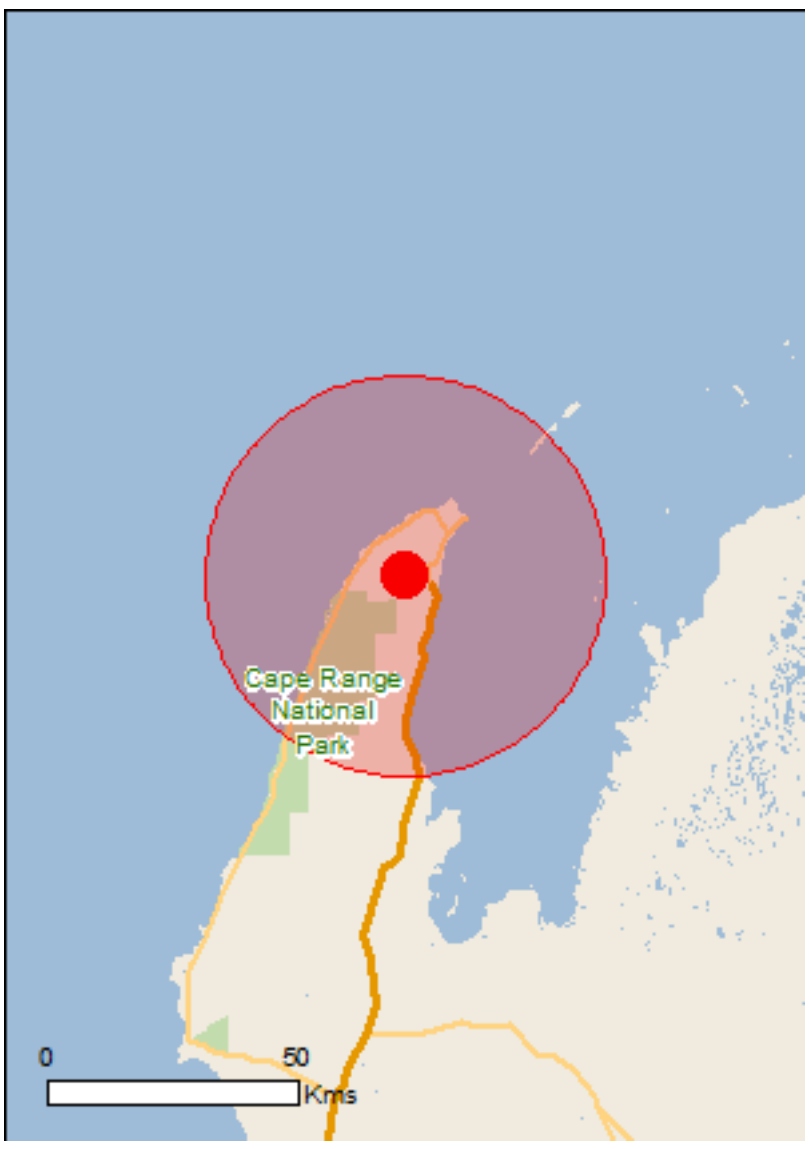
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 03/06/20 11:58:38



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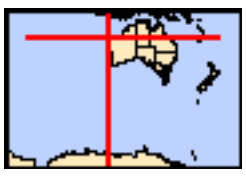

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	48

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	6
Commonwealth Heritage Places:	1
Listed Marine Species:	79
Whales and Other Cetaceans:	29
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	2

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	6
Regional Forest Agreements:	None
Invasive Species:	11
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	4

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The Ningaloo Coast	WA	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Fish		
Milyeringa veritas Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area
Ophisternon candidum Blind Cave Eel [66678]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Mororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur

Name	Status	Type of Presence
		within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica		
Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata		
Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaena glacialis australis		
Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera bonaerensis		
Antarctic Minke Whale, Dark-shoulder Minke		Species or species

Name	Threatened	Type of Presence
Whale [67812]		habitat likely to occur within area
[Balaenoptera borealis](#) Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Balaenoptera edeni](#) Bryde's Whale [35]		Species or species habitat likely to occur within area
[Balaenoptera musculus](#) Blue Whale [36]	Endangered	Migration route known to occur within area
[Balaenoptera physalus](#) Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Breeding known to occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
[Dugong dugon](#) Dugong [28]		Breeding known to occur within area
[Eretmochelys imbricata](#) Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
[Isurus oxyrinchus](#) Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
[Isurus paucus](#) Longfin Mako [82947]		Species or species habitat likely to occur within area
[Manta alfredi](#) Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
[Manta birostris](#) Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
[Megaptera novaeangliae](#) Humpback Whale [38]	Vulnerable	Breeding known to occur within area
[Natator depressus](#) Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
[Orcinus orca](#) Killer Whale, Orca [46]		Species or species habitat may occur within area
[Physeter macrocephalus](#) Sperm Whale [59]		Species or species habitat may occur within area
[Pristis clavata](#) Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
[Pristis zijsron](#) Green Sawfish, Dindagubba, Narrowsnout Sawfish	Vulnerable	Species or species

Name	Threatened	Type of Presence
[68442]		habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Defence - EXMOUTH ADMIN & HF TRANSMITTING
Defence - EXMOUTH VLF TRANSMITTER STATION
Defence - LEARMONTH - RAAF BASE
Defence - LEARMONTH RADAR SITE - TWIN TANKS EXMOUTH
Defence - LEARMONTH RADAR SITE - VLAMING HEAD EXMOUTH

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur

Name	Threatened	Type of Presence within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area

Name	Status	Type of Presence
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks	[Resource Information]
Name	Label
Gascoyne	Multiple Use Zone (IUCN VI)
Ningaloo	Recreational Use Zone (IUCN IV)

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Bundegi Coastal Park	WA
Cape Range	WA
Jurabi Coastal Park	WA
Muiron Islands	WA
Victor Island	WA
Y Island	WA

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Cape Range Subterranean Waterways	WA

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Canyons linking the Cuvier Abyssal Plain and the	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-21.91302 114.07787

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Attachment B: Flora species recorded with the survey area

Family	Species
Convolvulaceae	*Ipomoea pes-caprae*
Fabaceae	*Acacia bivenosa*
	Acacia gregorii
	Acacia inaequilatera
	Acacia sericophylla
	Acacia spathulifolia
	Acacia stellaticeps
	Acacia tetragonophylla
	Daviesia pleurophylla (P4)
	Labichea cassioides
	Swainsona calcicola
Goodeniaceae	*Scaevola sericophylla*
Malvaceae	*Brachychiton obtusilobus* (P4)
	Corchorus elachocarpus
Meliaceae	*Owenia reticulata*
Myrtaceae	*Calytrix truncatifolia*
	Corymbia hamersleyana
	Corymbia zygophylla
	Melaleuca cardiophylla
	Verticordia forrestii
Poaceae	*Triodia angusta*
	Triodia basedowii
	Triodia wiseana
Proteaceae	*Banksia ashbyi*
	Grevillea stenobotrya
	Hakea stenophylla
Sapindaceae	*Alectryon oleifolius*
Scrophulariaceae	*Eremophila ?latrobei* subsp. *glabra*
	Eremophila forrestii subsp. *forrestii*
	Myoporum montanum
Solanaceae	*Solanum lasiophyllum*

Attachment C: Photographs of Vegetation Types

Plate 1: Vegetation Type 1

Plate 2: Vegetation Type 2

Plate 3: Vegetation Type 3

Appendix C

Bore Completion Logs

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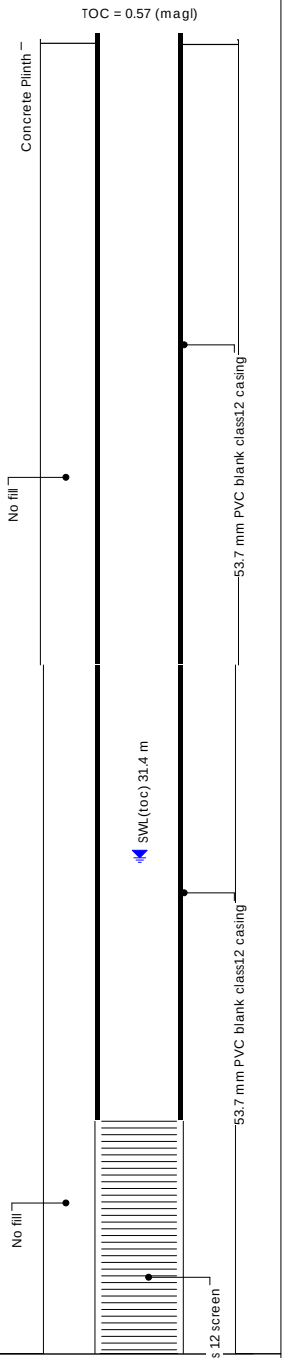
securing your water future

Borehole: LH01M

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 33 (mAHD)	Total Depth: 53.5 m
Client: MIN North West Resorts Pty Ltd	Easting: 200801	SWL: 31.4 m (toc) on 21/08/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7582754	Salinity: 23700 mg/L on 21/08/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes
0		Ground Surface	
		SP-SM fine SAND with silt poorly graded, loose, SR, qtz dark reddish brown.	
		SW coarse SAND with trace fine gravel well graded, loose, SR, qtz dark reddish brown. Weakly cemented	
10		SW med SAND with trace fine gravel well graded, loose, SR, qtz dark reddish brown pale brown. Weakly cemented	
		SW gravelly med SAND well graded, medium dense, SR, calcareous pale reddish brown pale brown. Limestone chips of up to 10mm	
		SW gravelly med SAND well graded, medium dense, SR, calcareous pale brown pale reddish brown. Limestone chips of up to 10mm	
		SW fine SAND with trace fine gravel well graded, medium dense, SR, calcareous pale yelllowish brown. Limestone chips of up to 15mm	
20		SW med SAND with trace fine gravel well graded, medium dense, SR, calcareous pale brown speckled pale reddish brown with pale yellow. Limestone chips of up to 15mm	
		SW med SAND with trace med gravel well graded, medium dense, SR, calcareous pale yellow speckled pale grey with pale brown. Limestone chips of up to 15mm	
30		SW med SAND well graded, loose, SR, qtz pale yellow pale grey.	
40		SW-SG med SAND with med gravel well graded, medium dense, SR, calcareous pale yellow pale grey. Limestone chips of up to 20mm	0.1 L/s, 8.33, 10.5 mS-cm 31.5 °C.
		SW coarse SAND well graded, medium dense, SR, calcareous pale grey pale yellowish brown with pale reddish brown. Limestone chips of up to 15mm	
50			



Drilling Company: Harrington Drilling
Drilling Equipment: Air Core and RC Hammer
Drilling Method: RC

Started: 19/08/2020
Completed: 20/08/2020
Compiled: 20/10/2020

Logged to Australian Standard: Geotechnical Site Investigations AS 1726-1993/Amdt 2-1994.

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Borehole: LH01M

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
		GW fine GRAVEL well graded, medium dense, SA, calcareous pale yellowish brown pale grey with pale brown. Limestone chips of up to 15mm		Native back fill

60
70
80
90
100

Logged to Australian Standard: Geotechnical Site Investigations AS 1726-1993/Amdt 2-1994.

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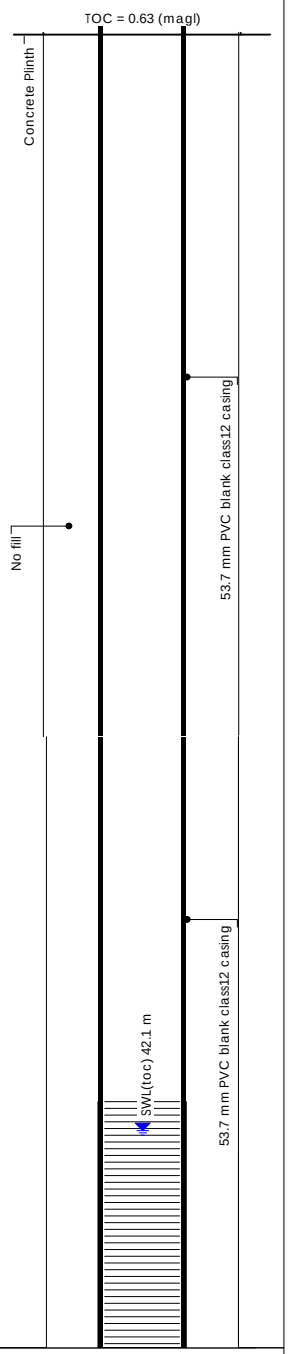
Borehole: LH02M

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 49 (mAHD)	Total Depth: 71 m
Client: MIN North West Resorts Pty Ltd	Easting: 200425	SWL: 42.1 m (toc) on 20/08/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7582770	Salinity: 11340 mg/L on 20/08/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes
0		Ground Surface	
		SP fine SAND with trace silt poorly graded, loose, SR, qtz dark reddish brown.	
		SW fine SAND with trace silt well graded, loose, SR, qtz dark reddish brown speckled brown.	
		SW fine SAND with trace silt well graded, loose, SR, qtz dark reddish brown. Minor FG Ferricrete	
10		GW med GRAVEL with trace silt well graded, dense, SR, calcareous reddish brown speckled brown with pale yellowish brown. Limestone conglomerate	
		SC clayey med SAND well graded, dense, SR, calcareous reddish brown speckled brown.	
		SW gravelly fine SAND well graded, dense, SR, calcareous pale brown speckled pale yellowish brown. Limestone chips up to 15mm	
20		SW gravelly fine SAND well graded, medium dense, SR, calcareous pale yellowish brown speckled pale brown with pale grey. Limestone chips up to 30mm	
		SW-SG med SAND with med gravel well graded, medium dense, SR, calcareous yellowish brown speckled pale brown with pale grey. Limestone chips up to 10mm	
		SW gravelly med SAND well graded, medium dense, SR, calcareous pale yellow speckled pale yelllowish brown with pale grey. Limestone chips up to 10mm	
30		SW med SAND well graded, loose, SR, qtz pale yellow speckled pale grey.	
		SW med SAND with trace med gravel well graded, medium dense, SR, calcareous pale yellow speckled pale grey. Limestone chips up to 30mm	
		SW fine SAND with trace med gravel well graded, medium dense, SR, calcareous pale yellow speckled pale grey. Limestone chips up to 15mm	
		SP med SAND with trace med gravel poorly graded, loose, SR, calcareous pale yellow speckled pale grey.	
40		SW med SAND well graded, loose, SR, qtz pale yellow speckled pale grey.	0.1 L/s, 7.92, 14.5 mS-cm
		SW med SAND well graded, loose, SR, qtz pale yellow speckled pale grey.	0.2 L/s, 8, 19 mS-cm
50			



Drilling Company: Harrington Drilling
Drilling Equipment: Air Core and RC Hammer
Drilling Method: RC

Started: 17/08/2020
Completed: 19/08/2020
Compiled: 20/10/2020

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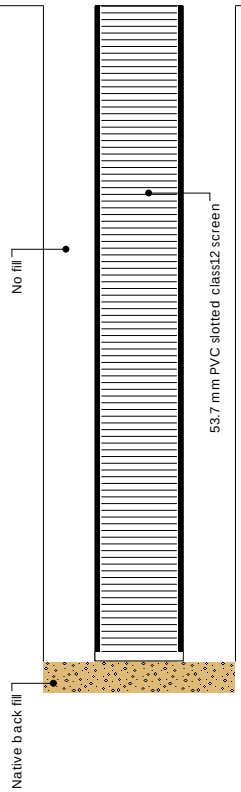
Borehole: LH02M

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes
		SW med SAND with trace med gravel well graded, medium dense, SR, calcareous pale yellow speckled pale grey with white. MG Chips	
		SW med SAND well graded, medium dense, SR, calcareous pale grey speckled dark grey with pale yellow. Water colour P Gy = P Ybr	1.5 L/s, 8.09, 28.9 mS-cm
		SW-SG coarse SAND with fine gravel well graded, medium dense, SR, calcareous pale grey speckled pale yellow with dark grey. FG Chips, white calcite	
		SP-SG med SAND with fine gravel poorly graded, medium dense, SR, calcareous pale grey speckled pale olive.	
		SW gravelly med SAND well graded, medium dense, SR, calcareous pale yellow speckled pale yelllowish brown with pale reddish brown. MG pale RBr chips	
60			1.8 L/s, 7.8, 32.8 mS-cm
		SW gravelly coarse SAND well graded, medium dense, SR, calcareous pale yelllowish brown speckled pale reddish brown with white. MG pale RBr chips	3.3 L/s, 7.69, 45.9 mS-cm
		SW med SAND well graded, medium dense, SR, calcareous pale reddish brown speckled pale yelllowish brown with white.	
		SW med SAND well graded, medium dense, SR, qtz pale yellow speckled pale grey.	
70		SW-SG med SAND with fine gravel well graded, medium dense, SR, calcareous pale yellow speckled pale reddish brown with pale grey. Chips pale RBr up to 25mm	4 L/s, 7.74, 40.6 mS-cm
80			
90			
100			

Bore Construction



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Borehole: LH03M

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 59 (mAHD)	Total Depth: 65.5 m
Client: MIN North West Resorts Pty Ltd	Easting: 200092	SWL: 50.3 m (toc) on 21/08/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7582795	Salinity: 9642 mg/L on 21/08/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
0		Ground Surface		TOC = 0.6 (magl)
		SP fine SAND poorly graded, loose, SR, qtz dark reddish brown.		Concrete Plinth
		SP med SAND poorly graded, loose, SR, qtz dark reddish brown.		
10		SW fine SAND dark reddish brown.		
		GW fine GRAVEL well graded, medium dense, SA, calcareous pale brown pale yellowish brown. Limestone chips up to 25mm		
		SM silty fine SAND well graded, medium dense, SA, calcareous pale reddish brown. Limestone chips up to 15mm		
		SW-SG med SAND with med gravel well graded, medium dense, SA, calcareous pale brown white. Limestone chips up to 15mm		
		SW-SG med SAND with med gravel well graded, medium dense, SR, calcareous pale reddish brown pale yellowish brown. Limestone chips up to 15mm		
20		SW gravelly med SAND well graded, medium dense, SR, calcareous pale grey speckled pale brown. Limestone chips up to 15mm		No fill
		SW-SG med SAND with med gravel well graded, medium dense, SR, calcareous pale brown speckled pale yelllowish brown. Limestone chips up to 15mm		
		SW-SG med SAND with fine gravel well graded, loose, SR, calcareous pale yelllowish brown pale brown with white. Limestone chips up to 10mm		
		GW fine GRAVEL well graded, medium dense, angular, calcareous yelllowish brown pale brown. Limestone chips up to 10mm		
		GW med GRAVEL well graded, medium dense, angular, calcareous pale brown pale yellowish brown. Limestone chips up to 10mm		
		GW med GRAVEL well graded, medium dense, angular, calcareous pale olive pale yelllowish brown. Limestone chips up to 15mm		
30		SW gravelly med SAND well graded, medium dense, SR, calcareous pale yellow speckled pale yelllowish brown with pale brown. Limestone chips up to 10mm		
		SW med SAND well graded, loose, SR, qtz pale yellow speckled pale yelllowish brown.		
		SW med SAND well graded, loose, SR, qtz pale reddish brown pale brown. Poor recovery		
		SW-SG fine SAND with med gravel well graded, medium dense, SR, calcareous pale yelllowish brown pale grey. Sandy limestone chips up to 25mm		
		SP fine SAND poorly graded, loose, SR, qtz pale yellow.		
40		SW med SAND well graded, loose, SR, qtz pale olive pale yellow with pale grey.		
		SP fine SAND poorly graded, loose, SR, qtz pale olive pale yellow with pale grey.		
50				53.7 mm PVC blank class12 casing
				53.7 mm PVC blank class12 casing

Drilling Company: Harrington Drilling	Started: 20/08/2020
Drilling Equipment: Air Core & RC Hammer	Completed: 21/08/2020
Drilling Method: RC	Compiled: 20/10/2020

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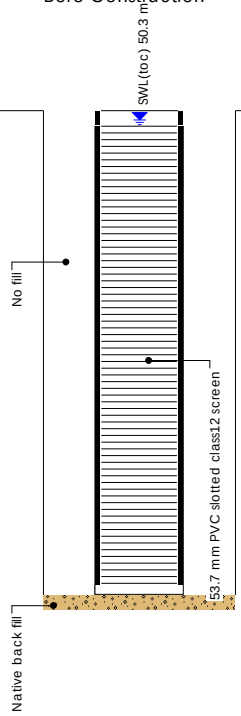
Borehole: LH03M

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes
		SW-SG med SAND with coarse gravel well graded, medium dense, SR, qtz pale olive pale grey. Limestone chips up to 30mm	
60		SW med SAND well graded, loose, SR, qtz pale yellow pale grey.	0.1 L/s, 7.67, 21.85 mS-cm 34 °C.
		SW-SG med SAND with med gravel well graded, medium dense, SR, calcareous pale yellow pale grey. Limestone chips up to 15mm	1 L/s, 7.73, 28.6 mS-cm 31.5 °C.
		GW sandy coarse GRAVEL well graded, medium dense, SA, calcareous pale yelllowish brown pale grey with dark grey.	
70			
80			
90			
100			

Bore Construction



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Borehole: LH04M

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 53 (mAHD)	Total Depth: 53 m
Client: MIN North West Resorts Pty Ltd	Easting: 200616	SWL: 43.64 m (toc) on 22/08/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7583798	Salinity: 3696 mg/L on 22/08/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
0		Ground Surface		TOC = 0.5 (magl)
		SW med SAND well graded, loose, SR, qtz dark reddish brown.		Concrete Plinth
		SP fine SAND poorly graded, loose, SR, qtz dark reddish brown.		
		GC clayey fine GRAVEL well graded, medium dense, SA, calcareous brown yelllowish brown. Iron stained limestone chips up to 15mm		
		CL CLAY with fine gravel, soft, low plasticity brown reddish brown. Iron stained limestone chips up to 15mm		
10		CL CLAY with fine gravel, soft, low plasticity reddish brown brown. Iron stained limestone chips up to 20mm		
		SC clayey med SAND well graded, loose, SR, qtz reddish brown.		
		CH CLAY with trace fine gravel, soft, medium plasticity reddish brown.		
		SW-SC fine SAND with clay well graded, medium dense, SR, calcareous brown yellowish brown.		
20		SP fine SAND poorly graded, medium dense, SR, calcareous pale brown yellowish brown.		No fill
		SW fine SAND with trace fine gravel well graded, medium dense, SR, calcareous pale grey white. Limestone chips up to 10mm		53.7 mm PVC blank class12 casing
		SW gravelly fine SAND well graded, medium dense, SR, calcareous grey speckled yelllowish brown.		
		GW fine GRAVEL well graded, medium dense, SR, calcareous pale grey white.		
		SW fine SAND well graded, medium dense, SR, calcareous pale yellow. Minor limestone chips up to 10mm		
30		SW med SAND well graded, medium dense, SR, calcareous reddish brown yelllowish brown. Minor limestone chips up to 15mm		
		SW med SAND well graded, loose, SR, calcareous pale yellow speckled brown. Minor limestone chips up to 25mm		
		SW med SAND with trace med gravel well graded, loose, SR, calcareous pale yellow pale grey. Minor limestone chips up to 25mm		
		SW med SAND well graded, loose, SR, qtz pale yellow pale grey.		SWL (toc) 43.64 m
40		SW gravelly med SAND well graded, loose, SR, calcareous pale brown pale grey. Limestone chips up to 10mm		
		SW gravelly med SAND well graded, loose, SR, calcareous pale yelllowish brown pale grey. Limestone chips up to 20mm	0.05 L/s, 7.46, 17.7 mS-cm 34.3 °C.	No fill
50				53.7 mm PVC blank class12 casing
				53.7 mm PVC slotted class12 screen

Drilling Company: Harrington Drilling
Drilling Equipment: RC Hammer and Air Core
Drilling Method: RC

Started: 22/08/2020
Completed: 22/08/2020
Compiled: 20/10/2020

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Borehole: LH04M

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
		SW med SAND well graded, loose, SR, qtz pale yellow.	1 L/s, 7.76, 32.1 mS-cm 30.8 °C.	Native back fill

60
70
80
90
100

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Borehole: LH05M

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 60 (mAHD)	Total Depth: 59 m
Client: MIN North West Resorts Pty Ltd	Easting: 200278	SWL: 47.59 m (toc) on 23/08/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7583036	Salinity: 10290 mg/L on 23/08/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
0		Ground Surface		TOC = 0.64 (magl)
		SP fine SAND poorly graded, loose, SR, qtz dark reddish brown.		Concrete Plinth
		SP med SAND poorly graded, loose, SR, qtz dark reddish brown.		
10		SW gravelly med SAND well graded, medium dense, SR, calcareous reddish brown. Limestone chips up to 10mm		
		SW-SG med SAND with fine gravel well graded, medium dense, SR, calcareous yellowish brown. Limestone chips up to 10mm		
		SW med SAND well graded, loose, SR, qtz yellowish brown.		
20		SW-SG coarse SAND with fine gravel well graded, loose, SR, calcareous yellowish brown pale grey. Limestone chips up to 10mm		
		SW-SG med SAND with med gravel well graded, loose, SR, calcareous pale grey pale brown. Limestone chips up to 10mm		No fill
		SW-SG med SAND with med gravel well graded, loose, SR, calcareous grey pale brown. Limestone chips up to 10mm		53.7 mm PVC blank class12 casing
		SP-SG fine SAND with med gravel poorly graded, loose, SR, calcareous grey pale yellowish brown. Limestone chips up to 10mm		
30		SP gravelly fine SAND poorly graded, very dense, SR, qtz pale yellowish brown. Sandstone		
		SW gravelly med SAND well graded, medium dense, SR, qtz pale yellowish brown. Sandstone		
		SW med SAND well graded, loose, SR, qtz pale olive pale grey. Minor limestone/sandstone chips at 36 - 42m		
40		SW coarse SAND well graded, loose, SR, qtz pale yellow pale grey. Minor limestone chips at 42 - 47m		SWL(toc) 47.59 m
				53.7 mm PVC blank class12 casing
50		SW med SAND well graded, loose, SR, qtz pale yellow pale grey		

Drilling Company: Harrington Drilling	Started: 21/08/2020
Drilling Equipment: RC Hammer and Air Core	Completed: 22/08/2020
Drilling Method: RC	Compiled: 20/10/2020

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Borehole: LH05M

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
			0.05 L/s, 7.93, 19.6 mS-cm 30.2 °C.	No fill
		SW-SG med SAND with med gravel well graded, loose, SR, calcareous pale yellow pale grey. Limestone chips up to 15mm	0.2 L/s, 7.69, 23.7 mS-cm 31 °C.	53.7 mm PVC slotted class12 screen
		SW med SAND well graded, loose, SR, qtz pale yellow. Minor limestone chips at 57 - 60m		
60			0.4 L/s, 7.8, 32.4 mS-cm 29.5 °C.	Native back fill
70				
80				
90				
100				

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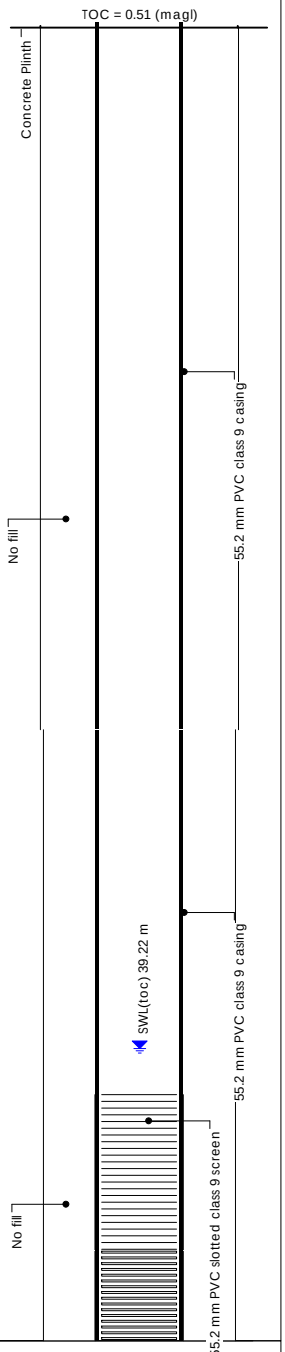
Borehole: LH06M

Project: Lighthouse Borefield	Zone:	Elevation: 47 (mAHD)	Total Depth: 53 m
Client: MIN North West Resorts Pty Ltd	Easting: 200735	SWL: 39.22 m (toc) on 24/08/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7584041	Salinity: 11232 mg/L on 24/08/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes
0		Ground Surface	
		GW med GRAVEL well graded, medium dense, SA, calcareous reddish brown brown with yelllowish brown.	
		GM silty coarse GRAVEL well graded, medium dense, SA, calcareous pale brown white.	
		GM silty fine GRAVEL well graded, medium dense, SA, calcareous pale grey pale reddish brown.	
		GM silty med GRAVEL well graded, medium dense, SA, calcareous pale brown pale yelllowish brown.	
		SC clayey coarse SAND well graded, loose, SR, qtz reddish brown yelllowish brown.	
10		GM silty fine GRAVEL well graded, medium dense, SR, calcareous pale brown pale grey.	
		SW gravelly med SAND well graded, medium dense, SR, calcareous reddish brown brown with yelllowish brown.	
		SM silty med SAND poorly graded, loose, SR, qtz dark reddish brown. Desert dune sand	
20		SW med SAND well graded, loose, SR, qtz yelllowish brown reddish brown.	
		SW coarse SAND well graded, loose, SR, qtz yelllowish brown reddish brown.	
		SW med SAND well graded, loose, SR, qtz yellow pale grey.	
		SW coarse SAND well graded, loose, SR, qtz yelllowish brown reddish brown.	
		SW med SAND well graded, loose, SR, qtz yellow pale grey. Minor limestone chips at 35 - 36m	
30		SW med SAND well graded, loose, SR, qtz pale olive.	
40		SW coarse SAND well graded, loose, SA, qtz pale olive pale yellow with pale grey.	0.1 L/s, 7.74, 1.77 mS-cm 30.7 °C.
		SW med SAND well graded, loose, SR, qtz pale brown pale reddish brown with yelllowish brown. Minor limestone chips at 53 - 54m	0.2 L/s, 7.25, 17.49 mS-cm 30.4 °C.
50			0.5 L/s, 7.43, 28.5 mS-cm 28.5 °C.



Drilling Company: Harrington Drilling
Drilling Equipment: RC Hammer and Air Core
Drilling Method: RC

Started: 23/08/2020
Completed: 23/08/2020
Compiled: 20/10/2020

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Borehole: LH06M

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
			1 L/s, 7.48, 40.6 mS-cm 30.6 °C.	Native back fill; 55.2 mm PVC slotted class12 screen

60
70
80
90
100

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Borehole: LH07M

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 54 (mAHD)	Total Depth: 59 m
Client: MIN North West Resorts Pty Ltd	Easting: 200611	SWL: 46.94 m (toc) on 17/08/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7583511	Salinity: 17880 mg/L on 17/08/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
0		Ground Surface		TOC = 0.6 (magl)
		SP fine SAND poorly graded, loose, SR, qtz reddish brown.		Concrete Plinth
10		SW-SG med SAND with med gravel well graded, dense, SR, calcareous pale brown pale yelllowish brown. Conglomerate limestone		Cement fill
		SW med SAND well graded, medium dense, SR, calcareous pale yelllowish brown pale reddish brown.		No fill
20		SW coarse SAND well graded, medium dense, SR, calcareous yellowish brown speckled pale brown with pale grey. Limestone chips up to 10mm		150 mm Steel surface casing
		SP-SG fine SAND with med gravel poorly graded, medium dense, SR, calcareous pale yelllowish brown speckled white. Limestone chips up to 15mm		53.7 mm PVC blank class12 casing
		SW-SG med SAND with coarse gravel well graded, medium dense, SR, calcareous pale yelllowish brown speckled pale brown. Limestone chips up to 30mm		
30		SW-SG med SAND with coarse gravel well graded, medium dense, SR, calcareous pale brown speckled pale yelllowish brown. Limestone chips up to 30mm		
		SP-SG fine SAND with coarse gravel poorly graded, medium dense, SR, calcareous pale yelllowish brown speckled pale brown. Limestone chips up to 15mm		53.7 mm PVC blank class12 casing
		SW med SAND with trace med gravel well graded, medium dense, SR, calcareous pale yelllowish brown speckled pale brown. Limestone chips up to 15mm		
40		SP fine SAND poorly graded, loose, SR, calcareous pale brown.		SWL (toc) 46.94 m
		SW med SAND with trace med gravel well graded, medium dense, SR, calcareous pale yelllowish brown. Limestone chips up to 15mm		
		SP fine SAND with trace med gravel poorly graded, medium dense, SR, calcareous pale grey. Limestone chips up to 15mm		
		SW med SAND with trace med gravel well graded, medium dense, SR, calcareous pale brown. Limestone chips up to 25mm		
		SW med SAND well graded, medium dense, SR, qtz pale yelllowish brown pale grey. Limestone chips up to 25mm	0.05 L/s, 6.6 mS-cm	No fill
50		SW med SAND well graded, loose, SR, qtz pale yellow		

Drilling Company: Harrington Drilling	Started: 14/08/2020
Drilling Equipment: RC Hammer and Air Core	Completed: 16/08/2020
Drilling Method: RC	Compiled: 20/10/2020

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Borehole: LH07M

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
60			0.5 L/s, 17.5 mS-cm	53.7 mm PVC slotted class12 screen; Native back fill
			1 L/s, 7.88, 29.8 mS-cm 28.8 °C.	
70				
80				
90				
100				

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Borehole: LH08M

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 43 (mAHD)	Total Depth: 48 m
Client: MIN North West Resorts Pty Ltd	Easting: 201004	SWL: 35.39 m (toc) on 24/08/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7584498	Salinity: 20000 mg/L on 24/08/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
0		Ground Surface		TOC = 0.78 (magl)
		SP fine SAND poorly graded, loose, SR, qtz dark reddish brown.		Concrete Plinth
		GM silty fine GRAVEL well graded, medium dense, SA, calcareous brown pale reddish brown. Limestone		
10		GM silty fine GRAVEL well graded, medium dense, SA, calcareous pale brown.		
		GC clayey fine GRAVEL well graded, medium dense, SA, calcareous reddish brown pale brown.		
		GM silty fine GRAVEL well graded, medium dense, SA, calcareous pale brown.		55.2 mm PVC class 9 casing
20		CH CLAY with fine sand, soft, medium plasticity reddish brown.		No fill
		SW coarse SAND well graded, loose, SA, qtz yelllowish brown speckled pale grey.		
		SP fine SAND poorly graded, loose, SR, qtz yelllowish brown. Poor recovery		
30		SW med SAND well graded, loose, SR, qtz reddish brown yelllowish brown. Minor limestone chips up to 15mm		SWL(toc) 35.39m
		SW med SAND well graded, loose, SR, qtz yelllowish brown.		55.2 mm PVC class 9 casing
		SW-SG med SAND with med gravel well graded, medium dense, SR, calcareous yelllowish brown reddish brown. Limestone chips up to 15mm		
		SW med SAND well graded, loose, SR, qtz pale yellow pale grey.	0.05 L/s, 7.86, 1.15 mS-cm 29.5 °C.	
40			0.1 L/s, 7.22, 19.17 mS-cm 29.8 °C.	No fill
		SW med SAND well graded, loose, SR, qtz pale yellow pale reddish brown with pale grey. Minor dense limestone chips at 46 - 47m	0.1 L/s, 7.42, 32.1 mS-cm 32.5 °C.	55.2 mm PVC slotted class 9 screen
		SW med SAND well graded, loose, SR, qtz pale yellow pale grey.	0.15 L/s, 7.47, 36.1 mS-cm 29.7 °C.	
50				

Drilling Company: Harrington Drilling	Started: 24/08/2020
Drilling Equipment: RC Hammer and Air Core	Completed: 24/08/2020
Drilling Method: RC	Compiled: 20/10/2020

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Borehole: LH08M

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
				Native back fill
60				
70				
80				
90				
100				

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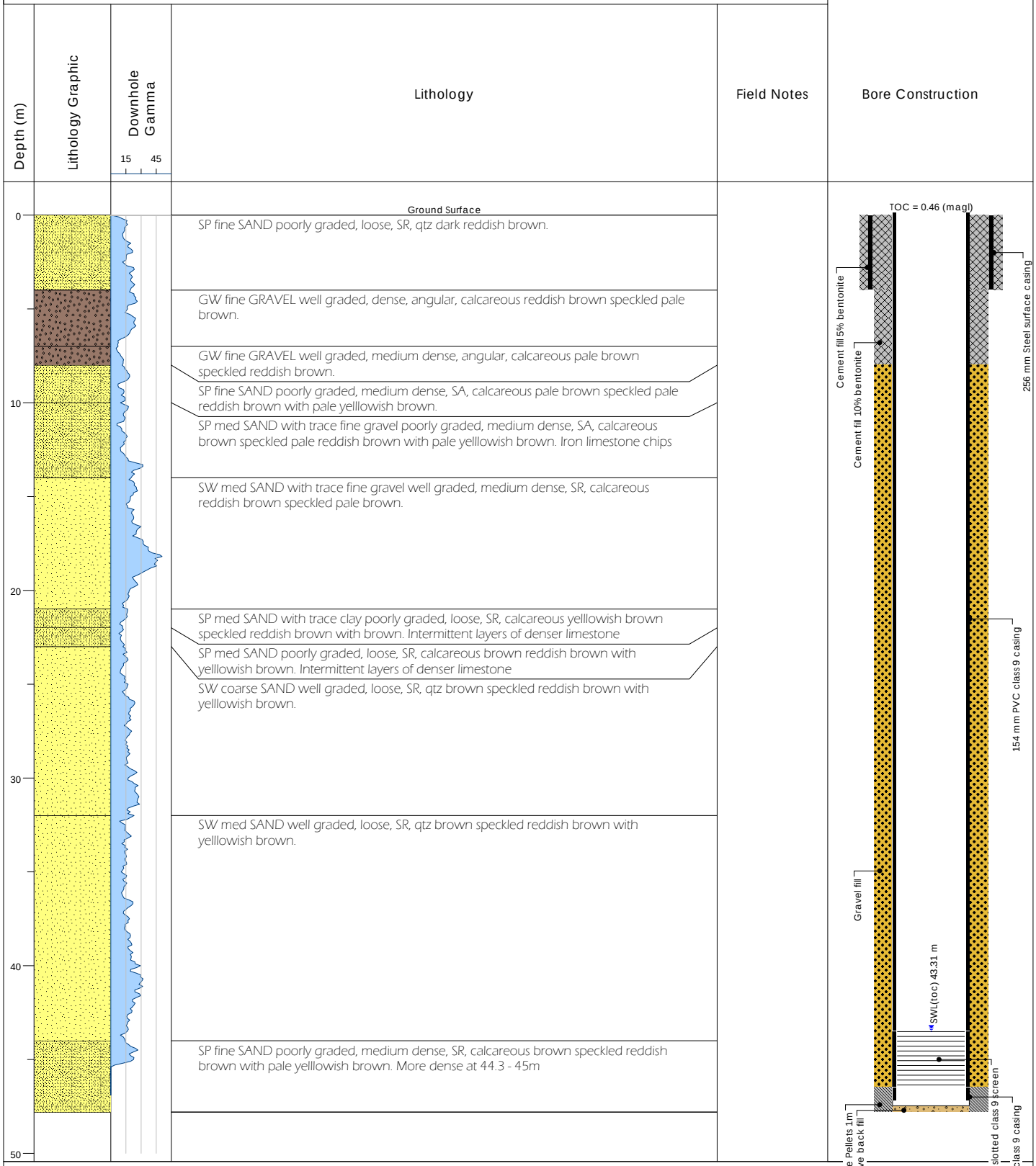
Borehole: LH04P

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 47 (mAHD)	Total Depth: 47.5 m
Client: MIN North West Resorts Pty Ltd	Easting: 200620	SWL: 43.31 m (toc) on 08/09/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7583776	Salinity: 9504 mg/L on 08/09/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE



Drilling Company: Harrington Drilling	Started: 3/09/2020
Drilling Equipment: Mud Rotary	Completed: 6/09/2020
Drilling Method: Mud	Compiled: 20/10/2020

Logged to Australian Standard: Geotechnical Site Investigations AS 1726-1993/Amdt 2-1994.

5/149 Herdsman Pde WA 6014
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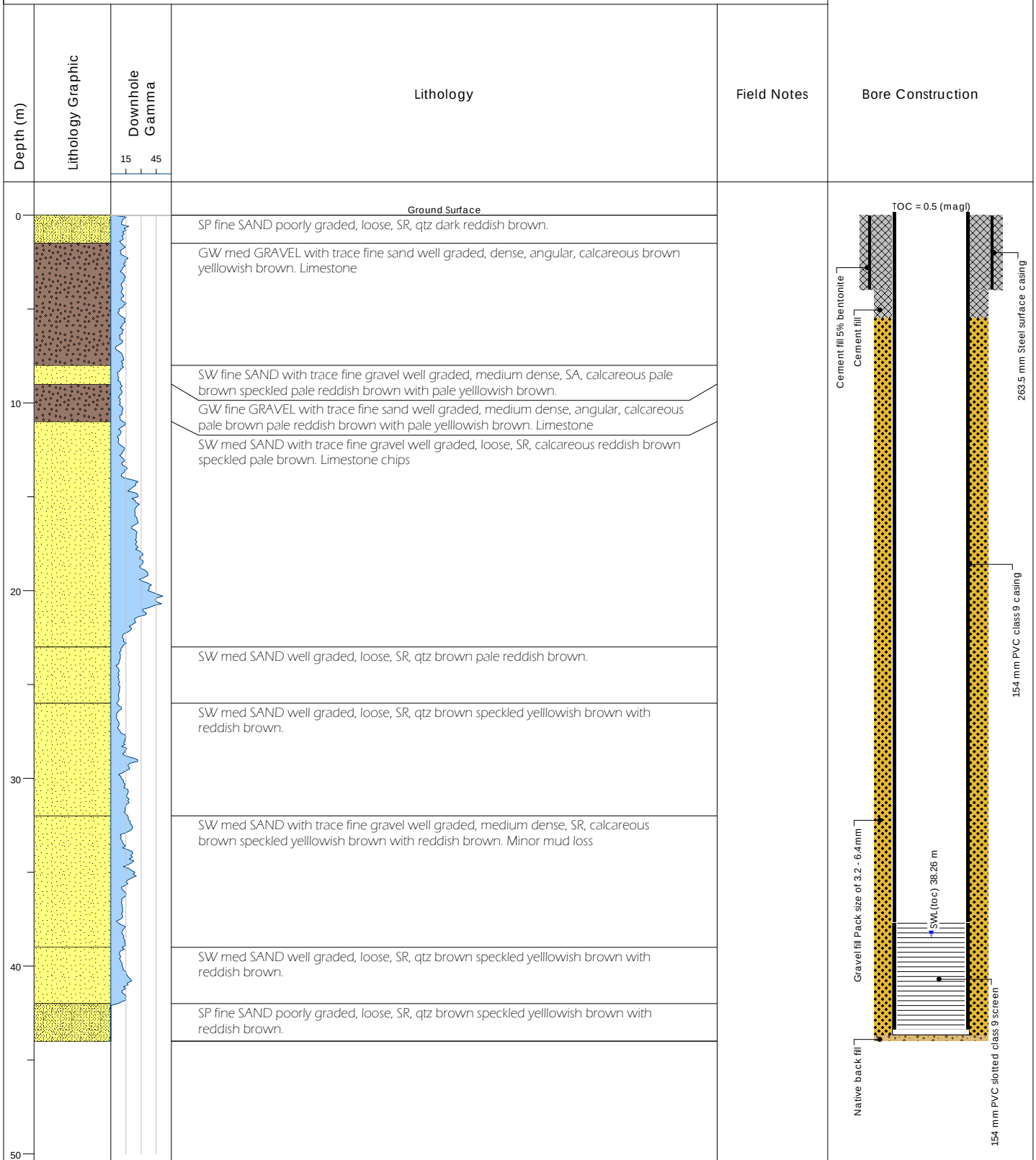
Borehole: LH06P

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 46 (mAHD)	Total Depth: 43.7 m
Client: MIN North West Resorts Pty Ltd	Easting: 200728	SWL: 38.26 m (toc) on 25/08/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7584023	Salinity: 10296 mg/L on 25/08/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE



Drilling Company: Harrington Drilling	Started: 25/08/2020
Drilling Equipment: RAB Hammer and Rotary Mud	Completed: 28/08/2020
Drilling Method: Mud	Compiled: 20/10/2020

Logged to Australian Standard: Geotechnical Site Investigations AS 1726-1993/Amdt 2-1994.

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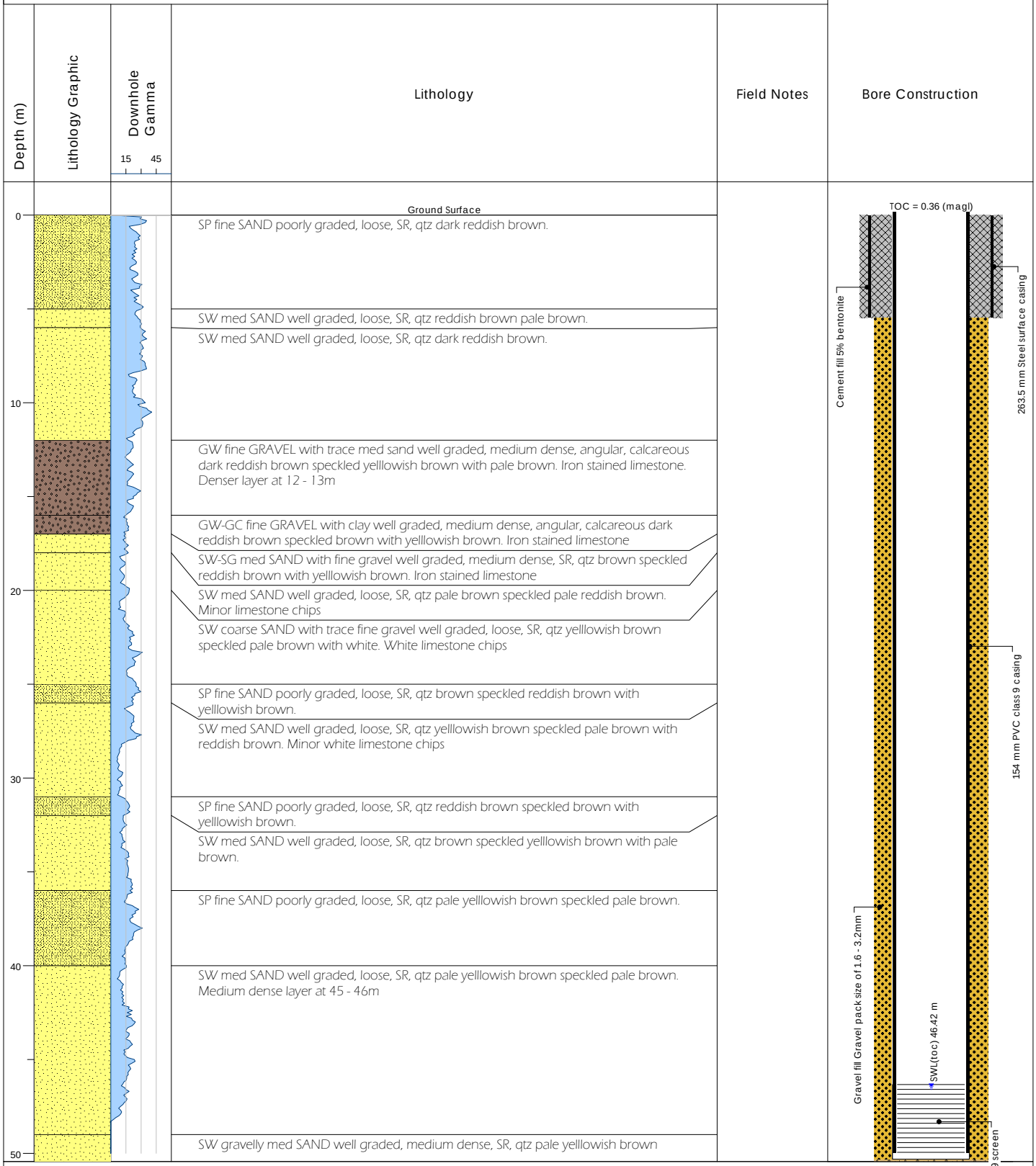
Borehole: LH07P

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 57 (mAHD)	Total Depth: 50.32 m
Client: MIN North West Resorts Pty Ltd	Easting: 200619	SWL: 46.42 m (toc) on 02/09/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7583530	Salinity: 13320 mg/L on 02/09/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE



Drilling Company: Harrington Drilling
Drilling Equipment: Rotary Mud
Drilling Method: Mud

Started: 30/08/2020
Completed: 2/09/2020
Compiled: 20/10/2020

Logged to Australian Standard: Geotechnical Site Investigations AS 1726-1993/Amdt 2-1994.

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Borehole: LH07P

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Downhole Gamma (15 – 45)	Lithology	Field Notes	Bore Construction
					Native back fill
60					
70					
80					
90					
100					

Logged to Australian Standard: Geotechnical Site Investigations AS 1726-1993/Amdt 2-1994.

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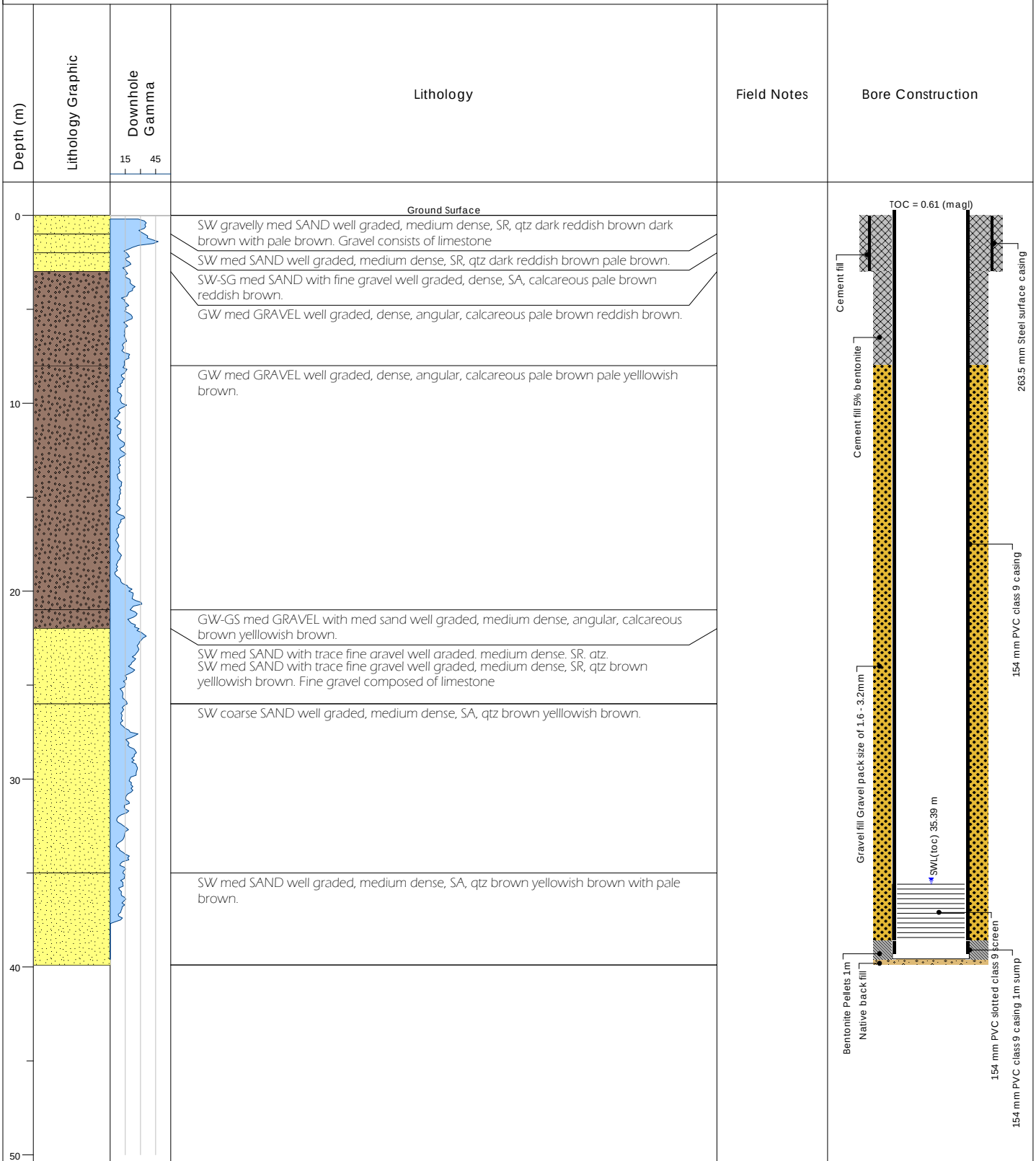
Borehole: LH08P

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 41 (mAHD)	Total Depth: 39.9 m
Client: MIN North West Resorts Pty Ltd	Easting: 200990	SWL: 35.39 m (toc) on 17/09/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7584487	Salinity: 2040 mg/L on 17/09/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE



Drilling Company: Harrington Drilling	Started: 12/09/2020
Drilling Equipment: Rotary Mud	Completed: 15/09/2020
Drilling Method: Mud	Compiled: 20/10/2020

Logged to Australian Standard: Geotechnical Site Investigations AS 1726-1993/Amdt 2-1994.

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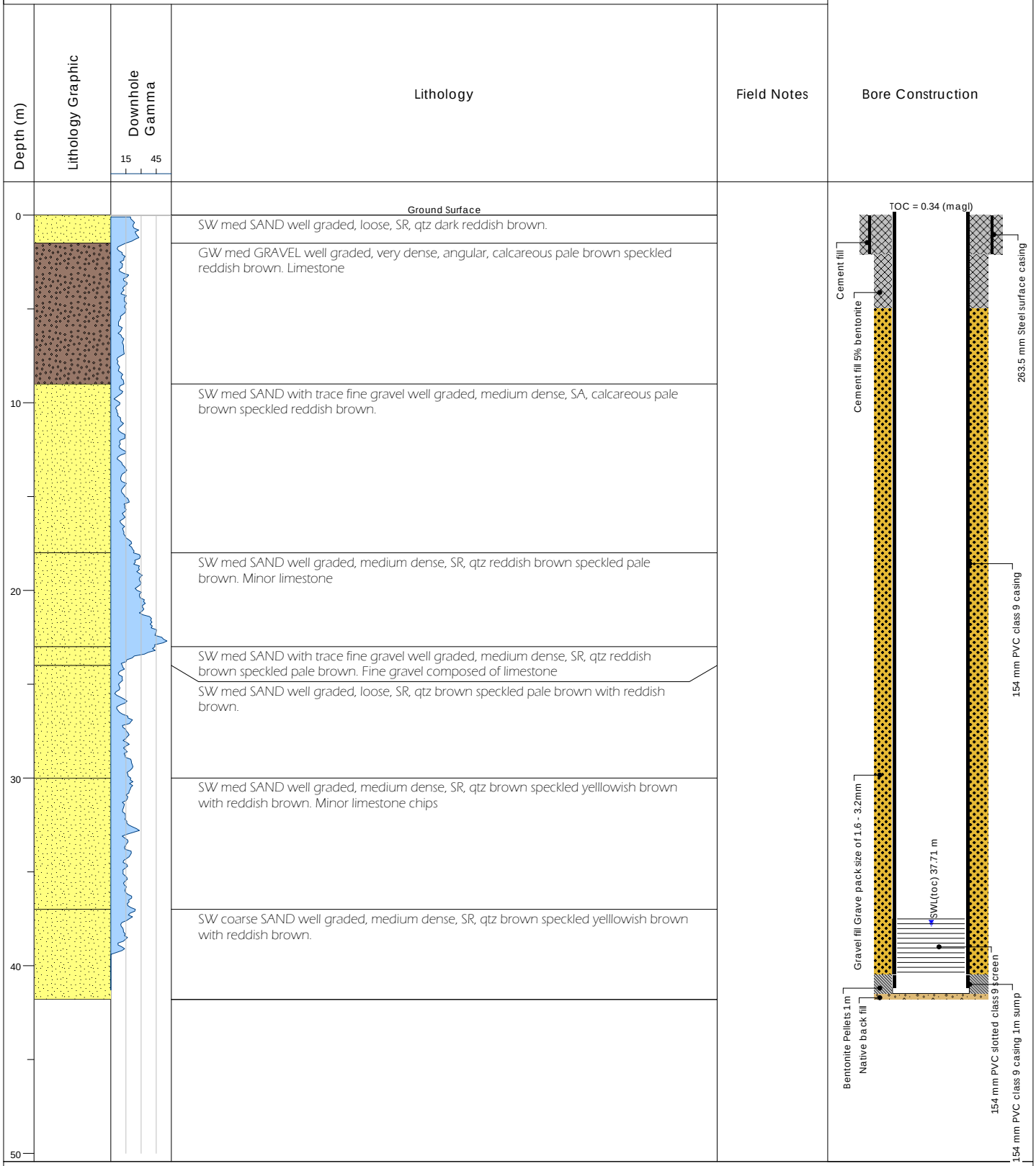
Borehole: LH09P

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 54 (mAHD)	Total Depth: 41.5 m
Client: MIN North West Resorts Pty Ltd	Easting: 200914	SWL: 37.71 m (toc) on 12/09/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7584277	Salinity: 3840 mg/L on 12/09/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE



Drilling Company: Harrington Drilling	Started: 8/09/2020
Drilling Equipment: Rotary Mud	Completed: 11/09/2020
Drilling Method: Mud	Compiled: 20/10/2020

Logged to Australian Standard: Geotechnical Site Investigations AS 1726-1993/Amdt 2-1994.

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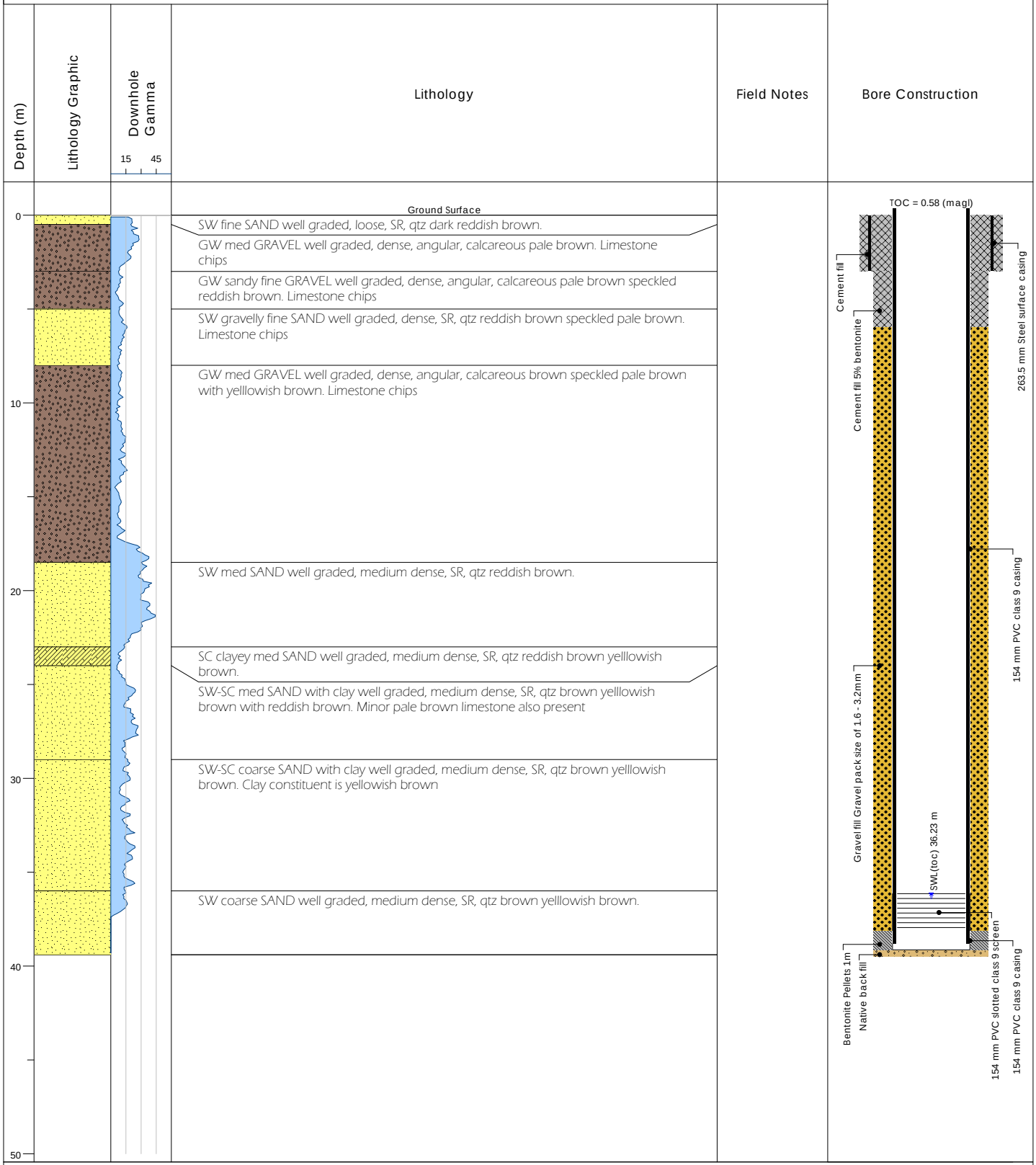
Borehole: LH10P

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 44 (mAHD)	Total Depth: 39.15 m
Client: MIN North West Resorts Pty Ltd	Easting: 2001006	SWL: 36.23 m (toc) on 20/09/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7584389	Salinity: 1764 mg/L on 20/09/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE



Drilling Company: Harrington Drilling	Started: 17/09/2020
Drilling Equipment: Mud Rotary	Completed: 20/09/2020
Drilling Method: Mud	Compiled: 20/10/2020

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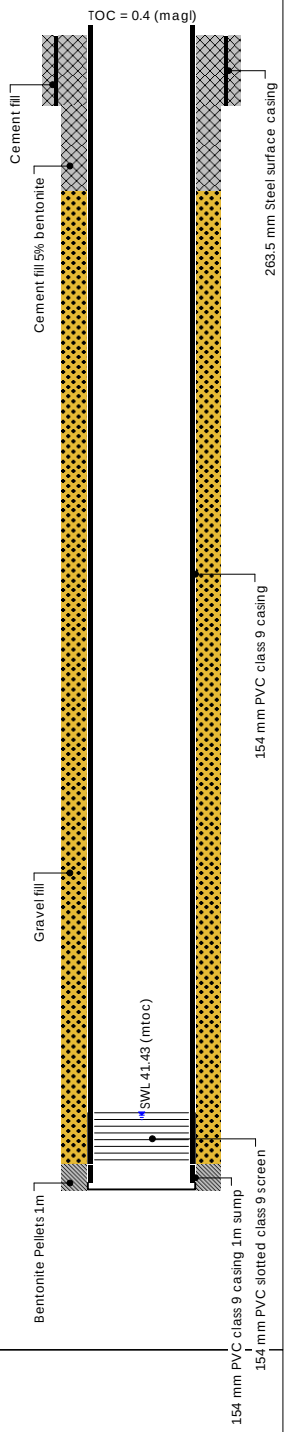
Borehole: LH11P

Project: Lighthouse Borefield	Zone: 50 (GDA94)	Elevation: 52 (mAHD)	Total Depth: 44.34 m
Client: MIN North West Resorts Pty Ltd	Easting: 200697	SWL: 41.43 m (toc) on 23/09/2020	Logged By: Kim Greenham
Location: Lighthouse Borefield	Northing: 7583921	Salinity: 4530 mg/L on 23/09/2020	Checked By: Ben Fisher

SUBSURFACE PROFILE

Depth (m)	Lithology Graphic	Lithology	Field Notes	Bore Construction
0		Ground Surface		
		SW fine SAND well graded, loose, SR, qtz dark reddish brown.		
		SW gravelly med SAND well graded, medium dense, SA, qtz reddish brown. Fine gravel composed of angular limestone chips		
		GW fine GRAVEL well graded, dense, angular, calcareous pale brown speckled pale reddish brown. Limestone		
10		SW-SG med SAND with fine gravel well graded, medium dense, SR, qtz pale reddish brown speckled pale brown. Fine gravel composed of limestone chips		
		SW med SAND with trace fine gravel well graded, medium dense, SR, qtz reddish brown speckled brown with pale brown. Minor limestone chips		
		SW med SAND with trace fine gravel well graded, medium dense, SR, qtz brown speckled reddish brown with brown. Minor limestone chips		
20		SW-SC med SAND with clay well graded, medium dense, SR, qtz dark reddish brown.		
		SW med SAND well graded, medium dense, SR, qtz brown reddish brown.		
		SW med SAND well graded, medium dense, SR, qtz brown yelllowish brown.		
30		SW med SAND well graded, medium dense, SR, qtz yelllowish brown brown.		
40				
50				



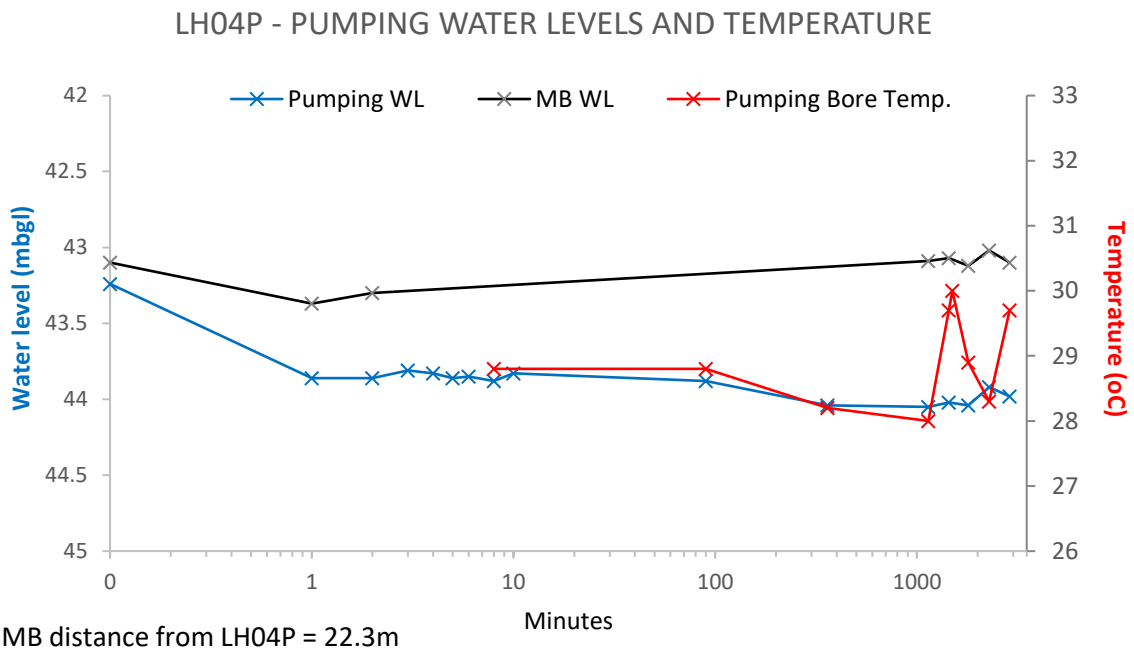
Drilling Company: Harrington Drilling
Drilling Equipment: Mud Rotary
Drilling Method: Mud

Started: 20/09/2020
Completed: 23/09/2020
Compiled: 19/10/2020

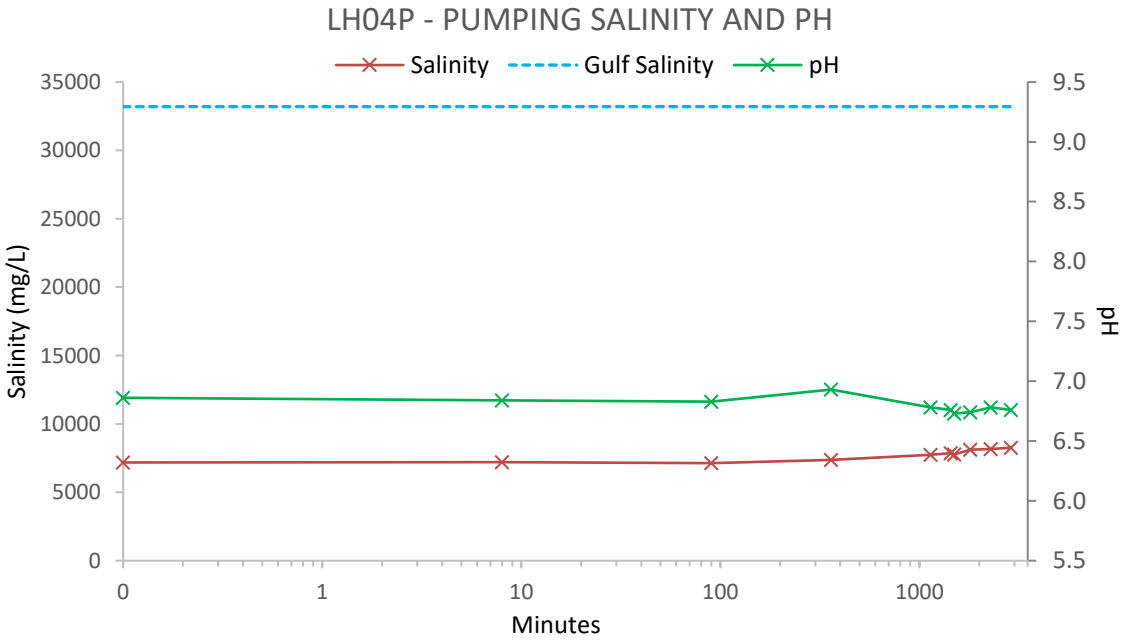
Logged to Australian Standard: Geotechnical Site Investigations AS 1726-1993/Amdt 2-1994.

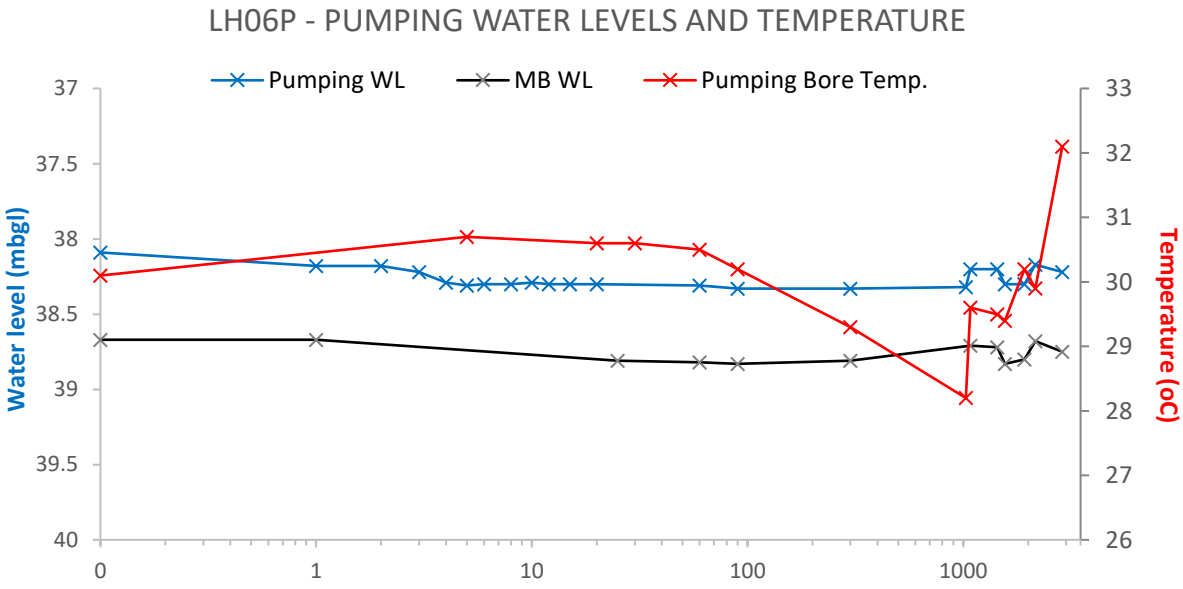
Appendix D

Pump Test Results

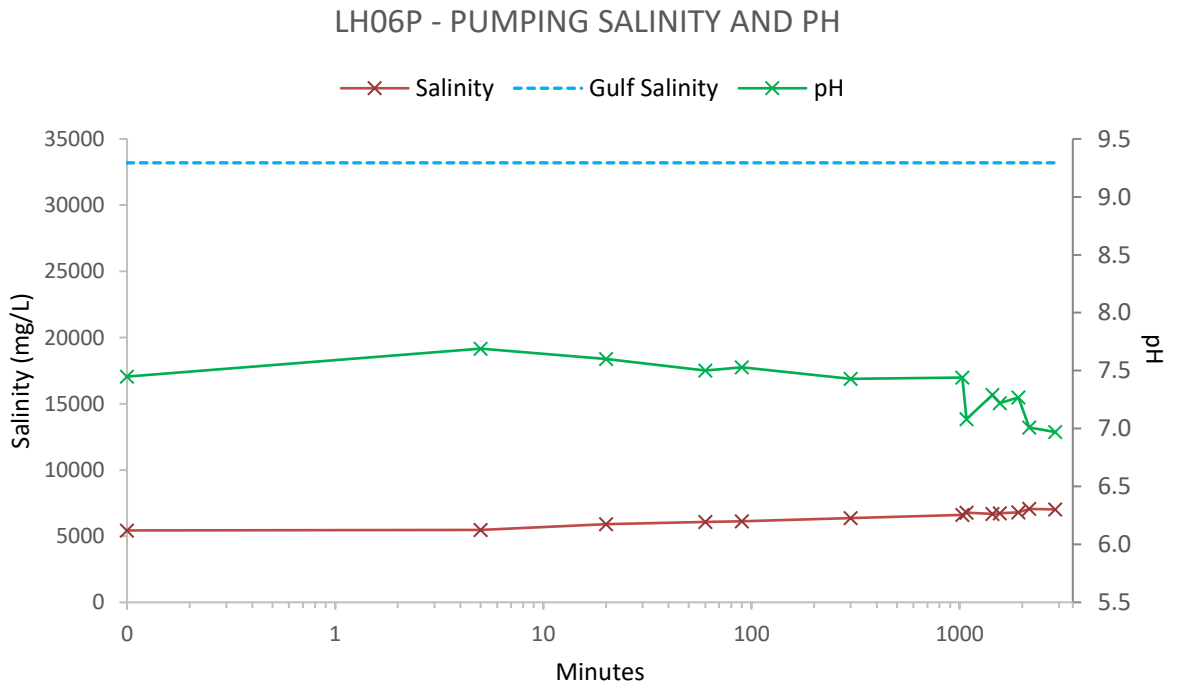


* MB distance from LH04P = 22.3m

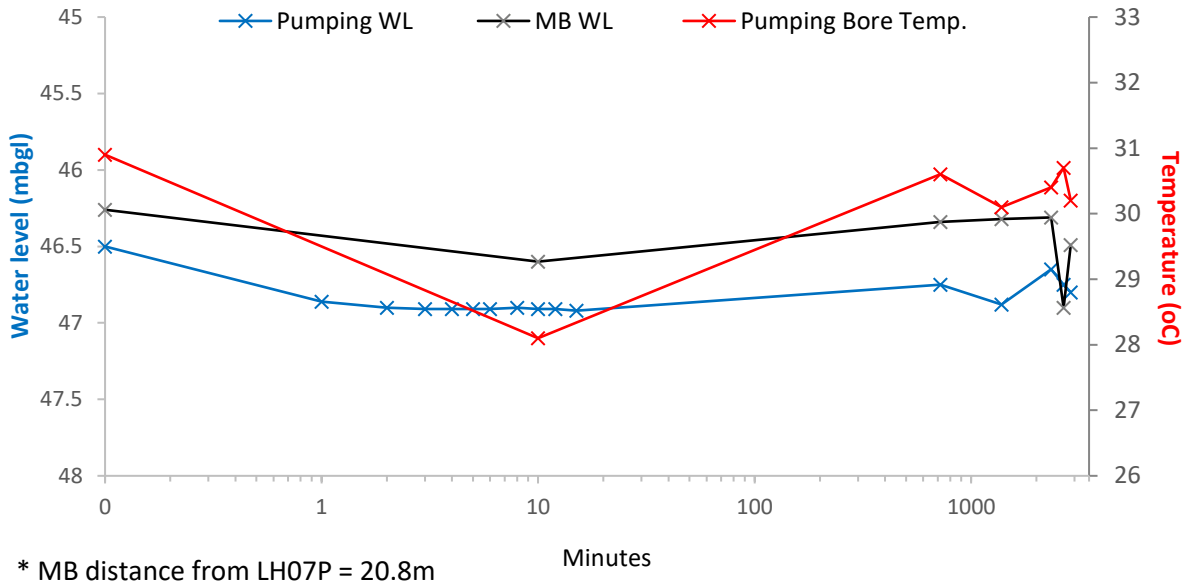




* MB distance from LH06P = 19.5m

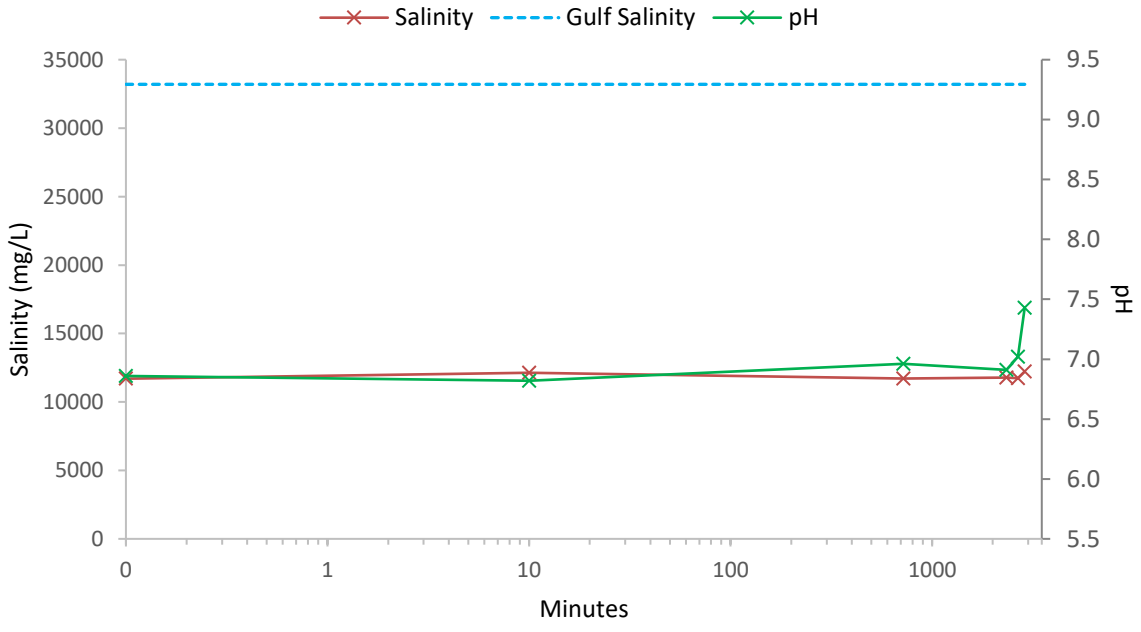


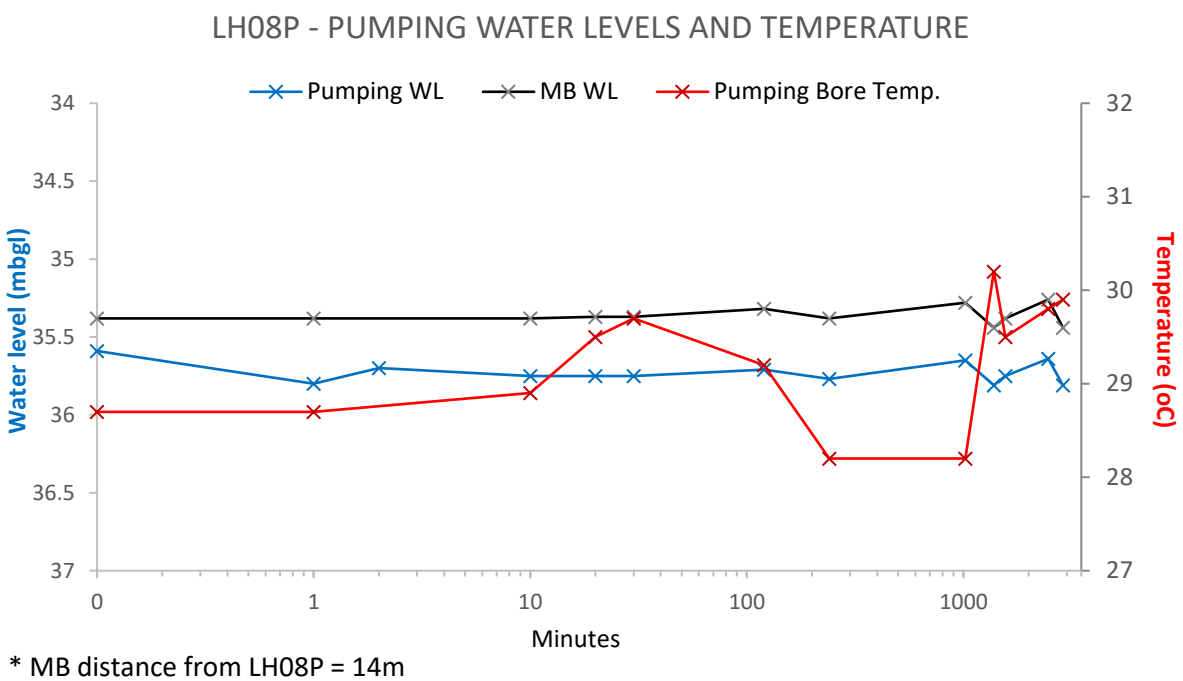
LHO7P - PUMPING WATER LEVELS AND TEMPERATURE



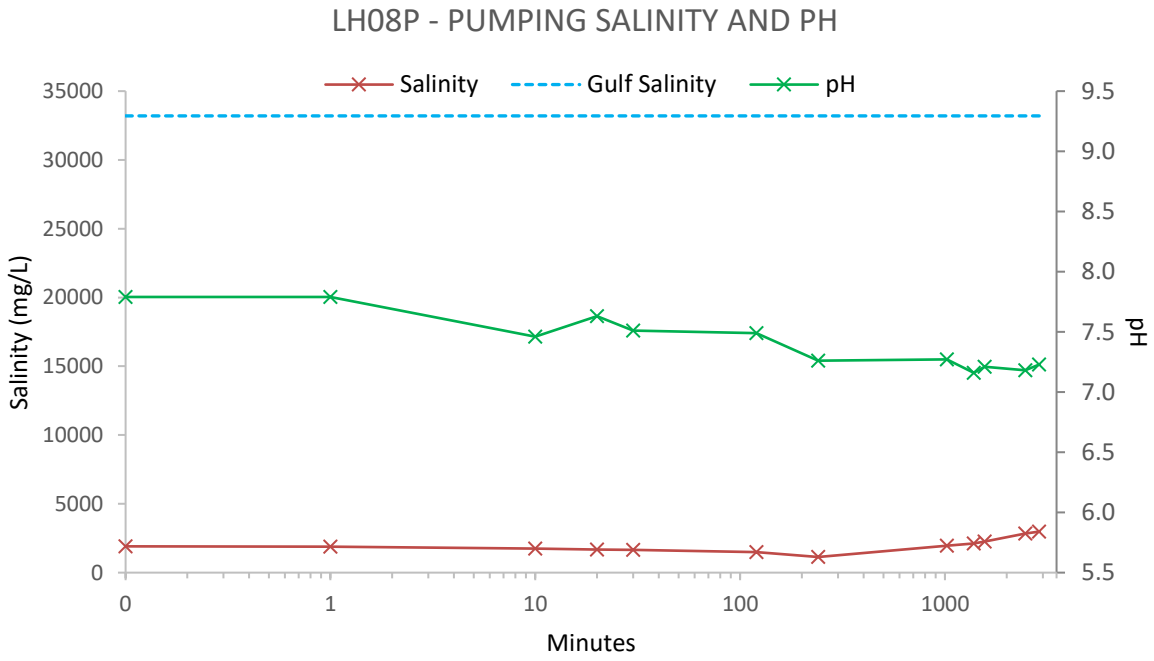
* MB distance from LH07P = 20.8m

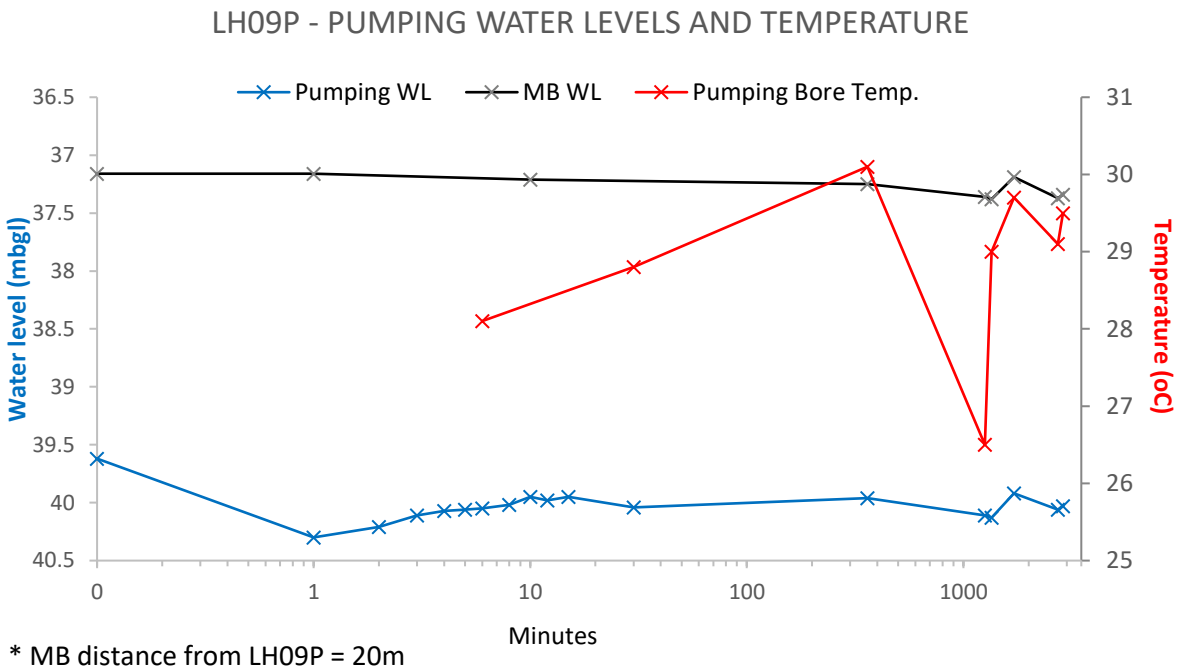
LH07P - PUMPING SALINITY AND PH



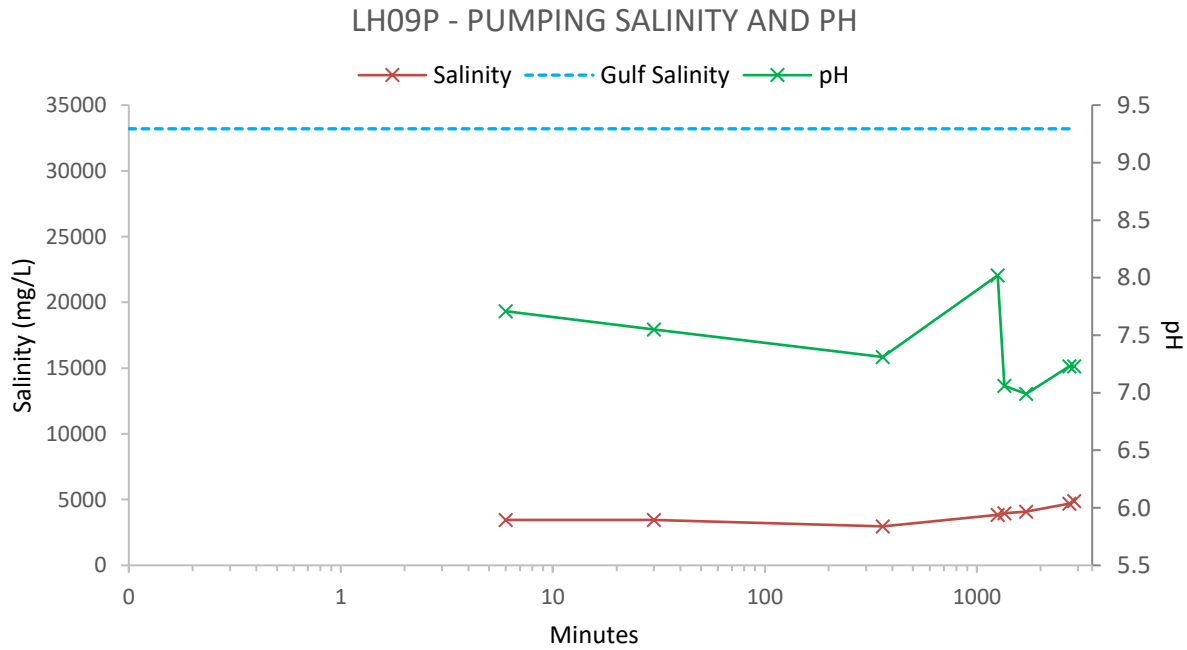


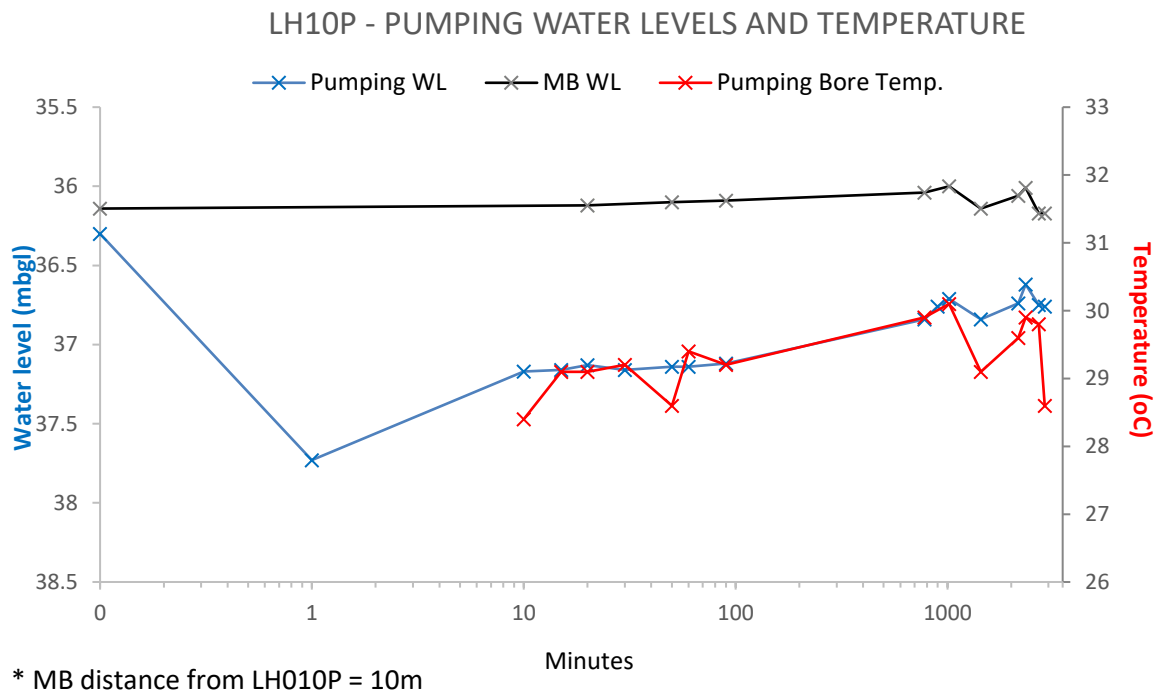
* MB distance from LH08P = 14m



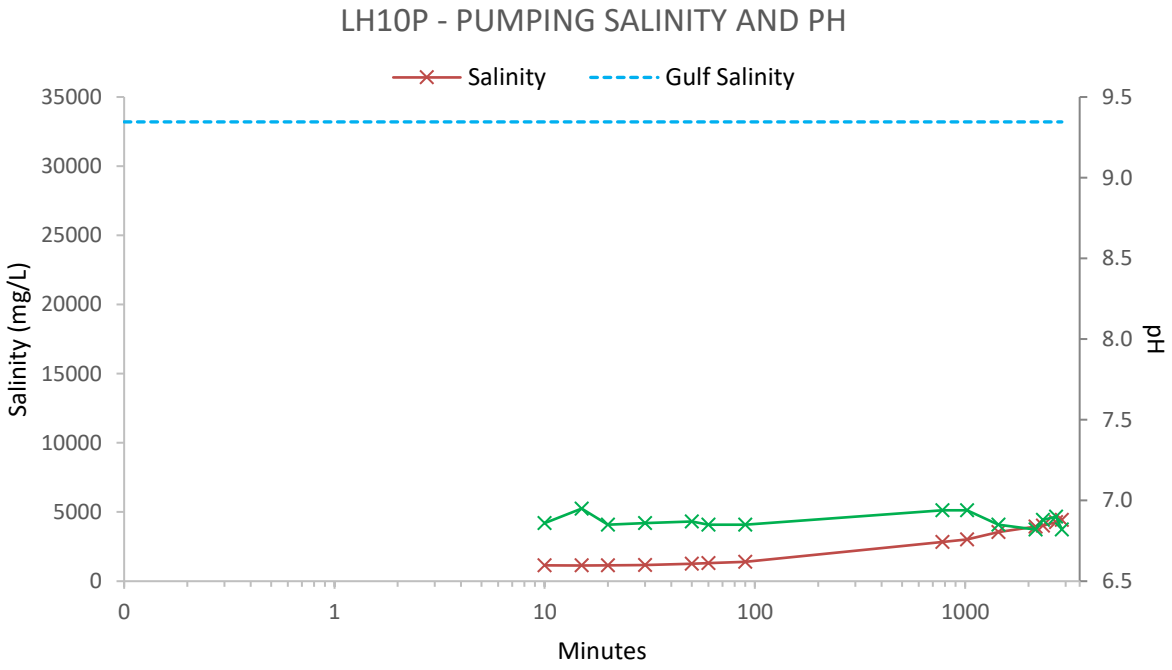


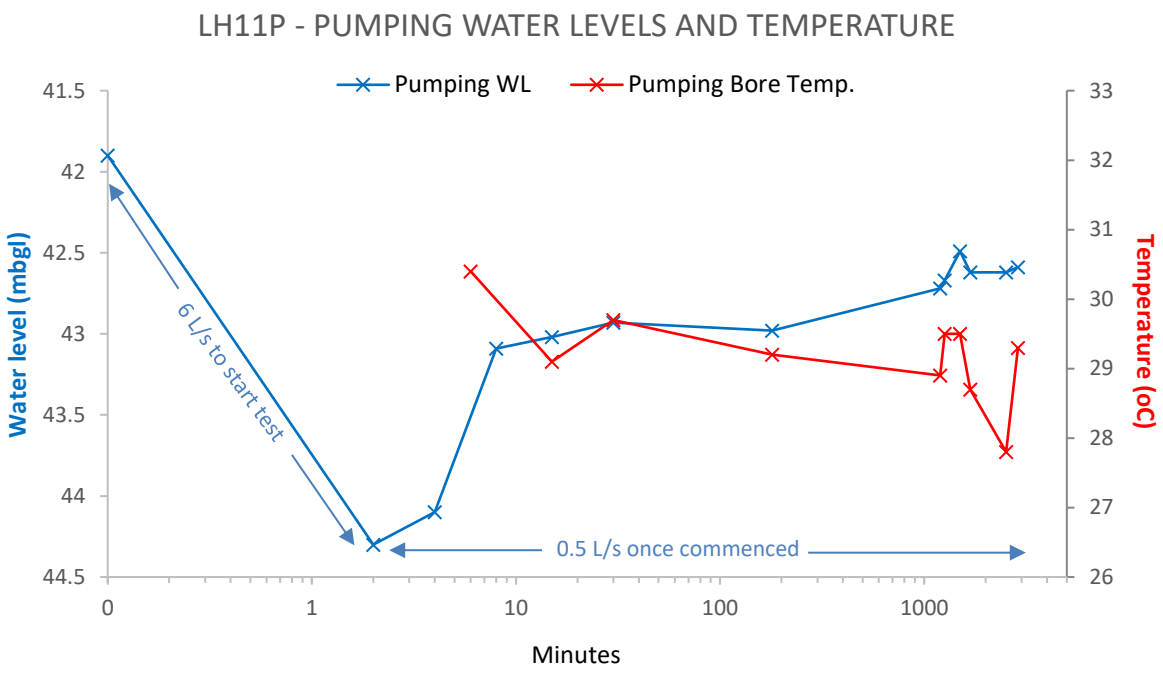
* MB distance from LH09P = 20m

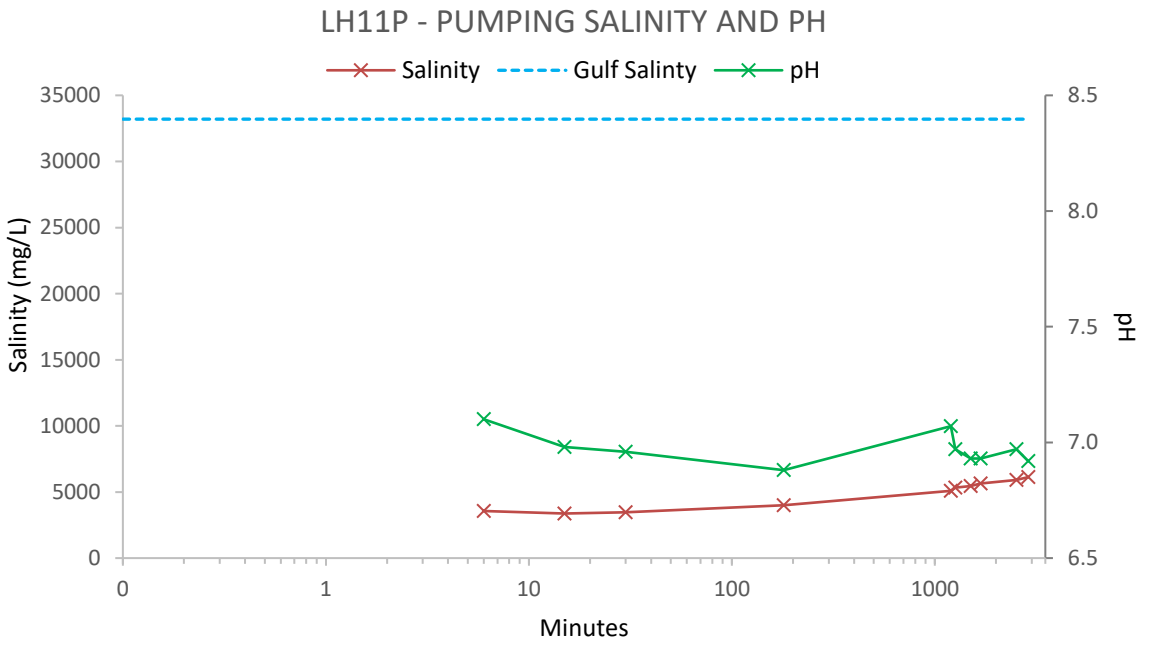




* MB distance from LH010P = 10m




LH11P - PUMPING WATER LEVELS AND TEMPERATURE
Pumping WL
Pumping Bore Temp.
Water level (mbgl)
Temperature (oC)
41.5
42
42.5
43
43.5
44
44.5
33
32
31
30
29
28
27
26
6 L/s to start test
0.5 L/s once commenced
0
1
10
100
1000
Minutes


LH11P - PUMPING SALINITY AND PH
Salinity
Gulf Salinty
pH
Salinity (mg/L)
pH
35000
30000
25000
20000
15000
10000
5000
0
8.5
8.0
7.5
7.0
6.5
0
1
10
100
1000
Minutes

Appendix E

Water Quality Results

Parameters	Units	LH04P	LH06P	LH07P	LH08P	LH09P
Laboratory Parameters						
Ion Balance	%	-2.6	-2.1	-3.7	-5.2	-2.8
pH	pH_unit	7.3	7.4	7.3	7.3	7.4
TDS (Evap)	mg/L	9400	7000	14000	2900	4700
Conductivity at 25C	uS/cm	15200	11600	21300	4900	8070
Turbidity	NTU	<0.5	<0.5	<0.5	<0.5	1.2
Turbidity – After Filtration	NTU	<0.5	<0.5	<0.5	<0.5	<0.5
True Colour	TCU	1	2	1	1	<1
Major Ions						
Calcium - Filterable	mg/L	298	204	302	202	186
Chloride	mg/L	5170	3810	7800	1420	2590
Fluoride	mg/L	0.53	0.46	0.78	0.17	0.44
Magnesium - Filterable	mg/L	265	220	430	80.2	147
Silica – SiO2	mg/L	47	26	41	19	32
Sodium - Filterable	mg/L	2690	2050	4010	689	1310
Sulfate	mg/L	590	490	990	330	270
Bicarbonate – HCO3	mg/L	350	350	340	240	300
Carbonate - CO3	mg/L	<1	<1	<1	<1	<1
Hydroxide - OH	mg/L	<1	<1	<1	<1	<1
Nutrients						
Nitrate as NO3-N (Calc)	mg/L	0.48	3.2	0.38	11	1.9
Ammonia as NH3-N	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Potassium - Filterable	mg/L	128	94.9	191	32.4	67.2
Metals						
Aluminium - Total	mg/L	0.007	<0.005	<0.005	0.007	0.068
Arsenic – Total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Barium - Total	mg/L	0.086	0.068	0.076	0.073	0.065
Beryllium - Total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron - Total	mg/L	1.4	1.1	2.1	0.47	0.73
Cadmium - Total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium - Total	mg/L	0.0007	0.0004	0.0007	0.0002	0.0005
Cobalt - Total	mg/L	0.0002	0.002	0.0005	0.0003	0.0003
Copper - Total	mg/L	0.0094	0.0018	0.0018	0.0021	0.0018
Iron – Filterable	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Iron - Total	mg/L	0.008	0.005	<0.005	<0.005	0.039
Lead - Total	mg/L	0.0029	<0.0001	0.0008	0.0007	0.0006
Manganese - Total	mg/L	0.0023	0.087	0.011	0.021	0.029
Molybdenum - Total	mg/L	0.0009	0.0012	0.0013	0.0003	0.0004
Nickel - Total	mg/L	0.0057	0.0022	0.0021	0.003	0.0014
Selenium - Total	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Silver - Total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Strontium - Total	mg/L	3.4	2.7	5.2	1.1	2.1
Tin - Total	mg/L	<0.0001	<0.0001	<0.0005	<0.0001	<0.0001
Zinc - Total	mg/L	0.057	0.009	0.011	0.009	0.01

Parameters	Units	LH10P	LH11P
Laboratory Parameters			
Ion Balance	%	-5.5	-3.4
pH	pH_unit	7.3	7.3
TDS (Evap)	mg/L	4400	6300
Conductivity at 25C	uS/cm	7250	10200
Turbidity	NTU	<0.5	<0.5
Turbidity – After Filtration	NTU	<0.5	<0.5
True Colour	TCU	1	<1
Major Ions			
Calcium - Filterable	mg/L	212	221
Chloride	mg/L	2300	3370
Fluoride	mg/L	0.3	0.41
Magnesium - Filterable	mg/L	123	173
Silica – SiO2	mg/L	31	35
Sodium - Filterable	mg/L	1060	1730
Sulfate	mg/L	280	390
Bicarbonate – HCO3	mg/L	270	330
Carbonate - CO3	mg/L	<1	<1
Hydroxide - OH	mg/L	<1	<1
Nutrients			
Nitrate as NO3-N (Calc)	mg/L	3.8	1
Ammonia as NH3-N	mg/L	<0.010	<0.010
Potassium - Filterable	mg/L	53.6	84.4
Metals			
Aluminium - Total	mg/L	<0.005	<0.005
Arsenic – Total	mg/L	<0.0001	<0.0001
Barium - Total	mg/L	0.062	0.066
Beryllium - Total	mg/L	<0.0001	<0.0001
Boron - Total	mg/L	0.62	1
Cadmium - Total	mg/L	<0.0001	<0.0001
Chromium - Total	mg/L	0.0004	0.0005
Cobalt - Total	mg/L	0.0003	0.0003
Copper - Total	mg/L	0.0016	0.0017
Iron – Filterable	mg/L	<0.005	<0.005
Iron - Total	mg/L	0.01	0.011
Lead - Total	mg/L	0.0004	0.0003
Manganese - Total	mg/L	0.025	0.02
Molybdenum - Total	mg/L	0.0002	0.0004
Nickel - Total	mg/L	0.001	0.0009
Selenium - Total	mg/L	<0.0002	<0.0002
Silver - Total	mg/L	<0.0001	<0.0001
Strontium - Total	mg/L	1.7	2.3
Tin - Total	mg/L	<0.0001	<0.0001
Zinc - Total	mg/L	<0.005	0.006