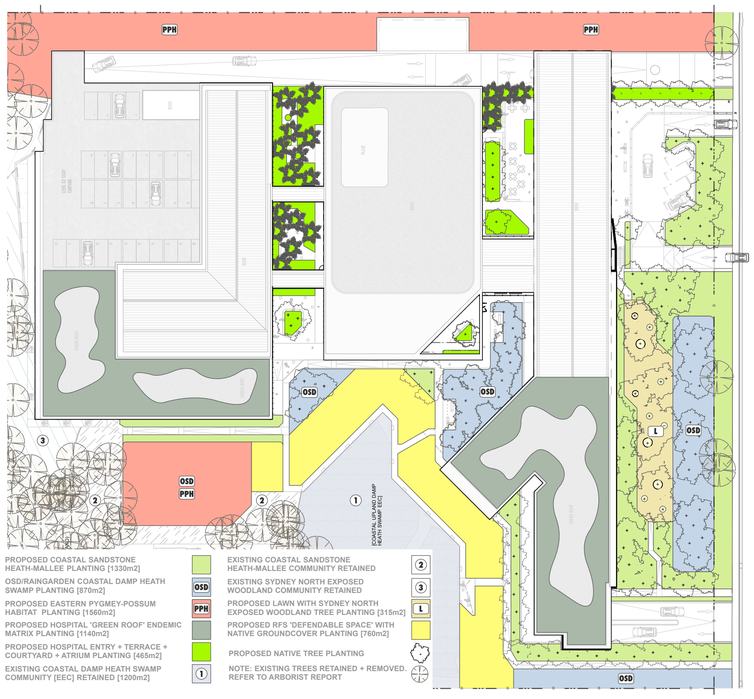
Appendix B: Landscape plan (Carmichael 2017)

PLANTING DESIGN PLAN



PROPOSED COASTAL SANDSTONE HEATH-MALLEE PLANTING [1330m2]
OSD/RAINGARDEN COASTAL DAMP HEATH SWAMP PLANTING [870m2]
PROPOSED EASTERN PYGMEY-POSSUM HABITAT PLANTING [1560m2]
PROPOSED HOSPITAL 'GREEN ROOF' ENDEMIC MATRIX PLANTING [1140m2]
PROPOSED HOSPITAL ENTRY + TERRACE + COURTYARD + ATRIUM PLANTING [465m2]
EXISTING COASTAL DAMP HEATH SWAMP COMMUNITY [EEC] RETAINED [1200m2]

EXISTING COASTAL SANDSTONE HEATH-MALLEE COMMUNITY RETAINED
EXISTING SYDNEY NORTH EXPOSED WOODLAND COMMUNITY RETAINED
PROPOSED LAWN WITH SYDNEY NORTH EXPOSED WOODLAND TREE PLANTING [315m2]
PROPOSED RFS 'DEFENDABLE SPACE' WITH NATIVE GROUNDCOVER PLANTING [760m2]
PROPOSED NATIVE TREE PLANTING
NOTE: EXISTING TREES RETAINED + REMOVED. REFER TO ARBORIST REPORT

COASTAL SANDSTONE HEATH-MALEE PLANTING

BOTANICAL NAME	COMMON NAME	ESTIMATED POT SIZE
TREES		
Eucalyptus haemastoma	Scribbly Gum	25L-75L
Angophora hispida	Dwarf Apple	25L-75L
Banksia serrata	Old Man Banksia	25L-75L
Corymbia gummifera	Red Bloodwood	25L-75L
Callitis rhomboidea	Oyster Bay Pine	25L-75L
SHRUBS/FERNS		
Banksia oblongifolia	Dwarf Banksia	tube-150mm
Banksia paludosa	Swamp Banksia	tube-150mm
Banksia ericifolia	Heath Banksia	tube-150mm
Grevillea parviflora	Small-flower Grevillea	tube-150mm
Grevillea speciosa	Red Spider-flower	tube-150mm
Callistemon citrunus	Red Bottlebrush	tube-150mm
Leptospermum grandifolium	Mountian Tea-tree	tube-150mm
Leptospermum squarrosum	Pink Tea-tree	tube-150mm
Hakea teretifolia	Dagger Hakea	tube-150mm
Lambertia formosa	Mountain Devil	tube-150mm
GROUNDCOVERS/GRASSES		
Xanthorrhoea resinosa	Grass tree	relocated
Dampiera stricta	Glasshouse Glory	tube-150mm
Lomandra obliqua	Mat-rush	tube-150mm
Gleichenia dicarpa	Coral Fern	tube-150mm
Epacris microphylla	Coral Heath	tube-150mm
Epacris obtusifolia	Wallum Heath	tube-150mm
Schoenus brevifolius	Zig-zag Bog-rush	tube-150mm

OSD/RAINGARDEN COASTAL DAMP HEATH SWAMP PLANTING

BOTANICAL NAME	COMMON NAME	ESTIMATED POT SIZE
TREES		
Callistemon salignus	Willow Bottlebrush	25L-75L
SHRUBS		
Banksia oblongifolia	Dwarf Banksia	tube-150mm
Banksia robur	Swamp Banksia	tube-150mm
Banksia paludosa	Swamp Banksia	tube-150mm
Banksia ericifolia	Heath Banksia	tube-150mm
Grevillea parviflora	Small-flower Grevillea	tube-150mm
Grevillea speciosa	Red Spider-flower	tube-150mm
Callistemon citrunus	Red Bottlebrush	tube-150mm
Leptospermum grandifolium	Mountian Tea-tree	tube-150mm
Leptospermum squarrosum	Pink Tea-tree	tube-150mm
GROUNDCOVERS/GRASSES/SEDGES		
Xanthorrhoea resinosa	Grass tree	relocated
Dampiera stricta	Glasshouse Glory	tube-150mm
Gahnia sieberiana	Sword Grass	tube-150mm
Juncus Usitatus	Common Rush	tube-150mm
Isolepsis nodosa	Club-rush	tube-150mm
Lomandra longifolia	Piny-head Mat-rush	tube-150mm
Gleichenia dicarpa	Coral Fern	tube-150mm
Baumea acuta	Twig Rush	tube-150mm
Baumea teretifolia	Common Twig Rush	tube-150mm
Schoenus brevifolius	Zig-zag Bog-rush	tube-150mm
Epacris microphylla	Coral Heath	tube-150mm
Epacris obtusifolia	Wallum Heath	tube-150mm

HOSPITAL ENTRY + COURTYARD + TERRACE + PODIUM PLANTING

BOTANICAL NAME	COMMON NAME	ESTIMATED POT SIZE
TREES		
Banksia serrata	Old Man Banksia	25L-75L
Glochidion ferdinandi	Cheese Tree	25L-75L
Livistonia australis	Cabbage Palm	25L-75L
Eleaocarpus reticulatus	Blueberry Ash	25L-75L
SHRUBS/FERNS		
Acmena smithii	Lillypilly	200mm
Grevillea buxifolia	Grey Spider-flower	200mm
Ceratopetalum gummifera	Christmas Bush	200mm
Macrozamia communis	Burrawong	200mm
Blechnum nudum	Water Fern	200mm
Asplenium australasicum	Birds Nest Fern	200mm
Cordyline stricta	Palm Lily	150mm
Cyathea cooperi	Tree Fern	25L
Doodia aspera	Rasp Fern	150mm
GROUNDCOVERS/GRASSES		
Dianella 'Little Jess'	'Little Jess'	150mm
Dianella 'Silver Streak'	'Silver Streak'	150mm
Lomandra 'Tanika'	Mat-rush 'Tanika'	150mm
Lomandra glauca'Aussie Blue'	'Aussie Blue'	150mm
Myoporum parvfolium	Creeping Boobialla	150mm
Viola hederacea	Native violet	150mm
CLIMBERS/SCRAMBLERS		
Hibbertia scandens	Guinea Flower	150mm
Hardenbergia violacea	Happy Wanderer	150mm

PLANTING SELECTION

COASTAL SANDSTONE HEATH-MALEE PLANTING

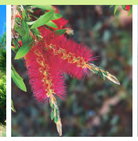

EUCALYPTUS HAEMASTOMA

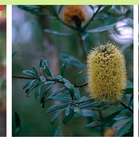

ANGOPHORA HISPIDA


BANKSIA SERRATA


CORYMBIA GUMMIFERA


CALLITRUS RHOMBOIDEA


CALLISTEMON CITRUNUS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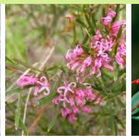
BANKSIA ERICIFOLIA


BANKSIA PALUDOSA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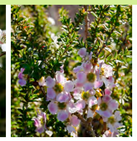
GREVILLEA SPECIOSA


LEPTOSPERMUM GRANDIFOLIUM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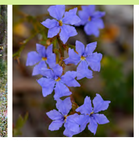
HAKEA TERETIFOLIA


LAMBERTIA FORMOSA


XANTHORRHOEA RESINOSA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LOMANDRA OBLIQUA

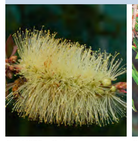

GLEICHENIA DICARPA


EPACRIS MICROPHYLLA

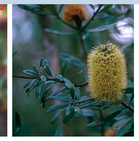

EPACRIS OBTUSIFOLIA


SHOENUS BREVIFOLIUS

OSD/RAINGARDEN COASTAL DAMP HEATH SWAMP PLANTING


CALLISTEMON SALIGNUS


CALLISTEMON CITRUNUS


BANKSIA OBLONGIFOLIA

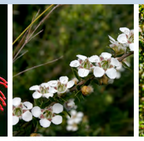

BANKSIA ROBUR


BANKSIA ERICIFOLIA


BANKSIA PALUDOSA


GREVILLEA PARVIFLORA


GREVILLEA SPECIOSA


LEPTOSPERMUM GRANDIFOLIUM


LEPTOSPERMUM SQUARROSUM


XANTHORRHOEA RESINOSA


DANPIERA STRICTA


GAHNIA SIEBERIANA


JUNCUS USITATUS


ISOLEPSIS NODOSA


LOMANDRA LONGIFOLIA


GLEICHENIA DICARPA


BAUMEA ACUTA

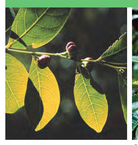

BAUMEA TERETIFOLIA


EPACRIS MICROPHYLLA


EPACRIS OBTUSIFOLIA


SHOENUS BREVIFOLIUS

HOSPITAL ENTRY + COURTYARD + TERRACE + PODIUM PLANTING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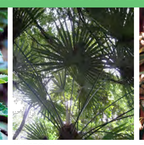
BANKSIA SERRATA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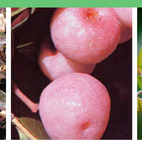
ELAEOCARPUS RETICULATUS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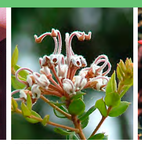

GREVILLEA BUXIFOLIA


CERATEPETALUM GUMMIFERA


BLECHNUM NUDUM

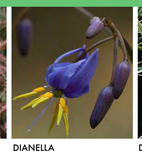

ASPLENIUM AUSTRALASICUM


CYATHEA COOPERI


MACROZAMIA COMMUNIS


CORDYLINE STRICTA


DOODIA ASPERA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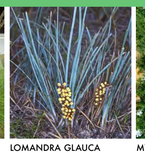
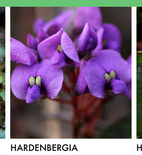
DIANELLA 'SILVER STREAK'


LOMANDRA 'TANIKA'


LOMANDRA GLAUCA 'AUSSIE BLUE'


MYOPORUM PARVIFOLIUM


VIOLA HEDERACEA


HARDENBERGIA VIOLACEA


HIBBERTIA SCANDENS

NEW PRIVATE HOSPITAL

WYVERN HEALTH

LANDSCAPE PLANTING STRATEGY

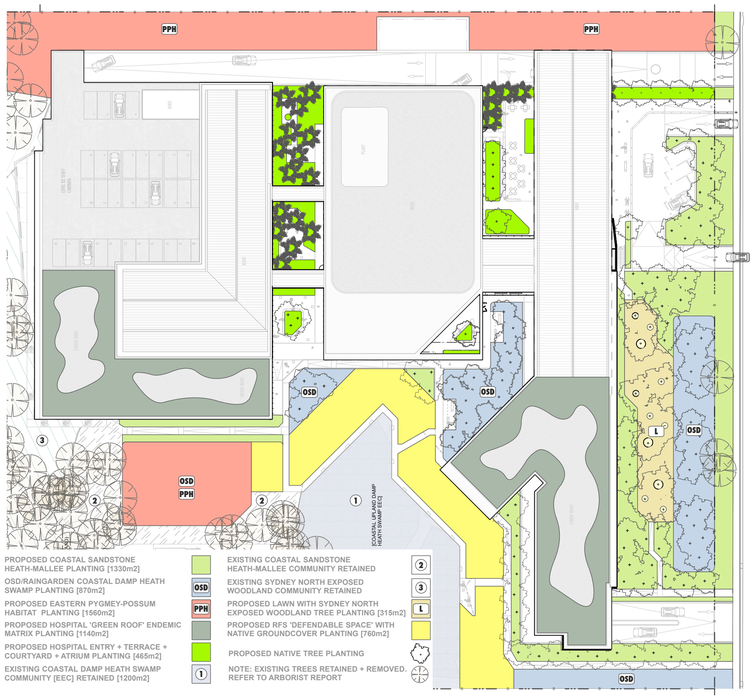
DEVELOPMENT APPLICATION [NOT FOR CONSTRUCTION] _LOT 02, LAROOL ROAD, TERRY HILLS, NSW, AUSTRALIA

SK 06A

REVISION_G
1:500 @ A1_50% @ A3

CARMICHAEL STUDIOS
PO Box 510, Roselle, NSW, 2039, Australia
ph: (02) 9810 0729
mob: 0412175439
email: rupert@carmichaelstudios.com.au

PLANTING DESIGN PLAN



PROPOSED COASTAL SANDSTONE HEATH-MALLEE PLANTING [1330m2]

OSD/RAINGARDEN COASTAL DAMP HEATH SWAMP PLANTING [870m2]

PROPOSED EASTERN PYGMEY-POSSUM HABITAT PLANTING [1560m2]

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EXISTING COASTAL DAMP HEATH SWAMP COMMUNITY [EEC] RETAINED [1200m2]

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PROPOSED LAWN WITH SYDNEY NORTH EXPOSED WOODLAND TREE PLANTING [315m2]

PROPOSED RFS 'DEFENDABLE SPACE' WITH NATIVE GROUNDCOVER PLANTING [760m2]

PROPOSED NATIVE TREE PLANTING

NOTE: EXISTING TREES RETAINED + REMOVED. REFER TO ARBORIST REPORT

HOSPITAL 'GREEN ROOF' ENDEMIC MATRIX PLANTING

BOTANICAL NAME	COMMON NAME	ESTIMATED POT SIZE
TREES		
NA	NA	NA
SHRUBS		
Correa reflexa	Native Fuchsia	tube-150mm
Correa alba	White corres	tube-150mm
Westringia fruticosa	Coastal rosemary	tube-150mm
GROUNDCOVERS/GRASSES/SEDGES		
Xanthorrhoea resinosa	Grass tree	relocated
Gahnia sieberiana	Sword Grass	tube-150mm
Juncus Usitatus	Common Rush	tube-150mm
Isolepsis nodosa	Club-rush	tube-150mm
Lomandra longifolia	Piny-head Mat-rush	tube-150mm
Schoenus brevifolius	Zig-zag Bog-rush	tube-150mm
Epacris microphylla	Coral Heath	tube-150mm
Epacris obtusifolia	Wallum Heath	tube-150mm
Lomandra glauca'Aussie Blue'	'Aussie Blue'	tube-150mm

EASTERN PYGMEY-POSSUM HABITAT PLANTING

BOTANICAL NAME	COMMON NAME	ESTIMATED POT SIZE
TREES		
NA	NA	NA
SHRUBS		
Banksia ericifolia	Heath Banksia	tube-150mm
GROUNDCOVERS/GRASSES/SEDGES		
NA	NA	NA

NOTE:
Banksia ericifolia to be planted at a density of 02 plants per m2.
Total proposed Eastern Pygmey-possum habitat planting area 1560m2.
Total proposed planting of Banksia ericifolia 3120 plants.

RFS 10M 'DEFENDABLE SPACE' NATIVE PLANTING

BOTANICAL NAME	COMMON NAME	ESTIMATED POT SIZE
TREES		
NA	NA	NA
SHRUBS		
NA	NA	NA
GROUNDCOVERS/GRASSES/SEDGES		
Microlaena stipoides	Weeping Grass	tube-seed

PLANTING SELECTION

EASTERN PYGMEY-POSSUM HABITAT PLANTING

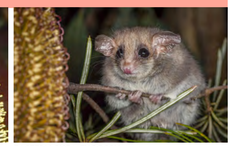

BANKSIA ERICIFOLIA


BANKSIA ERICIFOLIA

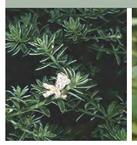

BANKSIA ERICIFOLIA FLOWER

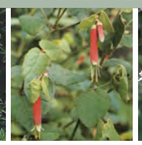

BANKSIA ERICIFOLIA FLOWER


EASTERN PYGMEY-POSSUM [CONSERVATION STUS VULNERABLE]


EASTERN PYGMEY-POSSUM [CONSERVATION STUS VULNERABLE]

HOSPITAL 'GREEN ROOF' ENDEMIC PLANTING


WESTRINGIA FRUTICOSA


CORREA REFLEXA


CORREA ALBA

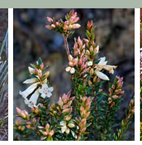

GAHNIA SIEBERIANA

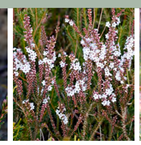

JUNCUS USITATUS


ISOLEPSIS NODOSA


LOMANDRA LONGIFOLIA


LOMANDRA GLAUCA 'AUSSIE BLUE'


EPACRIS MICROPHYLLA


EPACRIS OBTUSIFOLIA


XANTHORRHOEA RESINOSA


SHOENUS BREVIFOLIUS

RFS 10m 'DEFENDABLE SPACE' PLANTING


MICROLAENA STIPOIDES


MICROLAENA STIPOIDES


MICROLAENA STIPOIDES

NEW PRIVATE HOSPITAL

WYVERN HEALTH

LANDSCAPE PLANTING STRATEGY

DEVELOPMENT APPLICATION [NOT FOR CONSTRUCTION] _LOT 02, LAROOL ROAD, TERRY HILLS, NSW, AUSTRALIA

SK 06B

REVISION_C
1:500 @ A1_50% @ A3

CARMICHAEL STUDIOS
PO Box 510, Roselle, NSW, 2039, Australia
ph: (02) 9810 0729
mob: 0412175439
email: rupert@carmichaelstudios.com.au

Appendix C: Hydrology Design (Martens 2017)

Wyvern Health P/L
C/- Bureau SRH

Hydrogeological Assessment: Lot 2/1145029, 4A Larool Road, Terrey Hills, NSW

martens consulting engineers

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

P1605687JR02V01
April 2017

Copyright Statement

Limitations Statement

The sole purpose of this report and the associated services performed by Martens & Associates Pty Ltd is to complete a hydrogeological assessment in accordance with the scope of services set out in the contract / quotation between Martens & Associates Pty Ltd and Wyvern Health P/L C/- Bureau SRH (hereafter known as the Client). That scope of works and services were defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

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In preparing this report, Martens & Associates Pty Ltd may have relied upon and presumed accurate certain information (or absence thereof) relative to the site. Except as otherwise stated in the report, Martens & Associates Pty Ltd has not attempted to verify the accuracy of completeness of any such information (including for example survey data supplied by others).

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Head Office
Suite 201, 20 George St
Hornsby, NSW 2077, Australia
ACN 070 240 890 ABN 85 070 240 890
Phone: +61-2-9476-9999
Fax: +61-2-9476-8767
Email: mail@martens.com.au
Web: www.martens.com.au

Document and Distribution Status

Author(s)	Reviewer(s)	Project Manager	Signature
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Revision No.	Description	Status	Release Date	Document Location			
				File Copy	Client		
3	Hydrogeological Assessment	Final	26.04.2017	1E, 1P	1P		
2		Final	21.04.2017	1E, 1P	1P		
1		Draft	07.03.2017	1P,1H	1P		

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All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Introduction

1.1 Overview

This report documents the findings of a hydrogeological assessment completed to support a development application for a proposed new private hospital development at Lot 2/1145029, 4A Larool Road, Terrey Hills, NSW (the "site").

The proposed development is located upslope/adjacent to an endangered ecological community (EEC) consisting of Coastal Upland Swamp (CUS) as mapped by Narla Environmental (2017).

The site location is shown in Attachment A.

1.2 Objectives

Assessment objectives included:

- Describe existing hydrogeological conditions.
- Document existing groundwater levels via installation of groundwater monitoring wells (MWs) containing data loggers.
- Assess soil hydraulic conductivity.
- Assess potential groundwater related impacts posed by the proposed development on the CUS and provide preliminary mitigation recommendations, should these be required.

Design of mitigation structure(s) such as groundwater collection/diversion systems and/or recharge systems was outside the assessment scope.

1.3 Proposed Development

Proposed architectural plans prepared by Bureau SRH (Project No. 16082, Plan Nos. SK102, SK103, SK104, SK105 and SK106, Rev. E, dated 22 December 2016) indicate that the development will include:

- Construction of a 3-storey health facility with a basement carpark in the eastern section of the site and a lower ground car park in the south-western section of the site.
- Bulk excavation for the basement parking level will extend to 183.2 mAHD, requiring a maximum of 7.0-8.0 m of cut in the north-eastern section.

- Bulk excavation for the lower ground level, in the eastern section of the site, will extend to 186.2 mAHD, requiring a maximum of 7.0-8.0 m of cut in the western section.

- Bulk excavation for the lower ground carpark, in the south-western of the site, will extend to 187.7 mAHD, requiring cut and fill in the order of 1.0 m.

1.4 Site Description

General site details are summarised in Table 1.

Table 1: General site description summary.

Element	Description/Detail
Lot / DP	Lot 2, DP 1145029
Local Government Area (LGA)	Northern Beaches Council
Site Area	4.03 ha (based on survey plans by Norton Survey Partners, reference 38442, dated 11.11.2016)
Existing site development	Undeveloped, however eastern section of site was partially cleared of vegetation
Neighbouring environment	Site is bordered by Larool Road to the west, Myoora Road to the east, small holdings with single storey residences to the north and south and also a school to the south. Land to the east has likely been filled to raise and level the land.
Expected Geology	Hawkesbury Sandstone comprising medium to coarse-grained quartz sandstone, very minor shale and laminate lenses (Sydney *1:100 000 Geological Map Sheet 9130, 1st edition,* Geological Survey of New South Wales, Sydney)
Expected Soil Landscape	The site is located in the Somersby soil landscape based on the NSW Office of Environment and Heritage (OEH) eSPADE online mapping tool. The Somersby landscape comprises moderately deep to deep Red Earths and Yellow Earths overlying laterite gravels and clays on crests and upper slopes; Yellow Earths and Earthy Sands on mid-slopes; Grey Earths, Leached Sands and Siliceous Sands on lower slopes and drainage lines, Gleyed Podzolic Soils in low lying poorly drained areas.
Site Topography	Western section of the site consists of a low hill with a plateau near the top, with prominent rock outcropping and some steep slopes. Eastern section consists of moderately undulating, hummocky terrain
Site Aspect	South in the south-western portion of the site and south-east in the eastern half of the site
Site Elevation	Ranges between approximately 184 mAHD (south-east corner) and 208 mAHD (top of plateau)
Typical Slope	Between 5 % and 10% in the moderately undulating sections of the site, and greater than 15% in steeper sections of the site near the low hill
Existing Vegetation	Western half of the site consists of "Duffy's Forest", a low open eucalypt woodland. The south-eastern section of the site contains "Coastal Upland Swamp". The rest of the site contains native vegetation, shrubs and trees. For detailed vegetation description refer to the project ecologist (Narla Environmental, 2017)

Site Drainage	Via overland flow towards a drainage channel in the southern section of the site, and ultimately into a pit in the southern corner of the site, near Myoora Road

2 Hydrogeological Assessment

2.1 Field Investigations

Field investigations relevant to the hydrogeological assessment were principally undertaken on 30/11/2016 in conjunction with a geotechnical investigation (MA, 2017), and included:

- General site walkover to assess existing site conditions.
- Drilling and logging of 13 boreholes (BHs) up to 2.1 metres below ground level (mBGL).
- Completion of six of the boreholes as shallow (maximum depth of 2 mBGL) groundwater monitoring wells (MWs).
- Purging of MWs by 12 volt submersible groundwater pump.
- Installation of groundwater data loggers in each MW.
- Groundwater level measurements at a five or 15 minute frequency from 30/11/2016 to 16/02/2017 for MW106, MW108 and MW110 and to 24/01/2017 for MW116 (logger failure).
- Measurement of groundwater levels by dip meter on:
    - 22/12/2016
    - 24/01/2017
    - 02/02/2017 (only MW109)
    - 16/02/2017

Approximate BH/MW locations are shown in Attachment A.

2.2 Sub-surface Conditions

The sub-surface profile across the eastern and south-west portions of the site typically comprises the following units:

Unit A: Silty sand / sand topsoil, colour varying between brown, grey and black, with some organic matter.

Unit B: Residual sand / clayey sand, colour varying between brown, grey, yellow and white.

Unit C: Inferred low strength sandstone.

Although the site and top of rock generally slopes to the south/south-east, observed sandstone outcropping in the west of the site indicates the sandstone is also cross-bedded with a dip towards the north/north-west. As a result, we expect rock to be terraced with terraces sloping to the north/north-west.

Table 2 summarises depths of encountered sub-surface conditions across different sections of the site.

Table 2: Generalised description of inferred sub-surface profile.

Unit	Indicative depth range (mBGL)	
	Across site [1]	BH108
A	0.0 – 0.2	0.0 – 0.7
B	0.2 – 0.9	NE [2]
C	>0.9	>0.7

Notes:

1. Soil profile generally similar across site, however depth range varies.
2. Not encountered.

2.3 Groundwater Levels

2.3.1 Observations During Fieldworks

During drilling, groundwater was encountered in BH102, BH108, BH110 and BH116, but not encountered in remaining boreholes (i.e. BH101, BH103, BH105, BH106, BH107, BH109, BH112, BH114 and BH115).

At BH102, sand and clayey sand between 0.2 mBGL and 0.75 mBGL was saturated and a groundwater level of 0.6 mBGL was measured prior to borehole backfill. Sandstone at this borehole was encountered at 0.8 mBGL.

At BH108, sand was saturated between 0.2 mBGL and 0.70 mBGL with sandstone encountered at 0.7 mBGL.

At BH110, sand was saturated between 0.3 mBGL and 1.0 mBGL with sandstone encountered at 1.3 mBGL.

At BH116, sand was saturated between 0.4 mBGL and 1.0 mBGL with sandstone encountered at 1.0 mBGL.

Monitoring wells (MWs) were constructed within BH105 (MW105), BH106 (MW106), BH108 (MW108), BH109 (MW109), BH110 (MW110) and BH116 (MW116). Data loggers were installed within each MW to monitor groundwater level. MW logs are provided in Attachment B.

2.3.2 Monitoring Results

2.3.2.1 Dip Measurements

Groundwater measurements made by dip meter were undertaken to provide reference for data logger levels. Dip meter measurements are summarised in Table 3.

Table 3: Groundwater level measurements made by dip meter.

	Groundwater Level (mAHD/mBGL)					
Date	**MW105**	**MW106**	**MW108**	**MW109**	**MW110**	**MW116**
22/12/2016	Dry	189.61/0.69	187.61/0.59	Dry	184.72/1.08	190.36/0.64
24/01/2017	Dry	189.39/0.91	Dry	Dry	184.21/1.59	190.04/0.96
02/02/2017	NM [1]	NM [1]	NM [1]	Dry	NM [1]	NM [1]
16/02/2017	Dry	189.38/0.92	Dry	Dry	NM [1]	190.06/0.94

Notes:

1. NM = not measured

2.3.2.2 Data Logger Measurements

Groundwater levels at MWs where groundwater was encountered (MW106, MW108, MW110 and MW116) are plotted in figures in Attachment C along with rainfall events during the monitoring period; approximate top of sandstone and approximate ground level are also shown. A statistical summary of the data is presented in Table 4 (mAHD) and Table 5 (mBGL).

Table 4: Statistical summary of data logger groundwater level measurements (mAHD).

	Groundwater Level (mAHD)					
Statistic	**MW105**	**MW106** [2]	**MW108** [1, 2]	**MW109** [1]	**MW110** [1]	**MW116** [1]
Minimum	NA - Dry	189.28	187.18	NA – Dry	184.11	190.00
Mean	NA – Dry	189.38	187.40	NA – Dry	184.50	190.13
Maximum	NA - Dry	189.63	188.09	NA - Dry	184.79	190.55
Range (m)	NA – Dry	0.36	0.91	NA - Dry	0.68	0.55

Notes:

1. Period for statistical analysis starts after recovery from purging undertaken on 30/11/2016 and ends on 16/02/2017 (24/01/2017 for MW116).
2. Statistical analysis period includes data when MW is dry (when this occurs the groundwater level observed by the data logger corresponds to, or near to, the bottom of the MW.

Table 5: Statistical summary of data logger groundwater level measurements (mBGL).

	Groundwater Level (mBGL)					
Statistic	**MW105**	**MW106** [2]	**MW108** [1, 2]	**MW109** [1]	**MW110** [1]	**MW116** [1]
Minimum	NA - Dry	0.67	0.11	NA – Dry	1.01	0.45
Mean	NA – Dry	0.92	0.80	NA – Dry	1.30	0.87
Maximum	NA – Dry	1.02 [3]	1.02 [3]	NA - Dry	1.69	1.00
Range (m)	NA – Dry	0.36	0.91	NA - Dry	0.68	0.55

Notes:

1. Period for statistical analysis starts after recovery from purging undertaken on 30/11/2016 and ends on 16/02/2017 (24/01/2017 for MW116).
2. Statistical analysis period includes data when MW is dry (when this occurs the groundwater level observed by the data logger corresponds to, or near to, the bottom of the MW.
3. Value corresponds with dry MW.

Monitoring data indicates groundwater levels respond to rainfall. Rainfall which occurred on 15/12/2016 (8.6 mm), 16/12/2016 (28.4 mm) and 17/12/2016 (6.4 mm) caused a marked groundwater level increase in all MWs which encountered groundwater. MW108, MW110 and MW116 groundwater levels increased by approximately 0.82 m, 0.27 m and 0.55 m respectively. MW106 transitioned from being dry to having a groundwater level approximately 0.33 m above the MW base. Groundwater level peak following this rainfall period occurred on 21/12/2016 (MW106), 16/12/2016 (MW108), 18/12/2016 (MW110) and 17/12/2016 (MW116), indicating a relatively delayed response to rainfall at MW106. Smaller rainfall amounts, such as that which occurred on 25/12/2016 (5.4 mm), caused 0.04 m (MW106), 0.17 m (MW108) and 0.05 m (MW116) rises in groundwater level. At MW110, no discernible groundwater level rise occurred following this day's rainfall. Similarly, on 08/02/2017, 20.8 mm of rainfall caused no discernible groundwater level rise in MW106 or MW110.

An interpretive summary of plotted MW levels is provided below:

MW106 – MW was dry from onset of monitoring until 20/12/2016, then groundwater present with level up to 0.12 m above the top of sandstone until 1-3/01/2017. Observed stable levels from 1-3/01/2017 suggest groundwater not being able to drain through the sandstone.

MW108 – groundwater observed at the soil/rock interface over the monitoring period except from 16/12/2016 to 28/12/2016 where groundwater increases to higher levels within the sand (up to 0.58 m above the sandstone). From 15/01/2017 to 09/02/2017 and 14/02/2017 to 16/02/2017, the MW is inferred to be dry.

MW110 – groundwater flowing over soil/rock interface and into MW at start of monitoring period and following rainfall period (15-17/12/2016). After this, until 27/01/2017, groundwater level steadily declines (drains out of MW through sandstone). From 27/01/2017 to end of monitoring period, the MW is inferred to be containing groundwater within the sandstone at a relatively constant level, unlikely due to groundwater flow within the sandstone but due to groundwater not being able to drain through the sandstone.

MW116 – groundwater flowing over soil/rock interface with frequent periods where groundwater is flowing at higher levels within the sand (up to 0.54 m above sandstone).

In summary, based on groundwater level monitoring, groundwater at the site is anticipated to be semi-permanent and perched on top of sandstone.

2.4 Groundwater Recharge

Based on assessment observations, the site's shallow groundwater system is recharged by rainfall.

Relatively higher recharge may be occurring in areas where recent vegetation clearing has taken place due to soil density decreasing as a result of vegetation removal and machine tracking and due to decreased evapotranspiration rates. This may explain why MW105 and MW109 were dry over the monitoring period and other MWs either permanently or temporarily contained groundwater.

2.5 Hydraulic Conductivity

Hydraulic conductivity (K) of the soils was assessed using the falling head method with the initial water level of the analysis period corresponding to ground level at MW106 and MW116. These MWs had only a small amount of groundwater above the well bottom, approximately 10 L of water was poured into the MWs and the response measured by a data logger. The data logger data was analysed using

the Hvorslev (1981) method. Analysis summary sheets are provided in Attachment D with results summarised in Table 6.

Table 6: Summary of hydraulic conductivity (K) testing results.

	MW106	MW116
Hydraulic Conductivity (K) (m/d)	0.748	0.445
Screened Material	Sand + sandstone	Sand + sandstone
Comment	Initial water level of falling head data analysed was equivalent to ground level	Initial water level of falling head data analysed was equivalent to ground level

MW106 and MW116 test values are considered representative of site sand K.

We note that K testing was also completed at MW108 and MW110 via a rising head slug test. However, test data was considered non representative of either the sand or underlying sandstone as the water which entered the MWs is inferred to have come from seepage overlying the soil/rock interface.

2.6 Groundwater Flow Direction

Groundwater (when present) predominantly flows along the soil/rock interface. As the top of the sandstone generally slopes to the south east, groundwater is inferred to flow in a south easterly direction (i.e. similar to land surface fall direction). Some ponding of the perched groundwater may accumulate where top of rock dips towards the north east (as evident in rock exposures to the west).

2.7 Existing Groundwater Flows

Existing groundwater flow to the CUS is likely highly variable year to year, month to month, due to climatic variation. Groundwater flow, "Q", to the CUS following the period of rainfall from 15-17/12/2016 was estimated using Darcy's Law and the following assumptions:

Q = KIA, where

K = 0.60 m/d (average of MW106 and MW116 test values)

I = 0.064 m/d (gradient of sandstone between MW108 and MW110)

A = 13.95 m² (CUS south easterly flow path width of 45 m multiplied by average depth of groundwater above the sandstone (0.31 m) following 15-17/12/2016 rainfall period, where MW110 was assigned nominal value of 5 mm).

The above assumptions result in a groundwater flow of 536 L/d or 0.0062 L/s.

During other times where limited groundwater is seeping over the sand/sandstone interface, e.g. assuming a seepage thickness of 5 mm, and with the same K and I assumptions, the daily flow to the CUS is estimated to be approximately 9 L/d, which is considered negligible. Considering the above, the CUS is inferred to be maintained by surface water flows and groundwater flows which occur following significant rainfall.

2.8 Development Impacts on Groundwater

Without mitigation measures, the proposed development is anticipated to reduce surface water and groundwater flows to the CUS due to:

1. Loss of surface water catchment area – the proposed development will remove a portion of the surface water catchment area and area of infiltration.

2. Groundwater flow restriction – the proposed development buildings, e.g. footings, walls (particularly for below ground basement levels) and fill material located upslope of the CUS will intercept the groundwater flow path to the CUS. They have the potential to divert groundwater flow around the CUS. Assuming a south easterly groundwater flow path, and assuming south easterly orientated groundwater flow generally occurs over the region of the CUS's surface water catchment, the proposed development will likely cut off groundwater flow to the CUS. Additionally, structures which are outside of the south easterly flow path to the CUS, but close to the CUS, such as the proposed basement (minimum offset of approximately 5 m), may lead to some dewatering of the CUS if designed and constructed as drained structures.

3 Recommendations

3.1 Key Constraints

From a hydrogeological/ecological viewpoint, loss of CUS surface water catchment area and elimination of south easterly groundwater flow paths to the CUS due to building footings, filling, basement walls (for below ground basement car parking) and drainage systems (e.g. basement drainage) will cause a reduction in water flow to the CUS, which may impact the CUS.

Surface and groundwater management will need to be included in detailed design of proposed development structures.

3.2 Recommendations

Existing development flows to the CUS should be maintained through design of appropriate stormwater and possibly groundwater management systems (to be undertaken at detailed design stage). If required, this will likely include trenches upslope of particular buildings to collect groundwater, and drainage to redirect groundwater to recharge trenches to be located upslope of the CUS. If at detailed design stage it is assessed that redirecting surface water flows to the CUS will be sufficient, the need for further groundwater structures may not be necessary.

If the proposed basement is drained, consideration will need to be given to how this impacts post development groundwater flows to the CUS. Provision of additional recharge systems may need to be considered, in association with any other stormwater related management controls.

Engineering design of proposed development structures, such as retaining walls, should take into account encountered groundwater conditions. Structures will be either fully tanked, or appropriately designed with drainage mechanisms to limit build-up of pore water pressures.

4 References

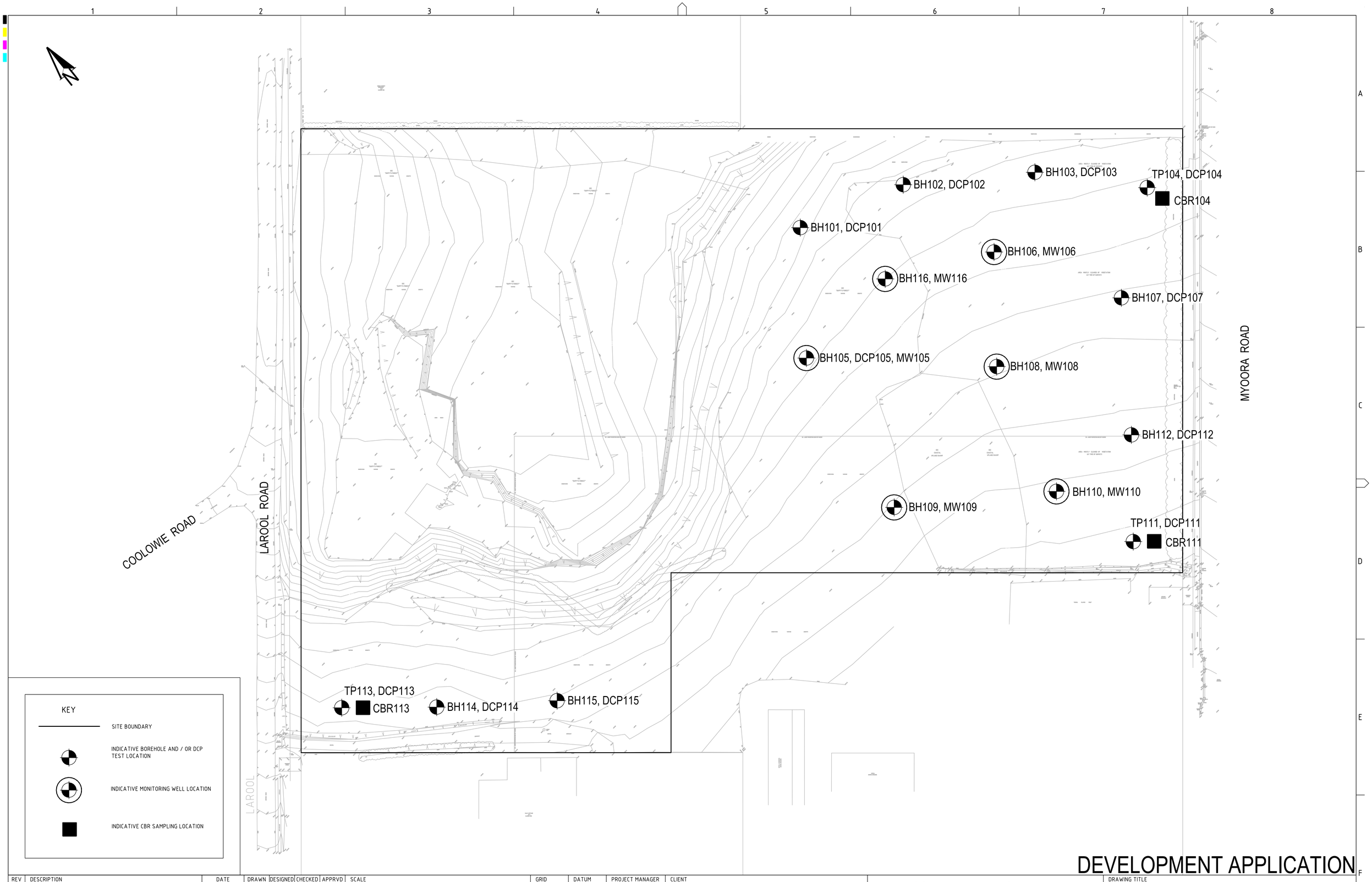
Herbert C. (1983) *Sydney 1:100 000 Geological Map Sheet 9130, 1st edition*, Geological Survey of New South Wales, Sydney.

Martens and Associates (2017), *Geotechnical Assessment: Lot 2/1145029, 4A Larool Road, Terrey Hills, NSW, report ref: P1605687JR01V03, April 2017*.

Narla Environmental (2017), *Flora and Fauna Assessment, Lot 2/1145029, 4A Larool Road, Terrey Hills NSW 2084, Report prepared for Wyvern Health Pty Ltd.*

Norton Survey Partners (2016) *Plan Showing Selected Detail and Levels Over No. 4A Larool Road, Terrey Hills, ref: 38442, "Survey Plan"*.

5 Attachment A – Site Layout and Borehole/MW Locations



DEVELOPMENT APPLICATION

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
C	**FINAL**	**24/04/2017**	**KT**	**MH**	**RE**	**RE**
B	FINAL	21/04/2017	KT	MH	RE	RE
A	FOR CLIENT REVIEW	15/02/2017	KT	MH	RE	RE

SCALE
0 5 10 15 20 25 30 35 40 45 50 METRES
A1 (A3) 1:500 (1:1,000)

GRID	DATUM	PROJECT MANAGER
MGA	MAHD	JF

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CLIENT
WYVERN HEALTH P/L C/- BUREAU SRH

PROJECT NAME/PLANSET TITLE
ENGINEERING SERVICES
GEOTECHNICAL ASSESSMENT
4A LAROOL ROAD, TERREY HILLS, NSW 2084
LOT 2, DP1145029

martens & Associates Pty Ltd
Consulting Engineers
Environment
Water
Geotechnical
Civil
Suite 201, 20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767
Email: mail@martens.com.au Internet: www.martens.com.au

DRAWING TITLE
SITE LAYOUT AND GEOTECHNICAL TESTING PLAN

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1605687	PS01	R03	PS01-J100	C

PRINTED: 24-JUL-2017 - USER: MHAAN
A1 / A3 LANDSCAPE (A1LC_v02.0.01)
DRAWING ID: P1605687-PS01-R03-J100

6 Attachment B – BH and MW Logs

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH101**
PROJECT	Geotechnical Assessment		LOGGED	BR	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Hand Auger	EASTING		RL SURFACE	194.5 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.05 m depth	NORTHING		ASPECT	SE	SLOPE 5-10%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
	M			194.50				SP	SAND, fine grained, grey, trace silt.		L	TOPSOIL
				0.10								
				194.40				SP	SAND, fine grained, yellow brown and orange brown, trace clay.			RESIDUAL SOIL
											MD	
											MD - D	
HA	M-H	Not Encountered	0.5							D		
											D	
			1.0	*1.00*								
	H			*1.05*				SC	Clayey SAND, fine grained, yellow brown, light grey.			
									Hole Terminated at 1.05 m			1.05: Terminated on inferred low strength sandstone.
			1.5									
			2.0									
			2.5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Suite 201, 20 George St. Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH102**
PROJECT	Geotechnical Assessment		LOGGED	MH	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Hand Auger	EASTING		RL SURFACE	192.6 m	DATUM AHD
EXCAVATION DIMENSIONS		⌀100 mm x 0.80 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				192.60				SM	Silty SAND, fine grained, dark brown/black.	M		TOPSOIL
				0.20								
				192.40				SP	SAND, fine grained, orange/brown, with some clay.		VL	RESIDUAL SOIL
HA	L-M											
			0.5							W	L	
	M										L - MD	
				0.75								
				0.80				SC	Clayey SAND, fine grained, orange/brown, inferred dense.	W		
									Hole Terminated at 0.80 m			0.80: Terminated on inferred low strength sandstone.
			1.0									
			1.5									
			2.0									
			2.5									

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Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH103**
PROJECT	Geotechnical Assessment		LOGGED	MH	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Push Tube	EASTING		RL SURFACE	191.6 m	DATUM AHD
EXCAVATION DIMENSIONS		ø75 mm x 0.93 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
	L			191.60				SP	SAND, fine to medium grained, brown, with some silt.	D		TOPSOIL
				0.15								
				191.45				SC	Clayey SAND, fine grained, brown.		L - MD	RESIDUAL SOIL
PT	L-M	Not Encountered	0.5						Colour becomes white at 0.75mBGL.	M		
											MD	
				0.93								
			1.0						Hole Terminated at 0.93 m			0.93: Terminated on inferred low strength sandstone.
			1.5									
			2.0									
			2.5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

martens

MARTENS & ASSOCIATES PTY LTD
Suite 201, 20 George St. Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH105**
PROJECT	Geotechnical Assessment		LOGGED	MH	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Hand Auger	EASTING		RL SURFACE	191.3 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 0.90 m depth	NORTHING		ASPECT	SE	SLOPE 5-10%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
	M			191.30				SP	SAND, fine grained, brown, trace silt.		MD	TOPSOIL
				0.10								
				191.20				SP	SAND, fine grained, yellow/brown, trace clay.			RESIDUAL SOIL
HA	M-H	Not Encountered	0.5							D	D	
				0.90								
			1.0						Hole Terminated at 0.90 m			0.90: Terminated on inferred low strength sandstone.
			1.5									
			2.0									
			2.5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

MARTENS & ASSOCIATES PTY LTD
Suite 201, 20 George St. Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH106**
PROJECT	Geotechnical Assessment		LOGGED	HD	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		4WD truck-mounted hydraulic drill rig	EASTING		RL SURFACE	190.3 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.10 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	L	Not Encountered		190.30				SP	SAND, fine grained, brown/black, with some organics and silt, inferred loose to medium dense.		L - MD	TOPSOIL
				0.20	5687/106/0.10/S/1 D 0.10 m							
				190.10				SP	SAND, fine grained, greyish brown, trace silt, inferred medium dense grading to dense.			RESIDUAL SOIL
	M		0.5		5687/106/0.50/S/1 D 0.50 m					M	MD - D	
				0.80								
AD/T	M		1.0	189.50	5687/106/1.0/R/1 D 1.00 m				SANDSTONE, fine grained, yellow and white/beige, distinctly weathered, inferred low strength.			WEATHERED ROCK 0.80: V-bit refusal.
				1.10					Hole Terminated at 1.10 m			1.10: Weathered rock found to be moist but not wet.
			1.5									
			2.0									
			2.5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH	COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH107**
PROJECT	Geotechnical Assessment	LOGGED	MH	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW	GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT	Push Tube	EASTING		RL SURFACE	188.5 m	DATUM AHD
EXCAVATION DIMENSIONS	ø75 mm x 0.86 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT	L	Not Encountered	0.5	188.50				SP	SAND, fine grained, dark brown, trace silt.	D		TOPSOIL
				0.20								
				188.30				SC	Clayey SAND/Sandy CLAY, fine grained, low plasticity clay, orange/brown.	M	MD	RESIDUAL SOIL
				0.80							D	
	M			*0.86*					SANDSTONE, fine to medium grained, red, inferred low strength, distinctly weathered.			WEATHERED ROCK
			1.0						Hole Terminated at 0.86 m			0.86: Terminated on inferred low strength sandstone.
			1.5									
			2.0									
			2.5									

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Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH108**
PROJECT	Geotechnical Assessment		LOGGED	HD	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		4WD truck-mounted hydraulic drill rig	EASTING		RL SURFACE	188.2 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.00 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M	Not Encountered	0.5	188.20	5687/108/0.2/S/1 D 0.20 m			SP	SAND, fine grained, black-brown, with some silt, inferred medium dense.	W	MD	TOPSOIL
				0.70								
AD/T	H		1.0	187.50 *1.00*	5687/108/0.80/R/1 D 0.80 m				SANDSTONE, fine grained, white/beige, distinctly weathered, inferred low strength.	M		WEATHERED ROCK 0.70: V-bit refusal.
			1.5						Hole Terminated at 1.00 m			
			2.0									
			2.5									

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Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH109**
PROJECT	Geotechnical Assessment		LOGGED	HD	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		4WD truck-mounted hydraulic drill rig	EASTING		RL SURFACE	187 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 2.10 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	L		0.5	187.00 *0.20* 186.80 *0.60*	5687/109/0.10/S/1 D 0.10 m 5687/109/0.50/S/1 D 0.50 m			SP SP	SAND, fine grained, pale yellow/white, with some silt, inferred loose. SAND, fine grained, dark yellow, with trace silt, inferred loose to medium dense.		L L - MD	TOPSOIL RESIDUAL SOIL
AD/T	M		1.0 1.5 2.0	186.40 *2.10*	5687/109/1.1/R/1 D 1.10 m 5687/109/1.50/R/1 D 1.50 m				SANDSTONE, fine grained, pale beige, with some silt.	M		WEATHERED ROCK 0.60: V-bit refusal.
			2.5						Hole Terminated at 2.10 m (Target depth reached)			

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Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH110**
PROJECT	Geotechnical Assessment		LOGGED	HD	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		4WD truck-mounted hydraulic drill rig	EASTING		RL SURFACE	185.8 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 2.10 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V				185.80				SP	SAND, fine grained, dark brown, with silt and organics, inferred loose to medium dense.	M	L - MD	TOPSOIL
				0.20	5687/110/0.10/S/1 D 0.10 m							
				185.60				SP	SAND, fine grained, yellow and grey-brown, with some silt, inferred medium dense.			RESIDUAL SOIL
			0.5		5687/110/0.50/S/1 D 0.50 m					W	MD	
				1.00								
	M		1.0	184.80				SP	SAND, fine grained, white/beige, with some silt, inferred medium dense to dense.		MD - D	
				1.30	5687/110/1.20/S/1 D 1.20 m							
AD/T				184.50					SANDSTONE, fine grained, red, distinctly weathered, inferred very low to low strength.			WEATHERED ROCK 1.30: V-bit refusal.
			1.5		5687/110/1.50/R/1 D 1.50 m					M		
			2.0	*2.10*								
									Hole Terminated at 2.10 m			2.10: Weathered rock found to be moist, not wet.
			2.5									

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CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH112**
PROJECT	Geotechnical Assessment		LOGGED	MH	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Push Tube	EASTING		RL SURFACE	187 m	DATUM AHD
EXCAVATION DIMENSIONS		⌀75 mm x 0.80 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PT	L	Not Encountered	0.5	187.00 ***0.10*** 186.90 ***0.30*** 186.70 ***0.80***				SM	Silty SAND, fine grained, dark brown.			TOPSOIL
								SP	SAND, fine grained, light grey, white, trace silt, trace clay.			RESIDUAL SOIL
								SP	SAND, fine grained, light grey, with some silt, with some clay.	M	VL D	
			1.0 1.5 2.0 2.5						Hole Terminated at 0.80 m			0.80: Terminated on inferred low strength sandstone.

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Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH114**
PROJECT	Geotechnical Assessment		LOGGED	MH	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Hand Auger	EASTING		RL SURFACE	188.5 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 0.80 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
	M			188.50				SP	SAND, fine grained, brown, trace silt, trace coarse subangular gravels.	D	MD - D	TOPSOIL
				0.10								
				188.40				SP	SAND, fine grained, yellow/brown, trace clay, trace coarse subangular gravels.			RESIDUAL SOIL 0.10: Possible extremely weathered sandstone.
HA	H	Not Encountered	0.5						Colour becomes white/brown at 0.6mBGL.	D - M	D and VD	
				0.70								
				187.80				SP	SAND, fine grained, white/brown, with some clay, trace coarse subangular gravels.	D	VD	
				0.80					Hole Terminated at 0.80 m			0.80: Terminated on inferred low strength sandstone or very dense sand.
			1.0									
			1.5									
			2.0									
			2.5									

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CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH115**
PROJECT	Geotechnical Assessment		LOGGED	MH	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Hand Auger	EASTING		RL SURFACE	188.5 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 0.25 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	M	Not Encountered		188.50				SP	SAND, fine grained, brown, trace silt.		MD - D	TOPSOIL
				0.10								
	H			188.40				SP	SAND, fine grained, brown/yellow, trace silt.	D	VD	RESIDUAL SOIL
				0.25								
									Hole Terminated at 0.25 m			0.25: Terminated on very dense sand. Bedrock expected to be at approximately 0.5mBGL based on exposed bedrock nearby and DCP test results.
			0.5									
			1.0									
			1.5									
			2.0									
			2.5									

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Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF BH116**
PROJECT	Geotechnical Assessment		LOGGED	HD	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		4WD truck-mounted hydraulic drill rig	EASTING		RL SURFACE	191 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.10 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V				191.00				SP	SAND, fine grained, dark brown, with some organics and silt, inferred medium dense.			TOPSOIL
					5687/116/0.20/S/1 D 0.20 m					M	MD	
				0.30								
				190.70				SP	SAND, fine grained, brown-grey, with some silt, inferred medium dense to dense.			RESIDUAL SOIL
	M		0.5		5687/116/0.50/S/1 D 0.50 m					W	MD - D	
		▽		*1.00*								
AD/T			1.0	190.00					SANDSTONE, fine grained, pale yellow/yellow, with light grey bands.	M		WEATHERED ROCK 1.00: V-bit refusal.
				1.10					Hole Terminated at 1.10 m			1.10: Weathered rock found to be moist but not wet.
			1.5									
			2.0									
			2.5									

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Engineering Log - BOREHOLE

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF MW105**
PROJECT	Geotechnical Assessment		LOGGED	MH	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Hand Auger	EASTING		RL SURFACE	191.3 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 0.90 m depth	NORTHING		ASPECT	SE	SLOPE 5-10%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID Static Water Level
	M			191.30				SP	SAND, fine grained, brown, trace silt.		MD	MW105
				0.10								Bentonite
				191.20				SP	SAND, fine grained, yellow/brown, trace clay.			Blank
HA	M-H	Not Encountered	0.5							D	D	Screen
												Sand
				0.90					Hole Terminated at 0.90 m			
			1.0									
			1.5									
			2.0									
			2.5									

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Engineering Log - TEST

CLIENT	Wyvern Health P/L C/- Bureau SRH	COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF MW106**
PROJECT	Geotechnical Assessment	LOGGED	HD	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW	GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT	4WD truck-mounted hydraulic drill rig	EASTING		RL SURFACE	190.3 m	DATUM AHD
EXCAVATION DIMENSIONS	Ø100 mm x 1.10 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID / Static Water Level
AD/V	L	Not Encountered	0.5	190.30				SP	SAND, fine grained, brown/black, with some organics and silt, inferred loose to medium dense.	M	L - MD	MW106 — Bentonite, Blank
				0.20								
	M			190.10				SP	SAND, fine grained, greyish brown, trace silt, inferred medium dense grading to dense.		MD - D	Screen, Sand
				0.80								
AD/T	M		1.0	189.50					SANDSTONE, fine grained, yellow and white/beige, distinctly weathered, inferred low strength.			
				1.10					Hole Terminated at 1.10 m			
			1.5									
			2.0									
			2.5									

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Engineering Log - TEST

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF MW108**
PROJECT	Geotechnical Assessment		LOGGED	HD	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		4WD truck-mounted hydraulic drill rig	EASTING		RL SURFACE	188.2 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.00 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID Static Water Level MW108
AD/V	M	Not Encountered	0.5	188.20				SP	SAND, fine grained, black-brown, with some silt, inferred medium dense.	W	MD	MW108 Bentonite Blank Screen Sand
				0.70								
AD/T	H		1.0	187.50 *1.00*					SANDSTONE, fine grained, white/beige, distinctly weathered, inferred low strength.	M		
									Hole Terminated at 1.00 m			
			1.5									
			2.0									
			2.5									

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Engineering Log - TEST

CLIENT	Wyvern Health P/L C/- Bureau SRH	COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF MW109**
PROJECT	Geotechnical Assessment	LOGGED	HD	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW	GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT	4WD truck-mounted hydraulic drill rig	EASTING		RL SURFACE	187 m	DATUM AHD
EXCAVATION DIMENSIONS	Ø100 mm x 2.10 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID Static Water Level MW109
AD/V	L		0.5	187.00 0.20 186.80 0.60 186.40				SP SP	SAND, fine grained, pale yellow/white, with some silt, inferred loose. SAND, fine grained, dark yellow, with trace silt, inferred loose to medium dense.		L L - MD	MW109 Bentonite Blank
AD/T	M	▽	1.0 1.5 2.0	2.10					SANDSTONE, fine grained, pale beige, with some silt.	M		Screen Sand
			2.5						Hole Terminated at 2.10 m (Target depth reached)			

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Engineering Log - TEST

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF MW110**
PROJECT	Geotechnical Assessment		LOGGED	HD	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		4WD truck-mounted hydraulic drill rig	EASTING		RL SURFACE	185.8 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 2.10 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID Static Water Level MW110
AD/V	M		0.5	185.80				SP	SAND, fine grained, dark brown, with silt and organics, inferred loose to medium dense.	M	L - MD	MW110 ← Bentonite Blank
				0.20 185.60				SP	SAND, fine grained, yellow and grey-brown, with some silt, inferred medium dense.	W	MD	← Screen
			1.0	1.00 184.80				SP	SAND, fine grained, white/beige, with some silt, inferred medium dense to dense.		MD - D	← Sand
AD/T			1.5	1.30 184.50					SANDSTONE, fine grained, red, distinctly weathered, inferred very low to low strength.	M		
			2.0	2.10					Hole Terminated at 2.10 m			
			2.5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Suite 201, 20 George St. Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - TEST

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF MW116**
PROJECT	Geotechnical Assessment		LOGGED	HD	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		4WD truck-mounted hydraulic drill rig	EASTING		RL SURFACE	191 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø100 mm x 1.10 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	PIEZOMETER DETAILS ID Static Water Level
AD/V	M		0.5	191.00				SP	SAND, fine grained, dark brown, with some organics and silt, inferred medium dense.	M	MD	MW116
				0.30 190.70				SP	SAND, fine grained, brown-grey, with some silt, inferred medium dense to dense.			Bentonite Blank
			1.0							W	MD - D	Sand Screen
AD/T				*1.00* 190.00 *1.10*					SANDSTONE, fine grained, pale yellow/yellow, with light grey bands.	M		
			1.5						Hole Terminated at 1.10 m			
			2.0									
			2.5									

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Engineering Log - TEST

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF TP104**
PROJECT	Geotechnical Assessment		LOGGED	BR	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Hand Spade	EASTING		RL SURFACE	190.5 m	DATUM AHD
EXCAVATION DIMENSIONS		0.70 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
S	H	Not Encountered		190.50				SP	SAND, fine grained, brown, with silt, trace rootlets.	D		TOPSOIL
				0.25								
	L		0.5	190.25	5687/104/0.25-0.70/CBR B 0.25 m			SP	SAND, fine to medium grained, light brown and beige, trace silt and clay.	D - M	MD	RESIDUAL SOIL
				0.70					Hole Terminated at 0.70 m (Target depth reached)			
			1.0									
			1.5									
			2.0									
			2.5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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MARTENS & ASSOCIATES PTY LTD
Suite 201, 20 George St. Hornsby, NSW 2077 Australia
Phone: (02) 9476 9999 Fax: (02) 9476 8767
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - TEST PIT

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF TP111**
PROJECT	Geotechnical Assessment		LOGGED	BR	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Hand Spade	EASTING		RL SURFACE	184.5 m	DATUM AHD
EXCAVATION DIMENSIONS		0.55 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
	L			184.50				SP	SAND, fine grained, brown, with silt, trace rootlets.	D		TOPSOIL
				0.15								
S	M	Not Encountered	0.5	184.35 *0.55*	5687/111/0.20-0.50/CBR B 0.20 m			SP	SAND, fine grained, yellow/brown, with clay, trace silt.	M	L - MD	RESIDUAL SOIL
			1.0						Hole Terminated at 0.55 m (Target depth reached)			
			1.5									
			2.0									
			2.5									

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mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - TEST PIT

CLIENT	Wyvern Health P/L C/- Bureau SRH		COMMENCED	30/11/2016	COMPLETED	30/11/2016	**REF TP113**
PROJECT	Geotechnical Assessment		LOGGED	BR	CHECKED	RE	Sheet 1 OF 1
SITE	4A Larool Road, Terrey Hills, NSW		GEOLOGY	Hawkesbury Sandstone	VEGETATION	Grass/Bush	PROJECT NO. P1605687
EQUIPMENT		Hand Spade	EASTING		RL SURFACE	188.5 m	DATUM AHD
EXCAVATION DIMENSIONS		ø75 mm x 0.30 m depth	NORTHING		ASPECT	SE	SLOPE 5%

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
S	M	Not Encountered		*0.05* 188.45				SP	SAND, fine grained, brown, with silt, trace medium subangular gravels.		MD - D	TOPSOIL RESIDUAL SOIL
S	M	Not Encountered			5687/113/0.1-0.3/CBR B 0.10 m			SP	SAND, fine grained, yellow brown, with clay, trace medium subangular gravels.	D	D	
				0.30					Hole Terminated at 0.30 m (Target depth reached)			
			0.5									
			1.0									
			1.5									
			2.0									
			2.5									

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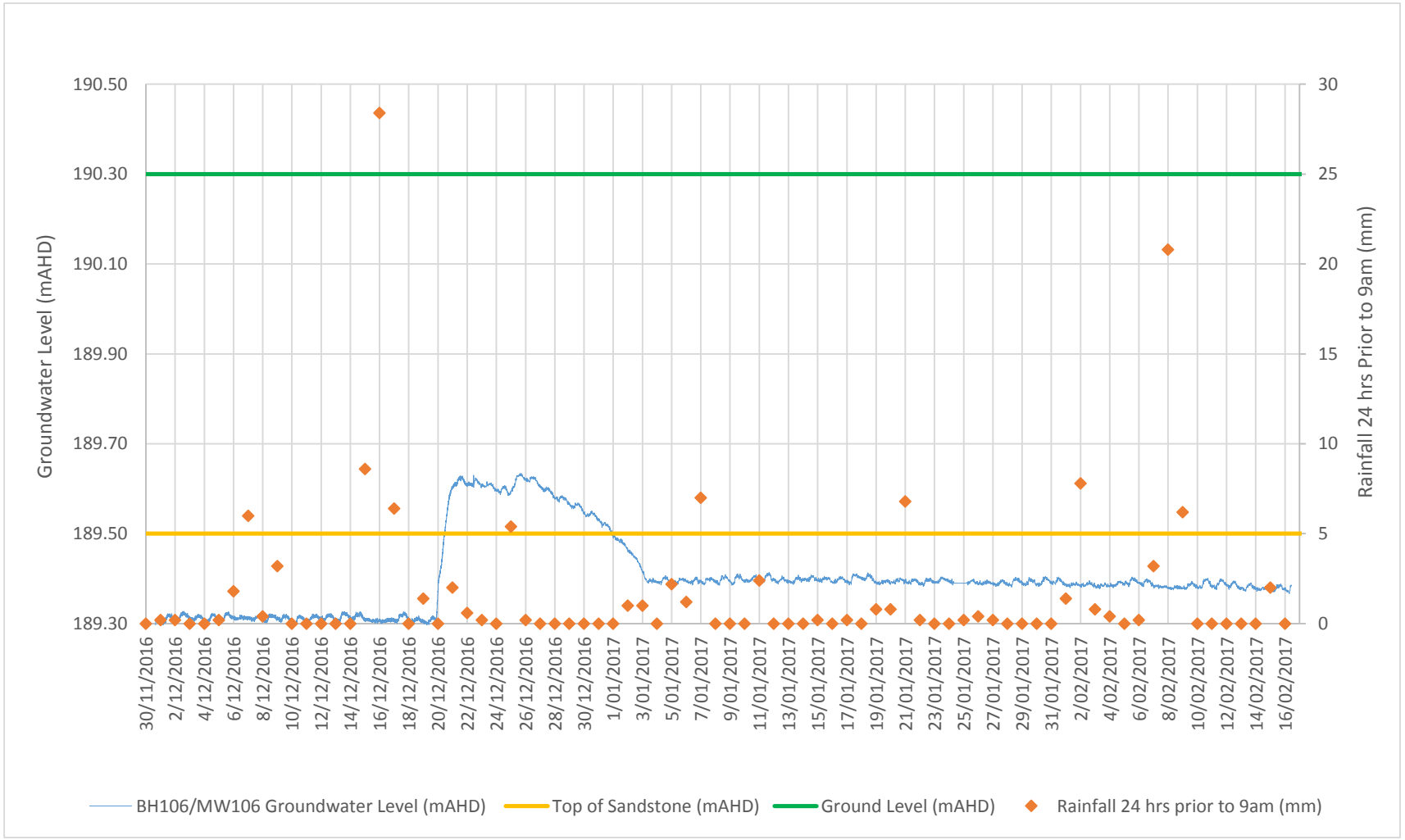
mail@martens.com.au WEB: http://www.martens.com.au

Engineering Log - TEST PIT

7 Attachment C – Groundwater Level Monitoring Data



Notes:
1. Ground level estimated from 1 m survey plan contours (Norton Survey Partners, 2016).
2. Sandstone level approximate based on borehole data and estimated surface level.
3. Rainfall data sourced from BOM (Station 66059, Terrey Hills).

Martens and Associates ABN 85 070 240 890			
Drawn:	BR	**BH106/MW106 Groundwater Level Monitored By Data Logger** **Lot 2/1145029, 4A Larool Road, Terrey Hills, NSW**	**FIGURE 1**
Approved:	JF		
Date:	07.03.2017		
Scale:	Not to scale		Report No: P1605687JR02V01

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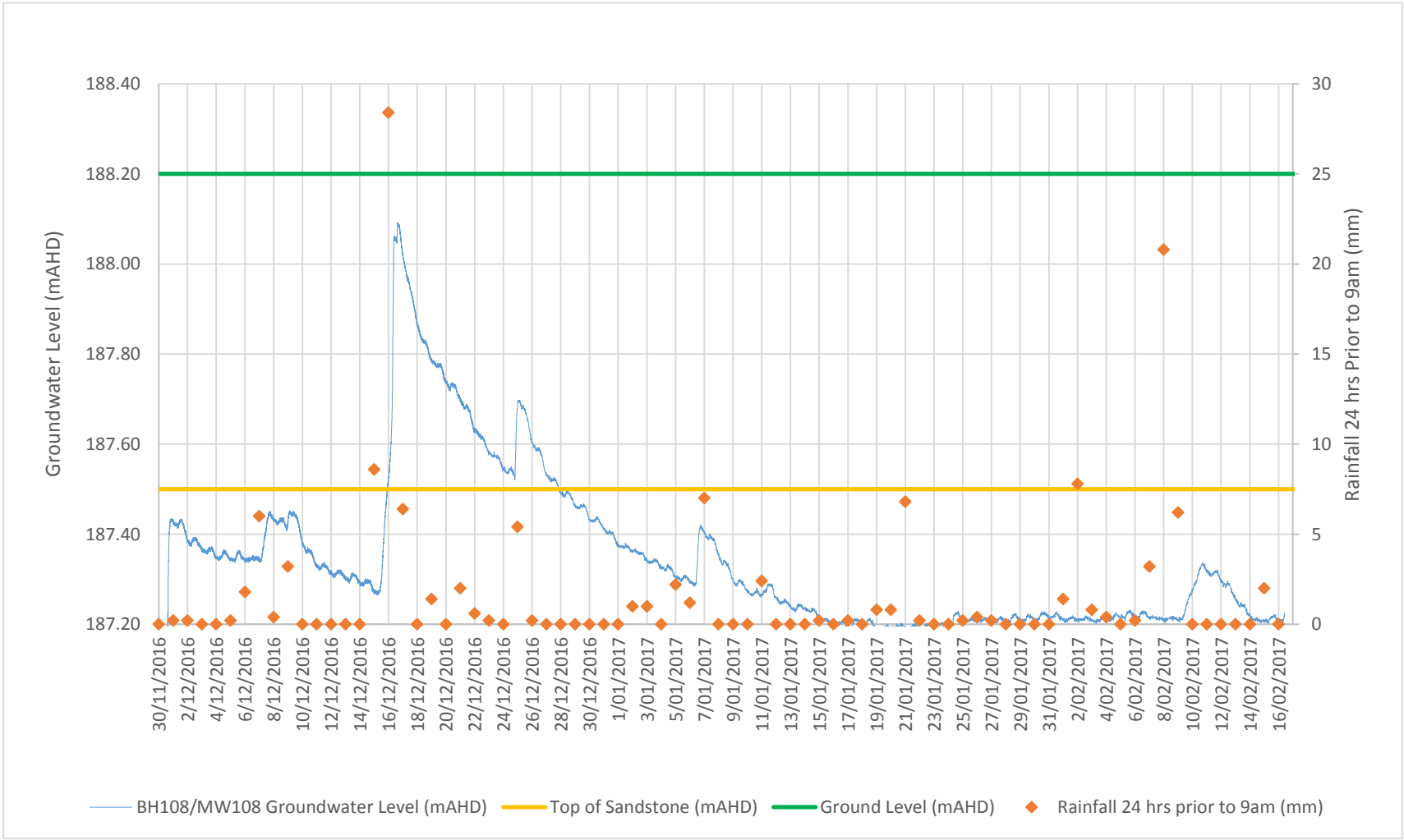
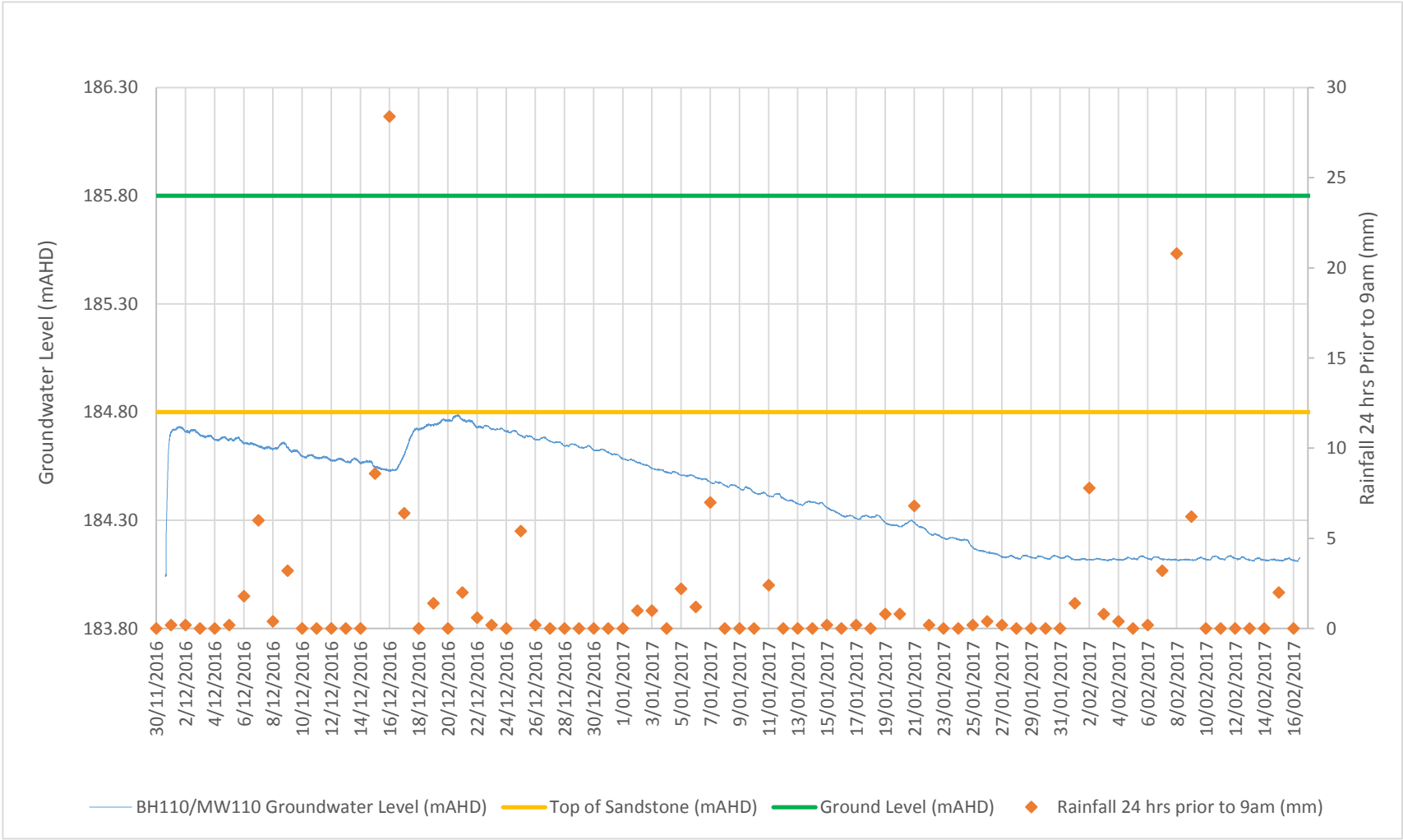


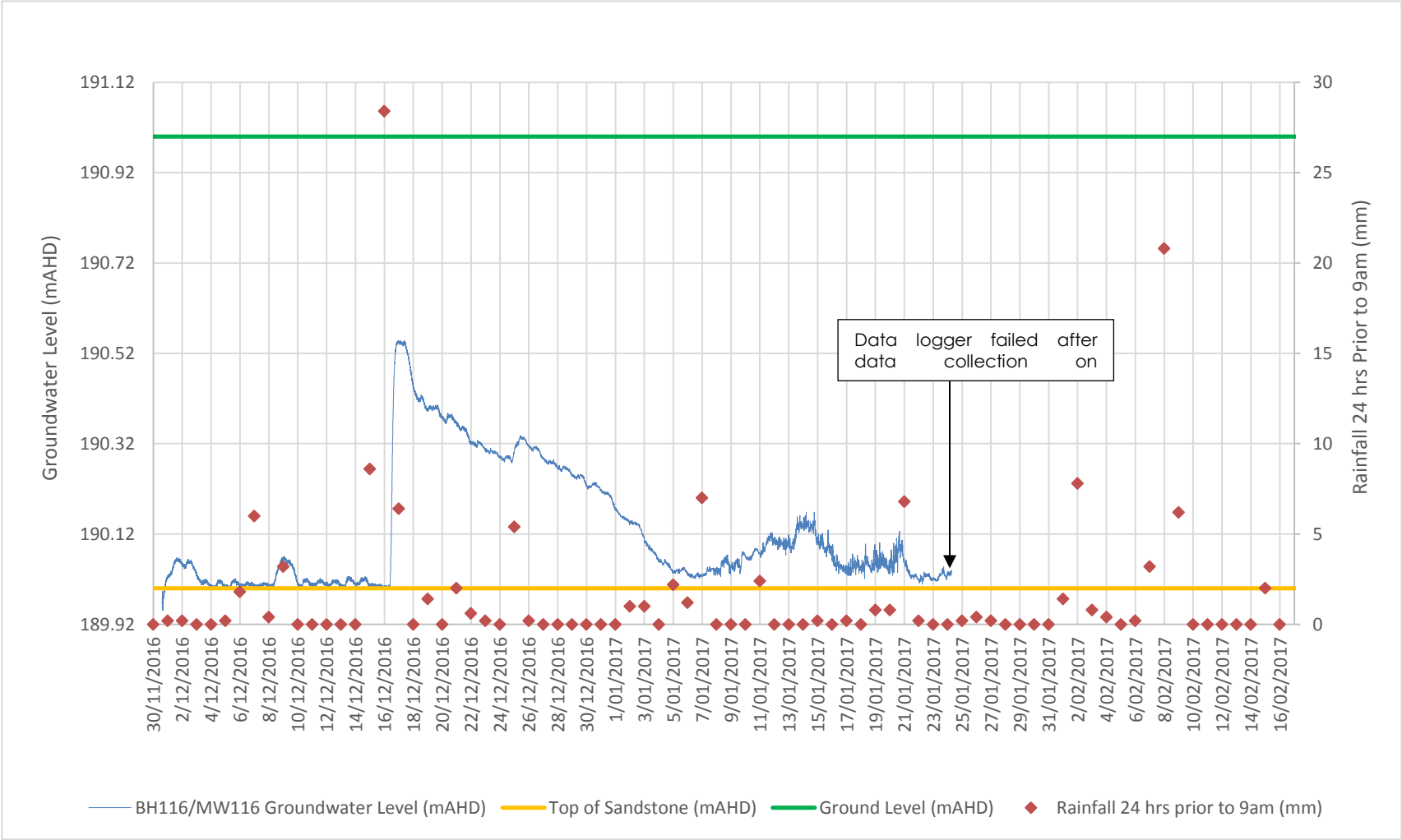
Notes:
1. Ground level estimated from 1 m survey plan contours (Norton Survey Partners, 2016).
2. Sandstone level approximate based on borehole data and estimated surface level.
3. Rainfall data sourced from BOM (Station 66059, Terrey Hills).

Martens and Associates ABN 85 070 240 890			
Drawn:	BR	**BH108/MW108 Groundwater Level Monitored By Data Logger** **Lot 2/1145029, 4A Larool Road, Terrey Hills, NSW**	**FIGURE 2**
Approved:	JF		
Date:	07.03.2017		
Scale:	Not to scale		Report No: P1605687JR02V01



Notes:
1. Ground level estimated from 1 m survey plan contours (Norton Survey Partners, 2016).
2. Sandstone level approximate based on borehole data and estimated surface level.
3. Rainfall data sourced from BOM (Station 66059, Terrey Hills).

Martens and Associates ABN 85 070 240 890			
Drawn:	BR	**BH110/MW110 Groundwater Level Monitored By Data Logger** **Lot 2/1145029, 4A Larool Road, Terrey Hills, NSW**	**FIGURE 3**
Approved:	JF		
Date:	07.03.2017		
Scale:	Not to scale		Report No: P1605687JR02V01



Notes:
1. Ground level estimated from 1 m survey plan contours (Norton Survey Partners, 2016).
2. Sandstone level approximate based on borehole data and estimated surface level.
3. Rainfall data sourced from BOM (Station 66059, Terrey Hills).

Martens and Associates ABN 85 070 240 890			
Drawn:	BR	**BH116/MW116 Groundwater Level Monitored By Data Logger** **Lot 2/1145029, 4A Larool Road, Terrey Hills, NSW**	**FIGURE 4**
Approved:	RE		
Date:	07.03.2017		
Scale:	Not to scale		Report No: P1605687JR02V01

8 Attachment D – Permeability Analysis Sheets

Single Bore Slug Test (Rising or Falling)

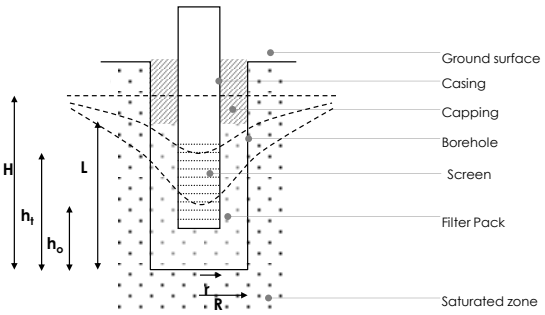
Method ST-13 Revised 7.3.2007

PROJECT DETAILS

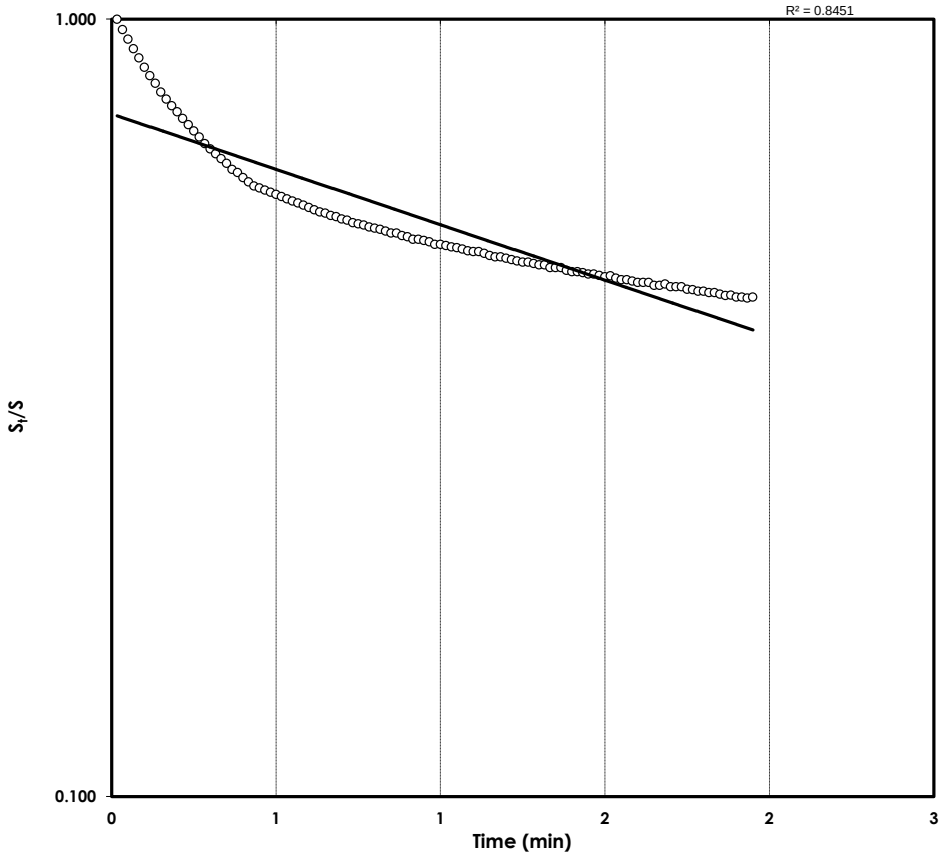
Project	Engineering Works: 4A Larool Road, Terrey Hills, NSW	Test Date	24.01.2017
Project Ref	P1605687JS02V01	Field Testing	M. Huan
Well Ref	MW106	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	J. Fulton

FIELD TEST DATA

FACTOR	Enter Data	Unit
H - Initial water level reading (depth)	0.91	mBGL
h_o - Water level reading at time = 0 (depth)	0.01	mBGL
r - Casing radius	0.025	m
R - Bore radius	0.050	m
L - Length of open screen	0.75	m
T_o - Length of characteristic time	2.17	minutes
K_{sat} - Saturated hydraulic conductivity	0.748	m/d



DATA PLOT



Head Office
Suite 201, Level 2, 20 George Street
Hornsby, NSW 2077
Ph: (02) 9476 9999 Fax: (02) 9476 8767,

>mail@martens.com.au
www.martens.com.au
MARTENS & ASSOCIATES PTY LTD
ABN 85 070 240 890 ACN 070 240 890

Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

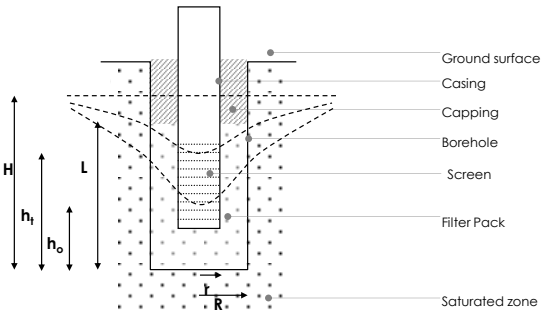
martens consulting engineers

PROJECT DETAILS

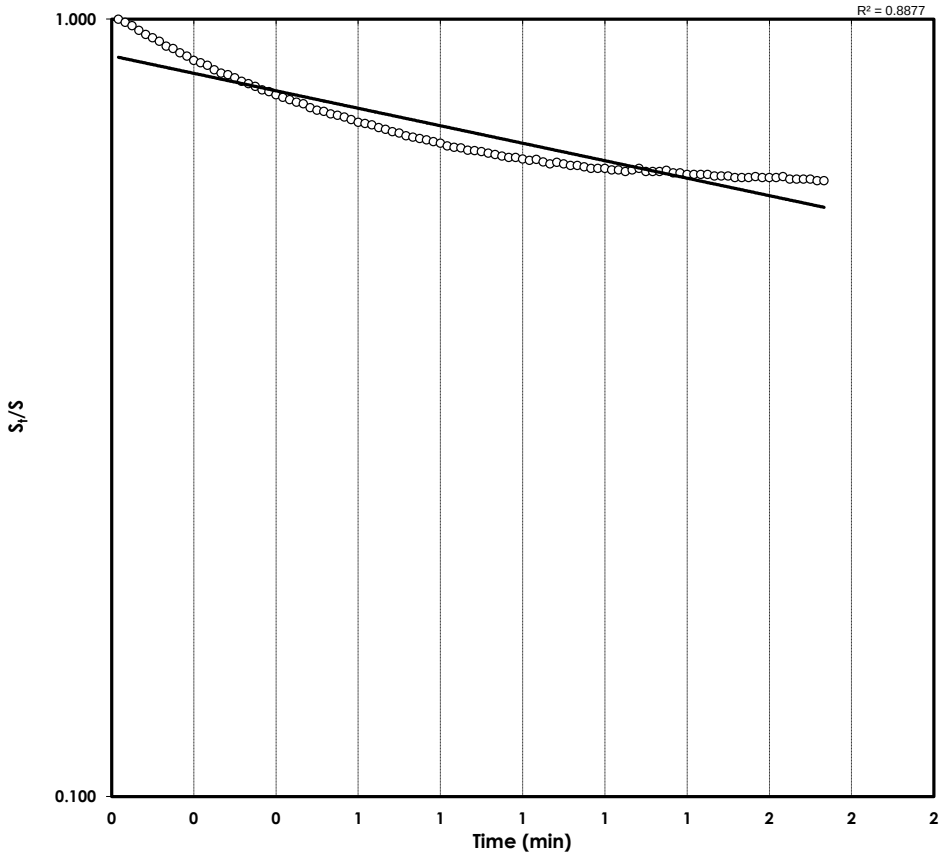
Project	Engineering Works: 4A Larool Road, Terrey Hills, NSW	Test Date	24.01.2017
Project Ref	P1605687JS02V01	Field Testing	M. Huan
Well Ref	MW116	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	J. Fulton

FIELD TEST DATA

FACTOR	Enter Data	Unit
H - Initial water level reading (depth)	0.96	mBGL
h_o - Water level reading at time = 0 (depth)	0.01	mBGL
r - Casing radius	0.025	m
R - Bore radius	0.050	m
L - Length of open screen	0.83	m
T_o - Length of characteristic time	3.42	minutes
K_{sat} - Saturated hydraulic conductivity	0.445	m/d



DATA PLOT



Head Office
Suite 201, Level 2, 20 George Street
Hornsby, NSW 2077
Ph: (02) 9476 9999 Fax: (02) 9476 8767,

>mail@martens.com.au
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9 Attachment E – Notes Relating To This Report

Information

Important Information About Your Report (1 of 2)

These notes have been prepared by Martens to help you interpret and understand the limitations of your report. Not all are necessarily relevant to all reports but are included as general reference.

Engineering Reports - Limitations

The recommendations presented in this report are based on limited investigations and include specific issues to be addressed during various phases of the project. If the recommendations presented in this report are not implemented in full, the general recommendations may become inapplicable and Martens & Associates accept no responsibility whatsoever for the performance of the works undertaken.

Occasionally, sub-surface conditions between and below the completed boreholes or other tests may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact Martens & Associates.

Relative ground surface levels at borehole locations may not be accurate and should be verified by on-site survey.

Engineering Reports – Project Specific Criteria

Engineering reports are prepared by qualified personnel. They are based on information obtained, on current engineering standards of interpretation and analysis, and on the basis of your unique project specific requirements as understood by Martens. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the Client.

Where the report has been prepared for a specific design proposal (e.g. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (e.g. to a twenty storey building). Your report should not be relied upon, if there are changes to the project, without first asking Martens to assess how factors, which changed subsequent to the date of the report, affect the report's recommendations. Martens will not accept responsibility for problems that may occur due to design changes, if not consulted.

Engineering Reports – Recommendations

Your report is based on the assumption that site conditions, as may be revealed through selective point sampling, are indicative of actual conditions throughout an area. This assumption often cannot be substantiated until project implementation has commenced. Therefore your site investigation report recommendations should only be regarded as preliminary.

Only Martens, who prepared the report, are fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report, there is a risk that the report will be misinterpreted and Martens cannot be held responsible for such misinterpretation.

Engineering Reports – Use for Tendering Purposes

Where information obtained from investigations is provided for tendering purposes, Martens recommend that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document.

Martens would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Engineering Reports – Data

The report as a whole presents the findings of a site assessment and should not be copied in part or altered in any way.

Logs, figures, drawings *etc* are customarily included in a Martens report and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), desktop studies and laboratory evaluation of field samples. These data should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Engineering Reports – Other Projects

To avoid misuse of the information contained in your report it is recommended that you confer with Martens before passing your report on to another party who may not be familiar with the background and purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Subsurface Conditions - General

Every care is taken with the report in relation to interpretation of subsurface conditions, discussion of geotechnical aspects, relevant standards and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions - the potential will depend partly on test point

(eg. excavation or borehole) spacing and sampling frequency, which are often limited by project imposed budgetary constraints.

- Changes in guidelines, standards and policy or interpretation of guidelines, standards and policy by statutory authorities.

- The actions of contractors responding to commercial pressures.

- Actual conditions differing somewhat from those inferred to exist, because no professional, no matter how qualified, can reveal precisely what is hidden by earth, rock and time.

  The actual interface between logged materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

If these conditions occur, Martens will be pleased to assist with investigation or providing advice to resolve the matter.

Subsurface Conditions - Changes

Natural processes and the activity of man create subsurface conditions. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Reports are based on conditions which existed at the time of the subsurface exploration / assessment.

Decisions should not be based on a report whose adequacy may have been affected by time. If an extended period of time has elapsed since the report was prepared, consult Martens to be advised how time may have impacted on the project.

Subsurface Conditions - Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those that were expected from the information contained in the report, Martens requests that it immediately be notified. Most problems are much more readily resolved at the time when conditions are exposed, rather than at some later stage well after the event.

Report Use by Other Design Professionals

To avoid potentially costly misinterpretations when other design professionals develop their plans based on a Martens report, retain Martens to work with other project professionals affected by the report. This may involve Martens explaining the report design implications and then reviewing plans and specifications produced to see how they have incorporated the report findings.

Subsurface Conditions – Geo-environmental Issues

Your report generally does not relate to any findings, conclusions, or recommendations about the potential for hazardous or contaminated materials existing at the site unless specifically required to do so as part of Martens' proposal for works.

Specific sampling guidelines and specialist equipment, techniques and personnel are typically used to perform geo-environmental or site contamination assessments. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Martens for information relating to such matters.

Responsibility

Geo-environmental reporting relies on interpretation of factual information based on professional judgment and opinion and has an inherent level of uncertainty attached to it and is typically far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded.

To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Martens to other parties but are included to identify where Martens' responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Martens closely and do not hesitate to ask any questions you may have.

Site Inspections

Martens will always be pleased to provide engineering inspection services for aspects of work to which this report relates. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site. Martens is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction.

Soil Data

Explanation of Terms (1 of 3)

Definitions

In engineering terms, soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material does not exhibit any visible rock properties and can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

The methods of description and classification of soils and rocks used in this report are typically based on Australian Standard 1726 and the Unified Soil Classification System (USCS) – refer Soil Data Explanation of Terms (2 of 3). In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

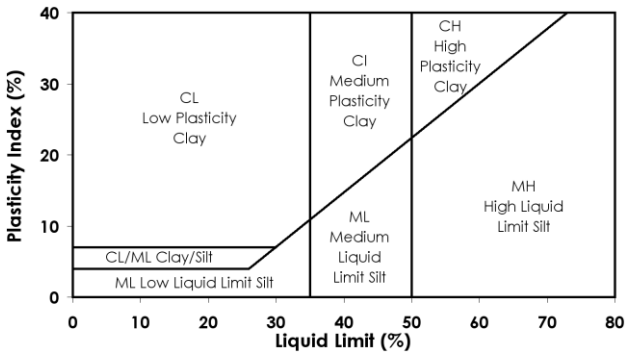
Particle Size

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (e.g. sandy CLAY). Unless otherwise stated, particle size is described in accordance with the following table.

Division	Subdivision	Size (mm)
BOULDERS		>200
COBBLES		63 to 200
GRAVEL	Coarse	20 to 63
	Medium	6 to 20
	Fine	2.36 to 6
SAND	Coarse	0.6 to 2.36
	Medium	0.2 to 0.6
	Fine	0.075 to 0.2
SILT		0.002 to 0.075
CLAY		< 0.002

Plasticity Properties

Plasticity properties of cohesive soils can be assessed in the field by tactile properties or by laboratory procedures.



Moisture Condition

Dry	Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.
Moist	Soil feels cool and damp and is darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
Wet	As for moist but with free water forming on hands when handled.

Consistency of Cohesive Soils

Cohesive soils refer to predominantly clay materials.

Term	C_u (kPa)	Approx. SPT "N"	Field Guide
Very Soft	<12	2	A finger can be pushed well into the soil with little effort. Sample extrudes between fingers when squeezed in fist.
Soft	12 - 25	2 – 4	A finger can be pushed into the soil to about 25mm depth. Easily moulded in fingers.
Firm	25 - 50	4 – 8	The soil can be indented about 5mm with the thumb, but not penetrated. Can be moulded by strong pressure in the figures.
Stiff	50 - 100	8 – 15	The surface of the soil can be indented with the thumb, but not penetrated. Cannot be moulded by fingers.
Very Stiff	100 - 200	15 – 30	The surface of the soil can be marked, but not indented with thumb pressure. Difficult to cut with a knife. Thumbnail can readily indent.
Hard	> 200	> 30	The surface of the soil can be marked only with the thumbnail. Brittle. Tends to break into fragments.
Friable	-	-	Crumbles or powders when scraped by thumbnail.

Density of Granular Soils

Non-cohesive soils are classified on the basis of relative density, generally from standard penetration test (SPT) or Dutch cone penetrometer test (CPT) results as below:

Relative Density	%	SPT 'N' Value* (blows/300mm)	CPT Cone Value (q_c MPa)
Very loose	< 15	< 5	< 2
Loose	15 - 35	5 - 10	2 - 5
Medium dense	35 - 65	10 - 30	5 - 15
Dense	65 - 85	30 - 50	15 - 25
Very dense	> 85	> 50	> 25

* Values may be subject to corrections for overburden pressures and equipment type.

Minor Components

Minor components in soils may be present and readily detectable, but have little bearing on general geotechnical classification. Terms include:

Term	Assessment	Proportion of Minor component In:
Trace of	Presence just detectable by feel or eye. Soil properties little or no different to general properties of primary component.	Coarse grained soils: < 5 % Fine grained soils: < 15 %
With some	Presence easily detectable by feel or eye. Soil properties little different to general properties of primary component.	Coarse grained soils: 5 – 12 % Fine grained soils: 15 – 30 %

Soil Data

Explanation of Terms (2 of 3)

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Symbols for Soils and Other

SOILS


COBBLES/BOULDERS


GRAVEL (GP OR GW)


SILTY GRAVEL (GM)


CLAYEY GRAVEL (GC)


SAND (SP OR SW)


SILTY SAND (SM)


CLAYEY SAND (SC)


SILT (ML OR MH)


ORGANIC SILT (OH)


CLAY (CL, CI OR CH)


SILTY CLAY


SANDY CLAY


PEAT


TOPSOIL

OTHER


FILL


TALUS


ASPHALT


CONCRETE

Unified Soil Classification Scheme (USCS)

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)				USCS	Primary Name
COARSE GRAINED SOILS More than 50 % of material less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm.	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Gravel
				Predominantly one size or a range of sizes with more intermediate sizes missing	GP	Gravel
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	GM	Silty Gravel
				Plastic fines (for identification procedures see CL below)	GC	Clayey Gravel
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of intermediate sizes missing.	SW	Sand
				Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Sand
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	SM	Silty Sand
				Plastic fines (for identification procedures see CL below)	SC	Clayey Sand

FINE GRAINED SOILS More than 50 % of material less than 63 mm is smaller than 0.075 mm	IDENTIFICATION PROCEDURES ON FRACTIONS < 0.2 MM					
	DRY STRENGTH (Crushing Characteristics)	DILATANCY	TOUGHNESS	DESCRIPTION	USCS	Primary Name
	None to Low	Quick to Slow	None	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	ML	Silt
	Medium to High	None	Medium	Inorganic clays of low to medium plasticity [1], gravely clays, sandy clays, silty clays, lean clays	CL [2]	Clay
	Low to Medium	Slow to Very Slow	Low	Organic slits and organic silty clays of low plasticity	OL	Organic Silt
	Low to Medium	Slow to Very Slow	Low to Medium	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	MH	Silt
	High	None	High	Inorganic clays of high plasticity, fat clays	CH	Clay
	Medium to High	None	Low to Medium	Organic clays of medium to high plasticity	OH	Organic Silt
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture				Pt	Peat

Notes:

1. Low Plasticity – Liquid Limit W_L < 35 % Medium Plasticity – Liquid limit W_L 35 to 60 % High Plasticity - Liquid limit W_L > 60 %.
2. CI may be adopted for clay of medium plasticity to distinguish from clay of low plasticity.

Soil Data

Explanation of Terms (3 of 3)

Soil Agricultural Classification Scheme

In some situations, such as where soils are to be used for effluent disposal purposes, soils are often more appropriately classified in terms of traditional agricultural classification schemes. Where a Martens report provides agricultural classifications, these are undertaken in accordance with descriptions by Northcote, K.H. (1979) *The factual key for the recognition of Australian Soils*, Rellim Technical Publications, NSW, p 26 - 28.

Symbol	Field Texture Grade	Behaviour of moist bolus	Ribbon length	Clay content (%)
S	Sand	Coherence nil to very slight; cannot be moulded; single grains adhere to fingers	0 mm	< 5
LS	Loamy sand	Slight coherence; discolours fingers with dark organic stain	6.35 mm	5
CLS	Clayey sand	Slight coherence; sticky when wet; many sand grains stick to fingers; discolours fingers with clay stain	6.35mm - 1.3cm	5 - 10
SL	Sandy loam	Bolus just coherent but very sandy to touch; dominant sand grains are of medium size and are readily visible	1.3 - 2.5	10 - 15
FSL	Fine sandy loam	Bolus coherent; fine sand can be felt and heard	1.3 - 2.5	10 - 20
SCL$^-$	Light sandy clay loam	Bolus strongly coherent but sandy to touch, sand grains dominantly medium size and easily visible	2.0	15 - 20
L	Loam	Bolus coherent and rather spongy; smooth feel when manipulated but no obvious sandiness or silkiness; may be somewhat greasy to the touch if much organic matter present	2.5	25
Lfsy	Loam, fine sandy	Bolus coherent and slightly spongy; fine sand can be felt and heard when manipulated	2.5	25
SiL	Silt loam	Coherent bolus, very smooth to silky when manipulated	2.5	25 + > 25 silt
SCL	Sandy clay loam	Strongly coherent bolus sandy to touch; medium size sand grains visible in a finer matrix	2.5 - 3.8	20 - 30
CL	Clay loam	Coherent plastic bolus; smooth to manipulate	3.8 - 5.0	30 - 35
SiCL	Silty clay loam	Coherent smooth bolus; plastic and silky to touch	3.8 - 5.0	30- 35 + > 25 silt
FSCL	Fine sandy clay loam	Coherent bolus; fine sand can be felt and heard	3.8 - 5.0	30 - 35
SC	Sandy clay	Plastic bolus; fine to medium sized sands can be seen, felt or heard in a clayey matrix	5.0 - 7.5	35 - 40
SiC	Silty clay	Plastic bolus; smooth and silky	5.0 - 7.5	35 - 40 + > 25 silt
LC	Light clay	Plastic bolus; smooth to touch; slight resistance to shearing	5.0 - 7.5	35 - 40
LMC	Light medium clay	Plastic bolus; smooth to touch, slightly greater resistance to shearing than LC	7.5	40 - 45
MC	Medium clay	Smooth plastic bolus, handles like plasticine and can be moulded into rods without fracture, some resistance to shearing	> 7.5	45 - 55
HC	Heavy clay	Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to shearing	> 7.5	> 50

Rock Data

Explanation of Terms (1 of 2)

Symbols for Rock

SEDIMENTARY ROCK


BRECCIA


CONGLOMERATE


CONGLOMERATIC SANDSTONE


SANDSTONE/QUARTZITE


SILTSTONE


MUDSTONE/CLAYSTONE


SHALE


COAL


LIMESTONE


LITHIC TUFF

IGNEOUS ROCK


GRANITE


DOLERITE/BASALT

METAMORPHIC ROCK


SLATE, PHYLLITE, SCHIST


GNEISS


METASANDSTONE


METASILTSTONE


METAMUDSTONE

Definitions

Descriptive terms used for Rock by Martens are based on AS1726 and encompass rock substance, defects and mass.

Rock Substance — In geotechnical engineering terms, rock substance is any naturally occurring aggregate of minerals and organic matter which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Rock substance is effectively homogeneous and may be isotropic or anisotropic.

Rock Defect — Discontinuity or break in the continuity of a substance or substances.

Rock Mass — Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

Degree of Weathering

Rock weathering is defined as the degree of decline in rock structure and grain property and can be determined in the field.

Term	Symbol	Definition
Residual soil[1]	Rs	Soil derived from the weathering of rock. The mass structure and substance fabric are no longer evident. There is a large change in volume but the soil has not been significantly transported.
Extremely weathered[1]	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly weathered[2]	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decrease compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original rock substance is no longer recognisable.
Moderately weathered[2]	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh	FR	Rock substance unaffected by weathering

Notes:
1 The term "Distinctly Weathered" (DW) may be used to cover the range of substance weathering between EW and SW.
2 Rs and EW material is described using soil descriptive terms.

Rock Strength

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the loading. The test procedure is described by the International Society of Rock Mechanics.

Term	Is (50) MPa	Field Guide	Symbol
Very low	>0.03 ≤0.1	May be crumbled in the hand. Sandstone is 'sugary' and friable.	VL
Low	>0.1 ≤0.3	A piece of core 150mm long x 50mm diameter may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	L
Medium	>0.3 ≤1.0	A piece of core 150mm long x 50mm diameter can be broken by hand with considerable difficulty. Readily scored with a knife.	M
High	>1 ≤3	A piece of core 150mm long x 50mm diameter cannot be broken by unaided hands, can be slightly scratched or scored with a knife.	H
Very high	>3 ≤10	A piece of core 150mm long x 50mm diameter may be broken readily with hand held hammer. Cannot be scratched with pen knife.	VH
Extremely high	>10	A piece of core 150mm long x 50mm diameter is difficult to break with hand held hammer. Rings when struck with a hammer.	EH

Rock Data

Explanation of Terms (2 of 2)

Degree of Fracturing

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude fractures such as drilling breaks (DB) or handling breaks (HB).

Term	Description
Fragmented	The core is comprised primarily of fragments of length less than 20 mm, and mostly of width less than core diameter.
Highly fractured	Core lengths are generally less than 20 mm to 40 mm with occasional fragments.
Fractured	Core lengths are mainly 30 mm to 100 mm with occasional shorter and longer sections.
Slightly fractured	Core lengths are generally 300 mm to 1000 mm, with occasional longer sections and sections of 100 mm to 300 mm.
Unbroken	The core does not contain any fractures.

Rock Core Recovery

TCR = Total Core Recovery

$$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100\%$$

SCR = Solid Core Recovery

$$= \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100\%$$

RQD = Rock Quality Designation

$$= \frac{\sum \text{Axial lengths of core} > 100\text{mm long}}{\text{Length of core run}} \times 100\%$$

Rock Strength Tests

- ▼ Point load strength Index (Is50) - axial test (MPa)
- ▶ Point load strength Index (Is50) - diametral test (MPa)
- ● Unconfined compressive strength (UCS) (MPa)

Defect Type Abbreviations and Descriptions

Defect Type (with inclination given)

BP	Bedding plane parting
FL	Foliation
CL	Cleavage
JT	Joint
FC	Fracture
SZ/SS	Sheared zone/ seam (Fault)
CZ/CS	Crushed zone/ seam
DZ/DS	Decomposed zone/ seam
FZ	Fractured Zone
IS	Infilled seam
VN	Vein
CO	Contact
HB	Handling break
DB	Drilling break

Planarity

Pl	Planar
Cu	Curved
Un	Undulating
St	Stepped
Ir	Irregular
Dis	Discontinuous

Roughness

Pol	Polished
Sl	Slickensided
Sm	Smooth
Ro	Rough
VR	Very rough

Thickness

Zone	> 100 mm
Seam	> 2 mm < 100 mm
Plane	< 2 mm

Coating or Filling

Cn	Clean
Sn	Stain
Ct	Coating
Vnr	Veneer
Fe	Iron Oxide
X	Carbonaceous
Qz	Quartzite
MU	Unidentified mineral

Inclination

Inclination of defect is measured from perpendicular to and down the core axis.
Direction of defect is measured clockwise (looking down core) from magnetic north.

Test, Drill and Excavation Methods

Explanation of Terms (1 of 3)

Sampling

Sampling is carried out during drilling or excavation to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling or excavation provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples may be taken by pushing a thin-walled sampling tube, e.g. U_{50} (50 mm internal diameter thin walled tube), into soils and withdrawing a soil sample in a relatively undisturbed state. Such samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Other sampling methods may be used. Details of the type and method of sampling are given in the report.

Drilling / Excavation Methods

The following is a brief summary of drilling and excavation methods currently adopted by the Company and some comments on their use and application.

Hand Excavation - in some situations, excavation using hand tools, such as mattock and spade, may be required due to limited site access or shallow soil profiles.

Hand Auger - the hole is advanced by pushing and rotating either a sand or clay auger, generally 75-100 mm in diameter, into the ground. The penetration depth is usually limited to the length of the auger pole; however extender pieces can be added to lengthen this.

Test Pits - these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils and, if it is safe to descend into the pit, collection of bulk disturbed samples. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (e.g. Pengo) - the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling (Push Tube) - the hole is advanced by pushing a 50 - 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength *etc.* is only marginally affected.

Continuous Spiral Flight Augers - the hole is advanced using 90 - 115 mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface or, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling - the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling - similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling - a continuous core sample is obtained using a diamond tipped core barrel of usually 50 mm internal diameter. Provided full core recovery is achieved (not always possible in very weak or fractured rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

In-situ Testing and Interpretation

Cone Penetrometer Testing (CPT)

Cone penetrometer testing (sometimes referred to as Dutch Cone) described in this report has been carried out using an electrical friction cone penetrometer.

The test is described in AS 1289.6.5.1-1999 (R2013). In the test, a 35 mm diameter rod with a cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system.

Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the push rod centre to an amplifier and recorder unit mounted on the control truck. As penetration occurs (at a rate of approximately 20 mm per second) the information is output on continuous chart recorders. The plotted results given in this report have been traced from the original records. The information provided on the charts comprises:

(i) Cone resistance (q_c) - the actual end bearing force divided by the cross sectional area of the cone, expressed in MPa.

(ii) Sleeve friction (q_f) - the frictional force of the sleeve divided by the surface area, expressed in kPa.

(iii) Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower (A) scale (0 - 5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main (B) scale (0 - 50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1 % - 2 % are commonly encountered in sands and very soft clays rising to 4 % - 10 % in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6)\ N \text{ (blows/300 mm)}$$

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:

$$q_c = (12 \text{ to } 18)\ C_u$$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes *etc.* This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Standard Penetration Testing (SPT)

Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample.

The test procedure is described in AS 1289.6.3.1-2004. The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm penetration depth increments and the 'N' value is taken as the number of blows for the last two 150 mm depth increments (300 mm total penetration). In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued. The test results are reported in the following form:

(i) Where full 450 mm penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7 blows:

as 4, 6, 7
N = 13

(ii) Where the test is discontinued, short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm

as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

Dynamic Cone (Hand) Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150mm increments of penetration. Normally, there is a depth limitation of 1.2m but this may be extended in certain conditions by the use of extension rods. Two relatively similar tests are used.

Perth sand penetrometer (PSP) - a 16 mm diameter flat ended rod is driven with a 9 kg hammer, dropping 600 mm. The test, described in AS 1289.6.3.3-1997 (R2013), was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

Cone penetrometer (DCP) - sometimes known as the Scala Penetrometer, a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm. The test, described in AS 1289.6.3.2-1997 (R2013), was developed initially for pavement sub-grade investigations, with correlations of the test results with California Bearing Ratio published by various Road Authorities.

Pocket Penetrometers

The pocket (hand) penetrometer (PP) is typically a light weight spring hand operated device with a stainless steel loading piston, used to estimate unconfined compressive strength, q_u, (UCS in kPa) of a fine grained soil in field conditions. In use, the free end of the piston is pressed into the soil at a uniform penetration rate until a line, engraved near the piston tip, reaches the soil surface level. The reading is taken from a gradation scale, which is attached to the piston via a built-in spring mechanism and calibrated to kilograms per square centimetre (kPa) UCS. The UCS measurements are used to evaluate consistency of the soil in the field moisture condition. The results may be used to assess the undrained shear strength, C_u, of fine grained soil using the approximate relationship:

$$q_u = 2 \times C_u.$$

It should be noted that accuracy of the results may be influenced by condition variations at selected test surfaces. Also, the readings obtained from the PP test are based on a small area of penetration and could give misleading results. They should not replace laboratory test results. The use of the results from this test is typically limited to an assessment of consistency of the soil in the field and not used directly for design of foundations.

Test Pit / Borehole Logs

Test pit / borehole log(s) presented herein are an engineering and / or geological interpretation of the subsurface conditions. Their reliability will depend to some extent on frequency of sampling and methods of excavation / drilling. Ideally, continuous undisturbed sampling or excavation / core drilling will provide the most reliable assessment but this is not always practicable, or possible to justify on economic grounds. In any case, the test pit / borehole logs represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of test pits / boreholes, the frequency of sampling and the possibility of other than 'straight line' variation between the test pits / boreholes.

Laboratory Testing

Laboratory testing is carried out in accordance with AS 1289 Methods of Testing Soil for Engineering Purposes. Details of the test procedure used are given on the individual report forms.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems:

- In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent prior weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes, which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Test, Drill and Excavation Methods

Explanation of Terms (3 of 3)

martens consulting engineers

DRILLING / EXCAVATION METHOD

HA	Hand Auger	RD	Rotary Blade or Drag Bit	NQ	Diamond Core - 47 mm
AD/V	Auger Drilling with V-bit	RT	Rotary Tricone bit	NMLC	Diamond Core – 51.9 mm
AD/T	Auger Drilling with TC-Bit	RAB	Rotary Air Blast	HQ	Diamond Core – 63.5 mm
AS	Auger Screwing	RC	Reverse Circulation	HMLC	Diamond Core – 63.5 mm
HSA	Hollow Stem Auger	CT	Cable Tool Rig	DT	Diatube Coring
S	Excavated by Hand Spade	PT	Push Tube	NDD	Non-destructive digging
BH	Tractor Mounted Backhoe	PC	Percussion	PQ	Diamond Core - 83 mm
JET	Jetting	E	Tracked Hydraulic Excavator	X	Existing Excavation

SUPPORT

Nil	No support	S	Shotcrete	RB	Rock Bolt
C	Casing	Sh	Shoring	SN	Soil Nail
WB	Wash bore with Blade or Bailer	WR	Wash bore with Roller	T	Timbering

WATER

▽ Water level at date shown

▷ Water inflow

◁ Partial water loss

◀ Complete water loss

GROUNDWATER NOT OBSERVED (NO)	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUNDWATER NOT ENCOUNTERED (NX)	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

PENETRATION / EXCAVATION RESISTANCE

L	Low resistance: Rapid penetration possible with little effort from the equipment used.
M	Medium resistance: Excavation possible at an acceptable rate with moderate effort from the equipment used.
H	High resistance: Further penetration possible at slow rate & requires significant effort equipment.
R	Refusal/ Practical Refusal. No further progress possible without risk of damage/ unacceptable wear to digging implement / machine.

These assessments are subjective and dependent on many factors, including equipment power, weight, condition of excavation or drilling tools, and operator experience.

SAMPLING

D	Small disturbed sample	W	Water Sample	C	Core sample
B	Bulk disturbed sample	G	Gas Sample	CONC	Concrete Core

U63 Thin walled tube sample - number indicates nominal undisturbed sample diameter in millimetres

TESTING

SPT 4,7,11 N=18	Standard Penetration Test to AS1289.6.3.1-2004 4,7,11 = Blows per 150mm. 'N' = Recorded blows per 300mm penetration following 150mm seating
DCP	Dynamic Cone Penetration test to AS1289.6.3.2-1997. 'n' = Recorded blows per 150mm penetration

Notes:

RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB 30/80mm	Hammer double bouncing on anvil after 80 mm penetration
N=18	Where practical refusal occurs, report blows and penetration for that interval

CPT	Static cone penetration test
CPTu	CPT with pore pressure (u) measurement
PP	Pocket penetrometer test expressed as instrument reading (kPa)
FP	Field permeability test over section noted
VS	Field vane shear test expressed as uncorrected shear strength (sv = peak value, sr = residual value)
PM	Pressuremeter test over section noted
PID	Photoionisation Detector reading in ppm
WPT	Water pressure tests

SOIL DESCRIPTION

Density		Consistency		Moisture	
VL	Very loose	VS	Very soft	D	Dry
L	Loose	S	Soft	M	Moist
MD	Medium dense	F	Firm	W	Wet
D	Dense	St	Stiff	Wp	Plastic limit
VD	Very dense	VSt	Very stiff	Wl	Liquid limit
		H	Hard		

ROCK DESCRIPTION

Strength		Weathering	
VL	Very low	EW	Extremely weathered
L	Low	HW	Highly weathered
M	Medium	MW	Moderately weathered
H	High	SW	Slightly weathered
VH	Very high	FR	Fresh
EH	Extremely high		

Wyvern Health P/L
C/- Bureau SRH

Stormwater Management Report:
Lot 2, DP 1145029
4a Larool Road, Terrey Hills, NSW

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

P1605687JR03V02
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Copyright Statement

Limitations Statement

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Head Office
Suite 201, 20 George St
Hornsby, NSW 2077, Australia
ACN 070 240 890 ABN 85 070 240 890
Phone: +61-2-9476-9999
Fax: +61-2-9476-8767
Email: mail@martens.com.au
Web: www.martens.com.au

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Author(s)	Reviewer(s)	Project Manager	Signature
A. van Gogh	S. Ziaee/J. Fulton	Jeff Fulton	

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All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Background

1.1 Scope

This report has been prepared to provide a stormwater management report in support of a development application (DA) for construction of a health care facility at 4a Larool Road, Terrey Hills.

This document provides an assessment of the effect of the proposed development upon the site and a management plan to appropriately mitigate any impacts.

1.2 Relevant Guidelines

This report has been prepared in accordance with the following standards/guidelines:

- Warringah Council On-site Stormwater Detention Technical Specification.
- Warringah Council Water Management Policy (2015).
- NSW MUSIC Modelling Guidelines (August 2015), compiled by BMT WBM.
- Adoption Guidelines for Stormwater Biofiltration Systems (2009), by the Facility for Advancing Water Biofiltration

2 Site Description

2.1 Site Description and Location

Site description is provided in Table 1.

Table 1: Site description summary.

Element	Site Details
Lot / DP	Lot 2, DP 1145029
Local Government Area	Northern Beaches Council (formerly Warringah Council)
Site Area	4.03 ha
Existing Site Development	Undeveloped, the eastern portion of the site has been partially cleared of vegetation
Neighbouring Environment	Site is bordered by Larool Road to the west, Myoora Road to the east, single storey rural residential residences to the north and south and the German International School to the south
Expected Geology	Hawkesbury Sandstone comprising medium to coarse-grained quartz sandstone, very minor shale and laminate lenses (Sydney *1:100 000 Geological Map Sheet 9130, 1st edition,* Geological Survey of New South Wales, Sydney)
Site Topography	Western section of the site consists of a low hill with a plateau near the top, with prominent rock outcropping and some steep slopes. Eastern section consists of moderately undulating, hummocky terrain
Site Aspect and Typical Slope	The site aspect is south and south-east. Grades are 5 % and 10 % in the moderately undulating sections of the site, and greater than 15 % (with some localised scarps) in steeper sections of the site in the north west
Site Elevation	Ranges between approximately 184 mAHD (southeast corner) and 208 mAHD (top of plateau)
Site Grading	Via overland flow towards a drainage channel in the southern section of the site, and ultimately into a pit in the southern corner of the site near Myoora Road
Vegetation	An endangered ecological community (EEC) named Duffys Forest, a low-open woodland, exists in the north western half of the site. There is also a coastal upland swamp (CUS) EEC located in the south west of the site. Some of the area to the north east, east, south east and south of the CUS appeared to have been recently cleared/slashed. Mulch piles and machine track depressions were observed. For a detailed vegetation description refer to documentation provided by the project ecologist (Narla Environmental)

2.2 Proposed Development

The proposed development is for a private hospital located in the eastern portion of the site. The construction will include:

- Three multi storey structures connected by walkways.
- Basement and rooftop carparking with associated driveways and an ambulance bay.
- Landscaped courtyards and gardens in between and around the buildings.
- General cut and fill works.

2.3 Existing drainage

Existing drainage infrastructure of the surrounding area includes:

- A swale is located along the southern boundary of the site. The drainage channel runs from the lower boundary of the mapped Coastal Upland Swamp, to a pit located adjacent to Myoora Road.

3 Stormwater Quality Assessment

3.1 Overview

This assessment has been completed to ensure compliance with Warringah Council regulations regarding the level of water quality treatment. Modelling was conducted using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC).

3.2 Stormwater Quality Objectives

The objectives for new developments are identified in the Warringah Council's Water Management Policy (2015). For a development on land within the riparian buffer of a coastal upland swamp the treatment objectives are as follows:

- Stormwater quality discharging from the development shall not impact the receiving waters.
- Disturbance to wetland sediments must be minimised by regulated discharge of stormwater and dissipation of flows at discharge locations.
- Stormwater flow is to mimic natural conditions and ensure a dispersed pattern of flow, avoiding centralised or concentrated discharge points into the wetland or waterway.

The first two objectives relate to the amount of pollutants that can be discharged from the site. This requirement has been confirmed by Council as ensuring that a net neutral or beneficial (NorBE) outcome is achieved for the site.

The third objective is concerned with maintenance of the site's hydrology, this has been addressed through the design of the stormwater treatment devices. Modelling was also completed in Section 4 to demonstrate mimicry of natural flow rates after development.

Warringah Council provides stormwater pollutant reduction targets for developments occurring in locations that are not in close proximity to endangered ecological communities. Although these targets will generally require that less water quality treatment is needed when compared to NorBE, a check was completed to ensure that the modelling treatment train is conservative. For reference, the stormwater treatment targets required by Warringah Council are as follows:

- 85% reduction in total suspended solids (TSS).
- 65% reduction in total phosphorus (TP).
- 45% reduction in total nitrogen (TN).
- 90% reduction in gross pollutants (GP).

3.3 Groundwater Objectives

The objectives for developments are identified in the Warringah Council's Water Management Policy (2015). Council requires that the groundwater regime be maintained as close as possible to pre-development conditions and not adversely impact on receiving waters.

We refer to the Hydrogeological Assessment prepared by Martens and Associates (report ref: P1605687JR02V01, April 2017), for further information relating to site groundwater regime. The report provides recommendations to reduce development impacts on groundwater.

3.4 Modelling Methodology

3.4.1 Approach

An iterative approach was used for post-development modelling to determine appropriate types, sizes and locations of stormwater treatment devices for modelling scenarios to achieve water quality objectives.

Individual treatment devices were assessed to determine the most effective treatment option.

3.4.2 Rainfall Data

Rainfall data was sourced from the closest locality. This was determined to be the Bureau of Meterology's (BoM) gauge at Duffys Forest (Namba Road) STN no. 066142.

Average areal potential evapotranspiration rates were estimated from the Climatic Atlas of Australian (Bureau of Meteorology, 2001).

3.4.3 Input Parameters

Input parameters for source and treatment nodes are consistent with relevant guidelines or manufacture's specifications.

All MUSIC modelling inputs and treatment node parameters are provided in Attachment A.

3.4.4 Catchment Areas

Pre-development and post-development pervious and impervious catchment areas are provided in MA planset PS02-E700.

3.5 Treatment Train Philosophy

The preferred stormwater treatment strategy for the site uses at source treatment to ensure objectives are satisfied. These are described below:

3.5.1 Gross Pollutant Traps (GPTs)

Stormwater360 Enviropod pit inserts (or similar) are proposed to be implemented in each pit. This GPT device will be used to capture litter, debris and other pollutants. Pit inserts have been proposed to reduce the burden and ease maintenance requirements of the bioretention basins.

3.5.2 Bio-infiltration Structures

Multiple biofiltration structures have been proposed to treat water before leaving the site. The basins provide treatment of water through filtration, biological uptake of nutrients, infiltration, evapotranspiration and detention. The basins have been sized to provide the necessary treatment to meet Council requisites.

Basins have been located to ensure surface flows discharge to the Coastal Upland Swamp, thus mimicking pre-development scenarios. This is discussed further in Section 3.7. Some of the bioretention basins have also been proposed to act as on-site detention. Modelling to determine basin sizes for OSD has been completed in Section 4.

3.6 MUSIC Results

Modelling against the NorBE criteria for the site has been undertaken with the results provided in Table 2.

Table 2: MUSIC modelling results for Neutral or Beneficial Outcome (NorBE).

Parameter	Pre-Development (kg/year)	Post-Development Treated (kg/year)	Complies
TSS	106	25	Yes
TP	0.49	0.48	Yes
TN	5.3	4.9	Yes
GP	0	0	Yes

These results demonstrate that the NorBE criteria are achievable for the development site. Water quality controls proposed reduce developed site pollutant loads below pre-development loads.

The results of the MUSIC model were also compared against Council's reduction targets to measure the systems treatment train effectiveness (TTE). These reduction targets are not a control for this development however the results of this check are available in Table 3. This configuration uses the proposed development with no treatment as the base case and compares it against the post development with treatment devices.

Table 3: MUSIC modelling for Treatment Train Effectiveness (TTE)

Parameter	Post-Development Untreated (kg/year)	Post-Development Treated (kg/year)	Reduction (%)	Complies
TSS	1090	25	97.7	Yes
TP	2.39	0.48	79.8	Yes
TN	19.5	4.9	75	Yes
GP	215	0	100	Yes

MUSIC results demonstrate that the TTE criteria are achievable.

3.7 Hydrology

The Warringah Water Management Policy (2015) requires that the stormwater flow after development 'mimics' the conditions prior to development. The design of the water quality and quantity structures to achieve these objectives is outlined below:

- Volume of infiltration: The proposed bioretention basins are to be unlined and constructed without an underdrain. This design makes provision for water treated in the basins to infiltrate into the soil as it would under existing conditions. In the MUSIC model, the proposed basins have been sized to allow all excess runoff, created due to the development, to infiltrate into the soil. This will assist in groundwater recharge and maintenance of subsurface water levels.

- Location of infiltration: Multiple small scale bioretention basins have been proposed in close proximity to the proposed development footprints and upslope of the mapped CUS (rather than a single end of line basin in the lowest portion of the site). These basins will allow the infiltration of stormwater to occur in the immediate vicinity and directly downstream of where the hospital facilities are to be constructed. Infiltration from these locations will help to mimic natural subsurface flows into/through the CUS.

- Flow dispersion and discharge: The placement and basin outlet structures have been designed to ensure that discharge into the CUS will be well dispersed, as is currently. Basins are proposed to be located around the upstream extents of the CUS. During larger storms, surface flows leaving the basins will be able to enter the CUS via level spreaders. The use of multiple basins and level spreaders will ensure that the flow into the swamp will mirror overland sheet flow, reflecting natural conditions. We refer to MA planset PS02-E100 and PS02-E200 for location of level spreaders and conceptual details.

- Retaining natural flows: At least 80% of pre-development flow rates have been maintained post-development. Quantitative analysis has been conducted for larger storms on basin discharge, we refer to Section 4.

3.8 Conclusions

The MUSIC modelling results demonstrate that no increase compared to existing sediment, nitrogen and phosphorus loads (NorBE) is achieved with the proposed water sensitive urban design devices.

Furthermore the effectiveness of the stormwater quality treatment system was found to comply with Council's reduction targets (for less ecologically sensitive sites).

Warringah Council's Water Management Policy requires that development has minimal impact on the site's hydrology. The design of the combined water quality and quantity structures will allow the natural surface and subsurface flows into the CUS to be mimicked.

4 Stormwater Quantity Assessment

4.1 Overview

This assessment has been completed to determine on-site detention (OSD) requirements for the proposed development. DRAINS hydrological and hydraulic modelling package was used to perform hydraulic analysis.

4.2 Water Quantity Objectives

Stormwater quantity management is to comply with the objectives of Warringah Council On-site Stormwater Detention Technical Specification as follows:

- The stormwater runoff after any development does not exceed the runoff prior to the development
- Pre and post development modelling must be carried out on all typical storm durations (between 10 minutes and 3 hours) for the 5, 20 and 100 year ARI storms.

Further to the requirements for OSD, Warringah Council's Water Management Policy (2015) has some additional requisites for hydrology:

- Stormwater flow is to mimic natural conditions, which has been previously explained in Section 3 of this report.

4.3 Modelling Methodology and Approach

4.3.1 Approach

An iterative approach was used for post-development modelling to determine appropriate types, sizes and locations for an on-site detention configuration.

4.3.2 Hydrological Model

The full computation method was used to size OSD basins for this site. The hydrological model was built using the prescribed inputs found in Section 4.4 of Warringah Council On-site Stormwater Detention Technical Specification.

4.3.3 Rainfall/IFD Data

IFD data that was used for the model was sourced from the Bureau of Meteorology (BoM), for the storm events and durations specified by Warringah Council.

4.3.4 Catchment Areas

Pre-development and post-development pervious and impervious catchment areas are provided in MA planset PS02-E600.

4.4 Results

Based on the provision of storage specified by the Warringah Council On-site Stormwater Detention Technical Specification permissible site discharge requirements and results have been provided in Table 4, Table 5 and Table 6 below.

Table 4: Peak 5 year ARI event site discharge values

Storm Duration	Pre Dev site discharge[1] (l/s)	Post Dev site discharge with OSD[1] (l/s)	% Mimicked
10 min	235	228	97.0
15 min	306	297	97.1
20 min	354	341	96.3
25 min	386	363	94.0
30 min	359	342	95.3
45 min	337	326	96.7
1 hr	368	364	98.9
1.5 hr	405	383	94.6
2 hr	469	403	85.9
3 hr	278	252	90.6

Notes:

1. Values obtained from DRAINS modelling.

Table 5: Peak 20 year ARI event site discharge values

Storm Duration	Pre Dev site discharge (l/s)	Post Dev site discharge with OSD (l/s)	% Mimicked
10 min	386	337	87.3
15 min	481	421	87.5
20 min	580	485	83.6
25 min	615	511	83.1
30 min	580	486	83.8
45 min	556	473	85.1
1 hr	538	510	94.8
1.5 hr	581	537	92.4
2 hr	660	556	84.2
3 hr	409	365	89.2

Table 6: Peak 100 year ARI event site discharge values

Storm Duration	Pre Dev site discharge (l/s)	Post Dev site discharge with OSD (l/s)	% Mimicked
10 min	583	477	81.8
15 min	689	567	82.3
20 min	807	653	80.9
25 min	797	671	84.2
30 min	773	643	83.2
45 min	737	630	85.5
1 hr	709	705	99.4
1.5 hr	760	738	97.1
2 hr	854	776	90.9
3 hr	537	475	88.5

4.5 Discussion

Following Warringah Council Water Management Policy (2015) pre-development flows, we have aimed to ensure that post-development peak flow rates must be mimicked within 80% of pre-development flows rates.

The above results show that Council guidelines as explained above are satisfied. The proposed development and on-site detention configuration will result in slightly lower peak flows, however the post-development flow patterns and regimes will be able to mimic the natural conditions.

Three OSD basins have been modelled in DRAINS to retain site flow features. These basins are noted on MA planset PS02-E100 in Attachment B. The total proposed OSD required for the site is approximately 245 kL.

4.6 Conclusion

Hydraulic modelling demonstrates that the proposed OSD system complies with Warringah Council's On-site Stormwater Detention Technical Specification. The configuration is also able comply with the directions of the Warringah Council Water Management Policy (2015).

5 References

BMT WBM (2015) *NSW MUSIC Modelling Guidelines,* August 2015.

FAWB (2009). *Adoption Guidelines for Stormwater Biofiltration Systems*, Facility for Advancing Water Biofiltration, Monash University, June 2009.

Martens And Associates (2017). Hydrogeological Assessment: 4a Larool Road, Terrey Hills, NSW.

Warringah Council, *On-site Stormwater Detention Technical Specification.*

Warringah Council *Water Management Policy,* December 2015.

6 Attachment A – Summary of MUSIC Input Parameters

MUSIC modelling input parameter values and source

Element	Factor	Input	Source
Setup	Climate File	Climate file, mlb file from Duffys Forest (Namba Road)	eWater
Source Nodes	Node Type	Site modelled as rural, residential, sealed road and roof	BMT WBM (2015)
	Rainfall Threshold	Based on surface type specified in Table 5-4 of NSW MUSIC Modelling Guidelines	BMT WBM (2015)
	Pervious Area Properties	Soil identified as sand, based on examined soils up to 0.5 m deep	Site Soil Tests
	Base & Storm flow Parameter	As per Table 5-6 & 5-7 of NSW MUSIC Modelling Guidelines	BMT WBM (2015)
	Estimation Method	Stochastically generated	BMT WBM (2015)
Gross Pollutant Traps	Low Flow Bypass	0 m^3/s	Stormwater360
	High Flow Bypass	0.02 m^3/s	Stormwater360
	Treatment Efficiency	Per manufacturer's specifications	Stormwater360
Basin 1	Low Flow By-Pass	0 m^3/s	BMT WBM (2015)
	High Flow By-Pass	100 m^3/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.2 m	By design, within FAWB recommended range
	Surface Area	200 m^2, filter area without a battered slope	By design
	Filter Area	200 m^2	By design
	Unlined filer media	70 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)
	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	80 mm/hr	FAWB (2009)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design
Basin 2	Low Flow By-Pass	0 m^3/s	BMT WBM (2015)
	High Flow By-Pass	100 m^3/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.1 m	By design, within FAWB recommended range
	Surface Area	42 m^2, filter area without a battered slope	By design
	Filter Area	42 m^2	By design
	Unlined filer media	25 m	Structure is unlined

Element	Factor	Input	Source
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)
	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	80 mm/hr	FAWB (2009)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design
Basin 3	Low Flow By-Pass	0 m^3/s	BMT WBM (2015)
	High Flow By-Pass	100 m^3/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.2 m	By design, within FAWB recommended range
	Surface Area	120 m^2, filter area without a battered slope	By design
	Filter Area	120 m^2	By design
	Unlined filer media	65 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)
	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	80 mm/hr	FAWB (2009)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design
Basin 4	Low Flow By-Pass	0 m^3/s	BMT WBM (2015)
	High Flow By-Pass	100 m^3/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.2 m	By design, within FAWB recommended range
	Surface Area	312 m^2, filter area without a battered slope	By design
	Filter Area	312 m^2	By design

Element	Factor	Input	Source
	Unlined filer media	140 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)
	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	80 mm/hr	FAWB (2009)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design
Swale	Low Flow By-Pass	0 m^3/s	BMT WBM (2015)
	High Flow By-Pass	100 m^3/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.1 m	By design, within FAWB recommended range
	Surface Area	50 m^2, filter area without a battered slope	By design
	Filter Area	50 m^2	By design
	Unlined filer media	90 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)
	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	80 mm/hr	FAWB (2009)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design

7 Attachment B – Stormwater Management Plan

PROJECT: PRIVATE HOSPITAL DEVELOPMENT

PLANSET: CONCEPT STORMWATER MANAGEMENT

CLIENT: WYVERN HEALTH P/L C/- BUREAU SRH

LOCALITY PLAN
N.T.S.

DRAWING LIST		
DWG No.	REV	DWG TITLE
GENERAL		
PS02-A000	B	COVER SHEET
PS02-A050	B	DEVELOPMENT OVERVIEW PLAN
SEDIMENT & EROSION CONTROL		
PS02-B300	B	SEDIMENT & EROSION CONTROL PLAN
PS02-B301	A	SEDIMENT & EROSION CONTROL DETAILS
DRAINAGE		
PS02-E100	B	DRAINAGE PLAN
PS02-E200	A	DRAINAGE DETAILS
PS02-E600	B	DRAINS MODELLING LAYOUT, CATCHMENT PLAN AND RESULTS
PS02-E700	B	MUSIC MODELLING LAYOUT, CATCHMENT PLAN AND RESULTS

LGA: NORTHERN BEACHES COUNCIL

4A LAROOL ROAD,
TERREY HILLS NSW
LOT 2 / DP 1145029

DEVELOPMENT APPLICATION

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
B	FINAL RELEASE FOR DA	28/04/2017	HE/AVG	AVG	SL/JF	JF
A	INITIAL RELEASE	12/04/2017	HE	AVG	JF	

SCALE

GRID | DATUM | PROJECT MANAGER: JF

CLIENT: WYVERN HEALTH P/L C/- BUREAU SRH

PROJECT NAME/PLANSET TITLE
PRIVATE HOSPITAL DEVELOPMENT
CONCEPT STORMWATER MANAGEMENT
4A LAROOL ROAD,
TERREY HILLS NSW

martens & Associates Pty Ltd
Consulting Engineers
Environment
Water
Geotechnical
Civil
Suite 201, 20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767
Email: mail@martens.com.au Internet: www.martens.com.au

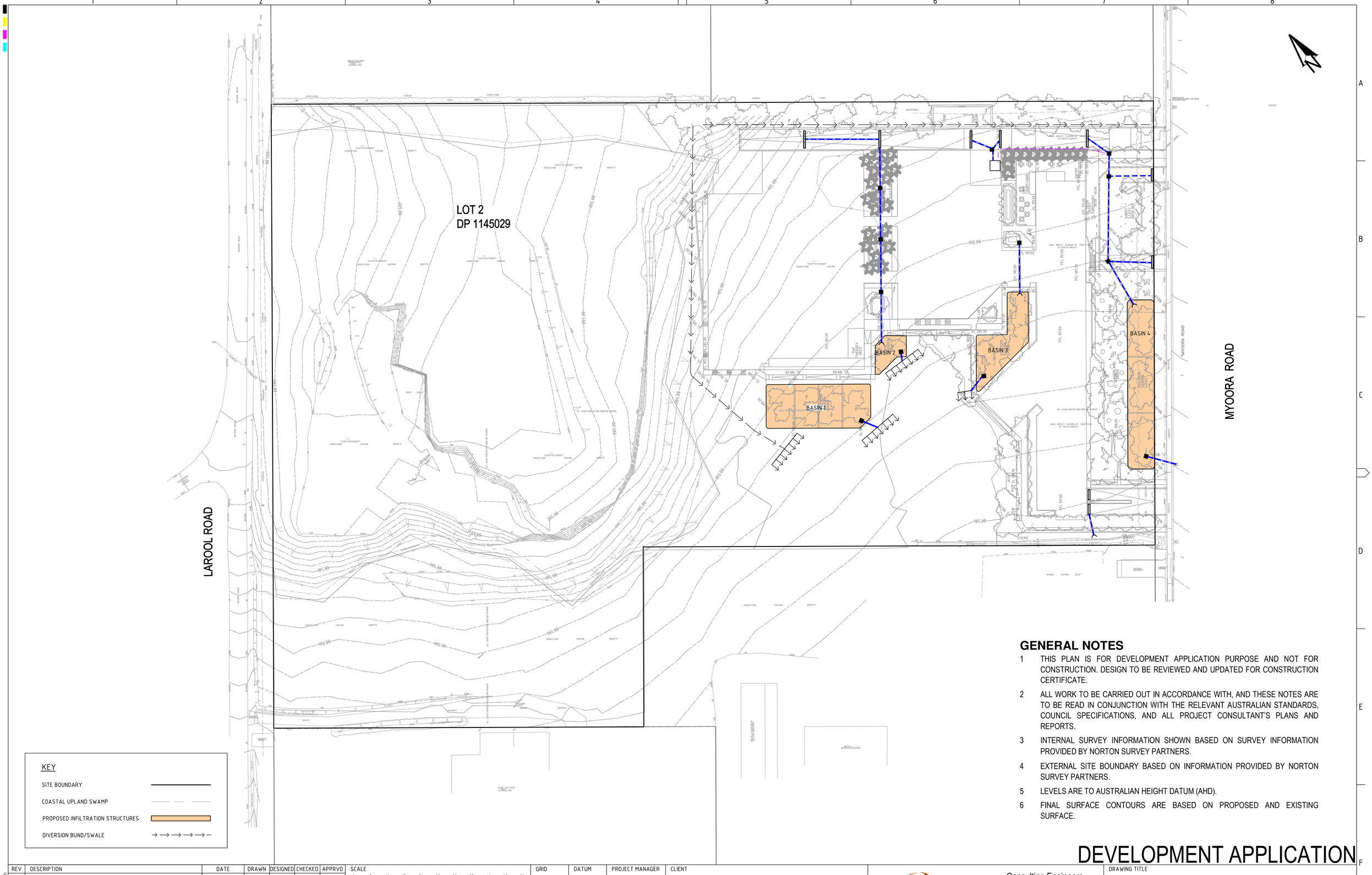
DRAWING TITLE: COVER SHEET

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1605687	PS02	R02	PS02-A000	B

DRAWING ID: P1605687-PS02-R02-A000

PRINTED: 28-04-2017 - USER: HELEN

A1 / A3 LANDSCAPE (A1LC_v02.01)



GENERAL NOTES

1. THIS PLAN IS FOR DEVELOPMENT APPLICATION PURPOSE AND NOT FOR CONSTRUCTION. DESIGN TO BE REVIEWED AND UPDATED FOR CONSTRUCTION CERTIFICATE.
2. ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH, AND THESE NOTES ARE TO BE READ IN CONJUNCTION WITH THE RELEVANT AUSTRALIAN STANDARDS, COUNCIL SPECIFICATIONS, AND ALL PROJECT CONSULTANT'S PLANS AND REPORTS.
3. INTERNAL SURVEY INFORMATION SHOWN BASED ON SURVEY INFORMATION PROVIDED BY NORTON SURVEY PARTNERS.
4. EXTERNAL SITE BOUNDARY BASED ON INFORMATION PROVIDED BY NORTON SURVEY PARTNERS.
5. LEVELS ARE TO AUSTRALIAN HEIGHT DATUM (AHD).
6. FINAL SURFACE CONTOURS ARE BASED ON PROPOSED AND EXISTING SURFACE.

DEVELOPMENT APPLICATION

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
B	FINAL RELEASE FOR DA	28/04/2017	HE/AVG	AVG	SL/JF	JF
A	INITIAL RELEASE	12/04/2017	HE	AVG	JF	

SCALE
0 5 10 15 20 25 30 35 40 45 50 METRES
A1 (A3) 1:500 (1:1,000)

GRID	DATUM	PROJECT MANAGER
MGA	mAHD	JF

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CLIENT
WYVERN HEALTH P/L C/- BUREAU SRH

PROJECT NAME/PLANSET TITLE
PRIVATE HOSPITAL DEVELOPMENT
CONCEPT STORMWATER MANAGEMENT
4A LAROOL ROAD,
TERREY HILLS NSW

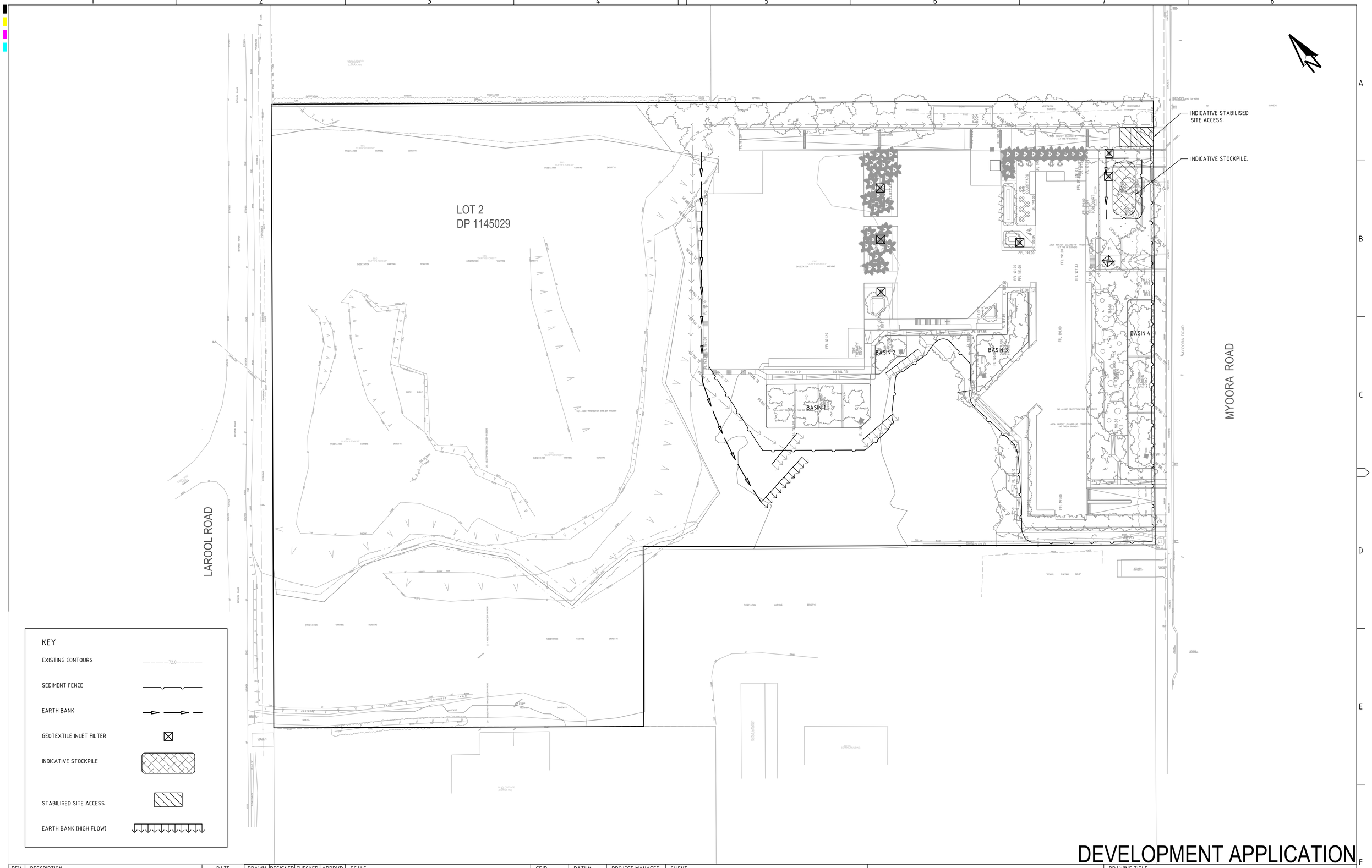
martens & Associates Pty Ltd
Consulting Engineers
Environment
Water
Geotechnical
Civil
Suite 201, 20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767
Email: mail@martens.com.au Internet: www.martens.com.au

DRAWING TITLE
DEVELOPMENT OVERVIEW PLANS

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1605687	PS02	R02	PS02-A050	B

DRAWING ID: P1605687-PS02-R02-A050

PRINTED: 28-4-2017 - USER: HELEN
A1 / A3 LANDSCAPE (A1LC_v02.0.01)



DEVELOPMENT APPLICATION

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
B	**FINAL RELEASE FOR DA**	**28/04/2017**	**HE/AVG**	**AVG**	**SL/JF**	**JF**
A	INITIAL RELEASE	12/04/2017	HE	AVG	JF	

SCALE
0 5 10 15 20 25 30 35 40 45 50 METRES
A1 (A3) 1:500 (1:1,000)

GRID	DATUM	PROJECT MANAGER
MGA	mAHD	JF

CLIENT
WYVERN HEALTH P/L C/- BUREAU SRH

PROJECT NAME/PLANSET TITLE
PRIVATE HOSPITAL DEVELOPMENT
CONCEPT STORMWATER MANAGEMENT
4A LAROOL ROAD,
TERREY HILLS NSW

martens & Associates Pty Ltd
Consulting Engineers
Environment
Water
Geotechnical
Civil
Suite 201, 20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767
Email: mail@martens.com.au Internet: www.martens.com.au

DRAWING TITLE
SOIL AND WATER MANAGEMENT PLAN

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1605687	PS02	R02	PS02-B300	B

DRAWING ID: P1605687-PS02-R02-B300

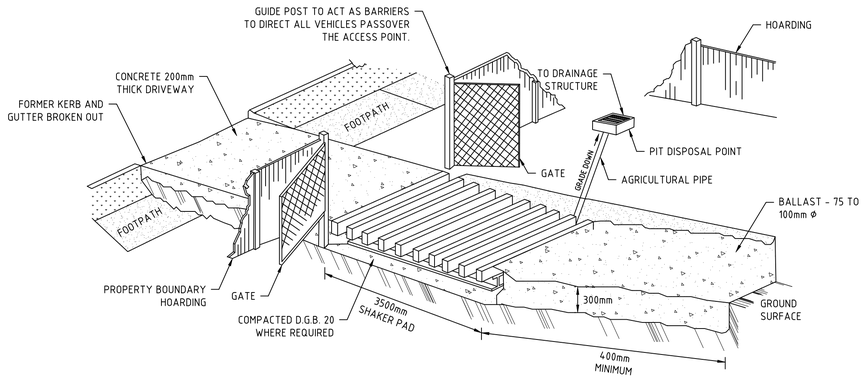
PRINTED: 28-4-2017 - USER: HELEN
A1 / A3 LANDSCAPE (A1LC_v02.0.01)

STABILISED ACCESS POINT

TYPE II SAP

THE TYPE II SAP DESIGN IS MORE DEFINED IN THAT IT REQUIRES AN AREA OF BALLAST WITHIN THE SITE COMBINED WITH A SHAKER PAD; ADJACENT THE SHAKER PAD AND IN THE PUBLIC WAY IS A TEMPORARY (CONCRETE) VEHICULAR CROSSING. (SEE DIAGRAM)

STABILISED ACCESS POINT - TYPE 2



IN BOTH TYPE I AND TYPE II SAP'S, THE TEMPORARY VEHICULAR CROSSING MUST:

- CONNECT TO AN EXISTING GUTTER LAYBACK (WHERE THE KERB AND GUTTER EXIST) . IF A GUTTER LAYBACK DOES NOT EXIST THEN THE CONNECTION MUST BE MADE TO THE GUTTER BY REMOVING THE ADJCENT KERB SECTION ONLY.
- CONNECT TO A DISH CROSSING (WHERE KERB AND GUTTER DOES NOT EXIST). IF A DISH CROSSING DOES NOT EXIST, THEN IT MUST BE CONSTRUCTED IN ACCORDANCE WITH DETAILS CONTAINED IN COUNCIL'S ISSUED FOOTPATH CROSSING LEVELS.

IT SHOULD BE NOTED THAT THESE TYPES OF SAPS ARE CONSIDERED TO BE APPLICABLE FOR THE MAJORITY OF ACTIVITIES HOWEVER SOME SITES MAY REQUIRE SPECIAL CONSIDERATION.

SHAKER PAD (CATTLE GRID)

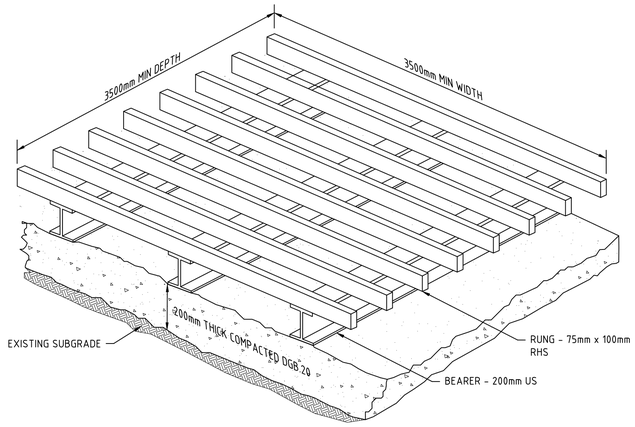
A CORRECTLY DESIGNED AND INSTALLED SHAKER PAD WILL ASSIST IN PREVENTING SEDIMENT TRANSFERE FROM A SITE. ANY STABILISED ACCESS POINT (SAP) CAN BE DESIGNED WITH A SHAKER PAD (COMPULSOPRY IN TYPE II SAP'S)

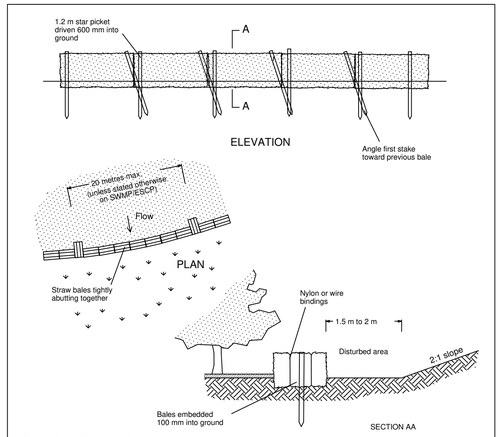
SHAKER PADS CAN BE DESIGNED AND CONSTRUCTED TO ENABLE RE-USE ON FUTURE PROJECTS.

THE SHAKER PAD:

- MUST BE DESIGNED AND CERTIFIED BY A PRACTICING STRUCTURAL ENGINEER. THE CERTIFIED DESIGN SHOULD BE SUBMITTED WITH THE RELEVENT APPLICATION.
- CAN BE CONSTRUCTED FROM ANY SUITABLE MATERIAL.
- MUST BE LOCATED ON A SUITABLY PREPARED AND COMPACTED SUB-GRADE/BASE MATERIAL.
- MUST BE SITUATED SUCH THAT THE RUNGS OF THE SHAKER PAD ARE LEVEL WITH THE ADJOINING NATURAL SURFACE.
- MUST BE A MINIMUM OF 3.5m IN LENGTH.
- MUST BE A MINIMUN OF 3.5m IN WIDTH.
- MUST HAVE CLEAR SPACING BETWEEN RUNGS OF 200 - 250mm.
- RUNGS MUST HAVE A MAXIMUM WIDTH (BEARING AREA) OF 75mm.
- MUST HAVE A MINIMUM CLEAR DEPTH OF 300mm IE FORM THE ROP OF THE RUNG TO THE FINISHED SUB-GRADE/BASE LEVEL.

THE SHAKER PAD MUST BE PROVIDED WITH SUITABLE BARRIERS AT THE SIDES TO ENSURE THAT ALL TYERS OF VEHICLES LEAVING THE SITE TRAVERSE THE DEVICE.

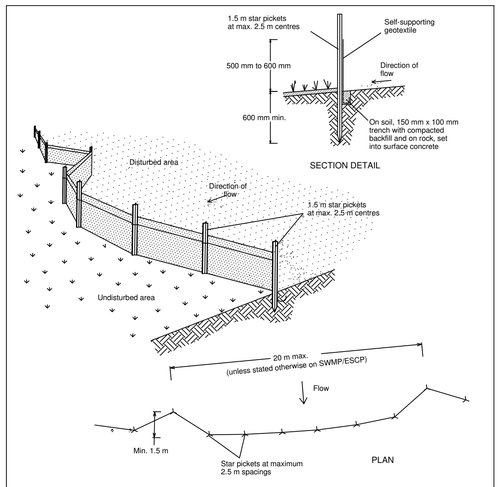




Construction Notes

1. Construct the straw bale filter as close as possible to being parallel to the contours of the site.
2. Place bales lengthwise in a row with ends tightly abutting. Use straw to fill any gaps between bales. Straws are to be placed parallel to ground.
3. Ensure that the maximum height of the filter is one bale.
4. Embed each bale in the ground 75 mm to 100 mm and anchor with two 1.2 metre star pickets or stakes. Angle the first star picket or stake in each bale towards the previously laid bale. Drive them 600 mm into the ground and, if possible, flush with the top of the bales. Where star pickets are used and they protrude above the bales, ensure they are fitted with safety caps.
5. Where a straw bale filter is constructed downslope from a disturbed batter, ensure the bales are placed 1 to 2 metres downslope from the toe.
6. Establish a maintenance program that ensures the integrity of the bales is retained - they could require replacement each two to four months.

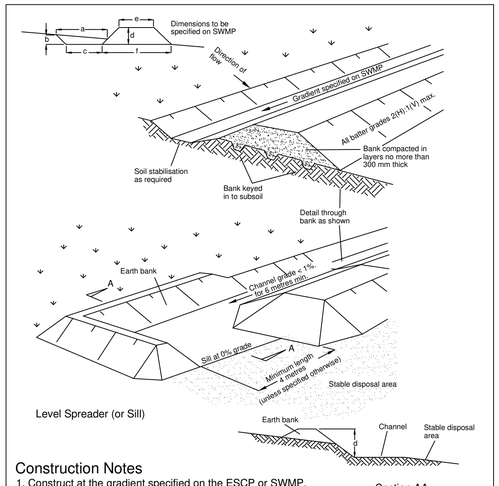
STRAW BALE FILTER SD 6-7



Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

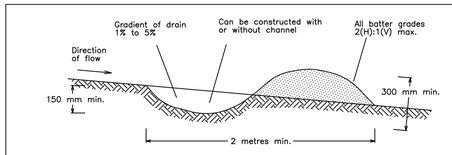
SEDIMENT FENCE SD 6-8



Construction Notes

1. Construct at the gradient specified on the ESCP or SWMP, normally between 1 and 5 percent
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped, at the dimensions shown on the SWMP.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction following Table 5.2 in Landcom (2004).
7. Where discharging to erodible lands, ensure they outlet through a properly constructed level spreader.
8. Construct the level spreader at the gradient specified on the ESCP or SWMP, normally less than 1 percent or level.
9. Where possible, ensure they discharge waters onto either stabilised or undisturbed disposal sites within the same subcatchment area from which the water originated. Approval might be required to discharge into other subcatchments.

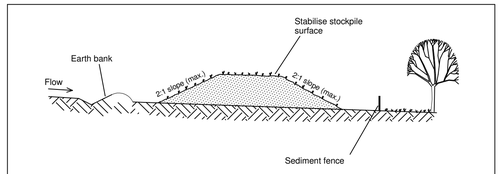
EARTH BANK (HIGH FLOWS) SD 5-6



Construction Notes

1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

EARTH BANK (LOW FLOW) SD 5-5



Construction Notes

1. Place stockpiles more than 2 (preferably 5) metres from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Standard Drawing 5-5) on the upslope side to divert water around stockpiles and sediment fences (Standard Drawing 6-8) 1 to 2 metres downslope.

STOCKPILES SD 4-1

DEVELOPMENT APPLICATION

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
A	INITIAL RELEASE	12/04/2017	HE	AVG	JF	

SCALE

GRID | DATUM | PROJECT MANAGER: JF

CLIENT: WYVERN HEALTH P/L C/- BUREAU SRH

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All measurements in millimetres unless otherwise specified.

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PROJECT NAME/PLANSET TITLE

PRIVATE HOSPITAL DEVELOPMENT

CONCEPT STORMWATER MANAGEMENT

4A LAROOL ROAD, TERREY HILLS NSW

martens & Associates Pty Ltd

Consulting Engineers

Environment
Water
Geotechnical
Civil

Suite 201, 20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767
Email: mail@martens.com.au Internet: www.martens.com.au

DRAWING TITLE: SOIL AND WATER MANAGEMENT DETAILS

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1605687	PS02	R02	PS02-B301	A

DRAWING ID: P1605687-PS02-R02-B301

SUMP (WITH PUMP) TANK WITHIN BASEMENTTO COLLECT DRIVEWAY RUNOFF. WATER TO BE DIRECTED TO BASIN 4. DETAILS TO BE PROVIDED AT CC STAGE, TO BE SIZED FOR 100 YR EVENT.

BUND/SWALE TO DIVERT UPSTREAM CATCHMENT

SCOUR PROTECTION

OSD/BIORETENTION BASIN 312m² FILTER AREA. 200mm RETENTION DEPTH, 500mm FILTER DEPTH. 120KL PROVIDE FOR OSD.

OSD/BIORETENTION BASIN 98m² FILTER AREA. RETENTION DEPTH 200mm, 500mm FILTER MEDIA. 45KL PROVIDED FOR OSD.

RAINGARDEN 42m² FILTER AREA, 500mm FILTER DEPTH. 100mm RETENTION DEPTH

SCOUR PROTECTION AND LEVEL SPREADER AT DISCHARGE LOCATION

BUND TO PREVENT LOCAL UPSTREAM FLOOD WATER INFLOW TO BASIN AND RETAIN COASTAL UPLAND SWAMP CATCHMENT

BASIN TO BE STEPPED DOWN SITE AS REQUIRED, PENDING FINAL LEVELS

SCOUR PROTECTION AND LEVEL SPREADER AT DISCHARGE LOCATION

CONNECT TO EXISTING DRAINAGE IN MYOORA ROAD

SCOUR PROTECTION AND LEVEL SPREADER AT DISCHARGE LOCATION

OSD/BIORETENTION BASIN 200m² FILTER AREA. RETENTION DEPTH 200mm. 80KL REQUIRED FOR OSD

EXISTING SWALE TO BE CONVERTED TO BIO-INFILTRATION BASIN

NOTE: DEVELOPMENT OUTLINE SHOWS BASEMENT

BASIN 1

BASIN 2

BASIN 3

BASIN 4

KEY

- STORMWATER PIPELINE
- RISING MAIN
- GRATED SURFACE INLET PIT
- GRATED DRAIN
- HEADWALL
- FLOW DIRECTION
- DIVERSION BUND/SWALE
- BASIN/TANK OUTLINE
- SITE BOUNDARY
- LEVEL SPREADER

DEVELOPMENT APPLICATION

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
B	FINAL RELEASE FOR DA	28/04/2017	HE/AVG	AVG	SL/JF	JF
A	INITIAL RELEASE	12/04/2017	HE	AVG	JF	

SCALE: A1 (A3) 1:250 (1:500) — 0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 METRES

GRID	DATUM	PROJECT MANAGER
MGA	mAHD	JF

CLIENT: WYVERN HEALTH P/L C/- BUREAU SRH

PROJECT NAME/PLANSET TITLE
PRIVATE HOSPITAL DEVELOPMENT
CONCEPT STORMWATER MANAGEMENT
4A LAROOL ROAD, TERREY HILLS NSW

martens & Associates Pty Ltd
Consulting Engineers
Environment
Water
Geotechnical
Civil
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Email: mail@martens.com.au Internet: www.martens.com.au

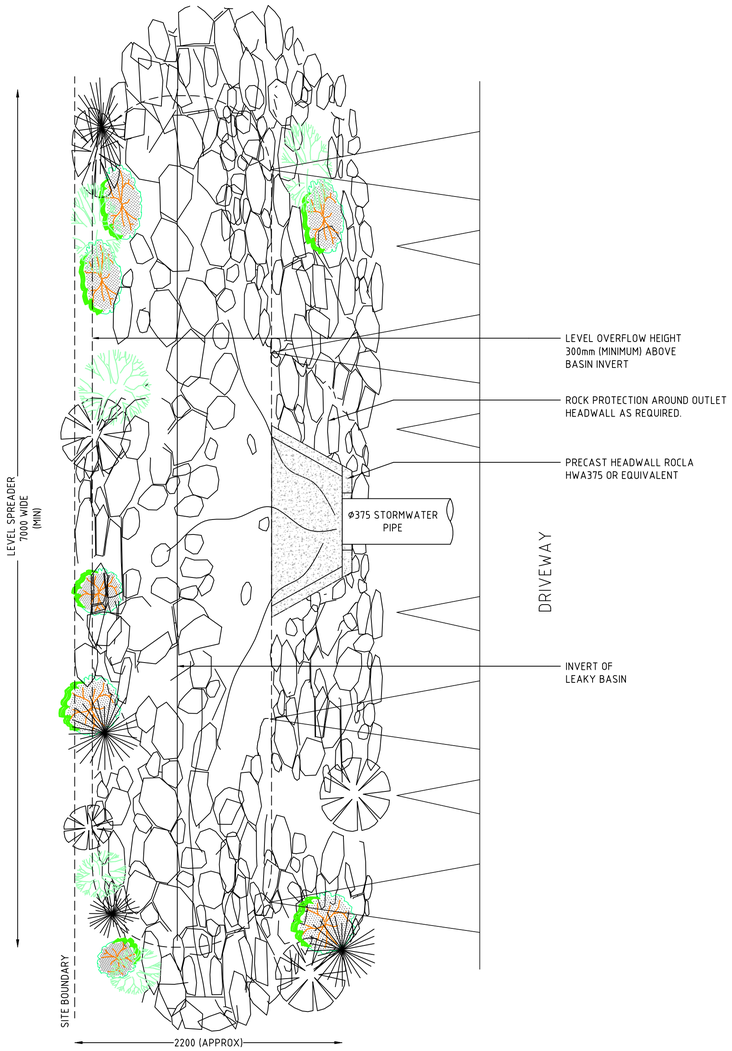
DRAWING TITLE: DRAINAGE PLAN

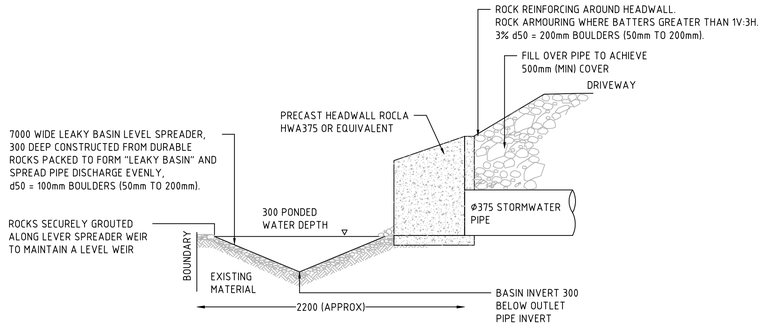
PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1605687	PS02	R02	PS02-E100	B

DRAWING ID: P1605687-PS02-R02-E100

PRINTED: 28-Apr-2017 - USER: HELOW

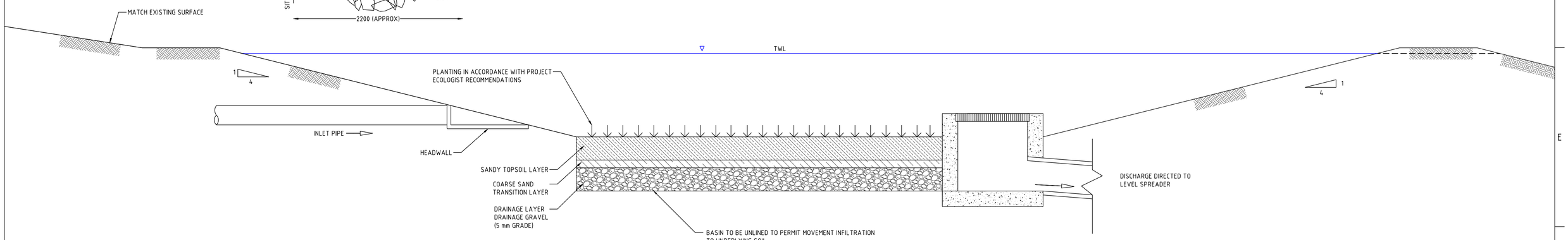
A1 / A3 LANDSCAPE (A1LC_v02.0.01)





DETAIL - LEAKY BASIN LEVEL SPREADER

NOT TO SCALE



TYPICAL SECTION BIO-FILTRATION BASIN

NOT TO SCALE

DEVELOPMENT APPLICATION

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
A	INITIAL RELEASE	12/04/2017	HE	AVG	JF	

SCALE

GRID | DATUM | PROJECT MANAGER: JF

CLIENT: WYVERN HEALTH P/L C/- BUREAU SRH

PROJECT NAME/PLANSET TITLE
PRIVATE HOSPITAL DEVELOPMENT
CONCEPT STORMWATER MANAGEMENT
4A LAROOL ROAD,
TERREY HILLS NSW

martens & Associates Pty Ltd
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Civil
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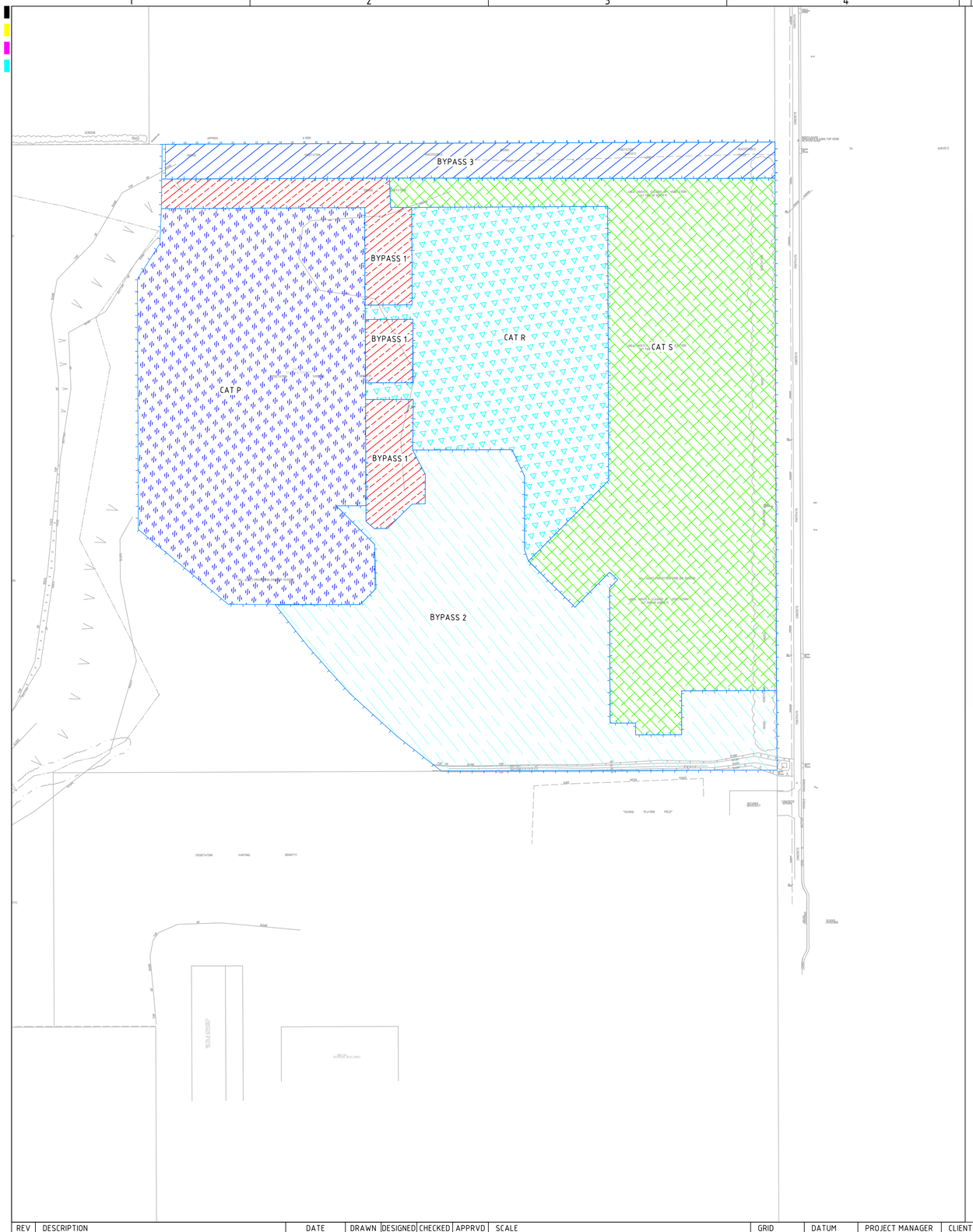
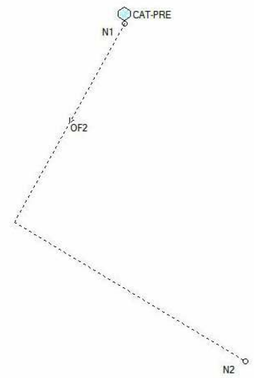
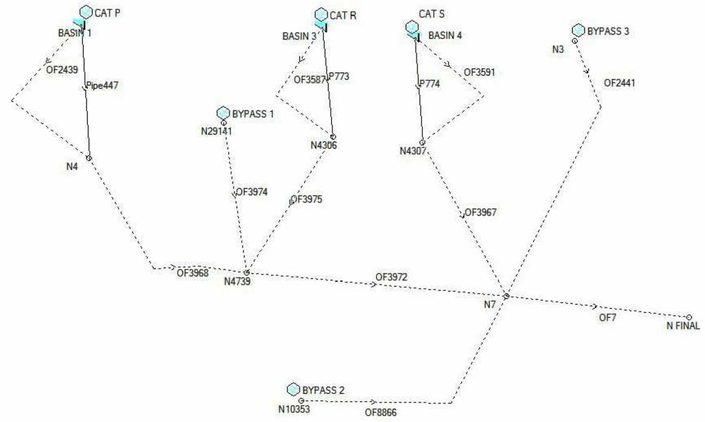
DRAWING TITLE: DRAINAGE DETAILS

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1605687	PS02	R02	PS02-E200	A

PRINTED: 28-04-2017 - USER: HELEN
A1 / A3 LANDSCAPE (A1LC_v02.0.01)
DRAWING ID: P1605687-PS02-R02-E200







OSD MODEL LAYOUT

KEY	DRAINS NODE	DESCRIPTION	AREA (ha)	% PAVED
	CAT P	BASIN 1	0.380	85%
	BYPASS 1	LANDSCAPING	0.089	66%
	CAT R	BASIN 3	0.243	85%
	CAT S	BASIN 4	0.440	72%
	BYPASS 2	SWAMP	0.339	11%
	BYPASS 3	LANDSCAPING	0.095	0%
		TOTAL AREA	**1.586**	**= 100% OF TOTAL AREA**
		TOTAL IMPERVIOUS AREA	**0.942**	**= %59 OF TOTAL AREA**
		TOTAL PERVIOUS AREA	**0.644**	**= %41 OF TOTAL AREA**

KEY	DRAINS NODE	DESCRIPTION	AREA (ha)	% PAVED
	CAT PRE	EXISTING SITE	1.586	0%
		TOTAL AREA	**1.586**	**= 100% OF TOTAL AREA**
		TOTAL IMPERVIOUS AREA	**0.000**	**= %0 OF TOTAL AREA**
		TOTAL PERVIOUS AREA	**1.586**	**= %100 OF TOTAL AREA**

CATCHMENTS RESULTS

OSD MODEL RESULTS		
SITE	**MYOORA ROAD, TERREY HILLS**	
ARI	**PRE DEVELOPMENT FLOW (Cu.m/s)**	**POST DEVELOPMENT FLOW (Cu.m/s)**
5 YEAR	0.469	0.403
20 YEAR	0.660	0.556
100 YEAR	0.854	0.776

OSD MODEL RESULTS

DEVELOPMENT APPLICATION

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SCALE
0 5 10 15 20 25 30 35 40 45 50 METRES
A1 (A3) 1:500 (1:1,000)

GRID	DATUM	PROJECT MANAGER
MGA	mAHD	JF

CLIENT
WYVERN HEALTH P/L C/- BUREAU SRH

PROJECT NAME/PLANSET TITLE
PRIVATE HOSPITAL DEVELOPMENT
CONCEPT STORMWATER MANAGEMENT
4A LAROOL ROAD,
TERREY HILLS NSW

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DRAWING TITLE
DRAINS MODELLING LAYOUT, CATCHMENT PLAN AND RESULTS

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1605687	PS02	R02	PS02-E600	B

DRAWING ID: P1605687-PS02-R02-E600

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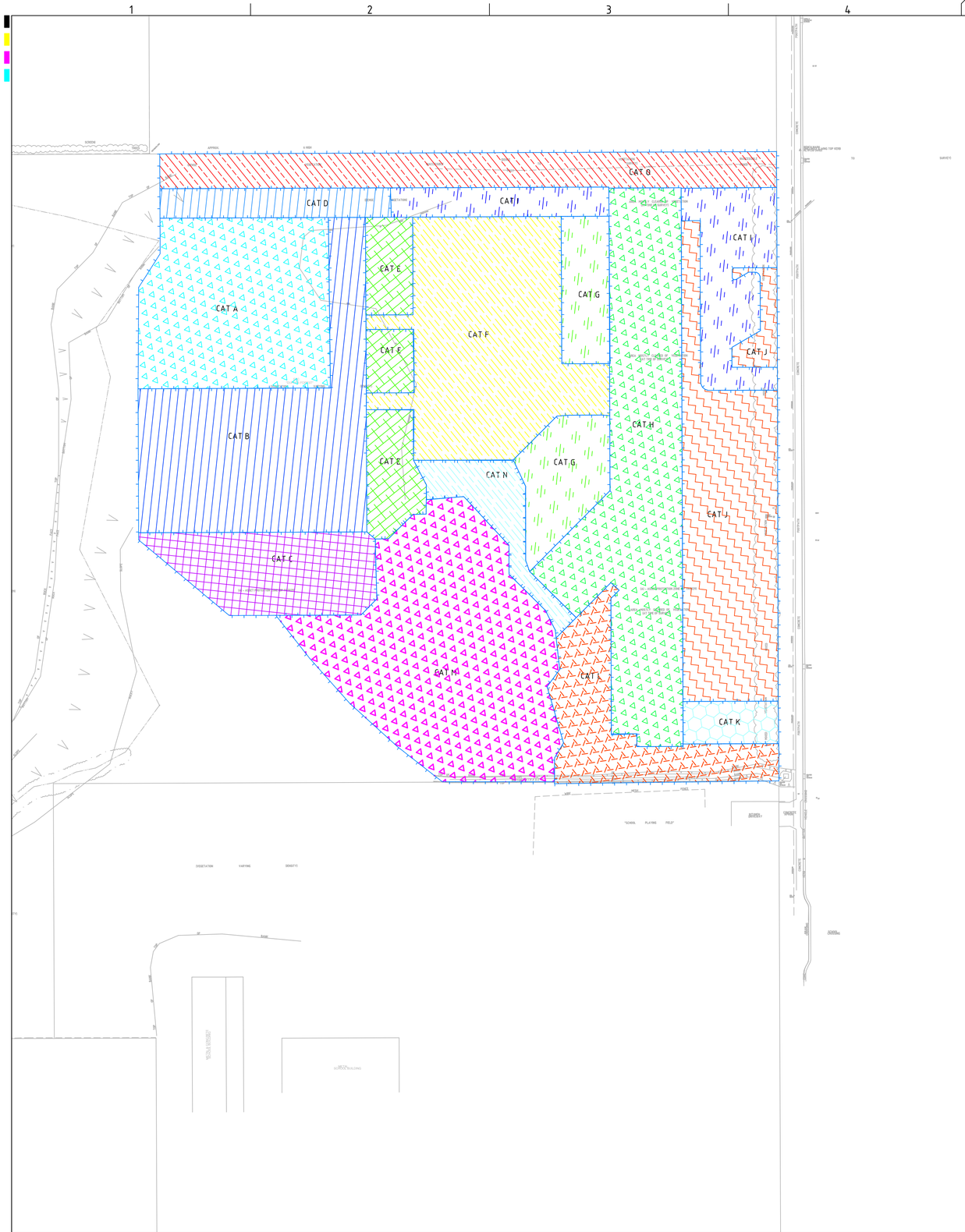
A1 / A3 LANDSCAPE (A1LC_v02.0.01)



KEY	MUSIC NODE	DESCRIPTION	AREA (ha)	% PAVED
	CAT PRE	EXISTING SITE	1.586	0%
		TOTAL AREA	**1.586**	**= 100% OF TOTAL AREA**
		TOTAL IMPERVIOUS AREA	**0.000**	**= %0 OF TOTAL AREA**
		TOTAL PERVIOUS AREA	**1.586**	**= %100 OF TOTAL AREA**

KEY	MUSIC NODE	DESCRIPTION	AREA (ha)	% IMPERVIOUS	MUSIC NODE REFERENCE
	CAT A	DRIVEWAY	0.138	100%	GSLLS MUSIC GUIDE
	CAT B	ROOFS	0.171	100%	GSLLS MUSIC GUIDE
	CAT C	LANDSCAPE	0.071	20%	GSLLS MUSIC GUIDE
	CAT D	DRIVEWAY	0.029	100%	GSLLS MUSIC GUIDE
	CAT E	LANDSCAPE	0.060	50%	GSLLS MUSIC GUIDE
	CAT F	ROOFS	0.170	100%	GSLLS MUSIC GUIDE
	CAT G	LANDSCAPE	0.073	50%	GSLLS MUSIC GUIDE
	CAT H	ROOFS	0.198	100%	GSLLS MUSIC GUIDE
	CAT I	ROAD	0.087	100%	GSLLS MUSIC GUIDE
	CAT J	LANDSCAPE	0.155	20%	GSLLS MUSIC GUIDE
	CAT K	ROAD	0.017	100%	GSLLS MUSIC GUIDE
	CAT L	LANDSCAPE	0.065	20%	GSLLS MUSIC GUIDE
	CAT M	RURAL	0.225	0%	GSLLS MUSIC GUIDE
	CAT N	LANDSCAPE	0.032	20%	GSLLS MUSIC GUIDE
	CAT O	BYPASS	0.095	10%	GSLLS MUSIC GUIDE
		TOTAL AREA	**1.586**	**= 100% OF TOTAL AREA**
		TOTAL IMPERVIOUS AREA	**0.951**	**= %60 OF TOTAL AREA**
		TOTAL PERVIOUS AREA	**0.635**	**= %40 OF TOTAL AREA**

OSD MODEL RESULTS

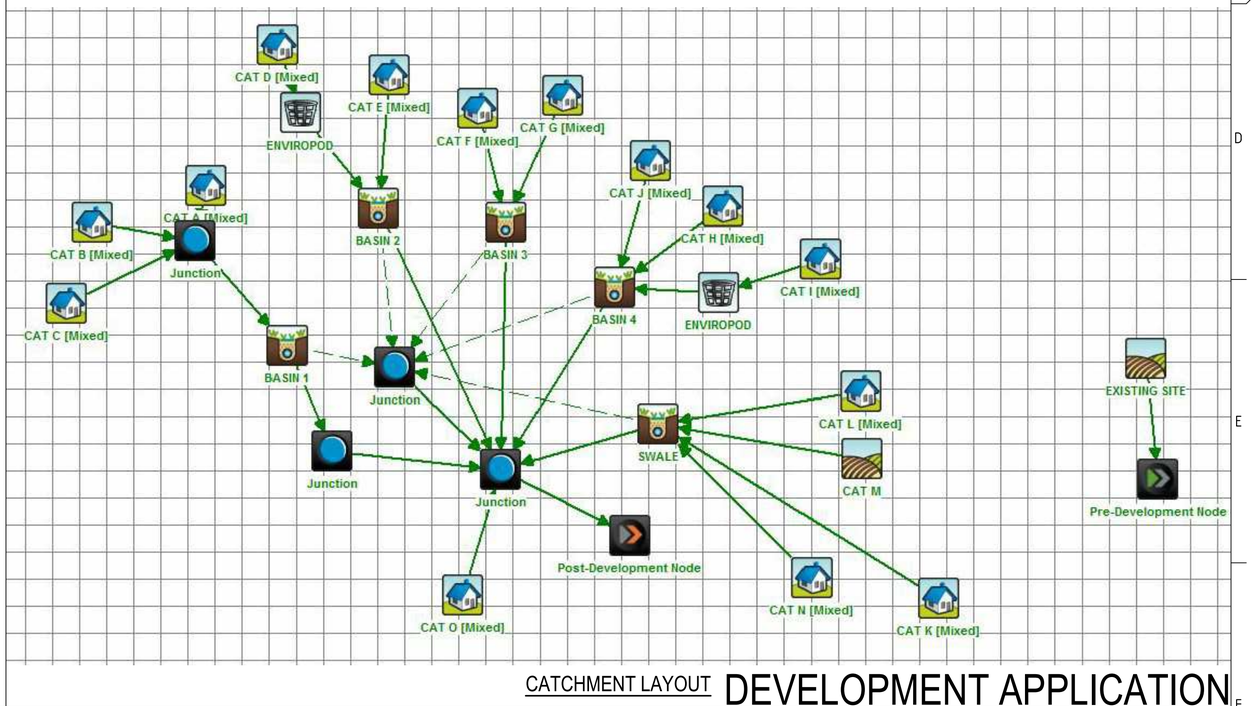
Treatment Train Effectiveness - Post-Development Node

	Sources		Residual Load		% Reduction	
	Pre	Post	Pre	Post	Pre	Post
Flow (ML/yr)	4.61	9.37	4.61	7.56	0	19.3
Total Suspended Solids (kg/yr)	106	1090	106	25.2	0	97.7
Total Phosphorus (kg/yr)	0.491	2.39	0.491	0.482	0	79.8
Total Nitrogen (kg/yr)	5.33	19.5	5.33	4.88	0	75
Gross Pollutants (kg/yr)	0	215	0	0	0	100

Warning - upstream treatment train includes losses

☑ Include Pre-Development

CATCHMENT RESULTS



CATCHMENT LAYOUT

DEVELOPMENT APPLICATION

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SCALE
0 5 10 15 20 25 30 35 40 45 50 METRES
A1 (A3) 1:500 (1:1,000)

GRID	DATUM	PROJECT MANAGER
MGA	mAHD	JF

CLIENT
WYVERN HEALTH P/L C/- BUREAU SRH

PROJECT NAME/PLANSET TITLE
PRIVATE HOSPITAL DEVELOPMENT
CONCEPT STORMWATER MANAGEMENT
4A LAROOL ROAD,
TERREY HILLS NSW

martens & Associates Pty Ltd
Consulting Engineers
Environment
Water
Geotechnical
Civil
Suite 201, 20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767
Email: mail@martens.com.au Internet: www.martens.com.au

DRAWING TITLE
MUSIC MODELLING LAYOUT, CATCHMENT PLAN AND RESULTS

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1605687	PS02	R02	PS02-E700	B

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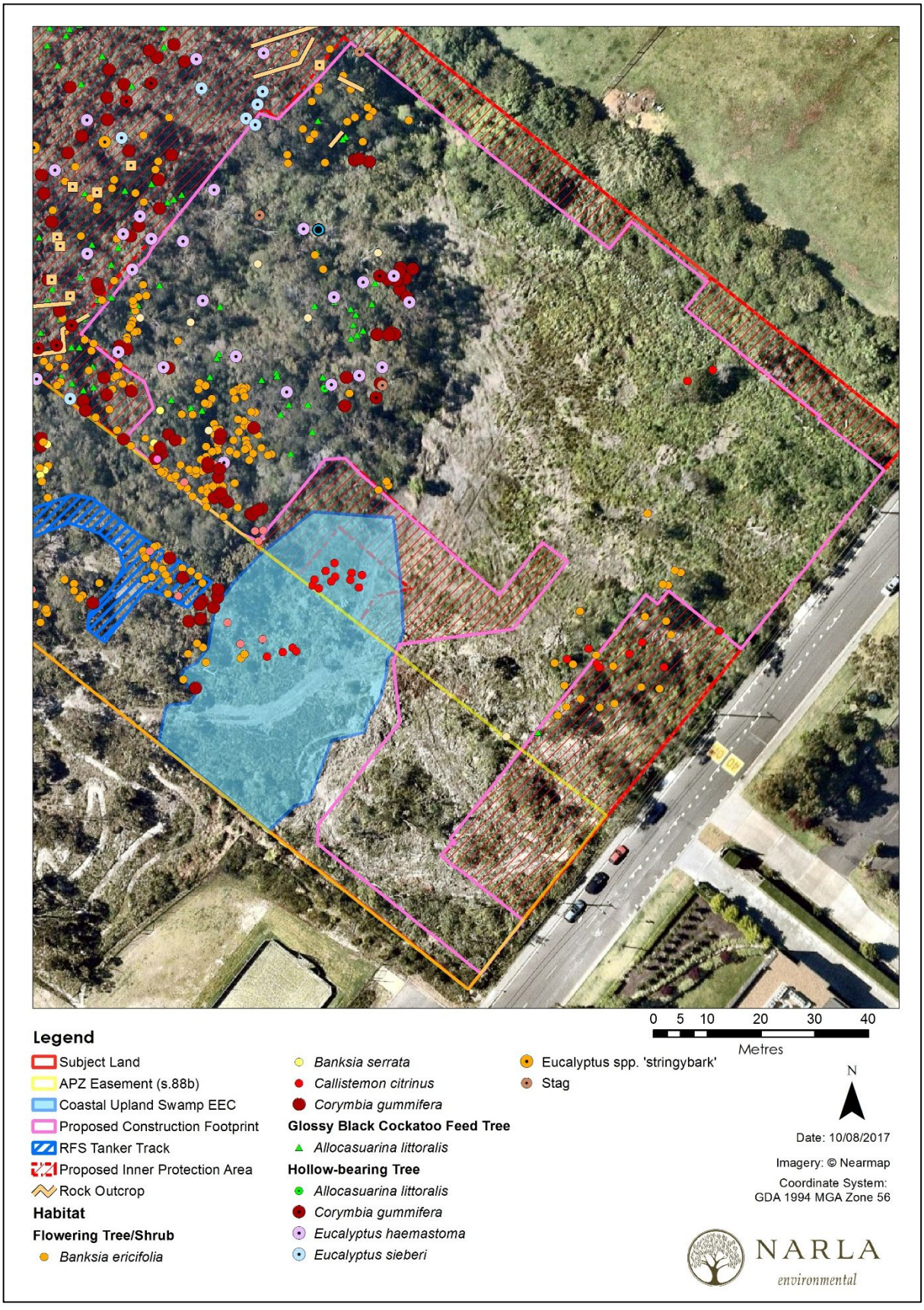
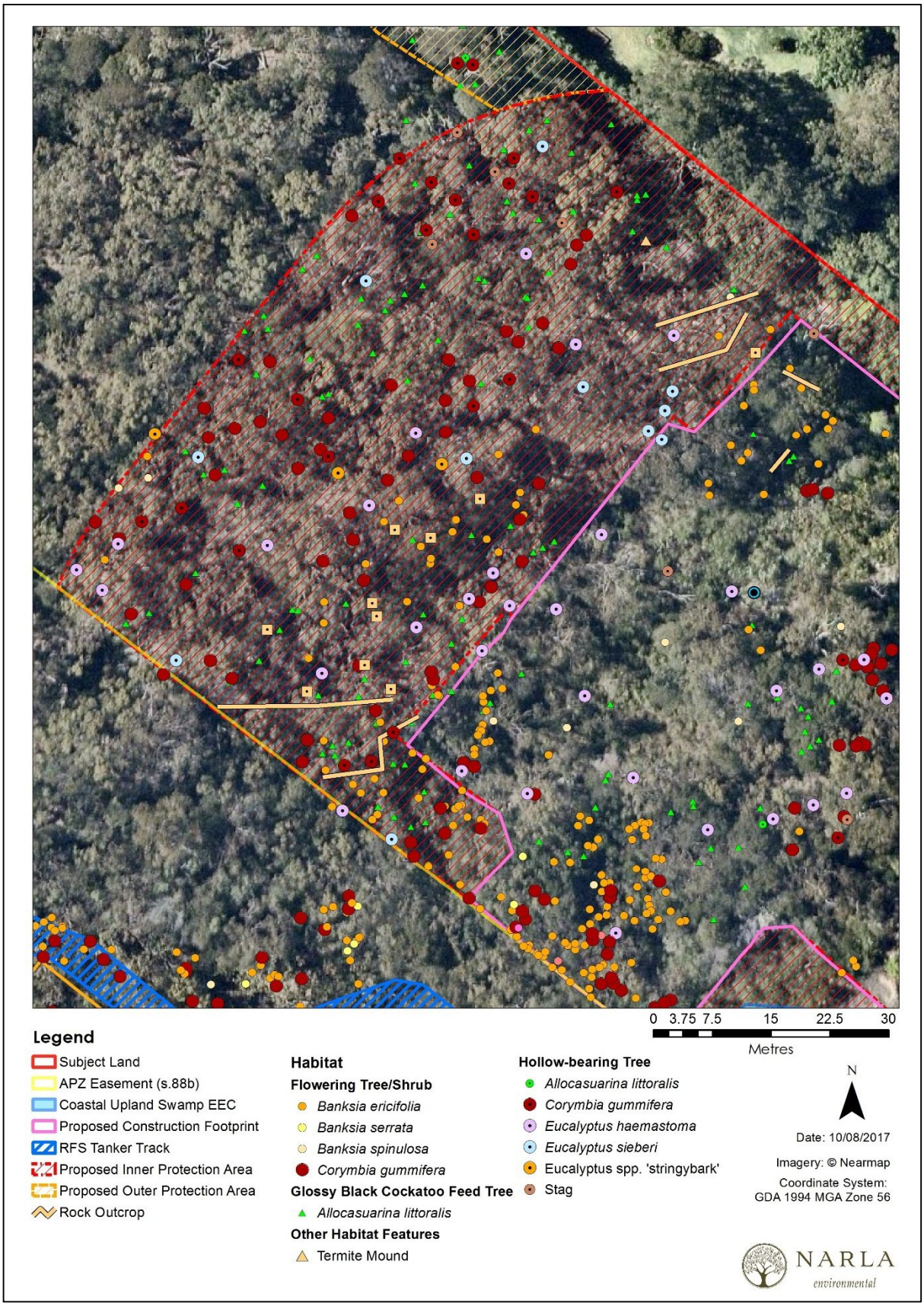
A1 / A3 LANDSCAPE (A1LC_v02.0.01)

Appendix D: Fauna Habitat Features within the Subject Site

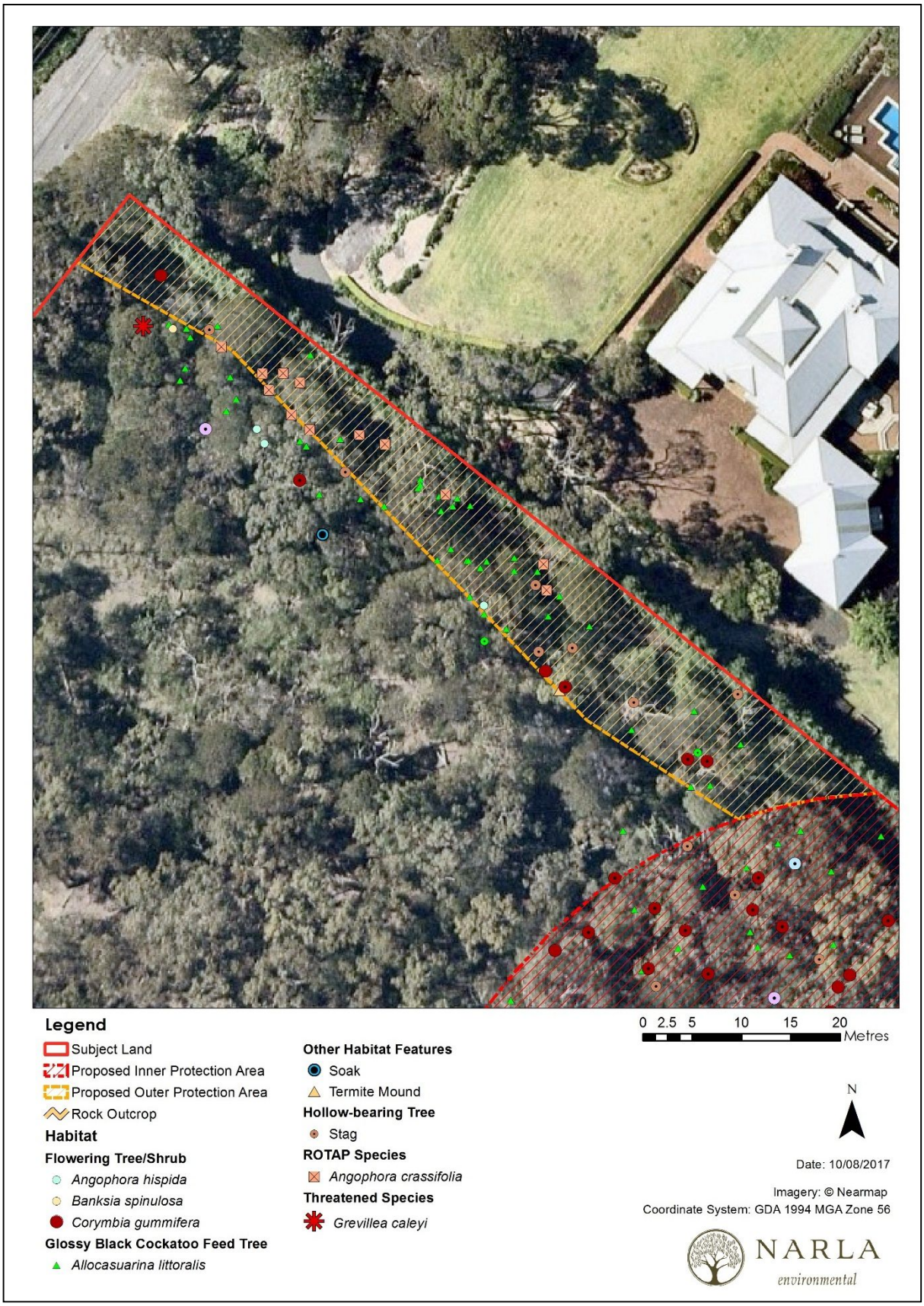
Habitat features identified by Narla within construction footprint



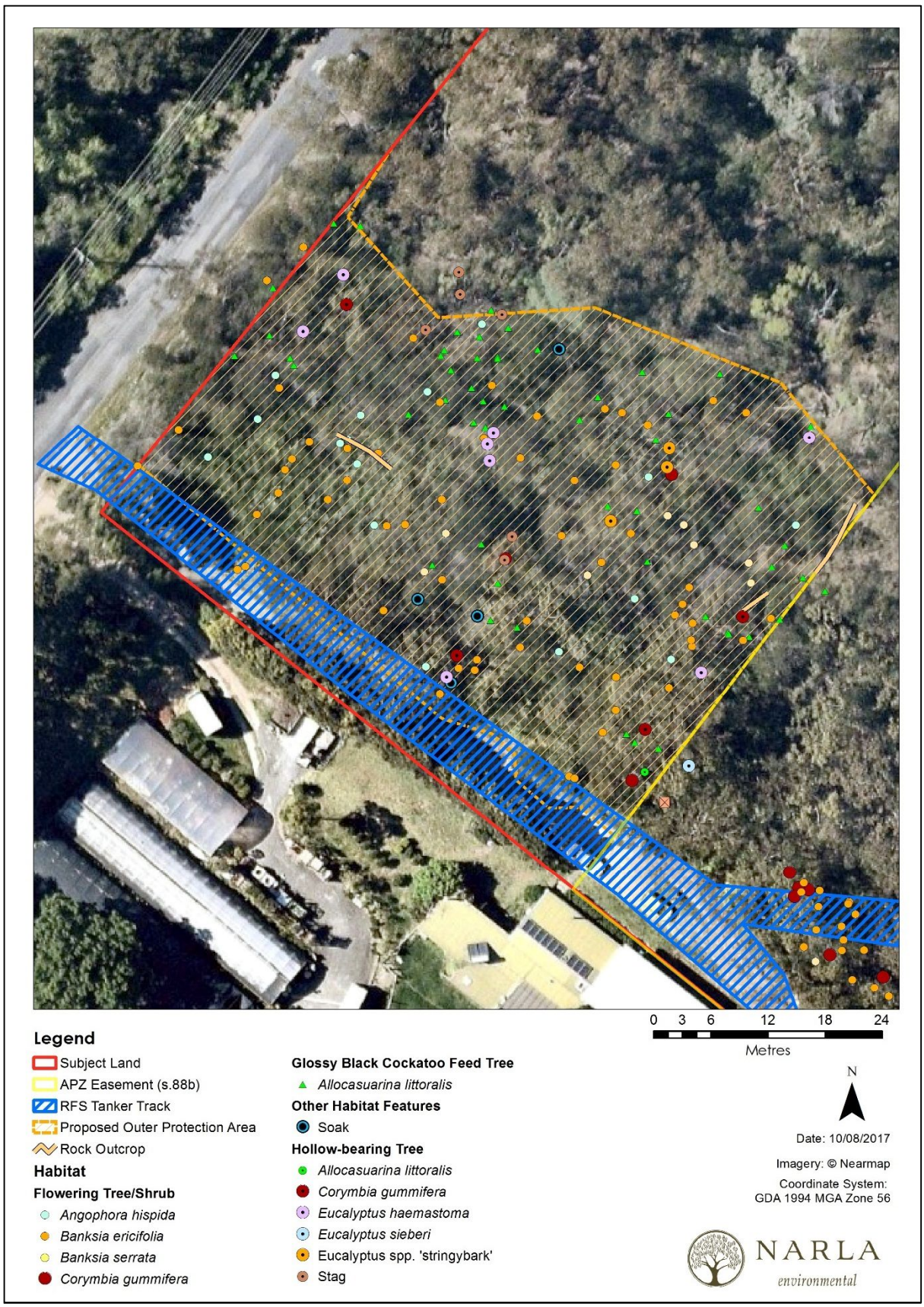
Habitat features identified by Narla within IPA APZ



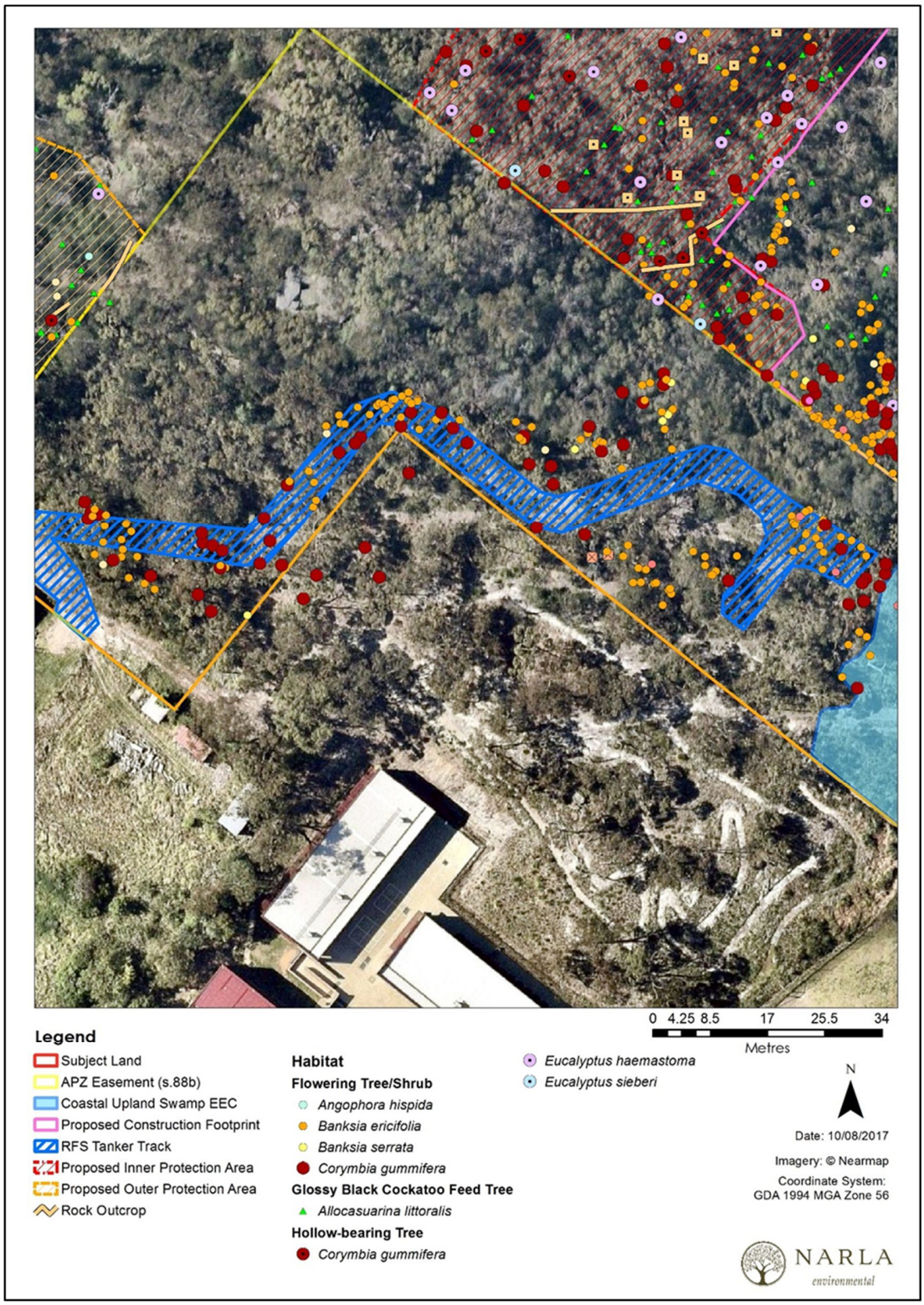
Habitat features identified by Narla within the North-east OPA APZ



Habitat features identified by Narla within the South-west OPA APZ and western end of the Tanker Track



Habitat features identified by Narla within the eastern end of the Tanker Track



Appendix E: Asset Protection Zone Vegetation Management and Replacement Plant Photos

Plate 15. Example of future APZ management photo taken in proposed OPA (south)

Plate 4. As much as possible the proponent will source advanced stock to replace any Eastern Pygmy Possum feed trees lost. This will significantly reduce the duration for flowering to reccommence and continue providing forage for Eastern Pygmy Possum and other wildlife (source Andreasens Green [top]; Gardening with Angus [bottom])

Appendix F: Threatened flora and fauna species with the potential to occur in the subject site

Name	Conservation Status	
	TSC Act	EPBC Act
FAUNA		
Giant Burrowing Frog	V	V
Red-crowned Toadlet	V	-
Rosenberg's Goanna	V	-
White-bellied Sea-Eagle	V	C
Little Eagle	V	-
Square-tailed Kite	V	-
Glossy Black-Cockatoo	V	-
Little Lorikeet	V	-
Swift Parrot	E	CE
Barking Owl	V	-
Powerful Owl	V	-
Masked Owl	V	-
Sooty Owl	V	-
Regent Honeyeater	E	CE
Black-chinned Honeyeater (eastern subspecies)	V	-
Varied Sittella	V	-
Dusky Woodswallow	V	-
Spotted-tailed Quoll	V	E
Southern Brown Bandicoot (eastern)	E	E
Eastern Pygmy-possum	V	-
Squirrel Glider	V	-
Grey-headed Flying-fox	V	V
Yellow-bellied Sheathtail-bat	V	-
Eastern Freetail-bat	V	-
Large-eared Pied Bat	V	V
Little Bentwing-bat	V	-
Eastern Bentwing-bat	V	-
Southern Myotis	V	-
Greater Broad-nosed Bat	V	-

FLORA		
Tetratheca glandulosa	V	-
Epacris purpurascens subsp. purpurascens	V	-
Cryptostylis hunteriana	V	V
Callistemon linearifolius	V	-
Eucalyptus camfieldii	V	V
Genoplesium baueri	E	E
Microtis angusii	E	E
Grevillea caleyi	CE	E
Lasiopetalum joyceae	V	V
Persoonia hirsuta	E	E
Pimelea curviflora subsp. curviflora	V	V

Appendix G: EP&A Act Assessment of Significance

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Eastern Pygmy-possum (*Cercartetus nanus*)	
TSC Act Status: Vulnerable	
Species Ecology	The Eastern Pygmy-possum is found throughout south-eastern Australia. Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. It feed largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. It also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) drays or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks. It is mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 ha and females about 0.35 ha. Young can be born whenever food sources are available; however, most births occur between late spring and early autumn. Frequently spends time in torpor especially in winter, with body curled, ears folded and internal temperature close to the surroundings.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	The proposed action is unlikely to adversely effect upon the life cycle of the Eastern Pygmy-possum. A small area of potential foraging and sheltering habitat for Pygmy Possums (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. Any potential feed trees and shrubs (e.g. *Banksia* spp., *Angophora hispida*, *Callistemon citrinus* and *Corymbia gummifera*) removed from the subject site in order to facilitate the hospital construction will be replaced at a ratio of 3:1 per species. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. All foraging trees and shrubs will be replaced within the subject site to a ratio of 3:1. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. A total of 80 *Banksia ericifolia* and 36 other foraging tree species will be removed from the development footprint. These trees will be replaced at a ratio of 2:1, resulting in the replacement of 240 *Banksia ericifolia* and 108 other foraging tree species within the subject site. According to the Landscape Plan a total of 1160 *Banksia ericifolia* are proposed for planting within the subject site.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Eastern Pygmy-possum (*Cercartetus nanus*)		
TSC Act Status: Vulnerable		
	No effects to Pygmy Possum movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant Eastern Pygmy Possum feed trees. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – this species does not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Eastern Pygmy-possum. A small area of potential foraging and sheltering habitat for Pygmy Possums (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Eastern Pygmy-possum (*Cercartetus nanus*)		
TSC Act Status: Vulnerable		
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	habitat, and 0.13 ha of weed infested habitat. Any potential feed trees and shrubs (e.g. *Banksia* spp., *Angophora hispida, Callistemon citrinus* and *Corymbia gummifera*) removed from the subject site in order to facilitate the hospital construction will be replaced at a ratio of 3:1 per species. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional foraging resources such as banksias to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to Pygmy Possum movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant Eastern Pygmy Possum feed plants. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Eastern Pygmy-possum (*Cercartetus nanus*)	
TSC Act Status: Vulnerable	
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	OEH (2016) outline the following five activities to assist this species: ▪ Control feral predators and rabbits. ▪ Avoid frequent burning of habitat. ▪ Protect habitat in proposed development areas and retain linkages across the broader landscape. ▪ Avoid overgrazing by stock and fire wood collection in areas of heathy understorey vegetation. ▪ Regenerate and replant local feed sources. The complementary BMP (Narla 2017a) provides recommendation for site management aimed at achieving all give of these actions, and thereby enhancing the habitat available within the subject site with the aim of supporting the growth of the current local population. The management of the subject property will ensure that: ▪ Pest fauna across the subject site will be controlled. ▪ Frequent burning of habitat will be prevented. ▪ All linkages between the subject site and the broader landscape will be maintained ▪ The property will not be subject to any grazing or firewood collection. ▪ All local food resources lost will be replaced
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are relevant to the protection of potential Eastern Pygmy Possum habitat within the subject site: 0. Loss of hollow-bearing trees 1. Removal of dead wood and dead trees 2. Predation by the European Red Fox (*Vulpes vulpes*) 3. Predation by the Feral Cat (*Felis catus*) 4. Clearing of native vegetation 5. Infection of native plants by *Phytophthora cinnamomi* (Phytophthora) 6. Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Eastern Pygmy-possum (*Cercartetus nanus*)	
TSC Act Status: Vulnerable	
	Each of these KTPs has been carefully considered within the complementary BMP (Narla 2017a). Key elements are briefly described here: ▪ Hygiene control methods for Phytophthora and Rust should be established and carefully maintained throughout construction and landscaping works; ▪ Exotic predators should be excluded from the subject site; ▪ Removal of nesting and or foraging resources for this species is to be minimised, with post work habitat enhancement methods including installation of nest boxes to a ratio of 2:1 and additional foraging trees and shrubs to a ratio of 3:1.

Conclusion

There will be some potential for effect on the Eastern Pygmy-possum (*Cercartetus nanus*) within the subject site associated with the proposed development; however, this does not constitute a significantly adverse effect upon the species such that a local viable population could be placed at risk of extinction, therefore no Species Impact Statement (SIS) is warranted for this species.

References:

NSW Office of Environment and Heritage (2016) Eastern Pygmy-possum (*Cercartetus nanus*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10604#

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Glossy Black-Cockatoo *(Calyptorhynchus lathami)*	
TSC Act Status: Vulnerable	
Species Ecology	The Glossy Black Cockatoo is uncommon although widely distributed in open forest and woodlands from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW. It feeds almost exclusively on *Casuarina spp.* and *Allocasuarina spp.* seeds, with Black Sheoak (*Allocasuarina littoralis*) and Forest She-oak (*A. torulosa*) particularly important are important food sources. This species, like many large cockatoos requires large hollow-bearing eucalyptus trees within which it nests. In order to be suitable for breeding sites, hollows must have a diameter of >15cm. Breeding takes place between March and May, when a single egg is laid.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	Evidence of Glossy Black-Cockatoos foraging within the subject site was recorded during the survey. There is abundant *Allocasuarina littoralis* on the subject site. It is expected that Glossy Black Cockatoo that reside in the nearby Ku-ring-gai Chase National Park may visit the subject site on occasion for foraging purposes. Permanent residence or breeding on the subject site is highly unlikely. A small area of potential foraging habitat for this species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. A total of 32 potential feed trees and shrubs (*Allocasuarina littoralis*) will be removed from the subject site in order to facilitate the hospital construction. These trees will be replaced at a ratio of 3:1. Where possible, female *Allocasuarina* (cone-bearing) trees will be planted within the landscape design. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Glossy Black-Cockatoo *(Calyptorhynchus lathami)*		
TSC Act Status: Vulnerable		
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – these species do not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Glossy Black-Cockatoo. A small area of potential foraging habitat for this species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. A total of 32 potential feed trees (*Allocasuarina littoralis*) will be removed from the subject site in order to facilitate the hospital construction. These trees will be replaced at a ratio of 3:1. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Glossy Black-Cockatoo *(Calyptorhynchus lathami)*		
TSC Act Status: Vulnerable		
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional foraging resources such as *Allocasuarina littoralis* to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to Glossy Black-Cockatoo movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the species is highly mobile and able to move subject to food availability. The majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant Glossy Black-Cockatoo feed trees. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,		The Glossy Black-Cockatoo Recovery Plan (OEH, 2016) identified seven recovery objectives. Of these three were relevant to the subject site: ▪ Raise public awareness of the importance of large old trees (living and dead), which provide roosting habitat and important hollow resources. Protect large old trees and smaller trees that contain large hollows, including from the effects of fire. Ensure the recruitment of large old trees by retaining medium-sized

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Glossy Black-Cockatoo *(Calyptorhynchus lathami)*	
TSC Act Status: Vulnerable	
	trees, facilitating regeneration, and undertaking replanting. ▪ Identify sites where hollows are limiting and develop and implement strategies to increase hollow availability that have clear objectives and include monitoring, maintenance, and reporting requirements. Actions include nest box installation, the humane control of introduced species, and the protection of trees having the potential to develop hollows. ▪ Increase the quality and extent of foraging habitat within a region. Prevent frequent fire that will result in the elimination of sheoak stands. Manage fire regimes to ensure a mosaic of age classes of important feed species, with a bias toward older age classes (which provide abundant food resources). Encourage the retention of sheoak food species in the understorey, and raise public awareness of the damage caused to food resources by slashing /underscrubbing, fuel reduction burns, and over-grazing The complementary BMP (Narla 2017a) provides recommendation for site management aimed at achieving these actions, thereby enhancing the habitat available within the subject site with the aim of supporting the growth of the current local population. The management of the subject property will ensure that: ▪ Pest fauna across the subject site will be controlled. ▪ Frequent burning of habitat will be prevented. ▪ All linkages between the subject site and the broader landscape will be maintained All *Allocasuarina littoralis* trees lost will be replaced in a ratio of 3:1 within the subject site. Any tree hollows lost will be replaced at a ratio of 2:1 through hollow augmentation.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Glossy Black-Cockatoo *(Calyptorhynchus lathami)*	
TSC Act Status: Vulnerable	
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The Key Threatening Processes relevant to the Glossy Black-Cockatoo within NSW are the following: ▪ Clearing of native vegetation ▪ Loss of hollow-bearing trees ▪ Infection of native plants by Phytophthora cinnamomi ▪ Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants This report and complimentary BMP address all KTPs in detail, ensuring there is no increase in their effect which may result for the proposed development works. Key components include the adoption of a strict hygiene plan to prevent the introduction/ spread of plant viruses and additional landscaping/ vegetation management to enhance existing habitat, and the replacement of native foraging trees lost in a ratio of 3:1 and hollows lost in a ratio of 2:1.

Conclusion

There will be some potential for effect on the Glossy Black-Cockatoo (*Calyptorhynchus lathami*) within the subject site associated with the proposed development; however, this does not constitute a significantly adverse effect upon the species such that a local viable population could be placed at risk of extinction, therefore no Species Impact Statement (SIS) is warranted for this species.

References:

NSW Office of Environment and Heritage (2016) Glossy Black-Cockatoo (*Calyptorhynchus lathami)*– Conservation Projects and Species Profile http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10140

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Heath Monitor / Rosenberg's Goanna (*Varanus rosebergi*)	
TSC Act Status: Vulnerable	
Species Ecology	Rosenberg's Goanna is found in heath open forest and woodland areas which contain termite mounds which the species require for nest sites. Habitat areas are necessarily large, to provide sufficient food resources including carrion, birds, eggs, reptiles and small mammals. It usually shelters in hollow logs, rock crevices and in burrows, which they may dig for themselves, or they may use other species' burrows, such as rabbit warrens. There are numerous records occurring in nearby Kur-ring-gai National park to the west and Garigal National Park to the south. The subject site forms an extension of the available habitat linkage to Ku-ring-gai Chase National Park.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	One Rosenberg's Goanna was opportunistically observed on the subject site in the Sydney Ironstone Bloodwood-Silvertop Ash Forest EEC. Extensive camera trapping across the subject site revealed multiple records of the large, more common Lace Monitor but no additional Rosenberg's Goanna. It is expected that the subject site forms a narrow extension of habitat from the much larger, extensive areas of habitat associated with Ku-ring-gai Chase National Park. Limited breeding habitat occurs on the subject site. The proposed action is unlikely to adversely effect upon the life cycle of the Rosenberg's Goanna. A small area of potential foraging and sheltering habitat for Rosenberg's Goanna (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. No termite mounds, large hollow-logs or caves suitable for breeding will be removed as a result of the construction of the proposed development. Extensive suitable habitat will remain on the subject site as well as in the adjacent Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential foraging and breeding habitat. No adverse effect to Rosenberg's Goanna movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the	Not applicable – this species does not belong to an Endangered Population

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Heath Monitor / Rosenberg's Goanna (*Varanus rosebergi*)		
TSC Act Status: Vulnerable		
endangered population such that a viable local population of the species is likely to be placed at risk of extinction,		
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Rosenberg's Goanna. A small area of potential foraging and sheltering habitat for Rosenberg's Goannas (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. No termite mounds will be removed as a result of the construction of the proposed development. Extensive suitable habitat will remain on the subject site, as well as connectivity with the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. Extensive suitable habitat will remain on the subject site, as well as connectivity with the adjoining Ku-

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Heath Monitor / Rosenberg's Goanna (*Varanus rosebergi*)		
TSC Act Status: Vulnerable		
		ring-gai Chase National Park, which provides approximately 150km² of potential habitat. No effects to Rosenberg's Goanna movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat lost is only likely to form intermittent foraging habitat for the species. This small amount of remnant habitat lost will be replaced through indigenous landscaping, revegetation and weed removal across the subject site. Extensive suitable habitat will remain on the subject site, as well as connectivity with the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km2 of potential habitat. Furthermore, all important microhabitats including caves, termite mounds and large hollow-logs will be protected or relocated on site for potential continued use by Rosenberg's Goanna.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,		Management Objectives and the devised actions for the Conservation of the Rosenberg's Goanna focus on the protection of wild populations, allowing for the retention or extension of existing ranges. Key Actions include: ▪ Retention of fallen timber, bush rock and termite mounds. ▪ Increasing community awareness of key habitat components (as listed above) and for the risk of collision to motorists i.e. through the installation of road signage

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Heath Monitor / Rosenberg's Goanna (*Varanus rosebergi*)	
TSC Act Status: Vulnerable	
	The development of the complementary BMP (Narla 2016) will provide detailed direction for the execution of these activities within the subject site.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are relevant to the protection of potential Rosenberg's Goanna habitat within the subject site: ▪ Removal of dead wood and dead trees ▪ Predation by the Feral Cat (*Felis catus*) ▪ Clearing of native vegetation Within the scope of the proposed action none of these KTPs are considered likely to be exacerbated. These KTP will all be managed through implementation of the recommendations of Flora and Fauna Report, and the BMP. Landscaping around the proposed buildings should support the continued potential for Rosenberg's Goannas in the area by providing suitable shelter opportunities.
Conclusion Although a small amount of potential foraging habitat will be removed, this does not pose a significant effect on the Rosenberg's Goanna (*Varanus rosenbergi*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	
References: NSW Office of Environment and Heritage (2015) Rosenberg's Goanna (*Varanus rosenbergi*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10826 NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Square-tailed Kite (*Lophoictinia isura*)	
TSC Act Status: Vulnerable	
Species Ecology	The Square-tailed Kite is found in a range of timbered habitats including dry woodlands and open forests, displaying a particular preference for watercourses with dense tree cover. Its range includes coastal and subcoastal areas from south-western to northern Australia, NSW, Queensland and Victoria, In NSW scattered records suggest the species is a consistent resident; however, in other areas further south it is migratory returning to areas for summer breeding. The Square-tailed Kite is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage. Individuals will often occupy large hunting ranges of more than 100m^2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	One Square-tailed Kite was observed flying over the subject site whilst site surveys were being undertaken. This may indicate that the bird intermittently passes through the area, and may utilise the site as a hunting ground. Potential breeding habitat exists in the form of tall forest trees, particularly in the Duffy's Forest area however this area is small and the chance of Square-tailed Kite pairing and nesting in this area is low considering the extensive suitable habitat and taller forests that exist in the surrounding area, including Ku-ring-gai Chase NP and Garigal NP. A small area of potential foraging habitat for the species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. All potential nesting trees within the APZ areas will be retained unaffected by the proposed development. The majority of habitat within the site that supports favourable prey items such as honeyeaters and smaller bird species will be protected. the foraging and perch potential within the site will be maintained. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Square-tailed Kite (*Lophoictinia isura*)		
TSC Act Status: Vulnerable		
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – this species does not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Square-tailed Kite. A small area of potential foraging habitat for this species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This includes large remnant trees suitable for this species to perch on for foraging and shelter. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Square-tailed Kite (*Lophoictinia isura*)		
TSC Act Status: Vulnerable		
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	Park, which provides approximately 150km^2 of potential habitat. ii) This bird is highly mobile and able to travel long distances over unsuitable habitat. It has been known to forage in towns and suburbs, therefore connectivity is not important. All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional habitat trees to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. No effects to Square-tailed Kite movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the species is highly mobile and able to move subject to food availability. The majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This small area of land is insignificant to the on-going existence of the species.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,		The Square-tailed Kite Recovery Plan (OEH, 2016) identified three recovery objectives. These objectives include: ▪ Protect known habitat from fires of a frequency greater than that

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Square-tailed Kite (*Lophoictinia isura*)	
TSC Act Status: Vulnerable	
	recommended for the retention of biodiversity. ▪ Retain and protect nesting and foraging habitat, particularly along watercourses. ▪ Report suspected illegal bird shooting and egg-collecting to DEC. The complementary BMP (Narla 2016) provides detailed direction for the restoration of any vegetation lost from the construction footprint, and protection of suitable nest trees within APZ areas and all areas of remnant bushland remaining on the subject site. Frequent burning of habitat will be prevented.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are relevant to the protection of potential Square-tailed Kite habitat within the subject site: ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Clearing of native vegetation Fire prevention management will continue to occur within the site. Landscaping around the proposed buildings should further support the inhabitation of prey bird species within the subject site. The complimentary BMP (Narla 2016) provides more detail on landscaping and bushfire management. Provided these recommendations of the Flora and Fauna Assessment and BMP are adhered to, no effect caused by the proposed action should increase the operation of any KTPs on the Square-tailed Kite.
Conclusion There will be no significant effect on the Square-tailed Kite (*Lophoictinia isura*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	
References: NSW Office of Environment and Heritage (2014) Square-tailed Kite (*Lophoictinia isura*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10495 NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	
TSC Act Status: Vulnerable	
Species Ecology	The Eastern bent-wing bat is found along the entire east coast of Australia. It has a dark reddish brown to dark brown fur with lighter fur on the belly and are almost double the size of the Little bent-wing bat, with a weight of 10 – 20 grams. The Eastern bent-wing is also predominantly a cave dweller but has been also known to roost in urban structures. The species form discrete populations that are centred on a maternity cave, however outside of breeding season individuals may disperse as far as 300 km. Breeding or roosting colonies can number from 100 to 150,000 individuals. Maternity caves have very specific temperature and humidity regimes. The species forages over a wide range, and individuals have been tracked flying up to 65 km in a night. Diet consists mainly of moths with a few flies, cockroaches and beetles. The species flies very fast in the upper levels of the tree canopy or just above it. In open areas, it often flies just a few metres above the ground. The echolocation call has a frequency between 40 and 45 kHz.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	A number of passive acoustic traces were recorded of the Eastern Bent-wing Bat, indicating that the species may forage within the subject site. The proposed action is unlikely to adversely effect upon the life cycle of the Eastern Bent-wing Bat. A small area of potential foraging habitat for Eastern Bent-wing Bats (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. All caves and rock crevices found within the sandstone outcropping will be retained on the subject site for use by this species for shelter and breeding. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. No effects to Eastern Bent-wing Bat movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)		
TSC Act Status: Vulnerable		
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – these species do not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – these species do not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Eastern Bent-wing Bat. Throughout and post the proposed development all suitable habitat within sandstone outcropping and rocky crevices for the Eastern bent-wing Bat will be retained and protected on site. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. The construction of the hospital may provide some disturbance to foraging bats through noise and light pollution. Noise however will largely be confined within daylight hours. The hospital itself will contain lights however the lighting will not
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)		
TSC Act Status: Vulnerable		
		constitute a significant increase upon the ambient, artificial lighting already present in the area on a nightly basis (buildings and streetlights). It is relevant to note that additional light can attract insects, which are prey items for this species. Extensive suitable foraging and sheltering habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to Eastern Bent-wing Bat movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. As this species is highly mobile; it is likely the species is already traversing through the local suburban environment to access larger habitat areas in nearby Kur-ring-gai and Garigal National Parks where the species has been frequently recorded. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	
TSC Act Status: Vulnerable	
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	The mitigation measures outlined within the BMP (Narla 2017a) have been development in line with OEH (2016) conservation actions for this species. These include: ▪ Control foxes and feral cats around roosting sites, particularly maternity caves. ▪ Retain native vegetation around roost sites, particularly within 300 m of maternity caves. ▪ Minimise the use of pesticides in foraging areas. ▪ Protect roosting sites from damage or disturbance. The complementary BMP (Narla 2017a) provides recommendation for site management aimed at achieving all give of these actions. The management of the subject property will ensure that: ▪ Pest fauna across the subject site will be controlled. ▪ Vegetation surrounding the caves within the sandstone outcropping will be either retained or replaced at a ratio of 3:1. ▪ A qualified Ecologist will be onsite during the clearing of vegetation and will advise the best course of action of roost sites are discovered during the clearing works.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are relevant to the protection of potential Eastern bent-wing Bat habitat within the subject site: ▪ Loss of hollow-bearing trees ▪ Clearing of native vegetation ▪ Removal of dead wood and dead trees ▪ Predation by the European Red Fox *Vulpes vulpes* ▪ Predation by the Feral Cat *Felis catus* Under the provision that the mitigation recommendations outlined in this report and the BMP are followed, the proposed action is considered unlikely to cause a significant adverse effect on the Eastern Bent-wing Bat. These mitigation actions include, habitat enhancement through maximum tree/ native vegetation

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	
TSC Act Status: Vulnerable	
	retention and bush management, plus application of cat/ fox exclusion mechanism.

Conclusion

There will be no significant effect on any of the Eastern Bent-wing Bat therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).

References:

NSW Office of Environment and Heritage (2016) Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10534

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)	
TSC Act Status: Vulnerable	
Species Ecology	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia however is rarely observed within the Sydney region. It forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. It roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. Breeding has been recorded from December to mid-March, when A single young is born. Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	One fragmented, passive acoustic trace was recorded that was tentatively identified as a Yellow-bellied Sheathtail Bat (T. Pearson 2016). The single trace indicates that the bat would have just been passing overhead, not roosting or hunting in the immediate vicinity (T. Pearson 2016). Only a single record of the species has been reported to the NSW Wildlife Atlas from within the 10km range of the subject site. This record had low spatial accuracy ~2250m, indicating that a local population of this bat is unlikely to occur on the subject site. The proposed action is unlikely to adversely effect upon the life cycle of the Yellow-bellied Sheathtail Bat. A small area of potential foraging and sheltering habitat for the species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. All caves and rock crevices found within the sandstone outcropping will be retained on the subject site for use by this species for shelter and breeding. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. No effects to Yellow-bellied Sheathtail Bat movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)		
TSC Act Status: Vulnerable		
	The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – the species do not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – the species do not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Yellow-bellied Sheathtail Bat. Throughout and post the proposed development all suitable habitat within sandstone outcropping and rocky crevices for the Yellow-bellied Sheathtail Bat will be retained and protected on site. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)		
TSC Act Status: Vulnerable		
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. The construction of the hospital may provide some disturbance to foraging bats through noise and light pollution. Noise however will largely be confined within daylight hours and additional light can attract additional insects, which are prey items for this species. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to Yellow-bellied Sheathtail Bat movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. As this species is highly mobile; it is likely the species is already traversing through the local suburban environment to access larger habitat areas in nearby Kur-ring-gai and Garigal National Parks where the species has been frequently recorded. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)	
TSC Act Status: Vulnerable	
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	The mitigation measures outlined within the BMP (Narla 2017a) have been development in line with OEH (2016) conservation actions for this species. These include: ▪ Revegetation which focuses on expanding existing smaller areas of suitable habitat and connecting areas of suitable habitat to create corridors for movement. ▪ Retention of stands of native vegetation, especially those with hollow-bearing trees (including dead trees), and retain other structures containing bats. ▪ Retain a buffer of vegetation around potential roost sites in vegetated areas ▪ Minimizing the use of pesticides within the subject site ▪ Encouraging regeneration and replanting of local flora species to maintain bat foraging habitat. The management of the subject property will ensure that: ▪ Revegetation on the subject site will occur with the aim of replacing vegetation lost with locally indigenous native plants. This includes the replacement of foraging trees at a ratio of 3:1 and replacement of hollows lost with the implementation of nest boxes at a ratio of 2:1. ▪ Vegetation surrounding the caves within the sandstone outcropping will be either retained or replaced at a ratio of 3:1. ▪ A qualified Ecologist will be onsite during the clearing of vegetation and will advise the best course of action of roost sites are discovered during the clearing works.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are relevant to the protection of potential Yellow-bellied Sheathtail Bat habitat within the subject site : ▪ Loss of hollow-bearing trees ▪ Clearing of native vegetation ▪ Removal of dead wood and dead trees ▪ Infection of native plants by *Phytophthora cinnamomi*

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)	
TSC Act Status: Vulnerable	
	Under the provision that the mitigation recommendations outlined in this report and the BMP are followed, the proposed action is considered unlikely to cause a significant adverse effect on Yellow-bellied Sheathtail Bats. These mitigation actions include hygiene protocols, habitat enhancement through maximum tree/ native vegetation retention and bush management, plus supplementary habitat in the form of nest boxes.

Conclusion

There will be no significant effect on any of the Yellow-bellied Sheathtailed Bat therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).

References:

NSW Office of Environment and Heritage (2016) Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10741

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Grey-headed Flying-Fox (*Pteropus poliocephalus*)	
TSC Act Status: Vulnerable	
Species Ecology	Grey-headed Flying-fox forage opportunistically, often at distances up to 30 km from camps, and occasionally up to 60-70 km per night, in response to patchy food resources. This species is a canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, open forests, woodlands, Melaleuca swamps and Banksia woodlands. As such, it plays an important ecosystem function by providing a means of seed dispersal and pollination for many indigenous tree species. Grey-headed Flying-foxes also feed on introduced trees including commercial fruit crops. Grey-headed Flying-foxes congregate in large numbers at roosting sites (camps) that may be found in rainforest patches, Melaleuca stands, mangroves, riparian woodland or modified vegetation in urban areas. Individuals generally exhibit a high fidelity to traditional camps and return annually to give birth and rear offspring. Grey-headed Flying-foxes show a regular pattern of seasonal movement. Much of the population concentrates in May and June in northern NSW and Queensland where animals exploit winter-flowering trees such as Swamp Mahogany *Eucalyptus robusta*, Forest Red Gum *E. tereticornis* and Paperbark *Melaleuca quinquenervia*.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	At the time of preparing this report there were no known roosts or camps of Grey-headed Flying-fox within the subject site or in the surrounding area. However, a small number of Grey-Headed Flying Foxes intermittently utilise the subject site to forage in fruiting trees or during periods of flowing in the *Banksia sp.,* Red Bloodwoods and other *Eucalyptus* spp. trees. The proposed action is unlikely to adversely effect upon the life cycle of the Grey-headed Flying-fox. A small area of potential foraging and sheltering habitat for Grey-headed Flying-fox (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. Any potential feed trees and shrubs (e.g. *Banksia* spp., *Angophora hispida, Callistemon citrinus* and *Corymbia gummifera*) removed from the subject site in order to facilitate the hospital construction will be replaced at a ratio of 3:1 per species. A total of 80 *Banksia ericifolia* and 36 other foraging tree species will be removed from the development footprint. These trees will be replaced at a ratio of 2:1, resulting in the replacement of 240 *Banksia ericifolia* and 108 other foraging tree species within the subject site. According to the Landscape Plan a total of 1160 *Banksia ericifolia* are proposed for planting within the subject site. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Grey-headed Flying-Fox (*Pteropus poliocephalus*)		
TSC Act Status: Vulnerable		
	All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. No effects to Grey-headed Flying-fox movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant Grey-headed Flying-fox feed trees. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable –species does not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Grey-headed Flying-fox. A small area of potential foraging and sheltering habitat for Grey-headed Flying-fox (0.5 ha) will be

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Grey-headed Flying-Fox (*Pteropus poliocephalus*)		
TSC Act Status: Vulnerable		
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. Any potential feed trees and shrubs (e.g. *Banksia* spp., *Angophora hispida*, *Callistemon citrinus* and *Corymbia gummifera*) removed from the subject site in order to facilitate the hospital construction will be replaced at a ratio of 3:1 per species. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional foraging resources such as flowering *Eucalyptus* spp., to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Habitat connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to Grey-headed Flying-fox movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant Grey-headed Flying-fox feed trees. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Grey-headed Flying-Fox (*Pteropus poliocephalus*)	
TSC Act Status: Vulnerable	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),	Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan	OEH (2006) has listed priority actions to help recover the Grey-headed Flying-fox. Including the following: ▪ Increase the extent and viability of foraging habitat for the Grey-headed Flying-fox that is productive during winter and spring through dedicated habitat creation and restoration using guides published by OEH (in preparation). ▪ Negotiate agreements with landholders, particularly in-perpetuity covenants or stewardship agreements that promote the protection and retention of high quality foraging habitat and roost sites for grey-headed flying-foxes. ▪ Planting new roost trees, managing understorey vegetation to maintain suitable microclimate conditions, establishing buffers between roost camps and nearby human settlements to minimise conflict The proposed action will function to protect the quality bushland patch which contains potential foraging resources for this species, ensuring the area remains intact. Furthermore, the application of the BMP (Narla 2017a) will aim to enhance habitat by managing understorey vegetation and assisting increased recruitment of canopy species through active removal of weeds.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The Key Threatening Processes (KTP) of relevance to Grey-headed Flying-Fox are: ▪ Clearing of native vegetation ▪ Predation by the European red fox (*Vulpes vulpes*) ▪ Predation by the feral cat (*Felis catus*) It is recommended that foraging and habitat trees be replaced at a ratio of 3:1. A total of 80 *Banksia ericifolia* and 36 other foraging tree species will be removed from the development footprint. These trees will be replaced at a ratio of 2:1, resulting in the replacement of 240 *Banksia ericifolia* and 108 other foraging tree species within the subject site. According to the Landscape Plan a total of 1160

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Grey-headed Flying-Fox (*Pteropus poliocephalus*)	
TSC Act Status: Vulnerable	
	Banksia ericifolia are proposed for planting within the subject site. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. The proposed action is unlikely to increase the risk of predation of Grey-headed Flying-foxes by exotic carnivores.

Conclusion

There will be no significant effect on the Grey-headed Flying Fox, therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).

References

NSW Office of Environment and Heritage (2016) Grey-headed Flying-fox (*Pteropus poliocephalus*) – Species Conservation Project http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10697

NSW Government (2016) NSW Legislation: Threatened Species Conservation act 1995 No 101, Section 3: Key Threatening Processes http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Giant Burrowing Frog (*Heleioporus australiacus*)	
TSC Act Status: Vulnerable	
Species Ecology	The Giant Burrowing Frog is distributed in south eastern NSW, and appears to exist as two distinct populations: a northern population largely confined to the sandstone geology of the Sydney Basin and extending as far south as Ulladulla, and a southern population occurring from north of Narooma through to Walhalla, Victoria. It is found in heath, woodland and open dry sclerophyll forest and notably within upland swamp community. It's associated with a variety of soil types, except those which are clay based as it spends much of the year buried within soil and/or leaf litter. Individuals are long-lived (up to 10 years), and highly territorial occupying a home range of approximately 0.04 ha. Within this range giant Burrowing Frogs with spend 95% of the time in non-breeding habitat, where they remain buried. Breeding takes place in soaks or pools within first order streams, and is apparently the only time when female and males occur together. Breeding mainly occurs in Autumn; however, calling may follow heavy rainfall events throughout the year. The Giant Burrowing Frog has a generalist diet and studies to date indicate that they eat mainly invertebrates including ants, beetles, cockroaches, spiders, centipedes and scorpions.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	No Giant Burrowing frogs were encountered within the subject site during targeted surveys and no records of the species were found within dispersal range during Bionet searches despite records existing with nearby Kur-ring-gai and Garigal National Parks. Despite this Giant burrowing frogs are known to inhabit Coastal Upland Swamp which has been confirmed within the subject site. As the species can remain buried for long periods of time it is plausible that the species may be present within the area but avoided detection. The proposed action is unlikely to adversely effect upon the life cycle of the Giant Burrowing Frog. A small area of potential foraging and sheltering habitat for the species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. A total of one soak will be removed from the subject site in order to facilitate the hospital construction. This soak will be replaced elsewhere on the subject site through the implementation of the Onsite Stormwater Drainage system (OSD) outlined in the complementary BMP (Narla 2017a). All additional soaks located within the APZ areas will be retained un effected by the proposed development. No effects to Giant Burrowing Frog movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Giant Burrowing Frog (*Heleioporus australiacus*)		
TSC Act Status: Vulnerable		
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – the species does not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – the species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Giant Burrowing Frog. A small area of potential foraging and sheltering habitat for the species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. Only one soak will be lost as a result of the proposed construction; however, a number of other soaks were recorded on site which can be utilised as potential habitat for this species. This soak will be replaced elsewhere on the subject site through the implementation of the Onsite Stormwater Drainage system (OSD) outlined in the complementary BMP (Narla 2017a). Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Giant Burrowing Frog (*Heleioporus australiacus*)		
TSC Act Status: Vulnerable		
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional augmented soaks to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to the movement of the species across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,		The mitigation measures outlined within the BMP (Narla 2017a) have been development in line with OEH (2015) conservation actions. These include: ▪ Utilising an urban water-sensitive design which adheres to Council Guidelines (Warringah Council 2004). ▪ Ensuring appropriate hygiene protocols are upheld for construction personnel and others traversing the site The complementary BMP (Narla 2017a) provides recommendation for site management aimed at achieving all give of these actions. It is recommended the OSD adheres to Warringah Council Guidelines. Surveys have been conducted

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Giant Burrowing Frog (*Heleioporus australiacus*)	
TSC Act Status: Vulnerable	
	on site and revealed no evidence of this species on the site.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are relevant to the protection of potential Giant Burrowing Frog habitat within the subject site: ▪ Infection of frogs by amphibian chytrid causing the disease *chytridiomycosis* ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plant ▪ Clearing of native vegetation ▪ Predation by the European Red Fox *Vulpes vulpes* ▪ Predation by the Feral Cat *Felis catus* Within the scope of the proposed action these KTPs are considered unlikely to be exacerbated. Landscaping around the proposed buildings should support the continued potential for Giant Burrowing Frogs and will be enhanced through the installation of raingardens expanding existing habitat area. A strict hygiene protocol must be established and maintained by all workers within the subject site and at all times, particularly any bush management contractors undertaking works within potential habitat areas. Post construction, exclusion of cats and foxes is proposed.

Conclusion

There will be no significant effect on the Giant Burrowing Frog (*Heleioporus australiacus*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).

References:

NSW Office of Environment and Heritage (2015) Giant Burrowing Frog (*Heleioporus australiacus*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10398

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Red-crowned Toadlet (*Pseudophryne australis*)	
TSC Act Status: Vulnerable	
Species Ecology	The Red-crowned Toadlet has a restricted distribution. It is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains. It occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Within these areas, it inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or capping. It shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Breeding congregations occur in dense vegetation and debris beside ephemeral creeks and gutters. Red-crowned Toadlet has not been recorded breeding in waters that are even mildly polluted or with a pH outside the range 5.5 to 6.5. Eggs are laid in moist leaf litter, from where they are washed by heavy rain; a large proportion of the development of the tadpoles takes place in the egg. Disperses outside the breeding period, when they are found under rocks and logs on sandstone ridges and forage amongst leaf-litter. Red-crowned Toadlet is usually found in small colonies scattered along ridges coinciding with the positions of suitable refuges near breeding sites. Due to this tendency for discrete populations to concentrate at particular sites, a relatively small localised disturbance may have a significant effect on a local population if it occurs on a favoured breeding or refuge site.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	Multiple targeted surveys undertaken at different times of year, following rain events and using call playback found no evidence of Red-crowned Toadlets inhabiting the subject site. A small area of potential foraging and sheltering habitat for Red-crowned Toadlet (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. The proposed development will aim to retain and protect potentially suitable habitat within remnant bushland, notably including the area containing Coastal Upland Swamp. Habitat creation is also proposed through the incorporation of raingardens which will mimic a natural coastal upland wet swamp vegetation community. As no population is likely to currently inhabit the subject site and existing habitat is to be retained, protected and ideally enhanced the proposed development is not anticipated to cause an adverse effect upon the viability of this species in the locality.
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species	Not applicable – this species does not belong to an Endangered Population

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Red-crowned Toadlet (*Pseudophryne australis*)		
TSC Act Status: Vulnerable		
that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,		
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Red-crowned Toadlet. A small area of potential foraging and sheltering habitat for the species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. One soak will be lost as a result of the proposed construction; however, a number of other soaks will remain on the subject site which can be utilised as potential habitat for this species. Furthermore, suitable wetland habitat will be replaced through the creation of 'raingardens' around OSD areas and the engineering of natural 'stream banks' containing pools and soaks around artificial drainage lines. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional augmented soaks to increase habitat and connectivity across the site.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Red-crowned Toadlet (*Pseudophryne australis*)	
TSC Act Status: Vulnerable	
	The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to Red-crowned Toadlet movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. Suitable soak/wetland habitat will be replaced through the creation of 'raingardens' around OSD areas and the engineering of natural 'stream banks' around artificial drainage lines.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),	Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	OEH (2012) outlines the following conservation actions relevant to the species within the subject site:- ▪ Apply mosaic pattern hazard reduction techniques. ▪ Retain and protect habitat and buffers around habitat, particularly vegetation on upper slopes and ridges. ▪ Protect water quality and maintain natural water flows in drainage lines below developed ridges. ▪ Do not remove sandstone rock from bushland in escarpment areas The proposed development is consistent with these actions. A summary is provided; however, for more detail refer to the complementary BMP (Narla 2017a). APZ management has been developed to simultaneously achieve biodiversity enhancement and safety requirements. Coastal Upland Swamp EEC will be retained and protected with a

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Red-crowned Toadlet (*Pseudophryne australis*)	
TSC Act Status: Vulnerable	
	surrounding buffer zone. Project hydrologists have developed plans to create near nature flow regimes within the subject site (Martens 2017a; 2017b). Habitat within the upper escarpment will be retained and protected, including the natural rock present within this area. As detailed in the BMP.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are relevant to the protection of Red-crowned Toadlets within the subject site: ▪ Clearing of native vegetation ▪ Infection of frogs by amphibian chytrid causing the disease *chytridiomycosis* ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plant ▪ Predation by the European Red Fox *Vulpes vulpes* ▪ Predation by the Feral Cat *Felis catus* A complementary BMP (Narla 2017a) has been created to ensure that none of these KTPs are exacerbated, and aims to guide potential easing of their action within the subject site. Key elements are summarised below. Landscaping around the proposed buildings will support the continued potential for Red-crowned Toadlet in the area by providing suitable shelter opportunities. A strict hygiene protocol will be established and maintained by the bush management contractors whilst undertaking works within potential habitat areas. Extensive vegetation management has been outlined and should be adopted.
Conclusion There will be no significant effect on the Red-crowned Toadlet (*Pseudophryne australis*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	
References: NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Red-crowned Toadlet (*Pseudophryne australis*)
TSC Act Status: Vulnerable
NSW Office of Environment and Heritage (2012) Red-crowned Toadlet (*Pseudophryne australis)*– Conservation Projects and Species Profile http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10692 [July 2016]

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Southern Brown Bandicoot (Eastern) (*Isoodon obesulus obesulus*)	
TSC Act Status: Endangered	
Species Ecology	The Southern Brown Bandicoot is crepuscular (active mainly after dusk and/or before dawn). It is generally only found in heath or open forest with a heathy understorey on sandy or friable soils. It feeds on a variety of ground-dwelling invertebrates and the fruit-bodies of hypogenous (underground-fruiting) fungi. Its foraging patterns often create distinctive conical holes in the soil. Males have a home range of approximately 5-20 hectares whilst females forage over smaller areas of about 2-3 hectares. The species nest during the day in a shallow depression in the ground covered by leaf litter, grass or other plant material. Nests may be located under Grass trees *Xanthorrhoea spp*., blackberry bushes and other shrubs, or in rabbit burrows. The upper surface of the nest may be mixed with earth to waterproof the inside of the nest. Mating occurs any time of the year, usually following heavy rain. Two or three litters of 2-4 young may be produced annually. The gestation period of 11-12 days is the shortest known of any marsupial. Young become independent around 60 days after being born.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	Despite rigorous targeted species searches of the Southern Brown Bandicoot, no individuals were encountered during the survey. Previous surveys on the subject site and immediate surrounds also failed to reveal any individuals of this species. This does not rule out the potential for it to occur on the subject site as there are records in the surrounding landscape (to 10km from the subject site). The proposed action is unlikely to adversely effect upon the life cycle of the Southern Brown Bandicoot. A small area of potential foraging and sheltering habitat for this species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. No effects to potential Southern Brown Bandicoot movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including low shrubs and groundcover suitable for the foraging requirements of this species. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the	Not applicable – the species does not belong to an Endangered Population

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Southern Brown Bandicoot (Eastern) (*Isoodon obesulus obesulus*)		
TSC Act Status: Endangered		
life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,		
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – the species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Southern Brown Bandicoot. A small area of potential foraging and sheltering habitat for bandicoots (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Southern Brown Bandicoot (Eastern) (*Isoodon obesulus obesulus*)		
TSC Act Status: Endangered		
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	2017a) will guide enhancement of habitat through installation of additional foraging resources such as low lying shrubs and groundcovers to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to bandicoot movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,		Management Objectives have been devised for the greater Garigal/ Kur-ring-gai National Park area including the urban areas of Terrey Hills and Duffys Forest (OEH, 2016). Activities include maintaining appropriate fire regimes and reducing pest species, specifically foxes. Monitoring actions are also specified to record species abundance, extent and condition to determine population trends through time. Many of these actions are outside of the scope of the current DA. The proposed action will not interfere with these objectives and actions as performed by council or National Parks. Fire within the subject site will continue to be actively prevented.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.		Five Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are of direct relevance to the Southern Brown Bandicoot:

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Southern Brown Bandicoot (Eastern) (*Isoodon obesulus obesulus*)	
TSC Act Status: Endangered	
	▪ Predation by the European Red Fox (*Vulpes vulpes*) ▪ Predation by the Feral Cat (*Felis catus*) ▪ High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Clearing of native vegetation ▪ Removal of dead wood and dead trees With the scope of the proposed action none of these KTPs are considered likely to be exacerbated. Currently evidence of feral cat, fox and dogs within the subject site present a high risk to any Southern Brown Bandicoots which may inhabit or pass through the subject site. All woody debris found within the proposed construction footprint will be relocated elsewhere on site to continue to provide habitat values. Extensive revegetation will take place through implementation of the landscape plan. Management of these and the remaining KTPS are addressed in detail within the complementary BMP (Narla 2016).

Conclusion

There will be no significant effect on the Southern Brown Bandicoot (*Isoodon obesulus obesulus*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).

References:

NSW Office of Environment and Heritage (2016) Southern Brown Bandicoot (eastern) (*Isoodon obesulus obesulus*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10439

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Spotted-tailed Quoll (*Dasyurus maculatus*)	
TSC Act Status: Vulnerable	
Species Ecology	The Spotted-tailed Quoll occupies large territories. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares, which they are known to traverse along densely vegetated creek lines. Although mostly nocturnal, the Spotted-tailed Quoll may also hunt diurnally. As a generalist predator, this species prefers to hunt medium sized mammals (500g-5kg), frequently consuming gliders, possums, small wallabies, rats, birds, bandicoots, rabbits, reptiles and insects. They may also eat carrion and domestic fowls. Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites. Where these habitats requirements are met, Spotted-tailed Quolls may utilise a range of vegetation types including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	Despite rigorous targeted searches, the Spotted-tailed Quoll was not recorded on the subject site. It is possible that roaming individuals may visit the site on occasion to forage. The proposed action is unlikely to adversely effect upon the life cycle of the Spotted-tailed Quoll. A small area of potential foraging and sheltering habitat for this species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. No effects to potential movement of this species across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including low shrubs and groundcover suitable for the foraging requirements of this species. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be	Not applicable – the species does not belong to an Endangered Population

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Spotted-tailed Quoll (*Dasyurus maculatus*)		
TSC Act Status: Vulnerable		
placed at risk of extinction,		
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – the species do not belong to an Endangered Ecological Community or Critically Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Spotted-tailed Quoll. A small area of potential foraging and sheltering habitat for bandicoots (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional foraging resources such as low lying shrubs and groundcovers to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to the movement of this
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Spotted-tailed Quoll (*Dasyurus maculatus*)		
TSC Act Status: Vulnerable		
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	species across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,		Management Objectives and the devised actions for the Conservation of Spotted-tailed Quoll focus on the protection of wild populations, allowing for the retention or extension of existing ranges. Many of the Critical Actions for this species are outside of the scope of this project, however the following Actions may be adjusted for application to the subject site: ▪ Identify and target restoration and revegetation projects at areas where connectivity between large areas of known habitat is compromised, with the aim of increasing the width, condition and security of critical landscape links. ▪ Implement cross-tenure predator control programs ▪ Monitor significant spotted-tailed quoll populations to investigate the effect of fox and wild dog baiting. The complementary BMP (Narla 2016) provides detailed direction for the execution of these activities within the subject site.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.		The following Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are relevant to the protection of potential Spotted-tailed Quoll habitat within the subject site: ▪ Removal of dead wood and dead trees

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Spotted-tailed Quoll (*Dasyurus maculatus*)	
TSC Act Status: Vulnerable	
	▪ Predation [and competition] by the Feral Cat (*Felis catus*) ▪ Predation [and competition] by the European Red Fox *Vulpes vulpes* ▪ Clearing of native vegetation ▪ Bushrock removal On the basis that the proposed development adheres to the recommendations made within this report and the complimentary BMP (Narla 2016), none of these KTPs are considered likely to be exacerbated. No effect upon bushrock must occur. Landscaping around the proposed buildings should support the continued potential for Spotted-tail Quolls to traverse the area, by providing suitable shelter opportunities.
Conclusion There will be no significant effect on the Spotted-tailed Quoll (*Dasyurus maculatus*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	
References: NSW Office of Environment and Heritage (2014) Spotted-tailed Quoll (*Dasyurus maculatus)* – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10207 NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Squirrel Glider (*Petaurus norfolcensis*)	
TSC Act Status: Vulnerable	
Species Ecology	The Squirrel Glider is widely dispersed throughout Eastern Australian. It inhabits Blackbutt-Bloodwood forest with heath understorey in coastal areas and old growth Box and River Red Gum forest west of the Great Dividing Range. Require abundant tree hollows for refuge and nest sites. Diet is seasonably based, consisting of Acacia gum, Eucalyptus sap, nectar, honey dew and manna, with invertebrates and pollen providing protein.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	Despite targeted searches the Squirrel Glider was not found to be present within the subject site. It is possible that individuals residing in the adjoining Crown Lands or National Parks may attend the subject site on occasion to forage. The proposed action is unlikely to adversely effect upon the life cycle of the Squirrel Glider. A small area of potential foraging and sheltering habitat for this species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. Any potential feed trees and shrubs (e.g. *Banksia* spp., *Angophora hispida, Callistemon citrinus* and *Corymbia gummifera*) removed from the subject site in order to facilitate the hospital construction will be replaced at a ratio of 3:1 per species. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. No effects to Squirrel Glider movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant Squirrel Glider feed trees. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Squirrel Glider (*Petaurus norfolcensis*)		
TSC Act Status: Vulnerable		
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – this species does not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Squirrel Glider. A small area of potential foraging and sheltering habitat for this species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. Any potential feed trees and shrubs (e.g. *Banksia* spp., *Angophora hispida, Callistemon citrinus* and *Corymbia gummifera*) removed from the subject site in order to facilitate the hospital construction will be replaced at a ratio of 3:1 per species. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Squirrel Glider (*Petaurus norfolcensis*)		
TSC Act Status: Vulnerable		
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional foraging resources such as banksias to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to this species movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant Squirrel Glider feed plants. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Squirrel Glider (*Petaurus norfolcensis*)	
TSC Act Status: Vulnerable	
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	Management Objectives and the devised actions for the Conservation of the Squirrel Glider largely focus on the protection of wild populations, and habitat retention on a landscape scale. These include: ▪ Protection of hollow bearing trees and stags, including retention of medium sized trees which may in the future produce hollows. ▪ Encouraging the retention of a floristically diverse understorey, and raising the public awareness of the damage that under scrubbing/ slashing can cause. The complementary BMP (Narla 2017a) form a detailed guide to encouraging the retention and enhancement of a floristically diverse vegetation assemblage across the entirety of the subject site. Flowering trees lost will be replaced at a ratio of 3:1. Hollow bearing trees will be replaced by augmented hollows at a ratio of 2:1.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are relevant to the protection of potential Squirrel Glider habitat within the subject site: ▪ Loss of hollow-bearing trees ▪ Removal of dead wood and dead trees ▪ Predation by the European Red Fox (*Vulpes vulpes*) ▪ Predation by the Feral Cat (*Felis catus*) ▪ Clearing of native vegetation ▪ Infection of native plants by *Phytophthora cinnamomi* (Phytophthora) ▪ Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae Each of these KTPs has been carefully considered within the complementary BMP (Narla 2017a). Key elements are briefly described as follows. Hygiene control methods for Phytophthora and Rust should be established and carefully maintained throughout construction and landscaping works. Exotic predators will be controlled and excluded from the subject site. Removal of nesting and or foraging resources for this species will be minimised, with post work habitat enhancement methods including replacement of nest hollows through

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Squirrel Glider (*Petaurus norfolcensis*)	
TSC Act Status: Vulnerable	
	hollow-augmentation to a ratio of 2:1, and installing foraging trees to a ratio of 3:1. A total of 80 *Banksia ericifolia* and 36 other foraging tree species will be removed from the development footprint. These trees will be replaced at a ratio of 2:1, resulting in the replacement of 240 *Banksia ericifolia* and 108 other foraging tree species within the subject site. According to the Landscape Plan a total of 1160 *Banksia ericifolia* are proposed for planting within the subject site. APZ management has been development to enhance and protect rather than remove potential habitat.

Conclusion

There will be no significant effect on the Squirrel Glider (*Petaurus norfolcensis*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).

References:

NSW Office of Environment and Heritage (2014) Squirrel Glider (*Petaurus norfolcensis*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10604#

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Nomadic Nectivorous Birds Regent Honeyeater (*Anthochaera phrygia*)[1] Swift Parrot (*Lathamus discolor*)[2] Little Lorikeet (*Glossopsitta pusilla*)[3]	
TSC Act Status: [1]Critically Endangered	
[2]Endangered	
[3]Vulnerable	
Species Ecology	The Regent Honeyeater breeds in a few, select locations between north-eastern Victoria and northern NSW. Breeding has not been recorded from Sydney (east of the ranges) in many decades. The closes known breeding site is the Capertee Valley (north-west of Sydney). The Regent Honeyeater is highly nomadic outside the breeding season. It has been recorded throughout the Sydney region and may occur wherever suitable food resources are present. Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. They forage on lerps and other insects, although they show a stronger preference for nectar from flowering *Eucalyptus, Angophora* and Mistletoes that grow in the Western Sydney area. The Swift Parrot breeds in tree hollows in Tasmanian Blue Gum forest on Tasmania and migrates to the NSW cost for the autumn and winter each year. During this time flocks of Swift Parrot become nomadic as they follow irruptions of food resources, including flowering trees including *Eucalyptus, Angophora, Corymbia*, Mistletoes and lerp (leaf psyllid insect exudate). Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. Swift Parrot has been recorded throughout the Sydney region wherever suitable food sources are present. It forages predominantly on lerps on all Eucalyptus and Angophora that grow in this area. The Little Lorikeet mostly occurs in dry, open eucalyptus forests and woodlands. The species does not undergo regular migration, but instead is considered nomadic with irregular large or small influxes of individuals occurring at any time of year. This is usually in response to seasonal variations in food supply. Little Lorikeets often forage in small groups with other species of lorikeet, feeding primarily on nectar and pollen from tall eucalyptus species. The Little Lorikeet may also forage within melaleucas and mistletoes. Breeding activity is largely known from the western slopes, where birds utilise small hollows (~3cm) within living smooth barked trees.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Nomadic Nectivorous Birds Regent Honeyeater (*Anthochaera phrygia*)[1] Swift Parrot (*Lathamus discolor*)[2] Little Lorikeet (*Glossopsitta pusilla*)[3]	
TSC Act Status: [1]Critically Endangered	
[2]Endangered	
[3]Vulnerable	
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	The proposed action is unlikely to adversely effect upon the life cycle of these species. A small area of potential foraging and sheltering habitat for these species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. Any potential feed trees and shrubs (e.g. *Banksia* spp., *Angophora hispida*, *Callistemon citrinus* and *Corymbia gummifera*) removed from the subject site in order to facilitate the hospital construction will be replaced at a ratio of 3:1 per species. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. A total of 80 *Banksia ericifolia* and 36 other foraging tree species will be removed from the development footprint. These trees will be replaced at a ratio of 2:1, resulting in the replacement of 240 *Banksia ericifolia* and 108 other foraging tree species within the subject site. According to the Landscape Plan a total of 1160 *Banksia ericifolia* are proposed for planting within the subject site. No effects to the movement of these highly mobile species will occur across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant feed trees suitable for these species. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the	Not applicable – these species do not belong to an Endangered Population

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Nomadic Nectivorous Birds Regent Honeyeater (*Anthochaera phrygia*)[1] Swift Parrot (*Lathamus discolor*)[2] Little Lorikeet (*Glossopsitta pusilla*)[3]		
TSC Act Status: [1]Critically Endangered		
[2]Endangered		
[3]Vulnerable		
endangered population such that a viable local population of the species is likely to be placed at risk of extinction,		
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – these species do not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of these species. A small area of potential foraging and sheltering habitat (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. Any potential feed trees and shrubs (e.g. *Banksia* spp., *Angophora hispida*, *Callistemon citrinus* and *Corymbia gummifera*) removed from the subject site in order to facilitate the hospital construction will be replaced at a ratio of 3:1 per species. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Nomadic Nectivorous Birds Regent Honeyeater (*Anthochaera phrygia*)[1] Swift Parrot (*Lathamus discolor*)[2] Little Lorikeet (*Glossopsitta pusilla*)[3]		
TSC Act Status: [1]Critically Endangered		
[2]Endangered		
[3]Vulnerable		
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	installation of additional foraging resources such as banksias to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to the movement of these highly mobile species will occur across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant feed trees suitable for these species. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,		The following conservation activities were taken from the Regent Honeyeater recovery plan (OEH 2016), however are relevant supporting the recovery of all three species. ▪ Retain large old trees, especially those that are hollow-bearing ▪ Ensure recruitment of trees into the mature age class so that there is not a lag period of decades between the death of old trees and hollow formation in younger trees. ▪ Protect large flowering Eucalyptus trees throughout the habitats frequented by

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Nomadic Nectivorous Birds Regent Honeyeater (*Anthochaera phrygia*)[1] Swift Parrot (*Lathamus discolor*)[2] Little Lorikeet (*Glossopsitta pusilla*)[3]	
TSC Act Status: [1]Critically Endangered	
[2]Endangered	
[3]Vulnerable	
	this species. Manage remnant woodlands and forest for recovery of old-growth characteristics. ▪ Where natural tree recruitment is inadequate, replant local species to maintain foraging habitat and breeding sites. ▪ Reduce the abundance of feral Honeybees and limit the exploitation of nectar by domestic bees where resources are spatially or temporally sparse (e.g. in years of drought) The complementary BMP (Narla 2017a) provides recommendation for site management aimed at achieving all give of these actions. Trees and shrubs lost due to construction will be replaced at a ratio of 3:1 per species. A total of 80 *Banksia ericifolia* and 36 other foraging tree species will be removed from the development footprint. These trees will be replaced at a ratio of 2:1, resulting in the replacement of 240 *Banksia ericifolia* and 108 other foraging tree species within the subject site. According to the Landscape Plan a total of 1160 *Banksia ericifolia* are proposed for planting within the subject site. Hollows will be replaced at a ratio of 2:1 through hollow augmentation. Increased fire effect will be actively prevented. Human visitation of the site will increase with the construction of the proposed residency. Nest box installation and monitoring.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Nomadic Nectivorous Birds Regent Honeyeater (*Anthochaera phrygia*)[1] Swift Parrot (*Lathamus discolor*)[2] Little Lorikeet (*Glossopsitta pusilla*)[3]	
TSC Act Status: [1]Critically Endangered	
[2]Endangered	
[3]Vulnerable	
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The KTPs relevant to this nomadic nectivorous birds within the study area are: ▪ Clearing of native vegetation ▪ Infection of native plants by *Phytophthora cinnamomi* ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Removal of dead wood The proposed action is considered unlikely to result in a significant increase to KTP. There will be no significant effect to these species, under the provision that the mitigation recommendations outlined in this report are followed. These mitigation actions will result in no net loss of habitat, addition of habitat trees recommended within the subject site.
Conclusion There will be no significant effect on the Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*) or Little Lorikeet (*Glosspsitta pusilla*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Nomadic Nectivorous Birds Regent Honeyeater (*Anthochaera phrygia*)[1] Swift Parrot (*Lathamus discolor*)[2] Little Lorikeet (*Glossopsitta pusilla*)[3]
TSC Act Status: [1]Critically Endangered
[2]Endangered
[3]Vulnerable

References:

Commonwealth of Australia Department of the Environment (DoE) (2015) Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (s266B) Approved Conservation Advice (including listing advice) for Conservation Advice *Anthochaera phrygia* regent honeyeater

Commonwealth of Australia Department of the Environment (DoE) (2016) Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (s266B) Approved Conservation Advice (including listing advice) for Conservation Advice *Lathamus discolor* swift parrot

NSW Office of Environment and Heritage (2016) Regent Honeyeater (*Anthochaera phrygia*)- Conservation Projects http://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=148 [July 2016]

NSW Office of Environment and Heritage (2016) Saving our Species. Regent Honeyeater (*Anthochaera phrygia*) http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10841 [May 2016]

NSW Office of Environment and Heritage (2016a) Saving our Species. Swift Parrot (*Lathamus discolor*) http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10455 [May 2016]

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Cave Roosting Bats Eastern Cave Bat (*Vespadelus troughtoni*) Large-eared Pied Bat (*Chalinolobus dwyeri*) Little Bent-wing Bat (*Miniopterus australis*)	
TSC Act Status: Vulnerable	
Species Ecology	All of these vulnerable microbat species are most frequently found within well-timbered habitat which contains caves. These four microbat species all require similar rock crack and crevice habitat for temporary (daytime) roost sites between night time foraging bouts. They may also use some of this habitat for winter torpor (suspended animation). All of these species are likely to hibernate within larger colonies in caves during the winter months. It is unlikely that any colonies occur on the subject site. The Little Bent-wing has highest potential to utilise the subject site as it is known from habitat not dissimilar to that that occurs in the locality, and has previously been recorded within both Kur-ring-gai and Garigal National Parks. Only a single record of the Large-eared Pied bat occurs within the study area approximately 4km south within Garigal National Park. No records of the Eastern Cave Bat were found within the study area. Very little is known about the ecology of this species.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	Bat acoustic survey revealed that whilst the subject site contained numerous different species of microbat, including the cave-roosting Eastern Bentwing. No records of the following species occur on the subject site: ▪ Eastern Cave Bat (Vespadelus troughtoni) ▪ Large-eared Pied Bat (Chalinolobus dwyeri) ▪ Little Bent-wing Bat (Miniopterus australis) The proposed action is unlikely to adversely effect upon the life cycle of these species. A small area of potential foraging and sheltering habitat for these species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. All caves and rock crevices found within the sandstone outcropping will be retained on the subject site for use by this species for shelter and breeding. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. No effects to the movement of these species across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Cave Roosting Bats Eastern Cave Bat (*Vespadelus troughtoni*) Large-eared Pied Bat (*Chalinolobus dwyeri*) Little Bent-wing Bat (*Miniopterus australis*)		
TSC Act Status: Vulnerable		
	reduce the viability of a local population, such that these species are likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – these species do not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – these species do not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of these species. Throughout and post the proposed development all suitable habitat within sandstone outcropping and rocky crevices for these species will be retained and protected on site. The construction of the hospital may provide some disturbance to foraging bats through noise and light pollution. Noise however will largely be confined within daylight hours and additional light can attract additional insects, which are prey items for this species. In addition, extensive suitable habitat is remains available to these species in the adjacent

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Cave Roosting Bats Eastern Cave Bat (*Vespadelus troughtoni*) Large-eared Pied Bat (*Chalinolobus dwyeri*) Little Bent-wing Bat (*Miniopterus australis*)		
TSC Act Status: Vulnerable		
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	Ku-ring-gai Chase National Park which hold approximately 150km^2 of suitable habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to the movement of these species across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. As this species is highly mobile; it is likely the species is already traversing through the local suburban environment to access larger habitat areas in nearby Kur-ring-gai and Garigal National Parks where the species has been frequently recorded.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Cave Roosting Bats Eastern Cave Bat (*Vespadelus troughtoni*) Large-eared Pied Bat (*Chalinolobus dwyeri*) Little Bent-wing Bat (*Miniopterus australis*)	
TSC Act Status: Vulnerable	
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	The mitigation measures outlined within the BMP (Narla 2017a) have been development in line with conservation actions as relevant to all species. These include: ▪ Protect known and potential forest and woodland habitat around cliffs, rock overhangs and old mine workings from clearing and isolation ▪ Revegetation which focuses on expanding existing smaller areas of suitable habitat and connecting areas of suitable habitat to create corridors for movement. ▪ Retention of stands of native vegetation, that which is floristically and structurally diverse ▪ Minimizing the use of pesticides within the subject site ▪ Reducing the occurrence of foxes and cats within the subject site. ▪ Limiting access to caves which may cause an increase in disturbance to fauna roosting within. The complementary BMP (Narla 2017a) provides recommendation for site management aimed at achieving all give of these actions. The management of the subject property will ensure that: ▪ Pest fauna across the subject site will be controlled. ▪ All linkages between the subject site and the broader landscape will be maintained ▪ Vegetation surrounding the caves within the rocky outcrops will be maintained and managed within the APZs. ▪ Access to the caves within the rocky outcrops will be limited

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Cave Roosting Bats Eastern Cave Bat (*Vespadelus troughtoni*) Large-eared Pied Bat (*Chalinolobus dwyeri*) Little Bent-wing Bat (*Miniopterus australis*)	
TSC Act Status: Vulnerable	
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act are relevant to the protection of potential habitat within the subject site for these species : ▪ Clearing of native vegetation ▪ Predation by the European Red Fox *Vulpes vulpes* ▪ Predation by the Feral Cat *Felis catus* Under the provision that the mitigation recommendations outlined in this report are followed, the proposed action is considered unlikely to cause a significant adverse effect on the listed bats. These mitigation actions include, habitat enhancement through maximum tree/ native vegetation retention and bush management, plus application of cat/ fox exclusion mechanism.

Conclusion

There will be no significant effect on any of the listed cave roosting bats therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).

References:

NSW Office of Environment and Heritage (2016) Eastern Cave Bat (*Vespadelus troughtoni*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10829

NSW Office of Environment and Heritage (2016) Large-eared Pied Bat (*Chalinolobus dwyeri*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10157

NSW Office of Environment and Heritage (2014) Little Bent-wing Bat (*Miniopterus australis*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10533

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Tree Roosting Microbats Eastern False Pipistrelle *(Falsistrellus tasmaniensis)* Eastern Freetail-bat (*Mormopterus norfolkensis*) Greater Broad-nosed Bat (*Scoteanax rueppellii*)	
TSC Act Status: Vulnerable	
Species Ecology	The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. Prefers moist habitats, with trees taller than 20 m. The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Usually solitary but also recorded roosting communally. The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. It utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m. Open woodland habitat and dry open forest suits the direct flight of this species. All species generally roosts in eucalypt hollows, but have been found under loose bark on trees or in the crevices of buildings. All species are largely insectivorous, however Greater Broad-nosed bats have been known to eat other smaller bats. The closest species records from the study area occur approximately 5km south of the subject site within Garigal National Park.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	The proposed action is unlikely to adversely effect upon the life cycle of these tree roosting microbats. A small area of potential foraging and sheltering habitat for these species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. No effects to the movement of these species across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including tree species likely to produce hollows in the future.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Tree Roosting Microbats Eastern False Pipistrelle *(Falsistrellus tasmaniensis)* Eastern Freetail-bat (*Mormopterus norfolkensis*) Greater Broad-nosed Bat (*Scoteanax rueppellii*)		
TSC Act Status: Vulnerable		
	The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – these species do not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – these species do not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of these species. A small area of potential foraging and sheltering habitat (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Tree Roosting Microbats Eastern False Pipistrelle *(Falsistrellus tasmaniensis)* Eastern Freetail-bat (*Mormopterus norfolkensis*) Greater Broad-nosed Bat (*Scoteanax rueppellii*)		
TSC Act Status: Vulnerable		
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional foraging resources such as additional native indigenous trees to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to the movement of these species will occur across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,		The mitigation measures outlined within the BMP (Narla 2017a) have been development in line with conservation actions as relevant to all species. These include:- ▪ Revegetation which focuses on expanding existing smaller areas of suitable habitat and connecting areas of

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Tree Roosting Microbats Eastern False Pipistrelle *(Falsistrellus tasmaniensis)* Eastern Freetail-bat (*Mormopterus norfolkensis*) Greater Broad-nosed Bat (*Scoteanax rueppellii*)	
TSC Act Status: Vulnerable	
	suitable habitat to create corridors for movement. ▪ Retention of stands of native vegetation, especially those with hollow-bearing trees (including dead trees), or which is floristically and structurally diverse ▪ Retain a buffer of vegetation around potential roost sites ▪ Minimizing the use of pesticides within the subject site ▪ Encourage regeneration and replanting of local flora species to maintain bat foraging habitat. ▪ Reducing the occurrence of foxes and cats within the subject site. The complementary BMP (Narla 2017a) provides recommendation for site management aimed at achieving all give of these actions. The management of the subject property will ensure that: ▪ Focuses on revegetating areas outside of the development footprint. Habitat trees will be replaced at a ratio of 3:1 ▪ Hollow bearing trees that are lost, will be replaced by augmented hollows at a rate of 2:1. ▪ Pest fauna across the subject site will be controlled.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The Key Threatening Processes relevant to the survival of these hollow-roosting bats in NSW are the following:- • Clearing of native vegetation • Loss of hollow-bearing trees • Infection of native plants by *Phytophthora cinnamomi* • Invasion, establishment and spread of *Lantana camara* • Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants • Removal of dead wood and dead trees • Predation by the European Red Fox *Vulpes vulpes* • Predation by the Feral Cat *Felis catus* Under the provision that the mitigation recommendations outlined in this report are followed, the proposed action is considered

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Tree Roosting Microbats Eastern False Pipistrelle *(Falsistrellus tasmaniensis)* Eastern Freetail-bat (*Mormopterus norfolkensis*) Greater Broad-nosed Bat (*Scoteanax rueppellii*)	
TSC Act Status: Vulnerable	
	unlikely to cause a significant adverse effect on the listed hollow- roosting bats. These mitigation actions include hygiene protocols, habitat protection via maximum tree/ native vegetation retention and bush management, hollow-habitat augmentation, and reducing site access for exotic predators.

Conclusion

There will be no significant effect on any of these vulnerable tree roosting bats therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).

References:

NSW Office of Environment and Heritage (2016) Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10331

NSW Office of Environment and Heritage (2016) Eastern Free-tailed Bat (*Mormopterus norfolkensis*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10544

NSW Office of Environment and Heritage (2016) Greater Broad-nosed Bat (*Scoteanax rueppellii*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10748

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Varied Sittella (*Daphoenositta chrysoptera*) TSC Act Status: Vulnerable		
Species Ecology	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades. Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	The Varied sittella was not observed on the subject site during the site assessment. Proximal records occur in Ku-ring-gai Chase National Park. It is possible that individuals could visit the site for foraging and possible breeding purposes. The species requires tall-rough-barked trees to forage and nest in. The proposed action is unlikely to adversely effect upon the life cycle of the Varied Sittella. A small area of potential foraging and sheltering habitat for the Varied Sittella (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development. No effects to the movement of this highly mobile species across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant Varied Sittella feed trees. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – the species does not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community,	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – the species does not belong to an Endangered Ecological Community or Critically Endangered Ecological Community

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Varied Sittella (*Daphoenositta chrysoptera*) TSC Act Status: Vulnerable		
whether the action proposed:	**(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the Varied Sittella. A small area of potential foraging and sheltering habitat for this species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional foraging resources such as banksias to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to the movement of this species across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including abundant Varied Sittella feed plants. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Varied Sittella (*Daphoenositta chrysoptera*) TSC Act Status: Vulnerable	
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	The Office of Environment and Heritage (OEH) has identified a number of recovery actions for this species. All relevant actions have been summarised as follows: ▪ Retain existing vegetation and remnant stands along roadsides and in paddocks. ▪ Increase the size of existing remnants by planting trees and establishing buffer zones. ▪ Where remnants have lost connective links, re-establish links by revegetating corridors or stepping stones. ▪ Limit firewood collection and retain dead timber in open forest and woodland areas. ▪ Encourage regeneration of habitat by fencing remnant stands and managing the intensity and duration of grazing. ▪ Control weeds in areas of known habitat. The proposed development will retain all existing flowering and hollow-bearing trees along the roadside where possible, and replace trees lost in a ratio of 3:1 to replace habitat lost. Buffer zones such as the APZs within the property will be managed and maintained to remove all noxious weeds and thin out senescing or dead trees, with replacement of lost trees within the APZ occurring in other areas of the property. Dead timber will be retained in areas outside of the construction footprint and APZs. All noxious and environmental weeds will be removed and replaced with locally indigenous trees and shrubs that are more suitable for use by Varied Sittella. All weed removal will be managed by qualified bush regenerators supervised by a qualified ecologist.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The Key Threatening Processes relevant to the survival of the Varied Sittella include the following: ▪ Declining habitat due to clearing ▪ Infestation of habitat by invasive weeds ▪ Clearing of native vegetation ▪ Removal of coarse woody debris and dead trees Under the provision that the mitigation recommendations outlined in this report are followed, the proposed action is considered unlikely to cause a significant adverse effect on this species. Although potential habitat will be removed from the subject site, larger bushland areas will remain available to the species within the wider vicinity (Ku-ring-gai National Park and Garigal National Park). As the subject site is located in an urbanised residential area, it is unlikely the removal of vegetation is likely to significantly effect the KTP discussed. Invasive weeds will be removed from the site which is likely to benefit this KTP to the wider region. Some native trees will be cleared, however all trees lost will be replanted in a ratio of 3:1 trees replaced to trees lost.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Varied Sittella (*Daphoenositta chrysoptera*) TSC Act Status: Vulnerable	
	Potential effects are to be mitigated through the measures outlined in this report including the requirement for a qualified Ecologist to be present on site during tree removal to supervise works and provide assistance to any birds directly effected.

Conclusion

There will be no significant effect on *Daphoenositta chrysoptera* (Varied Sittella), therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).

References:

The Office of Environment and Heritage (2016) Varied Sittella (*Daphoenositta chrysoptera*) – Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20135 [April 2017]

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Vulnerable Large Forest Owls Powerful Owl (*Ninox strenua*) Barking Owl (*Ninox connivens*) Masked Owl (*Tyto novaehollandiae*)	
TSC Act Status: Vulnerable	
Species Ecology	The Powerful Owl is found in tall forests across eastern Australia, south of the tropics. It is mostly found east of the Great Dividing Range. The species is not common but it is widespread in NSW. Multiple breeding pairs exist in Sydney. The Species usually requires large hollows to nest in. The Powerful Owl nests in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. While the female and young are in the nest hollow the male Powerful Owl roosts nearby (10-200 m) guarding them, often choosing a dense "grove" of trees that provide concealment from other birds that harass him. Pairs of Powerful Owls demonstrate high fidelity to a large territory, the size of which varies with habitat quality and thus prey densities. In good habitats, a mere 400 ha can support a pair; where hollow trees and prey have been depleted the owls need up to 4000 ha. The Barking Owl is found throughout continental Australia except for the central arid regions. Although common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains (especially the Pilliga) and in some northeast coastal and escarpment forests. Many populations have crashed as woodland on fertile soils was cleared, leaving linear riparian strips of remnant trees as the last inhabitable areas. Sometimes extend their home range into urban areas, hunting birds in garden trees and insects attracted to streetlights. The Masked Owl extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution. Pairs have a large home-range of 500 to 1000 hectares. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting These owls share broad habitat requirements, in that they require remnant forest or tall woodland to forage within, medium to large vertebrate prey items to feed on, dense tree canopies to roost in and large tree-hollows to nest in. Suitable nest hollows are very rare in the landscape, and typically occur in large, old trees in dense vegetated gullies. These birds predominantly hunt medium sized birds and small to medium sized terrestrial and arboreal mammals.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	No individuals of these three large forest owls were recorded on the subject site, despite extensive targeted spotlighting survey and call playback per the NSW guidelines. It is expected that any of these three owls could occur on the subject site, particularly the Powerful Owl. Use of the subject site would mainly be for intermittent hunting and temporary roosting. Breeding is unlikely to take place on the subject site, owing to the lack of suitable sized and positioned tree-hollows that could be used for nesting. The proposed action is unlikely to adversely effect upon the life cycle of these large forest owls. A small area of potential foraging and sheltering habitat for these species (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. A total of 136 trees and shrubs (*Banksia* spp., *Angophora hispida*, *Callistemon citrinus* and *Corymbia gummifera*) will be removed from the subject site in order to facilitate the hospital construction. These trees provide foraging habitat for small and medium sized marsupials and birds that could be preyed upon by the large forest owls. These trees and shrubs will be replaced at a ratio of 3:1 per species. A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. All suitable foraging and shelter trees within the APZ areas will be retained un effected by the proposed development.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Vulnerable Large Forest Owls Powerful Owl (*Ninox strenua*) Barking Owl (*Ninox connivens*) Masked Owl (*Tyto novaehollandiae*)		
TSC Act Status: Vulnerable		
	No effects to the movement of these highly mobile species across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including large Eucalypt species that have the potential for use by these species in the future. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species are likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – these species do not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – these species do not belong to an Endangered Ecological Community or Critically Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of these species. A small area of potential foraging and sheltering habitat (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. A total of 136 trees and shrubs (*Banksia spp., Angophora hispida, Callistemon citrinus and Corymbia gummifera*) will be removed from the subject site in order to facilitate the hospital construction. These trees and shrubs will be replaced at a ratio of 3:1 per species.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Vulnerable Large Forest Owls Powerful Owl (*Ninox strenua*) Barking Owl (*Ninox connivens*) Masked Owl (*Tyto novaehollandiae*)		
TSC Act Status: Vulnerable		
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	A total of 24 hollow-bearing trees constituting approximately 78 (51 x 3-5cm – 5cm; 23 x 6cm – 10cm; 4 x 10-15cm) tree hollows (estimates only) will be removed from the subject site to allow construction of the hospital. These hollows will be replaced at a ratio of 2:1 through hollow augmentation. None of these hollows located within the construction footprint are large enough for these owls to roost in. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through installation of additional foraging resources such as banksias to increase habitat and connectivity across the site. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. No effects to movement across the subject property, and between the subject property and adjoining bushland outside of the subject property will occur. This is because the majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. Furthermore, the remaining area of the subject property outside of the development footprint will be landscaped with locally indigenous vegetation, including large Eucalypt species that have the potential for use by these species in the future. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Vulnerable Large Forest Owls Powerful Owl (*Ninox strenua*) Barking Owl (*Ninox connivens*) Masked Owl (*Tyto novaehollandiae*)	
TSC Act Status: Vulnerable	
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	OEH has listed priority actions to help recover the Barking Owl and Masked Owl. The following actions are relevant to the subject site and proposed development project. ▪ Protect woodland and open forest remnants, especially those containing hollow-bearing trees. ▪ Retain standing dead trees and large fallen logs. ▪ Retain and protect stands of native vegetation, especially those with hollow-bearing trees. ▪ Retain hollow-bearing trees as well as large, mature trees that will provide hollows in the future. Recommendations have been put forward to adhere to the proposed actions to minimise the effect of development on these species. Although a number of hollow bearing trees will be removed for the construction of the hospital; none of these hollows were large enough for breeding for either species. Fallen logs and cleared trees will be relocated outside of the construction footprint. Additional hollow-bearing trees and native vegetation will remain on the subject site in areas outside the construction footprint. An important mitigation measure is the requirement for a qualified Ecologist to be present on site during tree removal to supervise works and provide assistance to any birds directly affected. Prior to works detailed preclearing must also be carried out.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The main key threatening processes to vulnerable large forest owls are: ▪ Clearing of native vegetation ▪ Removal of dead wood and dead trees ▪ Removal of hollow-bearing trees Potential effects are to be mitigated through the measures outlined in this report and the BMP (2017a) including the requirement for a qualified Ecologist to be present on site during tree removal to supervise works and provide assistance to any birds directly effected. Loss of foraging habitat trees will be mitigated through the replacement of trees at a ratio of 3:1. All tree-hollows lost will be replaced with augmented hollows at a ratio of 2:1.
Conclusion There will be no significant effect on the Barking Owl (*Ninox connivens*) and Masked Owl (*Tyto novaehollandiae*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test)
for
Vulnerable Large Forest Owls
Powerful Owl (*Ninox strenua*)
Barking Owl (*Ninox connivens*)
Masked Owl (*Tyto novaehollandiae*)

TSC Act Status: Vulnerable

References

NSW Office of Environment and Heritage (2016) Saving Our Species. Barking Owl (Ninox connivens) (Profile) http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10561 [April 2017]
NSW Office of Environment and Heritage (2016) Saving Our Species. Masked Owl (*Tyto novaehollandiae*) (Profile) http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10820 [April 2017]
NSW Office of Environment and Heritage (2016) Saving Our Species. Powerful Owl (Ninox strenua) (Profile) http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10562 [April 2017]
Northern Beaches Council (2017) Powerful Owl http://www.pittwater.nsw.gov.au/environment/native_animals/threatened_species/animals/powerful_owl?SQ_DESIGN_NAME=printer_friendly

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Caley's Grevillea (*Grevillea caleyi*)	
TSC Act Status: Critically Endangered	
Species Ecology	Restricted to an 8 km square area around Terrey Hills, approximately 20 km north of Sydney. Caleys Grevillea occurs in three major areas of suitable habitat, namely Belrose, Ingleside and Terrey Hills/Duffys Forest. All natural remnant sites occur within a habitat that is both characteristic and consistent between sites. All sites occur on the ridgetop between elevations of 170 to 240m asl, in association with laterite soils and a vegetation community of open forest, generally dominated by *Eucalyptus sieberi* and *E. gummifera*. It is commonly found in the endangered Duffys Forest ecological community. It is generally killed by fire and relies entirely on seed that is stored in the soil for regeneration. Generally seedlings do not flower and produce seed before 2-5 years of age. Flowering is sporadic throughout the year, but with a definite spring pulse. Fecundity is low with only about 3% of flowers result in seed. Seed dispersal is low and predation is high, therefore it is estimated that 8-12 years is required to develop a sufficient seedbank to replace a population. Seed dormancy mechanisms are not fully understood; however it is thought that smoke and perhaps heat may play a role in breaking dormancy. Pollination is mostly expected to take place from bird vectors although it is thought that this species may be self-compatible.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	Within the subject site two clumps of three and seven plants were identified within the Duffy's Forest Endangered Ecological Community. No other plants were recorded outside of this area during extensive searches of the subject site in the present study, and previous studies. As Caley's Grevillea occurs in an area that will be un effected by the proposed development, it is unlikely that the development will have a significant effect on the survival of these individuals. However, to mitigate potential effects, fencing of approximately 5 m to 10 m will be erected around each clump of Caley's Grevillea. This fencing will be managed for competing native plants and weeds, in order to maximise growth and survivorship of Caley's Grevillea. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. The Duffy's Forest EEC that contains the Caley's Grevillea will be managed for conservation purposes through active weed control and other forms of habitat enhancement such as the possible use of appropriately timed ecological burns. In addition, vegetation including Caley's Grevillea will be monitored by a qualified Ecologist and the health of the plants will be reported on. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction. It is expected that the proposed hospital works and the increased resources allocated to managing the Duffy's Forest and the two Caley's Grevillea clumps, will assist in ensuring the long-term survival of this plant on the subject site, and its entire distribution.
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – these species do not belong to an Endangered Population

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Caley's Grevillea (*Grevillea caleyi*)		
TSC Act Status: Critically Endangered		
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) No habitat of Caley's Grevillea will be removed. Fencing of an area approximately 5m to 10m in diameter will be erected around each clump of Caleys Grevillea. This fencing will be managed for competing native plants and weeds, in order to maximise growth and survivorship of Caley's Grevillea. The Duffy's Forest EEC will be managed for conservation purposes through active weed control and other forms of habitat enhancement such as manual thinning of competing/resource minimising processes such as dead and senescent shrubs, leaf litter. There is a possibility of applying well-timed ecological burns. All of the vegetation on the subject site, and the two clumps of Caley's Grevillea will be by a qualified Ecologist and the findings of each monitoring trip detailed in a report. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. The majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) The proposed development will be situated predominantly in lands that are mostly cleared of native vegetation. A small area of vegetation (0.5 ha) will be removed by the proposed construction works. No *Grevillea caleyi* were found in the area to be cleared.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,		The proposed development will be managed in a way which is consistent to the recovery strategies/ conservation activities of this species. For greater detail refer to the BMP (Narla 2017a).

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Caley's Grevillea (*Grevillea caleyi*)	
TSC Act Status: Critically Endangered	
	Key elements are the essential adoption and adherence to a strict hygiene and vegetation management protocol, particularly by bush regeneration staff, and exclusion of unauthorised access to within proximity of the Caley's Grevillea plants. The proponent will explore implementing an ecological burn program implementing appropriate fire management practice at an interval of 8-12 years. The proponent will also be restricting public access through fencing off of Duffy's Forest areas and will continue to fund restoration works undertaken by qualified bush regeneration contractors with experience in managing Caley's Grevillea.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) are documented to effect upon the survival of Caley's Grevillea: ▪ Clearing of native vegetation ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Infection of native plants by *Phytophthora cinnamomi* ▪ Removal of dead wood, dead trees and logs (as this affect the recycling of nutrients, and removes habitat for vertebrates, invertebrates and microbial organisms influencing long term survival) The proposed development will not exacerbate any of these KTPs. Vegetation clearing will not occur close to any specimens of Caley's Grevillea, and protective vegetation buffers will also be retained. In particular, fencing of up to 10m will be erected around each Caley's Grevillea plant so as to protect the plant and promote growth and survivorship of the species. Hygiene protocols will be adopted and adhered to throughout works, particularly by all bush regeneration staff. Thinning of dead and senescing shrubs, trees and leaf litter in the Duffy's Forest area may assist in reducing resource competition with any un-germinated Caley's Grevillea present in the seed bank.
Conclusion There will be no significant effect on Caley's Grevillea (*Grevillea caleyi*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	
References: NSW Office of Environment and Heritage (2014) Caley's Grevillea (*Grevillea caleyi*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10361 NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Deanne's Paper Bark (*Melaleuca deanei*)		
TSC Act Status: Vulnerable		
Species Ecology	Deane's Paperbark occurs in two distinct areas, in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas respectively. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas. The nearest records of the species lie ~4km to the north of the subject site. The species occurs mostly in ridgetop woodland, with only 5% of sites in heath on sandstone. Flowers appear in summer but seed production appears to be small and consequently the species exhibits a limited capacity to regenerate.	
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	No individuals of this plant were found on the subject site, despite extensive targeted surveys. The proposed action is unlikely to adversely effect upon the life cycle of this species. A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for all these threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – these species do not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Deanne's Paper Bark (*Melaleuca deanei*)		
TSC Act Status: Vulnerable		
	occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for all these threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through the management of vegetation throughout the APZ areas, as well as the planting of local indigenous plants already present on the subject site that are compatible with each vegetation community. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. The majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Deanne's Paper Bark (*Melaleuca deanei*)	
TSC Act Status: Vulnerable	
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	Management activities relevant to application for this species within the subject site were to :- ▪ Ensure that personnel planning and undertaking hazard reduction burns are able to identify the species and are aware of its habitat. ▪ Develop a fire management plan for the population. ▪ Apply mosaic pattern hazard reduction techniques to ensure the same areas are not burned repeatedly. ▪ Minimise accidental damage on road/track edges ▪ Within the subject site these actions have been addressed through the recommendation that only qualified bush management contractors be enlisted to carry out bushfire management works. ▪ All other access to bushland should be restricted. ▪ Fire will continue to be actively prevented within the subject site and surrounding area. The complementary BMP (Narla 2017a) provides recommendation for site management aimed at achieving all give of these actions.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	Key Threatening Processes (KTPs) relevant to the continued survival of Deane's Paper bark within the locality of the subject site are: ▪ Clearing of native vegetation ▪ Invasion of native plant communities by exotic perennial grasses ▪ Grazing by the feral European Rabbit *Oryctolagus cuniculus* ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Invasion, establishment and spread of *Lantana camara* ▪ Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants ▪ Invasion and establishment of exotic vines and scramblers These KTPS have been addressed in detail within the complimentary BMP (Narla 2017a). Important elements are the continued bushfire prevention management, particularly through the removal of weedy vegetation.
Conclusion There will be no significant effect on the Deane's Paperbark (*Melaleuca deanei*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Deanne's Paper Bark (*Melaleuca deanei*)
TSC Act Status: Vulnerable

References:

NSW Office of Environment and Heritage (2014) Deane's Paperbark (*Melaleuca deanei*)– Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10515

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Vulnerable Herbs ***Pimelea curviflora* var. *curviflora*** ***Tetratheca glandulosa*** ***Lasiopetalum joyceae***	
TSC Act Status: Vulnerable	
Species Ecology	*Pimelea curviflora curviflora* is confined to coastal areas of Sydney and Illawarra, occurring on shaley/ lateric soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands. It flowers between October and May, at which point it is most likely to be identifiable within the field. At other times, it can be highly cryptic, with an inconspicuous fine and scraggly form often growing within dense grasses and sedges. It is usually recorded as rare, even within known sites with most identified areas containing only a few specimens. It appears reasonably fire tolerant and can exist for some time without foliage after fire (or grazing) relying on underground tuberous roots. There are only 2 localities presently reserved in a National Park or Nature Reserve. It has been recorded only once in Garigal National Park in 1992 and in Muogamarra Nature Reserve in 1971 despite other surveys in both areas. *Teratheca glandulosa* is a small, spreading shrub which grows 20 - 50cm in height. Stems often become entwined among other small shrubs, sedges and grasses. Leaves are opposite 5 - 10 mm long and 1 mm wide with recurved (rolled under) margins. Leaf margins have small stiff hairs that give them a "toothed" appearance. Restricted to the following Local Government Areas: Baulkham Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah, and Wyong. There are approximately 150 populations of this plant ranging from Sampons Pass (Yengo NP) in the north to West Pymble (Lane Cove NP) in the south. The eastern limit is at Ingleside (Pittwater LGA) and the western limit is at East Kurrajong (Wollemi NP). The current north-south range is approximately 65km. Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes such as Lucas Heights, Gymea, Lambert and Faulconbridge. Topographically, the plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils are generally shallow, consisting of a yellow, clayey/sandy loam. Stony lateritic fragments are also common in the soil profile on many of these ridgetops. Flowers July-November however residual flowers may persist until late December. Flowering influenced by seasonal weather conditions and/or the microclimate effects (eg. exposure) of each particular site. *Lasiopetalum joyceae* has a restricted range occurring on lateritic to shaley ridgetops on the Hornsby Plateau south of the Hawkesbury River. It is currently known from 34 sites between Berrilee and Duffys Forest. Seventeen of these are reserved, though many are situated at the reserve edge and subject to subsequent edge effects such as nutrient enrichment and weed encroachment. Little is known about its ecology.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	No individuals of any of these three plants were recorded on the subject site, despite extensive targeted surveys undertaking across the most optimal survey times. The proposed action is unlikely to adversely effect upon the life cycle of the species. A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for the threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Vulnerable Herbs *Pimelea curviflora* var. *curviflora* *Tetratheca glandulosa* *Lasiopetalum joyceae*		
TSC Act Status: Vulnerable		
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – these species do not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – these species do not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. Within the APZ approximately 0.86 ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for all these threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Vulnerable Herbs *Pimelea curviflora* var. *curviflora* *Tetratheca glandulosa* *Lasiopetalum joyceae*		
TSC Act Status: Vulnerable		
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through the management of vegetation throughout the APZ areas, as well as the planting of local indigenous plants already present on the subject site that are compatible with each vegetation community. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. The majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,		Management Objectives and the devised actions for the Conservation for all three species were focused through site species actions in areas with known populations. The management activities that may equally be applied to the subject site are: ▪ Minimize disturbance from recreational users ▪ Maintain appropriate fire regime. ▪ Reduce and maintain weed densities at low levels ▪ Minimise accidental damage on road/track edges Within this subject site these issues have been addressed through the recommendation that only qualified bush management contractors be enlisted to carry out vegetation management works. All other access to bushland should be restricted. Fire will continue to be actively prevented and managed within the subject site and surrounding area. Well-timed ecological burns may be explored. Active weed removal by qualified bush regenerators will be undertaken across the entire subject site. Resource competition pressures from dead/senescing dense trees and shrubs, ground covers or leaf litter will

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Vulnerable Herbs *Pimelea curviflora* var. *curviflora* *Tetratheca glandulosa* *Lasiopetalum joyceae*	
TSC Act Status: Vulnerable	
	be reduced through manual thinning by qualified bush regenerators within APZ areas.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	Key Threatening Processes (KTPs) relevant to these species within the locality are: ▪ Clearing of native vegetation ▪ Invasion of native plant communities by exotic perennial grasses ▪ Grazing by the feral European Rabbit, *Oryctolagus cuniculus* ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Invasion, establishment and spread of *Lantana camara* ▪ Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants Each of these KTPs has been carefully considered within the complementary BMP (Narla 2017a). Key elements are briefly described here: APZ management of selective vegetation thinning has been developed to enhance rather than remove potential habitat. Weed management by Qualified Bush Regeneration contractors. Consideration of rabbit management action.
Conclusion There will be no significant effect on *Pimelea curviflora var. curviflora* or *Tetratheca glandulosa* therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS) for either species.	
References: NSW Office of Environment and Heritage (2016) Pimelea curviflora var. curviflora (*Pimelea curviflora var. curviflora*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10629 NSW Office of Environment and Heritage (2016) *Tetratheca glandulosa* – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10798 NSW Office of Environment and Heritage (2016) *Lasiopetalum joyceae*– Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10451 NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Narrow-leaf Finger Fern (*Grammitis stenophylla*)		
TSC Act Status: Endangered		
Species Ecology	Narrow-leaf Finger Fern grow in moist places (usually near streams) attached to rocks or in trees. It is generally associated with rainforest and moist eucalypt forests but has been found within a range of vegetation communities provided suitable moisture levels are present. It occurs in eastern Queensland and eastern NSW. In NSW it has been found on the south, central and north coasts and as far west as Mount Kaputar National Park near Narrabri. The Narrow-leaf Finger Fern is a little fern, growing in small colonies, with hanging or erect fronds. The simple, narrow fronds are mostly 1 - 5 cm long, 1 - 4 mm wide, dark green and smooth, and thin but leathery. The clumps of spores on the upper two-thirds of the back of the frond appear as dark circular or oval patches in rows either side of the midrib. The base of the frond stem is hairless, unlike that of the similar-looking Finger Fern *Grammitis billardieri*.	
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	No individuals of this species were found on the subject site, despite extensive targeted surveys in suitable habitat. Its presence cannot be ruled out so potential impacts upon this species will be assessed. The proposed action is unlikely to adversely effect upon the life cycle of the species. No suitable growing habitat (wet-sandstone cliff faces and boulders) will be destroyed or impacted as a result of the proposed action. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for the threatened species will remain within the APZ areas. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – this species does not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Narrow-leaf Finger Fern (*Grammitis stenophylla*)		
TSC Act Status: Endangered		
	occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed action is unlikely to adversely effect upon the life cycle of the species. No suitable growing habitat (wet-sandstone cliff faces and boulders) will be removed or modified as a result of the proposed action. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for all these threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All sandstone cliff faces and remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through the management of vegetation throughout the APZ areas, as well as the planting of local indigenous plants already present on the subject site that are compatible with each vegetation community. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. The majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) The proposed action is unlikely to adversely effect upon the life cycle of the species. No suitable growing habitat (wet-sandstone cliff faces and boulders) will be removed or modified as a result of the proposed action. Even if this habitat was altered or destroyed, it is not considered that the proposed action would have significant effect on the species as the habitat would not be considered essential to the species survival.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),		Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Narrow-leaf Finger Fern (*Grammitis stenophylla*)	
TSC Act Status: Endangered	
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	The OEH Species Action Statement for the Narrow-leaf Finger Fern states "This species is likely to be secure in NSW for the long term without targeted management, assuming adequate ongoing management of habitat within the public reserve system. This species is therefore a lower priority for investment than other, more threatened species that have urgent management requirements. Any change in the status of this species (e.g. decline in abundance or emergence of a significant threat) will trigger a shift to the Site-managed stream and the development of a conservation project, which will be prioritised for implementation."
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	Key Threatening Processes (KTPs) relevant to the continued survival of Narrow-leaf Finger Fern within the locality of the subject site are: ▪ Clearing of native vegetation Primary threats to this species which are not listed as KTPs are:- ▪ Damage to habitat by human visitation. ▪ Illegal collection by fern enthusiasts All three of these threats have been addressed within the BMP (Narla 2017a). Key element are to restrict public access to the high quality bushland which occurs within the subject site which holds the greatest potential to support this species. The greatest possible extent of native vegetation will be retain, protected and managed by qualified bush regenerators for the life of the proposed development.
Conclusion There will be no significant effect on the Narrow-leaf Finger Fern (*Grammitis stenophylla*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	
References: NSW Office of Environment and Heritage (2012) Narrow-leaf Finger Fern (*Grammitis stenophylla*)– Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10356 NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995 Assessment of Significance (7-part Test) For Ground Orchids: Bauer's Midge Orchid (*Genoplesium baueri*)[1] Angus's Onion Orchid (*Microtis angussi*)[2] Leafless Tongue Orchid (*Cryptostylis hunteriana*)[3]	
TSC Act Status: [1,2]Endangered	
[3]Vulnerable	
Species Ecology	The Bauer's Midge Orchid (*Genoplesium baueri)* is a ground orchid (herb). It grows to 6–15 cm high. The inflorescence is 1–3 cm long, with 1–6 flowers that are about 15 mm across and are green and red or wholly reddish. The species usually grows in heathland to shrubby woodland on sands or sandy loams or open forest, shrubby forest and heathy forest on well-drained sandy and gravelly soils. The species does not produce a new tuber at the end of each growing season; instead it persists from the one tuber-like perennial root. Flowering usually occurs from December to April .It is reported that the species is most often seen soon after fire. Despite favourable seasonal conditions, some plants do not regularly appear each year. When they do appear, plants are visible above ground for approximately two months before dying back into dormancy. The species is thought to number around 250 individuals over an area of 168km². It is known largely from historical records from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. Angus's Onion Orchid is a terrestrial orchid. Microtis species are commonly called 'onion orchids'. This refers to the leaves which are cylindrical like those of plants of the onion family. Grows to 25 - 60 cm tall with green, linear cylindrical and tapering leaves from 40 - 140 cm long and 4 - 8 mm wide. The leaves are usually much longer than the flowering stem which emerges from the leaf at about 12 - 20 cm above the soil. The flowering stem is 8 - 18 cm long and bears 20 - 60 small green flowers. Each flower is about 2.5 mm in diameter and bears a short, sharp but soft point, and is hood shaped. The flower is made up of two whorled sections, one within the other. Currently known from only one site at Ingleside, north of Sydney. A collection previously thought to be this species was made from Sunny Corner 100 km west of Sydney, but has since been confirmed as being genetically distinct and may possibly be a subspecies. The Ingleside population occurs on soils that have been modified but were originally those of the restricted ridgetop lateritic soils in the Duffys Forest - Terrey Hills - Ingleside and Belrose areas. These soils support a specific and distinct vegetation type, the Duffys Forest Vegetation Community which is listed as an endangered ecological community under the TSC Act and ranges from open forest to low open forest and rarely woodland. The Leafless Tongue Orchid has been recorded from as far north as Gibraltar Range National Park south into Victoria around the coast as far as Orbost. It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra (although it is uncommon at all sites). Also recorded at Munmorah State Conservation Area, Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park and Ben Boyd National Park. It does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*). Little is known about the ecology of the species; being leafless it is expected to have limited photosynthetic capability and probably depends upon a fungal associate to meet its nutritional requirements from either living or dead organic material. In addition to reproducing from seed, it is also capable of vegetative reproduction and thus forms colonies which can become more or less permanent at a site.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a	No individuals of any of these species were found on the subject site, despite extensive targeted surveys conducted at optimal times. The proposed action is unlikely to adversely effect upon the life cycle of the species. A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995 Assessment of Significance (7-part Test) For Ground Orchids: Bauer's Midge Orchid (*Genoplesium baueri*)[1] Angus's Onion Orchid (*Microtis angussi*)[2] Leafless Tongue Orchid (*Cryptostylis hunteriana*)[3]		
TSC Act Status: [1,2]Endangered		
[3]Vulnerable		
viable local population of the species is likely to be placed at risk of extinction,	revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for the threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – this species does not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not belong to an Endangered Ecological Community or Critically Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995 Assessment of Significance (7-part Test) For Ground Orchids: Bauer's Midge Orchid (*Genoplesium baueri*)[1] Angus's Onion Orchid (*Microtis angussi*)[2] Leafless Tongue Orchid (*Cryptostylis hunteriana*)[3]		
TSC Act Status: [1,2]Endangered		
[3]Vulnerable		
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i i) A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for all these threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through the management of vegetation throughout the APZ areas, as well as the planting of local indigenous plants already present on the subject site that are compatible with each vegetation community. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. The majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat supports no known individuals of these three species. If it did, it is not considered the habitat would be essential to the long-term survival of these species as suitable habitat would continue to exist on site and the immediate surrounds, active steps would be taken to relocate any individuals, all remaining habitat will be protected and managed in and most importantly, extensive suitable habitat for these three species will continue to occur in the surrounding Crown Land and National Parks.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995 Assessment of Significance (7-part Test) For Ground Orchids: Bauer's Midge Orchid (*Genoplesium baueri*)[1] Angus's Onion Orchid (*Microtis angussi*)[2] Leafless Tongue Orchid (*Cryptostylis hunteriana*)[3]	
TSC Act Status: [1,2]Endangered	
[3]Vulnerable	
	This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),	Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	Conservation actions for all three species were found to significantly overlap. A summary of the relevant actions to be applied to onsite management are: ▪ Minimise effects of recreational activities, i.e. reduce potential for trampling ▪ Maintain suitable drainage / hydrological regime ▪ Minimise effects of slashing on the species/habitat ▪ Manage weeds, particularly exotic grasses and herbaceous ▪ Identify appropriate fire regimes All of these actions have been considered and addressed within the BMP (Narla 2017b). Key elements are to reduce access to bushland/ potential habitat areas so that valuable flora is not unwittingly damaged by the public. Vegetation management will be only undertaken by suitably experienced Bush Regenerators, able to identify any threatened orchids that may emerge and adaptively provide suitable protection for the specimen's in-situ. Monitoring the effect of the proposed development on hydrology.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The KTPs relevant to the three listed orchid which may potential occur within the study area are:- ▪ Clearing of native vegetation ▪ Grazing by the feral European rabbit (*Oryctolagus cuniculus*) ▪ Invasion of native plant communities by exotic perennial grasses ▪ Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants ▪ Additional habitat areas across the subject site such as that within unlisted vegetation communities also have potential to harbour cryptic threatened species, such as ground orchids which are easily trampled.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995 Assessment of Significance (7-part Test) For Ground Orchids: Bauer's Midge Orchid (*Genoplesium baueri*)[1] Angus's Onion Orchid (*Microtis angussi*)[2] Leafless Tongue Orchid (*Cryptostylis hunteriana*)[3]	
TSC Act Status: [1,2]Endangered	
[3]Vulnerable	
	Each of these KTPs has been discussed within the BMP (Narla 2017a). Key elements are that vegetation management will be only undertaken by suitably experienced Bush Regenerators; the active suppression of fire and the prevention/ minimiseation of clearing native vegetation.

Conclusion

There will be no significant effect on any of the locally occurring Bauer's Midge Orchid, Angus's Onion Orchid or Leafless tongue Orchid therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).

References

NSW Office of Environment and Heritage (2016a) Bauer's Midge Orchid - profile (profile) http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10875
NSW Office of Environment and Heritage (2016b) Leafless Tongue Orchid - profile (profile) http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10187
NSW Office of Environment and Heritage (2016c) Angus's Onion Orchid - profile (profile) http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10531
NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Hairy Geebung (*Persoonia hirsuta*)		
TSC Act Status: Endangered		
Species Ecology	Found on sandy soils in dry sclerophyll open forest, woodland and heath on sandstone. Occurs in a scattered distribution around Sydney, distributed from Singleton in the north, along the east coast to Bargo in the south and the Blue Mountains to the west. It has been recorded within the nearby Ku-ring-gai National Park. This species has a large area of occurrence, but is usually present as isolated individuals or very small populations. This fragmentation within the landscape makes the species particular at risk of local extinction, with small scale clearing or habitat disturbance having the potential to wipe out local populations. It is likely killed by fire (as other Persoonia species are) but will regenerate from seed. One individual of this plant was tentatively recorded as being present on the subject site, by 'Blue Mountains Wilderness Services in 2004'. This specimen was never relocated by the author who discovered it. It is possible that the individual died. It is also possible that it was misidentified as the species can be confused with similar looking low-growing shrubs with, soft, hirsute-foliage. Several similar looking species occur on the subject site.	
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	The proposed action is unlikely to adversely effect upon the life cycle of the species. A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for the threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – these species do not belong to an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Hairy Geebung (*Persoonia hirsuta*)		
TSC Act Status: Endangered		
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for all these threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through the management of vegetation and competing pressures (such as weeds, extensive leaf litter and dense, senescing shrubs) throughout the APZ areas. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. The majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat supports no known individuals of these three species. If it did, it is not considered the habitat would be essential to the long-term survival of these species as suitable habitat would continue to exist on site and the immediate surrounds, active steps would be taken to relocate any individuals, all remaining habitat will be protected and managed in and most importantly, extensive suitable habitat for these three
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Hairy Geebung (*Persoonia hirsuta*)	
TSC Act Status: Endangered	
	species will continue to occur in the surrounding Crown Land and National Parks. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),	Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	Management Objectives and the devised actions for the Conservation of the Hairy Geebung aim to secure populations within the wild. This is focused through site species actions in areas with known populations. Cromer is the closest of these to the subject site and is located on the other side of Garigal National Park. The recommended management actions for this site are: ▪ Minimize disturbance from recreational users ▪ Maintain appropriate fire regime. Within the subject site these actions have been addressed through the recommendation that only qualified bush management contractors be enlisted to carry out bushfire management works. All other access to bushland should be restricted. Fire will continue to be actively prevented within the subject site and surrounding area. However the introduction of ecological burning program is recommended.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	Key Threatening Processes (KTPs) relevant to the continued survival of the Hairy Geebung within the locality of the subject site are: ▪ Clearing of native vegetation ▪ Invasion of native plant communities by exotic perennial grasses ▪ Grazing by the feral European Rabbit *Oryctolagus cuniculus* ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Invasion, establishment and spread of *Lantana camara* ▪ Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants ▪ Invasion and establishment of exotic vines and scramblers These KTPS have been addressed in detail within the complimentary BMP (Narla 2017a). Important elements are the continued bushfire prevention management, particularly through the removal of weedy vegetation.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Hairy Geebung (*Persoonia hirsuta*)
TSC Act Status: Endangered
Conclusion There will be no significant effect on the Hairy Geebung (*Persoonia hirsuta*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).
References: NSW Office of Environment and Heritage (2016) Hairy Geebung (*Persoonia hirsuta*) – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10595 NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Camfield's Stringybark (*Eucalyptus camfieldii*)	
TSC Act Status: Vulnerable	
Species Ecology	Camfield's Stringybark occurs on poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas. Associated species frequently include stunted species of *E. oblonga* Narrow-leaved Stringybark, *E. capitellata* Brown Stringybark and *E. haemastoma* Scribbly Gum. Population sizes are difficult to estimate because its extensive lignotubers may be 20 m across. A number of stems arise from these lignotubers giving the impression of individual plants. Flowering period is irregular, flowers recorded throughout the year. This species has poor response to too frequent fires. Restricted distribution in a narrow band with the most northerly records in the Raymond Terrace area south to Waterfall. Localised and scattered distribution includes sites at Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites in Royal National Park. No individuals of this plant were recorded on the subject site, during the site assessment. All of the stringybark trees bearing fruit and accessible leaves were identified as more common stringybark species. While no individuals were confirmed on the subject site, it does not rule out the potential for the species to occur.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	The proposed action is unlikely to adversely effect upon the life cycle of the species. A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. No individual Camfield's Stringybark will be removed from this area. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for the threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. No individual Camfield's Stringybark will be removed from this area. Any individual trees that resemble Camfield's Stringybark in APZ areas will be retained and protected. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. The proposed action will not cause a net loss in habitat resources and therefore will not have an adverse effect such that will be likely to reduce the viability of a local population, such that the species is likely to be placed at risk of extinction.
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – these species do not belong to an Endangered Population

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Camfield's Stringybark (*Eucalyptus camfieldii*)		
TSC Act Status: Vulnerable		
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	Not applicable – this species does not constitute an Endangered Ecological Community
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site. Within the APZ approximately 0.86ha of potential habitat occurs. This area will be managed by qualified Bush Regenerators by selective thinning of all layers of the vegetation to levels that meet the requirements of an APZ. Habitat for all these threatened species will remain within the APZ areas. Any individual plant that resembles the species will be protected and preserved, and the location noted for any future preservation and/or management. Extensive suitable habitat will remain on the subject site and in the adjoining Ku-ring-gai Chase National Park, which provides approximately 150km^2 of potential habitat. ii) All remnant bushland outside of the construction footprint it to be retained and protected (a total of 3.3 ha). Throughout and post the proposed development the complementary BMP (Narla 2017a) will guide enhancement of habitat through the management of vegetation throughout the APZ areas. The habitat on the subject site will not become fragmented from other areas. Connectivity will continue to occur to adjoining reserves on the Larool Road side of the bushland. The majority of remnant habitat on the subject site, including the location of habitat connectivity (the connection spans across Larool Road) will be retained (3.3 ha) and enhanced. iii) A small area of potential habitat available on the subject site (0.5 ha) will be removed by the proposed construction works. This includes 0.37 ha of good quality remnant habitat, and 0.13 ha of weed infested or partially cleared habitat. This habitat will be replaced through implementation of the landscape plan (0.33 ha) and restoration and revegetation of all weed infested areas on the subject site.
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Camfield's Stringybark (*Eucalyptus camfieldii*)	
TSC Act Status: Vulnerable	
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),	Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	Management activities relevant to application for this species within the subject site were to :- ▪ Measures should be taken to reduce the effect of arson e.g. Buffer zones around arson-prone areas to prevent spread of fire, as well as buffers around populations. ▪ Where fuel reduction is required to protect human life and property, mechanical means that leave populations intact should be pursued in preference to burning. ▪ Protect areas of known and potential habitat from clearing and disturbance. ▪ Prevent further loss and fragmentation of habitat. ▪ Investigate appropriate fire intervals and management practices. ▪ Undertake surveys within potential habitat All of these actions were considered carefully and contributed to the development of the BMP (Narla 2017a). Important elements are the continued prevention of bushfire, limiting access to the site available to the public, protection and retention of habitat. All vegetation management works are to be undertaken strictly by qualified bush regenerators able to identify this species should it emerge.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	Key Threatening Processes (KTPs) relevant to the continued survival of the Camfield's Stringybark within the locality of the subject site are: ▪ Clearing of native vegetation ▪ Infection of native plants by *Phytophthora cinnamomi* ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Invasion, establishment and spread of *Lantana camara* ▪ Invasion and establishment of exotic vines and scramblers These KTPS have been addressed in detail within the complimentary BMP (Narla 2017a). Important elements are the continued prevention of bushfire, the adherence to strict soil hygiene protocol and the removal of weedy vegetation by bush regeneration contractors who are able to identify even juvenile specimens of threatened flora species.
Conclusion There will be no significant effect on the Camfield's Stringybark (*Eucalyptus camfieldii*) therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for Camfield's Stringybark (*Eucalyptus camfieldii*)
TSC Act Status: Vulnerable

References

NSW Office of Environment and Heritage (2012) Camfield's Stringybark (*Eucalyptus camfieldii*)– Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10287

NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for *Duffys Forest ecological community in the Sydney Basin Bioregion*		
TSC Act Status: Endangered Ecological Community		
Species Ecology	Duffys Forest Ecological Community is the accepted name for the ecological community that is dominated by a combination of Silver-top Ash (*Eucalyptus sieberi*), Red Bloodwood (*Corymbia gummifera*) and Brown Stringybark (*Eucalyptus capitellata*) and occurs on the ridgetops, plateaus, upper slopes and occasionally mid slopes on Hawkesbury sandstone geology, typically in association with laterite soils and soils derived from shale and laminite lenses. It has the structural form predominantly of open-forest to woodland. The Duffys Forest Ecological Community has been reported from the Warringah, Pittwater, Ku-ring-gai, Hornsby and Manly Local Government Areas, although it may occur elsewhere in the Sydney Basin Bioregion.	
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	Not Applicable – Duffy's Forest is not a species.	
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – Duffy's Forest is not an Endangered Population	
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	i) The area containing quality Duffy's Forest EEC is considered unlikely to be significantly affected directly or indirectly by the proposed development and associated works. This vegetation community is located away from the development footprint. A small area of this community will be managed as an APZ (0.34 ha). This area will be managed by qualified bushland restoration professionals to ensure it meets the minimum canopy, shrub and ground-layer requirements of an 'Inner Protection Area' pursuant to the RFS approved recommendations of the Bushfire Report (Peterson 2017). No trees >20cm dbh will be removed. No unnecessary tree, shrub or ground cover removal will occur. Fuel-load management actions will only be undertaken by skilled and qualified bushland managers under guidance or supervision of a qualified Ecologist. Focus will be given on removing all weeds (as they contribute high fuel loads in the Duffys Forest EEC), thinning dense, dead or senescing tall shrub layers (that are out-competing other elements of the community), thinning dense leaf litter accumulations
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	

		and selectively removing dead branches or other branches from canopy trees (not hollow-bearing). Ground covers will be retained intact. All hollow-trees (including dead) will be retained. The structure and floristics of the entire APZ area within the Duffys Forest EEC will remain characteristic of moderate to good Duffys Forest EEC. The proposed fire tanker track will incur a total of 0.01 ha of select vegetation removal from the southernmost extent of the Duffys Forest EEC on the subject site (close to the boundary with the German School). The tanker track will be located entirely within an existing, purposely established APZ easement. The loss is approximately 0.005% of the total estimated area remaining in Warringah ward of Northern beaches LGA (Smith & Smith 2009). This area is entirely inside of the Coneyancing Act 1919 s.88b easement that was registered for bushfire management (including fire breaks and fire fighting access) and therefore does not require further assessment or mitigation under the proposed DA. The loss of this small slither of Duffy's Forest from the edge of a larger extent from this activity is considered insignificant. The presence of an easement purposely established over this area makes the impact even less significant. All significant fauna 'feed' shrubs and trees will be protected (or replaced elsewhere in the Duffys Forest if removed). Proposed APZ activities will assist in reducing competition pressures on groundcover, shrub germinates and tree germinates, and will provide the 'ecological' disturbance services of a well-timed low-intensity ecological burn. Established vegetation buffers will be retained in between the development and the Duffy's Forest EEC. The predicted shadow of the proposed development will not fall on areas which currently contain Duffy's Forest Community. A Conservation Area consisting of 0.95 ha of Duffys Forest Ecological Community will be conserved in perpetuity and managed for species diversity and habitat values. iii) The proposed development is not likely to substantially and adversely modify the composition of Duffys forest such that its local occurrence is likely to be placed at risk of extinction. The entire extent fo Duffys Forest originally mapped on the subject site (outside of the Coneyancing Act 1919 s.88b easement) will remain post development. It is considered that the proposed action may assist in the long-term viability of the Duffys Forest on the subject site, through the removal of resource pressures that prevent the germination of the seedbank and the promotion of successful growth of new seedlings.

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for *Duffys Forest ecological community in the Sydney Basin Bioregion*		
TSC Act Status: Endangered Ecological Community		
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) The proposed development will require the establishment of an IPA APZ which will overlap with the extent of Duffy's Forest EEC. The location and extent of the IPA APZ was proposed to minimise the required clearing or modification of the highest quality Duffy's Forest EEC located at the core of the patch. The management requirements of this APZ area may result in the minor modification of 0.34 ha of the community at its southern periphery. This area represents approximately 22% of the area of Duffy's Forest EEC which occurs within the subject site and 0.1% of the total estimated extent of the community (3,000 ha) in existence (OEH 2017a). This area will be managed by qualified bushland restoration professionals to ensure it meets the minimum canopy, shrub and ground-layer requirements of an 'Inner Protection Area' pursuant to the RFS approved recommendations of the Bushfire Report (Peterson 2017). Fuel-load management actions will only be undertaken by skilled and qualified bushland managers under guidance or supervision of a qualified Ecologist. Focus will be given on removing all weeds (as they contribute high fuel loads in the Duffys Forest EEC), thinning dense, dead or senescing tall shrub layers (that are out-competing other elements of the community), thinning dense leaf litter accumulations and selectively removing dead branches or other branches from canopy trees (not hollow-bearing). Ground covers will be retained intact. All hollow-trees (including dead) will be retained. The structure and floristics of the entire APZ area within the Duffys Forest EEC will remain characteristic of moderate to good Duffys Forest EEC. No unnecessary tree, shrub or ground cover removal will occur. All APZ management works will be strictly monitored and reported on by an experienced Ecologist with a report being submitted to council for record and review each year. The proposed fire tanker track will incur a total of 0.01 ha of select vegetation removal from the southernmost extent of the Duffys Forest EEC on the subject site (close to the boundary with the German School). The loss is approximately 0.005% of the total estimated area remaining in Warringah ward of Northern beaches LGA (Smith & Smith 2009). The tanker track will be located entirely within an existing, purposely established APZ easement. The loss of this small slither of Duffy's Forest from the edge of a larger extent from this activity is considered insignificant. The presence of an easement purposely established over this area makes the impact even less significant. All hollow-trees (including dead) will be retained. All significant fauna 'feed' shrubs and trees will be protected (or replaced elsewhere in the Duffys Forest
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for *Duffys Forest ecological community in the Sydney Basin Bioregion*	
TSC Act Status: Endangered Ecological Community	
	if removed). Proposed APZ activities will assist in reducing competition pressures on groundcover, shrub germinates and tree germinates, and will provide the 'ecological' disturbance services of a well-timed low-intensity ecological burn. ii) The proposed development will be confined within historically cleared land which does not provide suitable habitat for the Duffy's Forest Community. The commentary BMP (Narla 2017a) has provided guidelines to increasing habitat by the installation of flora relevant to the Duffy's Forest community in fringing areas in order to support greater habitat connectivity. In addition, bush regeneration works will aim to enhance the existing extent through noxious weed eradication, environmental weed management and encouragement of natural flora recruitment. iii) All areas which support viable patches of Duffy's Forest community are important. None of the community will be removed or fragmented as a result of the proposed development. Some modification will occur within periphery areas as required for APZ, which includes selective vegetation by qualified bush regenerators. This area will be managed by qualified bushland restoration professionals to ensure it meets the minimum canopy, shrub and ground-layer requirements of an 'Inner Protection Area' pursuant to the RFS approved recommendations of the Bushfire Report (Peterson 2017). No unnecessary tree, shrub or ground cover removal will occur. Fuel-load management actions will only be undertaken by skilled and qualified bushland managers under guidance or supervision of a qualified Ecologist. Focus will be given on removing all weeds, thinning dense, dead or senescing tall shrub layers (that are out-competing other elements of the community), thinning dense leaf litter accumulations and selectively removing dead branches or other branches from canopy trees (not hollow-bearing). Ground covers will be retained intact. All hollow-trees (including dead) will be retained. All significant fauna 'feed' shrubs and trees will be protected (or replaced elsewhere in the Duffys Forest if removed). Proposed APZ activities will assist in reducing competition pressures on groundcover, shrub germinates and tree germinates, and will provide the 'ecological' disturbance services of a well-timed low-intensity ecological burn.
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),	Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this EEC.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	The proposed development will be managed in a way which is consistent to the recovery strategies/ conservation activities of this species. For greater

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	detail refer to the BMP (Narla 2017a). Key elements area: ▪ The essential adoption and adherence to a strict hygiene protocol particularly by bush regeneration staff. ▪ A recommended ecological burn program implementing appropriate fire management practice at an interval of 8-12 years. ▪ Restricting public access through fencing off of Duffy's Forest areas. ▪ Restoration works undertaken by qualified bush regeneration contractors. ▪ Undertake priority weed control. ▪ Prevent ion of erosion and stormwater damage.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) are documented to effect upon the survival of Duffy's Forest EEC: ▪ Clearing of native vegetation ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition ▪ Infection of native plants by *Phytophthora cinnamomi* ▪ Removal of dead wood, dead trees and logs (as this affect the recycling of nutrients, and removes habitat for vertebrates, invertebrates and microbial organisms influencing long term survival) The proposed development will not exacerbate any of these KTPs. Broad vegetation clearing will not occur within the Duffy's forest community. Protective vegetation buffers will be retained or enhanced through installation of native plant relevant to the community. Hygiene protocols will be adopted and adhered to throughout works, particularly by all bush regeneration staff. Removal of some dead wood from the APZ may occur, however it may be redistributed into other parts of the Duffys Forest EEC, outside of the APZ.
Conclusion There will be no significant effect on *Duffys Forest Ecological Community in the Sydney Basin Bioregion* therefore the proposed action should not warrant the producing of a Species Impact Statement (SIS).	
References: NSW Office of Environment and Heritage (2015) Duffys Forest Ecological Community in the Sydney Basin Bioregion – Conservation Projects and Species Profile: http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10254 NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full	

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for *Coastal Upland Swamp ecological community in the Sydney Basin Bioregion*	
TSC Act Status: Endangered Ecological Community	
Species Ecology	Coastal Upland Swamp in the Sydney Basin Bioregion is the name given to the ecological community in the Sydney Basin bioregion associated with periodically waterlogged soils on Hawkesbury sandstone plateaus, generally where mean annual rainfall exceeds 950 mm. Coastal Upland Swamp is generally associated with soils that are acidic and vary from yellow or grey mineral sandy loams with a shallow organic horizon to highly organic spongy black peats with pallid subsoils. They vary in depth from a few centimetres to at least 4 metres. The vegetation is dominated by sclerophyll shrubs and/or sedges, with dynamic mosaics of structural forms that may include tall scrub, open heath and/or sedge land. Although typically treeless, Coastal Upland Swamp may include scattered trees.
(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – This is not a species.
(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,	Not applicable – This is not an Endangered Population

Environmental Planning and Assessment Act 1979 and Threatened Species Conservation Act 1995– Assessment of Significance (7-part Test) for *Coastal Upland Swamp ecological community in the Sydney Basin Bioregion*		
TSC Act Status: Endangered Ecological Community		
(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:	**(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**	i) This EEC will not be directly affected by vegetation clearing for the construction of the proposed hospital. The proposed hospital buildings and associated carparks will be located in close proximity to the Coastal Upland Swamp, however a proposed planted landscape buffer comprising vegetation representative of the Coastal Upland Swamp EEC will separate the Coastal Upland Swamp and the proposed buildings and ancillary structures (Carmichael Studios 2017). In the event that the proposed development caused an adverse impact to Coastal Upland Swamp within the subject site, the loss of total extent (0.17 ha) would constitute a loss of: ▪ 0.003% of the total current extent of this community in existence (5,360 ha) (NSW Scientific Committee 2012) ▪ 0.3% of the total occurrence of this community in the former Warringah Local Government Area (56.41 ha) (Smith and Smith 2009; Narla 2017). ▪ 12% of the local occurrence (the area between Cooyong Road and Dundundra Falls Reserve, including the subject site) in Terrey Hills Considering that the majority of the Coastal Upland Swamp was already impacted by the s88b easement, the impacts to be assessed under this SIS are restricted to the impacts to the small portion of Coastal Upland Swamp that protrudes outside of this easement (0.043ha). This would constitute a loss of: ▪ 0.00074% of the total current extent of this community in existence (5,360 ha) (NSW Scientific Committee 2012) ▪ 0.078% of the total occurrence of this community in the former Warringah Local Government Area (56.41 ha) (Smith and Smith 2009; Narla 2017). ▪ 3% of the local occurrence (the area between Cooyong Road and Dundundra Falls Reserve) in Terrey Hills Management of the defendable space will be undertaken by qualified bush regenerators with the aim of minimising the amount of slashing of Coastal Upland Swamp to meet the requirements outlined in RFS Guidelines. The proposed 'Defendable Space' between the building and the Coastal Upland Swamp will require slashing of 0.01 hectares of good condition Coastal Upland Swamp and 0.01 hectares of weed infested Coastal Upland Swamp. It is not expected slashing will affect the Coastal Upland Swamp assemblage, other than keeping the sedges to a low level. This is because slashing will only take place after the conclusion of the main flowering
	(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,	

		period for sedges and herbs (spring). Slashing will also focus on removing the fire hazard associated with senescent shrubs and weeds, rather than native Coastal Upland Swamp sedges and herbs. Groundwater flows will be maintained to the Coastal Upland Swamp by diverting the groundwater water around the underground carpark and into the Coastal Upland Swamp. The mechanism for this diversion has been proposed by Martens (2017). In addition to the diversion of water back into the Swamp, onsite water retention basins will be planted entirely with locally-indigenous Coastal Upland Swamp flora species. Water retention basins within the Coastal Upland Swamp will further recharge the EEC during periods of excessive rain. ii) Detailed management recommendations have been provided to guide the protection of this community in-situ in light of the proposed development. This includes the proposed installation of a buffer zone containing Coastal Upland Swamp species that will separating the exiting extent of the community from the proposed development footprint. The proposed installation of raingardens in association with onsite stormwater detention systems (OSD) has also been designed to mimic near natural water flows which will continue to support the area hydrologically (Martens 2017a;2017b; Carmichael Studios 2017). Further details of mitigation measures are described within the body of the complementary BMP (Narla 2017a). Despite the proposed impact mitigation measures, the complex interactions between abiotic (e.g. soil, aspect, hydrology) and biotic features (e.g. microbiological, floristic and faunal) of this community make it difficult to predict and mitigate the potential indirect effects of the proposed development upon the Coastal Upland Swamp EEC (e.g. from shading, altered hydrology etc.) In the unlikely event that the composition of the patch of Coastal Upland Swamp occurring within the subject site (covers 0.17 ha in total) was substantially or adversely modified as a result of the proposed development, the loss of this 0.17 ha patch of Coastal Upland Swamp would constitute a loss of 0.003% of the total extent of this community within NSW (5360 ha). Such a loss is categorised as insignificant to the survival of the community within NSW. Within Warringah estimates of the area covered by Coastal Upland Swamp are 55 ha (Warringah 2005), however this does not constitute all of the areas of this EEC that were not mapped during this study (such as the patch found on the subject site). The loss of the patch found within the subject site would constitute 0.3% of the EEC distribution in Warringah (Smith and Smith 2009). As this estimated extent was based largely on course aerial mapping undertaken 13 years ago it is purely indicative and is likely to significantly under-estimate the true extent of the community within the

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		locality. It is not expected that a loss of 0.3% of the total extent of this community would constitute a significant effect on its local occurrence such that it is likely to be placed at risk of extinction.
(d) in relation to the habitat of a threatened species, population or ecological community:	**(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**	i) A maximum of 0.02 ha of Coastal Upland Swamp will be managed as part of a 10m buffer of 'defendable space' between the building and the remaining Coastal Upland Swamp. This will involve slashing the shrub and sedge layer to reduce fuel loads for fire. Over half of this consists of already weed infested, edge-affected vegetation. No hard surfaces, aggregates or landscaping will take place in this area The proponent intends on protecting the entire remaining existing extent of Coastal Upland Swamp to be conserved within the subject site for the life of the proposed development. No direct clearing of Coastal Upland Swamp will take place. The proponent intends on restoring and extending the area of Coastal Upland Swamp on the subject site through active planting and bushland regeneration actions. The proposed auxiliary raingardens around the OSD, and the vegetated buffer zone around the Coastal Upland Swamp will aim to increase this extent. The proponent aims to eradicate all weeds from the Coastal Upland Swamp on the subject site in order to improve the condition of the vegetation and its native flora and fauna components. Despite this, in the unlikely event that the Coastal Upland Swamp is affected by the proposed development, the extent totals 0.17 ha. This extent equals approximately 0.003% of the total extent of the community within NSW, and less than 0.3% of the known extent within the Warringah locality (Smith and Smith 2009). ii) The area of Coastal Upland Swamp is an isolated patch which does not adjoin any known patches which occur in the direct vicinity. The only connectivity between the patch on the subject site, and surrounding patches is through spread of propagules, particularly pollen, by long-distance migratory honeyeaters such as Yellow-faced Honeyeater, Red Wattlebird, Little Wattlebird and Eastern Spinebill. The proposed development will not exacerbate this fragmentation or isolation. Honeyeaters will still be able to visit this patch and spread propagules with adjoining patches. iii) If the patch of Coastal Upland Swamp occurring within the subject site (covers 0.17 ha in total) was substantially or adversely modified as a result of the proposed development, the loss of this 0.17 ha patch of Coastal Upland Swamp would constitute a loss of
	(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and	
	(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,	

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	0.003% of the total extent of this community within NSW (5360 ha). Such a loss is categorised as insignificant to the survival of the community within NSW. Within Warringah estimates of the area covered by Coastal Upland Swamp are 56.41 ha (Warringah 2005), however this does not constitute all of the additional areas of this EEC that were mapped during this study (such as the patch found on the subject site and the extensive network in Dundundra Falls Reserve). The loss of the patch found within the subject site would constitute 0.3% of the EEC distribution in Warringah (Smith and Smith 2009).
(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),	Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this EEC.
(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,	OEH is currently developing a targeted approach for managing Ecological Communities. In the interim, the following management actions have been identified for this community. ▪ The extent and condition of this ecological community will be improved or maintained primarily via positive management consistent with Catchment Action Plans, water management plans, and by regulating clearing. Where it occurs on private lands, this ecological community will also benefit from voluntary agreements with landholders to manage the land for conservation purposes. Within the subject site the total area of Coastal Upland Swamp will be conserved and managed through implementation of the VMP (Narla 2017a). This will also provide for long term management of the community in-situ, including weed removal and expansion of this EEC within the subject site through direct revegetation efforts.
(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the effect of, a key threatening process.	The following Key Threatening Processes (KTPs) are documented to effect upon the survival of this EEC: ▪ Clearing of native vegetation ▪ High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition The proposed development will not exacerbate any of these KTPs. Vegetation clearing will not occur within the extent of Coastal Upland Swamp, and protective vegetation buffers will be retained or enhanced through installation of native plant relevant to the community. Fire will be continued to be actively suppressed.

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for
Coastal Upland Swamp ecological community in the Sydney Basin Bioregion

TSC Act Status: Endangered Ecological Community

Conclusion
There was considered insufficient data to accurately determine the effect of the proposed development on *Coastal Upland Swamp in the Sydney Basin Bioregion* within the locality. Whilst on a state-wide basis the effect was deemed insignificant it is recommended that further study be undertaken.

References:
NSW Office of Environment and Heritage (2016) Coastal Upland Swamp in the Sydney Basin – Conservation Projects and Species Profile http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=20261
NSW Government (2016) Threatened Species Conservation Act 1995 101- Schedule 3: Key Threatening Processes, NSW Legislation http://www.legislation.nsw.gov.au/#/view/act/1995/101/full
Office of Environment and Heritage (OEH) (2012) Coastal Upland Swamp in the Sydney Basin Bioregion - endangered ecological community listing, NSW Scientific Committee - final determination http://www.environment.nsw.gov.au/determinations/coastaluplandswampfd.htm

Warringah Council (2005) Warringah Natural Area Study- Vegetation communities and plant species, Report prepared for Warringah Council by Peter Smith and Judy Smith of P&J Smith Ecological Consultants, August 2005
Smith, P. and Smith, J. (2009) Warringah Natural Area Survey: Vegetation History and Wildlife Corridors 2009 Update
Threatened Species Scientific Committee (TSSC) (2014) Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (s266B) Conservation Advice (including listing advice) for Coastal Upland Swamps in the Sydney Basin Bioregion

Appendix H: Field Data Sheets

Appendix I: Flora and Fauna Assessment – 4A Larool Road, Terrey Hills

Appendix J: Biodiversity Management Plan – 4A Larool Road, Terrey Hills

NARLA

environmental

Eastern Sydney Office
2/26-30 Tepko Road
Terrey Hills
NSW 2084

Western Sydney Office
7 Twenty-fifth Avenue
West Hoxton
NSW 2171

Hunter Valley Office
10/103 Glenwood Drive
Thornton
NSW 2322

www.narla.com.au

Ph: 02 9986 1295