Sealark Pty Ltd
C/- Allen Price & Scarratts

Integrated Water Cycle Management Plan (IWCMP): Callala Bay Expansion Area, Callala Bay, NSW

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT


P1806796JR01V08
January 2022

Copyright Statement

Limitations Statement

The sole purpose of this report and the associated services performed by Martens & Associates Pty Ltd is to prepare an integrated water cycle management plan in accordance with the scope of services set out in the contract / quotation between Martens & Associates Pty Ltd and Sealark Pty Ltd C/- Allen Price & Scarratts (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.

Martens & Associates Pty Ltd derived the data in this report primarily from a number of sources which may include for example site inspections, correspondence regarding the proposal, examination of records in the public domain, interviews with individuals with information about the site or the project, and field explorations conducted on the dates indicated. The passage of time, manifestation of latent conditions or impacts of future events may require further examination / exploration of the site and subsequent data analyses, together with a re-evaluation of the findings, observations and conclusions expressed in this report.

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).

The findings, observations and conclusions expressed by Martens & Associates Pty Ltd in this report are not, and should not be considered an opinion concerning the completeness and accuracy of information supplied by others. No warranty or guarantee, whether express or implied, is made with respect to the data reported or to the findings, observations and conclusions expressed in this report. Further, such data, findings and conclusions are based solely upon site conditions, information and drawings supplied by the Client *etc*. in existence at the time of the investigation.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between Martens & Associates Pty Ltd and the Client. Martens & Associates Pty Ltd accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

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**	
A. van Gogh Brenna Nichols		Andrew Norris		Andrew Norris			
Revision No.	**Description**	**Status**	**Release Date**	**Document Location**			
				File Copy	Client		
1	Preliminary design	Draft	18/02/2019	1E, 1P, 1H	1P		
2	For submission	Final	15/03/2019	1E, 1P, 1H	1P		
3	For discussion	Draft	25/01/2021	1E, 1P, 1H	1P		
4	For discussion	Draft	08/02/2021	1E, 1P, 1H	1P		
5	For submission	Final	10/02/2021	1E, 1P, 1H	1P		
6	Response to Council Comments	Final	02/06/2021	1E, 1P, 1H	1P		
7	Response to Council Comments for Client Comment	Final	19/01/2022	1E, 1P, 1H	1P		
8	Response to Council Comments	Final	27/01/2022	1E, 1P, 1H	1P		

Distribution Types: F = Fax, H = hard copy, P = PDF document, E = other electronic format. Digits indicate number of document copies.

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

Contents

1 INTRODUCTION 6

1.1 Scope 6

1.2 Relevant Guidelines 6

2 SITE DESCRIPTION 7

2.1 Site Description and Location 7

2.2 Future Development 7

3 STORMWATER QUALITY ASSESSMENT 8

3.1 Stormwater Quality Objectives 8

3.2 Modelling Methodology 8

3.2.1 Overview 8

3.2.2 MUSIC Models 9

3.3 Input Parameters 10

3.3.1 Climate Data 10

3.3.2 Effective Impervious Area 10

3.3.3 Catchment Area Details 10

3.3.4 Source Node Parameters 11

3.3.5 Treatment Train Input Parameters 12

3.4 Treatment Train Philosophy 12

3.4.1 Rainwater Tank 12

3.4.2 Gross Pollutant Traps 12

3.4.3 Bioretention Basins 13

3.4.4 Stormwater Ponds 14

3.5 MUSIC Results 14

3.5.1 Scenario 1 - Stormwater Quality Results 14

3.5.2 Scenario 2 – Stormwater Reuse Sensitivity Analysis Results 15

3.5.3 Scenario 3 - Wetland Sensitivity Analysis Results 15

3.5.4 Pond Water Balance Results 16

3.6 Discussion 17

3.6.1 Scenario 1 - Stormwater Quality 17

3.6.2 Scenario 2 - Stormwater Reuse Sensitivity Analysis 18

3.6.3 Scenario 3 - Wetland Sensitivity Analysis 18

3.6.4 Pond Water Balance 19

3.7 Conclusion of Stormwater Quality Modelling 19

4 STORMWATER QUANTITY ASSESSMENT 21
4.1 Water Quantity Objectives 21
4.2 Modelling Methodology and Approach 21
4.2.1 Overview 21
4.2.2 Approach 21
4.2.3 Modelling Set Up 22
4.2.4 Rainfall/IFD Data 22
4.2.5 Catchment Areas 22
4.3 DRAINS Results 22
4.4 Discussion 23
4.4.1 Provision of OSD 23
4.4.2 Depth of OSD Ponding Above Bioretention Basin 24
4.4.3 Depth of OSD Ponding Above Permanent Pool 24
4.5 Conclusion of Stormwater Quantity Modelling 24
5 WATERCOURSE ASSESSMENT 25
5.1 Overview 25
5.2 Watercourse mapping 25
5.3 Walkover Inspection 26
6 RESPONSES TO AGENCY COMMENTS 27
6.1 NSW Office of Environment and Heritage 27
6.2 NSW Department of Primary Industry Fisheries 27
6.3 Shoalhaven City Council 28
7 CONCLUSION 31
7.1 Overview 31
7.2 Stormwater Quality 31
7.3 Stormwater Quantity 31
7.4 Watercourse Assessment 31
8 REFERENCES 32
9 ATTACHMENT A – SUBDIVISION LAYOUT 33
10 ATTACHMENT B – PLANSET 37
11 ATTACHMENT C – SUMMARY OF MUSIC INPUT PARAMETERS 41

1 Introduction

1.1 Scope

Martens & Associates Pty Ltd (**MA**) have prepared this report to support the proposed rezoning for residential use of Sealark's lands at the corner of Callala Beach Road and Emmett Street, Callala Bay (**the Site**) in Shoalhaven City Council (SCC) (**Council**) Local Government Area (**LGA**).

This document provides an assessment of the likely effects of residential development upon the Site in relation to stormwater quality and flows and documents a proposal to mitigate potential detrimental impacts. This report has been prepared to advise the required types, areas and sizes of water quality and quantity treatment devices.

A previous version of this report (dated 13 March 2019) was submitted and has been assessed with comments provided by the NSW Office of Environment and Heritage (**OEH**) and NSW Department of Primary Industry (**DPI**) Fisheries, refer to Section 6.1 and Section 6.2. This version of the report includes subdivision layout and engineering design modifications to address comments raised by SCC, refer to Section 6.3.

The updated stormwater management solution provides treatment for TN, TP and TSS to achieve post development loads not more than pre development loads (referred to as the Neutral or Beneficial effect). Further sensitivity analysis of alternative stormwater treatment train solutions (reduced rainwater tank reuse rates and wetlands substituted for bioretention basins) have been developed and documented as a result of consultation with Council in 2021.

1.2 Relevant Guidelines

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

- Shoalhaven City Council Development Control Plan (**SDCP**) (2020).
- NSW MUSIC Modelling Guidelines (2015), compiled by BMT WBM.
- NSW Department of Water and Energy (**DWE**) (2008) *NSW Guidelines for Greywater Reuse in Sewered, Single Household Residential Premises*
- Facility for Advancing Water Biofiltration (**FAWB**) (2009) *Stormwater Biofiltration Systems Adoption Guidelines*

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 20 DP 1263402; Lots 9, 10, 11, 17, 18, DP 253793; Lots 599-628, DP 11388
Local Government Area	Shoalhaven City Council
Site Area	Approximately 38 ha
Existing Site Development	Limited development with internal unsealed access tracks.
Neighbouring Environment	Low density residential properties east, Emmett Street south and Callala Beach Road to the west. Directly north of the Site is forest.
Site Topography	Gently sloping terrain.
Site Aspect and Typical Slope	The Site generally has a southerly aspect, with grades largely between approximately 0 % and 5 %. Site elevation ranges between approximately 30 mAHD (northwestern site corner) and 8 mAHD (southern boundary).
Site Drainage	Via overland flow to Emmett Street, existing culverts convey flow to the southern side of Emmett Street.
Vegetation	Forest

2.2 Future Development

Future development will likely include (refer to Attachment A):

- 374 individual lots.
- Construction of internal roads network.
- Construction of a stormwater drainage network.
- Water quality and water quantity treatment devices.
- Bulk earthworks across the Site.
- Construction of dwellings and associated residential structures.
- Public reserves.

3 Stormwater Quality Assessment

3.1 Stormwater Quality Objectives

SDCP Section A10.2 requires the following stormwater quality pollutant load reduction (of the post development average annual load of pollutants) criteria be achieved at a minimum:

- 80% reduction in total suspended solids (**TSS**).
- 45% reduction in total phosphorus (**TP**).
- 45% reduction in total nitrogen (**TN**).

Given the Site's location and downstream wetland ecosystem, NSW Department of Planning and Environment requires a water quality management strategy developed to achieve a Neutral or Beneficial Effect (**NorBE**) on water quality of coastal water bodies in their Gateway Determination issued 13th July 2018.

To address both Shoalhaven City Council and NSW DoPE's requirements, the proposed water quality objectives are:

- SDCP (2014) pollutant load reduction criteria.
- NorBE.

3.2 Modelling Methodology

3.2.1 Overview

Model for Urban Stormwater Improvement Conceptualisation (*MUSIC*, Version 6.3) developed by eWater for Catchment Hydrology was used to evaluate the treatment train effectiveness (**TTE**) and pre development and post development pollutant generation from the proposed development area. Modelling has been undertaken in accordance with NSW MUSIC Modelling Guidelines (2015) and includes water quality treatment devices required to achieve adopted objectives.

The future conceptual layout was provided by Allen Price & Scarratts, refer to Attachment A. Pre development and post development MUSIC model layouts are provided in Attachment B.

3.2.2 MUSIC Models

To meet all stipulated stormwater objectives three MUSIC models were created. The source nodes remain unchanged in all models. The differences and aims for each model are described below:

1. **Scenario 1 (P1806796MUS03V01):** This model was used to determine overall water quality requirements and perform a water balance assessment on the ponds.

2. **Scenario 2 (P1806796MUS03V02):** This model was used for a sensitivity analysis to determine the effect holiday houses, and the associated reduction in stormwater reuse, would have on the development.

3. **Scenario 3 (P1806796MUS03V03)**: This model was used for a sensitivity analysis to compare how much area would be required if wetlands were used as water quality devices instead of the proposed bioretention basins.

To achieve the above aims, the following scenarios were analysed for each MUSIC model:

- **Pre development:** The existing site was modelled to determine baseline pollutant generation rates for TSS, TP, TN and GP.

- **Post development (untreated):** The developed site was modelled without any water quality improvement devices.

- **Post development (treated):** The developed site was modelled, including water quality improvement devices to achieve SDCP pollutant reduction requirements.

The MUSIC models include all areas that are disturbed by the proposed development or drain to stormwater quality treatment devices. An iterative approach was used to determine appropriate sizes of stormwater treatment devices.

Areas where the existing land cover will not be disturbed have been excluded from the model. This includes the area preserved for the protection of *Genoplesium Orchid* which does not drain to water quality treatment devices.

3.3 Input Parameters

3.3.1 Climate Data

MUSIC was run using the Jervis Bay pluviograph data obtained from *eWater*. The data was run on a 6-minute time step from 10/10/2001 – 31/05/2008. Average monthly evapotranspiration data was based on *Climatic Atlas of Australia Evapotranspiration* (BoM, 2001) as recommended in NSW MUSIC Modelling Guidelines (2015).

3.3.2 Effective Impervious Area

The MUSIC model requires an estimate of the effective impervious area (**EIA**) as a percentage of each catchment. EIA represents the impervious area that contributes to surface runoff observed at the outlet during days where the daily rainfall exceeds the rainfall threshold. It is the proportion of total impervious surfaces that are linked by a continuous series of impervious surfaces. NSW MUSIC Modelling Guideline (2015) provides guidance for converting expected total impervious areas (**TIA**) to EIA.

EIAs for sub catchments modelled in MUSIC consisted of the adopted parameters summarised in Table 2.

Table 2: Factors used to determine EIA percentages.

Catchment	Typical Area (m^2)	TIA (%)	EIA Factor[1]	EIA (%)
Forest	Varies	0	0.00	0
Residential Lot Area[2]	500	80[3]	0.60	48
Revegetated Land	Varies	25[3]	0.05	1
Sealed Road (Road Reserve)	Varies	43[4]	1.00	43
Roof Area	250[4]	100	1.00	100
Unsealed Road	Varies	100	0.50	50

Notes

1. Based on NSW MUSIC Modelling Guidelines Table 5-3.
2. EIA for whole lot area including roof.
3. Based on SDCP.
4. Based on an analysis of aerial imagery of nearby local developments.

3.3.3 Catchment Area Details

Catchment areas were divided into roofs, sealed roads, residential, forest and unsealed road land uses. The Site is separated into eastern, western and southern catchments and catchment areas bypassing treatment devices. Catchment area details, including EIA, for pre and post scenarios are provided in Table 3 and Table 4.

Table 3: Pre development scenario catchment areas.

Music Node ID	Description	Area (ha)	EIA %
1B01	Forest	34.73	0
1B02	Existing cleared land	2.39	0
1B03	Unsealed road	1.49	0.5
	Total – area	38.61	= 100 % of overall area
	Total – impervious	0.75	= 2 % of overall area
	Total – pervious	37.87	= 98 % of overall area

Table 4: Post development scenario catchment details.

Music Node ID	Description	Area (ha)	EIA %
1C01	Roof area west	4.45	100%
1C03	Roof area east	4.53	100%
1C06	Roof area south	0.38	100%
1C07	Road reserve west	4.30	43%
1C08	Road reserve east	4.30	43%
1C09	Road reserve south	0.13	43%
1C11	Remaining lot area west	5.61	6%
1C13	Remaining lot area east	5.73	7%
1C16	Remaining lot area south	0.57	14%
1C17	Open space west	1.17	1%
1C18	Open space east	1.56	1%
1C19	Open space bypass	0.06	1%
1C20	Public reserve west	2.46	1%
1C21	Public reserve bypass	3.39	1%
	Total – area	38.61	= 100 % of overall area
	Total – impervious	14.03	= 36 % of overall area
	Total – pervious	24.58	= 64 % of overall area

Notes

1. Calculated to ensure total lot area is 48% EIA.

3.3.4 Source Node Parameters

Modelled pervious area parameters were based off the values provided within NSW MUSIC Modelling Guideline (2015) Table 5-5. A silty clay soil type was adopted for the modelling based on borehole logs taken at the Site. Stormwater pollutant parameters were adopted from NSW MUSIC Modelling Guideline (2015) Tables 5-6 and 5-7. Source node parameters are provided in Attachment C.

3.3.5 Treatment Train Input Parameters

Individual input parameters for all treatment nodes are consistent with NSW MUSIC Modelling Guidelines (2015) and are provided in Attachment C.

3.4 Treatment Train Philosophy

The stormwater treatment strategy for the proposed subdivision uses roof water capture and reuse in combination with end of line controls to ensure treatment objectives are satisfied. Individual stormwater quality improvement devices (SQIDs) for the proposed development are outlined in the following sections.

3.4.1 Rainwater Tank

A rainwater tank will be provided on each future dwelling to capture roof water for reuse. Captured water shall be used for toilet flushing, laundry uses and outdoor irrigation. The following was included in the modelling:

1. 374 x 6 kL rainwater tank for each of the anticipated residential lots modelled at 80% of the volume capacity.

2. An average internal daily reuse rate of 0.265 kL/day/dwelling based on DWE (2008).

3. An annual external reuse rate of 55 kL/year/dwelling based on NSW MUSIC Modelling Guidelines (2015) for 500 m^2 lots.

A BASIX certificate can generally be satisfied for individual dwellings with 3 kL rainwater tanks. The water quality treatment train requires 6 kL rainwater tanks which will likely exceed the minimum BASIX requirements.

3.4.2 Gross Pollutant Traps

Three Rocla CDS gross pollutant trap (**GPT**) devices are proposed as the primary treatment device to remove trash, debris and coarse sediments from the stormwater runoff. The modelled treatment efficiency of the Rocla CDS GPT is based on manufacturer's specifications.

It is understood that Council prefers trash racks to GPTs unless it is demonstrated the proposed device meets specific criteria outlined in SDCP Section A11.8. Table 5 outlines how Rocla CDS GPTs are able to meet Council criteria and should be accepted for use in the stormwater treatment train.

Table 5: Council acceptance criteria for GPTs (SDCP, 2014).

Council Criteria	Comment
The device can achieve the desired treatment performance	Demonstrated by MUSIC model results, refer to Section 3.5.
The maintenance costs are less than that of an equivalent conventional device	Rocla CDS can be cleaned by mechanical grab or by removing the basket, equivalent to a trash rack.
No specialist equipment is required to carry out maintenance activities	
Major consumable parts e.g. filters and cartridges are not required to be purchased.	Rocla CDS has no consumable parts.

The proposed Rocla CDS unit has similar maintenance needs and requirements to a trash rack. Consequently, an impact analysis was not considered necessary to determine potential increases to the bioretention basins or stormwater ponds if a trash rack were used.

3.4.3 Bioretention Basins

Two bioretention basins have been modelled to treat the eastern and western catchments respectively. Each bioretention basin will have an integrated stormwater pond to provide a combined stormwater quality and quantity system. Subdivision layout provided in Attachment A shows indicative bioretention and pond locations. The bioretention basin and stormwater pond locations are located at the bottom of the catchment areas.

Stormwater generated by the development area (with exception of bypass areas shown in Attachment B) will be conveyed by way of pit and pipe to flow control structures upslope of the water quality treatment areas. The bioretention basins shall treat low flow stormwater runoff approximately up to 4EY while high flows will be diverted to the stormwater pond.

The lined bioretention basins provide treatment through filtration, evapotranspiration and detention. Treated flows from the bioretention basin are to be discharged from the bioretention basin into the receiving environment and not into the adjacent stormwater pond. An overview of preliminary bioretention basin specifications are provided in Table 6 and all parameters are provided in Attachment C.

Table 6: Summary of bioretention basin details.

Parameter	Western Basin	Eastern Basin
Surface Area (m^2)	3,900	3,900
Filter Area (m^2)	3,900	3,900
Filter Depth (m)[1]	0.4	0.4
Extended Detention Depth (m)[2]	0.3	0.3

Notes

1. Parameter based on recommended filter depth ranges provided by FAWB Stormwater Biofiltration Systems Adoption Guidelines Section 2.
2. Parameter based on SDCP Section A5.6.

3.4.4 Stormwater Ponds

Two permanent stormwater ponds, for the eastern and western catchments respectively, have been integrated into the stormwater management strategy. The stormwater ponds are designed to capture the high flow bypass from the bioretention basins as described in Section 0.

The primary purpose of the stormwater ponds is the control of flows, the secondary purpose is to improve water quality. The ponds are designed to enable urban runoff to be retained and detained to reduce the rate of stormwater release as part of the combined bioretention, stormwater pond and OSD system. An overview of preliminary stormwater pond specifications are provided in Table 7 and all parameters are provided in Attachment C.

Table 7: Summary of stormwater pond details.

Parameter	Western Basin	Eastern Basin
Surface Area (m^2)	2780	2150
Permanent Pool Depth (m)[1]	1.5	1.5
Permanent Pool Volume (m^3)	3170	2310
Extended Detention Depth (m)	0.75	0.95

Notes

1. Parameter based on SDCP Supporting Document 1 Section 2.2.3.

3.5 MUSIC Results

3.5.1 Scenario 1 - Stormwater Quality Results

Results of the MUSIC model Scenario 1 are summarised in Table 8 and Table 9 and indicate that post development water quality objectives are satisfied by the proposed stormwater treatment train.

Table 8: Scenario 1 MUSIC TTE results.

Parameter	Sources	Residual Load	Achieved Reduction	Required Reduction	Complies (Y/N)
TSS (kg/year)	37600	3660	-90.3%	-80%	Y
TP (kg/year)	75.1	19.0	-74.7%	-45%	Y
TN (kg/year)	559	197	-64.8%	-45%	Y

Table 9: Scenario 1 MUSIC NorBE results.

Parameter	Pre Development	Post Development	% Change	Complies (Y/N)
TSS (kg/year)	22200	3660	-83.5%	Y
TP (kg/year)	23.6	19.0	-19.5%	Y
TN (kg/year)	207	197	-4.8%	Y

3.5.2 Scenario 2 – Stormwater Reuse Sensitivity Analysis Results

Results of the MUSIC model Scenario 2 are summarised in Table 10 and Table 11 and indicate that post development water quality objectives are satisfied by the proposed stormwater treatment train with inclusion of a 35% reduction in reuse rates due to some dwellings being assumed to be used as holiday houses.

Table 10: Scenario 2 MUSIC TTE results.

Parameter	Sources	Residual Load	Achieved Reduction	Required Reduction	Complies (Y/N)
TSS (kg/year)	38100	3710	-90.3%	-80%	Y
TP (kg/year)	75.9	19.6	-74.2%	-45%	Y
TN (kg/year)	558	201	-64.0%	-45%	Y

Table 11: Scenario 2 MUSIC NorBE results.

Parameter	Pre Development	Post Development	% Change	Complies (Y/N)
TSS (kg/year)	22500	3710	-83.5%	Y
TP (kg/year)	22.9	19.6	-14.4%	Y
TN (kg/year)	209	201	-3.8%	Y

3.5.3 Scenario 3 - Wetland Sensitivity Analysis Results

Results of the MUSIC model Scenario 3 are summarised in Table 12 and Table 13 and indicate that post development water quality objectives are satisfied by the proposed stormwater treatment train. Wetland sizes were iteratively expanded until objectives were met.

Table 12: Scenario 3 MUSIC TTE results.

Parameter	Sources	Residual Load	Achieved Reduction	Required Reduction	Complies (Y/N)
TSS (kg/year)	38500	4380	-88.6%	-80%	Y
TP (kg/year)	75.9	16.9	-77.7%	-45%	Y
TN (kg/year)	552	202	-63.4%	-45%	Y

Table 13: Scenario 3 MUSIC NorBE results.

Parameter	Pre Development	Post Development	% Change	Complies (Y/N)
TSS (kg/year)	22400	4380	-80.4%	Y
TP (kg/year)	23.0	16.9	-26.5%	Y
TN (kg/year)	207	202	-2.4%	Y

3.5.4 Pond Water Balance Results

Council has expressed concern that catchment sizes may be insufficient to maintain permanent ponds and that algal blooms may result from insufficient inflow. A water balance assessment for the eastern and western ponds in Scenario 1 has been undertaken over the modelling period with the results shown below in Figure 1.

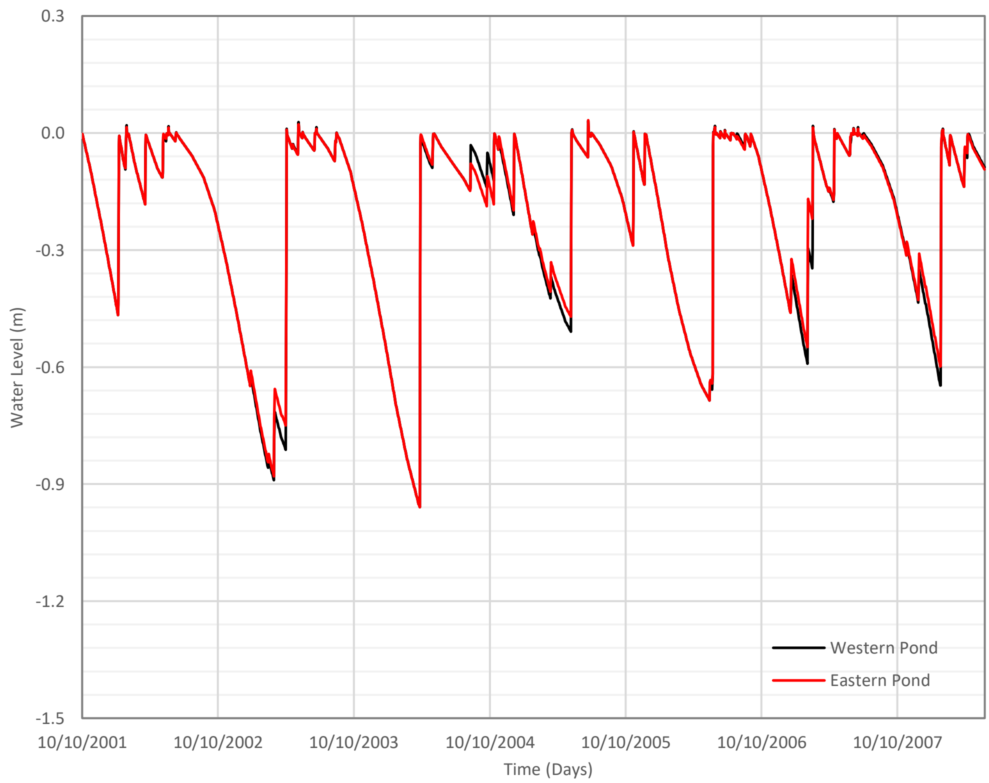


Figure 1: Pond water level fluxes over the modelled period.

Water levels are defined as:

1. 0 m represents the maximum level of standing water within the stormwater pond.

2. > 0 m means the stormwater pond is spilling water, this occurs until inflows cease and the water levels reaches 0 m (i.e. top water level).

3. < 0 m represents the drawdown of the stormwater pond's permanent pool. The stormwater pond has an average permanent pool depth of 1.5 m. If the stormwater pond draws down to -1.5 m than the stormwater pond has 'run dry'.

3.6 Discussion

3.6.1 Scenario 1 - Stormwater Quality

The results demonstrate that the proposed stormwater quality management system is sufficient to achieve adopted objectives. The stormwater quality management system is able to reduce the developed conditions pollutant generation below the existing load for the pollutants.

There are differences to the overall pollutant loads between previously submitted modelling. These model differences are attributed to:

1. An increase in the area modelled for both the pre and post development to better reflect the existing condition of the Site and the proposed development.

2. Subdivision layout changes that resulted in additional lots creating greater impervious areas and higher rates of stormwater reuse.

3. The use of different proprietary devices, GTPs changing from the Humes Humegards to the Rocla CDS units.

4. More complete characterisation of the predevelopment catchment conditions to include unsealed roads through the Site.

5. The stochastic method of calculating generated pollutants.

Water quality modelling results are preliminary only and treatment train design should be further refined at detailed design stage of the development.

3.6.2 Scenario 2 - Stormwater Reuse Sensitivity Analysis

Scenario 2 was modelled to determine the impact of some dwellings being only intermittently used for holiday purposes. Holiday homes will consume significantly less stormwater through reuse than continually occupied dwellings.

To assess the impact, Scenario 1 was updated with a 35% reduction in the nominate reuse rates. This reduction rate was used for the sensitivity analysis as the 2016 Census data identified the number of unoccupied dwellings, which are assumed to be holiday homes, as 30.9%.

Modelling results demonstrated that NorBE is still achieved when water reuse is reduced by 35% and that the final treatment efficiency is not significantly affected by the rainwater reuse levels.

3.6.3 Scenario 3 - Wetland Sensitivity Analysis

SDCP Section A11.2 stipulates wetlands are a preferred water quality treatment device. Wetlands were tested to treat the post development source nodes to determine how much additional area would be required if wetlands were to replace the bioretention and stormwater pond system.

For the wetland to be an effective treatment system and ensure the development meets NorBE criteria, both the eastern and western wetlands would need to be 2.65 ha. An overview of preliminary wetland specifications required to meet NorBE targets are provided in Table 14 and all parameters are provided in Attachment C.

Table 14: Scenario 3 MUSIC NorBE results.

Parameter	Western Wetland	Eastern Wetland
Surface Area (m^2)	26,000	26,000
Permanent Pool Depth (m)[1]	1.0	1.0
Permanent Pool Volume (m^3)	26,000	26,000
Extended Detention Depth (m)[2]	0.35	0.35

Notes

1. Parameter based on NSW MUSIC Modelling Guidelines.
2. Parameter based on Melbourne Water Wetland Design Manual (2020) Section 3.3.

Modelling results demonstrated that, for NorBE to be achieved, the use of wetlands instead of a bioretention system will require an increase of approximately 3.9 ha in water quality treatment surface area. Table 15 demonstrates a comparison between the total required treatment surface areas for water quality treatment systems between Scenario 1 and Scenario 3.

Table 15: Treatment node surface area comparison.

Parameter	Scenario 1: Total Bioretention Basin and Stormwater Pond Area	Scenario 3: Total Wetland Area	Difference
Surface Area (m²)	12,850	52,000	+39,150

These results suggest that for this development site, wetlands are highly inefficient when compared to bioretention and would result in excessive area requirements.

3.6.4 Pond Water Balance

Figure 1 depicts the water balance for the stormwater ponds. The water balance demonstrates that over the modelled period the ponds do not run dry. During the driest period approximately 0.96 m of drawdown was modelled which correlates to about 36% of the maximum volume of the permanent pool remaining. This modelling confirms that the catchments are adequate to maintain a permanent pool.

Council raised concerns regarding the potential for algal blooms in the stormwater ponds with insufficient inflows. Algal blooms may occur when nutrient (such as nitrogen and phosphorous) concentrations in water bodies are high and when water remains stagnant and warms particularly if stratification occurs. The bioretention basins are designed to capture the first flush during storm events (the initial surface runoff during storm events which likely contains the highest concentration of pollutants) for treatment.

Proposed stormwater ponds will receive the high flow bypass containing lower pollutant concentrations. Additionally, as evidenced in Figure 1, the ponds are regularly flushed by stormwater runoff and are unlikely to require artificial means for destratification to prevent algal blooms.

3.7 Conclusion of Stormwater Quality Modelling

MUSIC modelling results indicate that both SDCP and NSW DoPE's water quality objectives will be met by the proposed water quality treatment solution in Scenario 1. The water sensitivity analysis meets NorBE targets when the development considers lots within the Site to be used as holiday homes. The use of a wetland over a combined bioretention basin and stormwater system increases the required water quality treatment area from 1.3 ha (combined bioretention basin and stormwater pond areas) to 5.2 ha (wetland areas). Therefore, the modelling demonstrates the bioretention and stormwater basins in Scenario 1 is the optimal design solution.

The proposed management system is consistent with the principles of Water Sensitive Urban Design (WSUD) because the proposed treatment strategy uses, in part, 'at source' controls rather than relying solely on end of line structures. Further refinement of the model at detailed design stage may alter the size and location of the proposed pond and bioretention basin and rainwater tank; however, performance outcomes of the final design are to achieve the water quality objectives documented in this report.

4 Stormwater Quantity Assessment

4.1 Water Quantity Objectives

Stormwater quantity management is to comply with the objectives of SDCP which are:

- Onsite detention (**OSD**) is to be provided to ensure the peak post development flow rate does not exceed the peak flow rate under existing conditions. The 0.2 exceedances yearly (EY) storm event, 5% and 1% annual exceedance probability (AEP) storm events must be considered.
- Minor system to be designed to carry all flow during minor storm events, up to and including the 0.2 EY storm, by way of a pit and pipe network.
- Major system to be designed to carry all flows during major storm events, up to and including the 1% AEP storm, by way of the pit and pipe network and overland flow paths.

4.2 Modelling Methodology and Approach

4.2.1 Overview

This water quantity assessment provides applicable preliminary permissible site discharge (**PSD**) values and site storage requirements (**SSR**) needed to satisfy Council OSD objectives. DRAINS modelling package, using the ILSAX engine, was used to perform hydrological and hydraulic analysis.

The assessment provided is for the purposes of a rezoning application only, as such the requirements calculated are only an indication of the requirements for any future development. These values will require refinement at future stages as more detailed information becomes available.

4.2.2 Approach

Modelling was undertaken for all durations of the following storms:

- 0.2 EY.
- 5% AEP.
- 1% AEP.

For each storm event the critical flow rate for the existing site conditions was determined. The calculated critical flow rate was used to model the preliminary PSD requirement for any future development within the Site boundaries.

To determine a preliminary SSR, a developed conditions model was created. Two OSD basins were iteratively sized until they were able to meet Council's objectives. The volume of storage provided within these OSD basins was used as the basis for the preliminary SSR value.

4.2.3 Modelling Set Up

ILSAX hydrological input parameters are listed below in Table 16.

Table 16: ILSAX hydrological inputs.

ILSAX Parameter	Value
Impervious Area Depression Storage (mm)	1
Supplementary Area Depression Storage (mm)	1
Grassed Area Depression Storage (mm)	5
Soil Type	3
Antecedent Moisture Condition (AMC)	3

4.2.4 Rainfall/IFD Data

Intensity Frequency Duration (**IFD**) parameters were obtained from the Bureau of Meteorology (**BOM**) and storm temporal patterns from the AR&R 2019 datahub.

4.2.5 Catchment Areas

Catchment delineation was developed using the concept layout plan. Impervious fractions were based on aerial photography for the existing conditions model and as recommended by Council's DCP for the developed conditions model.

4.3 DRAINS Results

Results and findings of the DRAINS modelling used to calculate preliminary PSD and SSR are summarised in Table 17 and Table 18, the output from DRAINS can be found in Attachment B – E600.

Table 17: Pre development peak flow rates and preliminary PSD requirements.

Storm Event	Existing Peak Discharge (m^3/s)	PSD Requirement	
		$m^3/s/ha$	l/s/ha
0.2 EY	3.46	0.102	102
5% AEP	5.54	0.164	164
1% AEP	8.94	0.264	264

Table 18: Preliminary SSR requirements.

Storm Event	Existing Peak Discharge (m^3/s)	Post Development Peak Discharge (m^3/s)	OSD Volume Required (m^3)	SSR Requirement (m^3/ha)
0.2 EY	3.46	2.80	6980	181
5% AEP	5.54	5.13	7580	196
1% AEP	8.94	8.40	8670	225

The depths of ponding in the OSD and bioretention basins modelled during the simulated storms are shown in Table 19.

Table 19: OSD depths of ponding.

Storm Event	Maximum Ponding within OSD (Above Permanent Pool)	Maximum Ponding within OSD (Above Bioretention Area)
0.2 EY	0.89	0.58
5% AEP	1.02	0.58
1% AEP	1.18	0.58

Preliminary DRAINS modelling, at this stage, indicates that the Site requires 225 m^3/ha, which equates to approximately 8.7 ML of OSD to achieve SDCP flow objectives.

4.4 Discussion

4.4.1 Provision of OSD

The required OSD volume (approximately 8,670 m^3) has been preliminarily modelled within two basins. Chapter G2 of Council's DCP allows up to 50% of the volume of any stormwater retention device, within a development, to contribute to the OSD requirements. To achieve compliance with stormwater quality controls a rainwater tank has been proposed on each individual lot. The size of the proposed rainwater tanks is 6 kL. The cumulative volume of all the proposed rainwater tanks totals approximately 2,240 kL, of which 1,120 m^3 could be used to reduce the end of line OSD requirements in accordance with SDCP.

Using rainwater tanks to contribute to OSD objectives reduces the balance of OSD required to approximately 7,550 m^3.

4.4.2 Depth of OSD Ponding Above Bioretention Basin

The depth of ponding within the bioretention basins is no greater than 0.58 m during the 1% AEP storm. This depth of ponding includes the bioretention extended detention depth and is measured from the surface of the filter media. SDCP allows up to 0.3 m of OSD to be provided above the extended detention depth which has also been modelled at 0.3 m (refer to Section 0.) for a total of 0.6 m of ponding. The modelled ponding within the bioretention basins complies with the requirements of SDCP.

4.4.3 Depth of OSD Ponding Above Permanent Pool

The maximum ponding within the OSD is 1.18 m (above the permanent pool) during the 1% AEP storm event. This is less than the desirable maximum ponding from SCDP A5.7 of 1.20 m. Further modelling which includes the effects of rainwater tank retention may further reduce the maximum basin ponding.

4.5 Conclusion of Stormwater Quantity Modelling

The results indicated that the stormwater quantity objectives set by SCC can be achieved on the Site. By achieving compliance with the preliminary PSD (Table 17) for any future rezoned development, the overall site post development peak discharge will be limited to existing rates for the storms modelled. Refinements will be required to justify the preliminary PSD and the SSR at the subdivision stage, which will include further details of the proposed development.

5 Watercourse Assessment

5.1 Overview

The Water Management Act (2000) requires that a controlled activity approval (CAA) be obtained for works within 40 m of a 'river'. An assessment of the Site has been undertaken to determine if any 'rivers' are present. This assessment of available mapping and a walk over inspection concluded that there are no rivers on the Site and that no provision for riparian corridors is necessary and a CAA shall not be required for future Site development works.

5.2 Watercourse mapping

Review of the 1:25,000 topographic map (Figure 2) of the Site (maps.six.nsw.gov.au) identifies no water courses on the Site. Review of NSW Planning Portal mapping (planningportal.nsw.gov.au) of the Site confirms that here are no areas mapped as "Riparian Lands and Watercourses" on the Site.

Figure 2: 1:25,000 topographic map sources from maps.six.nsw.gov.au.

5.3 Walkover Inspection

Site walkover inspections have been undertaken with particular attention to the areas in the south of the Site nearest to the road culverts beneath Emmett Street. These walkovers identified no evidence (bed and banks, etc) of watercourses on the Site. Some evidence of flow concentration and direction to the culverts was observed along the alignment of a bush track running east – west parallel to Emmett St, however this track clearly does not constitute a 'river' under the definition of the Water Management Act (2000).

6 Responses to Agency Comments

6.1 NSW Office of Environment and Heritage

NSW OEH has provided comments in their letter dated 27 June 2019 (Doc Ref: D19/232896), which is summarised in Table 20. OEH's comments have been adequately addressed in this report as detailed.

Table 20: MA response to OEH' comments.

#	OEH Comment Summary	MA Response
1	Total combined pollutant reduction (TN, TP and TSS) to be beyond NorBE in order to give greater confidence that NorBE outcomes would be actually achieved.	The updated design provided more reduction beyond NorBE for TN, TP and TSS. Refer to section 3.5.1 for details.
2	The proposed bioretention basin location / footprint isn't shown on the plans.	The preliminary location of water quality structures are provided in Attachment A.

6.2 NSW Department of Primary Industry Fisheries

NSW DPI Fisheries have provided comments in their letter dated 8 July 2019 (Doc Ref: D19/228426), which is summarised in Table 21. We consider that DPI Fisheries' comments have been adequately addressed by this report.

Table 21: MA response to OEH's comments regarding the Site's flood risk management.

#	DPI Fisheries' Comment Summary	MA Response
1	The overall reduction demonstrated for TN is relatively small at -0.28%. Given that a margin of uncertainty is inherent in any modelling, DPI Fisheries suggests that additional measures are implemented to increase theoretical TN reduction.	The updated design provided more reduction beyond NorBE for TN, TP and TSS. Refer to section 3.5.1 for details.
2	To ensure an appropriately sized bio-retention basin is constructed, the Land Use Plan for this gateway determination is to identify and set aside a suitable location and area of land for this purpose within the subdivision site.	The preliminary location of water quality structures are provided in Attachment A.
3	The stormwater treatment train for the proposed new subdivision relies upon the reuse of roof water. It is not clear how the MUSIC model has accounted for the potential that a number of the dwellings within this location may be for holiday purposes, and whether the lower water re-use at these properties would have an impact upon achieving the stated stormwater treatment targets.	The stormwater treatment strategy for the proposed subdivision uses roof water capture and reuse in combination with end-of-line controls to ensure treatment objectives are satisfied. To address the possible impact of dwellings used for holiday purposes only, a sensitivity analysis (Section 3.2.2) was completed. This demonstrated that NorBE is still achieved when water reuse is reduced by 35% and that the final treatment efficiency is not significantly affected by the rainwater reuse levels.

#	DPI Fisheries' Comment Summary	MA Response
4	Regarding the MUSIC modelling results for the existing Callala Bay township, we fail to see how the model can result in these reported benefits, given that the only treatment measure proposed for the existing township is a GPT.	The previously proposed stormwater system improvements to treat runoff from the existing township has been excluded from the updated IWCMP.
5	The IWCMP does not include any commitment to the maintenance of stormwater treatment measures. DPI Fisheries requests further information regarding planned GPT maintenance, including a commitment to maintenance frequency and how the ongoing maintenance is to be funded over time.	Ownership and responsibility for operation of these devices shall pass to Council. Arrangements for maintenance and funding are a matter to be finalised by Council as the Site's development planning progresses.
6	DPI Fisheries queries whether this planning proposal includes any proposal to monitor pollutant loads of stormwater discharges from the proposed and existing sites, to establish whether the NorBE requirement is achieved in practice and over time.	The ongoing cost of monitoring pollutant loads has been included in life cycle costing estimation. Water sampling is likely to be conducted during the establishment phase. It is anticipated ongoing monitoring of water quality would be a part of Council's routine activities.
7	Please note that the IWCMP only relates to the post-construction treatment of stormwater. The discharge of sediments during construction presents a considerable risk to downstream catchments. This potential for such an impact should be acknowledged and managed appropriately.	The IWCMP provides conceptual design for rezoning purposes. Detailed temporary sediment control plans will be provided at DA stage and would address industry best practices at the time of the DA.
8	No clear reason has been provided within the IWCMP as to why the NorBE requirements cannot be achieved within the proposed subdivision site only. One would expect best practice and a clear attempt at trying to achieve the NorBE requirement within the development site.	The decision to include treatment devices in the existing township was made in consultation with Council in an effort to achieve the best total catchment outcome. In response to comments from government agencies, the solution has been redesigned to remove treatment of existing Callala Bay township runoff. The updated design provides treatment for TN, TP and TSS to achieve NorBE solely within the new development area.

6.3 Shoalhaven City Council

SCC comments in email dated 28th October 2021 from Eric Hollinger, Special Projects Coordinator at SCC, have been addressed in this updated report, refer to Table 22.

Table 22: MA response to Council comments regarding water quality.

	Element	MA Comment
Stormwater treatment measures - Trash Racks vs GPT	A GPT is not supported at this stage based on the information provided. Further clarification is required as to the implications of using trash racks instead of a GPT. What impact does this have on the area set aside for stormwater treatment? Report indicates this will result in an increase in size of water quality treatment area by approx. 1,500m2 – please clarify	Refer to Section 3.4.2.

	Element	MA Comment
	where this increase applies i.e. to the stormwater ponds, bioretention devices or both?	
Rainwater tanks	How do assumed tank volumes compare against BASIX requirements – will they exceed BASIX requirements?	Refer to Section 3.4.1.
MUSIC Modelling	MUSIC modelling is unclear, there are inconsistencies between model presentation and conclusions in the report – has revised MUSIC modelling been undertaken?	Updated modelling has been undertaken. Refer to Section 3 for updated MUSIC methodology, source and treatment node input parameters, and results.
	Please advise as to whether the bushland reserve area drains into the stormwater quality devices – if so these areas need to be included in the MUSIC model.	
	Please provide Council with a copy of the MUSIC model.	Noted.
Bioretention Basins	No comments on use of wetlands as alternative as per previous Council request.	Refer to Section 3.2.2 and Section 3.6.3.
	Require more detail on proposed bioretention basins – how many are required? Require plan layout and concept details on surface area, volume, and extended detention depth as well as typical section. Current proposed bioretention basin extended detention depth and filter media depth are inconsistent with DCP requirements without justification.	Refer to Section 0 and APS drawings and plans.
	Require details of mean annual outflow expected from bioretention devices as stormwater ponds rely on these to maintain appropriate water level.	Refer to Section 3.5.4.
Stormwater Quality Ponds	Require a plan layout and typical section for the two proposed stormwater ponds.	Refer to APS drawings and plans
	The extended detention depth for the water quality pond of 1.8m remains a concern – the report does not address Council's previous concerns and simply removes this detail from the revised report.	Refer to Section 4.4
	Can water quality targets be met with a single SQID type device?	No.
	Council generally support water quality ponds where maintenance adequately addressed and where no mechanical devices are proposed. Please confirm mechanical devices will not be necessary.	Refer to Section 3.4.4.
OSD	Please clarify the proposed depth of OSD above the stormwater ponds and bioretention device extended detention depth.	Refer to Section 4.4
Concept Designs	As detailed above, concept designs and sections are required to show the layout of the proposed stormwater quality improvement devices. These concept designs need to show number and layout of devices, battered edges (complying with Councill's Engineering Specifications) and adequate buffers for maintenance access. A typical section through the basins also required.	Refer to APS drawings and plans
	The report should discuss how the footprint of land set aside for stormwater treatment was determined.	Refer to APS drawings and plans

	Element	MA Comment
	Adequate footprint needs to be set aside for stormwater treatment in the design phase to address performance requirements (stormwater ad water quality management) and to achieve and safety and ease of maintenance requirements.	

7 Conclusion

7.1 Overview

The following subsections form a summary of the project's integrated water cycle management plan (IWCMP).

7.2 Stormwater Quality

The proposed treatment train for the developed site shall integrate measures including rainwater tanks, GPTs, two ponds and two bioretention basins. This treatment train shall achieve stormwater pollutant retention as required by SCC quality performance criteria.

MUSIC modelling demonstrates that areas draining to the receiving wetland achieve NSW DoPE's stated water quality objective through runoff capture, treatment and reuse as detailed in the MUSIC model.

7.3 Stormwater Quantity

In accordance with SDCP, OSD is required to ensure developed condition flows do no exceed existing conditions. DRAINS modelling concluded approximately 9 ML of OSD is required. The detention volume may be reduced to 7,780 m^3 through the provision of rainwater tanks on individual lots (6 kL/lot – see Section 3.4.1).

7.4 Watercourse Assessment

Review of available site mapping and site walkover inspections confirms that there are no watercourses on the Site. As a result, it is concluded that no riparian corridor requirements shall apply and that future works shall not require a controlled activity approval under the Water Management Act.

8 References

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

Bureau of Meteorology (2001) *Climatic Atlas of Australia Evapotranspiration*

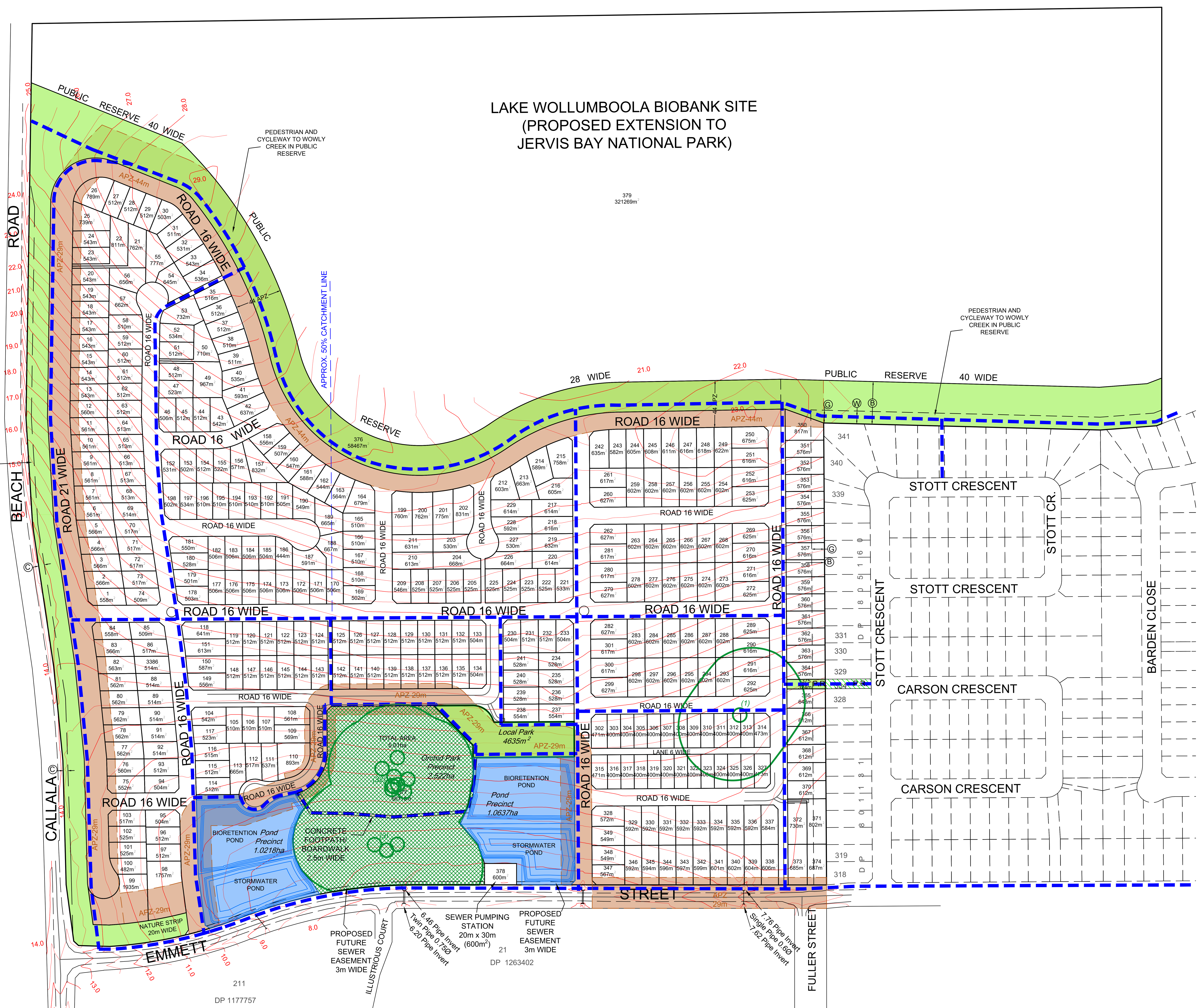
NSW Department of Water and Energy (DWE) (2008) *NSW Guidelines for Greywater Reuse in Sewered, Single Household Residential Premises*

Shoalhaven City Council Development Control Plan (2014).

Allen Price and Scarratts (APS) (02.12.2021) *Plan showing proposed residential subdivision over land north of Emmett Street, west of Callala Beach Road and Lot 20 DP 1263402 at Callala Bay for Sealark Pty Ltd*

9 Attachment A – Subdivision Layout

SUBDIVISION MASTERPLAN



0 25 50 75 100
SCALE:- 1:2000

PEDESTRIAN/ CYCLEWAY

GENOPLESIUM BAUERI - (ECOLOGICAL REPORT 18.03.2019)

GENOPLESIUM BAUERI SPECIES POLYGON (ECOLOGICAL REPORT 18.03.2019)

NOTE:

- ROADS 21 WIDE & 16 WIDE
- LOT YIELD

LOT YIELD	500m² LOTS	348
	400m² LOTS (rear lane)	26
	PUBLIC RESERVE	2
	DRAINAGE RES./ORCHIDS (incl. Recreation Park)	1
	SEWER PUMPING STATION	1
	RESIDUE LOT	1

(B) EASEMENT FOR BUSHFIRE FUEL REDUCTION 40 WIDE (DP 777916) (SCC)
TO BE EXPUNGED

(C) EASEMENT FOR SEWER PIPELINE 5 WIDE & VARIABLE (VIDE DEALING AC196382 & DP 1065841)

(G) RIGHT OF CARRIAGEWAY 12 WIDE (DP 777916) (SCC)
TO BE EXPUNGED

(W) EASEMENT FOR WATER SUPPLY 12 WIDE (DP 789141) (SCC)
TO BE EXPUNGED

NOTE:

This plan was prepared for the client as an indicative subdivision design to accompany a planning application to Shoalhaven City Council.

The information shown on this plan is not suitable for any other purpose.

The property dimensions, contours and other physical features have been compiled from existing information and have not been verified by field survey.

The dimensions, areas and total number of lots shown on this plan are subject to field survey and also to the requirements of Council and any other authority which may have requirements under any relevant legislation.

In particular, no reliance should be placed on the information on this plan for detailed subdivision design or for any financial dealings involving the land.

Allen Price & Scarratts Pty Ltd therefore disclaims any liability for any loss or damage whatsoever or howsoever incurred, arising from any party using or relying upon this plan for any purpose other than as a document prepared for the sole purpose of accompanying an application to council for planning and which may be subject to alteration for reasons beyond the control of Allen Price & Scarratts Pty Ltd.

Unless stamped by Council, this plan is not a plan of an approved subdivision.

This note is an integral part of this plan.

NOTE:
CADASTRAL INFORMATION HAS BEEN OBTAINED FROM NSW LAND & PROPERTY INFORMATION (LPI) DIGITAL CADASTRAL DATA BASE (DCDB) AND IS SUBJECT TO SURVEY. IT SHOULD BE VIEWED AS APPROXIMATE ONLY.

M:\Projects\20000\25000s\25930 Drawings\N25930-09 SUBDIVISION MASTERPLAN.dwg

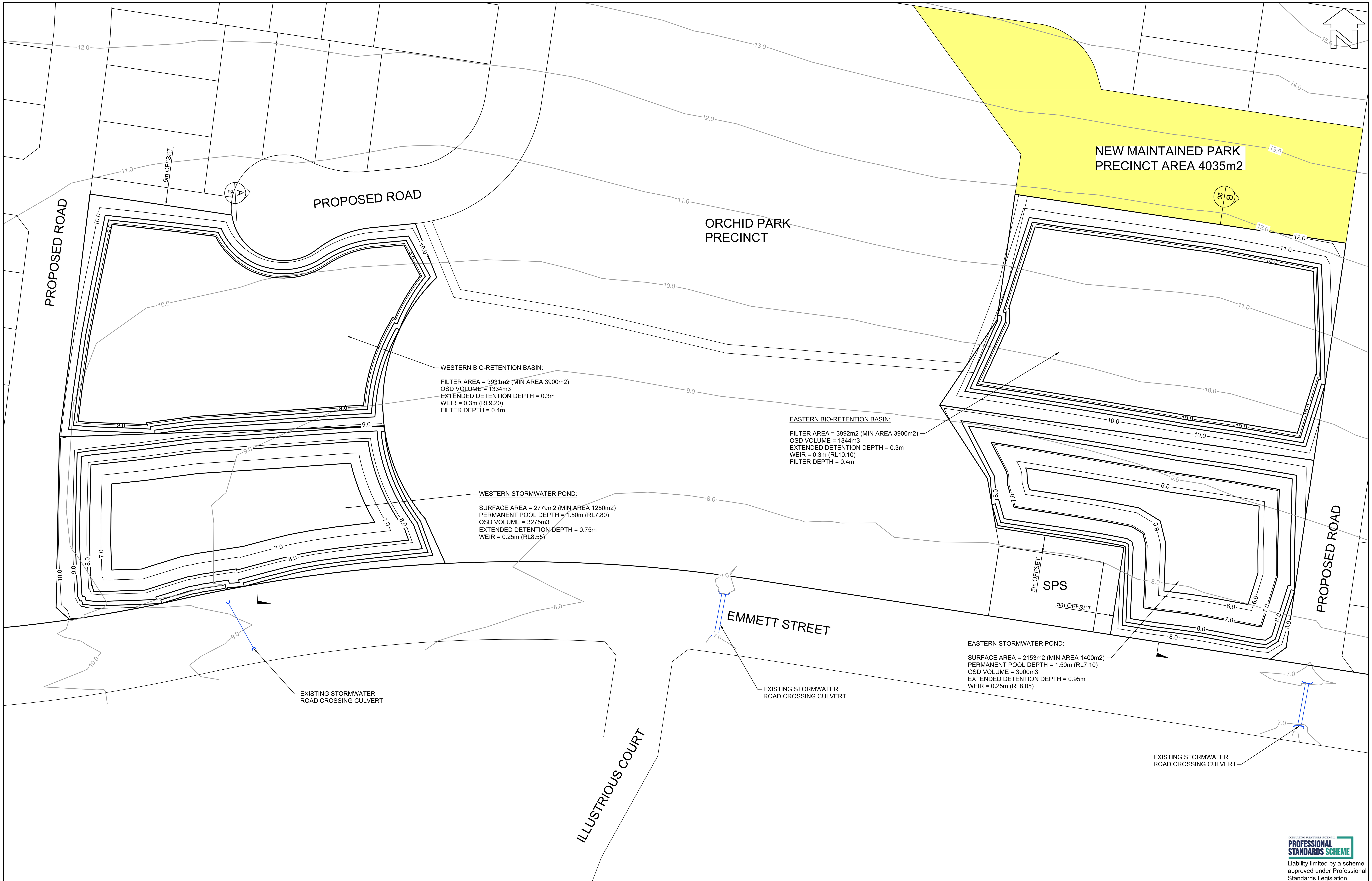
RATIO:	DATUM:	SURVEY		REV	DESCRIPTION	BY	DATE
1:2000 (AT A1 ORIGINAL)	ORIGIN: SSM RL	DESIGN	MP/JH	P1	MAINTAINED PARK AREA CHANGED	DS	10.08.2021
		DRAWN	DS	P2	LOT LAYOUT REVISED	DS	02.12.2021
		CHECK'D	MP	P3	NOTES REVISED	DS	18.01.2022
	DATE OF PLAN: 29.09.2020			P4	APZs CLARIFIED. PED./CYCLEWAY REVISED.	DS	20.01.2022
				P5	POND AREA REVISED. LOT YIELD REDUCED.	DS	25.01.2022
				P6	APZs REVISED	DS	27.01.2022

allen price & scarratts pty ltd
land and development consultants
Nowra Branch: 75 Plunkett Street, Nowra NSW 2541
Kiama Branch: 1/28 Bong Bong Street, Kiama NSW 2533
phone:(02) 4421 6544
consultants@allenprice.com.au www.allenprice.com.au

PLAN SHOWING PROPOSED RESIDENTIAL SUBDIVISION MASTERPLAN OVER LAND NORTH OF EMMETT STREET, WEST OF CALLALA BEACH ROAD AND LOT 20 DP 1263402 AT CALLALA BAY FOR SEALARK PTY LTD

DRAWING STATUS: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

DRAWING NUMBER: 25930-09 | SHEET 1 OF 1 | REVISION P6



LAYOUT PLAN
SCALE 1:500

0 5 10 15 20 25
SCALE:- 1:500

PROFESSIONAL STANDARDS SCHEME
Liability limited by a scheme approved under Professional Standards Legislation

BEWARE!
THE CONTRACTOR IS TO VERIFY THE LOCATION OF ALL EXISTING SERVICES PRIOR TO COMMENCEMENT OF CONSTRUCTION AND SHALL BE RESPONSIBLE, AT THE CONTRACTOR'S EXPENSE, FOR ANY REPAIRS TO DAMAGE CAUSED DURING CONSTRUCTION.

DIAL BEFORE YOU DIG
www.1100.com.au

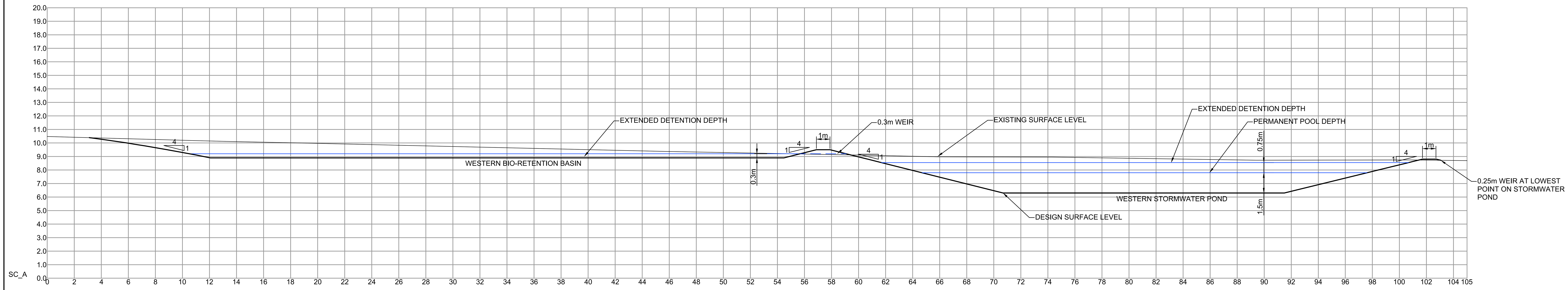
RATIO:	DATUM:	SURVEY	APS	REV	DESCRIPTION	BY	DATE
1:500 (AT A1 ORIGINAL)	AUSTRALIAN HEIGHT DATUM	DESIGN	CJG	=			
	ORIGIN: SSM RL	DRAWN	CJG				
	DATE OF PLAN: JANUARY 2022	CHECK'D	RH				

allen price & scarratts pty ltd
land and development consultants
Nowra Office: 75 Plunkett Street, Nowra NSW 2541
Kiama Office: 1/28 Bong Bong Street, Kiama NSW 2533
phone:(02) 4421 6544
consultants@allenprice.com.au www.allenprice.com.au

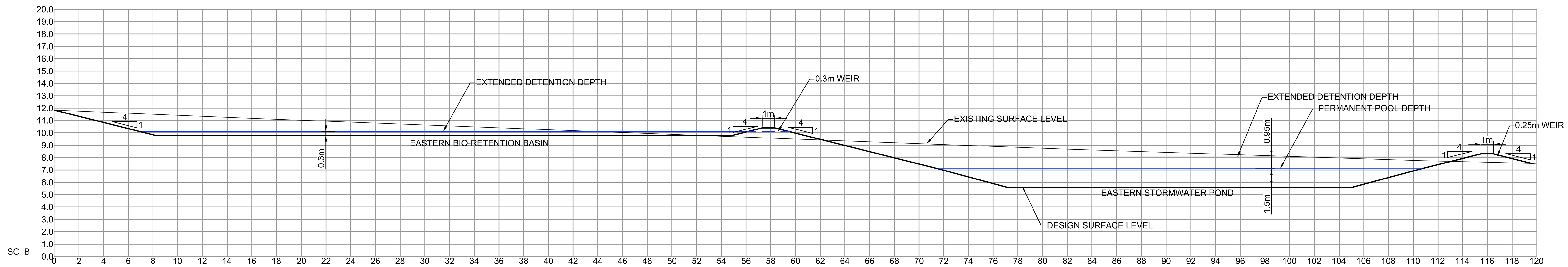
PRELIMINARY BASIN AND POND LAYOUT PLAN
OVER LAND NORTH OF EMMETT STREET
WEST OF CALLALA BEACH ROAD AND
LOT 20 DP 1263402 AT CALLALA BAY
FOR SEALARK PTY LTD

DRAWING STATUS
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

DRAWING NUMBER N25930-19
SHEET 1 OF 2
REVISION P0



SECTION A
SCALE 1:150
19



SECTION B
SCALE 1:200
19

BEWARE!

THE CONTRACTOR IS TO VERIFY THE LOCATION OF ALL EXISTING SERVICES PRIOR TO COMMENCEMENT OF CONSTRUCTION AND SHALL BE RESPONSIBLE, AT THE CONTRACTOR'S EXPENSE, FOR ANY REPAIRS TO DAMAGE CAUSED DURING CONSTRUCTION.

DIAL BEFORE YOU DIG®
www.1100.com.au

PROFESSIONAL STANDARDS SCHEME
Liability limited by a scheme approved under Professional Standards Legislation

SCALE:- 1:150
SCALE:- 1:200

RATIO:	DATUM: AUSTRALIAN HEIGHT DATUM	SURVEY	APS	REV	DESCRIPTION	BY	DATE
AS NOTED (AT A1 ORIGINAL)	ORIGIN: SSM RL	DESIGN	CJG	=			
		DRAWN	CJG				
	DATE OF PLAN: JANUARY 2022	CHECK'D	RH				

allen price & scarratts pty ltd
land and development consultants
Nowra Office: 75 Plunkett Street, Nowra NSW 2541
Kiama Office: 1/28 Bong Bong Street, Kiama NSW 2533
phone:(02) 4421 6544
consultants@allenprice.com.au www.allenprice.com.au

PRELIMINARY BASIN AND POND CROSS SECTIONS PLAN
OVER LAND NORTH OF EMMETT STREET
WEST OF CALLALA BEACH ROAD AND
LOT 20 DP 1263402 AT CALLALA BAY
FOR SEALARK PTY LTD

DRAWING STATUS: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

DRAWING NUMBER: N25930-20
SHEET 2 OF 2
REVISION P0

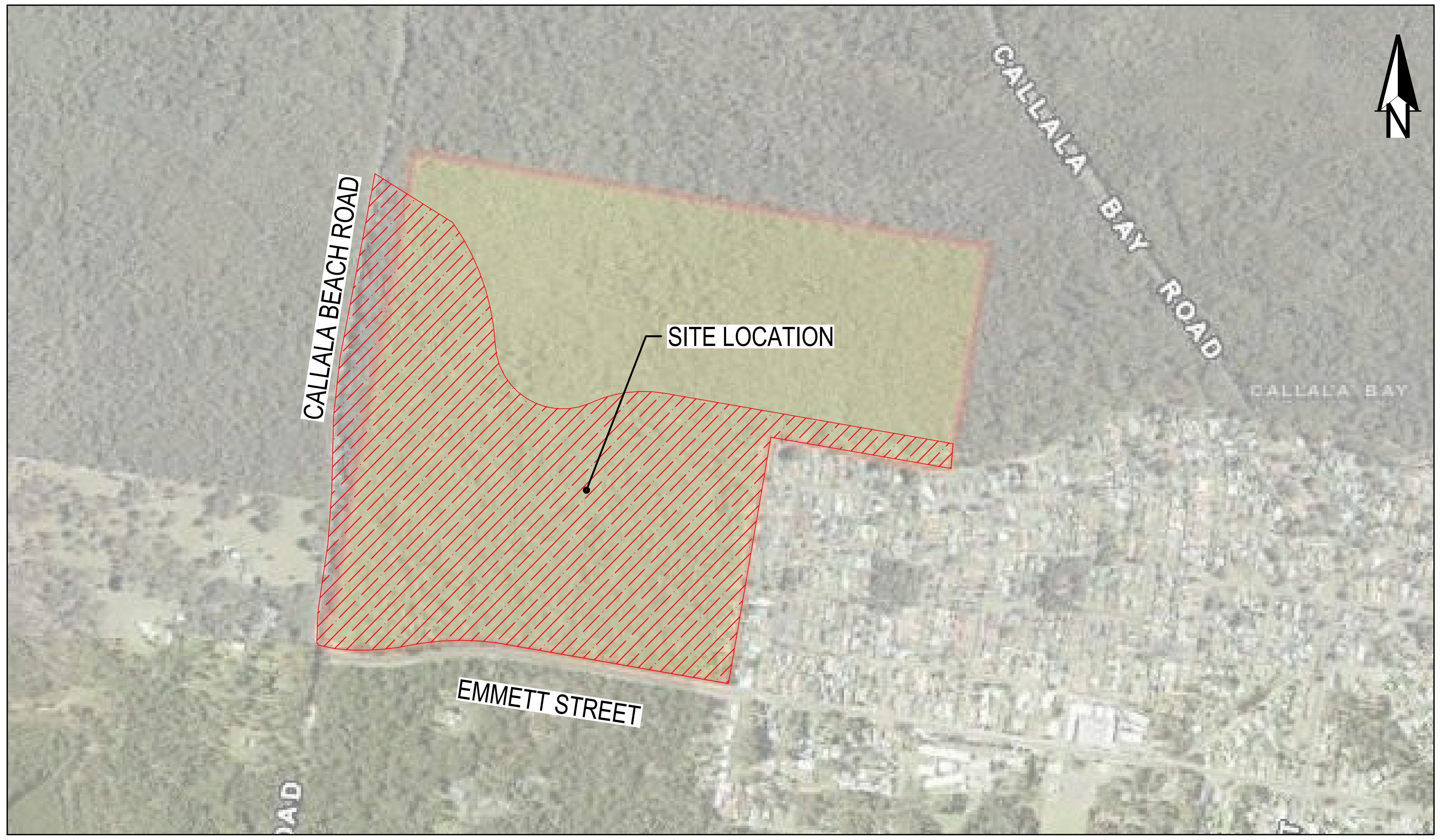
10 Attachment B – Planset

PROJECT: PROPOSED RESIDENTIAL SUBDIVISION

PLANSET: STORMWATER MANAGEMENT PLAN

CLIENT: SEALARK PTY LIMITED

DRAWING LIST		
DWG No.	REV	DWG TITLE
GENERAL		
PS01-A000	E	COVER SHEET
DRAINAGE		
PS01-E600	D	ON SITE DETENTION CATCHMENT PLAN, MODEL AND RESULTS
PS01-E710	E	WATER QUALITY CATCHMENT PLAN, MODEL AND RESULTS



LOCALITY PLAN
N.T.S.

GENERAL NOTES

1. THIS PLAN IS FOR REZONING APPLICATION PURPOSE AND NOT FOR DA OR CONSTRUCTION.
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. SURVEY INFORMATION PROVIDED BY STRATASURV (REF 4109DT-01)
4. LEVELS ARE TO AUSTRALIAN HEIGHT DATUM (AHD).

LGA: SHOALHAVEN CITY COUNCIL

CALLALA BAY EXPANSION AREA, CALLALA BAY, NSW
PART OF LOT 2 / DP775060
LOTS 9,10, 11, 17, 18/ DP253793
LOTS 599-628/ DP11388

PLANNING PROPOSAL

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
E	**REVISED PER COUNCIL COMMENTS (DATED 28/10/2021)**	**27/01/2022**	**AVG/BN**	**AVG/BN**	**AN**	**AN**
D	REVISED PER COUNCIL COMMENTS (DATED 28/10/2021)	19/01/2022	AVG/BN	AVG/BN	AN	AN
C	MINOR AMENDMENT	08/02/2021	LL	CL	AN	AN
B	MINOR AMENDMENT	18/01/2021	GHO\GM	AVG	AN	AN
A	INITIAL RELEASE	18/02/2019	GHO	AVG/EZ/DI	AN	AN

SCALE

PRINTED: ---- - USER: BNICHOLS

A1 / A3 LANDSCAPE (A1LC_v02.0.01)

GRID: ---
DATUM: ---
PROJECT MANAGER: AN

CLIENT: SEALARK PTY LIMITED

PROJECT NAME/PLANSET TITLE
PROPOSED RESIDENTIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
CALLALA BAY EXPANSION AREA
CALLALA BAY, NSW

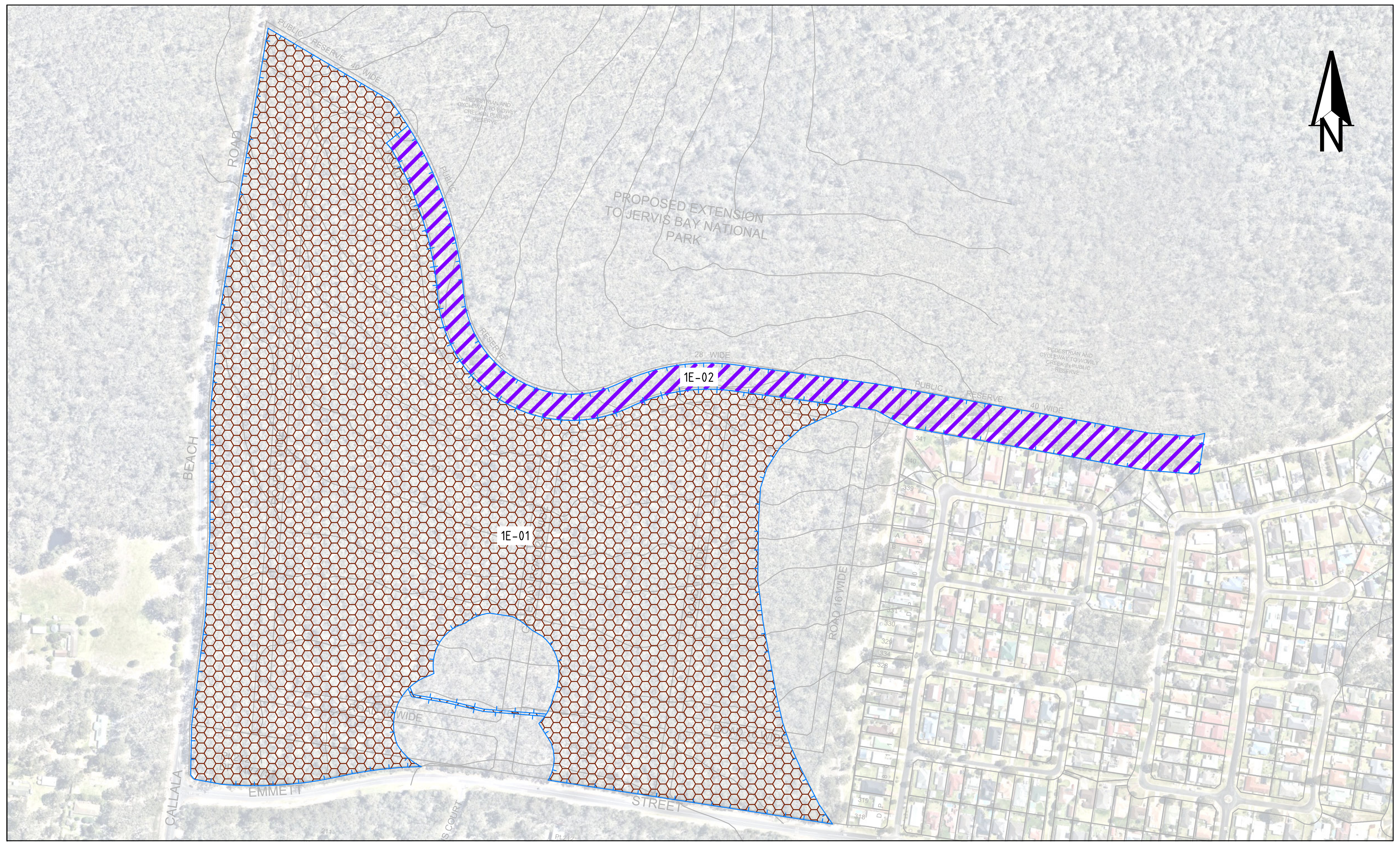
martens & Associates Pty Ltd
Consulting Engineers
Environment
Water
Geotechnical
Civil
Suite 201, 20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767
Email: mail@martens.com.au Internet: www.martens.com.au

DRAWING TITLE: COVER SHEET

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1806796	PS01	R06	PS01-A000	E

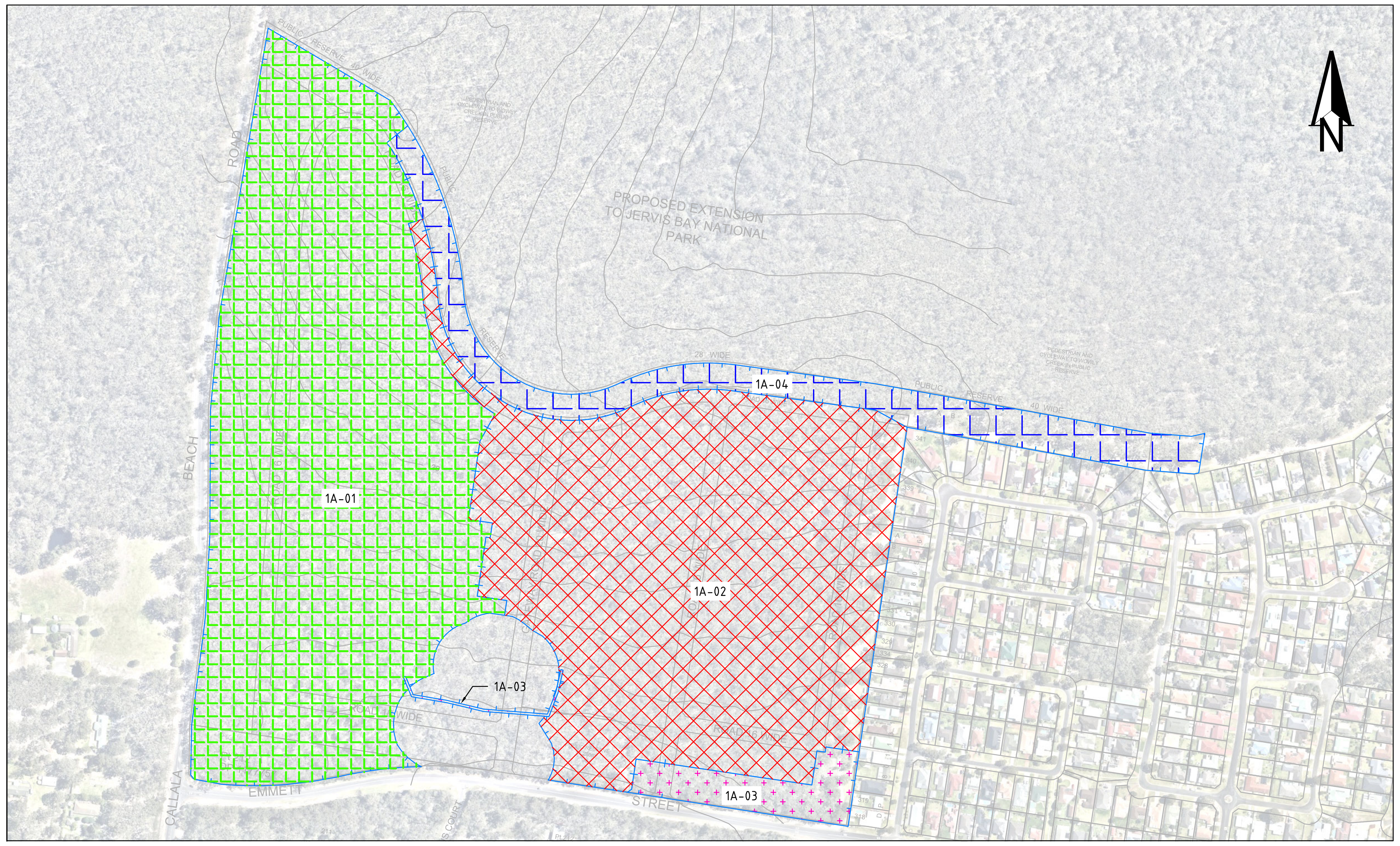
DRAWING ID: P1806796-PS01-R06-A000

1 2 3 4 5 6 7 8



PRE DEVELOPMENT OSD CATCHMENT PLAN

SCALE: 1:4000



POST DEVELOPMENT OSD CATCHMENT PLAN

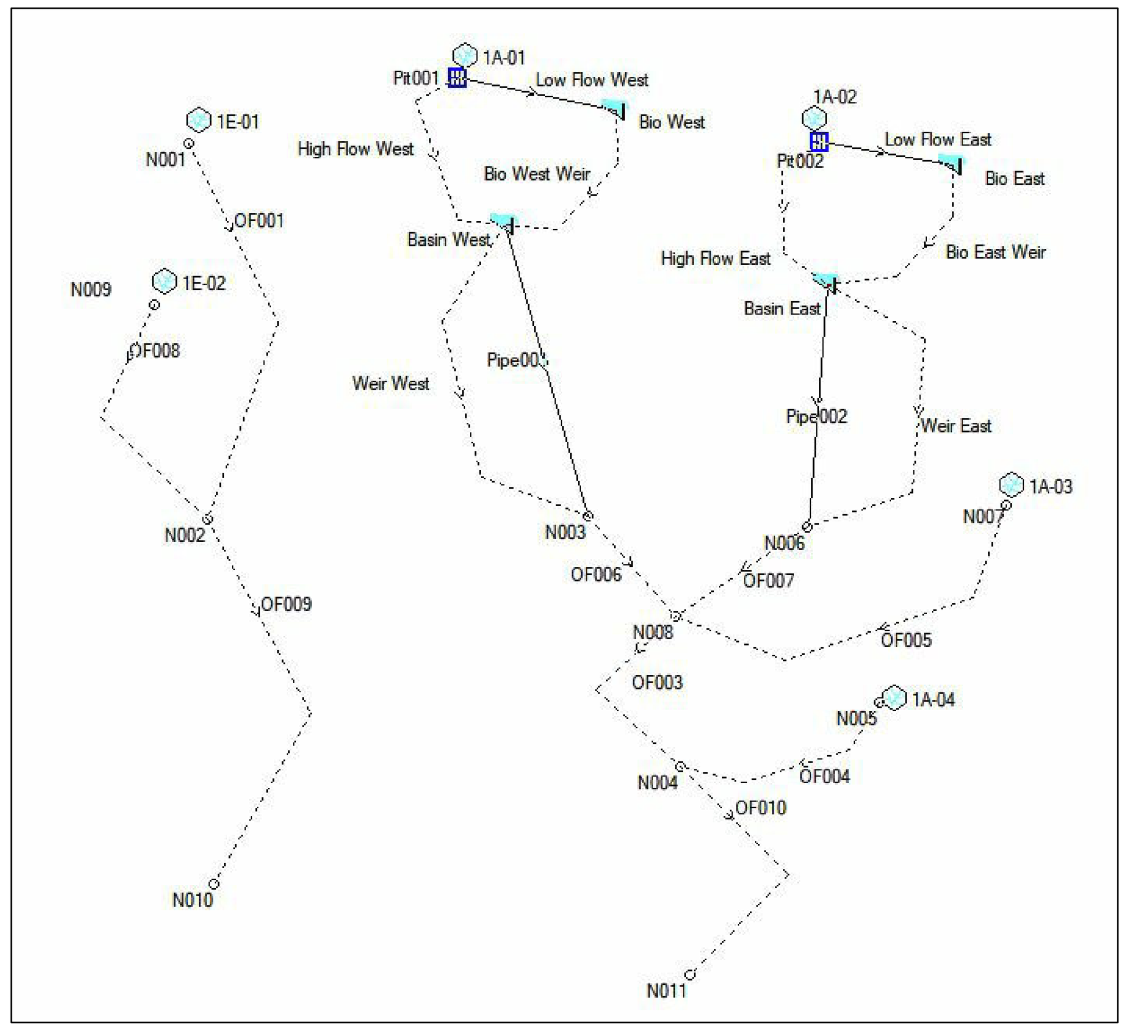
SCALE: 1:4000

PRE DEVELOPMENT OSD CATCHMENT AREAS

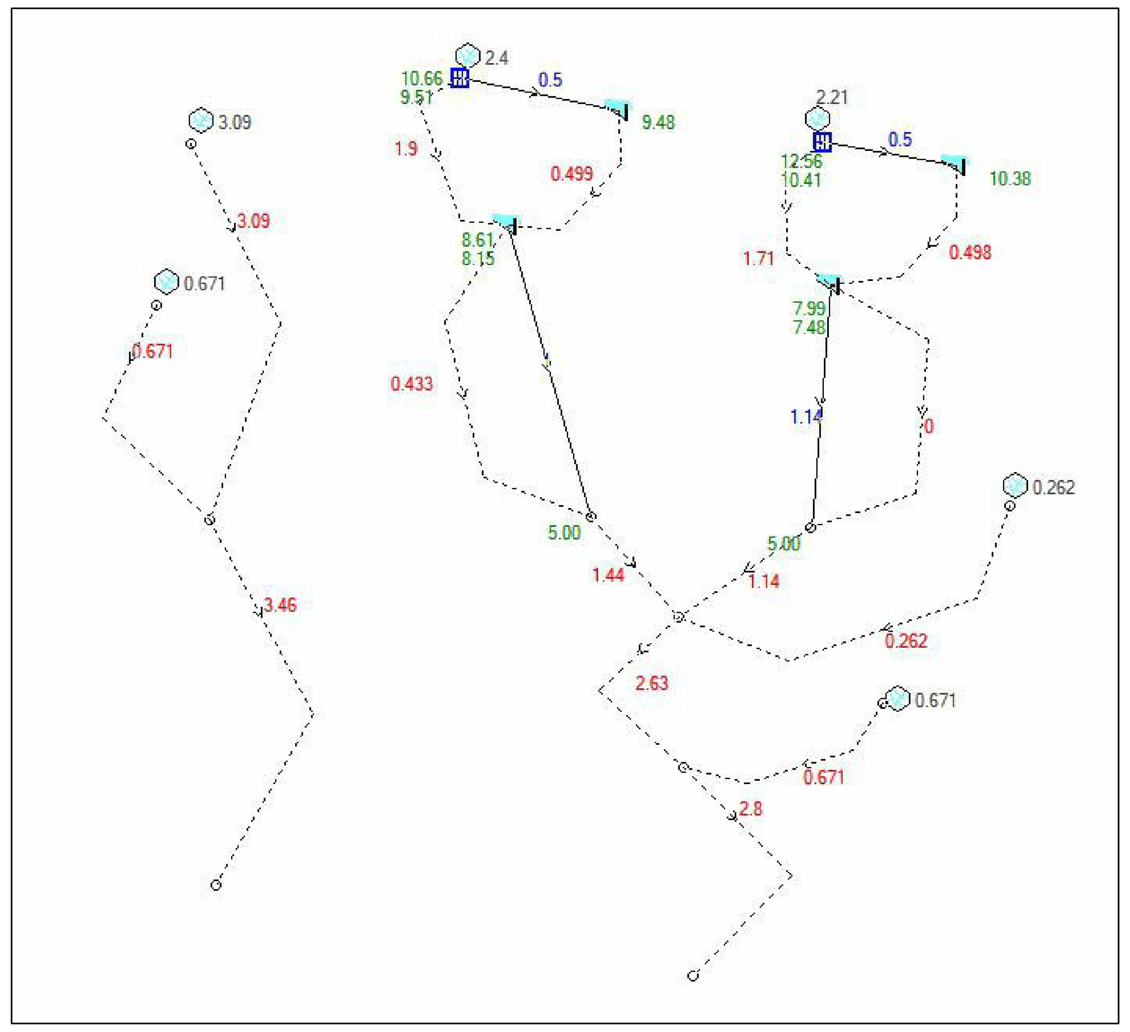
KEY	DRAINS NODE	AREA (ha)	% PAVED	% SUPPLEMENTARY	% GRASSED
	1E-01	30.43	1%	1%	98%
	1E-02	3.39	6%	6%	88%

PRE DEVELOPMENT OSD CATCHMENT AREAS

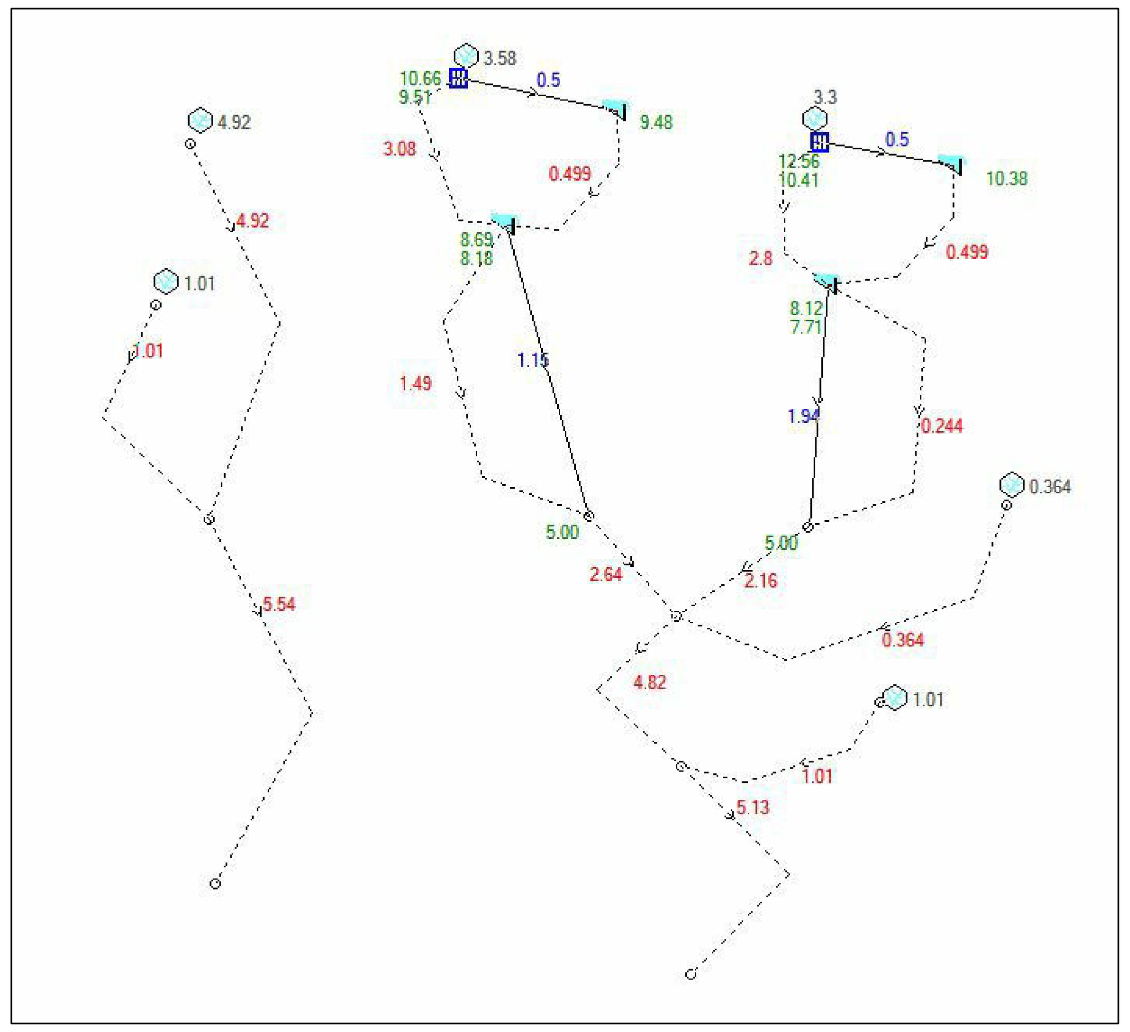
KEY	DRAINS NODE	AREA (ha)	% PAVED	% SUPPLEMENTARY	% GRASSED
	1A-01	17.98	37%	25%	38%
	1A-02	16.12	43%	29%	28%
	1A-03	1.11	48%	32%	20%
	1A-04	3.39	6%	6%	88%



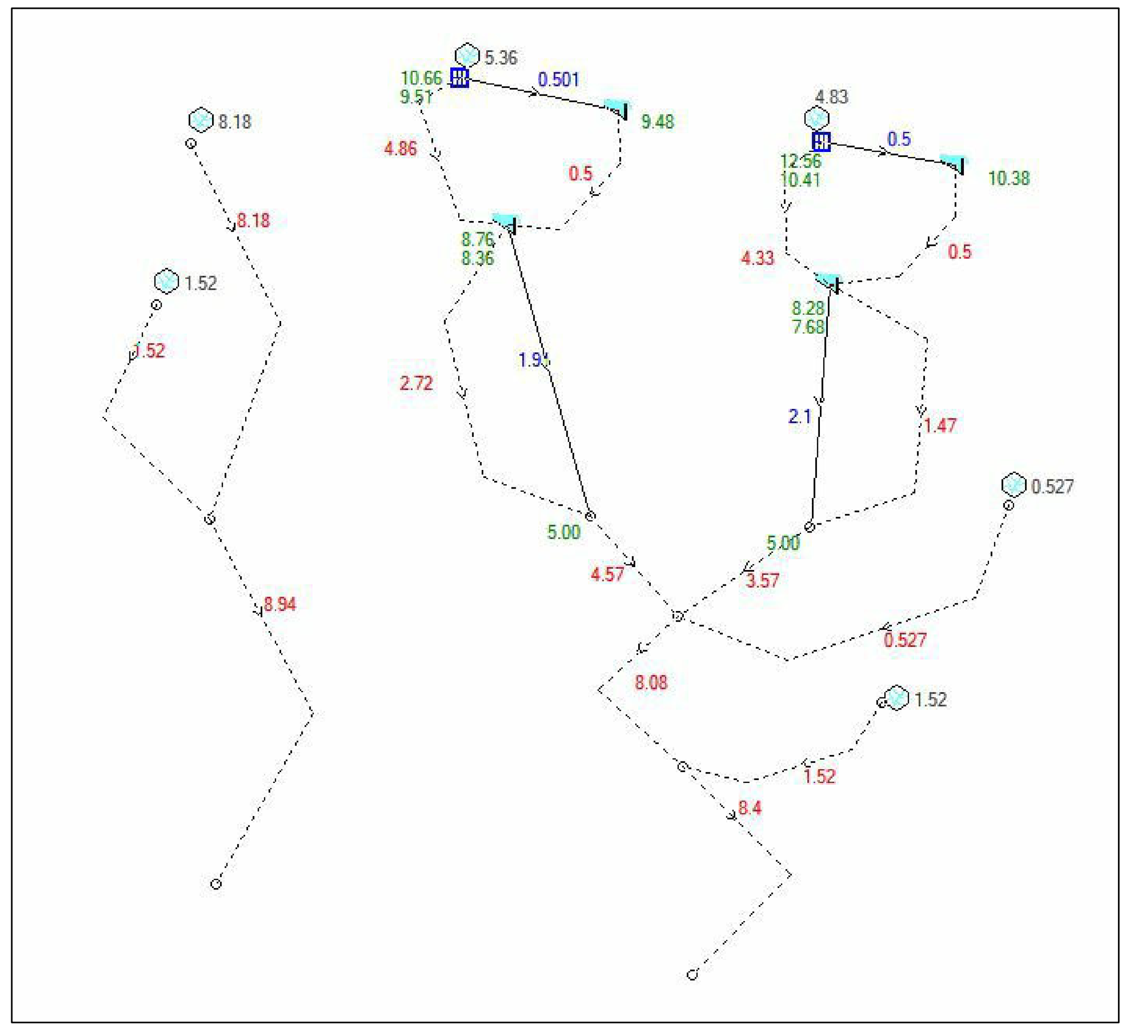
DRAINS MODEL LAYOUT



0.2 EY STORM RESULTS



5% AEP STORM RESULTS



1% AEP STORM RESULTS

PLANNING PROPOSAL

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
D	REVISED PER COUNCIL COMMENTS (DATED 28/10/2021)	27/01/2022	AVG/BN	AVG/BN	AN	AN
C	REVISED PER COUNCIL COMMENTS (DATED 28/10/2021)	19/01/2022	AVG/BN	AVG/BN	AN	AN
B	MINOR AMENDMENT	18/01/2021	GHO\GM	AVG	AN	AN
A	INITIAL RELEASE	18/02/2019	GHO	AVG/EZ/DI	AN	AN

SCALE 0 40 80 120 160 200 240 280 320 360 400 METRES
A1 (A3) 1:4,000 (1:8,000)

GRID: MGA
DATUM: mAHD
PROJECT MANAGER: AN

DISCLAIMER & COPYRIGHT

CLIENT: SEALARK PTY LIMITED

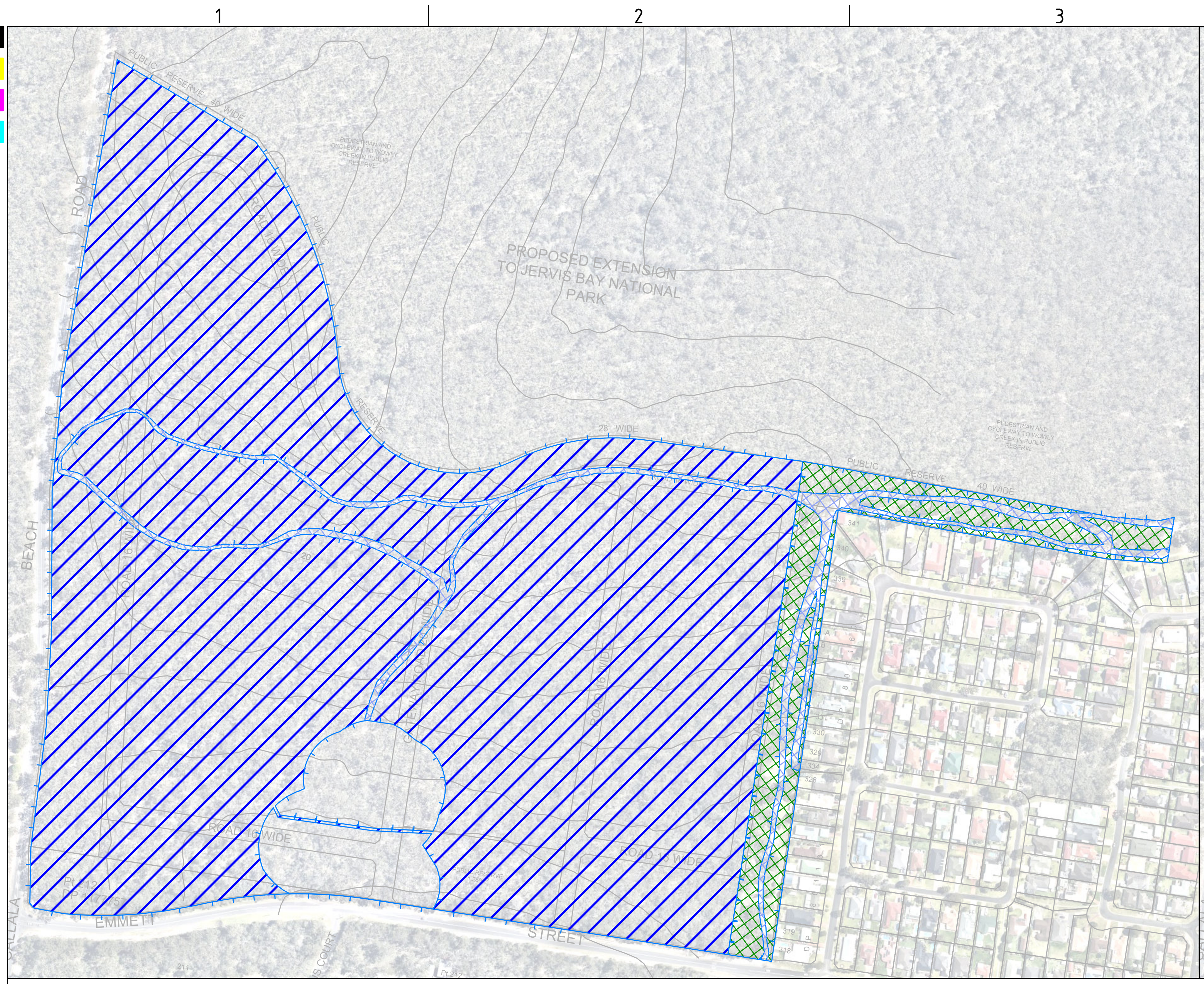
PROJECT NAME/PLANSET TITLE
PROPOSED RESIDENTIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
CALLALA BAY EXPANSION AREA
CALLALA BAY, NSW

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
ON SITE DETENTION CATCHMENT PLAN
MODEL & RESULT (PRE VS POST)

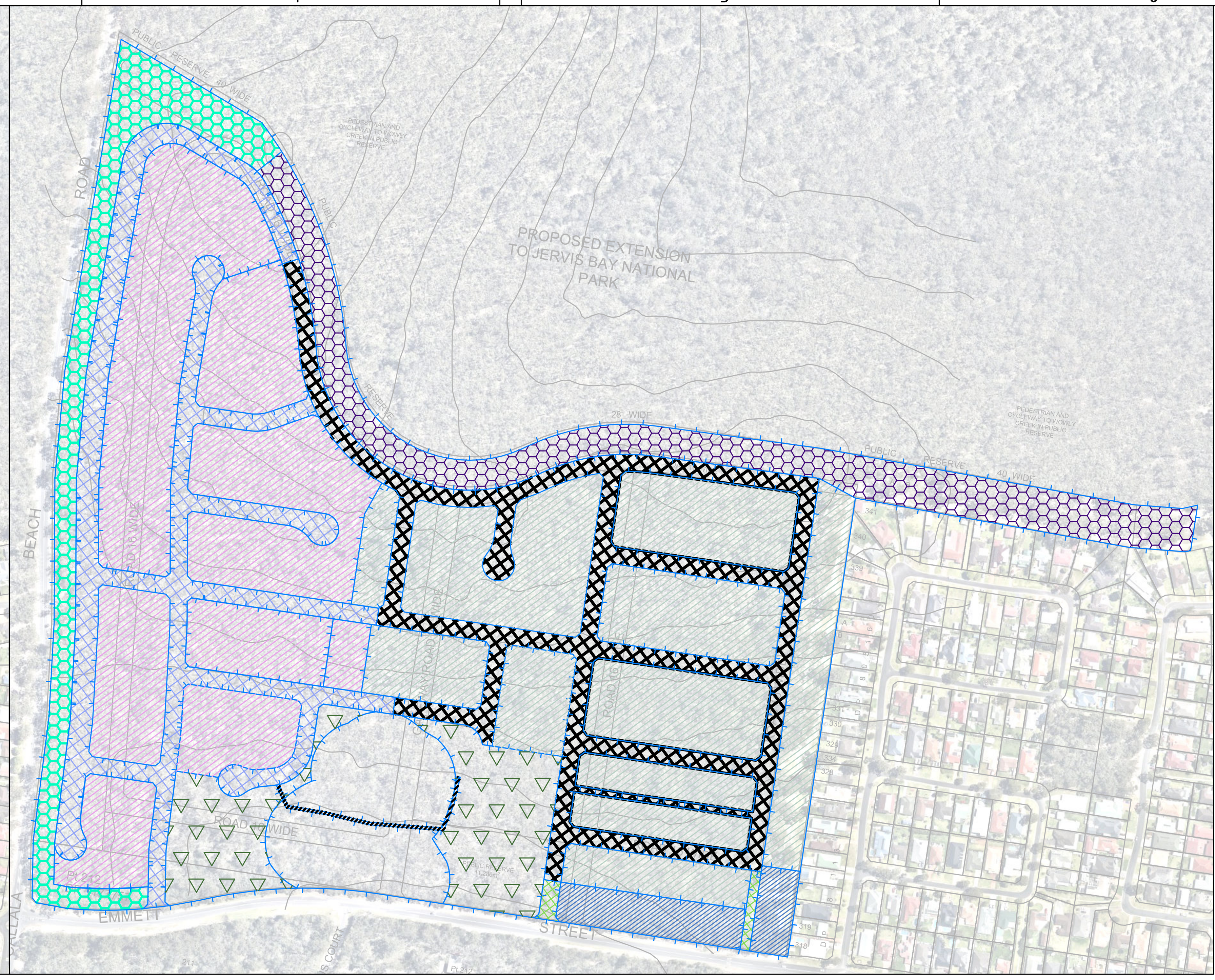
PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1806796	PS01	R06	PS01-E600	D

DRAWING ID: P1806796-PS01-R06-E600



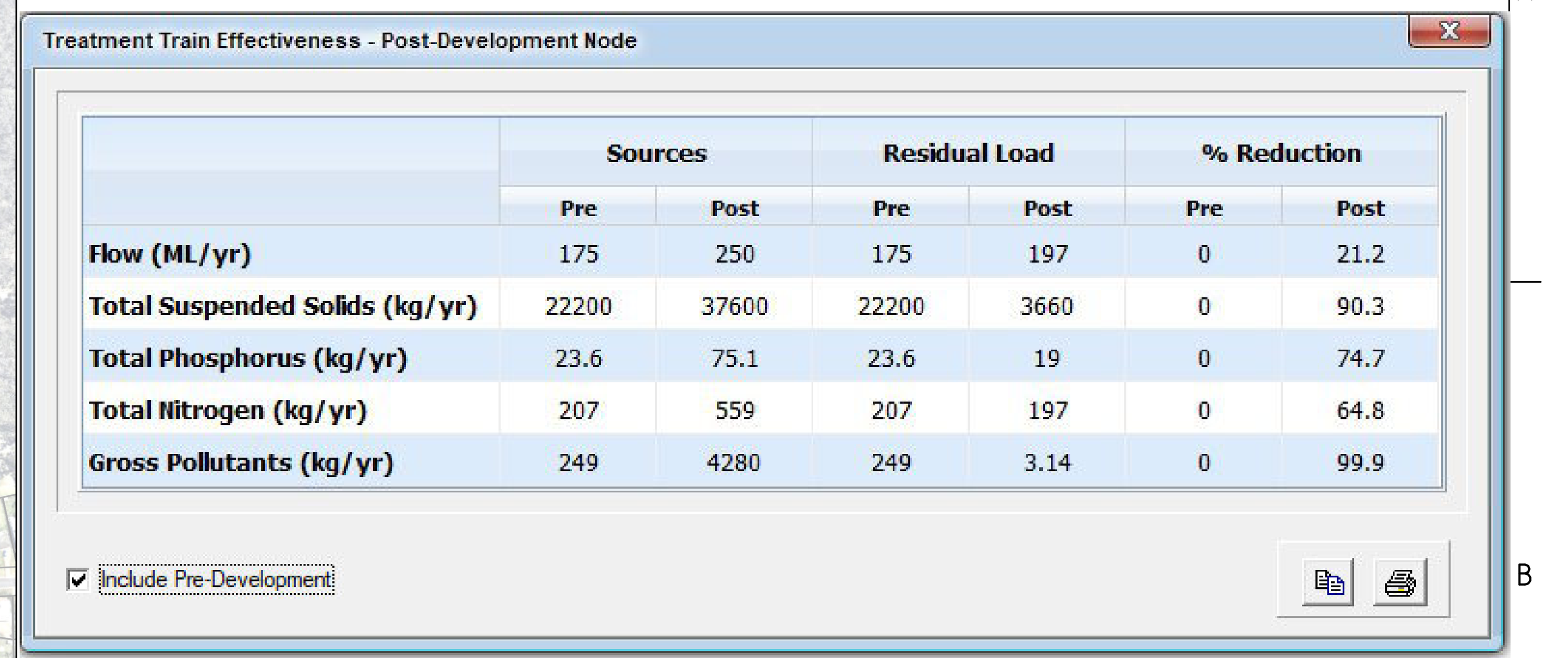
PRE DEVELOPMENT MUSIC CATCHMENT LAYOUT FOR CALLALA BAY DEVELOPMENT

SCALE 1:4000



POST DEVELOPMENT MUSIC CATCHMENT LAYOUT FOR CALLALA BAY DEVELOPMENT

SCALE 1:4000



Treatment Train Effectiveness - Post-Development Node

	Sources		Residual Load		% Reduction	
	Pre	Post	Pre	Post	Pre	Post
Flow (ML/yr)	175	250	175	197	0	21.2
Total Suspended Solids (kg/yr)	22200	37600	22200	3660	0	90.3
Total Phosphorus (kg/yr)	23.6	75.1	23.6	19	0	74.7
Total Nitrogen (kg/yr)	207	559	207	197	0	64.8
Gross Pollutants (kg/yr)	249	4280	249	3.14	0	99.9

Include Pre-Development

MUSIC MODELLING RESULTS (P1806796MUS03V01)

MUSIC CATCHMENT DETAILS FOR CALLALA BAY DEVELOPMENT

PRE DEVELOPMENT

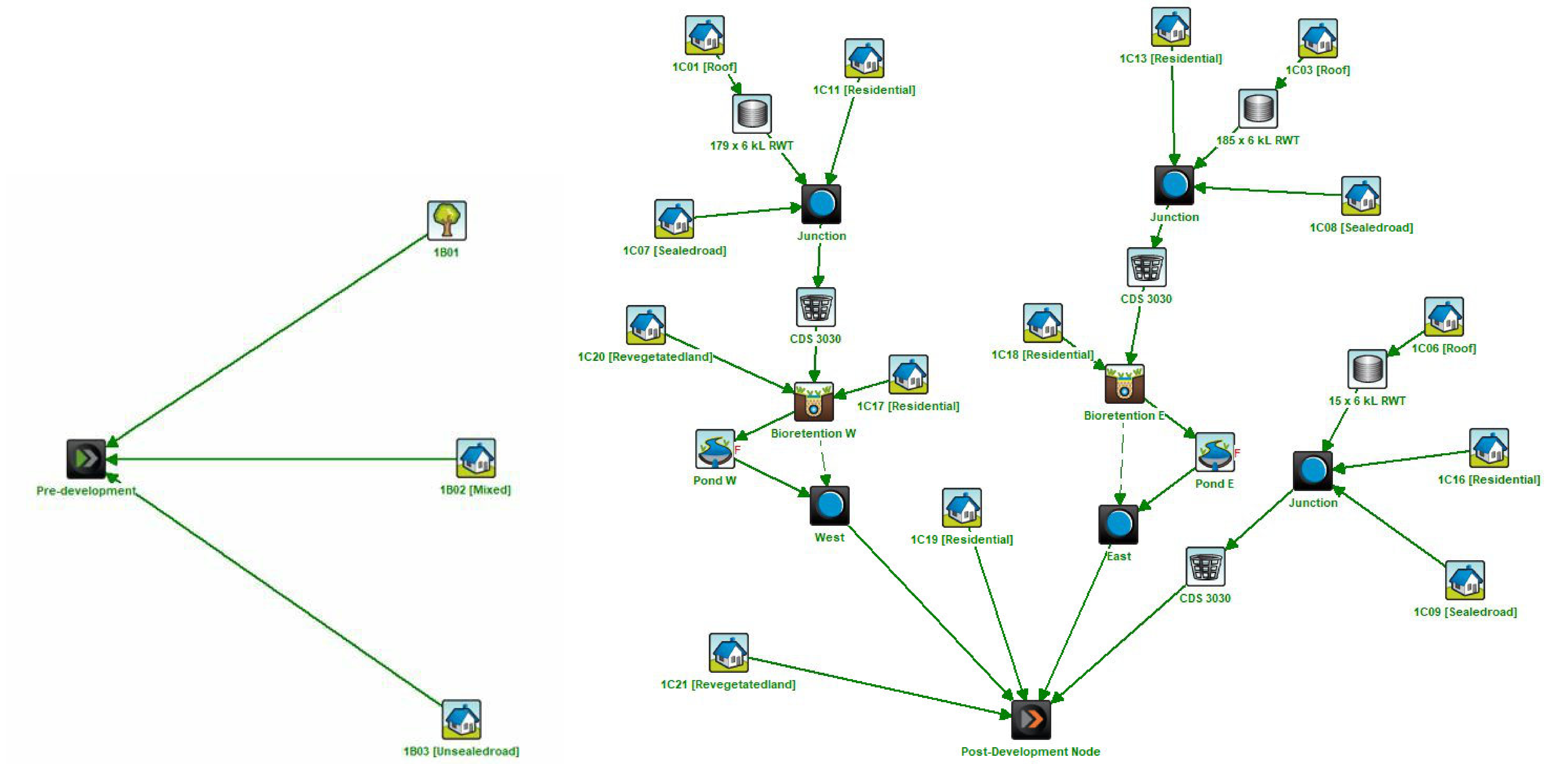
KEY	DESCRIPTION	MUSIC NODE ID	AREA (ha)	IMPERVIOUS %	MUSIC NODE REFERENCE
	FOREST	1B01	34.73	0	NSW MUSIC MODELLING GUIDELINES 2015
	EXISTING CLEARED LAND	1B02	2.39	0	NSW MUSIC MODELLING GUIDELINES 2015
	UNSEALED ROAD	1B03	1.49	50	NSW MUSIC MODELLING GUIDELINES 2015
		TOTAL - AREA	38.61	= 100 % OF OVERALL AREA	
		TOTAL - IMPERVIOUS	0.75	= 2 % OF OVERALL AREA	
		TOTAL - PERVIOUS	37.87	= 100 % OF OVERALL AREA	

POST DEVELOPMENT

KEY	DESCRIPTION	MUSIC NODE ID	AREA (ha)	IMPERVIOUS %	MUSIC NODE REFERENCE
	ROOF AREA WEST	1C01	4.45	100	NSW MUSIC MODELLING GUIDELINES 2015
	ROOF AREA EAST	1C03	4.53	100	NSW MUSIC MODELLING GUIDELINES 2015
	ROOF AREA SOUTH	1C06	0.38	100	NSW MUSIC MODELLING GUIDELINES 2015
	ROAD RESERVE WEST	1C07	4.30	43	NSW MUSIC MODELLING GUIDELINES 2015
	ROAD RESERVE EAST	1C08	4.30	43	NSW MUSIC MODELLING GUIDELINES 2015
	ROAD RESERVE SOUTH	1C09	0.13	43	NSW MUSIC MODELLING GUIDELINES 2015
	REMAINING LOT AREA WEST	1C11	5.61	6	NSW MUSIC MODELLING GUIDELINES 2015
	REMAINING LOT AREA EAST	1C13	5.73	7	NSW MUSIC MODELLING GUIDELINES 2015
	REMAINING LOT AREA SOUTH	1C16	0.57	14	NSW MUSIC MODELLING GUIDELINES 2015
	OPEN SPACE WEST	1C17	0.50	1	NSW MUSIC MODELLING GUIDELINES 2015
	OPEN SPACE EAST	1C18	0.94	1	NSW MUSIC MODELLING GUIDELINES 2015
	OPEN SPACE BYPASS	1C19	0.06	1	NSW MUSIC MODELLING GUIDELINES 2015
	PUBLIC RESERVE WEST	1C20	2.46	1	NSW MUSIC MODELLING GUIDELINES 2015
	PUBLIC RESERVE BYPASS	1C21	3.39	1	NSW MUSIC MODELLING GUIDELINES 2015
	TOTAL TREATMENT AREA	TREATMENT	1.29	0	NSW MUSIC MODELLING GUIDELINES 2015
		TOTAL - AREA	38.61	= 100 % OF OVERALL AREA	
		TOTAL - IMPERVIOUS	14.03	= 36 % OF OVERALL AREA	
		TOTAL - PERVIOUS	24.58	= 64 % OF OVERALL AREA	

NOTES:

1. ALL LOTS HAVE BEEN SPLIT INTO 'ROOF' 'ROAD' AND 'REMAINING'. ASSUMED EACH LOT IN CALLALA BAY EXPANSION AREA HAS A ROOF AREA OF 250M2, A PROPERTY ACCESS DRIVEWAY OF 6M AND A TOTAL EFFECTIVE IMPERVIOUS AREA OF 60%.
2. ASSUMED 100% OF ROOF AREA DRAINS TO RAINWATER TANK.



MUSIC MODELLING LAYOUT (P1806796MUS03V01)

PLANNING PROPOSAL

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
E	**REVISED PER COUNCIL COMMENTS (DATED 28/10/2021)**	**27/01/2022**	**AVG/BN**	**AVG/BN**	**AN**	**AN**
D	REVISED PER COUNCIL COMMENTS (DATED 28/10/2021)	19/01/2022	AVG/BN	AVG/BN	AN	AN
C	MINOR AMENDMENT	08/02/2021	LL	CL	AN	AN
B	UPDATE LAYOUT	18/01/2021	GHO\GM	AVG	AN	AN
A	INITIAL RELEASE	18/02/2019	GHO	AVG/EZ/DI	AN	AN

PRINTED: ---- - USER: BNICHOLS

A1 / A3 LANDSCAPE (A1LC_v02.0.01)

SCALE 0 50 100 150 200 250 300 350 400 450 500 METRES
A1 (A3) 1:5,000 (1:10,000)

GRID: MGA | DATUM: mAHD | PROJECT MANAGER: AN

CLIENT: SEALARK PTY LIMITED

PROJECT NAME/PLANSET TITLE: PROPOSED RESIDENTIAL SUBDIVISION
STORMWATER MANAGEMENT PLAN
CALLALA BAY EXPANSION AREA
CALLALA BAY, 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: WATER QUALITY CATCHMENT PLAN MODEL & RESULT

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1806796	PS01	R06	PS01-E710	E

DRAWING ID: P1806796-PS01-R06-E710

11 Attachment C – Summary of MUSIC Input Parameters

Element	Factor	Input	Source
Setup	Climate File	Jervis Bay Pluviograph. 6-minute time step from 10/10/2001 – 31/05/2008	eWater
Soil Rainfall Runoff Parameters	Soil Storage Capacity	54 mm	Soil types based on geotechnical site investigations. Parameters based on BMT WBM NSW MUSIC Modelling Guidelines (2015).
	Initial Storage	25% of capacity	
	Field Capacity	51 mm	
	Infiltration Capacity Coefficient "a"	180 mm/d	
	Infiltration Capacity Exponent "b"	3	
	Initial Depth	10 mm	
	Daily Recharge Rate	25%	
	Daily Baseflow Rate	25%	
	Daily Deep Seepage	0%	
Source nodes	Node Type	Roofs, sealed road pavement, residential and rural residential areas	Layout plan
	Rainfall Threshold	Based on land use type or surface type as specified in Table 5-4 of NSW MUSIC Modelling Guidelines (2015)	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	Pervious Area Parameters	Based on Table 5-5 of LLS NSW MUSIC Modelling Guidelines (2015) and weighted average of top 1 m borehole log	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	EMC's	Based on Table 5-6 and Table 5-7 of LLS NSW MUSIC Modelling Guidelines (2015)	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	Estimation Method	Stochastically Generated	BMT WBM NSW MUSIC Modelling Guidelines (2015)
Pollutant Parameters	Base Flow (mg/l)	NSW MUSIC Modelling Guideline (2015) Tables 5-6 and 5-7	NSW MUSIC Modelling Guideline (2015) Tables 5-6 and 5-7
	Storm Flow (mg/L)	Land use pollutants per NSW MUSIC Modelling Guideline (2015) Tables 5-6 and 5-7	NSW MUSIC Modelling Guideline (2015) Tables 5-6 and 5-7
379 x 6 kL Rainwater Tank	Low Flow Bypass	0 m^3/s	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	High Flow Bypass	0.010 m^3/s per dwelling	By Design

Element	Factor	Input	Source
342 x 6 kL Rainwater Tank cont.	Volume below overflow	80% x 6 kL (4.8 kL) per residential lot	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	Depth above overflow	0.2 m	Tank design
	Surface Area	2.4 m^2 per tank	Tank design
	Overflow pipe diameter	90 mm per tank	Tank design
	Reuse	0.265 kL/day for internal reuse; 55.115 kL/yr for external reuse.	NSW DWE (2008), BMT WBM NSW MUSIC Modelling Guidelines (2015)
3 x Rocla CDS 3030 GPT	Low Flow Bypass	0 m^3/s	CDA 3030 MUSIC node
	High Flow Bypass	1.75 m^3/s	CDA 3030 MUSIC node
	Treatment Efficiency	As per manufacturer's specifications	CDA 3030 MUSIC node
2 x Bioretention Basins (West and East)	Low Flow Bypass	0 m^3/s	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	High Flow Bypass	0.5 m^3/s	High flow bypass is approximately 4EY flow into the basin calculated from latest DRAINS model.
	Extended Detention Depth	0.3 m	SDCP
	Surface Area	3,930 m^2 (West) / 3,990 m^2 (East)	By Design
	Filter Area	3,930 m^2 (West) / 3,990 m^2 (East)	By Design
	Unlined Filter Media Perimeter	0.01 m	By Design
	Saturated Hydraulic Conductivity	100 mm/hour	By Design
	Filter Depth	0.4 m	FAWB guidelines
	TN Content of Filter Media	400 mg/kg	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	Orthophosphate Content of Filter Media	40 mg/kg	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	Exfiltration Rate	0.00 mm/hr	BMT WBM NSW MUSIC Modelling Guidelines (2015)

Element	Factor	Input	Source
2 x Bioretention Basins (West and East)	Overflow Weir Width	2 m	By Design
2 x Ponds (West and East)	Low Flow Bypass	0 m³/s	By Design
	High Flow Bypass	100 m³/s	Set to ensure all flows drain to ponds
	Surface Area	2,780 m² (West) / 2,150 m² (East)	By Design
	Extended Detention Depth	0.75 m (West) / 0.95 m (East)	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	Permanent Pool Volume	3,170 m³ (West) / 2.310 m³ (East)	By Design
	Initial Volume	3,170 m³ (West) / 2,310 m³ (East)	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	Exfiltration Rate	0 mm/hr	By Design
	Evaporation Loss	100%	By Design
	Equivalent Pipe Diameter	750 mm	By Design
	Overflow Weir Width	16 m (West) / 8 mm (East)	By Design
2 x Wetlands (West and East)	Low Flow Bypass	0 m³/s	By Design
	High Flow Bypass	100 m³/s	Set to ensure all flows drain to ponds
	Surface Area	26,000 m² (West) / 26,000 m² (East)	By Design
	Extended Detention Depth	0.35 m	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	Permanent Pool Volume	26,000 m² (West) / 26,000 m² (East)	By Design
	Initial Volume	26,000 m² (West) / 26,000 m² (East)	BMT WBM NSW MUSIC Modelling Guidelines (2015)
	Exfiltration Rate	0 mm/hr	By Design
	Evaporation Loss	125%	By Design
	Equivalent Pipe Diameter	150 mm	By Design

Element	Factor	Input	Source
2 x Wetlands (West and East)	Overflow Weir Width	16 m	By Design