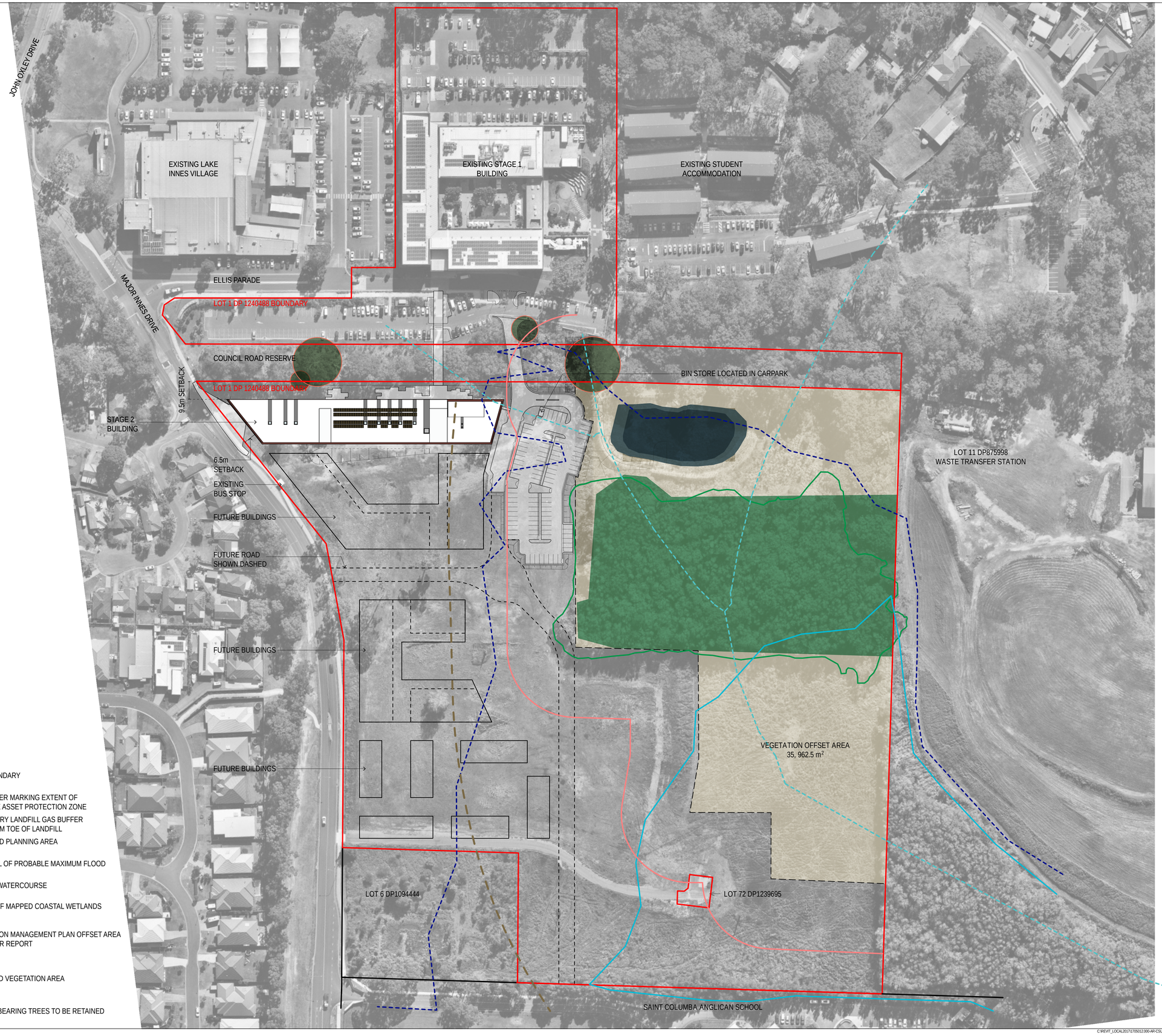

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ISSUE	DATE	FOR
1	20.09.18	Development Application
2	27.09.18	Development Application
3	03.10.18	Development Application

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PROJECT MANAGER
PROJECT MANAGER
SAVILLS TEL

CLIENT
CHARLES STURT UNIVERSITY

CLIENT NUMBER
CLIENT 1705012.000

PROJECT
PORT MACQUARIE STAGE 2
CSU PORT MACQUARIE

BVN PROJECT NUMBER
1705012

DRAWING KEY

TRUE NORTH PROJECT NORTH

GRAPHIC SCALE
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SCALE
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STATUS
TENDER

DRAWING
SITE PLAN

AR-DA-A10-02 ISSUE 3

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LANDSCAPE ENTRY
LEVEL 2

LEGEND

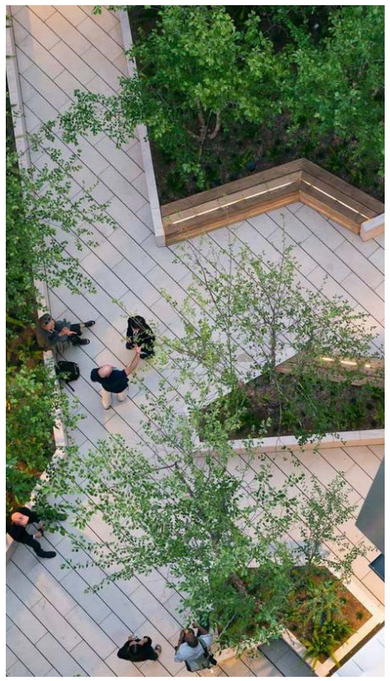
1. Grey brick paving forecourt.
2. Existing concrete footpath.
3. Large native trees in paving to frame entrance to level 2.
4. Mass planting of shade tolerant species below deck.
5. Level 2 concrete varandah

CHARLES STURT UNIVERSITY **PORT MACQUARIE**

LANDSCAPE DEVELOPMENT APPLICATION

SEPTEMBER 2018




O C U L U S

Landscape architecture | urban design

Level 1/5 wilson street | po box 307 | newtown | nsw | 2042

p. 02 9557 5533 | f. 02.9519.8323 | australia@oculus.com.au

w w w . o c u l u s . i n f o

LANDSCAPE MASTERPLAN
GROUND FLOOR

LEGEND

1. Passive seating zones/outdoor learning space
2. Open lawn area (make good to existing landscape)
3. Central brick-paved axis.
4. Native mass planting to the perimeter of the carpark.
5. Native small to medium tree planting with native, low grasses and shrubs in central medians.
6. Carpark under R.E.F

LANDSCAPE DETAIL PLAN
GROUND FLOOR

LEGEND

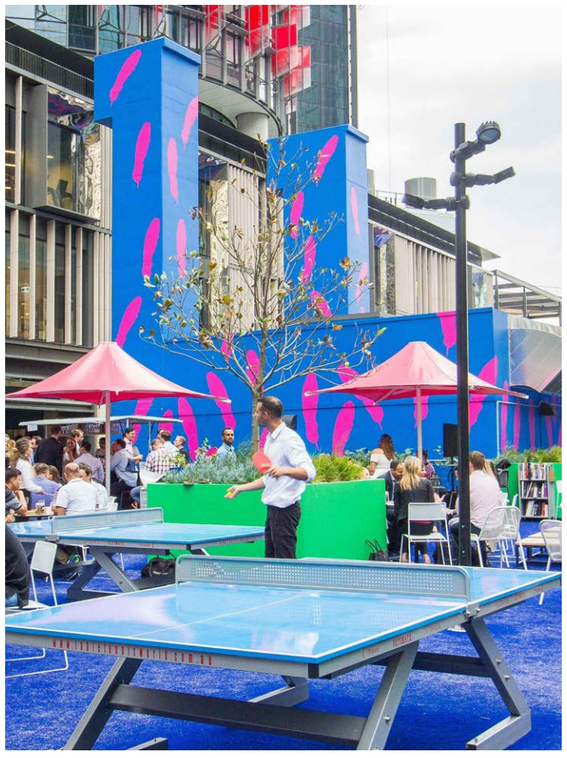
1. Picnic setting with umbrellas
2. Existing riparian corridor.
3. Stone block seats with timber batten fixtures
4. Buffer planting to road
5. Small native trees
6. Native planting

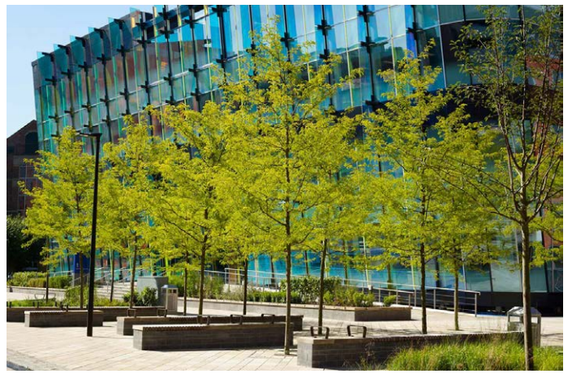
LANDSCAPE ENTRY
LEVEL 2

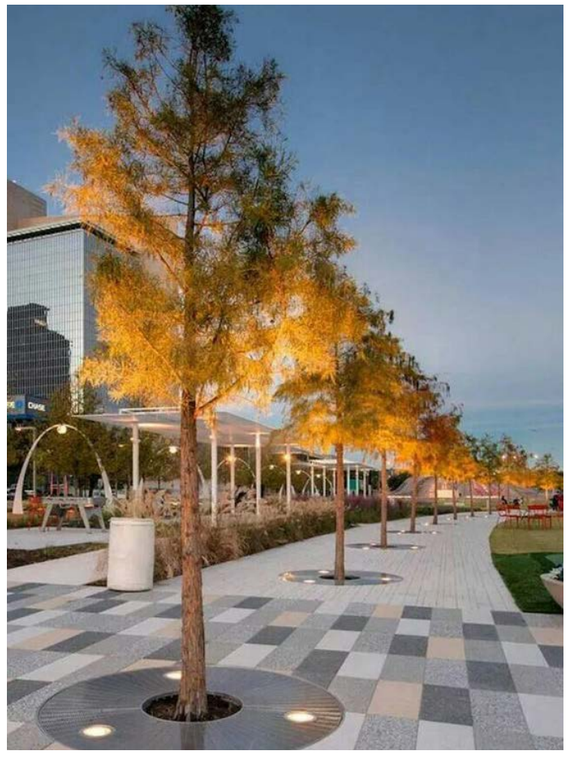
LEGEND

1. Grey brick paving forecourt.
2. Existing concrete footpath.
3. Large native trees in paving to frame entrance to level 2.
4. Mass planting of shade tolerant species below deck.
5. Level 2 concrete varandah

LANDSCAPE PRECEDENTS







PLANTING PALETTE

TREES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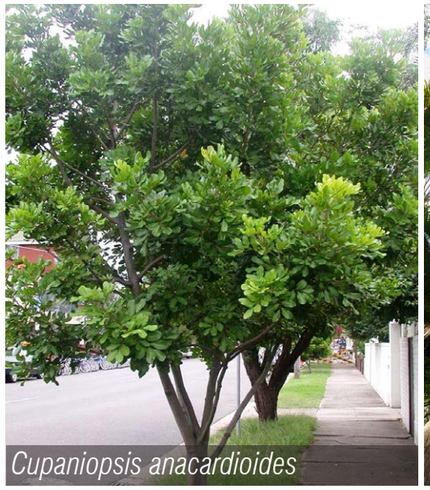
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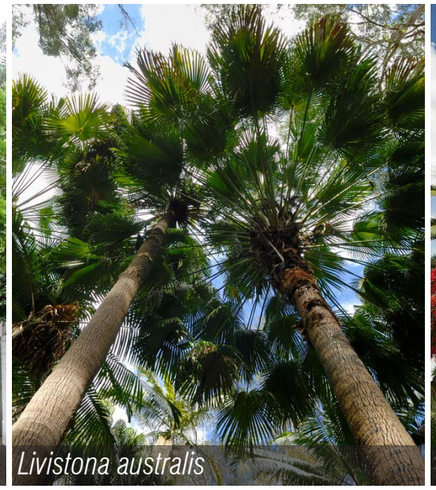
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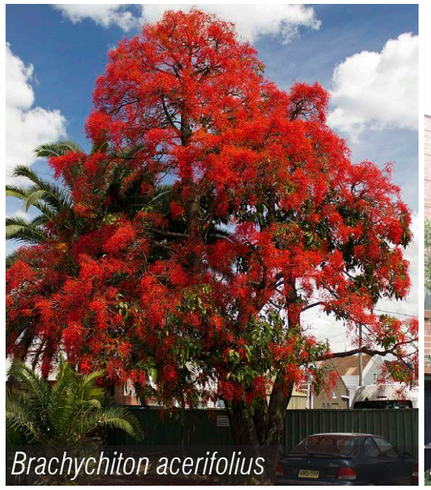
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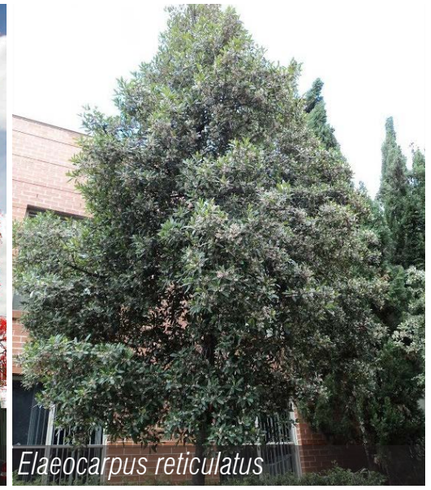
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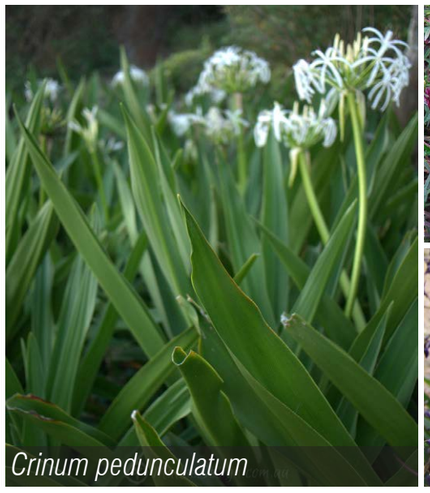
SHRUBS & GROUNDCOVERS


Westringia fruticosa


Poa labillardieri ‘Eskdale’


Crinum pedunculatum


Grevillea ‘Bronze Rambler’

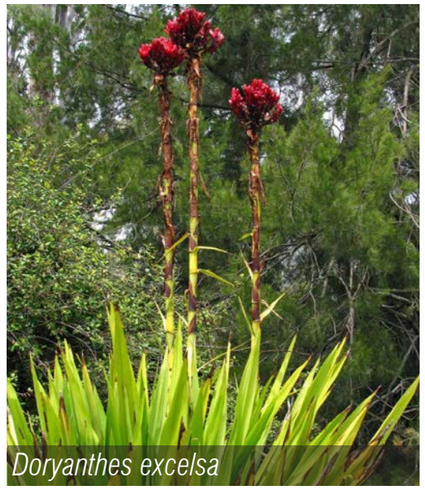

Dianella caerulea ‘Little Jess’


Lomandra longifolia


Aspidistra elatior


Callistemon ‘Better John’

ACCENTS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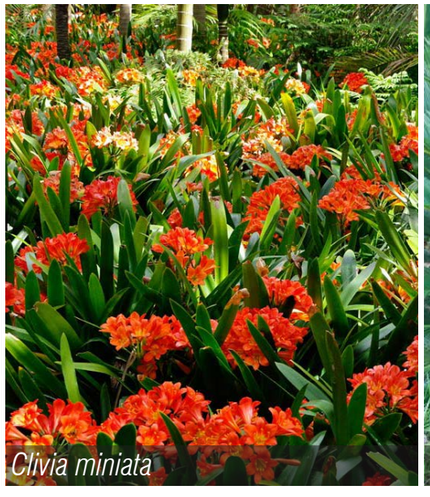
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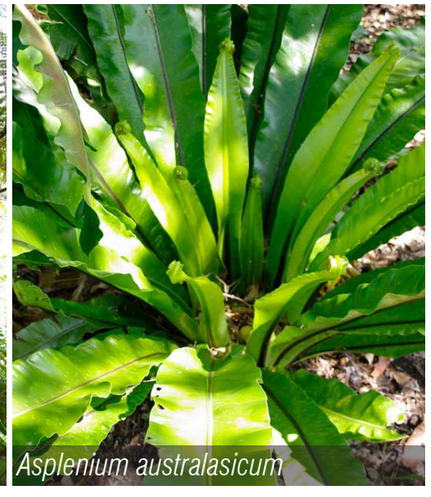
Cycas revoluta


Cyathea Cooperi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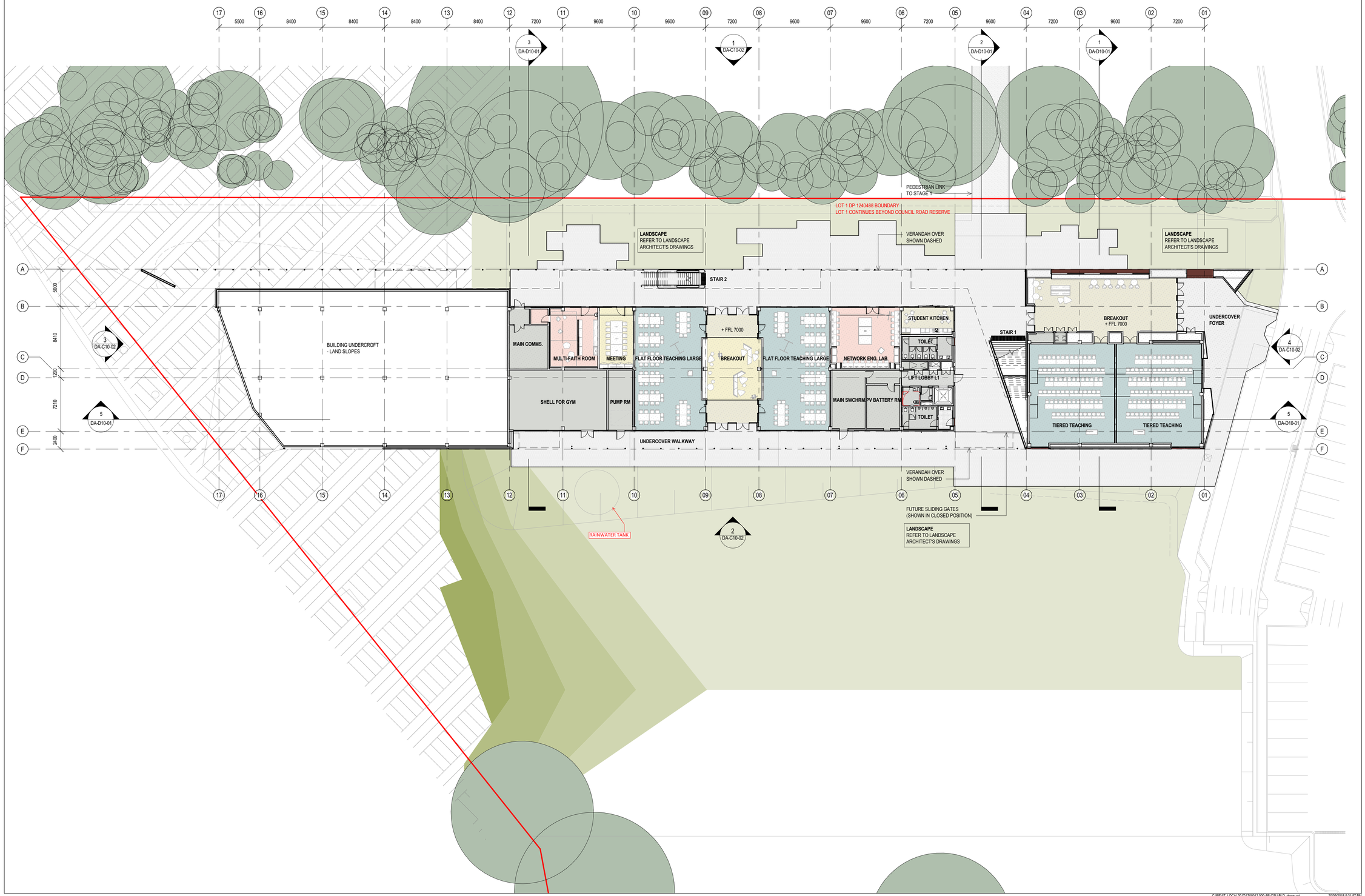

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CONSULTANT

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SAVILLS TEL

CLIENT

CHARLES STURT UNIVERSITY

CLIENT NUMBER

CLIENT 1705012.000

PROJECT

PORT MACQUARIE STAGE 2
CSU PORT MACQUARIE

BVN PROJECT NUMBER

1705012

DRAWING KEY

TRUE NORTH PROJECT NORTH

GRAPHIC SCALE

0 5000 12500

SCALE

1 : 250@A1

STATUS

TENDER

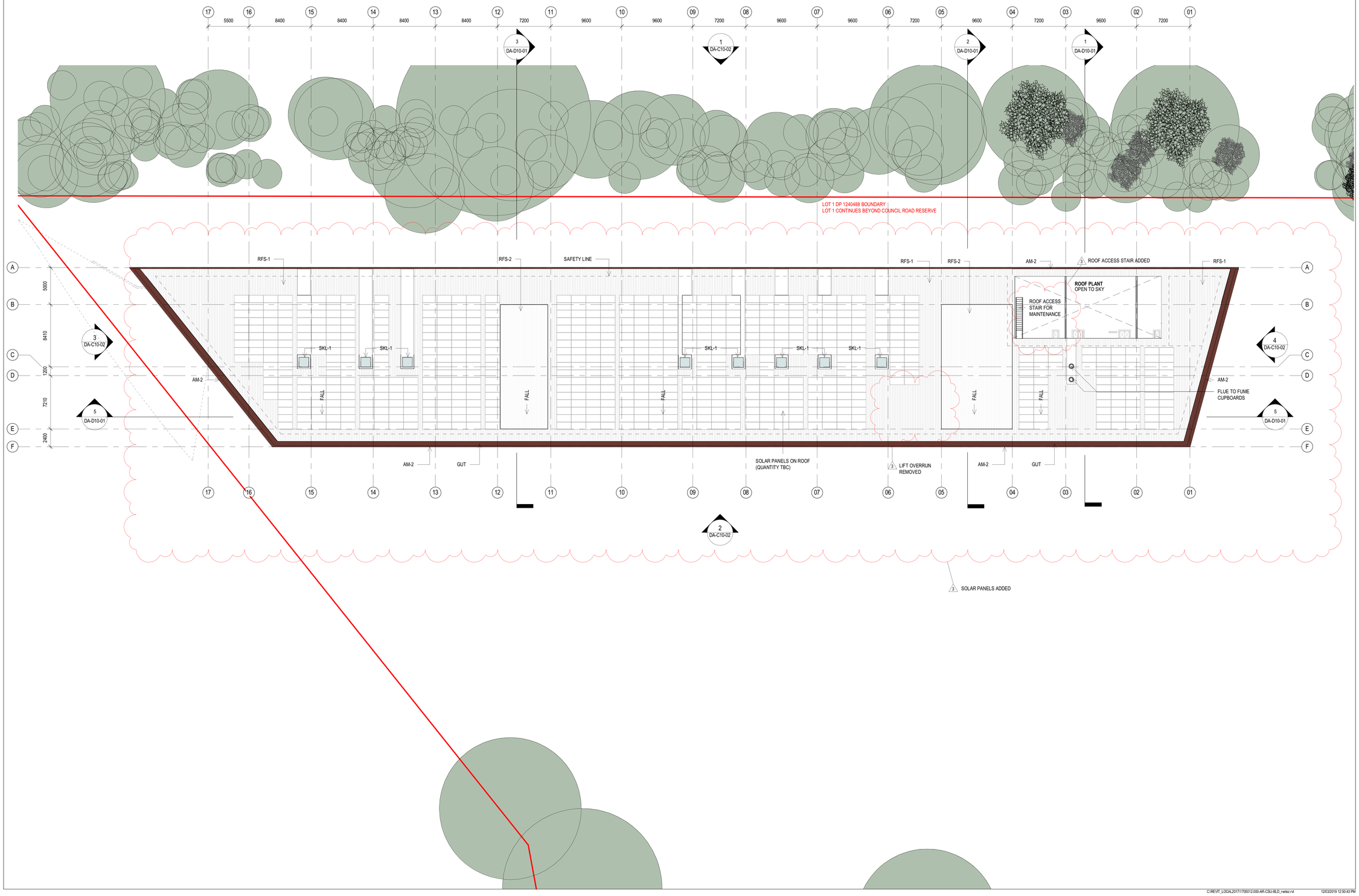
DRAWING

RAINWATER TANK MARKUP 18.01.19

DA PLAN - STAGE 2A LEVEL 01

AR-DA-B10-01

ISSUE 1



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1	20.09.18	Development Application
2	12.03.19	DA Revised
3	12.03.19	DA Revised

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PORT MACQUARIE STAGE 2
CSU PORT MACQUARIE

BVN PROJECT NUMBER
1705012

DRAWING KEY

TRUE NORTH PROJECT NORTH

GRAPHIC SCALE
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SCALE
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STATUS
TENDER

DRAWING
DA PLAN - STAGE 2A ROOF

AR-DA-B10-03 | ISSUE 3

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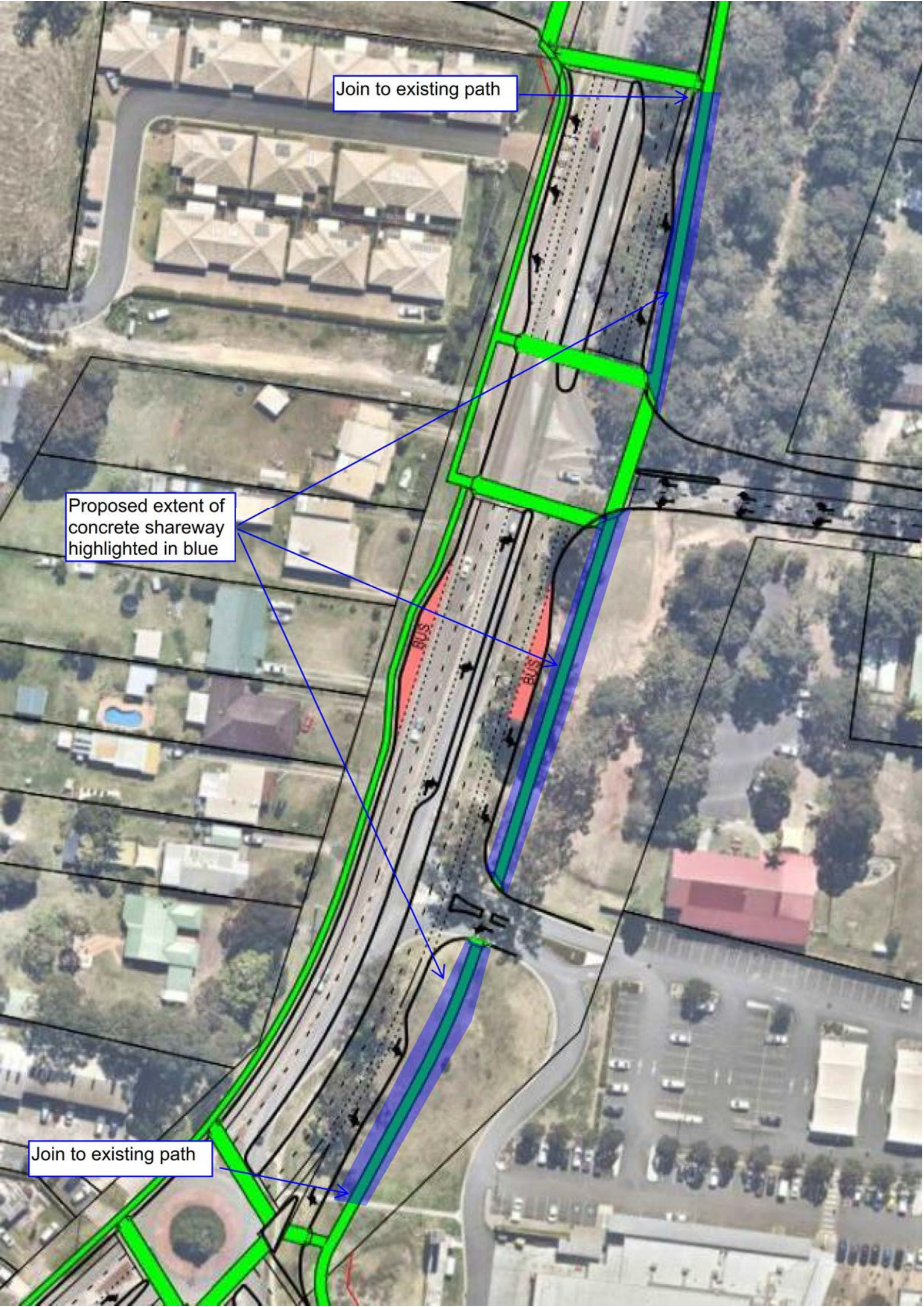
Join to existing path
Proposed extent of concrete shareway highlighted in blue
BUS
BUS
Join to existing path

All communications to be addressed to:

Headquarters
4 Murray Rose Ave
Sydney Olympic Park NSW 2127

Telephone: 1300 NSW RFS
e-mail: records@rfs.nsw.gov.au

Headquarters
Locked Bag 17
Granville NSW 2142

Facsimile: 8741 5433

The General Manager
Port Macquarie-Hastings Council
PO Box 84
PORT MACQUARIE NSW 2444

Your Ref: 2018/834
Our Ref: D18/8134
DA18112216189 AB

ATTENTION: Patrick Galbraith-Robertson

13 December 2018

Dear Mr Galbraith-Robertson

Development Application - 1//1240488 - 11 Ellis Parade Port Macquarie

I refer to your correspondence dated 12 November 2018 seeking advice regarding bush fire protection for the above Development Application in accordance with Section 4.14 of the 'Environmental Planning and Assessment Act 1979'.

The New South Wales Rural Fire Service (NSW RFS) has considered the information submitted and provides the following recommended conditions:

Asset Protection Zones

The intent of measures is to provide sufficient space and maintain reduced fuel loads so as to ensure radiant heat levels of buildings are below critical limits and to prevent direct flame contact with a building. To achieve this, the following conditions shall apply:

1. To allow for emergency service personnel and residents to undertake property protection activities, a defendable space that permits unobstructed pedestrian access is to be provided around the building.
2. At the commencement of building works and in perpetuity the property around the building shall be managed as follows as outlined within section 4.1.3 and Appendix 5 of 'Planning for Bush Fire Protection 2006' and the NSW Rural Fire Service's document 'Standards for asset protection zones':

   - north to the property boundary (council road reserve) as an asset protection zone;
   - east for a distance of 37 metres as an asset protection zone;
   - south for a distance of 50 metres as an asset protection zone; and

- west to the property boundary as an asset protection zone (APZ).

Water and Utilities

The intent of measures is to provide adequate services of water for the protection of buildings during and after the passage of a bush fire, and to locate gas and electricity so as not to contribute to the risk of fire to a building. To achieve this, the following conditions shall apply:

3. New water, gas and electricity services are to comply with Planning for Bush Fire Protection 2006.

Access

The intent of measures for internal roads is to provide safe operational access for emergency services personnel in suppressing a bush fire, while residents are accessing or egressing an area. To achieve this, the following conditions shall apply:

4. New internal roads shall comply with Section 4.2.7 Access - Internal Roads of Planning for Bush Fire Protection 2006. The proposed car parking area to comply with council's car parking requirements.

Evacuation and Emergency Management

The intent of measures is to provide suitable emergency and evacuation (and relocation) arrangements for occupants of special fire protection purpose developments. To achieve this, the following conditions shall apply:

5. Arrangements for emergency and evacuation are to comply with section 4.2.7 of 'Planning for Bush Fire Protection 2006'.

Design and Construction

The intent of measures is that buildings are designed and constructed to withstand the potential impacts of bush fire attack. To achieve this, the following conditions shall apply:

6. New construction shall comply with Sections 3 and 6 (BAL 19) Australian Standard AS3959-2009 'Construction of buildings in bush fire-prone areas' and section A3.7 Addendum Appendix 3 of 'Planning for Bush Fire Protection'.

Landscaping

7. New landscaping to the site is to comply with the principles of Appendix 5 of 'Planning for Bush Fire Protection 2006'.

General Advice – consent authority to note

This advice only applies to the proposed building, car park and ancillary infrastructure only (stage 2).

No bush fire assessment has been undertaken for future buildings as denoted on the site plan.

Should you wish to discuss this matter please contact Alan Bawden on 1300 NSW RFS.

Yours sincerely

John Ball
Manager

For general information on bush fire protection please visit www.rfs.nsw.gov.au

Design
for a better
future /

SAVILLS

CHARLES STURT UNIVERSITY PORT MACQUARIE

STAGE 2 BUILDING WORKS - NOISE IMPACT ASSESSMENT

wsp

SEPTEMBER 2018

Question today
Imagine tomorrow
Create for the future

Charles Sturt University Port Macquarie
Stage 2 Building Works - Noise Impact Assessment

Savills

WSP
Level 27, 680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001

Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
wsp.com

REV	DATE	DETAILS
1	20 September 2018	Updated with King+Campbell comments

	NAME	DATE	SIGNATURE
Prepared by:	Andrew Thompson	20 September 2018	
Reviewed by:	T Krikke	20 September 2018	
Approved by:	C Marsh	20 September 2018	

TABLE OF CONTENTS

EXECUTIVE SUMMARY

WSP Australia Pty Ltd (WSP) has been engaged to conduct a noise impact assessment as part of the Development Application process for the proposed development of Charles Sturt University (CSU) Port Macquarie Campus Stage 2 Building Works which includes a 2 storey teaching, learning and administration building comprising an area of 2,935m^2.

Various noise sensitive receivers near the proposed development have been identified; including residential, educational, and commercial receivers.

Measurements of the prevailing noise conditions were undertaken to determine the applicable industrial noise limits as outlined in the NSW Noise Policy for Industry at nearby noise sensitive receivers.

Design noise criteria has been determined based on the Port Macquarie-Hastings Council Development Control Plan, the NSW Noise Policy for Industry, and the NSW Road Noise Policy. Construction Noise guidelines have been provided as outlined in the NSW Interim Construction Noise Guideline.

The internal acoustic environment is proposed to be designed in line with applicable Australian Standards, State and Local policies and CSU's internal technical guide for acoustics.

Mechanical plant items have not yet been selected, therefore (environmental) noise emissions from mechanical plant will need to be reviewed during the detailed design stages. The major plant will be located on the eastern side of the development to maximise distance to the nearest residential receivers to minimise impact to the residences.

The potential noise impacts from the carpark, waste collection, pedestrian traffic have been addressed and indicative mitigation measures provided. The increases to road traffic noise due to the operation of the proposed development have been assessed, based on the provided traffic assessment, and are expected to be negligible. Detailed assessment should be undertaken once the design progresses to ensure that the proposed development will achieve compliance with the applicable environmental noise limits as outlined in this report.

1 INTRODUCTION

WSP Australia Pty Ltd (WSP) has been commissioned by Savills (Aust) Pty Limited (Savills Australia) to undertake a Noise Impact Assessment for the proposed Charles Sturt University Port Macquarie Campus Stage 2 (CSU PMQ Stage 2).

1.1 PROJECT BACKGROUND

CSU PMQ Stage 2 will be located on the corner of Ellis Parade car park and Major Innes Road. The proposed development is a 2-storey campus building designed for general purpose teaching facilities. The intent of our advice is to design a building that will create an internal acoustic environment providing a comfortable environment for its occupants, and comply with applicable local, state, and Australian guidelines.

1.2 PROVIDED PROJECT INFORMATION

This report has been written with reference to the following project documentation:

- 'Charles Sturt University CSU Port Macquarie DA Acoustic Assessment' report prepared by ARUP, dated 16 January 2014 [*Stage 1 DA Acoustic Assessment*]
- Charles Sturt University Port Macquarie Stage 2 Architectural documentation [*DA Set*]

1.3 SITE LOCATION AND IDENTIFIED RECEIVERS

The CSU PMQ Stage 2 development is bounded by Major Innes Road to the west, and Ellis Parade and Charles Sturt University Port Macquarie Stage 1 to the north.

As shown in Figure 1.1, the site is surrounded by a mixture of urban development including residential and commercial buildings. Table 1.1 outlines the identified noise sensitive receivers which have the potential to be affected by noise emissions from the proposed development. Approximate distances from the proposed development have also been provided.

The proposed stage 2 building works is located in the northern half of the site highlighted in Figure 1.1.

Figure 1.1 Location map of identified receivers in relation to proposed development (Source: Nearmap)

Table 1.1 Identified nearest noise sensitive receivers

RECEIVER/LOCATION	TYPE OF RECEIVER (AS PER NSW NPfI)	APPROXIMATE DISTANCE FROM PROJECT SITE (m)[1]
5 Sherana Place, Port Macquarie	Residential	25
Charles Sturt University Student Accommodation	Residential	100
Charles Sturt University Port Macquarie Stage 1	Educational	15
St Columba Anglican School	Educational	200
Lake Innes Village Shopping Centre (525 John Oxley Drive, Port Macquarie)	Commercial	65

(1) Noted distances are approximate and for illustrative purposes only. Noise modelling to be undertaken based on actual distances from noise source to receiver.

2 EXISTING ENVIRONMENT

This section provides a summary of the relevant baseline noise data, including the location, dates and measured noise levels.

To establish the acoustic performance for both noise ingress and noise egress, the prevailing external noise environment must be established.

2.1 NOISE LOGGING

Unattended noise monitoring has previously been undertaken for CSU PMQ Stage 1, and is detailed in the Stage 1 DA Acoustic Assessment. This report provided the results of a noise survey conducted between 2nd December 2013 and 10th December 2013. WSP has utilised the results of the noise monitoring conducted for Stage 1, which has been supplemented by additional on-site measurements by WSP as outlined.

The results of CSU PMQ Stage 1 noise and vibration monitoring are replicated in the following sections.

2.2 NOISE SURVEY SUMMARY

The CSU PMQ Stage 1 noise survey consisted of two unattended noise loggers setup within the development site of Stage 1.

WSP undertook attended noise measurements at the Stage 2 development site to validate the previous unattended measurements. Indicative locations of the logging equipment are shown in Figure 2.1.

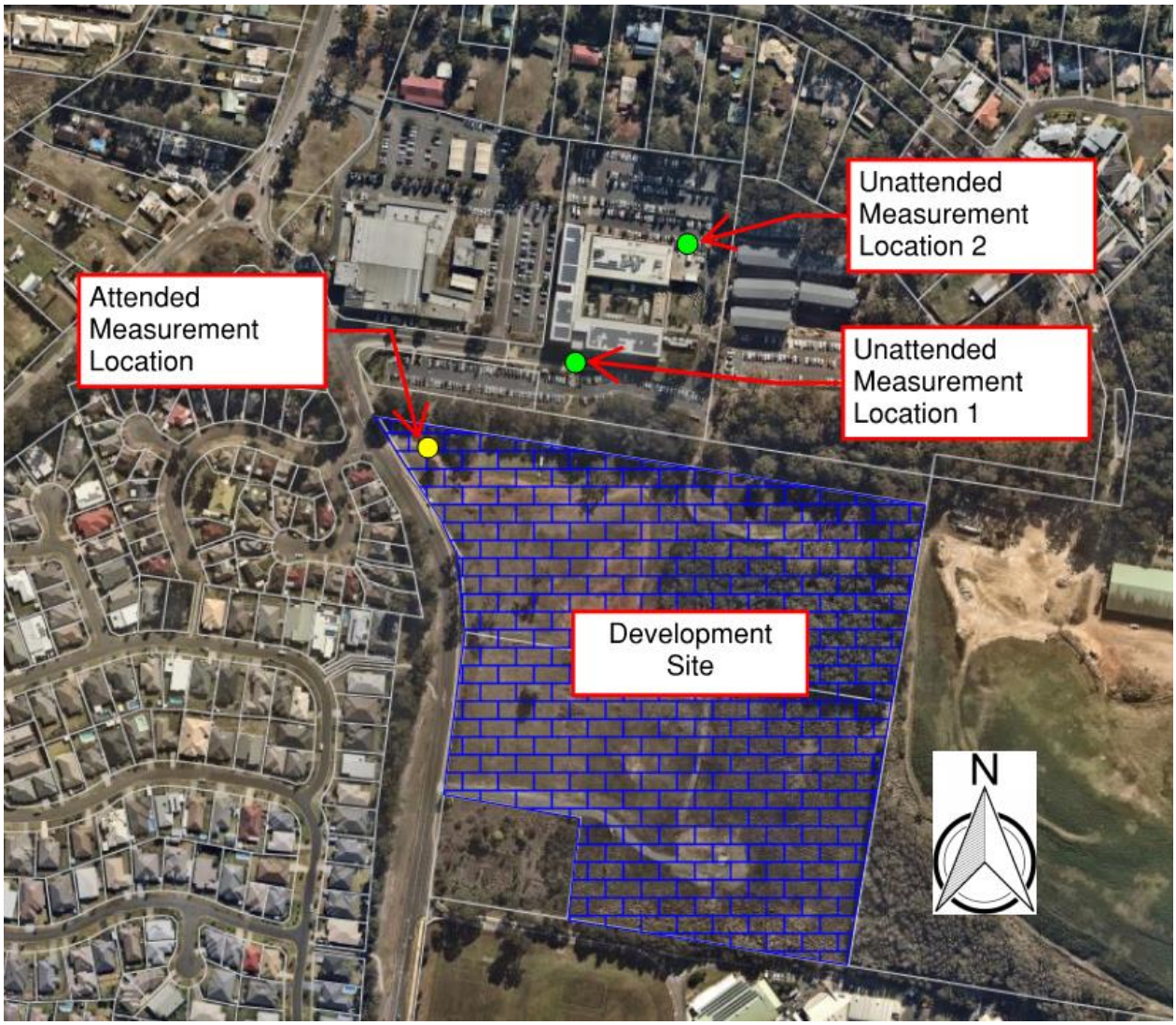

Figure 2.1 Indicative logger locations, CSU PMQ development (Source: Nearmap)

2.2.1 UNATTENDED LOGGING

The Rating Background Noise Level (RBL) is defined in the NSW NPfI and is a measure of background noise, used for assessment purposes at the nearest potentially affected receiver. A summary of the measured RBL levels and $L_{Aeq,15minute}$ noise levels noise levels at the survey locations presented in the Stage 1 DA Acoustic Assessment are provided in Table 2.1.

Table 2.1 Summary of unattended noise measurements

LOCATION ID	TIME PERIOD	dBA $L_{eq,\ 15\ minute}$	dBA RBL
Unattended measurement Location 1	Day	51	43
	Evening	45	41
	Night	40	44

LOCATION ID	TIME PERIOD	dBA $L_{eq,\ 15\ minute}$	dBA RBL
Unattended measurement Location 2	Day	50	43
	Evening	54	42
	Night	47	41

(1) Day: the period from 7:00 am to 6:00 pm Monday to Saturday; or 8:00 am to 6:00 pm on Sundays and public holidays; Evening: the period from 6:00 pm to 10:00pm; Night: the remaining periods.

2.2.2 OPERATOR ATTENDED NOISE SURVEY

WSP carried out operator attended measurements to characterise the noise environment and validate unattended noise measurements undertaken for Stage 1. An operator attended measurement was carried out at the development site (as seen in Figure 2.1) on 10th May 2018.

INSTRUMENTATION AND QUALITY CONTROL

The monitoring equipment was fitted with windshields and were field calibrated before and after monitoring. No significant drifts in calibration (± 0.5 dB) were noted.

All the monitoring equipment has a current certified calibration certificate (National Association of Testing Authorities, NATA) at the time of use. Details of all equipment used to conduct the noise survey are presented in Table 2.2. Copies of the calibration certificates can be provided upon request.

Table 2.2 Noise monitoring equipment

MANUFACTURER AND MODEL NO.	SURVEY METHOD	SERIAL NO.	CALIBRATION DUE DATE
Norsonic 140	Attended measurement	1404791	09/10/2018

During the surveys, the weather was noted as being dry with minimal wind and suitable for noise monitoring. It should be noted that measurements were undertaken during the daytime, evening, and night-time periods.

The results of the attended noise surveys and observations are detailed in Table 2.3.

Table 2.3 Summary of attended noise monitoring results

LOCATION	TIME	dBA $L_{eq,\ 15\ minute}$	dBA $L_{90,\ 15\ minute}$	OBSERVATIONS
7 Major Innes Road, Port Macquarie	11:30 am – 11:45am	65	47	Birds – approximately 52 to 57 dBA Loud traffic (bus, motorbike, etc.) – approximately 73 to 78 dBA
	6:45 pm – 7:00 pm	62	46	Insects – approximately 50 dBA Loud traffic (bus, motorbike, etc.) – approximately 73 to 78 dBA
	11:40 pm – 11:55 pm	50	34	Insects – approximately 40 dBA Distant traffic audible on John Oxley Drive

The night time RBL of both unattended measurement locations has been identified to be impacted by insect noise, as noted in the Stage 1 Acoustic Assessment. Therefore, the $L_{90,\ 15\ minute}$ from the night time attended measurement has been adopted as the project night time RBL, as a conservative measure.

3 NOISE CRITERIA

This report has been written with reference to the following documents, which set out acoustic criteria for educational developments within the Port Macquarie-Hastings Council (PMHC) and the State of New South Wales (NSW):

- Port Macquarie-Hastings Council Development Control Plan 2013 (PMHC DCP)
- NSW Noise Policy for Industry 2017 (NSW NPfI)
- NSW Road Noise Policy 2011 (NSW RNP)
- NSW Interim Construction Noise Guideline 2015 (NSW ICNG)

Furthermore, the following Standards and Industry guidelines are referenced in this report:

- Australian/New Zealand Standard AS/NZS 2107:2016 - Acoustics – Recommended design sound levels and reverberation times for building interiors.

3.1 PORT MACQUARIE-HASTINGS COUNCIL

It should be noted that the CSU PMQ Stage 2 development falls under the commercial development land use category in the Port Macquarie-Hastings Council Development Control Plan 2013 (PMHC DCP). The PMHC DCP outlines the following acoustic requirements:

Loading Bays

2.5.3.20 Objective

- *Loading bays do not adversely impact upon the design integrity of the building or the streetscape.*
- *Loading bays do not impact on visual or acoustic privacy for nearby residents.*

Development Provisions

a) The location and design of loading bays should integrate into the overall design of the building and car parking areas.

b) Where visible from the public domain, loading bays are located behind the building.

c) Where loading bays are located close to a sensitive land use, adequate visual and acoustic screening is provided.

Commercial development adjoining Residential Land uses

3.4.3.35 Objective

- *To promote compatibility between business and commercial development and preserve the amenity of adjoining residential areas.*
- *To ensure that the interface between business and commercial development and adjoining residential areas is of a high quality and achieves adequate visual and acoustic privacy.*

Development Provisions

a) The development is designed so that all vehicle movement areas and servicing areas are located away from adjoining residential areas.

b) Where this cannot be achieved visual and acoustic treatment of the interface is required.

c) The building elevation adjoining the residential area should be:

- *Articulated, with changes in setback at intervals no greater than 10m;*
- *Use a variety of materials and treatments;*

— *Be setback a minimum of half the height of the wall or a minimum of 3.0 metres whichever is greater.*

d) Waste areas are located and managed to minimise pests, noise and odour.

3.2 ENVIRONMENTAL NOISE EMISSIONS

Noise emissions from the proposed development to surrounding noise sensitive areas are required to comply with the NSW Noise Policy for Industry 2017 (NSW NPfI).

The assessment procedure for industrial noise sources has three components:

- Controlling intrusive noise impacts in the short term for residences
- Maintaining noise level amenity for residences and other land uses
- Assessment of sleep disturbance for residences

In assessing the noise impact of industrial sources, all three components must be taken into account for residential receivers. In most cases, only one will become the limiting criterion and form the project trigger levels for the industrial source under assessment.

3.2.1 PROJECT INTRUSIVENESS NOISE LEVEL

The project intrusiveness noise level for residential receivers prescribed in the NSW NPfI may be summarised as:

$$L_{Aeq;\ 15\text{-}minute} \leq \text{Rating Background Level } (L_{A90}) + 5 \text{ dB(A)}$$

Based on the RBL as outlined in Section 2.2, the project intrusiveness noise level has been established for the proposed development in accordance with the NSW NPfI and is presented in Table 3.1.

Table 3.1 Established Project Intrusiveness Noise Level, residential receivers only

RECEIVER LOCATION	TIME PERIOD	RBL dBA	PROJECT INTRUSIVENESS NOISE LEVEL (RBL + 5dB) dBA $L_{eq,\ 15\ minute}$
Unattended measurement location 1	Day	43	**48**
	Evening	41	**46**
	Night	34	**39**

3.2.2 PROJECT AMENITY NOISE LEVELS

To limit continuing increases in noise levels, the maximum amenity noise level within an area from industrial noise sources should not normally exceed the amenity noise levels prescribed in the NSW NPfI.

The recommended amenity noise levels represent the objective for **total** industrial noise at a receiver location, whereas the **project amenity noise level** represents the objective for noise from a **single** industrial development at a receiver location as follows:

Project amenity noise level = recommended amenity noise level (Table 2.2 of NSW NPfI) minus 5 dB(A)

The amenity criterion has been established at the identified receivers based on the results of the attended and unattended noise survey. The established amenity criteria applicable to the proposed development are presented in Table 3.2.

Table 3.2 Established Project Amenity Noise Level

LOCATION	TYPE OF RECEIVER	RECOMMENDED AMENITY NOISE LEVEL (ANL) dBA $L_{eq,\ period}$	PROJECT AMENITY NOISE LEVEL (ANL -5dB) dBA $L_{eq,\ period}$	PROJECT ADJUSTED ANL dBA $L_{eq\ period}$		
				Day[1]	Evening[1]	Night[1]
Coles (525 John Oxley Drive, Port Macquarie)	Commercial	65	60	**60**	**60**	**60**
St Columba Anglican School	School classroom	45[2]	40	**40**	-	-
CSU Port Macquarie Stage 1	School classroom	45[2]	40	**40**	-	-
St Columba Anglican School (outside areas)	Active recreation area	55	50	**50**	-	-
5 Sherana Place, Port Macquarie	Residential (sub-urban)	Day: 55 Evening: 45 Night: 40	Day: 50 Evening: 40 Night: 35	**50**	**40**	**35**
Charles Sturt University Student Accommodation	Residential (sub-urban)	Day: 55 Evening: 45 Night: 40	Day: 50 Evening: 40 Night: 35	**50**	**40**	**35**

(1) day: the period from 7:00 am to 6:00 pm Monday to Saturday; or 8:00 am to 6:00 pm on Sundays and public holidays; evening: the period from 6:00 pm to 10:00pm; night: the remaining periods.

(1) A 10dB internal to external correction has been applied, in accordance with Section 2.6 of the NSW NPfI.

3.2.3 MAXIMUM NOISE LEVEL EVENT ASSESSMENT

The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.

As outlined in the NPfI, where the development night-time noise levels at a residential location exceed the following, a detailed maximum noise level event assessment should be undertaken:

- *"$L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*
- *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater."*

Table 3.3 summarises the maximum noise level event screening criteria for this project.

Table 3.3 Maximum noise level event – project screening criteria

PROVIDED SCREENING CRITERIA	ADJUSTED RBL dBA $L_{eq,\ 15\ minute}$	PROJECT SCREENING CRITERIA
40 $L_{Aeq,\ 15\ minute}$ dBA	*(34 + 5)*[1] 39	**40 $L_{eq,\ 15\ minute}$ dBA**
52 L_{AFmax} dBA	*(34 + 15)*[2] 49	**52 L_{Fmax} dBA**

(1) RBL + 5 as outlined in the NPfI

(2) RBL + 15 as outlined in the NPfI

3.2.4 PROJECT NOISE TRIGGER LEVEL

In assessing the noise impact of the proposed development on surrounding residential receivers, both the intrusiveness and amenity criterion must be considered. In most cases, only one criterion will become the limiting criterion and form the project noise trigger levels (PNTL) for the source under assessment.

It is noted that, in order to standardise the time periods for the intrusiveness and amenity noise levels, the following conversion between $L_{eq,\ period}$ and $L_{eq,\ 15\ minute}$ has been applied (as per Section 2.2 of the NSW NPfI):

$$L_{Aeq,\ 15min} = L_{Aeq,\ period} + 3\ dB$$

As required in Section 2.2 of the NSW NPfI, all project noise trigger levels and limits are expressed as $L_{Aeq,15min}$, unless otherwise expressed. A summary of all relevant criteria is presented in Table 3.4.

Table 3.4 Summary of NSW Noise Policy for Industry Project Noise Trigger Levels (PNTL)

RECEIVER LOCATION	ASSESSMENT/ RECEIVER TYPE	PROJECT NOISE TRIGGER LEVELS dBA $L_{eq\ 15\ minute}$		
		DAY[1]	EVENING[1]	NIGHT[1]
5 Sherana Place, Port Macquarie	*Intrusiveness*	*48*	*46*	*39*
	Amenity	*53*	*43*	*38*
	PNTL	**48**	**43**	**38**
Charles Sturt University Student Accommodation	*Intrusiveness*	*48*	*46*	*39*
	Amenity	*53*	*43*	*38*
	PNTL	**48**	**43**	**38**
Coles (525 John Oxley Drive, Port Macquarie)	Commercial	**63**	**63**	**63**
St Columba Anglican School	School Classroom	**43**	-	-
CSU Port Macquarie Stage 1	School Classroom	**43**	-	-
St Columba Anglican School (outside areas)	Active recreation area	**53**	-	-

(1) day: the period from 7:00 am to 6:00 pm Monday to Saturday; or 8:00 am to 6:00 pm on Sundays and public holidays; evening: the period from 6:00 pm to 10:00pm; night: the remaining periods.

3.3 ROAD TRAFFIC NOISE

To assess the effect of the proposed development in terms of the increase of traffic on the nearby residences, the NSW Road Noise Policy (RNP) provides objective criteria. The relevant criteria have been drawn out of the policy and detailed below.

The road policy is used in this assessment to address noise associated with potential traffic increases on the surrounding road network due to the proposed development. Noise generated by additional traffic on the road is to be assessed against façade corrected noise levels when measured in front of a building façade. The external criteria are assessed at 1 metre from the affected residential building façades and at a height of 1.5 metres from the floor. The internal criteria are assessed at the centre of the habitable room most exposed to traffic noise, with operable windows open to provide sufficient ventilation. This criterion is outlined in Table 3.5 and Table 3.6.

Table 3.5 Noise assessment criteria - residential land uses (Source: NSW RNP Section 2.3.1)

ROAD CATEGORY	PROJECT TYPE/LAND USE	ASSESSMENT CRITERIA	
		DAY (7AM-10PM)	NIGHT (10PM-7AM)
Local road	Existing residences affected by additional traffic on existing local roads generated by land use developments	55 dBA $L_{eq\ (1\ hour)}$ (external)	50 dBA $L_{eq\ (1\ hour)}$ (external)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use	60 dBA $L_{eq\ (15\ hour)}$ (external)	55 dBA $L_{eq\ (9\ hour)}$ (external)

Table 3.6 Noise assessment criteria – non-residential land uses (Source: NSW RNP Section 2.3.1)

PROJECT TYPE/LAND USE	ASSESSMENT CRITERIA	
	DAY (7AM-10PM)	NIGHT (10PM-7AM)
School classrooms	Sleeping rooms: 35 dBA L_{Aeq} (1 hour) (internal) Indoor play areas: 40 dBA L_{Aeq} (1 hour) (internal) Outdoor play areas: 55 dBA L_{Aeq} (1 hour) (external)	-
Open space (active use)	60 dBA Leq (15 hour) (external)	-

Where existing traffic noise levels are above the noise assessment criteria, the NSW RNP aims to protect against excessive decreases in amenity as the result of a project. Where road traffic noise increases by more than 2dB as a result of a land use development, mitigation should be considered to control excessive increase in noise level. An increase of up to 2dB represents a minor impact that is considered barely perceptible to the average person.

Therefore, a maximum 2dB increase in traffic noise levels is considered to be the applicable assessment criterion for receivers which are currently experiencing traffic noise levels greater than the assessment criteria in Table 3.5 and Table 3.6.

3.4 CONSTRUCTION NOISE

Management of noise emissions during construction are best mitigated through the implementation of a site noise and vibration management plan by the prospective builder.

The requirements for construction noise and vibration mitigation are outlined in the NSW Interim Construction Noise Guideline (ICNG).

3.4.1 AIR-BORNE NOISE MANAGEMENT LEVELS

The measured background noise levels (RBL) presented in Section 2.2 have been used to determine the construction Noise Management Levels (NMLs) as per the definitions in the NSW ICNG.

3.4.1.1 RESIDENTIAL RECEIVERS

NMLs are the level of noise above which receivers are considered to be 'noise affected'. They are based on the measured RBL plus an additional allowance of 10dB during standard hours and 5dB outside of standard hours.

Where construction noise levels are above 75dBA at residential receivers during standard hours, they are considered 'highly noise affected' and require additional considerations to mitigate potential impacts. The application of the management levels for noise at residences is outlined in Table 3.7.

Table 3.7 Construction noise management levels for residential receivers and working hours (Source: Table 2 of the NSW ICNG)

TIME OF DAY	NML DBA $L_{eq;15\ minute}$ [1,2]	HOW TO APPLY
Recommended standard hours: Monday - Friday 7am - 6pm Saturday 8am - 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured dBA $L_{eq;15\ minute}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: — times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) — if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

(1) Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

(2) The RBL is the overall background noise level representing each assessment period (day/evening/night) over the whole monitoring period. The term RBL is described in detail in the NSW INP.

3.4.1.2 OTHER SENSITIVE LAND USES

Construction noise to other sensitive land uses are typically considered to be disruptive. The NSW ICNG provides maximum noise levels for typical educational, places of worship, offices and retail outlets. Table 3.8 presents the NMLs for non-residential sensitive receivers at the building exterior. External noise levels are to be assessed at the most affected point within 50 m of the area boundary.

Table 3.8 Construction noise management levels at sensitive land uses (other than residences) (Source: Table 3 of the NSW ICNG)

RECEIVER	NML dBA $L_{eq;15\ minute}$ (applies when properties are being used)
General Commercial and Retail	70 - external
Educational institutes: — St Columba Anglican School	45 – internal; 55 - external [1]

(1) As per the NSW ICNG, a typical difference between internal and external noise levels is typically 10 dB with windows open for adequate ventilation

3.4.2 CONSTRUCTION TRAFFIC NOISE

The NSW ICNG does not specify appropriate criteria for noise arising from construction traffic. The ICNG refers to the *Environmental Criteria for Road Traffic Noise* (EPA 1999) which has been superseded by the NSW RNP for assessment of construction traffic on public roads. Therefore, construction traffic must be assessed against the same criteria as operational road traffic, which is outlined in Section 3.3.

3.5 INTERNAL ACOUSTIC DESIGN

The acoustic design criteria for the internal environment for the Stage 2 development are proposed to be derived from guidance provided in

- AS/NZS 2107:2016 *Acoustics—Recommended design sound levels and reverberation times for building interiors*;
- NSW EPA *Assessing vibration: a technical guideline*;
- Association of Australasian Acoustical Consultants (AAAC) *Guideline for Educational Facilities Acoustics 2010*; and,
- CSU's internally developed technical guideline for acoustics.

3.5.1 INTERNAL NOISE LEVELS

Specific design criteria for the various spaces within the development will be determined during the design stages to ensure all spaces are fit for purpose.

The design noise level recommendations apply to:

- Mechanical Services noise
- External noise intrusion from:
  - traffic noise,
  - general ambient noise of neighbouring properties (e.g. plant noise); and
  - building services plant of the development.

3.5.2 REVERBERATION TIME

Specific design criteria and sound absorptive treatments for the various spaces within the development will be determined during the design stages to ensure all spaces are fit for purpose and an appropriate level of speech intelligibility is achieved.

3.5.3 VIBRATION

Specific design criteria for the various spaces within the development will be determined during the design stages to ensure all spaces are fit for purpose.

4 ENVIRONMENTAL NOISE EMISSION ASSESSMENT

The following sections outline a preliminary review of potential environmental noise emissions to nearby noise sensitive receivers.

4.1 NOISE EMISSIONS FROM THE DEVELOPMENT

4.1.1 INDUSTRIAL NOISE SOURCES – BUILDING SERVICES EQUIPMENT

As the proposed development is in the early design stages, detailed design of building services equipment has not been undertaken. Therefore, a detailed acoustic assessment is not possible at this stage. However, noise emissions from all major external (mechanical) plant will be assessed during the detailed design stages to ensure compliance with the applicable acoustic criteria as outlined in Section 3.2. The assessment will include, typical day, evening and night-time operation and emergency operations.

Current design assumes the inclusion of the following typical plant that contributes to environmental noise emissions:

- General exhaust fans
- Fume cupboard exhaust flues
- External condensing units

Where necessary, acoustic mitigation measures will be applied to the design. These may include;

- Selection of quiet mechanical equipment
- Selection of equipment location located as far as practicable from any noise sensitive receiver
- Acoustic louvres or partial barriers to the plant deck
- Acoustic attenuators and/or inclusion of lined ducts

4.1.2 CARPARK AND LOADING BAY

It is understood that a carpark of 96 spaces is to be constructed as part a separate development.

The Port Macquarie-Hastings Council DCP requires adequate acoustic screening where sensitive land uses are close to a car park/loading bay. The car park has been located on the eastern side of the development furthest away from residential receivers, at an approximate minimum distance of 115 metres, to minimise any potential noise impact. Therefore, the noise impact of the carpark on nearby sensitive receivers is expected to be minimal.

The potential noise impact from the carpark on the nearby sensitive receivers will be assessed in more detail during later stages of design. Further acoustic treatments may be recommended if necessary to comply with the applicable criteria.

4.1.3 WASTE COLLECTION

Noise emissions generated by waste collection activities should be controlled by administrative measures to ensure that collection times occur outside of sleeping hours, minimising any potential disturbance to nearby residents. It is understood that CSU is planning to use an internal room for garbage storage prior to collection.

4.1.4 PEDESTRIAN NOISE

Noise emissions generated by pedestrian traffic are expected to be minimal during typical sleeping hours. However, due to the 24hr operation of CSU administrative measures, such as signage reminding pedestrians to minimise noise, should still be enacted to ensure potential disturbance to residents is minimised.

4.2 OPERATIONAL ROAD TRAFFIC

Increases to road traffic noise due to the operation of the proposed development are subject to the NSW RNP as detailed in Section 3.3.

The existing and future traffic flows for the Stage 2 development site have been reviewed based on the traffic assessment provided (ref: 18030 TEF Let 01 Early Works 180730, dated 30 July 2018). Traffic flows for the CSU PMQ Stage 2 development and the modelled increase in noise levels are summarised in Table 4.1.

Table 4.1 Summary of traffic flow increase in peak periods

LOCATION	TRAFFIC FLOW, VEHICLES/HOUR		TRAFFIC INCREASE, %	INCREASE IN NOISE LEVEL, dB	NSW RNP MAX INCREASE, dB	COMPLIES
	BASE SCENARIO	WITH DEVELOPMENT				
AM peak						
Ellis Pde	378	401	6%	0.3	≤ 2	**Yes**
Major Innes Rd	1435	1458	2%	0.1		**Yes**
PM peak						
Ellis Pde	356	417	17%	0.7	≤ 2	**Yes**
Major Innes Rd	1116	1177	5%	0.2		**Yes**

Due to the existing traffic along Major Innes Road and a comparatively minor predicted increase in traffic volume resulting from CSU PMQ Stage 2, the overall acoustic environment is anticipated not to be impacted by the increase of road traffic and the impact to the residential receivers will be negligible.

The predicted less than 1 dB increase in noise level are anticipated not to be significant. Therefore, the minor increase in road traffic noise will not be discussed further in this report.

4.3 CONSTRUCTION NOISE AND VIBRATION EMISSION

A Construction Noise and Vibration Management Plan (CNVMP) should be developed by the builder in consultation with the Stakeholders and an Acoustic Engineer prior to construction commencement on site.

5 INTERNAL ACOUSTIC DESIGN

As the proposed development is in the early design stages, detailed design of has not been undertaken. Therefore, a detailed assessment is not possible during this stage.

At this stage preliminary advice and example treatments are provided in the following sections.

5.1 EXTERNAL NOISE INTRUSION

The building envelope is comprised of the glass, framing, masonry, and roof elements of the façade. The façade vision elements (glazing) are typically the controlling elements with regards to external noise intrusion.

The traffic noise levels measured at the curb of Major Innes Road were as high as 65 dBA L_{eq} during the day as outlined in Section 2.

Preliminary acoustic modelling has been conducted based on typical façade and room layouts to determine the minimum glazing requirements. Our modelling indicates that for the most affected areas glazing with a 30 dB Rw performance will be sufficient to attenuate traffic noise to the most affected teaching spaces. This target can be achieved with the following typical glazing:

- 6.38mm laminated glass; or,
- 6mm glass / 12mm cavity / 6mm glass Double Glazed Unit.

Further detailed modelling will be undertaken during the design stages to confirm the suitability of these preliminary glazing requirements or whether they can be rationalised based on final design.

Glazing recommendations may also be refined for the different facades of the building. For example, the Eastern facade will be exposed to lower noise levels compared to the Western façade facing Major Innes Road.

Additionally, other factors such as thermal and structural requirements will need to be considered in the final facade glazing design.

5.2 INTERNAL NOISE LEVELS

All building services plant will be assessed during the detailed design stages to ensure compliance with the applicable acoustic criteria as outlined in Section 3.

Treatments that should be considered are:

- Selection of quieter equipment
- Selection of equipment location
- Acoustic louvres
- Acoustic attenuators and/or lined duct sections.

5.3 ROOM ACOUSTICS

Sound absorptive palling areas will be assessed during the detailed design stages to ensure compliance with the applicable acoustic criteria as outlined in Section 3.

Treatments that should be considered are:

- Inclusion of sound absorptive panelling

- Location of Sound absorptive panelling
- Usage and type of space
- Volume of spaces.

5.4 VIBRATION

Vibration isolation of all equipment will be considered during the design stages. Guidance will be taken from the design methodology provided by the American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE) Chapter 48: *Sound and Vibration Control*

6 CONCLUSION

A noise impact assessment has been undertaken for the proposed Charles Sturt University Port Macquarie Campus – Stage 2.

Noise design objectives were set in accordance with the criteria set out in the Port Macquarie-Hastings Council Development Control Plan, NSW Noise Policy for Industry, NSW Road Noise Policy, and NSW Interim Construction Noise Guidelines following an assessment of existing ambient and background noise levels for the area.

Environmental noise emissions from the carpark, waste collection, pedestrian traffic, and operational road traffic have been addressed. As the development is in the early design stages, detailed environmental noise emissions assessment has not been undertaken. The proposed development will need to be designed to achieve compliance with the applicable environmental noise limits as outlined in this report. It is expected that the location of mechanical plant on the eastern side of the building, coupled with suitable acoustic treatment will ensure compliance with the relevant criteria.

When construction commences a detailed Construction Noise and Vibration Management Plan (CNVMP) should be developed by the appointed builder to ensure compliance with the applicable construction noise limits as outlined in this report.

Preliminary guidance and considerations for the internal acoustic environment has been provided. The internal acoustic environment is proposed to be designed in line with applicable Australian Standards, State and Local policies and CSU's internal technical guide for acoustics.

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17 December 2018

Jennifer Kay
Senior Project Manager
Savills Australia

Via email: jkay@savills.com.au

Review of Additional Ground Gas Assessment– Charles Sturt University Port Macquarie Stage 2

Dear Jennifer**,**

1. Introduction and Background

JBS&G Australia Pty Ltd (JBS&G) was engaged by Savills Australia (Savills, the client) to conduct a review of ground gas data collected at the Charles Sturt University (CSU) Stage 2 development site (the site). The site is located to the west of the Port Macquarie-Hastings Council (Council) waste transfer station located on Kingfisher Road Port Macquarie. The waste transfer station was formerly a landfill operated by Council for 35 years until 2001 when it was closed and capped. It is understood that Council has ongoing obligations to ensure that landfill gas from the former landfill does not migrate off-site.

JBS&G previously reviewed (*Review of Landfill Gas Investigation – Charles Sturt University Port Macquarie Stage 2.* Dated 30 May 2018. Ref 54971/115738. (JBS&G 2018a)) ground gas data collected as part of monitoring at the landfill. The review concluded that the risk associated with sub surface migration of methane from the former landfill to the CSU Stage 2 development is low. However, concentrations of carbon dioxide were detected on the CSU site above the criteria specified in NSW EPA (2016) *Environmental Guidelines – Solid Waste Landfills 2nd Edition*. It was unclear whether the source of carbon dioxide was due to naturally occurring processes from the adjacent wetlands/low lying areas or as a result of migration from the landfill.

Subsequently JBS&G provided recommendations (*Ground Gas Management – Charles Sturt University Port Macquarie Stage 2.* Dated 21 September 2018. Ref 54971/116336. (JBS&G 2018b)) for additional ground gas monitoring on the CSU site. The monitoring program outlined in JBS&G (2018b) has been completed by Regional Geotechnical Solutions (RGS) and this letter provides a review of the data and provides recommendations for future ground gas management at the site.

The layout of the proposed Stage 2 development and its proximity to the former council landfill is provided in **Attachment 2**. The development comprises a carpark and a long narrow building in an east west orientation on the northern portion of Lot 1 DP 1240488. The eastern edge of the carpark is located adjacent to an existing detention basin and is approximately 175 m west of the former landfill.

2. Monitoring Program

The ground gas assessment completed at the site by RGS was as follows:

- Installation of six ground gas monitoring wells. Two wells (PGAS201 and PGAS202) were installed on the eastern edge of the proposed carpark while four (PGAS203, PGAS204B,

PGAS205 and PGAS206) were installed between the proposed carpark and the future building. The installation report (including gas well location figure) is presented in **Attachment 3**.

- Four rounds of ground gas monitoring were completed at the site in October and November 2018. The monitoring generally included assessment of flow rates, water levels, pressures and concentrations of methane (CH_4), carbon dioxide (CO_2), oxygen (O_2), carbon monoxide (CO) and hydrogen sulphide (H_2S). The results of the RGS monitoring are presented in **Attachment 4**.

Following a review of the monitoring data an additional round of monitoring was undertaken in early December 2018 by RGS and JBS&G. A summary table of all monitoring results is provided in **Attachment 5**. The summary table also includes gas screening values (GSV) for methane and carbon dioxide calculated using the methodology described in the *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases* (EPA 2012). Table 6 from EPA (2012) is reproduced below and indicates the relationship between GSV and characteristic gas situation/risk classification for sites impacted by ground gas.

Table 6: Modified Wilson and Card classification

	Gas screening value threshold (L/hr)	Characteristic gas situation	Risk classification	Additional factors	Typical sources
	<0.07	1	Very low risk	Typically methane <1% v/v and/or carbon dioxide <5% v/v, otherwise consider increase to Situation 2	Natural soils with low organic content Typical fill
	<0.7	2	Low risk	Borehole flow rate not to exceed 70 L/hr, otherwise consider increase to Situation 3	Natural soils with high organic content Fill
	<3.5	3	Moderate risk		Old inert waste landfill Flooded mine workings
	<15	4	Moderate to high risk	Consider need for Level 3 risk assessment	Mine workings susceptible to flooding Closed putrescible waste landfill
	<70	5	High risk	Level 3 risk assessment required	Shallow, un-flooded abandoned mine workings
	>70	6	Very high risk		Recent putrescible waste landfill

Notes:

1. Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for the minimum periods defined in Section 3.4.
2. Source of gas and generation potential must be identified in the conceptual site model.
3. Soil gas investigation should be in accordance with the guidance provided in Section 3.4.
4. Where there is no detectable flow, the lower measurement limit of the instrument should be used.
5. To determine a GSV of <0.07, instruments capable of making accurate concentration measurement to 0.5% v/v and flow measurement to 0.1 L/hr are recommended.

3. Review

Comments on the ground gas monitoring data presented in **Attachment 5** are as follows:

- The measured water levels at PG201, PG202 and PG204b were higher than the screened interval during each monitoring event (indicating that ground gas from the unsaturated zone is unable to enter the well). As a result, the gas monitoring results from these locations is not relevant to assessing risks at the site.
- The very high water table at PG201 and PG202 indicates that there is a negligible risk of migration of ground gas from the former landfill to the site.
- Of the five rounds of monitoring at PG203 the water level was within the screened interval for two rounds. During these two rounds measured flows were low (<0.1 L/hr), methane concentrations were low, moderate carbon dioxide concentrations were reported (3.2 and 3.8% v/v) and H_2S/CO were less than the measurement limit. Due to the very low flows, calculated GSV values were very low (<0.07 L/hr) and as a result there is very low risk associated with ground gas at this location.
- Water levels were within the screened interval at PG205 during all monitoring events. Peak measured flow rates varied from -7.5 to 0.3 L/hr and stabilised rates varied from -2.5 to 0.3 L/hr. The cause of the negative flow (i.e. from the surface into the well) is unclear and while measurement error is possible the results of the additional monitoring in December 2018 also identified negative flow.
- Measured methane concentrations at PG205 were low with a maximum concentration of 0.5% v/v (peak and stabilised). In contrast, carbon dioxide concentration were high with a maximum reported value of 25.1% v/v (peak and stabilised). Concentrations of H_2S/CO were low (<3 ppm).
- GSVs for stabilised flow/concentrations for PG205 were low (<0.07 L/hr) for both methane and carbon dioxide. However, adoption of worse case stabilised concentration and stabilised flow (assuming that the flows can occur in both directions) results in a GSV for CO_2 of 0.65. While this GSV is still relatively low, EPA (2012) indicates it is sufficient to require the installation of gas protection measures in future structures at the site.
- In addition to the above, the concentrations of carbon dioxide at PG205 significant exceed the level (5% v/v) at which acute toxic effects occur to humans. Due to this, and irrespective or measured flow rates/calculated GSVs, gas protection measures will be required in future buildings at the site and any subsurface structures will be required to be treated as hazardous confined spaces.
- Water levels were within the screened interval at PG206 during three of the monitoring rounds. During these rounds measured flows were highly variable with very high peak negative flows (-40 L/hr) reported although stabilised flows were generally relatively low. Maximum positive flows at PG206 were 2 L/hour (peak and stabilised). Measured methane concentrations were low (<0.2% v/v), elevated carbon dioxide concentrations were reported (12.8% v/v peak and stabilised) and H_2S/CO were low (< 1 ppm). The calculated GSV values were low (max 0.256 L/hr) and while this is relatively low, EPA (2012) indicates it is sufficient to require the installation of gas protection measures in future structures at the site.
- As discussed for PG205, the measured carbon dioxide concentrations at PG206 exceed 5% v/v and as a result gas protection measures will be required in future buildings at the site and any subsurface structures will be required to be treated as hazardous confined spaces.

4. Gas Protection Measures

Review of Table 6 in EPA (2012) indicates that for a maximum GSV value of 0.65 a characteristic gas situation (CS) of 2 is applicable. It is noted that this CS is also generally applicable to scenarios where carbon dioxide concentrations are greater than 5% v/v. EPA (2012) provides guidance on required gas protection values for CS based on the sensitivity of the development proposed for the land. Table 7 from EPA (2012) is reproduced below and indicates that for a CS of 2 the required gas protection value is 3 for a school use.

Table 7: Guidance values for gas protection

Characteristic gas situation (CS)	Required gas protection guidance value				
	Low density residential	Medium–high density residential (strata title)	Public buildings, schools, hospitals, shopping centres	Standard commercial buildings (offices, etc.)	Large commercial (warehousing) and industrial buildings
1	0	0	0	0	0
2	3	3	3	2	1 (a)
3	4	3	3	2	2
4	6 (b)	5 (b)	5	4	3
5	6 (b)	6 (b)	6 (c)	5	4
6	6 (b)	6 (b)	6 (c)	6	6

(a) If maximum measured methane concentration exceeds 20%, increase to CS3.
(b) Residential development not recommended at CS4 and above without pathway intervention and high level of management.
(c) Consideration of evacuation issues and social risks required.

Various measures can be implemented to provide gas protection in buildings. These measures provide varying levels of protection and EPA (2012) has assigned different values to different protection measures. Table 8 from EPA (2012) is reproduced below and can be used to determine appropriate protection measures for the site. As discussed above a gas protection value of 3 is required for the site and considering the proposed development this can potentially be achieved by:

- Construction of the building with a ventilated basement car park or undercroft (for example a suspended slab on piles with a void and open sides to allow ventilation); or
- Passive sub-floor ventilation (gas collection and ventilation system beneath the slab) with ‘very good performance’ and a reinforced concrete slab; or
- Reinforced concrete ground bearing foundation with limited service penetrations cast into slab and a proprietary gas resistant membrane to reasonable levels of workmanship under independent construction quality assurance (CQA) with integrity testing and independent validation.

Table 8: Scores for protection measures

Measure or system element	Score	Comments
Venting and dilution measures		
Passive sub-floor ventilation with very good performance (steady state concentration of methane over 100% of ventilation layer remains below 1% v/v at a wind speed of 0.3 m/s)	2.5	
Passive sub-floor ventilation with good performance (steady state concentration of methane over 100% of ventilation layer remains below 1% v/v at a wind speed of 1 m/s and below 2.5% v/v at a wind speed of 0.3 m/s)	1	If passive ventilation cannot meet this requirement an active system will be required.
Subfloor ventilation with active abstraction or pressurisation	2.5	Robust management systems must be in place to ensure long-term operation and maintenance.
Ventilated car park (basement or undercroft)	4	Assumes that car park is vented to deal with exhaust fumes in accordance with BCA[a] requirements.
Floor slabs		
Reinforced concrete ground bearing floor slab	0.5	It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum. Breaches in floor slabs, such as joints, have to be effectively sealed against gas ingress to maintain these performances.
Reinforced concrete ground bearing foundation raft with limited service penetrations cast into slab	1	
Reinforced concrete cast in situ or post-tensioned suspended slab with minimal service penetrations and water bars around all penetrations and at joints	1.5	
Fully tanked basement	2	
Membranes		
Taped and sealed membrane to reasonable levels of workmanship with inspection and validation	0.5	The performance of membranes is dependent upon the design and quality of the installation, protection from and resistance to damage post installation and the integrity of joints in membranes that require joints. Materials that offer some degree of self-sealing and repair are preferred.
Proprietary gas-resistant membrane to reasonable levels of workmanship under independent construction quality assurance (CQA)	1	
Proprietary gas resistant membrane to reasonable levels of workmanship under independent CQA with integrity testing and independent validation	2	
Monitoring and detection (alarms)		
Intermittent monitoring using hand-held equipment	0.5	Monitoring and alarm systems are only valid as part of a combined gas protection system. Where fitted, permanent systems should be installed in the underfloor venting system but can also be provided in the occupied space as a back-up.
Permanent monitoring system installed in the occupied space of the building	1	
Permanent monitoring system installed in the underfloor venting / dilution system	2	
Pathway intervention		
Vertical barriers	–	Required for residential and public buildings at CS4 and above.
Vertical venting systems	–	

[a] Building Code of Australia

5. Conclusions and Recommendations

Based on a review of the monitoring data collected by RGS and subject to the Limitations in **Attachment 1** the following is conclusions and recommendations are provided:

- High groundwater levels limit the extent and utility of ground gas monitoring at the site;
- Due to the high groundwater levels gas migration from the landfill to the proposed carpark and building area is considered unlikely and as a result the presence of ground gas on the site is likely to be the result of natural processes;
- Reported methane, carbon monoxide and hydrogen sulphide concentrations are low and are not considered to be a risk to future development at the site;
- Reported carbon dioxide concentrations were variable. Two monitoring locations recorded carbon dioxide concentration exceeding 5% v/v (the level at which acute toxic effects occur in humans) with a maximum concentration of 25.1% v/v being measured at PG205;
- The maximum calculated gas screening value (GSV) was 0.65 L/hr resulting in a characteristic gas situation (CS) of 2 which requires a gas protection level of 3;
- While a number of strategies could be implemented to achieve the required level of gas protection for the proposed future building JBS&G recommend the use of a reinforced concrete slab with service penetrations cast insitu in combination with an integrity tested gas resistant membrane installed with independent quality assurance; and
- All subsurface structures (stormwater pits etc) at the site should be treated as potentially hazardous confined spaces. Appropriate management procedures should implemented to ensure that any future access to subsurface structures is undertaken is a safe manner.

Should you require clarification, please contact the undersigned on 02 8245 0300 or by email gdasey@jbsg.com.au.

Yours sincerely:

Chris Bielby
Senior Environmental Consultant
JBS&G Australia Pty Ltd

Reviewed/Approved by:

Greg Dasey
Senior Principal
JBS&G Australia Pty Ltd

Attachments
1) Limitations
2) Site Layout
3) RGS Gas Well Installation Report
4) RGS Ground Gas Monitoring Results
5) Summary Ground Gas Monitoring

Attachment 1 – Limitations

This report has been prepared for use by the client who has commissioned the works in accordance with the project brief only, and has been based in part on information obtained from the client and other parties.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS&G, and should not be relied upon by other parties, who should make their own enquires.

Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements.

Limited sampling and laboratory analyses were undertaken as part of the investigations undertaken, as described herein. Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS&G reserves the right to review the report in the context of the additional information.

Attachment 2 – Site Layout

EXISTING LAKE INNES VILLAGE

EXISTING STAGE 1

EXISTING STUDENT ACCOMMODATION

ELLIS PARADE

NEW PAVING TO EXISTING STAGE 1 CARPARK TO DEMARCATE PEDESTRIAN WALKWAY FROM CARPARK

EXISTING STAGE 1 CARPARK

ROAD LINK

PEDESTRIAN WALKWAY LINK BRIDGE

COUNCIL ROAD RESERVE

LOT 1 DP 1240488 BOUNDARY

EXISTING BASIN

STAGE 2 BUILDING

NEW CARPARK

SURVEYED EXTENT OF EXISTING VEGETATION

LEGEND

- SITE BOUNDARY
- 60m BUFFER MARKING EXTENT OF BUSHFIRE ASSET PROTECTION ZONE
- EXTENT OF MAPPED COASTAL WETLANDS
- SURVEYED VEGETATION AREA
- EXISTING TREES
- EXISTING VEGETATION OFFSET AREA BOUNDARY
- PROPOSED VEGETATION OFFSET AREA BOUNDARY
- LEP FLOOD PLANNING AREA
- LEP LEVEL OF PROBABLE MAXIMUM FLOOD
- 250m LANDFILL GAS BUFFER

C:\REVIT_LOCAL2017\1705012.000-AR-CSU-BLD_dngay.rvt 30/08/2018 6:37:25 PM

BVN

Telephone +61 7 3852 2525
Facsimile +61 7 3852 2544
www.bvn.com.au

NOTE

CONTRACTOR TO CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCEMENT OF WORK OR PREPARATION OF SHOP DRAWINGS. DO NOT SCALE THIS DRAWING

ISSUE	DATE	FOR
1	30.08.18	For Information

CONSULTANT

CIVIL/STRUCTURAL CONSULTANTS
TTW ENGINERRS TEL 02 9439 7288

CONSULTANT

SERVICES CONSULTANTS
ARUP ENGINEERS TEL 02 9320 9320

CONSULTANT

LANDSCAPE CONSULTANT
OCULUS TEL 02 9557 5533

PROJECT MANAGER

PROJECT MANAGER
SAVILLS TEL

CLIENT

CHARLES STURT UNIVERSITY

CLIENT NUMBER

CLIENT 1705012.000

PROJECT

PORT MACQUARIE STAGE 2
CSU PORT MACQUARIE

BVN PROJECT NUMBER

1705012

DRAWING KEY

TRUE NORTH PROJECT NORTH

GRAPHIC SCALE

0 2000 5000

SCALE

As indicated@A1

STATUS

PRELIMINARY

DRAWING

SITE PLAN - STAGE 2

	ISSUE
AR-A10-AA-03	1

Attachment 3 – RGS Gas Well Installation Report

REGIONAL GEOTECHNICAL SOLUTIONS

Manning-Great Lakes
Port Macquarie
Coffs Harbour

RGS20316.1-AY

3 September 2018

Savills Australia
Level 25, Governor Phillip Tower
1 Farrer Place
SYDNEY NSW 2000

Attention: Jennifer Kay

Dear Jennifer,

RE: Stage 2, Charles Sturt University, Major Innes Drive, Port Macquarie
Gas Monitoring Well Installation

As requested, Regional Geotechnical Solutions, (RGS), has installed gas monitoring wells at the six nominated locations in the general vicinity of Stage 2 of the proposed Charles Sturt University development, Major Innes Drive, Port Macquarie.

The gas monitoring wells are required for a gas monitoring program to be undertaken as part of the development.

Monitoring well installation details are summarised below:

- Field work for the well installation was undertaken on 21 August 2018;
- Approximate monitoring well locations are shown on Figure 1;
- Gas monitoring wells were constructed in boreholes drilled by 4WD mounted drilling rig to the top of the groundwater table. Groundwater was encountered in all boreholes;
- Boreholes were logged by an Engineering Geologist and borehole logs are attached;
- Each well is protected by a galvanised metal cover that has a lid secured by padlock;
- Monitoring wells were clearly marked with the borehole reference and number. Coordinates of each well location were recorded by hand held GPS and are shown on the attached logs.

Monitoring well construction was as per Table 1. A summary of specific construction details for each monitoring well is attached.

Table 1: Monitoring Well Construction

Item	Description
Well Casing	Screw jointed 50mm Class 18 PVC casing. Solid casing from approximately 0.5m above the ground to approximately 0.5m below the ground surface (BGS). Screen casing from 0.5m BGS to base of well.
End Cap	Fitted to base of screen section of well
Gravel Pack	Filter pack around well annulus comprises non-carbonate fine grained gravels from the base of the well to approximately 0.45m BGS
Bentonite Seal	Placed above gravel pack to approximately 0.15m BGS. Water added to hydrate bentonite to form seal.
Concrete	Upper 0.15m BGS sealed with concrete to provide foundation for galvanised metal cover.
Gas valve and cap	Removable well cap with gas monitoring valve installed at top of well
Monument	Galvanised steel monument 100mm x 100mm x 1000mm with lockable cover and padlock founded in concrete

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

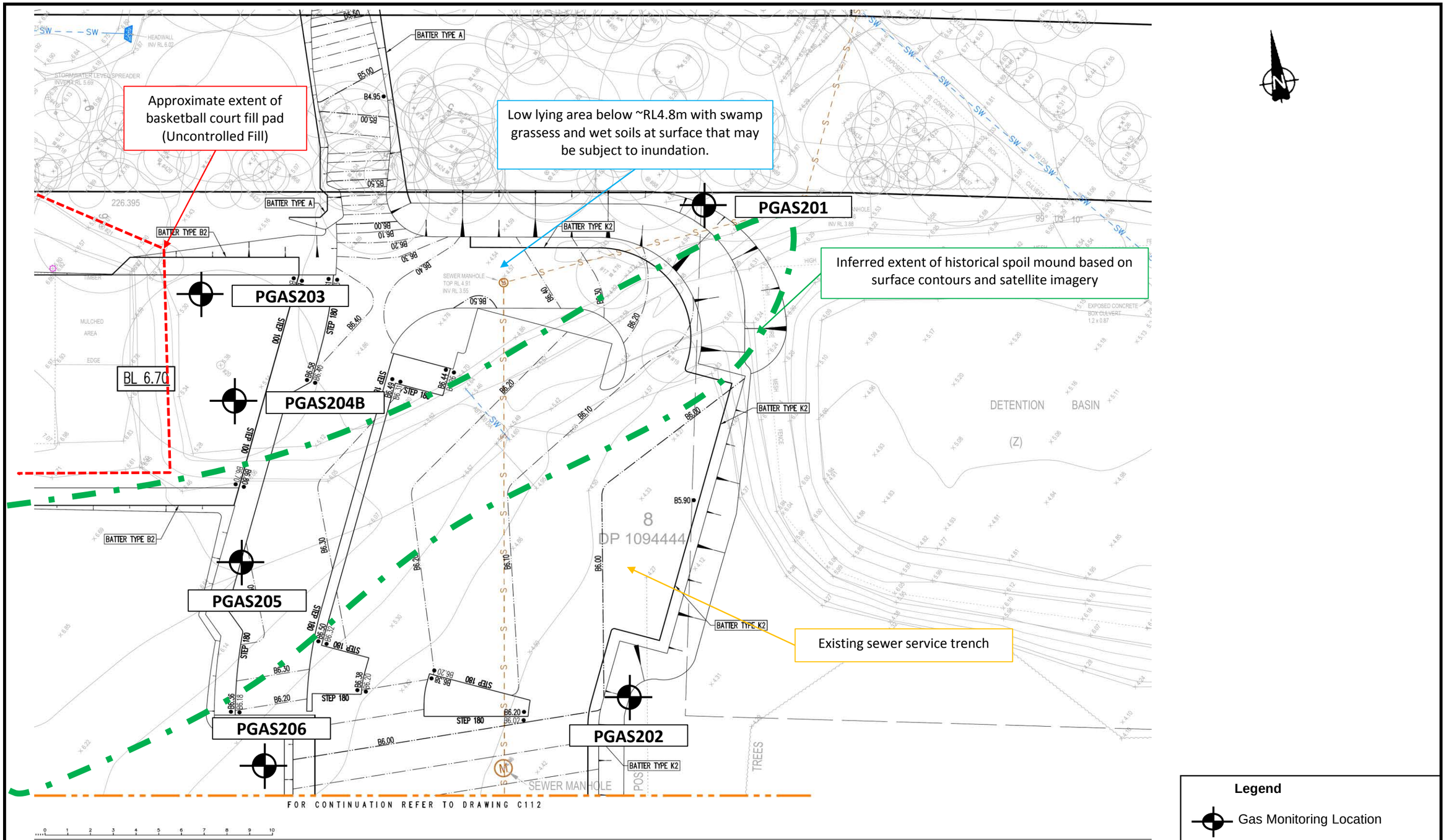
For and on behalf of

Regional Geotechnical Solutions Pty Ltd

Tim Morris

Associate Engineering Geologist

Attachments: Results of Field Investigations



Based on supplied drawing titled "EARLY WORKS BULK EARTHWORKS PLAN SHEET 2 OF 3"

REGIONAL GEOTECHNICAL SOLUTIONS

Client	SAVILLS AUSTRALIA	Job No.	RGS20316.1
Project:	CHARLES STURT UNIVERSITY STAGE 2	Drawn By:	GC
	MAJOR INNES ROAD, PORT MACQUARIE	Date:	31-Aug-18
Title:	INVESTIGATION LOCATION PLAN	Drawing No.	**Figure 1**

ENGINEERING LOG - BOREHOLE

BOREHOLE NO PGAS201

REGIONAL GEOTECHNICAL SOLUTIONS

CLIENT:	Savills Australia	**PAGE:**	1 of 1
PROJECT NAME:	Stage 2, Charles Sturt University	**JOB NO:**	RGS20316.1
SITE LOCATION:	Gas Monitoring Bores	**LOGGED BY:**	GC
TEST LOCATION:	Major Innes Drive, Port Macquarie	**DATE:**	21/8/18

DRILL TYPE: 4WD Mounted Drill Rig **EASTING:** 488273 m **SURFACE RL:** 4.6 m

BOREHOLE DIAMETER: 120 mm **INCLINATION:** 90° **NORTHING:** 6519536 m **DATUM:** RL

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC			4.6	0.0		ML	0.10m **FILL:** Sandy Clayey SILT, dark grey, plastic, traces of Gravel, fine, subrounded	M	Fb	HP	180	FILL/TOPSOIL
						CH	**Silty CLAY:** Medium to high plasticity, grey, with pale brown mottling	M > w_P	Fb			ALLUVIAL
			4.0	1.0								
			3.0	2.0			Traces of Sand, fine to medium grained, traces of Gravel, fine, subangular, Quartz					
	▶						2.00m					
						CH	2.20m **Gravelly Sandy CLAY:** Brown/grey, with red mottling, Sand fine to medium grained, Gravel fine to medium, subangular/subrounded	M < w_P	VSt			
			2.0	2.6			Hole Terminated at 2.20 m Refusal due to Weathered Rock					
				3.0								
			1.0	4.0								
			0.0	5.0								
			-1.0									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO PGAS202

CLIENT: Savills Australia
PROJECT NAME: Stage 2, Charles Sturt University
SITE LOCATION: Gas Monitoring Bores
TEST LOCATION: Major Innes Drive, Port Macquarie

PAGE: 1 of 1
JOB NO: RGS20316.1
LOGGED BY: GC
DATE: 21/8/18

DRILL TYPE: 4WD Mounted Drill Rig
BOREHOLE DIAMETER: 120 mm
INCLINATION: 90°
EASTING: 488281 m
NORTHING: 6519502 m
SURFACE RL: 4.4 m
DATUM: RL

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC						MH	**TOPSOIL:** Sandy Clayey SILT, dark grey, traces of grass roots up to 5mm	M	Fb			TOPSOIL
			4.0	0.25m		CH	**Silty CLAY:** Medium to high plasticity, grey with pale brown mottling Some Gravel, fine grained, subrounded	M > w_P	St	HP	150	ALLUVIAL
	▶		3.0	1.0			1.50m Hole Terminated at 1.50 m					
			2.0	2.0								
			1.0	3.0								
			0.0	4.0								
			-1.0	5.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO PGAS203

CLIENT: Savills Australia
PROJECT NAME: Stage 2, Charles Sturt University
SITE LOCATION: Gas Monitoring Bores
TEST LOCATION: Major Innes Drive, Port Macquarie

PAGE: 1 of 1
JOB NO: RGS20316.1
LOGGED BY: GC
DATE: 21/8/18

DRILL TYPE: 4WD Mounted Drill Rig
BOREHOLE DIAMETER: 120 mm
INCLINATION: 90°
EASTING: 488227 m
NORTHING: 6519539 m
SURFACE RL: 5.2 m
DATUM: RL

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC			5.0			MH	**TOPSOIL:** Sandy Clayey SILT, dark grey, Sand fine to medium grained, traces of grass roots up to 10mm	D	Fb			TOPSOIL
							0.30m					
						CH	**Gravelly Sandy CLAY:** Medium to high plasticity, red/brown, Sand fine to medium grained, Gravel, fine, subrounded	M < w_P	Fb / St	HP	180	ALLUVIAL
							0.70m					
				1.0		CH	**Sandy CLAY:** Medium to high plasticity, pale brown with red/orange mottling, Sand fine to medium grained, some Gravel, fine grained, subrounded					
			4.0				1.40m					
	▶					CH	**Gravelly Sandy CLAY:** Medium plasticity, red/brown, Sand fine to medium grained, Gravel, fine grained					
				2.0			2.00m					
			3.0			CH	**Gravelly Sandy CLAY:** Medium to high plasticity, pale brown with red/pale grey Gravel, fine grained, subrounded, Sand fine to medium grained					
							2.50m					
							Hole Terminated at 2.50 m					
				3.0								
			2.0									
				4.0								
			1.0									
				5.0								
			0.0									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: PGAS204B

CLIENT: Savills Australia
PROJECT NAME: Stage 2, Charles Sturt University
SITE LOCATION: Gas Monitoring Bores
TEST LOCATION: Major Innes Drive, Port Macquarie

PAGE: 1 of 1
JOB NO: RGS20316.1
LOGGED BY: GC
DATE: 21/8/18

DRILL TYPE: 4WD Mounted Drill Rig
BOREHOLE DIAMETER: 120 mm
INCLINATION: 90°
EASTING: 488837 m
NORTHING: 6519530 m
SURFACE RL: 5.2 m
DATUM: RL

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC			5.0			ML	**TOPSOIL:** Sandy Clayey SILT, dark grey, Sand fine to medium grained, traces of grass roots up to 5mm	M	Fb			TOPSOIL
						CH	**Gravelly Sandy CLAY:** Medium to high plasticity, yellow/pale brown, Sand fine to medium grained, Gravel, fine, subrounded	M > w_P	Fb / St	HP	180	ALLUVIAL
				1.0			Colour change at 0.6m to red/brown with pale brown mottling	M < w_P	VSt / Fb	HP	300	
			4.0			CH	**Sandy CLAY:** Medium to high plasticity, pale brown, Sand fine to medium grained, traces of Gravel, fine to medium, subrounded Red mottling					
				2.0		CH	**Gravelly Sandy CLAY:** Medium plasticity, red/brown, Gravel, fine, subrounded, Sand fine to medium grained					
			3.0	3.0			Hole Terminated at 3.00 m					
			2.0	4.0								
			1.0	5.0								
			0.0									

0.30m
1.20m
2.00m
3.00m

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - BOREHOLE

BOREHOLE NO PGAS205

REGIONAL GEOTECHNICAL SOLUTIONS

CLIENT:	Savills Australia	**PAGE:**	1 of 1
PROJECT NAME:	Stage 2, Charles Sturt University	**JOB NO:**	RGS20316.1
SITE LOCATION:	Gas Monitoring Bores	**LOGGED BY:**	GC
TEST LOCATION:	Major Innes Drive, Port Macquarie	**DATE:**	21/8/18

DRILL TYPE: 4WD Mounted Drill Rig **EASTING:** 488140 m **SURFACE RL:** 6.9 m

BOREHOLE DIAMETER: 120 mm **INCLINATION:** 90° **NORTHING:** 6519475 m **DATUM:** RL

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC			6.0	0.00		CH	**FILL:** Sandy Silty CLAY, low to medium plasticity, dark grey, traces of yellow, some Gravel, fine to medium grained, subrounded	M > w_P	Fb / St	HP	180	FILL/TOPSOIL
				0.60m								
				0.70m		MH	**TOPSOIL:** Sandy Clayey SILT, dark grey/black, Sand fine to medium grained					TOPSOIL
			5.0	1.00		CH	**Gravelly Sandy CLAY:** Medium to high plasticity, dark brown/yellow, Sand fine to medium grained, Gravel, fine grained, subrounded					ALLUVIAL
							At 1.3m Colour change to red with pale brown mottling					
			4.0	2.00								
				3.00m								
						CH	**Sandy CLAY:** Medium to high plasticity, yellow/pale brown, Sand fine to medium grained, some Gravel, fine, subangular	M < w_P	Fb / VSt	HP	300	RESIDUAL SOIL
				3.50m								
			3.0	4.00		CH	**Sandy Silty CLAY:** Pale grey/green with pale brown mottling, traces of foliated Rock fabric					EXTREMELY WEATHERED SERPENTINITE
				4.40m								
			2.0	5.00			Hole Terminated at 4.40 m					
			1.0									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO PGAS206

CLIENT: Savills Australia
PROJECT NAME: Stage 2, Charles Sturt University
SITE LOCATION: Gas Monitoring Bores
TEST LOCATION: Major Innes Drive, Port Macquarie

PAGE: 1 of 1
JOB NO: RGS20316.1
LOGGED BY: GC
DATE: 21/8/18

DRILL TYPE: 4WD Mounted Drill Rig
BOREHOLE DIAMETER: 120 mm
INCLINATION: 90°
EASTING: 488223 m
NORTHING: 6519469 m
SURFACE RL: 5.7 m
DATUM: RL

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/TC			5.0	0.0		ML	**TOPSOIL:** Sandy SILT, dark brown/dark grey, Sand fine to medium grained	D	Fb			TOPSOIL
				0.25m		CH	**Gravelly Sandy CLAY:** Medium to high plasticity, pale brown with red mottling, Gravel, fine, subrounded, Sand fine to medium grained	M < w_P	Fb / VSt	HP	300	ALLUVIAL
				1.0			At 0.8m Colour change to red/brown with pale brown mottling					
			4.0				Some grey mottling					
				2.0								
				2.50m		CH	**Sandy CLAY:** Medium to high plasticity, brown with grey mottling, some Gravel, fine, subangular					RESIDUAL SOIL
			3.0	3.0								
				3.50m		CH	**Sandy Silty CLAY:** Medium to high plasticity, grey/green with pale brown mottling, traces of Rock fabric					EXTREMELY WEATHERED SERPENTINITE
			2.0	4.0								
			1.0	5.0								
				5.50m			Hole Terminated at 5.50 m					
			0.0									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

MONITORING WELL DETAILS

Client: SAVILLS AUSTRALIA
Project: STAGE 2, CHARLES STURT UNIVERSITY

Location: Refer Figure 1
Logged By: GC

BOREHOLE NUMBER: PGAS-201
Job Number: RGS20316.1
Date: 31/08/2018

Drill Rig: 4WD
Hole diameter: 120mm **Slope:**
Surface RL:
Datum:

Drilling and Sampling													
Method	Water	Well Details	Well Notes	Depth (m)			Refer separate log sheets for material description						Observations
AD		Concrete; Bentonite; Blank PVC; Screen PVC in gravel pack		0.15									TOPSOIL/FILL
				0.45									ALLUVIAL
				0.5									
				1.0									
				1.5									
				2.0									
							Hole Terminated at 2.2m						
				2.5									
				3									
				3.5									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- – – · Gradational or transitional change
- —— Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

MONITORING WELL DETAILS

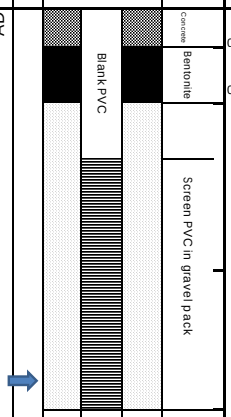
REGIONAL GEOTECHNICAL SOLUTIONS

Client: SAVILLS AUSTRALIA
Project: STAGE 2, CHARLES STURT UNIVERSITY

Location: Refer Figure 1
Logged By: GC

BOREHOLE NUMBER: PGAS-202
Job Number: RGS20316.1
Date: 31/08/2018

Drill Rig: 4WD
Hole diameter: 120mm **Slope:**
Surface RL:
Datum:

Drilling and Sampling												
Method	Water	Well Details	Well Notes	Depth (m)			Refer separate log sheets for material description					Observations
AD			Concrete Bentonite Screen PVC in gravel pack	0.15 0.45 0.5 1.0 1.5			TOPSOIL ALLUVIAL					
		Blank PVC					Hole Terminated at 1.5m					
				2.0 2.5 3 3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

MONITORING WELL DETAILS

REGIONAL GEOTECHNICAL SOLUTIONS

Client: SAVILLS AUSTRALIA
Project: STAGE 2, CHARLES STURT UNIVERSITY

Location: Refer Figure 1
Logged By: GC

BOREHOLE NUMBER: PGAS-203
Job Number: RGS20316.1
Date: 31/08/2018

Drill Rig: 4WD
Hole diameter: 120mm **Slope:**
Surface RL:
Datum:

Drilling and Sampling												
Method	Water	Well Details	Well Notes	Depth (m)			Refer separate log sheets for material description					Observations
AD		Concrete; Bentonite; Blank PVC; Screen PVC in gravel pack		0.15								TOPSOIL
				0.45								ALLUVIAL
				0.5								
				1.0								
				1.5								
				2.0								
				2.5			Hole Terminated at 2.5m					
				3								
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- - - Gradational or transitional change
- —— Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

MONITORING WELL DETAILS

REGIONAL GEOTECHNICAL SOLUTIONS

Client: SAVILLS AUSTRALIA
Project: STAGE 2, CHARLES STURT UNIVERSITY

Location: Refer Figure 1
Logged By: GC

BOREHOLE NUMBER: PGAS-204B
Job Number: RGS20316.1
Date: 31/08/2018

Drill Rig: 4WD
Hole diameter: 120mm **Slope:**
Surface RL:
Datum:

Drilling and Sampling												
Method	Water	Well Details	Well Notes	Depth (m)			Refer separate log sheets for material description					Observations
AD		Concrete; Bentonite; Blank PVC; Screen PVC in gravel pack		0.15								TOPSOIL
				0.45								ALLUVIAL
				0.5								
				1.0								
				1.5								
				2.0								
				2.5								
				3			Hole Terminated at 2.5m					
				3.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

MONITORING WELL DETAILS

REGIONAL GEOTECHNICAL SOLUTIONS

Client: SAVILLS AUSTRALIA
Project: STAGE 2, CHARLES STURT UNIVERSITY

Location: Refer Figure 1
Logged By: GC

BOREHOLE NUMBER: PGAS-205
Job Number: RGS20316.1
Date: 31/08/2018

Drill Rig: 4WD
Hole diameter: 120mm **Slope:**
Surface RL:
Datum:

Drilling and Sampling												
Method	Water	Well Details	Well Notes	Depth (m)			Refer separate log sheets for material description					Observations
AD		Concrete; Bentonite; Blank PVC; Screen PVC in gravel pack		0.15								FILL/TOPSOIL
				0.45								TOPSOIL
				0.5								ALLUVIAL
				1.0								
				1.5								
				2.0								
				2.5								
				3								RESIDUAL
				3.5								EW SERPENTINITE
				4								
							Hole Terminated at 4.4m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

MONITORING WELL DETAILS

REGIONAL GEOTECHNICAL SOLUTIONS

Client: SAVILLS AUSTRALIA
Project: STAGE 2, CHARLES STURT UNIVERSITY

Location: Refer Figure 1
Logged By: GC

BOREHOLE NUMBER: PGAS-206
Job Number: RGS20316.1
Date: 31/08/2018

Drill Rig: 4WD
Hole diameter: 120mm **Slope:**
Surface RL:
Datum:

Drilling and Sampling													
Method	Water	Well Details	Well Notes	Depth (m)			Refer separate log sheets for material description						Observations
AD		Concrete; Bentonite; Blank PVC; Screen PVC in gravel pack		0.15									TOPSOIL
				0.45									ALLUVIAL
				0.5									
				1.0									
				1.5									
				2.0									
				2.5									RESIDUAL
				3									
				3.5									EW SERPENTINITE
				4									
				4.5									
				5			Hole Terminated at 5.5m						

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- - - Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Attachment 4 – RGS Ground Gas Monitoring Results

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 9/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1016
Temperature (°C): 25
Equipment Used: GA5000
Last Calibrated: 5/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-201	0	1.8	17.89	0.1	5.5	16.7	6	1	1.3	0.78	
	30										
	60 (1)	1.2	17.89	0	3.2	18	2	0			
	90										
	120 (2)	0.5	17.89	0	3	19.2	1	0			
	180 (3)	0.2									
	240 (4)	0									
	300 (5)	0.1									
	360 (6)	0.1									
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 9/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1016
Temperature (°C): 25
Equipment Used: GA5000
Last Calibrated: 5/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-202	0	-0.6	10.99	0.5	5.5	17.7	4	0	1.1	0.7	
	30	-1.4	10.99								
	60 (1)	-1.4	10.99	0	4.1	17.4	3	0			
	120 (2)	-1.3	10.99	0	3.9	17.5	3	0			
	180 (3)	-1	10.99	0	3.2	17.7	3	0			
	240 (4)	-0.7	10.99	0	3.2	17.7	3	0			
	300 (5)	-0.6	10.99								
	360 (6)	-0.5	10.99								
	420 (7)	-0.4									
	480 (8)	-0.4									
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 9/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1016
Temperature (°C): 25
Equipment Used: GA5000
Last Calibrated: 5/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-203	0	0	0.22	0	3.2	18.8	1	0	1.9	0.77	
	30	0	0.22								
	60 (1)	0	0.22	0	3.2	17.7	0	0			
	120 (2)	0	0.22	0	3.2	17.7	0	0			
	180 (3)	0	0.22	0	3.2	17.7	0	0			
	240 (4)	0			3.2	17.7	0	0			
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 9/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1016
Temperature (°C): 25
Equipment Used: GA5000
Last Calibrated: 5/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-204B	0	0	0.1	0	0.4	20.3	1	0	1.8	0.73	
	30	0	0.1								
	60 (1)	0	0.1	0	0.2	20.4	0	0			
	120 (2)	0	0.1	0	0.1	20.5	0	0			
	180 (3)	0	0.1	0	0.1	20.5	0	0			
	240 (4)			0	0.1	20.5	0	0			
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 9/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1016
Temperature (°C): 25
Equipment Used: GA5000
Last Calibrated: 5/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-205	0	0.3	0.17	0	19.8	2.7	0	0	2.51	0.76	
	30	0.3	0.17								
	60 (1)	0.3	0.17	0	20.2	1.4	0	0			
	120 (2)	0.3	0.17	0	20.5	1.3	0	0			
	180 (3)	0.3	0.17	0	20.5	1.3	0	0			
	240 (4)	0.3	0.17	0.1	19.9	2	0	0			
	300 (5)	0.3	0.17	0.2	16.8	5	0	0			
	360 (6)			0.2	14.3	7.4	0	0			
	420 (7)			0.3	12.2	9.3	0	0			
	480 (8)			0.3	11	10.5	0	0			
	540 (9)			0.3	9.5	12	0	0			
	600 (10)			0.3	8.1	13.3	0	0			
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 9/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1016
Temperature (°C): 25
Equipment Used: GA5000
Last Calibrated: 5/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-206	0	0.1	18.96	0	9.9	8.5	1	0	1.8	0.75	
	30	0.5	18.96								
	60 (1)	1.1	18.96	0	8.9	7.4	0	0			
	120 (2)	1.6	18.96	0	7.8	8.8	0	0			
	180 (3)	1.8	18.96	0	6.9	9.9	0	0			
	240 (4)	2	18.96	0	10.9	10.9	0	0			
	300 (5)	2	18.96	0	11.4	11.4	0	0			
	360 (6)		18.96	0	11.8	11.8	0	0			
	420 (7)		18.96	0	12	12	0	0			
	480 (8)		18.96	0	12.3	12.3	0	0			
	540 (9)		18.96	0	12.6	12.6	0	0			
	600 (10)		18.96	0	12.8	12.8	0	0			
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 22/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1014
Temperature (°C): 23
Equipment Used: GFM430
Last Calibrated: 18/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-201	0	-64		0	2.1	20.9	0	0	1.15	0.78	
	30										
	60 (1)	0		0	3.1	18.3	0	0			
	90										
	120 (2)	0		0	2.1	19.2	0	0			
	180 (3)			0	1.6	19.7	0	0			
	240 (4)			0	1.3	20	0	0			
	300 (5)			0	1.1	20.1	0	0			
	360 (6)			0	1	20.2	0	0			
	420 (7)			0	0.9	20.3	0	0			
	480 (8)			0	0.9	20.3	0	0			
	540 (9)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 22/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1014
Temperature (°C): 23
Equipment Used: GFM430
Last Calibrated: 18/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-202	0	-24		0	4.1	17.2	0	0	0.75	0.78	
	30	-9									
	60 (1)	-5.7		0	4.2	18.4	0	0			
	120 (2)	-3.1			3.4	18					
	180 (3)	-1.3		0	3.2	18.1	0	0			
	240 (4)	-1.3		0	2.9	18.7	0	0			
	300 (5)			0	2.8	18.5	0	0			
	360 (6)			0	2.6	18.7	0	0			
	420 (7)			0	2.4	18.8	0	0			
	480 (8)			0	2.3	18.9	0	0			
	540 (9)			0	2.3	18.9	0	0			
	600 (10)										
	660 (11)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 22/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1014
Temperature (°C): 23
Equipment Used: GFM430
Last Calibrated: 18/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-203	0	-51		0	2.7	18.5	0	0	1.3	0.77	
	30										
	60 (1)	-23.9		0	2.5	19.1	0	0			
	120 (2)	-6.5		0	2.7	18.5	0	0			
	180 (3)	0		0	2.4	18.8	0	0			
	240 (4)	0		0	2.2	18.9	0	0			
	300 (5)			0	2.2	19	0	0			
	360 (6)			0	2.1	19.1	0	0			
	420 (7)			0	2	19.4	0	0			
	480 (8)			0	2	19.4	0	0			
	540 (9)										
	600 (10)										
	660 (11)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 22/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1014
Temperature (°C): 23
Equipment Used: GFM430
Last Calibrated: 18/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-204B	0	0		0.4	0.2	20.8	0	0	1.3	0.73	
	30										
	60 (1)	0		0	0	21.1	0	0			
	120 (2)	0		0	0	21.12	0	0			
	180 (3)			0	0	21.2	0	0			
	240 (4)										
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	660 (11)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 22/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1014
Temperature (°C): 23
Equipment Used: GFM430
Last Calibrated: 18/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-205	0	0		0	11.2	20.2	0		1.4	0.75	
	30										
	60 (1)	0		0	10	8.5	0				
	120 (2)	0		0	10.2	7.6	0				
	180 (3)	0		0	10.9	6.8	0				
	240 (4)			0	11.2	6.6	0				
	300 (5)			0	11.3	17.5	0				
	360 (6)			0	11.4	6.8	0				
	420 (7)			0	11.3	6.5	0				
	480 (8)			0	11.5	6.4	0				
	540 (9)			0	11.8	6.3	0				
	600 (10)			0	11.6	6.2	0				
	660 (11)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 22/10/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1014
Temperature (°C): 23
Equipment Used: GFM430
Last Calibrated: 18/10/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-206	0	-40		0.2	9.8	20.2	0	0	1.7	0.75	
	30										
	60 (1)	-1.2		0	9	8.2	0	0			
	120 (2)	0		0	7.4	10.2	0	0			
	180 (3)	0		0	6.4	12.2	0	0			
	240 (4)			0	6.1	20.2	0	0			
	300 (5)			0	5.8	12.9	0	0			
	360 (6)			0	5.4	12.8	0	0			
	420 (7)			0	5	20.5	0	0			
	480 (8)			0	4.9	13.6	0	0			
	540 (9)			0	4.9	13.6	0	0			
	600 (10)										
	660 (11)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 5/11/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1012
Temperature (°C): 32
Equipment Used: GA5000
Last Calibrated: 2/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-201	0	-5.5	13.79	0	0.2	19.2	4	0	1m	0.76m	
	30	8.2									
	60 (1)	18	13.79	0	0.2	19.2	4	0			
	90										
	120 (2)	18.5									
	180 (3)	18.5									
	240 (4)										
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 5/11/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1012
Temperature (°C): 32
Equipment Used: GA5000
Last Calibrated: 2/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-202	0	5.5	-39.56	0	0.5	18.3	2	0	1m	0.79m	
	30	8.3	-39.56								
	60 (1)	17.9	-39.56	0	6.3	15.6	6	0			
	120 (2)	21.1	-39.56	0	6.2	15.6	3	0			
	180 (3)	22.7									
	240 (4)	23.4									
	300 (5)	24.2									
	360 (6)	24.2									
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 5/11/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1012
Temperature (°C): 32
Equipment Used: GA5000
Last Calibrated: 2/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-203	0	0	0.17	0	0.1	20.4	0	0	1.4m	0.77m	
	30		0.17								
	60 (1)	0.2	0.17	0	3.9	17.4	0	0			
	120 (2)	0.4	0.17	0	3.9	17.4	0	0			
	180 (3)	0.4	0.17	0	4	17.4	0	0			
	240 (4)		0.17	0	4	17.4	0	0			
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 5/11/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1012
Temperature (°C): 32
Equipment Used: GA5000
Last Calibrated: 2/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-204B	0	0.1	0.24	0	0.1	20.3	0	0	1.7	0.73	
	30	0.2	0.24								
	60 (1)	0.2	0.24	0	0	20.3	0	0			
	120 (2)	0.2	0.24	0	0	20.3	0	0			
	180 (3)	0.2	0.24	0	0	20.3	0	0			
	240 (4)										
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 5/11/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1012
Temperature (°C): 32
Equipment Used: GA5000
Last Calibrated: 2/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-205	0	-7.5	-0.05	0.4	24.7	0.5	0	0	1.8m	0.75m	
	30	-7.2	-0.05								
	60 (1)	-6.3	-0.05	0.4	25.1	0	0	0			
	120 (2)	-5.8	-0.05	0.5	25.1	0	0	0			
	180 (3)	-5.8	-0.05	0.5	25.1	0	0	0			
	240 (4)	-3.2									
	300 (5)	-2.5									
	360 (6)	2.5									
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 5/11/2018

Monitored By: GC
Weather: Sunny
Atmospheric Pressure (Mb): 1012
Temperature (°C): 32
Equipment Used: GA5000
Last Calibrated: 2/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-206	0	-8.3	-16.48	0	1.3	18.1	1	1	1.4m	0.74	
	30	-7.5	-16.48								
	60 (1)	-5.5	-16.48	0	9.5	7.3	2	1			
	120 (2)	-3.7	-16.48	0	9.3	7.5	2	1			
	180 (3)	-2.5	-16.48	0	9.3	7.5	1	1			
	240 (4)	-2.1									
	300 (5)	-1.8									
	360 (6)	-1.8									
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 19/11/2018

Monitored By: TM
Weather: Sunny
Atmospheric Pressure (Mb): 1006
Temperature (°C): 25
Equipment Used: GFM430
Last Calibrated: 16/11/18
Visible Signs of Vegetation Stress: No
Other Comments: Water pooling on surface

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-201	0								0.84	0.76m	
	30			0	4.7	17.5	42	3			
	60 (1)			0	2.2	19.3	33	1			
	90			0	1.5	19.8	27	1			
	120 (2)			0	1.3	20	20	1			
	180 (3)			0	0.9	20.3	13	1			
	240 (4)										
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 19/11/2018

Monitored By: TM
Weather: Sunny
Atmospheric Pressure (Mb): 1006
Temperature (°C): 25
Equipment Used: GFM430
Last Calibrated: 16/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-202	0								0.86m	0.79m	
	30			0	2.9	18.8	6	0			
	60 (1)			0	2.6	19.1	5	0			
	120 (2)			0	2.3	19.2	5	0			
	180 (3)			0	2.2	19.3	3	0			
	240 (4)			0	1.8	19.4	3	0			
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 19/11/2018

Monitored By: TM
Weather: Sunny
Atmospheric Pressure (Mb): 1006
Temperature (°C): 25
Equipment Used: GFM430
Last Calibrated: 16/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-203	0			0	4	17.3	3	0	1.63m	0.77m	
	30			0	3.6	17.8	3	0			
	60 (1)			0	3.4	18	3	0			
	120 (2)			0	3.2	18.1	0	0			
	180 (3)			0	2.8	18.4	0	0			
	240 (4)			0	2.4	18.7	0	0			
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 19/11/2018

Monitored By: TM
Weather: Sunny
Atmospheric Pressure (Mb): 1006
Temperature (°C): 25
Equipment Used: GFM430
Last Calibrated: 16/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-204B	10			0	0.2	20.1	0	0	1.42	0.73	
	30			0	0.1	20.8	0	0			
	60 (1)			0	0.1	20.8	0	0			
	120 (2)			0	0.1	20.8	0	0			
	180 (3)			0	0.1	20.8	0	0			
	240 (4)										
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 19/11/2018

Monitored By: TM
Weather: Sunny
Atmospheric Pressure (Mb): 1006
Temperature (°C): 25
Equipment Used: GFM430
Last Calibrated: 16/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-205	10			0	17.8	1	0	0	1.62	0.75m	
	30			0	18.3	0.4	0	0			
	60 (1)			0	18.7	0.2	0	0			
	120 (2)			0	18.8	0.2	0	0			
	180 (3)			0	18.7	0.3	3	0			
	Re-monitor one hour after initial round of monitoring and water level check										
	30			0	13.7	6.6	0	0			
	60			0	13.6	6.5	0	0			
	90			0	13.6	6.4	0	0			
	120			0	13.7	6.4	0	0			

GAS MONITORING

REGIONAL GEOTECHNICAL SOLUTIONS

Job No. RGS20316.1
Client: Charles Sturt University
Project: Stage 2 Gas Monitoring
Date: 19/11/2018

Monitored By: TM
Weather: Sunny
Atmospheric Pressure (Mb): 1006
Temperature (°C): 25
Equipment Used: GFM430
Last Calibrated: 16/11/18
Visible Signs of Vegetation Stress: No
Other Comments:

BH	Time (Seconds)	Gas Flow (l/hr)	Borehole Pressure (Pa/mbar)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	CO (ppm)	H2S (ppm)	Depth to Water (mbgl)	Top Standpipe Depth (mbgl)	Notes
PGAS-206	0								1.65	0.74	
	30			0	0.2	20	0	0			
	60 (1)			0	0.1	20.6	0	0			
	120 (2)			0	0.1	20.7	0	0			
	180 (3)			0	0.1	20.6	0	0			
	240 (4)										
	300 (5)										
	360 (6)										
	420 (7)										
	480 (8)										
	540 (9)										
	600 (10)										
	600 (10)										

Attachment 5 – Summary Ground Gas Monitoring

Table A: Landfill Gas Measurements and GSV Values
Project: Stage 2 CSU Port Macquarie

Well No.	Top of Well Screen (mbgs)	Date of Monitoring	Depth to water (mbgs)	Atmospheric Pressure (mb)	Stabilised Differential Pressure (mb)	Peak Flow Rate (L/h)	Stabilised Flow Rate (L/h)	Peak CH_4 (%)	Stabilised CH_4 (%)	CH_4 GSV (L/hr)	Peak CO_2 (%)	Stabilised CO_2 (%)	CO_2 GSV (L/hr)	O_2 (%)	H_2S (ppm)	CO (ppm)
PG201	0.70	9/10/2018	0.52	1016	17.9	1.8	0.1	0.1	0.0	0.00	5.5	3.0	0.00	19.2	0	1
PG201	0.70	22/10/2018	0.37	1014	NM	-64	0.0	0.0	0.0	0.00	3.1	0.9	0.00	20.3	0	0
PG201	0.70	5/11/2018	0.24	1012	13.8	18.5	18.5	0.0	0.0	0.00	0.2	0.2	0.04	19.2	0	4
PG201	0.70	19/11/2018	0.08	1006	NM	NM	NM	0.0	0.0	NA	4.7	0.9	NA	20.3	1	13
PG201	0.70	3/12/2018	<0.10	1006	0.0		0.1		0.0	0.00		5.9	0.01	18.1	0	36
PG202	0.70	9/10/2018	0.4	1016	11.0	-1.4	-0.4	0.5	0.0	0.00	5.5	3.2	-0.01	17.7	0	3
PG202	0.70	22/10/2018	-0.03	1014	NM	-24	-1.3	0.0	0.0	0.00	4.2	2.3	-0.03	18.9	0	0
PG202	0.70	5/11/2018	0.21	1012	-39.6	24.2	24.2	0.0	0.0	0.00	6.3	6.2	1.50	15.6	0	3
PG202	0.70	19/11/2018	0.07	1006	NM	NM	NM	0.0	0.0	NA	2.9	1.8	NA	19.4	0	3
PG202	0.70	3/12/2018	<0.10	1007	-2.0		-0.4		0.0	0.00		4.1	-0.02	18.9	0	0
PG203	1.00	9/10/2018	1.13	1016	0.2	0	0.0	0.0	0.0	0.00	3.2	3.2	0.00	17.7	0	0
PG203	1.00	22/10/2018	0.53	1014	NM	NM	NM	0.0	0.0	NA	2.7	2.0	NA	19.4	0	0
PG203	1.00	5/11/2018	0.63	1012	0.2	0.4	0.4	0.0	0.0	0.00	4.0	4.0	0.02	17.4	0	0
PG203	1.00	19/11/2018	0.86	1006	NM	NM	NM	0.0	0.0	NA	4.0	2.4	NA	18.7	0	0
PG203	1.00	3/12/2018	1.3	1006	0.0		0.1		0.0	0.00		3.8	0.00	18.4	0	0
PG204b	1.50	9/10/2018	1.07	1016	0.1	0	0.0	0.0	0.0	0.00	0.4	0.1	0.00	20.5	0	0
PG204b	1.50	22/10/2018	0.57	1014	NM	0	0.0	0.4	0.0	0.00	0.2	0.0	0.00	21.2	0	0
PG204b	1.50	5/11/2018	0.97	1012	0.2	0.2	0.2	0.0	0.0	0.00	0.1	0.0	0.00	20.3	0	0
PG204b	1.50	19/11/2018	0.69	1006	NM	NM	NM	0.0	0.0	NA	0.2	0.1	NA	20.8	0	0
PG204b	1.50	3/12/2018	1.1	1006	0.0		0.1		0.0	0.00		0.0	0.00	21.4	0	0
PG205	0.60	9/10/2018	1.75	1016	0.2	0.3	0.3	0.3	0.3	0.00	20.5	8.1	0.02	13.3	0	0
PG205	0.60	22/10/2018	0.65	1014	NM	0	0.0	0.0	0.0	0.00	11.8	11.6	0.00	6.2	NM	0
PG205	0.60	5/11/2018	1.05	1012	-0.1	-7.5	-2.5	0.5	0.5	-0.01	25.1	25.1	-0.63	0.0	0	0
PG205	0.60	19/11/2018	0.87	1006	NM	NM	NM	0.0	0.0	NA	18.8	18.7	NA	0.3	0	3
PG205	0.60	3/12/2018	1.7	1008	-3.0		-0.7		0.0	0.00		24.8	-0.17	0.1	0	0
PG206	0.90	9/10/2018	1.05	1016	19.0	2	2.0	0.0	0.0	0.00	12.8	12.8	0.26	12.8	0	0
PG206	0.90	22/10/2018	0.95	1014	NM	-40	0.0	0.2	0.0	0.00	9.8	4.9	0.00	13.6	0	0
PG206	0.90	5/11/2018	0.66	1012	-16.5	-8.3	-1.8	0.0	0.0	0.00	9.5	9.3	-0.17	7.5	1	1
PG206	0.90	19/11/2018	0.91	1006	NM	NM	NM	0.0	0.0	NA	0.2	0.1	NA	20.6	0	0
PG206	0.90	3/12/2018	0.7	1006	-3.0		-0.6		0.0	0.00		12.3	-0.07	8.4	0	0

54971/116336
L002 (Ground Gas Management - CSU Port Macquarie Stage 2 - Rev 0).docx

21 September 2018

Jennifer Kay
Senior Project Manager
Savills Australia

Via email: jkay@savills.com.au

Ground Gas Management – Charles Sturt University Port Macquarie Stage 2

Dear Jennifer,

The Stage 2 development of the Charles Sturt University (CSU) campus at Port Macquarie is proposed to be undertaken on land located to the west of the Port Macquarie-Hastings Council (Council) waste transfer station located on Kingfisher Road Port Macquarie. The waste transfer station was formerly a landfill operated by Council for 35 years until 2001 when it was closed and capped. It is understood that Council has ongoing obligations to ensure that landfill gas from the former landfill does not migrate off-site.

JBS&G Australia Pty Ltd (JBS&G) was engaged by Savills Australia (Savills) to conduct a review of landfill gas assessment and management requirements at the Kingfisher Road landfill site and implications for the Stage 2 development of CSU. A letter documenting the review and providing recommendations for further site investigations was prepared (Review of Landfill Gas Investigation – Charles Sturt University Port Macquarie Stage 2, JBS&G 2018) and is provided in **Attachment 2**.

The review concluded that the risk associated with sub surface migration of methane from the former landfill to the CSU Stage 2 development is low. However, concentrations of carbon dioxide have been detected on the CSU site above the criteria specified in NSW EPA (2016) *Environmental Guidelines – Solid Waste Landfills 2nd Edition*. It is unclear whether the source of carbon dioxide is due to naturally occurring processes from the adjacent wetlands/low lying areas or as a result of migration from the landfill.

Current plans for the Stage 2 CSU development (refer **Attachment 3**) show that a portion of the proposed building lies within a 250 metre buffer around the former landfill site boundary. Further assessment of ground gas risks has therefore been recommended to determine whether gas protection measures are required on the CSU site. Additional assessment should involve the installation of a network of monitoring bores on the CSU site with at least six measurements (preferably during falling atmospheric pressure) of gas concentration and flow being completed over a minimum period of 3 months. Landfill gas monitoring bores (minimum of six) should be located as follows:

- At the western edge of the proposed basin area;
- Near the centre of the proposed carpark;
- Two locations within the footprint of the Stage 2 building; and
- Two locations within the footprint of the future CSU Campus Stage.

No bores are required in the regeneration area or proposed stormwater treatment area. Assessment works should be undertaken in accordance with NSW EPA (2012) *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases*.

The results of the additional assessment in conjunction with any ongoing landfill gas monitoring undertaken by Council at the former landfill will provide input into the assessment of risk at the CSU site posed by the off-site migration of landfill gases and the plan for management of ground gas.

Importantly, the undertaking of additional ground gas assessment should not preclude development approval within the landfill buffer zone. The results of the monitoring on the boundary of the landfill (as reported in JBS&G 2018) indicate that potential risks to the Stage 2 development are limited to the presence of carbon dioxide. Low/negligible risks were identified for methane on the western/northern boundary of the landfill. Given this, any potential requirement for gas mitigation measures for the proposed development will likely be limited to those required to manage carbon dioxide and not explosive risks associated with methane.

The approval authority may consider inclusion of consent conditions requiring the engagement of a NSW EPA Accredited Site Auditor to review the ground gas investigation works, determine the appropriateness of a long term management plan for ground gas controls (if required) and provide a Site Audit Statement indicating that the site is suitable for its intended use. This would allow development approval to be issued prior to completion of the ground gas investigation works while still ensuring that the appropriate controls are implemented at the site to manage risk (if any) associated with ground gas from the council landfill.

JBS&G consider that for the proposed Stage 2 building envelope (**Attachment 3**) ground gas protection measures can be incorporated satisfactorily if determined to be required after receipt of the results of the additional monitoring.

Should you require clarification, please contact the undersigned on 02 8245 0300 or by email gdasey@jbsg.com.au.

Yours sincerely:

Dr Greg Dasey
Senior Principal
JBS&G Australia Pty Ltd

Attachments

1) **Limitations**
2) **Review of Landfill Gas Investigation – Charles Sturt University Port Macquarie (JBS&G 2018)**
3) **CSU Stage 2 Development Plans**

Attachment 1 – Limitations

This report has been prepared for use by the client who has commissioned the works in accordance with the project brief only, and has been based in part on information obtained from the client and other parties.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS&G, and should not be relied upon by other parties, who should make their own enquires.

Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements.

Limited sampling and laboratory analyses were undertaken as part of the investigations undertaken, as described herein. Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS&G reserves the right to review the report in the context of the additional information.

Attachment 2 – *Review of Landfill Gas Investigation – Charles Sturt University Port Macquarie Stage 2*, JBS&G 2018

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L001 (Review of Landfill Gas Investigation - CSU Port Macquarie Stage 2 - Rev 0).docx

30 May 2018

Jennifer Kay
Senior Project Manager
Savills Australia

Via email: jkay@savills.com.au

Review of Landfill Gas Investigation – Charles Sturt University Port Macquarie Stage 2

Dear Jennifer**,**

1. Introduction

JBS&G Australia Pty Ltd (JBS&G) was engaged by Savills Australia (Savills, the client) to conduct a review of *Kingfisher Road Landfill Site: Landfill Gas Investigation – 2016 Update* dated September 2016 and prepared by GHD with respect to its implications for the Charles Sturt University (CSU) Stage 2 development.

The layout of the proposed Stage 2 development and its proximity to the former council landfill is provided in **Attachment 2**.

2. Scope of Works

Th scope of works comprised review of the document *Kingfisher Road Landfill Site: Landfill Gas Investigation – 2016 Update* dated September 2016 and prepared by GHD and preparation of this letter outlining the requirements for additional landfill gas assessments, the relevance of buffer zones and potential requirements for implementation of mitigation measures at the site for the proposed development. The client also supplied monthly monitoring data (as an EXCEL spreadsheet) for the period May to August 2017 and an Adobe document presenting monitoring data for September 2017.

3. Review

3.1 Landfill Gas Investigation

Portions of GHD 2016 relevant to the Stage 2 development are summarised as follows:

- The objectives of the report were to review data collected since 2014. Data prior to 2014 was reported by GHD in *Kingfisher Road Landfill Site Landfill Gas Investigation* report (GHD 2014). The 2014 report was prepared in response to the proposed re-zoning of land located to the west and south of the landfill. The land to the west is the site (i.e. the land proposed for the CSU Stage 2 development);
- The new data primarily consisted of 12 rounds of landfill gas monitoring at bores located around the perimeter of the landfill. In addition to the review, GHD was engaged to provide conclusions and recommendations relevant to the data review;
- The landfill was utilised for over 35 years for waste disposal with landfilling ceasing in 2001. The landfill was capped and revegetated in accordance with a closure plan;

- The former landfill is present as a large mound (up to approximately 25 mAHD) that slopes steeply towards the boundaries. At the western boundary the ground level varies from approximately 10-12 mAHD in the north to approximately 2 mAHD in the south;
- Soils beneath and surrounding the landfill consist of low permeability clayey silts and clayey sands although the report notes that quaternary sands are present to the east, south and southwest and beneath the landfill. Siltstone is present below the unconsolidated materials.
- Review of the borelogs for the landfill gas bores confirms the presence of sands at shallow depths along the low lying southern and western boundary of the landfill. In higher areas (north western corner of the landfill) no sand is present and colluvial/residual clay overly the siltstone;
- Groundwater levels are noted to be approximately 1 m below the natural ground surface. Data collected since 2014 confirms that the depth to groundwater is very (<1.5 m) shallow along the southern and western portion of the landfill. Depth to groundwater increases to approximately 3 m in the north-western portion where the topography is higher and the soils type is predominantly clay;
- The landfill does not have a gas drainage layer in the cap and no base/side wall liner is present;
- GHD note that the *"relatively elevated groundwater table is likely to restrict the subsurface migration of landfill gas to some extent"*;
- The landfill gas monitoring program previously (prior to 2015) comprised monitoring of 4 boreholes (BH1 – BH4) however, GHD concluded that the construction of these bores was not suitable for ongoing monitoring. Subsequently 6 additional bores (PGAS-1 to PGAS-06) (refer **Attachment 3**) were installed and were monitored on a monthly basis from March 2015 to March 2016;
- GHD did not consider the results of flow monitoring from the PGAS series of bores to be reliable. As a result, gas screening values were not calculated and no comparison to the characteristic gas situations presented in "*Guidelines for the Assessment and Management of Site Impacted by Hazardous Ground gases* (EPA 2012) was undertaken;
- GHD adopted assessment criteria from the NSW EPA Landfill Guidelines (2016). JBS&G assumes that this reference should be to "*Environmental Guidelines – Solid Waste Landfills 2nd Edition* 2016" (EPA 2016). The adopted criteria were 1 % v/v methane and 1.5 % v/v carbon dioxide. JBS&G assume these values are quoted from Section 5.3 of EPA (2016) and note that the values are intended to trigger the requirement for further assessment and are not directly applicable to assessing risk to off-site properties;
- Exceedances of the adopted methane criteria only occurred for locations on the southern boundary of the landfill and are therefore not relevant to assessing risk to the CSU Stage 2 development;
- Exceedances of the adopted carbon dioxide criteria occurred at all monitoring locations (southern, western and north western);
- GHD concluded that the carbon dioxide concentrations were increasing with time at all bores but there was no trend for methane;
- It was noted that the wetland sediments of Kooloonbung Creek could be a natural source of ground gases. As a result, GHD indicated that it was not possible to define the precise source of the gases detected in the bores surrounding the landfill;

- Further, GHD concluded that "*it is not possible to confirm with a high level of certainty if off-site landfill gas migration is occurring from the"* landfill;
- JBS&G note that as methane was not detected at significant levels on the western/north western boundary of the landfill it is reasonable to conclude that methane is not migrating from the landfill to the CSU Stage 2 development site. As carbon dioxide concentrations were relatively high it is not possible to conclude that it is not migrating onto the adjacent land;
- A landfill gas generation and emission model was presented in the report. The model indicates that peak generation of gas has occurred and generation rates are expected to decrease with time;
- GHD concluded that the likelihood of significant sub-surface migration of methane was low and if it was to occur it would most likely be at the southern boundary. Further it was concluded that there was a moderate risk of sub-surface migration of carbon dioxide. Similarly, it was concluded that the potential extent of migration from the landfill of methane was low (i.e. of the order of tens of metres) and moderate for carbon dioxide;
- GHD highlighted the potential for natural sources of ground gases to be present on the CSU site;
- While GHD concluded that it was unclear what buffer distance should apply to the landfill, they then proposed a distance of 250 m and indicated that land within that buffer zone "*be required to undertake a ground gas risk assessment for any proposed building/structure and to install any gas protection measures found to be required by that assessment"*; and
- A number of recommendations were provided in the report including:
    - Establishment of a temporary 250 m landfill gas buffer around the landfill;
    - Require new developments within the buffer to assess and manage ground gas risk in accordance with NSW EPA guidance (i.e. EPA 2012, EPA 2016);
    - Based on the above assessment outcomes, establish a long-term gas buffer distance;
    - Council to survey bores, review the closure plan and OEMP, identify long term gas management measures, address data quality issues and continue a monitoring program to determine whether they should notify EPA; and
    - Undertake additional investigation to assess the source of ground gases and expand the monitoring program (additional location on and past the site boundary).

3.2 2017 Monitoring Data

The 2017 monthly monitoring data (May to September 2017) includes measurements collected from the bores installed in 2015 (PGAS-1 to PGAS-06) as well as three new bores (installed in May 2017). The bores were labelled PGAS8 and PGAS9 located in St Columba School and PGAS10 located at the site (CSU). The exact locations of the new bores are unclear.

Monitoring data for the existing bores reported gas concentrations within the range discussed in GHD (2016). Data for the new bores on the school and CSU properties was of a similar methane concentration (i.e. low <0.1% v/v), whilst elevated concentrations (up to 5.8% v/v at the school and up to 11.9 % v/v on the CSU property) of carbon dioxide were reported. The maximum recorded gas flow rate was 4.6 L/hour although only one other measured flow exceeded 0.1 L/hr.

No information was provided to determine whether the data quality issues identified in GHD (2016) were addressed prior to collection of the 2017 data.

4. Summary and Recommendations

The *Kingfisher Road Landfill Site: Landfill Gas Investigation – 2016 Update* dated September 2016 and prepared by GHD is considered a useful and comprehensive assessment of the data available for the landfill in 2016. Due to the identified limitations to the extent and quality of the data available in 2016, GHD has adopted a number of conservative assumptions with the result that a very conservative buffer zone has been applied to the land surrounding the landfill. Notwithstanding this the buffer distance is consistent with NSW EPA guidance (EPA 2016). The conclusions/ recommendations presented in GHD (2016) are considered to be generally appropriate although it is unclear which (if any) of the recommendations have been actioned by Council.

JBS&G agree with the GHD conclusion that the risk associated with sub surface migration of methane from the landfill to the CSU Stage 2 development site is low, as reported concentrations on the western and northern boundaries of the landfill are less than the criteria specified in EPA (2016) and methane was not detected during 2017 in the monitoring bore on the CSU site.

However, the reported carbon dioxide concentrations both on the boundary of the landfill and in the monitoring bore (PGAS10) on the CSU site exceed the criteria specified in EPA (2016) and as a result it is concluded that there is a moderate risk associated with carbon dioxide. The source of the elevated carbon dioxide concentrations is not clear. However, whether it is present due to naturally occurring processes in the adjacent wetlands/low lying areas or is a result of migration from the landfill does not affect the requirement for further assessment on the CSU site.

JBS&G consider that further assessment of ground gas risks is required to determine whether gas protection measures are required on the CSU site and/or the temporary buffer distance is appropriate. The assessment should be undertaken in accordance with the methodology presented in the risk assessment framework of the "*Guidelines for the Assessment and Management of Site Impacted by Hazardous Ground gases"* (EPA 2012). This will require that a network of monitoring bores is established on the CSU site with at least 6 measurements (preferably during falling atmospheric pressure) of gas concentration and flow being completed over a minimum period of 3 months. The landfill gas monitoring bores (approximately 6) should be located along the perimeter of, and within the area, proposed for the new enclosed structures. No bores are required in the regeneration area or proposed stormwater treatment area.

It is important to note that the conclusion/recommendation above is influenced by the reported concentrations of carbon dioxide at PGAS10 being greater than 1.5% and particularly being greater than 5% v/v (the level of acute toxic effects to humans). The exact location of this bore is unclear and it is recommended that further information is sought from Council regarding this bore (location plans, installation details, etc). Similarly, additional information from Council regarding progress on implementation of the recommendations presented in GHD (2016) may also influence requirements for further assessment/gas mitigation measures at the CSU site.

Requirements for mitigation measures on the CSU site will rely on the outcome of the risk assessment. While current data (PGAS10) indicates that mitigation may be required, there may be potential to decrease the extent of required mitigation measures where it can be determined that the gas is sourced from natural processes and flow rates are very low (less than 1 L/hr) on the CSU site. Where flow rates are high, or the gas is clearly derived from the landfill, then mitigation measures will be required unless Council implements actions to prevent off-site migration of gases from the landfill.

Should you require clarification, please contact the undersigned on 02 8245 0300 or by email ncussen@jbsg.com.au.

Yours sincerely:

Dr Greg Dasey
Senior Principa
JBS&G Australia Pty Ltd

Reviewed/Approved by:

Joanne Rosner
Senior Principal
JBS&G Australia Pty Ltd

Attachments
1) Limitations
2) Site Layout
3) Bore Locations

Attachment 1 – Limitations

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Limited sampling and laboratory analyses were undertaken as part of the investigations undertaken, as described herein. Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history and which may not be expected at the site.

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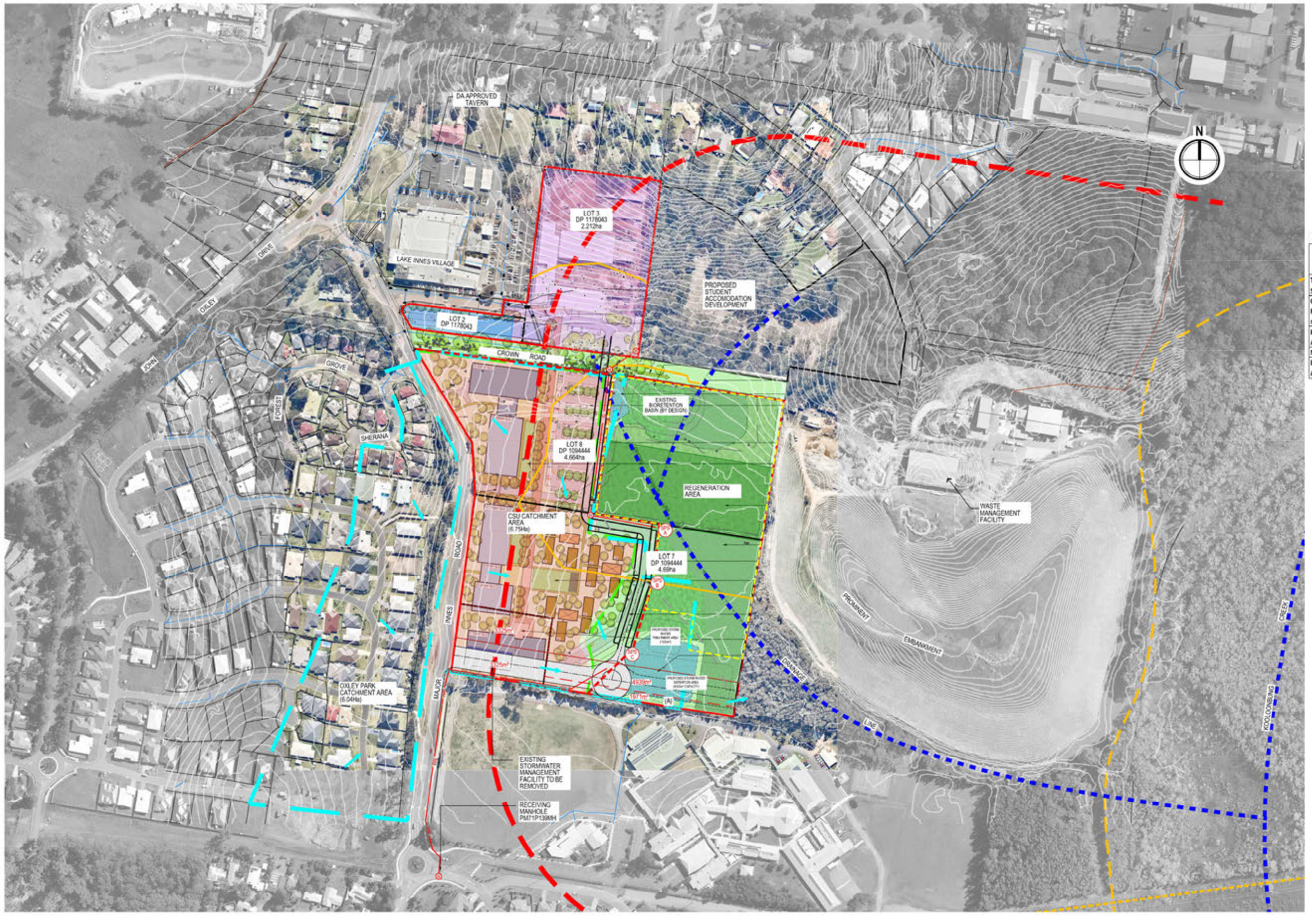
This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS&G reserves the right to review the report in the context of the additional information.

Attachment 2 – Site Layout

PRELIMINARY
03.02.2017



LEGEND

- PROPERTY BOUNDARY
- TEMPORARY LANDFILL GAS BUFFER - 250m AS RECOMMENDED BY GHD SEPTEMBER 2016
- EXISTING TRAILS
- EXTENT OF APZ
- POSSIBLE R3 / E2 - E3 ZONE BOUNDARY
- R3 / E2 - E3 ZONE BOUNDARY FROM COUNCIL REPORT 20 FEBRUARY 2013
- DRAINAGE LINES/CREEKS
- STORMWATER CATCHMENT BOUNDARY
- STORMWATER FLOW DIRECTION
- CSU KOALA OFFSET/NATURAL REGENERATION AREA - 3.22Ha AS PER SLR VEGETATION MANAGEMENT PLAN AREAS 06/02/2015 (3.7 Ha BY MEASUREMENT)
- POSSIBLE KOALA OFFSET/NATURAL REGENERATION AREA - 3.58 Ha.
- PROPOSED SEWER & MANHOLE
- PROPOSED SEWER RISING MAIN
- SPS PUMP STATION LOCATION - ALTERNATIVE OPTIONS
- (A) EXISTING EASEMENT TO DRAIN WATER 10 WIDE (AE164803 & DP 1094444)

CSU Koala Offset / Natural Regeneration Area Comparison Table

	SLR Vegetation Management Plan (06/02/2015) (Ha)	Possible Revised Areas (Ha)
Total Regeneration Area (Including Stage 1 Bio-retention)	3.74	3.58
CSU Koala Offset / Natural Regeneration (Ex. Stage 1 Bio-retention Basin)	3.22	3.06
Paperbard Forest Regeneration Area	1.65	1.65
Natural Regeneration Area	1.57	1.41
Difference in Natural Regeneration Area	N/A	-0.16

PRELIMINARY ONLY - DO NOT USE FOR CONSTRUCTION

K-C REF: D:\5555_CharlesSturt\Jon-Eva\Parade\21-Planning\5555P_Base Plan.dwg - A1(L) WORKING PLAN 1 - 03- Feb - 2017, Ivana

KING + CAMPBELL

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F: 02 6583 4064
E: info@kingcampbell.com.au

REV	DATE	DESCRIPTION
A	11.02.2016	ISSUED FOR INFORMATION
B	03.02.2017	GHD TEMPORARY BUFFER

DATUM: AHD
SCALE: 1:2000 @ A1 (1:4000 @ A3)

PROJECT NO:	5555
DA NO.:	-
DESIGNED BY:	MM
DRAWN BY:	MM
CHECKED BY:	BC
DATE CREATED:	01.2016

DRAWING TITLE: LAND USE WORKING PLAN 1 - CONCEPT MASTER PLAN WITH POSSIBLE ROAD, STORMWATER, SEWER, ZONING & VMP CONCEPTS

A1

PROJECT: CHARLES STURT UNIVERSITY
LOTS 7 & 8 DP1094444

CLIENT: CHARLES STURT UNIVERSITY

DRAWING NO: 5555P_Base Plan

SURFACE: -

REVISION: B

Attachment 3 – Bore Locations

Legend

Bore Location

REGIONAL GEOTECHNICAL SOLUTIONS	**Client**	PORT MACQUARIE HASTINGS COUNCIL	Job No. RGS20130.1
	Project:	KINGFISHER LANDFILL GAS MONITORING BORES	Drawn By: TLM Date: 18-Mar-15
	Title:	APPROXIMATE POSITION OF BORES	Drawing No. **Figure 1**

NOTES:

LANDFILL SURFACE GAS MONITORING

1. Take readings on 25m grid as shown this sheet. Take reading at the approximate centre of each grid space location and record reading in that space.
2. Take readings 50mm above the ground surface.
3. Monitoring must be carried out when the wind velocity is less than 10kph.
4. Where a monitoring location falls in an area of final cover, place an "X" in the top right hand corner of the grid cell.
5. Where a monitoring location falls in an area consisting of waste or daily cover, place a "W" in the record sheet. A gas reading should not be recorded in this case.
6. Where a monitoring location falls in an area where no land filling has occurred, leave the record sheet cell blank.

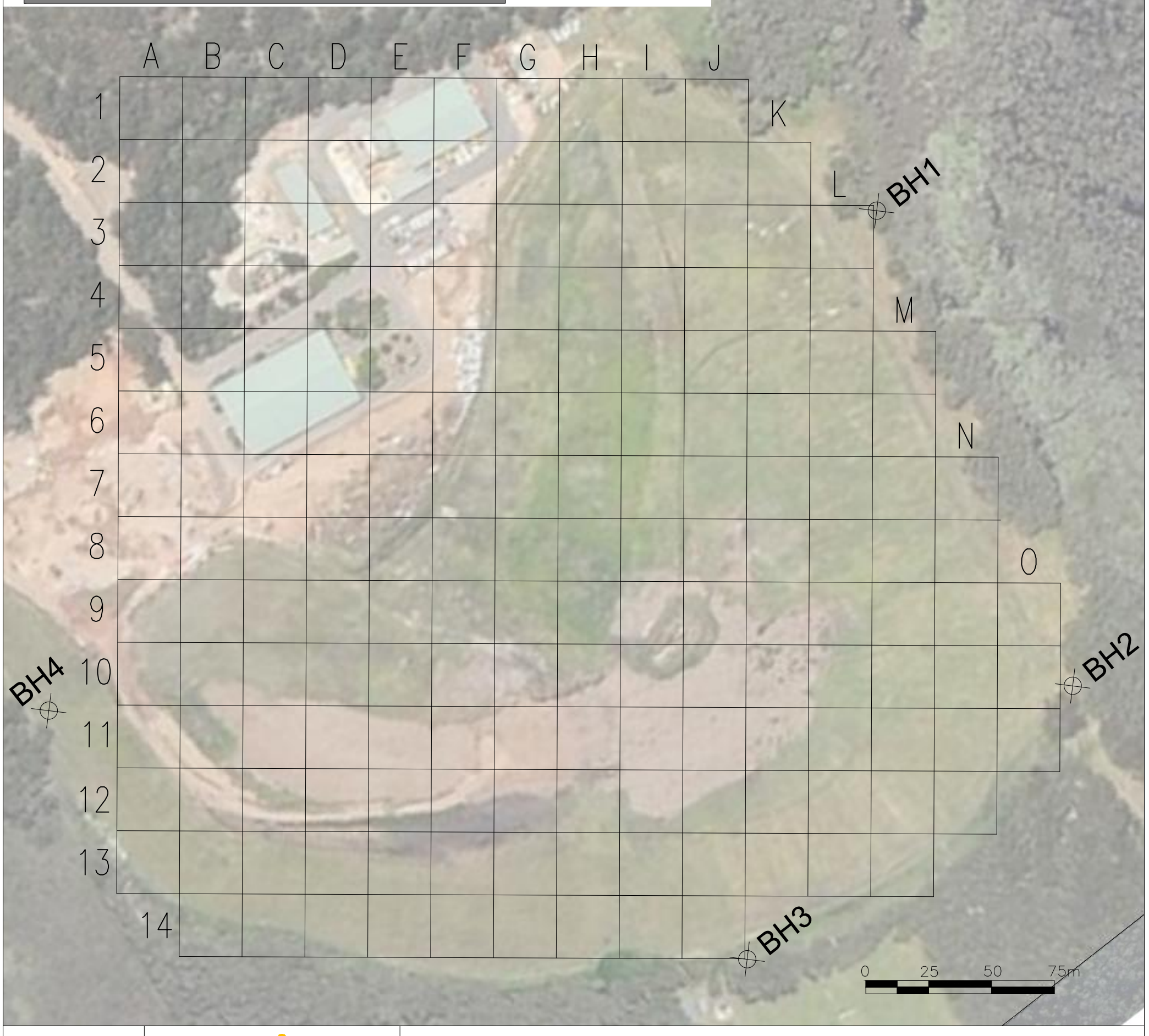
SUBSURFACE LANDFILL GAS MONITORING

7. After opening PVC cap on the borehole, allow the bore to breath for approximately 5 minutes or until readings are stable.
8. Take readings by placing the gas sample inlet tubing directly into the top of PVC peizometer pipe.

GAS ACCUMULATION MONITORING

9. Take readings within offices and buildings (except open sheds) before the buildings are opened in the morning.
10. Readings should be taken in each room and within various enclosed spaces such as beneath desks and in cupboards.

SURFACE GAS MONITORING RESULTS



N

PORT MACQUARIE HASTINGS

KINGFISHER

SOP - G2 ATTACHMENT 1

GAS MONITORING RECORD SHEET

NAME:	DATE:
WEATHER:	

Attachment 3 – CSU Stage 2 Development Layout

EXISTING LAKE INNES VILLAGE

EXISTING STAGE 1

EXISTING STUDENT ACCOMMODATION

ELLIS PARADE

NEW PAVING TO EXISTING STAGE 1 CARPARK TO DEMARCATE PEDESTRIAN WALKWAY FROM CARPARK

EXISTING STAGE 1 CARPARK

ROAD LINK

PEDESTRIAN WALKWAY LINK BRIDGE

COUNCIL ROAD RESERVE

LOT 1 DP 1240488 BOUNDARY

EXISTING BASIN

STAGE 2 BUILDING

NEW CARPARK

SURVEYED EXTENT OF EXISTING VEGETATION

LEGEND

- SITE BOUNDARY
- 60m BUFFER MARKING EXTENT OF BUSHFIRE ASSET PROTECTION ZONE
- EXTENT OF MAPPED COASTAL WETLANDS
- SURVEYED VEGETATION AREA
- EXISTING TREES
- EXISTING VEGETATION OFFSET AREA BOUNDARY
- PROPOSED VEGETATION OFFSET AREA BOUNDARY
- LEP FLOOD PLANNING AREA
- LEP LEVEL OF PROBABLE MAXIMUM FLOOD
- 250m LANDFILL GAS BUFFER

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NOTE

CONTRACTOR TO CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCEMENT OF WORK OR PREPARATION OF SHOP DRAWINGS. DO NOT SCALE THIS DRAWING

ISSUE	DATE	FOR
1	30.08.18	For Information

CONSULTANT

CIVIL/STRUCTURAL CONSULTANTS
TTW ENGINERRS TEL 02 9439 7288

CONSULTANT

SERVICES CONSULTANTS
ARUP ENGINEERS TEL 02 9320 9320

CONSULTANT

LANDSCAPE CONSULTANT
OCULUS TEL 02 9557 5533

PROJECT MANAGER

PROJECT MANAGER
SAVILLS TEL

CLIENT

CHARLES STURT UNIVERSITY

CLIENT NUMBER

CLIENT 1705012.000

PROJECT

PORT MACQUARIE STAGE 2
CSU PORT MACQUARIE

BVN PROJECT NUMBER

1705012

DRAWING KEY

TRUE NORTH PROJECT NORTH

GRAPHIC SCALE

0 2000 5000

SCALE

As indicated@A1

STATUS

PRELIMINARY

DRAWING

SITE PLAN - STAGE 2

	ISSUE
AR-A10-AA-03	1