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Engineering

Working Beyond Expectations

On-site Wastewater Management Plan

Proposed Worimi Eco-Tourism Development

Property:
Lot 227 DP 1097995
Stockton Bight Track, Fullerton Cove

Applicant:
Worimi Local Aboriginal Land Council

Date:
June 2019

Document Control Sheet

Issue No.	Amendment	Date	Prepared By	Checked By
A	Initial Issue	21 June 2019	RJ	CB

Limitations Statement

This report has been prepared in accordance with and for the purposes outlined in the scope of services agreed between ADW Johnson Pty Ltd and the Client. It has been prepared based on the information supplied by the Client, as well as investigation undertaken by ADW Johnson and the sub-consultants engaged by the Client for the project.

Unless otherwise specified in this report, information and advice received from external parties during the course of this project was not independently verified. However, any such information was, in our opinion, deemed to be current and relevant prior to its use. Whilst all reasonable skill, diligence and care have been taken to provide accurate information and appropriate recommendations, it is not warranted or guaranteed and no responsibility or liability for any information, opinion or commentary contained herein or for any consequences of its use will be accepted by ADW Johnson or by any person involved in the preparation of this assessment and report.

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APPENDICES

1.0 Introduction and Background

1.1 INTRODUCTION

ADW Johnson Pty Ltd (ADWJ) has been commissioned by Worimi Local Aboriginal Land Council (LALC) to prepare an On-site Wastewater Management Plan for the proposed development of Lot 227 DP 1097995, located on Stockton Bight Track, Fullerton Cove.

This report has been prepared to accompany the Development Application (DA) plans and documentation to provide evidence that the proposed on-site wastewater management system and controls are generally in accordance with *Port Stephens Council (PSC) On-Site Sewage Development Assessment Framework (DAF)* requirements & *AS 1547:2012 On-site Domestic Wastewater Management*. This assessment serves to provide an overview of the proposed on-site wastewater management plan and a more detailed assessment should be undertaken during the design phase for submission of a Construction Certificate (CC).

The site owner and author details are listed in **Table 1**.

Table 1 – Site Owner and Author Details

Council Area	Port Stephens Council
Owner	Worimi Local Aboriginal Land Council
Lot and DP	Lot 227 DP 1097995
Authors Name and Qualifications	Rhys Johns (Civil Engineer)
Reviewers Name and Qualifications	Cameron Black (Senior Hydraulic Engineer)
Consultants Name	ADW Johnson Pty Ltd
Consultants Contact Details	(02) 4978 5100

1.2 BACKGROUND

The proposed development site is located on the Stockton Bight Track, Fullerton Cove and is described as Lot 227 DP 1097995. The owner of the site is the Worimi LALC. The development site locality is shown in **Figure 1**.

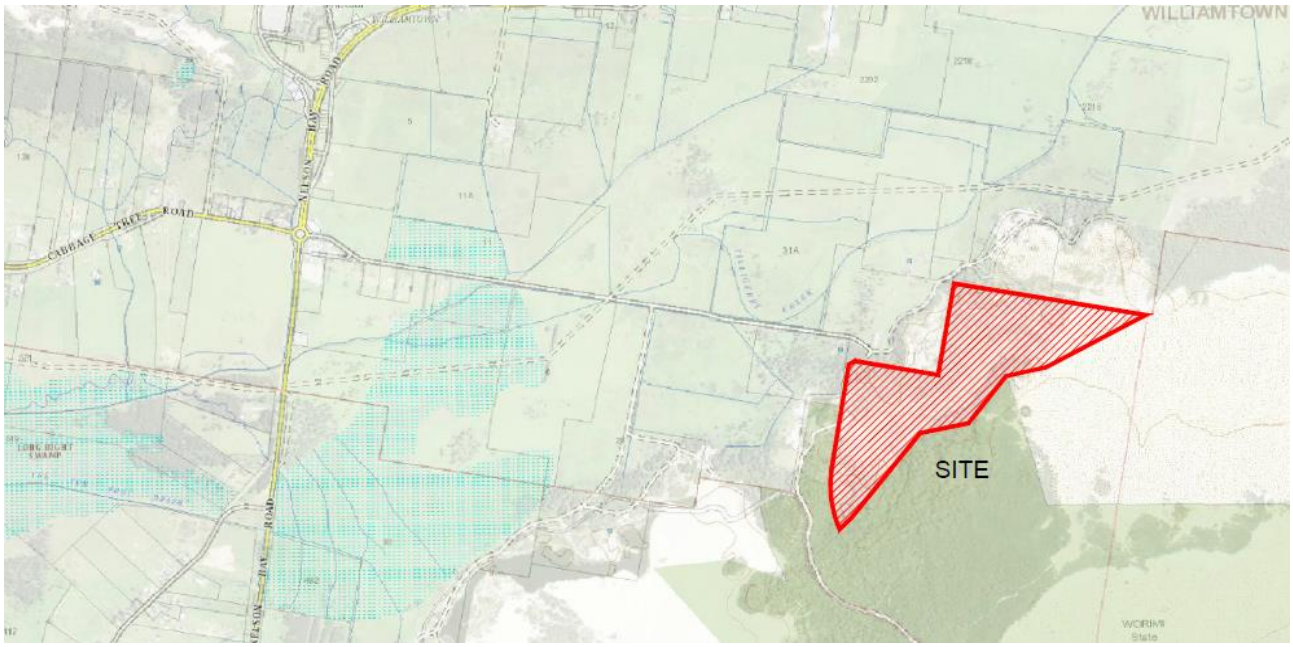

Figure 1 - Site locality

The site is zoned E3 – Environmental Management under Port Stephens Local Environmental Management Plan 2013 (PS LEMP). The proposed development, defined as 'Eco-tourist facilities', is a permissible development with development consent within this zone. Accordingly, the assessment for the proposed is under Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) with Council as the consent authority.

The site is currently vacant aside from a single shipping container used by the Worimi LALC for storage, fencing and natural access tracks.

1.3 PROPOSED DEVELOPMENT

The subject site (**Figure 1**) is located adjacent Stockton Bight Track and the total site land area is approximately 1 ha in size.

The proposed development will incorporate a carpark, a visitor's centre, common building, manager's residence, amenity blocks and 44 accommodation lodges with access via Lavis Lane. The carpark will include vehicle and quad bike access to various existing and proposed dune tracks. There are three proposed amenity blocks across the site with separate male and female blocks each including showers, toilets and hand basins.

1.4 EXISTING WATER AND SEWER SERVICES

Following review of Dial-Before-You-Dig (DBYD) information for the proposed development site, it was determined that there are no existing water or wastewater services within the vicinity of the site. This was confirmed in writing by Hunter Water.

The closest watermain connection point services 20 Lavis Lane, Williamtown, approximately 2 km west of the proposed development site. It is proposed to service the development via on-site rainwater tanks for each of the proposed amenity blocks, managers residence and the visitors centre. The rainwater tanks harvest rainwater via roof area run-off and will be topped up with potable water from water tanker trucks along the access road during extended periods of low to no rainfall.

The closest sewer connection point available is located approximately 2.4 km west of the site. Due to the location of the sewer connection point, it is proposed to manage wastewater on-site.

1.5 HAZARD CLASS

PSC has identified the site as 'High Hazard' in Council's on-site sewage management mapping. This report stands to provide sufficient information with the DA to make an assessment on the proposed wastewater system.

The site is classified as a non-domestic site, hence the assessment has been undertaken in accordance with *Section 3.2 Non-domestic On-site Systems High/Very High Hazard (10-100 kL/day) of PSC's On-site Sewage DAF*.

High hazard assessment criteria is outlined under *Section 3.2 of PSC On-site Sewage DAF in Table 3-11 Minimum Standard for Wastewater Management Reports*.

2.0 Site and Soil Assessment

2.1 LOCALITY AND LANDSCAPE CHARACTERISTICS

The subject site is located close to the end of Lavis Lane, Williamtown, along Stockton Bight Track, see **Figure 2**. It is located south-east of Newcastle Airport, within Worimi Conservation Lands. The subject site is approximately 18 km from Nelson Bay and 28 km from Newcastle City Centre.

Figure 2 – Locality Map

The site is defined as an irregular shaped parcel of land, extending west off Stockton Bight Track, Fullerton Cove and bounded by undeveloped bushland to the north and south; Stockton Bight Track to the west; and Stockton sand dunes to the east.

2.2 SITE ASSESSMENT

Cardno has been commissioned to undertake geotechnical investigations of the subject site. Site investigations and field work was undertaken on the 19th May 2019.

Topographically the site is located within regionally low-lying gently undulating terrain, with local topography characterised by aeolian sand dunes. Vegetation of the site comprises predominately open pasture with sparsely scattered mature trees, with tree density increasing around the site boundary. Surface levels on the site generally vary from about 4 m AHD to 20 m AHD.

Table 2 provides site assessment criteria and ratings of the identified unconstrained areas of the site potentially suitable for land application of wastewater in accordance with *PSC DAF Table 6-1 Minimum Standards for Site and Soil Assessment Procedures*.

Table 2 – Site Assessment

Site Feature	Conditions/Comments	Limitation
Slope	Site slopes typically range between 1 to 8° and fall towards the natural low point.	Minor limitation
Exposure	Adequate sun and wind exposure. Northerly exposure with the proposed area receiving full sun throughout the middle of the day.	No limitation
Vegetation	Predominately open pasture with sparsely scattered mature trees.	No limitation
Flood Potential	Above 1 in 100-year flood level.	No limitation
Run-on and Up-slope Seepage	Stormwater shall be diverted with use of diversion banks and channels around the land application area.	No limitation
Site Drainage	High drainage and infiltration of the site was observed.	Minor limitation
Depth to Limiting Horizon	Aeolean and aeoelan sand only encountered in the test pits conducted.	No limitation
Buffer Distances	Groundwater bores evident and the site lies within Hunter Water's Stockton Sandbeds groundwater drinking catchment.	Major limitation

Majority of suitable area for land application of effluent is less than 10% slope and would be suitable for either sub surface irrigation (SSI) or evaporation / transpiration trenches (ETA). Final land application design to be undertaken in consideration of natural slopes and land topography and may require some minor adjustments to provide a uniform sloping area.

The site is underlain by sands with high to moderate permeability. Any land application area should therefore be designed with a low long-term application rate in comparison to the hydraulic conductivity.

Whilst groundwater bores have been identified within 400m of the site the nominal 250m buffer to groundwater bores is easily meet. The site is located within the designated Hunter Water Stockton Sandbeds water supply area. Any onsite effluent application to land must therefore ensure suitable treatment and adoption of a suitable LTAR that mitigates against the possibility of any nutrient or pathogen migration into the below groundwater system. Provision of monitoring bores and an annual monitoring program may also be considered to ensure groundwater quality does not adversely change resulting from the provision of a land application system.

2.3 REVIEW OF AVAILABLE DATA

Reference to Newcastle Coalfield Regional 1:100,00 Geological Map Sheet Series 9231 and part 9131, 9132, 9232 indicate that the site is underlain by Quaternary aged deposit comprising of gravel, sand, silt and clay.

The site vicinity, as described by NSW Office of Environment eSPADE v2.0 web application tool, includes the following descriptions:

> *Physiography:*
> *Dune in dunefield under dry sclerophyll forest on aeolian, sand lithology and used for timber/scrub/unused. Profile is rapidly drained, erosion hazard is high, and no salting evident.*
>
> *Soil Hydrology:*
> *Profile is highly permeable and rapidly drained, no free water, run on is low and runoff is high.*
>
> *Profile Field Notes:*
> *Steep Holocene Dunes. Additional vegetation including Banksia Costata.*

2.4 SOIL ASSESSMENT

The subsurface conditions encountered across the site have been categorised and summarised as follows:

- AEOLEAN: Sand, grey-brown and fine to medium grain size with organics was encountered within to depths of up to 0.8m BGL in all test pits, overlying;
- AEOELAN: Sand, pale yellow-brown and fine to medium grain size was encountered down to the depth of the investigation. The consistency was observed to be generally very loose to loose.

No groundwater was encountered in the test pits conducted. It should be noted that groundwater levels are likely to fluctuate with variations in climatic and site conditions.

Table 3 provides soil assessment criteria and ratings in accordance with *PSC DAF Table 6-1 Minimum Standards for Site and Soil Assessment Procedures*.

Table 3 – Soil Assessment

Soil Feature	Conditions/Comments	Limitation
Depth to Groundwater (permanent or episodic)	None was encountered in the test pits conducted.	No limitation
Soil Texture	Fine to medium grained sand with <5% clay content.	Minor limitation
Coarse Fragments	Very few (<2%)	No limitation
Rocks and Rock Outcrops	No rock or rock outcrops present.	No limitation
Presence of Fill	No fill present.	No limitation
Soil Structure	Single grained.	No limitation
pH	5.1 to 6.2	No limitation
EC (dS/m)	0.03 to 0.07	No limitation
Emerson Aggregate Class	No Emerson Aggregate	No limitation

Soil Feature	Conditions/Comments	Limitation
	testing was undertaken as results of PSD tests indicated the material contained effectively no fine-grained particles, and as such would be non-dispersive.	
Cation Exchange Capacity (Cations) (meq/kg)	0.9 to 7.7	Minor limitation
Exchangeable Sodium Percentage (ESP) (% meq)	3.9 to 14.3%	Minor limitation
Phosphorous Sorption (mg/kg)	77 to 310 mg/kg (1300 – 5300 kg/Ha/yr)	Moderate limitation

Soil texture could be ameliorated by the importation of a loam soil to be tyned into the proposed land application area prior to construction. This would improve the organic content of the natural aeolean grey-brown sandy soils, minimise hydraulic conductively and improve the cation exchange capacity allowing the retention of greater nutrient levels within the immediate soil zone.

Despite the natural soils being predominately sand and unlikely to become sodic, elevated levels of sodium and salts in the treated effluent may result in the reduction in performance of the land application system over time. A gypsum additive could therefore be applied to the land application area on an annual basis to ensure the soils remain suitable for long term effluent application.

The relatively low phosphorus sorption capacity of the natural soils will be mitigated through appropriate sizing of the land application area to ensure a mass balance can be achieved without any concentration of phosphorus over the long-term operation of the system

2.5 SYSTEM DESIGN AND PERFORMANCE

The observed soil features include highly permeable sandy loams with moderate site slopes and within a designated drinking water catchment area. Following assessment of the site and soil in the location of the proposed development site, it has been found that there is only a moderate limitation to effluent disposal.

Given the above site assessment, it is recommended to incorporate as a minimum, primary and secondary treatment of the site wastewater. The provision of composting toilets within the site amenities blocks will also assist to reduce the hydraulic and nutrient loading on any future land application area.

2.6 RECEIVING ENVIRONMENT

The subject site lies wholly within Hunter Water's Stockton Sandbeds drinking water catchment. The water source is an unconfined sand aquifer which runs from Fullerton Cove in the west to Anna Bay in the east. It is bounded by the Pacific Ocean to the south and by Tilligerry Creek to the north. Hunter Water currently does not extract water from this aquifer, but plans are in place to do so in the event of a water shortage. Due to the redundancy in Hunter Water's network prior to The Stockton Sandbeds being used as an extraction water source, it is seen that the source would not be compromised by the proposed development site, however this should be confirmed with Hunter Water.

The location of the site ensures that adequately buffering from any existing groundwater extraction bores can be maintained. Furthermore, the provision of groundwater monitoring bores local to the site coupled with an annual monitoring program will ensure that any onsite wastewater management system operates such to minimise and ameliorate any environmental effects.

3.0 System Selection and Design

3.1 OVERVIEW

In assessing the various options available for the collection, treatment and potentially recycling of wastewater, the following factors are relevant:

- Site constraints;
- Public health impacts;
- Risk to the environment;
- Public acceptance of various systems; and
- Capital costs and ongoing operational and maintenance costs.

A range of options were then considered including:

- Centralised treatment system and dispersal;
- Waste separation (composting toilets) with individual treatment systems for each amenities block, managers resident, and individual effluent dispersal; and
- Waste separation (composting toilets) with centralised treatment and centralised dispersal.

3.2 PRELIMINARY DESIGN CALCULATIONS

The design flow for sizing the wastewater treatment units and land application areas is based on the following design criteria for the proposed on-site wastewater management system:

- 44 accommodation lodges or camp sites, 1 manager's residence, 1 visitors centre
- Occupation rate of 3 persons per camp site/manager's residence/visitors centre
- Water supply by way of roof water collection and tank storage with standard water saving fixtures provided throughout
- Tanks will be topped up with potable water from water tanker truck during extended periods of low to no rainfall
- Provision of waterless composting toilets
- 3 amenities blocks comprising showers, handbasins and composting toilets for female, male and disabled use
- Typical wastewater design flow for camping grounds (fully serviced) with on-site roof water tank supply of 100 L/persons/day
- Average occupancy assumed to be 50% of the peak occupancy due to the intermittent nature of occupancy of the site

Table 4 demonstrates the wastewater generation adopted for the assessment:

Table 4 – Wastewater Design Flows

Facility Type	Qty	Peak Occupancy (persons)	Peak Wastewater (L/day)	Average Wastewater (L/day)
Amenity Block	3	44/amenities block 132 in total	2,200 13,200	1,100 6,900
Manager's Residence	1	3	300	150
Visitors Centre	1	3	300	150
TOTAL	**8**	**138**	**13,800**	**6,900**

The total peak occupancy design flow is 13,800 L/day and the average occupancy design flow is 6,900 L/day. The hydraulic load calculations used ensure that a flush style toilet system could be adopted if preferred however, in order to minimise the demand for water and reduce the volume of wastewater to be managed, each facility is proposed to make use of composting toilets. For each facility, any leachate from the composting toilets along with greywater from any hand basins, showers and laundry will be plumbed collectively to the proposed treatment system.

3.3 TREATMENT SYSTEM SELECTION

To mitigate against high peak loading and wastewater generation fluctuations it is proposed to provide some flow attenuation through adoption of primary treatment at source septic tanks. The provision of minimum 8,000 L septic tank (2.3m deep x 2.5m dia.) for each amenity block and minimum 5,000 L septic tank (1.75m deep x 2.4m dia.) for both the manager's residence and the visitors centre will ensure sufficient flow attenuation and primary treatment capacity. Each septic tank would be fitted with a Taylex filter on the outlet.

Whilst typical commercial treatment systems, such as the Econocyle commercial unit or similar, would be suitable to service each amenities block and allow for flush toilets, the provision of flushing toilets will create a high water demand for the site. Given the provision of rainwater collection tanks as the primary water source the use of Composting toilets is preferred in order to reduce the water demand requirements of the site.

Due to the observed site soil characteristics the provision of secondary treatment following the septic tank is required. Units proposed for secondary treatment could include:

- Aerated wastewater treatment systems (AWTS)
- Sand filters
- Textile packed bed reactors
- Submerged aerated filters
- Membrane bioreactors; or
- Constructed wetlands (reed beds).

Due to the variable nature of the wastewater loading which will be highly dependent on occupation rates the provision of constructed reedbed filters are considered to offer the best secondary treatment provisions for the site.

The proposed treatment process train for onsite wastewater management will therefore comprise:

- Baffled septic tank with outlet filter to capture and allow solids to settle and digest, thereby reducing the biochemical oxygen demand (BOD) and TSS;
- Constructed subsurface flow wetland to allow for further removal of BOD and TSS and provide for denitrification;
- Sand filter to further polish and clarify the effluent removing any remaining TSS, BOD and micro-organisms; and
- Effluent pump(s) and subsurface irrigation system to proposed land application area.

The effective operation of the septic tank and disposal area rely on the effective operation and maintenance of the systems. Provision for a suitable operation and maintenance manual is to be adhered to in accordance with Council's guidelines. It is the land owner's responsibility to ensure effective and successful management, operation and maintenance

of on-site wastewater management systems. The Local Government Act and subordinate regulation are the key legislative instrument utilised for regulation of these systems.

3.4 SIZING OF LAND APPLICATION AREAS

Land application areas (LAA) have been sized in accordance with *PCS DAF Technical Manual Section9.2 Hydraulic Design of Land Application Areas*, see **Table 5**.

Table 5 – Land Application Area Sizing

Input	Description	Peak Value	Avg. Value	Units
LAA	Land Application Area	3,067[1]	1533[1]	m^2
Q	Design Wastewater Generation Rate	13,800[2]	6,900[2]	L/day
DLR	Design Loading Rate	5[3]	5[3]	mm/day
CAF	Climate Adjustment Factor	0.5[4]	0.5[4]	mm/day

[1] Calculated from Eq. 1 from PSC DAF Technical Manual
[2] Peak occupancy design flow
[3] DLR taken from Table N1 for Soil Category 1 from AS 1547
[4] CAF taken from Table 9-3 for Nelson Bay (East) from PSC DAF Technical Manual

In addition to the LAA calculation outlined above, the characteristics of the treated effluent and the disposal areas required for water nutrient balance purposes (as calculated in **Appendix C**). A summary of the results is shown in **Table 6**.

Table 6 – Nutrient Balance Area Sizing

Input	Required Irrigation Area (m^2)
Volume (Min. Area Method)	1,398
Nitrogen Load	4,458
Phosphorous Load	4,502

The total area required for land application areas is therefore taken to be the largest calculated area being 4,500 m^2 as dictated by the nitrogen and phosphorus loadings.

A Site Plan in **Appendix A** shows the following information and demonstrates constraints mapping to show suitable land application areas on the subject site:

- Proposed allotment boundaries, dimensions and areas;
- Location of existing and proposed buildings, access roads, footpaths, vegetation and groundwater bores;
- Location of exclusion zones;
- Elevation contours; and
- Location of existing and proposed drainage lines.

The Site Plan (**Appendix A**) indicates that there is potentially a total of 23,500 m^2 of unconstrained land available for land application of effluent. Given the total available unconstrained area is significantly greater than the required area, it is concluded that the site can sustainably support long term land application of treated effluent. It has also been demonstrated that the site is capable of providing a primary LAA and nominating a reserve LAA within the unconstrainted land areas available.

4.0 Conclusion

This On-site Wastewater Management Plan has been prepared to accompany the DA plans and documentation to provide an overview of the proposed on-site wastewater management system and controls are generally in accordance with Council requirements. On-site wastewater management is considered appropriate for the proposed development based on the design overview outlined in this report. This report addresses the site and soil constraints.

The proposed wastewater management system for the proposed eco-tourism facility will comprise:

- Composting toilets at each Amenities block;
- Baffled septic tank to capture and allow solids to settle and digest, thereby reducing the biochemical oxygen demand (BOD) and TSS;
- Constructed wetland to allow for further removal of BOD and TSS and provide for denitrification;
- Sand filter to further polish and clarify the effluent removing any remaining TSS, BOD and micro-organisms; and
- Effluent pump(s) and subsurface irrigation system to proposed land application area.

Suitable unconstrainted areas exist on the current site for land application areas for treated effluent disposal.

This assessment serves to provide an overview of the proposed on-site wastewater management plan. More detailed design of the system should be undertaken prior to construction certificate approval.

Appendices

A. Site Constraints Mapping for Land Application Areas
B. Report on Geotechnical Investigation – Worimi Ecotourism Development 17 June 2019 prepared by Cardno with appendices:
    - Site Plan
    - Engineering Logs
    - Laboratory Test Results
C. Site Specific Land Capability Assessment Design Calculations

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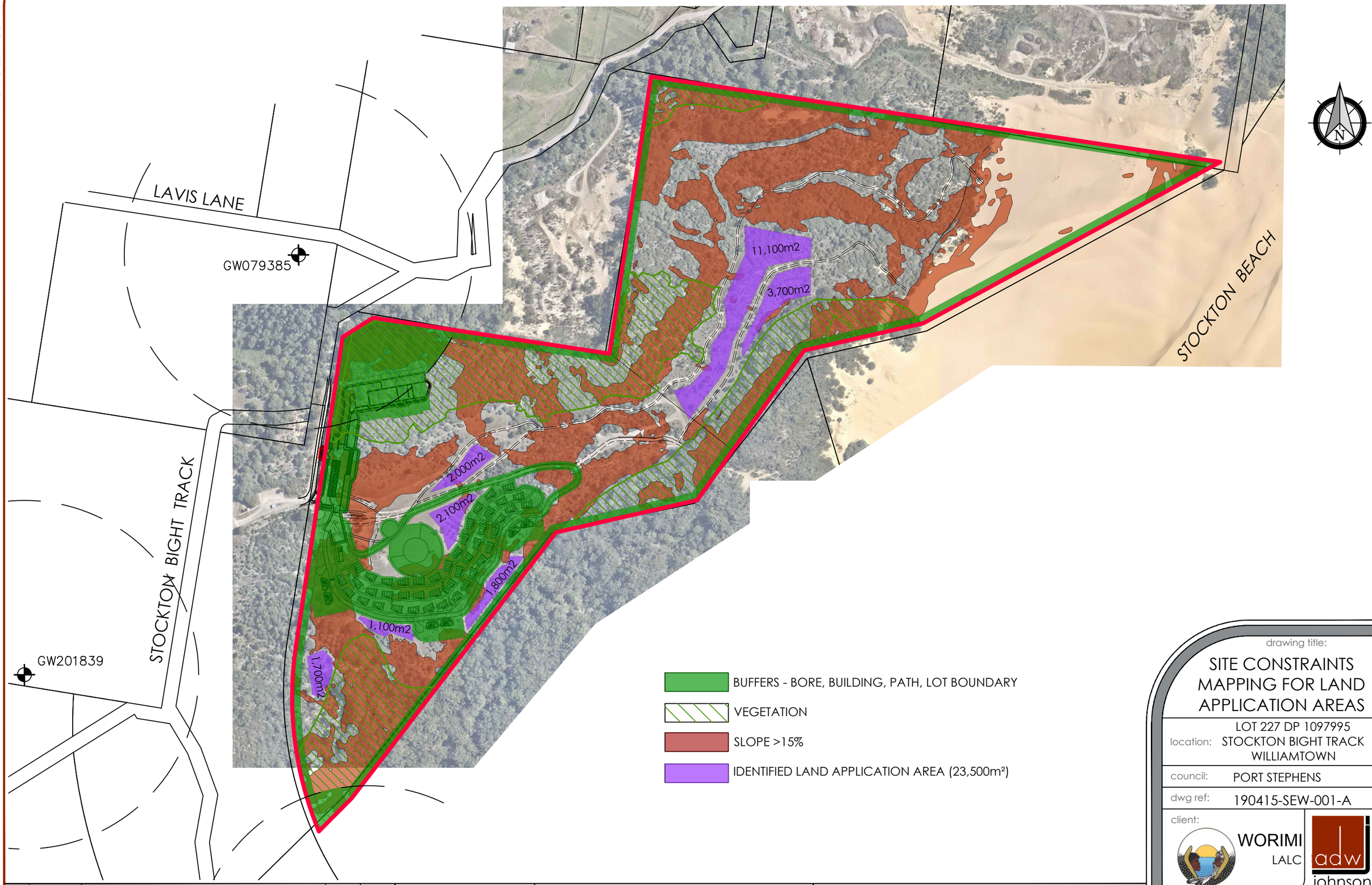

BUFFERS - BORE, BUILDING, PATH, LOT BOUNDARY

VEGETATION

SLOPE >15%

IDENTIFIED LAND APPLICATION AREA (23,500m²)

ver.	date	comment	drawn	pm	level information	scale (A3 original size)	notes
A	20-06-19	INITIAL ISSUE	MS	RJ	DATUM: AHD CONTOUR INTERVAL: 1.0m	0 125 250m SCALE: 1:5000 (FULL)	

drawing title:

SITE CONSTRAINTS MAPPING FOR LAND APPLICATION AREAS

location: LOT 227 DP 1097995 STOCKTON BIGHT TRACK WILLIAMTOWN

council: PORT STEPHENS

dwg ref: 190415-SEW-001-A

client: WORIMI LALC

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Plotted By: Mark Spitzkowsky Plot Date: 21/06/19 2:53:54PM Cad File: N:\190415_MAIN JOB ON S DRIVE-JPSERVER06\190415-SEW-001-A.DWG
This plan includes coloured information. If you have a black and white copy you do not have all of the information. This note is coloured RED.

Report on Geotechnical Investigation

Worimi Ecotourism Development

82219112

Prepared for

Worimi Local Aboriginal Land Council c/-
ADW Johnson Pty Ltd

20 June 2019

Cardno

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0	17/06/2019	Draft Issue for Client	GA	IGP
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Appendices

Tables

1 Introduction

This report presents the results of geotechnical investigation undertaken by Cardno (NSW/ACT) Pty Ltd (Cardno) for the proposed Worimi Ecotourism development, Fullerton Cove. The geotechnical investigation has been undertaken in accordance with Cardno's proposal (Ref No. 48980519-0257, Rev. 2, dated 23 April 2019), and was commissioned by Mr Nicholas Stephens of ADW Johnson Pty Ltd on behalf of Worimi Local Aboriginal Land Council.

It is understood that Worimi Local Aboriginal Land Council (LALC) are proposing to construct an ecotourism resort consisting of 44 villas near Stockton Bight Track, Fullerton Cove. Owing to the lack of suitable nearby infrastructure, wastewater service will be provided through on-site methods. As per the requirements of Port Stephens Council's Development Assessment Framework (DAF), a wastewater management report must be completed. Cardno have been engaged to undertake a geotechnical investigation to inform the development of a wastewater management report.

The purpose of this investigation was to obtain geotechnical information on the subsurface conditions, and geotechnical data for on-site effluent disposal assessment. The following guidelines were referenced for the purpose of this investigation:

- Australian/New Zealand Standard 1547-2012 On-Site Domestic Wastewater Management [1]; and
- Environment & Health Protection Guidelines: On-site Sewage Management for Single Households [2].

2 Site Description

The investigated site is defined as an irregular shaped parcel of land situated within part of Lot 227 of DP 1097995, extending west off Stockton Bight Track, Fullerton Cove and bounded by:

- Undeveloped bushland to the north and south;
- Stockton Bight Track to the west; and
- Stockton sand dunes to the east.

It is understood that the site is currently used by Sand Dune Adventures as access to Stockton Beach for quad biking tours.

Topographically the site is located within regionally low lying gently undulating terrain, with local topography characterised by aeolian sand dunes. Site slopes typically range between 4-8° and fall towards a low point at the centre of the site.

Vegetation of the site comprised predominantly open pasture with sparsely scattered mature trees, with tree density increasing around the site boundary.

The following features were observed at the time of site investigation:

- A large shed and several shipping containers were noted within the elevated western section of the site, understood to be used as storage for Sand Dune Adventures.
- Several access tracks were noted to run through the site to facilitate access to the Stockton sand dunes for the quad biking tours.
- Natural surface drainage comprised surface flows draining to the low point at the centre of the site.

3 Investigation Methodology

3.1 Site Investigation

The site investigation was undertaken on 16th May 2019, and comprised the following:

- A site walkover and visual inspection by an engineer from Cardno including site mapping and logging of significant site features.
- Excavation of six (6) test pits (two at each site) with a 3.5t excavator. Test pits were excavated to a target depth of 2.0m, with all test pits collapsing due to instability prior to the target depth.
- Drilling of one (1) shallow borehole with a 3.5t excavator fitted with a 300mm auger attachment to facilitate subsurface infiltration testing. The borehole was excavated to a depth of 0.5 m, from where the testing was undertaken.
- All test pits were backfilled with excavated spoil on completion.
- Bulk and disturbed samples were taken for subsequent laboratory assessment.
- Dynamic Cone Penetrometer (DCP) testing was undertaken at each test pit to assess subsurface strength properties.

Field investigation including logging of subsurface profiles and collection of samples was carried out by an experienced geotechnical engineer from Cardno. The location of test pits are shown on Figure 1, attached in Appendix A. Subsurface conditions are summarised in the Section 0 and detailed in the engineering logs attached in Appendix B, together with explanatory notes.

3.2 Sampling and Contamination Procedures

Environmental sampling was performed according to Cardno standard operating procedures with sampling data recorded on Chain of Custody sheets and the general sampling procedure comprising:

- The use and changing of disposable gloves between each sampling event to prevent cross contamination;
- Decontamination of all sampling equipment using a 3% solution of phosphate free detergent (Decon 90) and distilled water prior to each bore;
- Samples were collected from a fresh face of the test bore side wall and not directly off the auger, using a glass sampling jar to extract the material;
- Soil sample storage for all sampling events was via sample containers supplied by SGS laboratories;
- Sufficient samples with zero headspace into laboratory prepared sampling jars with the sample details added to the label on the jar;
- Samples were sent to the laboratory with recommended holding times; and
- The sample jars were preserved in a chilled esky containing ice immediately after sampling and during transport to the laboratories. The laboratory chain of custody documentation was completed and accompanied the samples during shipment (a copy of the COC is attached to the laboratory test results).

3.3 Laboratory Testing

Laboratory testing on selected samples recovered during the site investigation comprised the following:

- Six (6) Particle Size Distribution (PSD) test;
- Six (6) pH and Electrical Conductivity test;
- Six (6) Sodicity & Exchangeable Cation test; and
- Six (6) Phosphorus Sorption Capacity test.

Geotechnical laboratory testing was conducted by Construction Sciences Pty Ltd, a NATA accredited construction materials testing laboratory, and the environmental testing was conducted at an external NATA accredited chemical testing laboratory. Results of laboratory testing are detailed in the report sheets attached in Appendix C and summarised in Section 4.3.

4 Investigation Findings

4.1 Published Data

A review of the NSW Office of Environment and Heritage, eSPADE v2.0 mapping system [3] indicates that the site is situated within the Boyces Track (9232bt) – comprising of loose dull yellow orange sand, located on steep stable Holocene sand dunes. Soils of this landscape are generally non-cohesive, highly permeable soils of low fertility.

4.2 Subsurface Conditions

The subsurface conditions encountered across the site have been categorised and summarised as follows:

- AEOLEAN: SAND, grey-brown and fine to medium grain size with organics was encountered within to depths of up to 0.8m BGL in all test pits, overlying;
- AEOELAN: SAND, pale yellow-brown and fine to medium grain size was encountered down to the depth of the investigation. The consistency was observed to be generally very loose to loose.

No groundwater or seepage was encountered in the test pits conducted. It should be noted that groundwater levels are likely to fluctuate with variations in climatic and site conditions.

4.3 Laboratory Test Results

The results of the Particle Size Distribution (PSD) tests undertaken on representative site soils encountered are summarised below in Table 4-1 with the report sheets attached in Appendix C.

Table 4-1 Summary of Particle Size Distribution Test Results

Hole ID	Depth (m BGL)	Soil Type	Passing 2.36 mm	Passing 75 µm
TP01	0.6-0.8	SAND; pale yellow-brown	100	0
TP02	0.3-0.5	SAND; grey-brown, trace clay	100	2
TP03	0.4-0.6	SAND; pale yellow-brown	100	0
TP04	0.9-1.1	SAND; pale yellow-brown	100	0
TP05	0.2-0.4	SAND; grey-brown, trace clay	100	2
TP06	0.8-1.0	SAND; pale yellow-brown	100	0

The results of remaining laboratory testing conducted are presented in Table 4-2 below.

Table 4-2 Results of Laboratory Testing

Sample Reference	Emerson Aggregate Test (1)	pH	EC (dS/m)	Sodicity (meq %)	Cation Exchange Capacity (meq/kg)	Phosphorus Absorption (mg/kg)	Coarse fragments % (larger than 2mm)
TP01 / 0.6-0.8	-	6.2	0.03	-	0.9	77	0
TP02 / 0.3-0.5	-	5.7	0.07	3.9	7.7	310	0
TP03 / 0.4-0.6	-	5.8	0.03	14.3	0.7	78	2
TP04 / 0.9-1.1	-	5.5	0.06	9.1	1.1	110	0
TP05 / 0.2-0.4	-	5.1	0.07	4	5.0	170	0
TP06 / 0.8-1.0	-	5.8	0.03	-	1.0	79	0

Notes to Table
1. No Emerson Aggregate testing was undertaken as results of Particle Size Distribution tests indicated the material contained effectively no fine-grained particles, and as such would be non-dispersive

4.4 Infiltration Test Results

Infiltration testing was conducted within the natural low-point of the site, at the client nominated location. In situ permeability testing of the subsurface soils was undertaken using a Talsma-Hallam Permeameter and procedures detailed in AS1547-2012 [1]. Testing was conducted within the nominated location; however difficulties were encountered due to the presence of clean sands at / below the test depth. A constant drop in water level was unable to be maintained in the test due to excessive infiltration into the sands, and the tests were deemed to be outside of the suitable range specified in AS1547-2012 [1] of 1×10^{-7} to 3×10^{-4} m/sec.

The test results are summarised in Table 4-3 below.

Table 4-3 Summary of Field Infiltration Testing

Test Location	Test Depth (bgl)	Soil profile at / below test depth	Saturated Hydraulic Conductivity (K_{sat}) (mm/hr)	Saturated Hydraulic Conductivity (K_{sat}) (m/sec)
Infiltration Test	0.5m	SAND	> 1080	> 3×10^{-4}

Notes to table:
Depths mentioned in table are below ground level (bgl)

The infiltration testing undertaken in the natural dry to moist SAND profile was unable to be performed in accordance with AS1547-2012 [1], due to the excessive infiltration. Therefore, it is likely that the subsurface infiltration (K_{sat}) will be greater than 1080 mm/hr (3×10^{-4} m/sec), however in the absence test results adoption of this lower bound value is recommended.

5 Limitations

Cardno (NSW/ACT) Pty Ltd (Cardno) have performed investigation and consulting services for this project in general accordance with current professional and industry standards. The extent of testing was limited to discrete test locations and variations in ground conditions can occur between test locations that cannot be inferred or predicted.

A geotechnical consultant or qualified engineer shall provide inspections during construction to confirm assumed conditions in this assessment. If subsurface conditions encountered during construction differ from those given in this report, further advice shall be sought without delay.

Cardno, or any other reputable consultant, cannot provide unqualified warranties nor does it assume any liability for the site conditions not observed or accessible during the investigations. Site conditions may also change subsequent to the investigations and assessment due to ongoing use.

This report and associated documentation was undertaken for the specific purpose described in the report and shall not be relied on for other purposes. This report was prepared solely for the use by Worimi Local Aboriginal Land Council c/- ADW Johnson Pty Ltd and any reliance assumed by other parties on this report shall be at such parties own risk.

6 References

[1] Australian/New Zealand Standard AS/NZS1547:2012, “On-site domestic-wastewater management,” Standards Australia/Standards New Zealand, 2012.

[2] Department of Land and Water Conservation et al., Environment & Health Protection Guidelines: On-site Sewage Management for Single Households, Sydney, January 1998.

[3] NSW office of Environment and Heritage, “eSPADE v2.0,” 2016.

APPENDIX A

SITE PLAN

NOTES:

Image underlay adapted from nearmaps aerial imagery.

LEGEND:

TPXXX Approximate test pit locations and numbers.

TP04

TP03

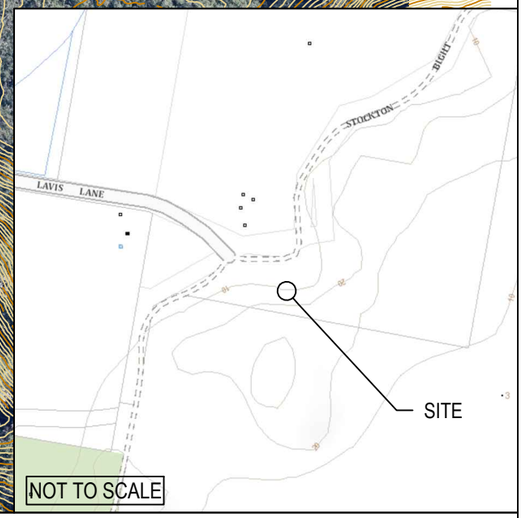
TP02

TP01

Infiltration Testing

TP05

TP06



NOT TO SCALE

0 50m

SCALE 1:1500 @A3

NORTH

Cardno
Shaping the Future
Cardno (NSW/ACT) Pty Ltd | ABN 95 001 145 035
Unit 1, 10 Denney Street
Broadmeadow, NSW 2292
Tel: 02 4965 4555 Fax: 02 4965 4666
Web: www.cardno.com.au

Drawn	JE	01/06/2019
Checked	GA	12/06/2019
Designed		
Verified		
Approved		

Client: ADW Johnson Pty Ltd

Project: Geotechnical Investigation
Fullerton Cove Ecotourism
Fullerton Cove, NSW

Title: Test Pit Location Plan

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

Job Number		Scale	Size
82219112		1:1500	A3

Drawing Number: Figure 1

Revision: A

DATE PLOTTED: 14 June 2019 11:40 AM BY : GEORGE ASHWORTH

XREFs:
CAD File: N:\Projects\82\21\9112_FULLERTON COVE ECOTOURISM\Drawings\Geotech\82219112 - Site Plan.dwg

APPENDIX

B

ENGINEERING LOGS

TEST PIT LOG SHEET

Client: ADW Johnson Pty Ltd
Project: Fullerton Cove Ecotourism
Location: Fullerton Cove, NSW

Hole No: TP01

Job No: 82219112 **Sheet:** 1 of 1

Position: Refer to site plan **Angle from Horizontal:** 90° **Surface Elevation:**
Machine Type: 3.5 tonne Excavator **Excavation Method:** 450mm bucket
Excavation Dimensions: **Contractor:** Mick Reed Excavations
Date Excavated: 16/5/19 **Logged By:** GA **Checked By:**

Excavation			Water	Sampling & Testing		Depth (m)	Material Description					
Method	Resistance	Stability		Sample or Field Test	PSP (blows per 150 mm) 1 3 6 12		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
EX	VE-E	Unstable	Not Encountered	B 0.60 - 0.80 m D 0.60 - 0.80 m		0.5		SP	SAND; fine to medium grained, grey-brown, trace root fibres	D	VL to L	AEOLIAN
						1.0			as above; colour change to pale yellow-brown, no root fibres	D to M		1.20 m: test pit collapsing
						1.5			1.40m TERMINATED AT 1.40 m Collapse			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

TEST PIT LOG SHEET

Client: ADW Johnson Pty Ltd
Project: Fullerton Cove Ecotourism
Location: Fullerton Cove, NSW

Hole No: TP02

Job No: 82219112 **Sheet:** 1 of 1

Position: Refer to site plan **Angle from Horizontal:** 90° **Surface Elevation:**
Machine Type: 3.5 tonne Excavator **Excavation Method:** 450mm bucket
Excavation Dimensions: **Contractor:** Mick Reed Excavations
Date Excavated: 16/5/19 **Logged By:** GA **Checked By:**

Excavation			Water	Sampling & Testing		Depth (m)	Material Description					
Method	Resistance	Stability		Sample or Field Test	PSP (blows per 150 mm) 1 3 6 12		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
EX	VE-E	Unstable	Not Encountered	B 0.30 - 0.50 m D 0.30 - 0.50 m		0.5		SP	SAND; fine to medium grained, grey-brown, trace root fibres	D	VL to L	AEOLIAN
										D to M		
						1.0			as above; colour change to pale yellow-brown, no root fibres	D to M		0.80 m: test pit collapsing
						1.5						
									1.80m TERMINATED AT 1.80 m Collapse			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
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VSt - Very Stiff
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RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

TEST PIT LOG SHEET

Client: ADW Johnson Pty Ltd
Project: Fullerton Cove Ecotourism
Location: Fullerton Cove, NSW

Hole No: TP03

Job No: 82219112 **Sheet:** 1 of 1

Position: Refer to site plan **Angle from Horizontal:** 90° **Surface Elevation:**
Machine Type: 3.5 tonne Excavator **Excavation Method:** 450mm bucket
Excavation Dimensions: **Contractor:** Mick Reed Excavations
Date Excavated: 16/5/19 **Logged By:** GA **Checked By:**

Excavation			Water	Sampling & Testing		Depth (m)	Material Description					
Method	Resistance	Stability		Sample or Field Test	PSP (blows per 150 mm) 1 3 6 12		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
EX	VE-E	Unstable	Not Encountered	B 0.40 - 0.60 m D 0.40 - 0.60 m		0.5 1.0		SP	SAND; fine to medium grained, grey-brown, trace root fibres	D		AEOLIAN
									as above; colour change to pale yellow-brown, no root fibres	D to M	L	0.60 m: test pit collapsing
						1.5			1.40m TERMINATED AT 1.40 m Collapse			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
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SOIL CONSISTENCY
VS - Very Soft
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VSt - Very Stiff
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RELATIVE DENSITY
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L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

TEST PIT LOG SHEET

Client: ADW Johnson Pty Ltd
Project: Fullerton Cove Ecotourism
Location: Fullerton Cove, NSW

Hole No: TP04

Job No: 82219112 **Sheet:** 1 of 1

Position: Refer to site plan **Angle from Horizontal:** 90° **Surface Elevation:**
Machine Type: 3.5 tonne Excavator **Excavation Method:** 450mm bucket
Excavation Dimensions: **Contractor:** Mick Reed Excavations
Date Excavated: 16/5/19 **Logged By:** GA **Checked By:**

Excavation			Water	Sampling & Testing		Depth (m)	Material Description					
Method	Resistance	Stability		Sample or Field Test	PSP (blows per 150 mm) 1 3 6 12		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
EX	VE-E	Unstable	Not Encountered	B 0.90 - 1.10 m D 0.90 - 1.10 m		0.5 1.0		SP	SAND; fine to medium grained, grey-brown, trace root fibres	D		AEOLIAN
									as above; colour change to pale yellow-brown, no root fibres	D to M	L	0.40 m: test pit collapsing
						1.5			1.30m TERMINATED AT 1.30 m Collapse			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
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DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
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S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

TEST PIT LOG SHEET

Client: ADW Johnson Pty Ltd
Project: Fullerton Cove Ecotourism
Location: Fullerton Cove, NSW

Hole No: TP05

Job No: 82219112 **Sheet:** 1 of 1

Position: Refer to site plan **Angle from Horizontal:** 90° **Surface Elevation:**
Machine Type: 3.5 tonne Excavator **Excavation Method:** 450mm bucket
Excavation Dimensions: **Contractor:** Mick Reed Excavations
Date Excavated: 16/5/19 **Logged By:** GA **Checked By:**

Excavation			Water	Sampling & Testing		Depth (m)	Material Description					
Method	Resistance	Stability		Sample or Field Test	PSP (blows per 150 mm) 1 3 6 12		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
EX	VE-E	Unstable	Not Encountered	B 0.20 - 0.40 m D 0.20 - 0.40 m		0.5 1.0 1.5		SP	SAND; fine to medium grained, grey-brown, trace root fibres	D		AEOLIAN
										D to M		
									as above; colour change to pale yellow-brown, no root fibres		L to MD	
										D to M		1.40 m: test pit collapsing
									1.90m TERMINATED AT 1.90 m Collapse			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

Cardno

TEST PIT LOG SHEET

Client: ADW Johnson Pty Ltd
Project: Fullerton Cove Ecotourism
Location: Fullerton Cove, NSW

Hole No: TP06

Job No: 82219112 **Sheet:** 1 of 1

Position: Refer to site plan **Angle from Horizontal:** 90° **Surface Elevation:**
Machine Type: 3.5 tonne Excavator **Excavation Method:** 450mm bucket
Excavation Dimensions: **Contractor:** Mick Reed Excavations
Date Excavated: 16/5/19 **Logged By:** GA **Checked By:**

Excavation				Sampling & Testing	Depth (m)	Material Description					
Method	Resistance	Stability	Water	Sample or Field Test		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
EX	VE-E	Unstable	Not Encountered					SAND; fine to medium grained, grey-brown, trace root fibres	D to M		AEOLIAN
				B 0.80 - 1.00 m D 0.80 - 1.00 m	0.5		SP	as above; colour change to pale yellow-brown, no root fibres	D to M		0.90 m: test pit collapsing
					1.0						
					1.10m			TERMINATED AT 1.10 m Collapse			
					1.5						

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
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ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (NSW/ACT) PTY LTD

APPENDIX C

LABORATORY TEST RESULTS

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 12 Callistemon Close
Warabrook NSW 2304

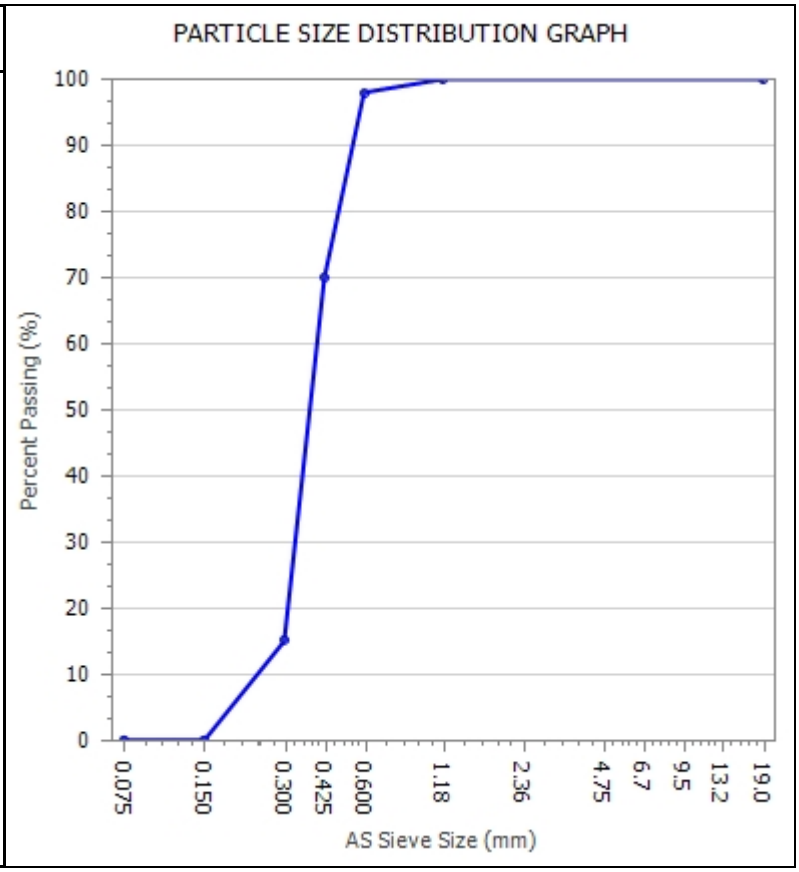
Laboratory: **Warabrook Laboratory**
Phone: 02 4965 4555
Fax: 02 4946 4666
Email: Newcastle@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/17422-1
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/177
Project:	Fullerton Cove Ecotourism	Lot Number:	
Location:	CMT Services - Warabrook Lab	Internal Test Request:	16822/T/14014
Supplied To:	George Ashworth	Client Reference/s:	82219112
Area Description:		Report Date / Page:	4/06/2019 Page 1 of 6

Test Procedures:	AS1289.3.6.1			
Sample Number	16822/S/69179	Sample Location		
Sampling Method	Tested As Received	Pit No.		TP01
Date Sampled	16/05/2019	Sample Type		Bulk Bag
Sampled By	Client Sampled	Sample Depth	m	0.6-0.8
Date Tested	29/05/2019			
Material Source	Not Supplied	Material Type	-	

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
19.0		**100**	
1.18		**100**	
0.600		**98**	
0.425		**70**	
0.300		**15**	
0.150		**0**	
0.075		**0**	



Remarks

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 16822

Approved Signatory: Joseph Stallard
Form ID: W9Rep Rev 2

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 12 Callistemon Close
Warabrook NSW 2304

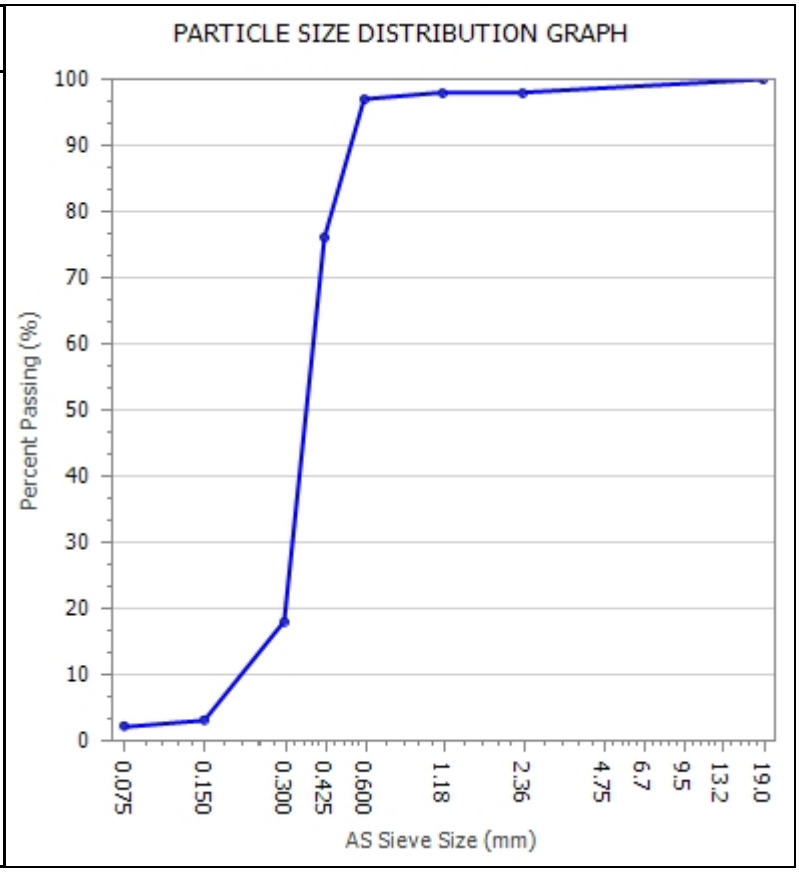
Laboratory: **Warabrook Laboratory**
Phone: 02 4965 4555
Fax: 02 4946 4666
Email: Newcastle@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/17422-1
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/177
Project:	Fullerton Cove Ecotourism	Lot Number:	
Location:	CMT Services - Warabrook Lab	Internal Test Request:	16822/T/14014
Supplied To:	George Ashworth	Client Reference/s:	82219112
Area Description:		Report Date / Page:	4/06/2019 Page 2 of 6

Test Procedures:	AS1289.3.6.1			
Sample Number	16822/S/69180	Sample Location		
Sampling Method	Tested As Received	Pit No.		TP02
Date Sampled	16/05/2019	Sample Type		Bulk Bag
Sampled By	Client Sampled	Sample Depth	m	0.3-0.5
Date Tested	29/05/2019			
Material Source	Not Supplied	Material Type	-	

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
19.0		**100**	
2.36		**98**	
1.18		**98**	
0.600		**97**	
0.425		**76**	
0.300		**18**	
0.150		**3**	
0.075		**2**	



Remarks

NATA

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Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 16822

Approved Signatory: Joseph Stallard
Form ID: W9Rep Rev 2

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 12 Callistemon Close
Warabrook NSW 2304

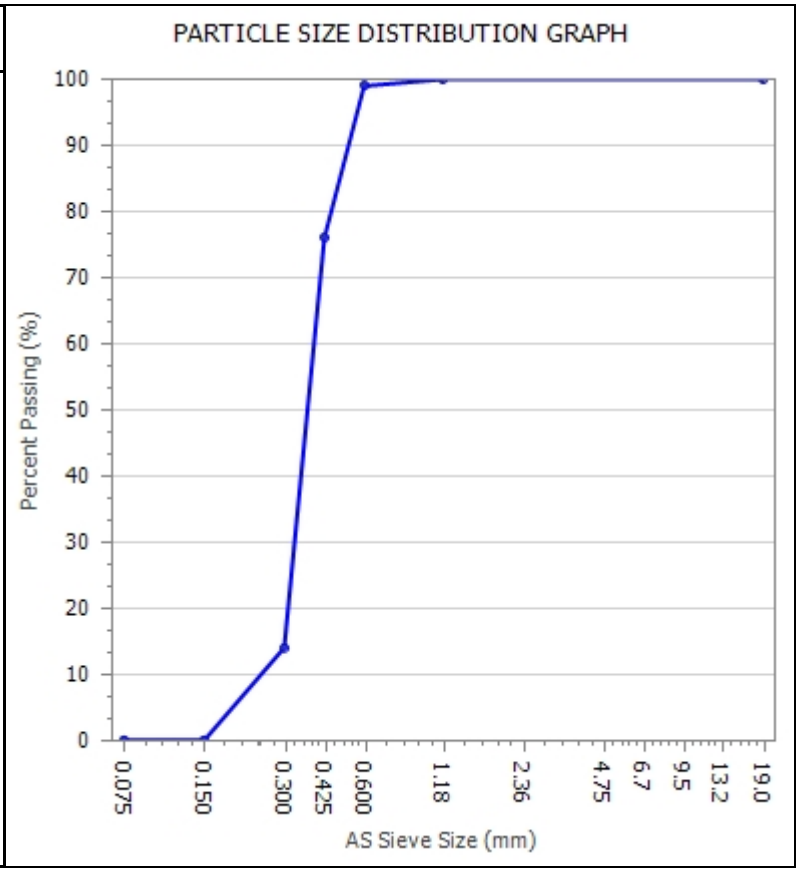
Laboratory: **Warabrook Laboratory**
Phone: 02 4965 4555
Fax: 02 4946 4666
Email: Newcastle@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/17422-1
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/177
Project:	Fullerton Cove Ecotourism	Lot Number:	
Location:	CMT Services - Warabrook Lab	Internal Test Request:	16822/T/14014
Supplied To:	George Ashworth	Client Reference/s:	82219112
Area Description:		Report Date / Page:	4/06/2019 Page 3 of 6

Test Procedures:	AS1289.3.6.1			
Sample Number	16822/S/69181	Sample Location		
Sampling Method	Tested As Received	Pit No.		TP03
Date Sampled	16/05/2019	Sample Type		Bulk Bag
Sampled By	Client Sampled	Sample Depth	m	0.4-0.6
Date Tested	29/05/2019			
Material Source	Not Supplied	Material Type	-	

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
19.0		**100**	
1.18		**100**	
0.600		**99**	
0.425		**76**	
0.300		**14**	
0.150		**0**	
0.075		**0**	



Remarks

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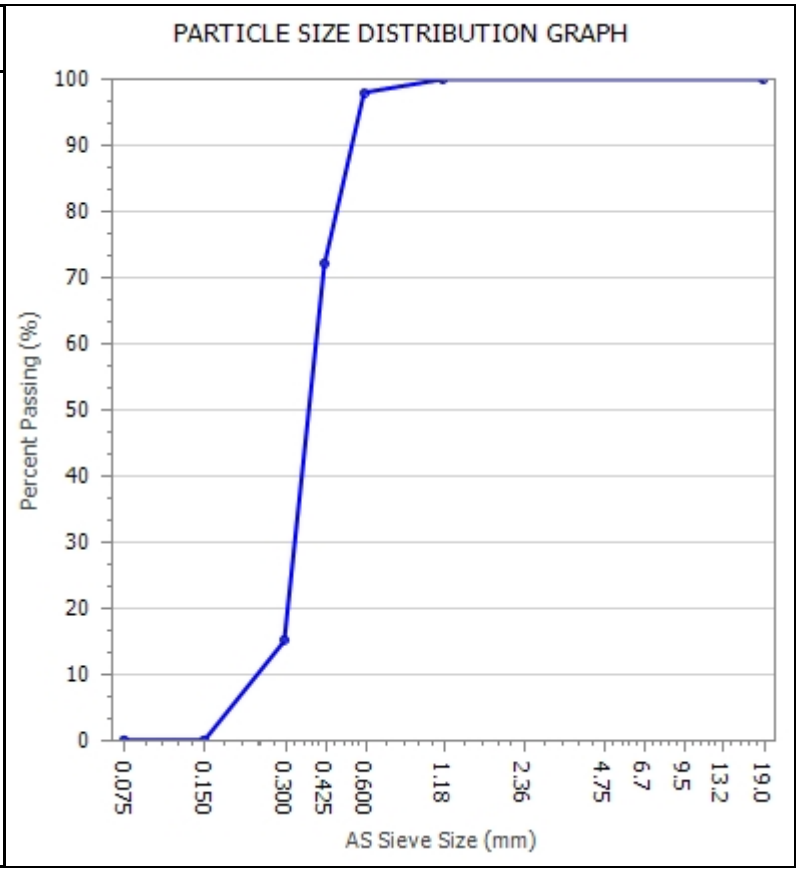
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/17422-1
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/177
Project:	Fullerton Cove Ecotourism	Lot Number:	
Location:	CMT Services - Warabrook Lab	Internal Test Request:	16822/T/14014
Supplied To:	George Ashworth	Client Reference/s:	82219112
Area Description:		Report Date / Page:	4/06/2019 Page 4 of 6

Test Procedures:	AS1289.3.6.1			
Sample Number	16822/S/69182	Sample Location		
Sampling Method	Tested As Received	Pit No.		TP04
Date Sampled	16/05/2019	Sample Type		Bulk Bag
Sampled By	Client Sampled	Sample Depth	m	0.9-1.1
Date Tested	29/05/2019			
Material Source	Not Supplied	Material Type	-	

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
19.0		**100**	
1.18		**100**	
0.600		**98**	
0.425		**72**	
0.300		**15**	
0.150		**0**	
0.075		**0**	



Remarks

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Laboratory: **Warabrook Laboratory**
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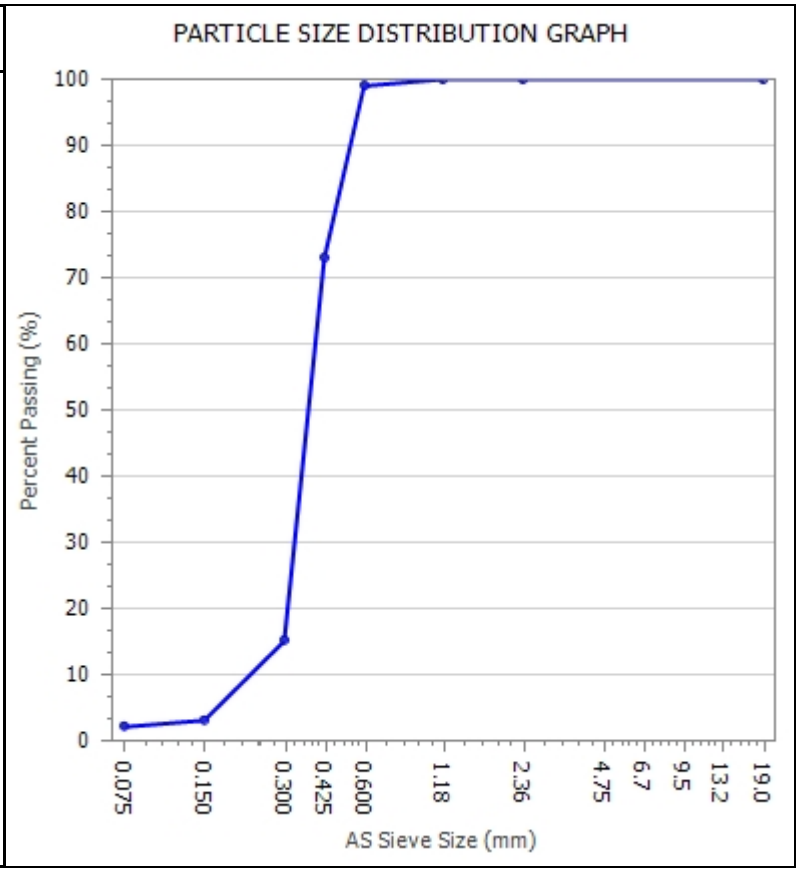
Email: Newcastle@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/17422-1
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/177
Project:	Fullerton Cove Ecotourism	Lot Number:	
Location:	CMT Services - Warabrook Lab	Internal Test Request:	16822/T/14014
Supplied To:	George Ashworth	Client Reference/s:	82219112
Area Description:		Report Date / Page:	4/06/2019 Page 5 of 6

Test Procedures:	AS1289.3.6.1			
Sample Number	16822/S/69183	Sample Location		
Sampling Method	Tested As Received	Pit No.		TP05
Date Sampled	16/05/2019	Sample Type		Bulk Bag
Sampled By	Client Sampled	Sample Depth	m	0.2-0.4
Date Tested	29/05/2019			
Material Source	Not Supplied	Material Type	-	

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
19.0		**100**	
2.36		**100**	
1.18		**100**	
0.600		**99**	
0.425		**73**	
0.300		**15**	
0.150		**3**	
0.075		**2**	



Remarks

NATA

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Accreditation Number: 1986
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Approved Signatory: Joseph Stallard
Form ID: W9Rep Rev 2

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ABN: 74 128 806 735

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Unit 1, 12 Callistemon Close
Warabrook NSW 2304

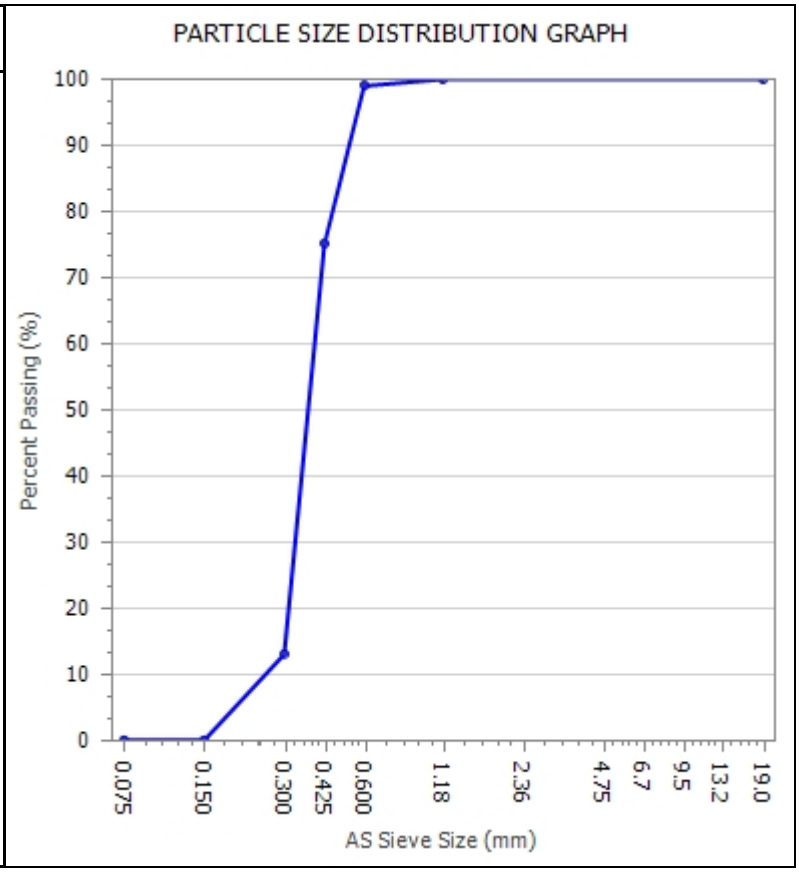
Laboratory: **Warabrook Laboratory**
Phone: 02 4965 4555
Fax: 02 4946 4666
Email: Newcastle@constructionsciences.net

PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/17422-1
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/177
Project:	Fullerton Cove Ecotourism	Lot Number:	
Location:	CMT Services - Warabrook Lab	Internal Test Request:	16822/T/14014
Supplied To:	George Ashworth	Client Reference/s:	82219112
Area Description:		Report Date / Page:	4/06/2019 Page 6 of 6

Test Procedures:	AS1289.3.6.1			
Sample Number	16822/S/69184	Sample Location		
Sampling Method	Tested As Received	Pit No.		TP06
Date Sampled	16/05/2019	Sample Type		Bulk Bag
Sampled By	Client Sampled	Sample Depth	m	0.8-1.0
Date Tested	29/05/2019			
Material Source	Not Supplied	Material Type	-	

AS Sieve (mm)	Specification Minimum	**Percent Passing (%)**	Specification Maximum
19.0		**100**	
1.18		**100**	
0.600		**99**	
0.425		**75**	
0.300		**13**	
0.150		**0**	
0.075		**0**	



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Accredited for compliance with ISO/IEC 17025 - Testing

Accreditation Number: 1986
Corporate Site Number: 16822

Approved Signatory: Joseph Stallard
Form ID: W9Rep Rev 2

CHAIN OF CUSTODY RECORD

Cardno
Shaping the Future

193415

LAB Name	SGS
Address	16/33 Maddox St Alexandria NSW 2015

Client	Cardno (NSW/ACT) Pty Ltd PO Box 74 Broadmeadow NSW 2292

Contact Numbers	
Phone	0249 654555
Fax	0249 654666

Contact	George Ashworth
Sampled by	George Ashworth
Project Ref:	82219112

E-mail	george.ashworth@cardno.com.au

(invoice to geotech@cardno.com.au)

Date Results Required	Standard TAT

Laboratory LIMS ID	Client Sample ID	Date Sampled	Matrix: Soil	Matrix: Water	Containers/Preservation: Soil Jar (G) Nat. Orange	0.5-1.0 litre (G) Nat. Yellow	0.1-1.0 litre (P) Nat. Green	50mL VOA Vial (G) H_2SO_4 Maroon	0.1-1.0 litre (P) H_2SO_4 Maroon	0.2-1.0 litre (G) H_2SO_4 Maroon	0.1-0.2 (P) Filtered?? Y=Yes, N=No (HNO_3) Red	0.2l (P) NaOH Blue	Other	Analysis Required: pH	EC	Cation Exchange Capacity	Exchangeable Sodium Percentage	Phosphorous Sorption	
1	TP01 / 0.6-0.8	19/05/2019	☒										☒	☒	☒	☒	☒	☒	
2	TP02 / 0.3-0.5	19/05/2019	☒										☒	☒	☒	☒	☒	☒	
3	TP03 / 0.4-0.6	19/05/2019	☒										☒	☒	☒	☒	☒	☒	
4	TP04 / 0.9-1.1	19/05/2019	☒										☒	☒	☒	☒	☒	☒	
5	TP05 / 0.2-0.4	19/05/2019	☒										☒	☒	☒	☒	☒	☒	
6	TP06 / 0.8-1.0	19/05/2019	☒										☒	☒	☒	☒	☒	☒	

SGS EHS Alexandria Laboratory

SE193415 COC
Received: 29 – May – 2019

Released by: George Ashworth Signature Date/Time 28/5/19 12:00pm
Received by: J.L Signature Date/Time 29/5/19 12:50pm

Custody Seals Intact? / Samples Received Chilled?

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	George Ashworth
Client	CARDNO (NSW/ACT) PTY LTD
Address	Unit 1 10 Denney Street Broadmeadow NSW 2292
Telephone	61 2 4940 5516
Facsimile	61 2 4965 4666
Email	george.ashworth@cardno.com.au
Project	**82219112**
Order Number	**82219112**
Samples	6

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE193415 R0**
Date Received	29/5/2019
Date Reported	5/6/2019

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

Phosphorous Sorption subcontracted to SGS Cairns, 2/58 Comport St, Portsmith QLD 4870, NATA Accreditation Number: 2562, Site Number: 3146. Report Number CE140055. Report no. CE140055 R0.

SIGNATORIES

Bennet Lo
Senior Organic Chemist/Metals Chemist

Dong Liang
Metals/Inorganics Team Leader

pH in soil (1:5) [AN101] Tested: 5/6/2019

PARAMETER	UOM	LOR	TP01/0.6-0.8 SOIL - 19/5/2019 SE193415.001	TP02/0.3-0.5 SOIL - 19/5/2019 SE193415.002	TP03/0.4-0.6 SOIL - 19/5/2019 SE193415.003	TP04/0.9-1.1 SOIL - 19/5/2019 SE193415.004	TP05/0.2-0.4 SOIL - 19/5/2019 SE193415.005
pH	pH Units	0.1	6.2	5.7	5.8	5.5	5.1

PARAMETER	UOM	LOR	TP06/0.8-1.0 SOIL - 19/5/2019 SE193415.006
pH	pH Units	0.1	5.8

Conductivity and TDS by Calculation - Soil [AN106] Tested: 5/6/2019

PARAMETER	UOM	LOR	TP01/0.6-0.8 SOIL - 19/5/2019 SE193415.001	TP02/0.3-0.5 SOIL - 19/5/2019 SE193415.002	TP03/0.4-0.6 SOIL - 19/5/2019 SE193415.003	TP04/0.9-1.1 SOIL - 19/5/2019 SE193415.004	TP05/0.2-0.4 SOIL - 19/5/2019 SE193415.005
Conductivity of Extract (1:5 as received)	µS/cm	1	3	7	3	6	7
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	3	7	3	6	8

PARAMETER	UOM	LOR	TP06/0.8-1.0 SOIL - 19/5/2019 SE193415.006
Conductivity of Extract (1:5 as received)	µS/cm	1	3
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	3

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) [AN122] Tested: 4/6/2019

PARAMETER	UOM	LOR	TP01/0.6-0.8 SOIL - 19/5/2019 SE193415.001	TP02/0.3-0.5 SOIL - 19/5/2019 SE193415.002	TP03/0.4-0.6 SOIL - 19/5/2019 SE193415.003	TP04/0.9-1.1 SOIL - 19/5/2019 SE193415.004	TP05/0.2-0.4 SOIL - 19/5/2019 SE193415.005
Exchangeable Sodium, Na	mg/kg	2	2	6	3	3	4
Exchangeable Sodium, Na	meq/100g	0.01	<0.01	0.03	0.01	0.01	0.02
Exchangeable Sodium Percentage*	%	0.1	11.0	3.5	15.6	13.4	3.2
Exchangeable Potassium, K	mg/kg	2	2	5	<2	<2	2
Exchangeable Potassium, K	meq/100g	0.01	<0.01	0.01	<0.01	<0.01	<0.01
Exchangeable Potassium Percentage*	%	0.1	6.6	1.6	5.1	3.7	1.2
Exchangeable Calcium, Ca	mg/kg	2	7	92	5	12	69
Exchangeable Calcium, Ca	meq/100g	0.01	0.04	0.46	0.02	0.06	0.35
Exchangeable Calcium Percentage*	%	0.1	41.8	59.4	33.3	51.4	70.0
Exchangeable Magnesium, Mg	mg/kg	2	4	33	4	4	15
Exchangeable Magnesium, Mg	meq/100g	0.02	0.03	0.27	0.03	0.04	0.13
Exchangeable Magnesium Percentage*	%	0.1	40.6	35.4	46.1	31.5	25.6
Cation Exchange Capacity	meq/100g	0.02	0.09	0.77	0.07	0.11	0.50

PARAMETER	UOM	LOR	TP06/0.8-1.0 SOIL - 19/5/2019 SE193415.006
Exchangeable Sodium, Na	mg/kg	2	<2
Exchangeable Sodium, Na	meq/100g	0.01	<0.01
Exchangeable Sodium Percentage*	%	0.1	7.4
Exchangeable Potassium, K	mg/kg	2	<2
Exchangeable Potassium, K	meq/100g	0.01	<0.01
Exchangeable Potassium Percentage*	%	0.1	4.7
Exchangeable Calcium, Ca	mg/kg	2	11
Exchangeable Calcium, Ca	meq/100g	0.01	0.06
Exchangeable Calcium Percentage*	%	0.1	60.0
Exchangeable Magnesium, Mg	mg/kg	2	3
Exchangeable Magnesium, Mg	meq/100g	0.02	0.03
Exchangeable Magnesium Percentage*	%	0.1	27.9
Cation Exchange Capacity	meq/100g	0.02	0.10

Moisture Content [AN002] Tested: 4/6/2019

PARAMETER	UOM	LOR	TP01/0.6-0.8 SOIL - 19/5/2019 SE193415.001	TP02/0.3-0.5 SOIL - 19/5/2019 SE193415.002	TP03/0.4-0.6 SOIL - 19/5/2019 SE193415.003	TP04/0.9-1.1 SOIL - 19/5/2019 SE193415.004	TP05/0.2-0.4 SOIL - 19/5/2019 SE193415.005
% Moisture	%w/w	0.5	2.4	2.1	2.1	2.1	2.8

PARAMETER	UOM	LOR	TP06/0.8-1.0 SOIL - 19/5/2019 SE193415.006
% Moisture	%w/w	0.5	2.5

Sample Subcontracted [] Tested: 5/6/2019

PARAMETER	UOM	LOR	TP01/0.6-0.8 SOIL - 19/5/2019 SE193415.001	TP02/0.3-0.5 SOIL - 19/5/2019 SE193415.002	TP03/0.4-0.6 SOIL - 19/5/2019 SE193415.003	TP04/0.9-1.1 SOIL - 19/5/2019 SE193415.004	TP05/0.2-0.4 SOIL - 19/5/2019 SE193415.005
SGS Cairns*	No unit	-	Subcontracted	Subcontracted	Subcontracted	Subcontracted	Subcontracted

PARAMETER	UOM	LOR	TP06/0.8-1.0 SOIL - 19/5/2019 SE193415.006
SGS Cairns*	No unit	-	Subcontracted

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M CaCl2) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos /cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN122	Exchangeable Cations, CEC and ESP: Soil sample is extracted in 1M Ammonium Acetate at pH=7 (or 1M Ammonium Chloride at pH=7) with cations (Na, K, Ca & Mg) then determined by ICP OES/ICP MS and reported as Exchangeable Cations. For saline soils, these results can be corrected for water soluble cations and reported as Exchangeable cations in meq/100g or soil can be pre-treated (aqueous ethanol/aqueous glycerol) prior to extraction. Cation Exchange Capacity (CEC) is the sum of the exchangeable cations in meq/100g.
AN122	The Exchangeable Sodium Percentage (ESP) is calculated as the exchangeable sodium divided by the CEC (all in meq/100g) times 100. ESP can be used to categorise the sodicity of the soil as below: ESP < 6% non-sodic ESP 6-15% sodic ESP >15% strongly sodic Method is referenced to Rayment and Lyons, 2011, sections 15D3 and 15N1.-

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
		NVL	Not validated.	LOR	Limit of Reporting.
**	Indicative data, theoretical holding time exceeded.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Unless it is reported that sampling has been perfomed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au.pv.sgsvr/en-gb/environment.

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ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS		LABORATORY DETAILS	
Contact	George Ashworth	Manager	Anthony Nilsson
Client	CARDNO (NSW/ACT) PTY LTD	Laboratory	SGS Cairns Environmental
Address	Unit 1 10 Denney Street Broadmeadow NSW 2292	Address	Unit 2, 58 Comport St Portsmith QLD 4870
Telephone	61 2 4940 5516	Telephone	+61 07 4035 5111
Facsimile	61 2 4965 4666	Facsimile	+61 07 4035 5122
Email	au.environmental.sydney@sgs.com	Email	AU.Environmental.Cairns@sgs.com
Project	**82219112**	SGS Reference	**CE140055 R0**
Order Number	**SE193415**	Date Received	31 May 2019
Samples	6	Date Reported	05 Jun 2019

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(3146).

SIGNATORIES

Alyson Bergamo
Senior Laboratory Technician

Anthony Nilsson
Operations Manager

Jon Dicker
Manager Northern QLD

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	CE140055.001 Soil 19 May 2019 TP01/0.6-0.8	CE140055.002 Soil 19 May 2019 TP02/0.3-0.5	CE140055.003 Soil 19 May 2019 TP03/0.4-0.6	CE140055.004 Soil 19 May 2019 TP04/0.9-1.1
Phosphorus Absorption Method: AN239 Tested: 5/6/2019							
Phosphorus Absorption*	mg/kg	1		**77**	**310**	**78**	**110**

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name CE140055.005 Soil 19 May 2019 TP05/0.2-0.4	CE140055.006 Soil 19 May 2019 TP06/0.8-1.0
Phosphorus Absorption Method: AN239 Tested: 5/6/2019				
Phosphorus Absorption*	mg/kg	1	**170**	**79**

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

No QC samples were reported for this job.

METHOD SUMMARY

CE140055 R0

METHOD	METHODOLOGY SUMMARY
AN239	A soil's capacity for sorbing (fixing) P is related to its texture and clay mineralogy: sorption increases with increasing clay content. The sorption capacity of a soil is estimated as mg P sorbed/kg soil.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Unless it is reported that sampling has been perfomed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au.pv.sgsvr/en-gb/environment.

Minimum Area Method Water Balance And Wet Weather Storage Calculations

Project : Worimi Ecotourism

Design Wastewater Flow	(Q)	l/day	13800
Design Percolation Rate	(R)	mm/wk	70

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	(D)		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	(P)		mm/month	98.6	123.2	120.6	104.3	113.7	121.4	71.9	77.4	61.3	74.5	81.0	80.2	1128.1
Evaporation	(E)		mm/month	213.9	173.6	151.9	114.0	83.7	75.0	80.6	108.5	138.0	173.6	189.0	226.3	1728.1
Crop factor	(C)			0.7	0.7	0.7	0.6	0.5	0.5	0.4	0.5	0.6	0.7	0.7	0.7	
Outputs																
Evapotranpiration	(ET)	E x C	mm/month	149.7	121.5	106.3	68.4	41.9	33.8	32.2	48.8	75.9	112.8	132.3	158.4	1082.1
Percolation	(B)	(R / 7) x D	mm/month	310.0	280.0	310.0	300.0	310.0	300.0	310.0	310.0	300.0	310.0	300.0	310.0	3650.0
Outputs		(ET+B)	mm/month	459.7	401.5	416.3	368.4	351.9	333.8	342.2	358.8	375.9	422.8	432.3	468.4	4732.1
Inputs																
Precipitation	(P)		mm/month	98.6	123.2	120.6	104.3	113.7	121.4	71.9	77.4	61.3	74.5	81.0	80.2	1128.1
Possible Effluent irrigation	(W)	(ET + B) - P	mm/month	361.1	278.3	295.7	264.1	238.2	212.4	270.3	281.4	314.6	348.3	351.3	388.2	3604.0
Actual Effluent Production	(I)	H / 12	mm/month	300.3	300.3	300.3	300.3	300.3	300.3	300.3	300.3	300.3	300.3	300.3	300.3	3604.0
Inputs		(P + I)	mm/month	398.9	423.5	420.9	404.6	414.0	421.7	372.2	377.7	361.6	374.8	381.3	380.5	4732.1
Storage	(S)	(P + I) - (ET + B)	mm/month	-60.8	22.0	4.6	36.2	62.2	88.0	30.0	18.9	-14.3	-48.0	-51.0	-87.9	-
Cumulative storage	(M)		mm	0.0	22.0	26.6	62.8	125.0	213.0	243.0	261.9	247.6	199.6	148.7	60.8	-

Irrigation Area	**(L)**	**365 x Q / H**	**m2**	**1397.6**

Storage	**(V)**	**largest M**	**mm**	**261.9**
		(V x L)/1000	**m3**	**366.1**

0

Note: H = sum of W

Area Calculation for Nitrogen Loading

Based on the 'catchment of mass balance' model: developed by Geary and Gardener (1996)

$$\text{Waste Reuse Area} = \frac{\text{Nitrogen load on field* (kg)} - \text{20\% of load** (kg)}}{\text{Nitrogen Uptake\# (kg/ha)} + \text{sustainable allowance\#\# (kg/ha)}}$$

* Nitrogen load on field = number of people x amount produced per person
(Generally 3.8kg/person is produced unless reduced by treatment (eg AWTS, wetland) or
exclusion from waste stream (eg compost toilet))
For Septic 0%, for AWTS 45% reduction, for Reed Bed 50% reduction - based on BSC's guidelines

** Allow for denitrification 20%

\# Accepted pasture uptake of nitrogen 120 kg/hectare in loam soils.
Refer to Default data for other vegetation / crop cover

10 kg per hectare a sustainable allowance to the environment

	INPUT		
Number of people =	138		
Nitrogen load per person =	0.525	kg/person	based on Reed Bed with 50% and Sand Filter with 25% reduction in TN
Nitrogen uptake =	120	kg/ha	

Waste Reuse Area = 0.446 ha

= 4,458 m²

Area Calculation for Phosphorus Loading

Refer to Byron Guidelines, p20

$$\text{Waste Reuse Area} = \frac{Ip}{[(Ps\ (\ Wtd - Bwt) / T) + Hp]} \times 10{,}000^{*}$$

Ip = Phosphorus content of the effluent kg/year (applied)
Ps = Phosphorus sorption capacity of soil (kg/ha/year) prior leaching#
Wtd = Water table depth (m)
Bwt = Buffer to water table (usually 0.5m)
Hp = Phosphorus removed by plants (kg/ha/year)
T = Time in years, taken as 50 years

\# Sorption capacity to a depth of 1 metre divided by 2

	INPUT		
Number of people =	138		
Phosphorus load per person =	0.6	kg/person/year	
Phosphorus output from Biolytix system =	8	**mg/L where P reduction measures are implemented**	
Wastewater load =	13800	kg/ha/year	from Table in "Default Data" sheet
Phosphorus sorption capacity, Ps =	8000		
Wtd =	2	kg/ha/year	from Table in "Default Data" sheet
Bwt =	0.5		
Hp =	10		
T =	50		

Waste Reuse Area = 3100 m²