

Stormwater Management Plan & Downstream Drainage Assessment

Yamba Gardens – Stages 1-10

Kahuna No.1 Pty Ltd

June 2021

BC-18008



BIOME

WATER AND ENVIRONMENTAL CONSULTING

Document Control

Project Name Yamba Gardens

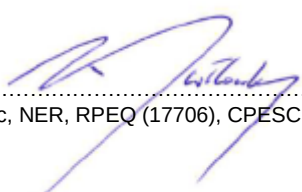
Project Number BC-18008

Report Title Stormwater Management Plan & Hydraulic Impact Assessment

Author Anna Kleinschmidt BEng, BSc Joe McDonald BEng

Reviewed by Brad Comley

Approved by Brad Comley
MSc, BAppSc, MEngPrac, NER, RPEQ (17706), CPESC (8128)



Version Number	Date	Distribution
1	4 June 2021	Mortons Urban Solutions Kahuna No.1 Pty Ltd

Biome Consulting Pty Ltd
ABN: 86 166 087 476

PO Box 3469, Australia Fair SOUTHPORT QLD 4215
Office: 5532 7779
Mobile: 0415 935 222
Email: brad@BIOMEconsulting.com.au
Internet: www.BIOMEconsulting.com.au

Issued in confidence for the sole benefit of our client, this document has been prepared to support a development application and is only to be used for the purpose for which it is supplied. Unofficial use of this document in any form is prohibited. BIOME Consulting Pty Ltd or any employee, contractor, or sub-consultant do not accept any liability with respect to unauthorised use. This disclaimer is valid despite recognition that the document may be made available to other persons for an application for permission or approval to fulfil a legal obligation.

Executive Summary

This report has been prepared on behalf of Kahuna No.1 Pty Ltd and presents a comprehensive review of available Stormwater Quality Improvement Devices (SQID) and stormwater Best Management Practices (BMP) to ensure that the proposed development adequately addresses the management of stormwater quantity and quality during the operational phase of the development. Additionally, this report also includes a hydraulic impact assessment (velocities and peak depths) to ensure the development does not impose any hydraulic impacts upon the western downstream drainage network (relevant to Lot 46) as requested by Clarence Valley Council.

In order to address the management of stormwater quantity during the operational phase of the development, two (2) formal stormwater detention basins have been proposed. These basins include purpose-built outlet structures and detention volume to control discharge from the site. In addition to the basins, detention storage will also be provided within the drainage swale along the northern boundary of the site adjacent to Miles Street. Modelling of the proposed detention measures and their associated outlet structures indicate that pre-developed flows can be maintained for all nominated ARI events at PD-A, PD-B and PD-C. It is estimated that a total detention volume of 20,194 m³ (for the 1% AEP) is required and has been provided to mitigate peak flows from the site.

TUFLOW modelling of the downstream discharge locations of Lot 46 has demonstrated that the proposed development will not adversely affect neighbouring properties or materially change the hydraulic impacts on the downstream drainage structures of Carrs Drive. It is noted the impacts associated with the eastern floodway (Lot 47) and general filling of the West Yamba development area has previously been investigated as part of the Hydraulic Impact Assessment undertaken by BMT. As such this report will not cover these items.

In order to address the management of stormwater quality for Stages 1-10 of the development, numerous streetscape bioretention systems (pods) have been proposed for incorporation within the road reserve areas of the development. This design concept will promote at source treatment of runoff from the road network, with treatment measures replacing traditional pit locations along the road. Two (2) treatment train options have been investigated as part of this assessment.

Option 1

This option includes stormwater treatment provided solely via a network of streetscape bioretention systems. MUSIC v6 modelling suggests that a total bioretention filter area of 3,065 m² (within an estimated 140 pods for Stages 1-10) is required to achieve pollutant removal efficiencies of 85%, 65%, 45% and 90% for TSS, TP, TN and gross pollutants respectively for the site.

Option 2

The second option includes rainwater tanks (for the beneficial reuse of stormwater) connected to the roof catchment area within each allotment and overflows directed to the internal road. This option has been included to investigate if any reductions in the total area of streetscape systems can be achieved in an effort to reduce ongoing maintenance costs.

MUSIC v6 modelling indicates that inclusion of rainwater tanks within each allotment could reduce the total bioretention filter area to 2,700 m², whilst achieving the required pollutant removal efficiencies of 65%, 45% and 90% for TP, TN and gross pollutants respectively. It should be noted however that a lower TSS pollutant removal efficiency of 81.6% is achieved.

Based on a life cycle costing analysis (MUSIC V6) the reduction in filter area has the potential to result in an annual maintenance cost saving to Council.

The level of detail provided within this report is suitable for development assessment only and should not be relied upon for construction purposes. A Detailed Stormwater Management Plan containing detailed engineering designs will be needed to finalise the stormwater concepts presented in this report. Detailed design documentation should be prepared in conjunction with civil operational works.

Contents

1	Introduction	1
1.1	Objectives	1
2	Site Location	2
2.1	Rainfall.....	3
3	Existing Case – Hydrological Assessment	4
3.1	Existing Case – Discharge Locations	4
3.2	Existing Case – External Catchments	5
3.3	Existing Case – Internal Catchments	5
3.4	Existing Case – <i>xpstorm</i> Runoff	6
3.5	Existing Case – Model Validation (Rational Method)	9
4	Proposed Development	10
5	Developed Case – Hydrological Assessment	12
5.1	Developed Case – External Catchments.....	12
5.2	Developed Case – Internal Catchments	12
5.3	Developed Case – <i>xpstorm</i> Runoff.....	13
5.3.1	Validation of Flows.....	14
5.3.2	Peak Discharge Comparison (m ³ /s) – Existing vs Developed (Unmitigated).....	15
6	Stormwater Quantity Management – Operational Phase.....	16
6.1	Schematic Design Plan	16
6.1.1	Upstream Flow Diversion and Conveyance	16
6.1.2	Internal Drainage	16
6.2	Quantity Control – Detention	16
6.2.1	<i>xpstorm</i> Modelling Parameters	17
6.2.2	Modelling Results	18
6.2.3	Detention Depths and Volumes	21
6.2.4	Sensitivity Analysis	22
6.3	Hydraulic Assessment – TUFLOW.....	23
6.3.1	Digital Terrain Model.....	23
6.3.2	Model Extent.....	23
6.3.3	Downstream Boundary Condition	23
6.3.4	Manning’s Coefficient	23
6.3.5	Structures	24
6.3.6	Hydrology	24
6.3.7	Pre-Development <i>TUFLOW</i> Modelling Results	24
6.3.8	Post-Development <i>TUFLOW</i> Modelling Results	26
6.3.9	Impact Assessment	29
6.4	Lawful Point of Discharge.....	30
7	Stormwater Quality Management – Operational Phase.....	32
7.1	Stormwater Quality Treatment Concepts.....	32
7.2	Quality Control – Pollutant Reduction.....	32
7.2.1	Rainfall and Evapotranspiration Data.....	32
7.2.2	Developed Case – Catchment Parameters.....	33
7.2.3	Treatment Measures.....	34
7.2.4	Bioretention Basin Staged Construction and Establishment.....	39
7.2.5	Modelling Results	40

7.2.6	Modelling Results – Life Cycle Costing	43
8	Water Quality Monitoring and Maintenance	44
8.1	Operational Phase Water Quality Monitoring.....	44
8.2	Operational Phase Device Maintenance	44
9	Conclusions	46
10	RPEQ Certification	48
11	References.....	49

Figures

Figure 2.1	Site Location (sourced from NSW Six Maps).....	2
Figure 4.1	Lot Layout Plan (Mortons Urban Solutions)	10
Figure 4.2	Lot Layout Plan (Mortons Urban Solutions)	11
Figure 6.1	Comparison 2-100 year ARI Hydrography at PD-A (Critical Duration)	19
Figure 6.2	Comparison 2-100 year ARI Hydrography at PD-B (Critical Duration)	20
Figure 6.3	Comparison 2-100 year ARI Hydrography at PD-C (Critical Duration)	20
Figure 6.4	Comparison 2-100 year ARI Hydrography at PD-D (Critical Duration)	21
Figure 6.5	Typical Detention Basin Depth Indicator & Warning Signs (Source: Department of Traffic and Main Roads)	22
Figure 6.6	<i>TUFLOW</i> Pre-Development Model Extent.....	24
Figure 6.7	0.01 AEP Pre-Development Peak Flood Depth	25
Figure 6.8	0.01 AEP Pre-Development Peak Flood Velocity	26
Figure 6.9	<i>TUFLOW</i> Post-Development Model Extent	27
Figure 6.10	0.01 AEP Post-Development Peak Flood Depth.....	28
Figure 6.11	0.01 AEP Post-Development Peak Flood Velocity.....	28
Figure 6.12	1% AEP Flood Level Afflux Plot	29
Figure 6.13	1% AEP Velocity Afflux Plot	30
Figure 7.1	Bioretention specifications (Typical)	38
Figure 7.2	Screen Capture of MUSIC Modelling Results (1xStreetscape Bio – 2,500 m ² Catchment) – Option 1	41
Figure 7.3	Screen Capture of MUSIC Modelling Results (1xStreetscape Bio – 2,500 m ² Catchment) – Option 2	41
Figure 7.4	Screen Capture of MUSIC Modelling Results (Total) – Option 1	42
Figure 7.5	Screen Capture of MUSIC Modelling Results (Total) – Option 2	42

Tables

Table 2.1 Adopted Intensity Frequency Data (mm/hr)	3
Table 3.1 Existing Case – External Catchment Characteristic.....	5
Table 3.2 Existing Case – Catchment Characteristic.....	5
Table 3.3 Existing Case – Critical Storm Assessment	6
Table 3.4 Existing Case – <i>xpstorm</i> Catchment Details	8
Table 3.5 Existing Case – Adopted Initial and Continuing Losses	8
Table 3.6 Existing Case – <i>xpstorm</i> Peak Discharge (m ³ /s).....	8
Table 3.7 Existing Case – Peak Flow Validation <i>xpstorm</i> vs Rational	9
Table 5.1 Developed Case – External Catchment Characteristic	12
Table 5.2 Developed Case – Catchment Characteristic	12
Table 5.3 Developed Case – <i>xpstorm</i> Catchment Details	13
Table 5.4 Developed Case – Adopted Initial and Continuing Losses.....	14
Table 5.5 Developed Case – <i>xpstorm</i> Peak Discharge (m ³ /s)	14
Table 5.6 Developed Case – Peak Flow Validation <i>xpstorm</i> vs Rational	14
Table 5.7 Peak Discharge Comparison (m ³ /s).....	15
Table 6.1 Depth Area Relationship.....	17
Table 6.2 Outlet Structures	18
Table 6.3 Peak Discharge Comparison (m ³ /s) – PD-A	18
Table 6.4 Peak Discharge Comparison (m ³ /s) – PD-B	18
Table 6.5 Peak Discharge Comparison (m ³ /s) – PD-C	19
Table 6.6 Detention Storage Details, Depths and Volumes (Basin B)	21
Table 6.7 Detention Storage Details, Depths and Volumes (Basin C)	21
Table 6.8 Sensitivity Analysis Results for 100 Year ARI Event.....	22
Table 7.1 Meteorological and Rainfall Runoff Data Reporting	32
Table 7.2 <i>MUSIC</i> v6 Sub-Catchment Areas	33
Table 7.3 Rainfall Runoff Parameters	33
Table 7.4 Pollutant Export Parameters (log mg/L)	34
Table 7.5 Rainwater Tank Parameters (Lumped).....	35
Table 7.6 Site Constraint Bioretention Design Recommendations.....	36
Table 7.7 Recommended Bioretention Design Levels relative to Groundwater or Tidal Levels	36
Table 7.8 Bioretention Parameters – Option 1.....	37
Table 7.9 Bioretention Parameters – Option 2 (including Rainwater Tanks).....	38
Table 7.10 Treatment Train Effectiveness – Option 1 (no rainwater tanks)	40
Table 7.11 Treatment Train Effectiveness – Option 2 (with RWT tanks).....	40
Table 7.12 Comparison of Treatment train options.....	41

Table 7.13 Life Cycle Costing Inputs – 1 x Streetscape Bioretention Basin.....	43
Table 7.14 Life Cycle Costing Results – 1 x Streetscape Bioretention Basin.....	43
Table 7.15 Operational Phase Water Quality Parameters and Sampling Frequencies	44
Table 7.16 Operational Phase Water Quality Discharge Criteria	44
Table 7.17 Operational Phase Device Maintenance Requirements.....	45

Appendix

Appendix A – Stormwater Management Design Drawings

Appendix B – Preliminary Civil Design Drawings (Mortons Urban Solutions)

Appendix C – ARR Data Hub Output Summary

Appendix D – 1% AEP Box and Whisker Comparison for Multiple Durations

Appendix E – Rational Method Validation

Appendix F – Life Cycle Costing Analysis – Output

Appendix G – Typical Maintenance Checklist (Bioretention)

1 Introduction

This conceptual stormwater management plan has been prepared so as to be considered as part of a Development Application for a Material Change of Use (MCU) and Reconfiguration of a Lot (ROL) over Lot 46 and Lot 47 on DP751395 at 52-54 Miles St, Yamba. (the subject site).

The report has been prepared on behalf of Kahuna No.1 Pty Ltd and presents a comprehensive review of available Stormwater Quality Improvement Devices (SQID) and stormwater Best Management Practices (BMP) to ensure that the proposed development adequately addresses the management of stormwater quantity and quality during the operational phase of the development. Additionally, this report also includes a hydraulic impact assessment (velocities and peak depths) to ensure the development does not impose any hydraulic impacts upon the western downstream drainage network (relevant to Lot 46) as requested by Clarence Valley Council.

The level of detail provided within this report is suitable for development assessment only and should not be relied upon for construction purposes. A Detailed Stormwater Management Plan containing detailed engineering designs will be needed to finalise the stormwater concepts presented in this report. Detailed design documentation should be prepared in conjunction with civil operational works.

1.1 Objectives

The overarching objective of this report is to present practical conceptual stormwater designs which can be integrated into the development proposal so as to ensure that the development does not cause an unacceptable impact or nuisance which could result in actionable damage to downstream properties and receiving environments during the operational phase of development.

The following objectives are to be achieved.

Operational Phase Objective (Quantity)	Maintain a Lawful Point of Discharge (LPD) for all site catchments in accordance with QUDM (2016).
Operational Phase Objective (Quality)	Stormwater discharged from the site achieves the specified load based reduction targets in accordance with Clarence Valley Council's Residential Zone Development Control Plan. For the development site relevant targets of 85% for TSS, 65% for TP, and 45% for TN have been adopted (Landcom's Water Sensitive Urban Design Strategy (2009)).

Additionally this report is to investigate the hydraulic impacts associated with the proposed development of the site. The objectives of the hydraulic impact assessment are to:

- Ensure the development does not result in impacts to the water levels upstream and downstream of the site (Lot 46); and
- No worsening of peak flows and velocities external to the site (Lot 46).

2 Site Location

The subject site is located within the Clarence Valley Council local area at 52-54 Miles St, Yamba and comprises two rectangular allotments, Lot 46 and 47 on 751395. The site has a total area of 42.53 ha, with street frontage to Carrs Road (West), Miles Street (North), and Golding Street (East).

There are currently two (2) existing residential dwellings located within the north eastern portion of the site. The remainder of the site consists of grassed areas, two main (2) drainage lines within the east and south west portion of the site, and existing denser vegetated areas associated with the drainage lines.

Based on existing survey information, the site is low lying and flat with elevations varying between 0.4-1.5 m AHD and average grades varying between 0.1-0.5%. The existing drainage lines convey flows from the site generally in a southerly direction ultimately discharging into Oyster Channel.

Refer to Figure 2.1 below which presents an aerial image depicting the site's location and surrounding road network.



Figure 2.1 Site Location (sourced from NSW Six Maps)

2.1 Rainfall

The hydrologic analysis undertaken in this report will rely on Australian Rainfall and Runoff (ARR) temporal pattern and IFD data obtained for the site from the BOM (Table 2.1).

Table 2.1 Adopted Intensity Frequency Data (mm/hr)

Storm Duration	Annual Exceedance Probability (AEP)					
	0.393 (2 yr ARI)	0.181 (5 yr ARI)	0.095 (10 yr ARI)	0.049 (20 yr ARI)	0.02 (50 yr ARI)	0.01 (100 yr ARI)
5 minute	149.0	187.0	216.0	249.0	294.0	330.0
10 minute	121.00	150.00	173.00	198.00	229.00	253.0
15 minute	102.00	127.00	146.00	166.00	192.00	212.00
20 minute	88.80	110.00	127.00	145.00	168.00	185.00
25 minute	79.00	98.20	113.00	129.00	151.00	167.00
30 minute	71.50	89.00	103.00	118.00	137.00	152.00
45 minute	56.40	70.60	81.90	94.50	112.00	125.00
60 minute	47.30	59.60	69.50	80.60	96.10	108.00
90 minute	36.80	46.90	55.10	64.50	77.80	88.70
120 minute	30.70	39.50	46.80	55.10	67.10	76.90
180 minute	24.00	31.20	37.30	44.30	54.50	62.90

3 Existing Case – Hydrological Assessment

xpstorm was utilised to assess the site's existing hydrology and generate hydrographs to represent the stormwater flows expected within each catchment and at the site's existing points of discharge (PD). Modelling was based on existing catchment areas and surface characteristics. Peak discharge rates for nominated Annual Exceedance Probabilities (AEPs) were derived from the output hydrographs. The following sections detail the input parameters used in the *xpstorm* modelling. Catchments have been delineated on Drawing DWG-200 – Appendix A.

3.1 Existing Case – Discharge Locations

Flows from the subject site currently discharge at five (5) Points of Discharge (PD), north west, south west, and south to the following locations:

- PD-A The stormwater infrastructure at the intersection of Miles Street & Carrs Drive. Flows from a small portion of Lot 46 discharge north to the existing drainage swale which runs west along Miles Street. Flows from the drainage swale are then conveyed west underneath Carrs Drive via a set of existing culverts (2 x 1200 x 300 RCBC) which discharge to an existing drainage channel which runs west along the Miles Street road reserve. The channel ultimately discharges to Oyster Channel.
- PD-B The existing drainage line and stormwater infrastructure of Carrs Drive. Flows from the western portion of the site currently discharge to the existing drainage line within the south western portion of the site. From here flows discharge both west to the existing culverts and drainage channel of Carrs Drive and also south to the neighbouring freehold allotment (Lot 9 on DP 1251010) where the drainage line continues south and discharges to an existing dam. Flows which are conveyed west underneath Carrs Drive via the culverts discharge into an existing channel located within Lot 2 on DP 733507 which ultimately discharges to Oyster Channel.
- PD-C The southern freehold allotment Lot 4 on DP63341. Flows from the eastern portion of the site are conveyed within an existing floodway that continues across the southern boundary of the site into freehold allotment, Lot 4 on DP63341.
- PD-D The southern freehold allotment Lot 5 on DP1210129. Flows from a small portion of Lot 47 discharge south to the southern neighbouring allotment. Flows discharge at this location as both sheet and channel flow. It is understood that discharge is ultimately conveyed to the existing floodway which continues through this allotment (Lot 5) from Lot 4 (identified as PD-C).
- PD-E The southern freehold allotment Lot 9 on DP 1251010. A portion of flows from the existing south western drainage line and also sheetflow from the south western corner of the site discharge along the southern boundary of the site. Flows discharge via the drainage line which continues south within Lot 9 to an existing dam and also via sheet flow across the site boundary.
- PD-F The existing drainage channel of Carrs Drive. A small portion of flows from Lot 46 discharge to the existing roadside drainage channel south of the cross-drainage culverts. Flows at this discharge location continue south within the channel.

The existing discharge locations are shown on Drawing DWG-200 – Appendix A.

For detention sizing and peak mitigation purposes, flows presented for PD-B in the 1D assessment (XPSTORM) are the combined discharge to the existing south-western drainage line. Given flows are split within this drainage line to two points of discharge, a 2D assessment has been constructed to further assess downstream impacts at PD-B and PD-E (refer to Section 6.3).

3.2 Existing Case – External Catchments

There are two (2) external upstream catchments that contribute flows directly onto the subject site. These catchments are predominantly associated with the northern neighbouring allotments north of Miles Street. The external catchment characteristics are summarised in Table 3.1 below and are delineated on Drawing DWG-200- Appendix A.

Table 3.1 Existing Case – External Catchment Characteristic

Catchment ID	Area (ha)	Cover (%)	Discharge Condition	PD ID
Ext A(1)	6.89	75 – Grassed/Cleared 25 - Dense Veg.	Sheet & Channel	PD-A
Ext C(1)	7.22	85 – Grassed/Cleared 10 – Dense Veg. 5 - Dwelling	Sheet & Channel	PD-C

3.3 Existing Case – Internal Catchments

The subject site has been divided into eight (8) internal catchment areas. The characteristic of the site's catchments are detailed in Table 3.2 below and have been delineated on Drawing 200 – Appendix A.

Table 3.2 Existing Case – Catchment Characteristic

Catchment ID	Area (ha)	Cover (%)	Discharge Condition	PD ID
Internal	A	100 – Grassed/Cleared	Sheet & Channel	PD-A
	B1	100 – Grassed/Cleared	Sheet & Channel	PD-B
	B2	95 – Grassed/Cleared 5 – Dense Veg.	Sheet & Channel	
	B3	30 – Dense Veg. 70 – Grassed/Cleared	Sheet & Channel	
	C	75 – Grassed/Cleared 20 - Dense Veg. 5 - Dwelling	Sheet & Channel	PD-C
	D	85 – Grassed/Cleared 15 - Dense Veg.	Sheet & Channel	PD-D
	E	70 – Grassed/Cleared 30 - Dense Veg.	Sheet & Channel	PD-E
	F	100 – Grassed/Cleared	Sheet & Channel	PD-F

3.4 Existing Case – *xpstorm* Runoff

The “Laurenson” routing method was applied to *xpstorm* for hydrological calculation and hydrograph generation. The contributing catchment was split into pervious (with 0% impervious fraction) and impervious (with 100% impervious fraction) areas. Adopted parameters for the Laurenson routing method include a Manning’s roughness coefficient (n) for impervious and pervious areas respectively. Infiltration uniform losses have been applied to the hydrologic model based on information obtained from the Australian Rainfall and Runoff Data Hub tool (reference: <https://data.arr-software.org>). It is noted that as the site is within NSW, ARR losses have been adjusted by a factor of 0.4 (consistent with Approach 5 described in ‘Floodplain Risk Management – Incorporating 2016 Australian Rainfall and Runoff in studies’, 2019).

Temporal Patterns and Rainfall Data

Site specific rainfall and temporal pattern data used in modelling was sourced from the Australian Rainfall and Runoff (ARR) Data Hub (2020). Refer to Appendix C for a summary of the data obtained.

Critical Storm Duration Assessment

The critical storm duration for each catchment was determined utilising the Ensemble Statistics Utility in *xpstorm*. From the critical storm duration, the median storm ensemble was utilised to determine peak flows for each respective catchment. In order to determine the peak flow at the sites point of discharge, the critical duration and median ensemble was selected Table 3.3 presents the critical storm duration and chosen median storm ensemble for each of the modelled catchments. Box and Whisker Plots showing the 1% AEP peak flows for the range of durations modelled is contained within Appendix D.

Table 3.3 Existing Case – Critical Storm Assessment

Catchment ID		Annual Exceedance Probability (AEP)	Critical Duration (minute)	Median Ensemble Storm No.
External	Ext A(1)	1%	120	2
		2%	180	9
		5%	180	2
		10%	180	6
		18%	180	2
		39%	180	6
	Ext C(1)	1%	180	9
		2%	180	9
		5%	180	6
		10%	180	6
		18%	180	6
		39%	180	6
	A	1%	120	2
		2%	180	4
		5%	120	2
		10%	180	7
		18%	270	2
		39%	180	2
		1%	120	9
		2%	120	9

Internal	B1	5%	180	9
		10%	120	7
		18%	120	5
		39%	120	7
	B2	1%	180	9
		2%	180	9
		5%	180	3
		10%	180	6
		18%	180	4
		39%	270	7
	B3	1%	45	6
		2%	45	6
		5%	60	3
		10%	60	7
		18%	120	4
		39%	120	7
	C	1%	120	2
		2%	180	2
		5%	180	2
		10%	180	6
		18%	180	2
		39%	180	6
	D	1%	90	10
		2%	90	10
		5%	180	6
		10%	180	9
		18%	120	9
		39%	180	2
	E	1%	90	10
		2%	90	10
		5%	180	6
		10%	180	9
		18%	120	9
		39%	180	2
	F	1%	120	9
		2%	120	4
		5%	120	5
		10%	120	7
		18%	120	9
		39%	120	2
	PD-A	1%	120	2
		2%	120	2
		5%	180	3
		10%	180	6

Point of Discharge		18%	180	2
		39%	180	6
	PD-B	1%	180	9
		2%	180	9
		5%	180	3
		10%	180	6
		18%	180	4
		39%	180	4
	PD-C	1%	180	9
		2%	180	9
		5%	180	3
		10%	180	6
		18%	180	6
		39%	180	6

The tables below contain the modelling parameters relied upon and present the resulting peak discharges expected for each catchment. The flows reported at PD-A and PD-C represent the combined external and internal catchment inflows at these points. PD-B represents the combined inflows for the internal 'B' catchments.

Table 3.4 Existing Case – *xpstorm* Catchment Details

Catchment ID		Impervious Area		Pervious Area	
		Area (ha)	Slope (%)	Area (ha)	Slope (%)
External	Ext A(1)	-	-	6.888	0.25
	Ext C(1)	-	-	7.219	0.21
Internal	A	-	-	1.020	0.23
	B1	-	-	1.007	0.27
	B2	-	-	16.899	0.34
	B3	-	-	0.767	1.22
	C	0.070	0.40	17.205	0.40
	D	-	0.29	2.351	0.29
	E	-	-	3.307	0.37
	F	-	-	0.617	0.23

Table 3.5 Existing Case – Adopted Initial and Continuing Losses

Impervious Area			Pervious Area			
IL (mm)	CL (mm/hr)	Manning's n	AEP	IL (mm)	CL (mm/hr)	Manning's n
0	0	0.014	0.393-0.01	24	1.44*	0.040

*CL(from ARR) x 0.4 ARR (consistent with Approach 5 described in 'Floodplain Risk Management – Incorporating 2016 Australian Rainfall and Runoff in studies', 2019)

Table 3.6 Existing Case – *xpstorm* Peak Discharge (m³/s)

Catchment/Point of Discharge	Annual Exceedance Probability (AEP)					
	0.393 (2 yr ARI)	0.181 (5 yr ARI)	0.095 (10 yr ARI)	0.049 (20 yr ARI)	0.02 (50 yr ARI)	0.01 (100 yr ARI)
Ext A(1)	0.28	0.40	0.56	0.69	0.79	0.93
Ext C(1)	0.27	0.39	0.54	0.68	0.80	0.92
A	0.05	0.10	0.12	0.15	0.18	0.18
B1	0.06	0.09	0.11	0.13	0.17	0.20
B2	0.59	0.88	1.20	1.51	1.82	2.11
B3	0.07	0.10	0.13	0.16	0.19	0.22
C	0.71	1.02	1.42	1.73	1.98	2.36
D	0.12	0.17	0.22	0.26	0.33	0.39
E	0.17	0.24	0.31	0.38	0.48	0.57
F	0.04	0.05	0.06	0.08	0.10	0.12
PD-A	0.33	0.47	0.65	0.80	0.92	1.09
PD-B	0.70	0.98	1.37	1.73	2.11	2.46
PD-C	0.91	1.32	1.84	2.30	2.83	3.30
PD-D	0.12	0.17	0.22	0.26	0.33	0.39
PD-E	0.17	0.24	0.31	0.38	0.48	0.57
PD-F	0.04	0.05	0.06	0.08	0.10	0.12

3.5 Existing Case – Model Validation (Rational Method)

For validation purposes, peak discharge values were calculated for 0.01 AEP using Rational Method and compared to those generated using *xpstorm*. The comparison is shown in Table 3.7 below and Rational calculations, which are in accordance with QUDM 2016 Section 4, are detailed within Appendix E.

Table 3.7 Existing Case – Peak Flow Validation *xpstorm* vs Rational

Catchment & Point of Discharge ID		<i>xpstorm</i> (m³/s)	Rational (m³/s)	Difference (%)
External	Ext A(1)	0.93	0.87	6.5
	Ext C(1)	0.92	1.04	-13.0
Internal	A	0.18	0.19	-5.6
	B1	0.20	0.20	0.0
	B2	2.11	2.48	-17.5
	B3	0.22	0.19	13.6
	D	0.39	0.38	2.6
	E	0.57	0.52	8.8
	F	0.12	0.11	8.3

*for modelling purposes B (Ext 2) has been included as a sub-catchment of B1.

The peak discharge calculated using Rational method is within 20% of the value generated using *xpstorm* for the 1% AEP. The modelling is therefore considered to be appropriately validated.



4 Proposed Development

The proposal is for the reconfiguration of Lot 46 and 47 into 310 residential allotments ranging in size from 400-600 m². In addition to the allotments the development will also include:

- An internal road network with pedestrian footpath;
- Streetscape stormwater treatment areas incorporated within the road reserves;
- Two (2) Stormwater detention basins for quantity management (located within drainage reserves); and
- Vegetated riparian zones.

The proposed lot layout plan is presented within Figure 4.1 and 4.2 (below).

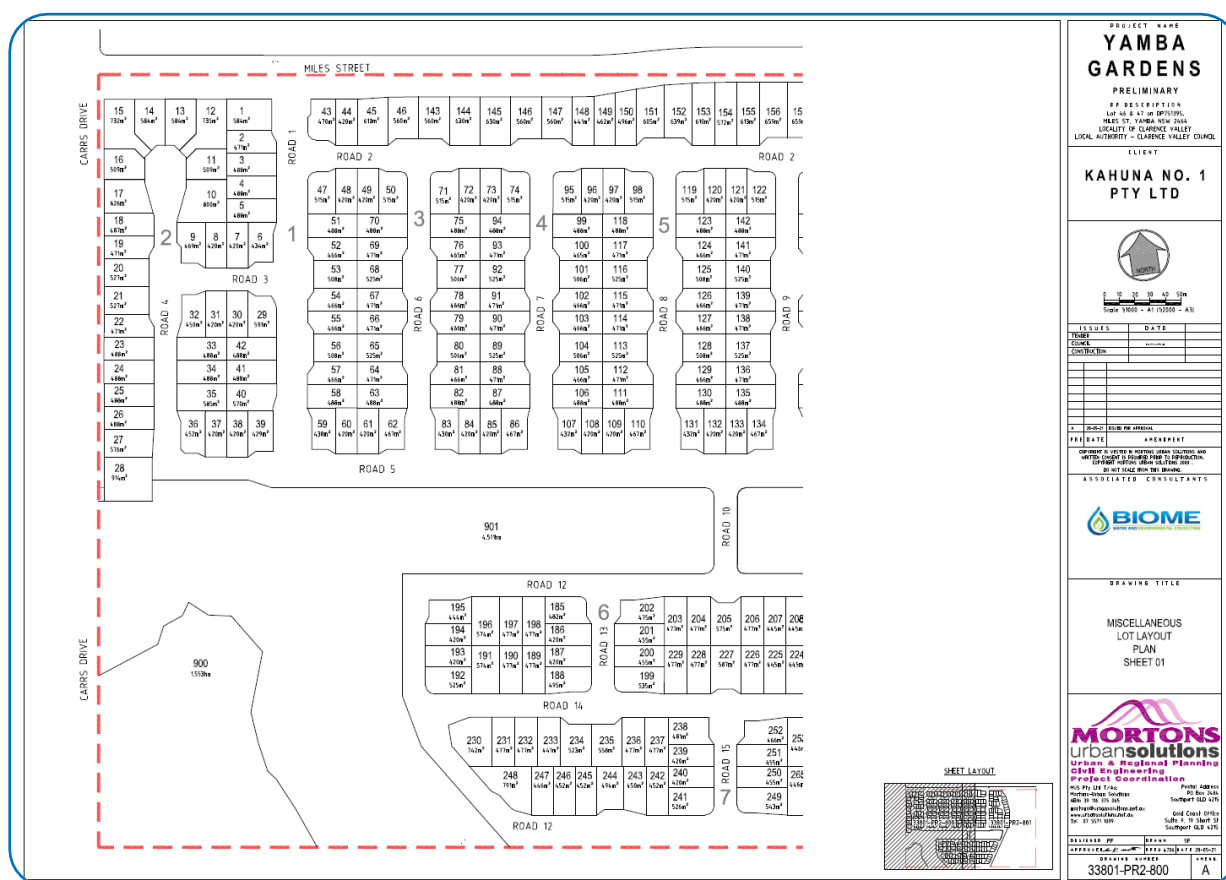


Figure 4.1 Lot Layout Plan (Mortons Urban Solutions)

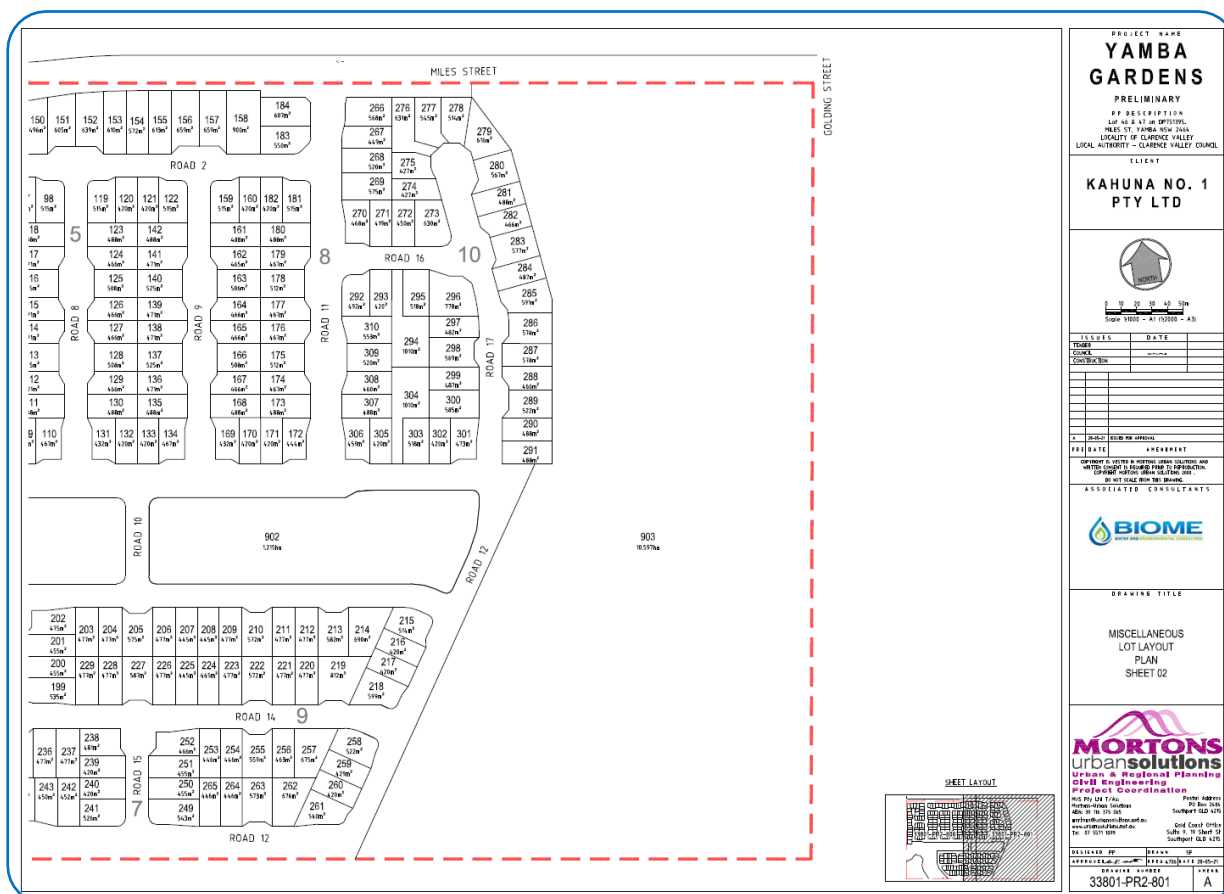


Figure 4.2 Lot Layout Plan (Mortons Urban Solutions)



5 Developed Case – Hydrological Assessment

xpstorm was utilised to assess the site's developed hydrology and generate hydrographs and peak discharge rates for the site catchments and at each PD. The following sections detail the parameters used in the *xpstorm* modelling. Catchments have been delineated on Drawing DWG-201 – Appendix A.

5.1 Developed Case – External Catchments

In the developed case two (2) of the external catchments; Ext A(1) and Ext C(1), will be altered due to the construction and improvement of Miles Street which bounds the northern boundary of the site. The external catchment characteristics of the altered catchments in the developed case are summarised in Table 5.1 below.

Table 5.1 Developed Case – External Catchment Characteristic

Catchment ID		Area (ha)	Cover (%)	Discharge Condition	PD ID
External	Ext A(1)	7.37	22 – Impervious 78 - Grassed	Point & Sheet	PD-A
	Ext C(1)	7.38	13 – Impervious 87 - Grassed	Point & Sheet	PD-C

5.2 Developed Case – Internal Catchments

The site will undergo substantial earthworks (fill) to profile the development area and raise the level of the land 2-3m to the 1% AEP design flood level. Underground piped drainage will be installed to collect minor stormwater flows, with major flows conveyed via the internal road network.

Five (5) major post development catchments (A,B,C1,C2 and D) have been delineated within the developable area based on the preliminary civil designs by Mortons Urban Solutions (Refer to Appendix B). Outside the developable area, a further five (5) catchments have been delineated within the site boundary and included within this assessment. Whilst the topography of these site catchments will remain consistent with the existing case, minor alterations in catchment areas and diversions will occur as a result of earthworks within the developable area of the site.

The characteristic of the site's catchments are detailed in Table 5.2 below and have been delineated on Drawing 201 – Appendix A.

Table 5.2 Developed Case – Catchment Characteristic

Catchment ID		Area (ha)	Cover (%)	Discharge Condition	PD ID
Internal (Development Area)	A	0.50	100 – Res Dev	Pipe – Road	PD-A
	B	17.36	100 – Res Dev	Pipe – Road	PD-B
	C1	0.55	100 – Res Dev	Pipe – Road	PD-C
	C2	7.29	100 – Res Dev	Pipe – Road	PD-C
	D	0.59	100 – Res Dev	Pipe – Sheet	PD-C



Internal (Remainder of Site Area)	B2	0.59	15 – Batter 25 – Dense Veg. 60 - Grassed/Cleared	Sheet & Channel	PD-B
	B3	0.77	30 – Dense Veg. 70 – Grassed/Cleared	Sheet & Channel	PD-B
	C3	11.19	75 – Grassed/Cleared 20 - Dense Veg. 5 - Dwelling	Sheet & Channel	PD-C
	D(Remain)	0.33	100 – Grassed/Cleared	Sheet & Channel	PD-D
	E	2.83	10 – Batter 30 – Dense Veg. 60 - Grassed/Cleared	Sheet & Channel	PD-E
	F	0.62	100 – Grassed/Cleared	Sheet & Channel	PD-F

5.3 Developed Case – *xpstorm* Runoff

The “Laurenson” routing method was applied to *xpstorm* for hydrological calculation and hydrograph generation. The contributing catchment was split into pervious (with 0% impervious fraction) and impervious (with 100% impervious fraction) areas. Adopted parameters for the Laurenson routing method include a Manning’s roughness coefficient (n) for impervious and pervious areas respectively. Infiltration uniform losses have been applied to the hydrologic model.

The tables below contain the modelling parameters relied upon and present the resulting peak discharges expected for each catchment. The flows reported at each PD represent the combined catchment inflows at this point.

Table 5.3 Developed Case – *xpstorm* Catchment Details

Catchment ID		Impervious Area		Pervious Area	
		Area (ha)	Slope (%)	Area (ha)	Slope (%)
External	Ext A(1)	1.59	0.50	5.78	0.25
	Ext C(1)	0.92	0.21	6.46	0.21
Internal (Developable Area)	A	0.35	0.50	0.15	0.50
	B	12.15	0.50	5.21	0.50
	C1	0.38	0.50	0.17	0.50
	C2	5.10	0.50	2.19	0.50
	D	0.36	0.5	0.26	0.50
Internal (remainder of site area)	B2	-	-	0.59	0.23
	B3	-	-	0.77	0.31
	C3	-	-	11.19	0.40
	D(Remain)	-	-	0.33	0.40
	E	-	-	2.83	0.37
	F	-	-	0.62	0.23



Table 5.4 Developed Case – Adopted Initial and Continuing Losses

Impervious Area			Pervious Area			
IL (mm)	CL (mm/hr)	Manning's n	AEP	IL (mm)	CL (mm/hr)	Manning's n
0	0	0.014	0.393-0.01	24	1.44*	0.040

*CL(from ARR) x 0.4 ARR (consistent with Approach 5 described in 'Floodplain Risk Management – Incorporating 2016 Australian Rainfall and Runoff in studies', 2019)

Table 5.5 Developed Case – *xpstorm* Peak Discharge (m³/s)

Catchment/Point of Discharge	Annual Exceedance Probability (AEP)					
	0.393 (2 yr ARI)	0.181 (5 yr ARI)	0.095 (10 yr ARI)	0.049 (20 yr ARI)	0.02 (50 yr ARI)	0.01 (100 yr ARI)
Ext A(1)	0.57	0.68	0.80	0.94	1.11	1.26
Ext C(1)	0.32	0.44	0.57	0.70	0.87	1.01
A	0.13	0.15	0.18	0.20	0.25	0.27
B	4.34	5.26	6.17	7.08	8.46	9.46
B2	0.04	0.05	0.06	0.08	0.10	0.12
B3	1.79	2.18	2.54	2.92	3.51	3.91
C1	0.14	0.19	0.19	0.22	0.25	0.37
C2	1.79	2.18	2.54	2.92	3.51	3.91
C3	0.49	0.71	0.97	1.17	1.38	1.63
D	0.13	0.18	0.18	0.21	0.23	0.36
E	0.14	0.22	0.29	0.35	0.42	0.50
F	0.04	0.05	0.06	0.08	0.10	0.12
PD-A	0.33	0.45	0.56	0.65	0.75	0.84
PD-B	4.23	5.12	6.12	7.06	8.43	9.42
PD-C	1.94	2.34	2.85	3.30	3.94	4.63
PD-D	0.13	0.18	0.19	0.22	0.25	0.38
PD-E	0.14	0.22	0.29	0.35	0.42	0.50
PD-F	0.04	0.05	0.06	0.08	0.10	0.12

5.3.1 Validation of Flows

Table 5.6 illustrates that the peak discharges generated using both methods compare moderately well for the 1.0 % AEP as both hydrological methods are within 20% of each other for the 1% AEP. It is noted that a few of the internal catchments (A2(int), A5 (int)) are up to 23% different, however this is attributed to the higher IL and CL losses (consistent with ARR) prevalent in the area. The modelling is considered to be appropriately validated.

Table 5.6 Developed Case – Peak Flow Validation *xpstorm* vs Rational

Catchment/Point of Discharge	<i>xpstorm</i> (m ³ /s)	Rational (m ³ /s)	Difference (%)
Ext A(1)	1.256	1.436	-14.3
Ext C(1)	1.010	1.210	-19.8
A	0.275	0.330	-20.0
B	9.457	9.677	-2.3



	B2	0.118	0.136	-15.3
	B3	0.22	0.19	13.6
	C1	0.373	0.311	16.6
	C2	3.913	4.630	-18.3
	C3	1.626	1.512	7.0
	E	0.334	0.400	-19.8
	F	0.12	0.11	8.3

5.3.2 Peak Discharge Comparison (m³/s) – Existing vs Developed (Unmitigated)

Table 5.7 presents a comparison of the peak discharges expected at each PD. Results indicate decreases in peak discharge are expected at PD-A, PD-D, and PD-E due to contributing catchment area reductions. Storage has also been created within the swales proposed for the upgrade of Miles Street and has contributed to the reduction of flows at PD-A. It is noted that there is a minor increase (0.009m³/s) in flow at PD-D for the 39.3% AEP, however this will be addressed as part of detailed design for the stormwater network with storage being created within stormwater pipe design for this catchment.

Increases in peak discharge to PD-B and PD-C are expected due to an increase in contributing catchment and impervious area.

Catchment F (discharge location PD-F) will not be altered as a result of the development therefore flows will remain as per the existing condition (refer to Table 3.6).

Table 5.7 Peak Discharge Comparison (m³/s)

PD	Scenario	Contributing Catchment Area (ha)	Annual Exceedance Probability (AEP)					
			0.393 (2 yr ARI)	0.181 (5 yr ARI)	0.095 (10 yr ARI)	0.049 (20 yr ARI)	0.02 (50 yr ARI)	0.01 (100 yr ARI)
PD-A	Existing	7.91	0.33	0.47	0.65	0.80	0.92	1.09
	Developed (Unmitigated)	7.87	0.33	0.45	0.56	0.65	0.75	0.84
	Difference		0.00	-0.02	-0.09	-0.15	-0.16	-0.25
PD-B	Existing	18.67	0.70	0.98	1.37	1.73	2.11	2.46
	Developed (Unmitigated)	19.16	4.23	5.12	6.12	7.06	8.43	9.42
	Difference		+3.53	+4.14	+4.76	+5.33	+6.32	+6.97
PD-C	Existing	24.49	0.91	1.32	1.84	2.30	2.83	3.30
	Developed (Unmitigated)	24.47	1.94	2.34	2.85	3.30	3.94	4.63
	Difference		+1.03	+1.02	+1.01	+1.00	+1.11	+1.34
PD-D	Existing	2.35	0.118	0.17	0.22	0.26	0.33	0.39
	Developed (Unmitigated)	0.59	0.127	0.17	0.19	0.22	0.25	0.38
	Difference		+0.009	0.00	-0.03	-0.04	-0.08	-0.01
PD-E	Existing	3.31	0.17	0.24	0.31	0.38	0.48	0.57
	Developed (Unmitigated)	2.63	0.14	0.22	0.29	0.35	0.42	0.50
	Difference		-0.03	-0.02	-0.02	-0.03	-0.06	-0.07



6 Stormwater Quantity Management – Operational Phase

In order to ensure that the operational phase objectives outlined within Section 1.1 of this report can be achieved, a network of stormwater management measures are proposed for inclusion within the development.

To achieve these objectives, both external and internal flows will need to be adequately managed prior to discharge to the site's points of discharge.

6.1 Schematic Design Plan

With consideration given to the existing site characteristics, the proposed development configuration and the range of available stormwater management control measures, a set of conceptual stormwater management designs have been proposed and detailed within the drawing set contained within Appendix A.

6.1.1 Upstream Flow Diversion and Conveyance

There are several upstream catchments north of the Miles street road reserve which are to be conveyed through or diverted around the development area in association with the upgrade of Miles Street. The preliminary designs for the roadside channels and cross drainage culverts are contained within Mortons Civil design drawings (refer to Appendix B). The western portion of the Miles Street upgrade has also been included within the 2D Hydraulic Model Assessment contained within Section 6.3 of this report.

6.1.2 Internal Drainage

The site's internal catchments will be developed as residential allotments which will be graded to allow stormwater flows to be collected within the internal road network of the development. Preliminary stormwater drainage designs have been prepared by Mortons Urban Solutions and are contained within Appendix B of this report.

Runoff collected within the kerb and channel of the internal roads during minor events is to be treated within street scape quality treatment measures. Flows will enter these measures via openings within the kerb. These measures have been designed to encourage 'at source treatment' of flows within the road reserves and to limit earthworks (fill) associated with a traditional piped network.

Post treatment stormwater flows from each streetscape measure will enter the underground piped network. Highflows above the piped network capacity are to be conveyed within the road reserves to the proposed detention basins within Catchments B and C.

6.2 Quantity Control – Detention

The proposed development will result in an increase in impervious and hardstand area and therefore an increase in peak discharge to PD-B and PD-C. Two (2) detention basins have been proposed to detain stormwater flows so as to ensure that there is no increase in discharge to downstream properties for all nominated AEP's at PD-B and PD-C.

The basins are to be located within the western and eastern portion of the site.



6.2.1 *xpstorm* Modelling Parameters

xpstorm has been relied upon to size the required detention basin and develop appropriate outlet configurations. *xpstorm* requires a depth area relationship to be defined when modelling an onsite detention (OSD). A summary of the total depth-area relationship applied to the storage nodes of the *xpstorm* model in the post-development (mitigated) scenario is contained in Table 6.1. The dimensions and proposed levels of the outlet structures used to mitigate the developed case peak discharge and achieve the required detention volumes are detailed in Table 6.2. The proposed outlet configurations were then utilised in the 2D assessment for the site (Section 6.3).

Table 6.1 Depth Area Relationship

Detention ID	RL (m AHD)	Depth (m)	Surface Area (ha)
Basin B	0.8	0	0.0010
	0.9	0.1	0.0940
	1	0.2	0.3784
	1.1	0.3	0.7488
	1.2	0.4	0.9422
	1.3	0.5	0.9942
	1.4	0.6	1.0388
	1.5	0.7	1.0861
	1.6	0.8	1.1458
	1.7	0.9	1.2115
	1.8	1	1.2788
	1.9	1.1	1.3435
	2	1.2	1.4284
	2.1	1.3	1.4885
	2.2	1.4	1.5332
	2.3	1.5	1.5743
	2.36	1.56	1.5981
Basin C	0.8	0	0.0010
	0.9	0.1	0.1050
	1	0.2	0.3724
	1.1	0.3	0.6612
	1.2	0.4	0.7519
	1.3	0.5	0.7839
	1.4	0.6	0.8163
	1.5	0.7	0.8491
	1.6	0.8	0.8822
	1.7	0.9	0.9157
	1.8	1	0.9494
	1.9	1.1	0.9832
	2	1.2	1.0167
	2.1	1.3	1.0497
	2.2	1.4	1.0813
	2.3	1.5	1.1136



	2.36	1.56	1.1310
--	------	------	--------

Table 6.2 Outlet Structures

Detention Basin ID	Low Flow Outlet		High Flow
	Pit Orifice	Pit & Pipe Outlet	High Flow Weir
Basin B	2x0.2mx0.4m rectangular orifice @ RL 0.8 m AHD 2x0.2mx0.4m rectangular orifice @ RL 1.4 m AHD	2 x 600x900 Pits, Crests @ RL 1.60 m AHD with 1x450mm & 1 x 525mm RCP Pipe outlets (US IL @ RL 0.8 m AHD) 1x450mm x 600mm high RCBC Headwall outlet (US IL @ RL 0.8 m AHD)	1 x 18 m wide weir, crest @ RL 1.95 m AHD
Basin C	1x0.2mx0.4m rectangular orifice @ RL 0.8 m AHD	1 x 600x900 Pits, Crests @ RL 1.55 m AHD with 1x450mm RCP outlet (US IL @ RL 0.8 m AHD)	1 x 12 m wide weir, crest @ RL 1.95 m AHD

6.2.2 Modelling Results

The results of *xpstorm* modelling indicate that the inclusion of the detention basins along with the proposed catchment delineation will mitigate the expected increases in peak discharge at the nominated points of discharge location during all nominated ARI events.

Table 6.3 to 6.5 presents a comparison between the expected peak discharges during nominated ARI events for the pre- and post-development mitigated cases at PD-A, PD-B, and PD-C. Figure 6.1 to 6.4 illustrates a comparison of the outlet hydrograph at PD-A, PD-B, PD-C, and PD-D.

Table 6.3 Peak Discharge Comparison (m³/s) – PD-A

Scenario	Contributing Catchment Area (ha)	Annual Exceedance Probability (AEP)					
		0.393 (2 yr ARI)	0.181 (5 yr ARI)	0.095 (10 yr ARI)	0.049 (20 yr ARI)	0.02 (50 yr ARI)	0.01 (100 yr ARI)
Existing	7.91	0.33	0.47	0.65	0.80	0.92	1.09
Developed (Unmitigated)	7.87	0.33	0.45	0.56	0.65	0.75	0.84
Difference (Existing vs Developed)		0.00	-0.02	-0.09	-0.15	-0.16	-0.25

Table 6.4 Peak Discharge Comparison (m³/s) – PD-B

Scenario	Contributing Catchment Area (ha)	Annual Exceedance Probability (AEP)					
		0.393 (2 yr ARI)	0.181 (5 yr ARI)	0.095 (10 yr ARI)	0.049 (20 yr ARI)	0.02 (50 yr ARI)	0.01 (100 yr ARI)
Existing	18.67	0.70	0.98	1.37	1.73	2.11	2.46
Developed (Unmitigated)	19.16	4.23	5.12	6.12	7.06	8.43	9.42



Developed (Mitigated)	19.16	0.70	0.95	1.36	1.60	1.87	2.43
Difference (Existing vs Developed)		0.00	-0.03	-0.00	-0.13	-0.22	-0.03

Table 6.5 Peak Discharge Comparison (m³/s) – PD-C

Scenario	Contributing Catchment Area (ha)	Annual Exceedance Probability (AEP)					
		0.393 (2 yr ARI)	0.181 (5 yr ARI)	0.095 (10 yr ARI)	0.049 (20 yr ARI)	0.02 (50 yr ARI)	0.01 (100 yr ARI)
Existing	24.49	0.91	1.32	1.84	2.30	2.83	3.30
Developed (Unmitigated)	24.47	1.94	2.34	2.85	3.30	3.94	4.63
Developed (Mitigated)	24.47	0.90	1.24	1.76	2.13	2.67	3.12
Difference (Existing vs Developed)		-0.01	-0.08	-0.08	-0.16	-0.16	-0.17

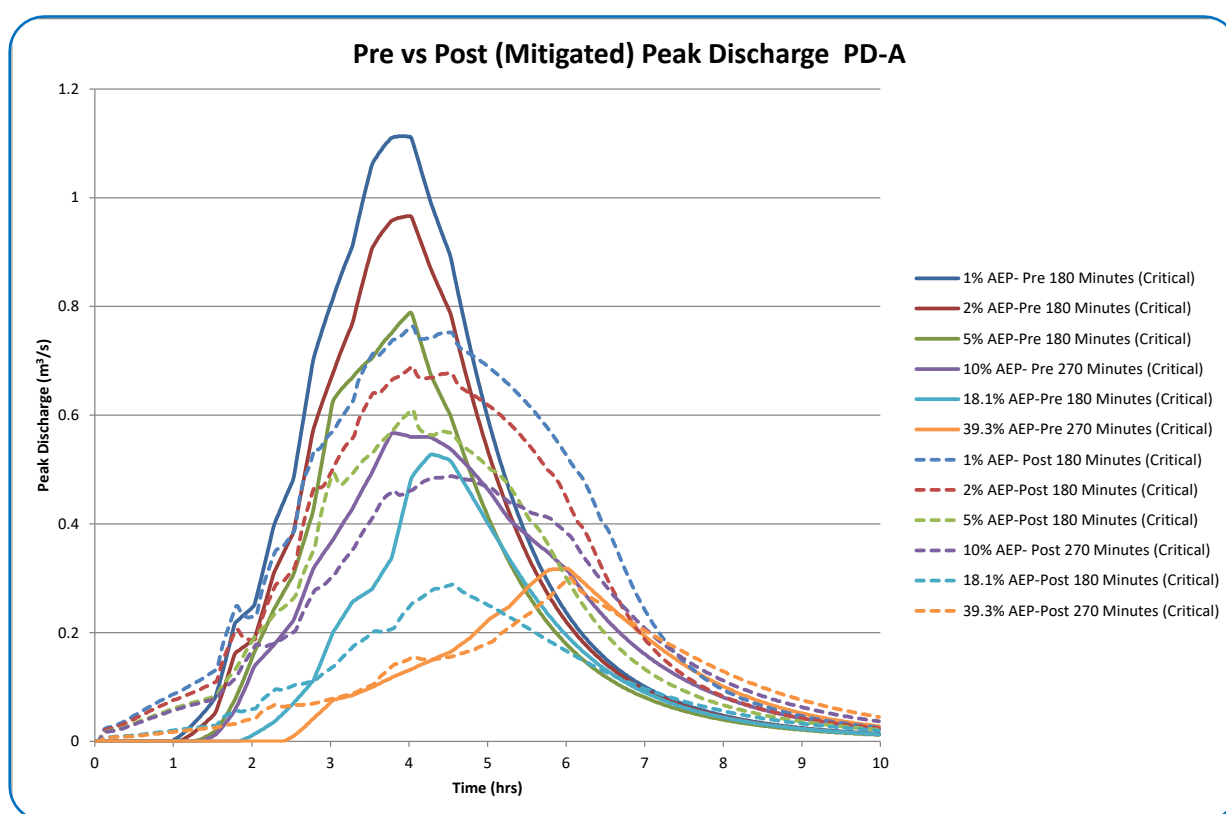


Figure 6.1 Comparison 2-100 year ARI Hydrography at PD-A (Critical Duration)

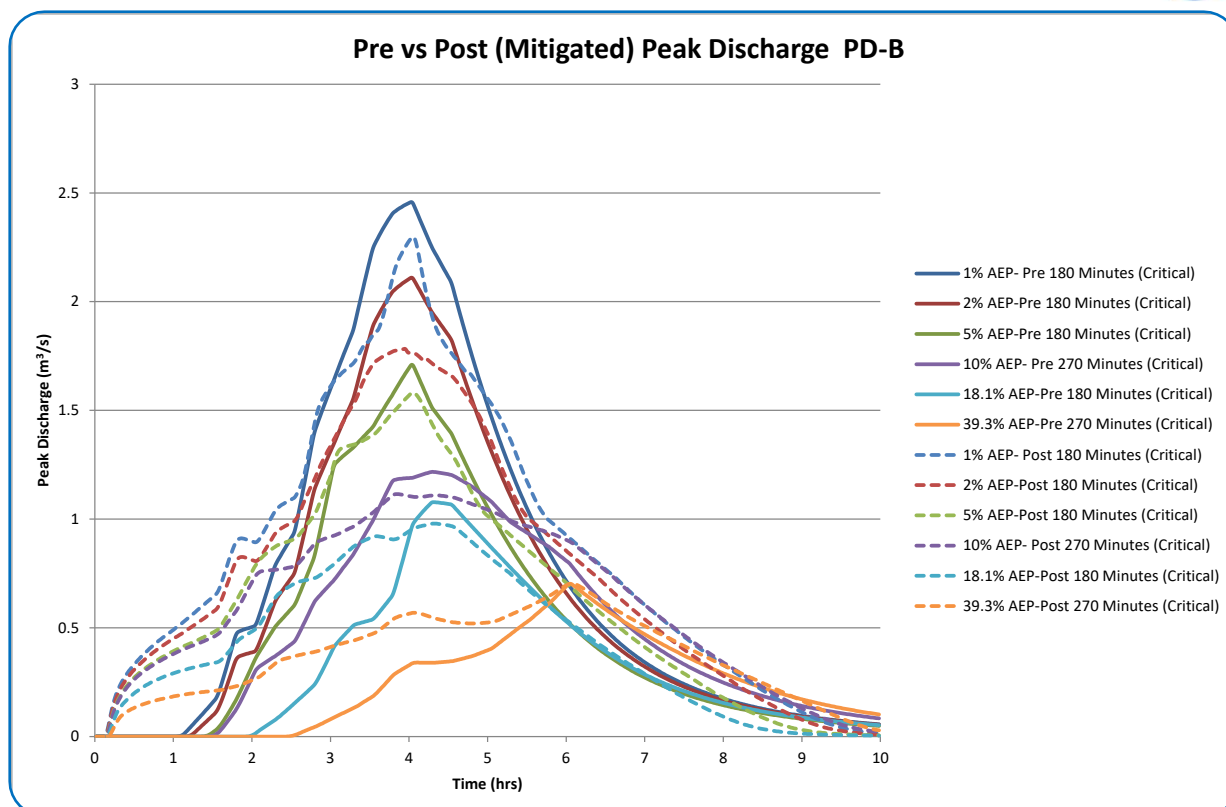


Figure 6.2 Comparison 2-100 year ARI Hydrography at PD-B (Critical Duration)

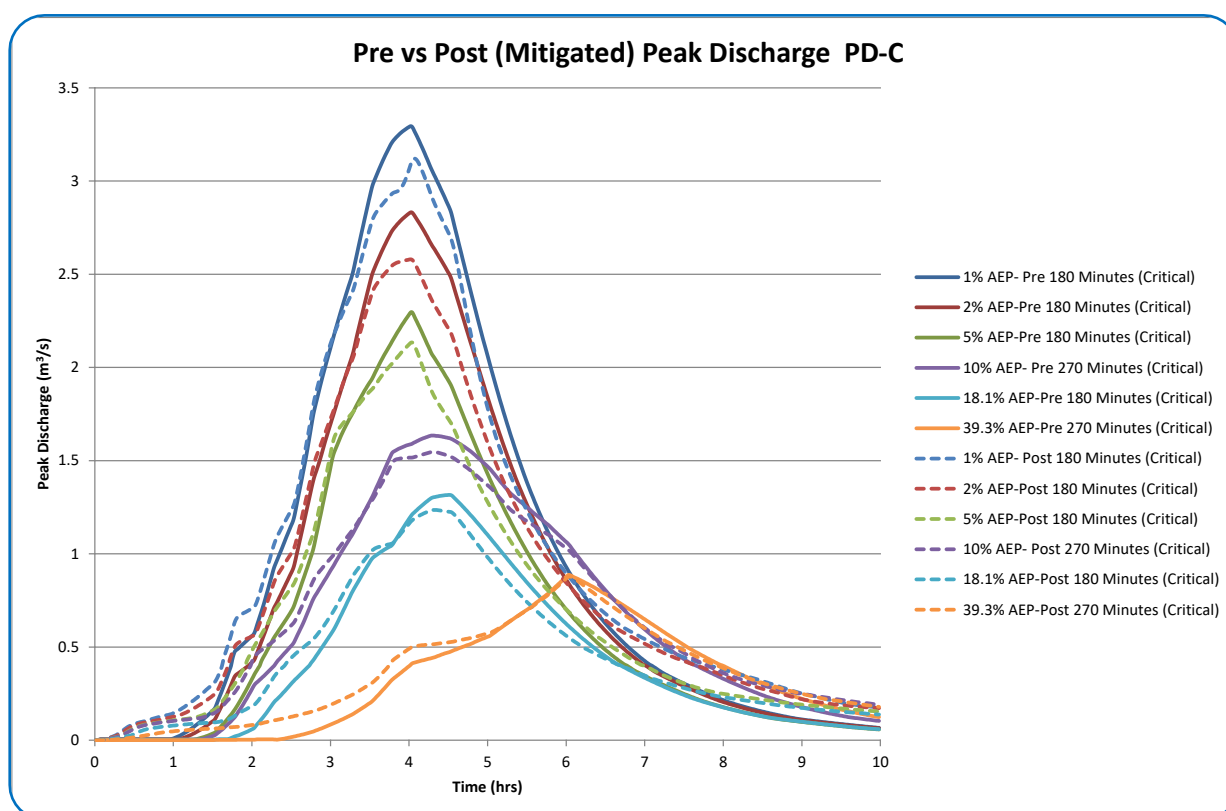


Figure 6.3 Comparison 2-100 year ARI Hydrography at PD-C (Critical Duration)

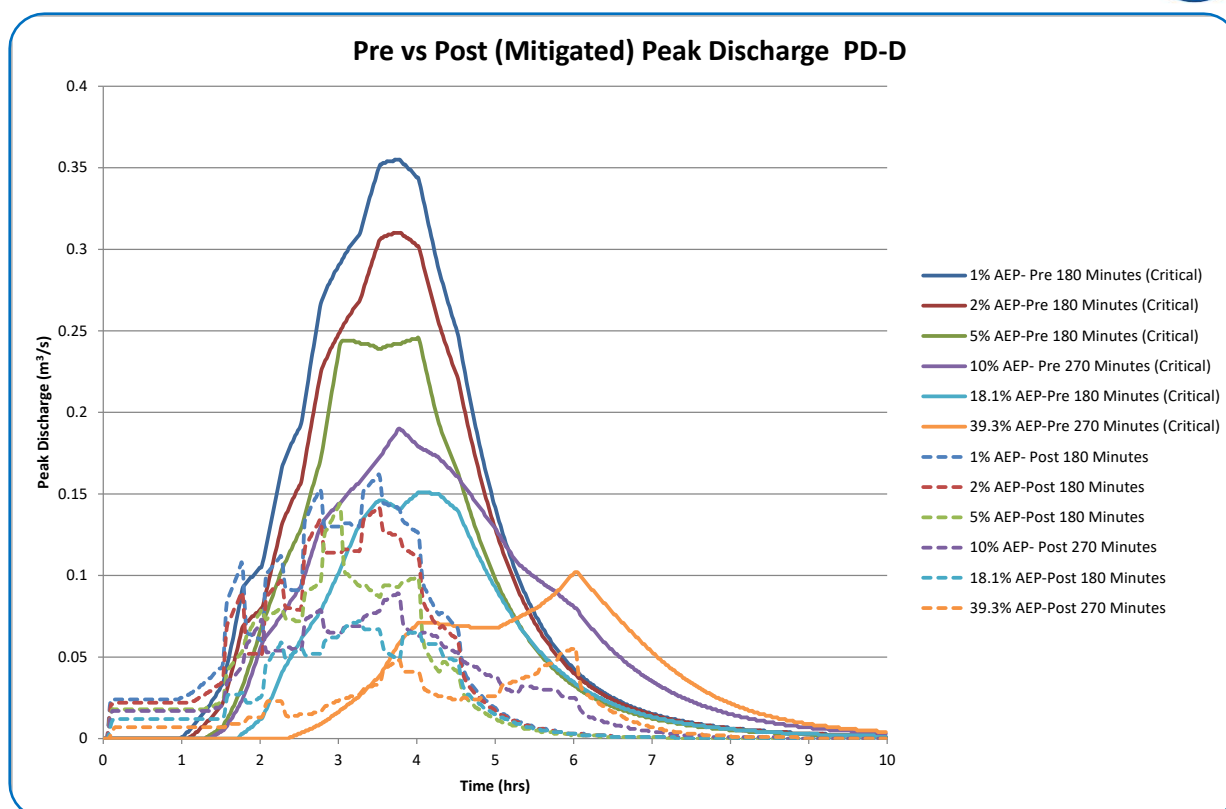


Figure 6.4 Comparison 2-100 year ARI Hydrography at PD-D (Critical Duration)

6.2.3 Detention Depths and Volumes

Table 6.6 and 6.7 presents the peak water levels, depths and volumes expected within the detention basins during both the 20 year ARI and 100 year ARI.

Table 6.6 Detention Storage Details, Depths and Volumes (Basin B)

	0.049 (20 yr ARI)	0.01 (100 yr ARI)
Base Level (m AHD)	0.8	0.8
Top of Bund Level (m AHD)	2.36	2.36
Weir Level (m AHD)	1.95	1.95
Peak Water Surface (m AHD)	1.79	2.01
Peak Depth of Water (m)	0.99	1.21
Peak Volume (m ³)	8,088	11,089
Freeboard Achieved (m)	0.57	0.36
Depth of Weir Flow (m)	-	0.06

Table 6.7 Detention Storage Details, Depths and Volumes (Basin C)

	0.049 (20 yr ARI)	0.01 (100 yr ARI)
Base Level (m AHD)	0.8	0.8
Top of Bund Level (m AHD)	2.36	2.36
Weir Level (m AHD)	1.95	1.95
Peak Water Surface (m AHD)	1.89	2.06



Peak Depth of Water (m)	1.09	1.26
Peak Volume (m ³)	7,419	9,105
Freeboard Achieved (m)	0.47	0.30
Depth of Weir Flow (m)	-	0.10

Basin Safety in Design

As water depths are expected to rise above 1.0 m within the detention basin during major events, in accordance with QUDM Section 5.12 it is recommended that a depth indicator be installed within the basin with its zero level relative to the lowest point in the basin floor. Refer to Figure 7.3 below for typical depth indicator. Warning signs are also recommended to deter access during rainfall events (refer to Figure 7.3 below).

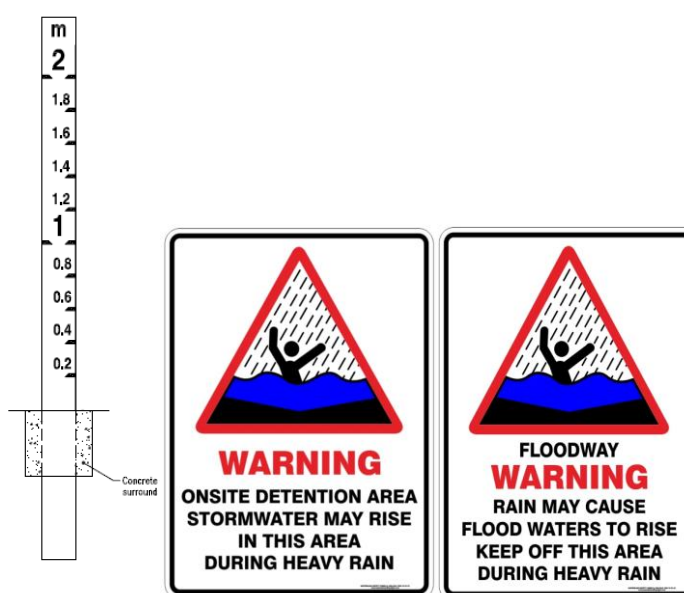


Figure 6.5 Typical Detention Basin Depth Indicator & Warning Signs (Source: Department of Traffic and Main Roads)

6.2.4 Sensitivity Analysis

Consideration has been given to the consequences of fully blocked outlet pipes for both basins. Table 6.8 illustrates the expected peak water levels within the basins if both the proposed pipe outlets became fully blocked. In this event, water levels would increase in the basin with all flow discharging over the weir structures.

Table 6.8 Sensitivity Analysis Results for 100 Year ARI Event

Basin ID	Peak Water Level (m AHD)	Top of Bund (m AHD)	Depth of Weir Flow (m)	Depth x Velocity Product
Basin B	2.20	2.36	0.25	0.21
Basin C	2.12	2.36	0.17	0.11

Based on the existing basin and weir configurations, peak water levels would not be expected to exceed the Top of Bund during the 100 year ARI. The expected maximum depth of flow over the weir has been modelled at less than 0.3 m. In addition the depth vs velocity product over the weirs is not expected to exceed 0.4 m²/s during a blocked case scenario.



6.3 Hydraulic Assessment – TUFLOW

In order to determine whether the discharge conditions resulting from the development will lead to unacceptable impacts to downstream properties to the west, a *TUFLOW* 1D/2D hydraulic assessment has been undertaken. *TUFLOW* is capable of simulating flow for both small and large study areas using both 2-Dimensional and 1-Dimensional flow based on topography.

Data used to construct the 2D hydraulic model includes:

- Survey of the site and surrounds;
- LiDAR of the wider catchment;
- design surfaces of proposed works by Mortons Urban Solutions; and
- existing pipe network data from survey.

Flows from the western portion of the site discharge to culverts under Carrs Drive and into a table drain leading to the Clarence River.

6.3.1 Digital Terrain Model

The digital terrain model (DTM) forms the basis of the topography of the assessment area. This study has relied upon LiDAR data obtained from the Department of Natural Resources and Mines to construct the DTM, with survey overlaid where available. To accurately represent this DTM within the *TUFLOW* model, a grid size of 1 m has been utilised which is fine enough to capture the detail within the smaller flowpaths within the model extent. For the post-development scenario the model has been modified to include the design surface by Mortons Urban Solutions.

6.3.2 Model Extent

The extent of the *TUFLOW* model has been selected to accurately represent flood behaviour at the site, and ensure all contributing flows are captured. The model extends approximately 130 m downstream of Carrs Drive and encompasses the entire upstream catchment. The *TUFLOW* model extent is illustrated in Figure 6.6.

6.3.3 Downstream Boundary Condition

Water levels at the downstream end of the model are represented by a “HQ” type outlet which represents that flows are free draining at this location. The downstream boundary of the model has been located far enough away from the site as to not influence flow within the area of interest. Initial water levels have been set at HAT.

6.3.4 Manning’s Coefficient

Based on recommendations from; *Chow. V. T, (1959) Open Channel Hydraulics, Main Roads Drainage Design Manual (1999)*, and aerial photography the following Manning Coefficients were applied:

- | | |
|---------------------|-------|
| • Concrete/Road: | 0.015 |
| • Grassed areas: | 0.045 |
| • Light Vegetation: | 0.060 |
| • Dense Vegetation: | 0.080 |
| • Central Swale: | 0.045 |
| • Waterbodies: | 0.020 |
| • Houses: | 0.300 |



6.3.5 Structures

The existing pipe network downstream of the site has been represented in the model as 1D elements. Information on this network has been sourced from site survey.

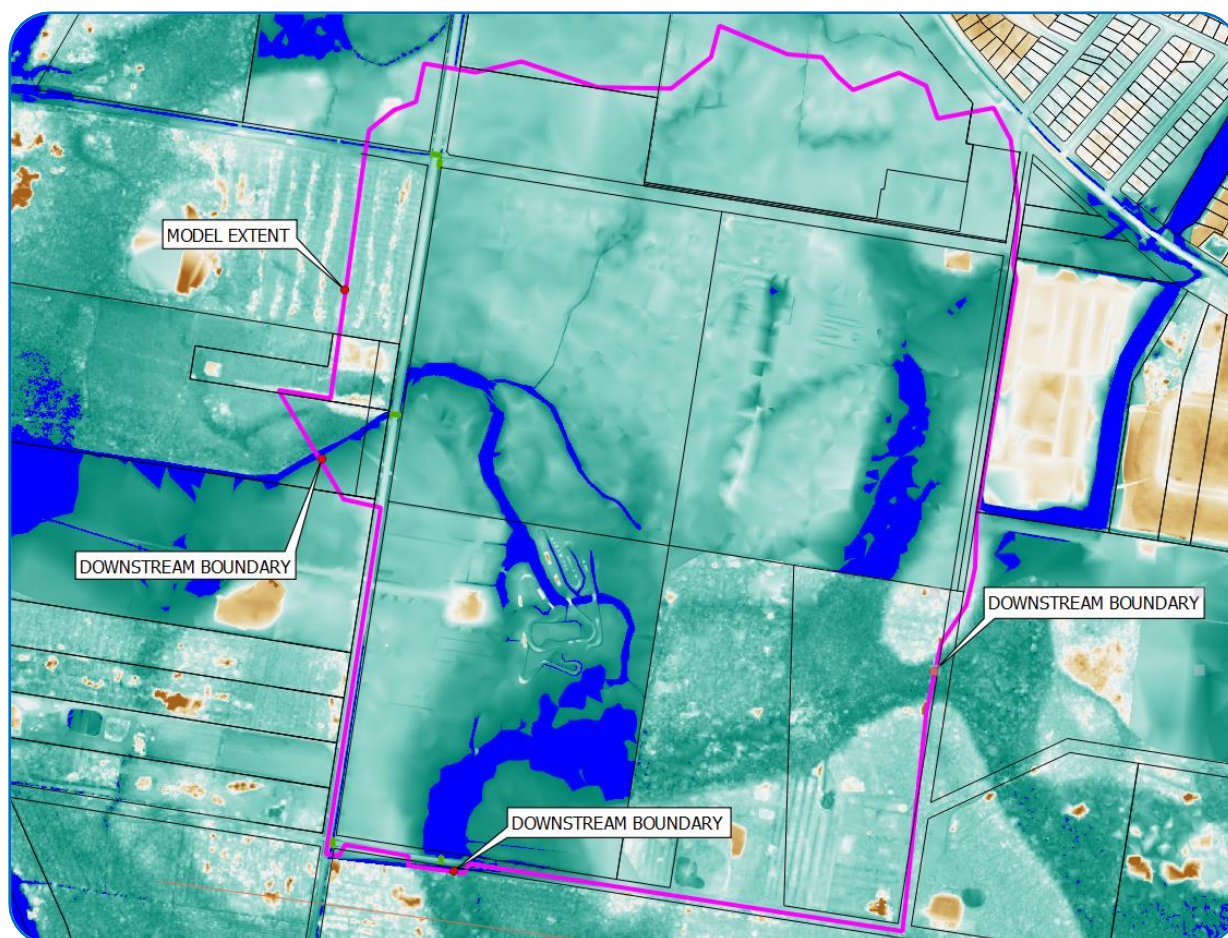


Figure 6.6 *TUFLOW* Pre-Development Model Extent

6.3.6 Hydrology

The TUFLOW model incorporates a rain-on-grid methodology for the catchment with rainfall and infiltration parameters as described in the above sections.

6.3.7 Pre-Development *TUFLOW* Modelling Results

The flooding behaviour of the site is characterised by shallow slow moving flow collecting in the low areas of the site and floodplain. There is a defined watercourse through the south-western corner of the site which conveys flow to the culverts under Carr Drive. Figure 6.7 below shows the 0.01 AEP peak depth through the site and downstream catchment, peak depths are generally less than 1m.

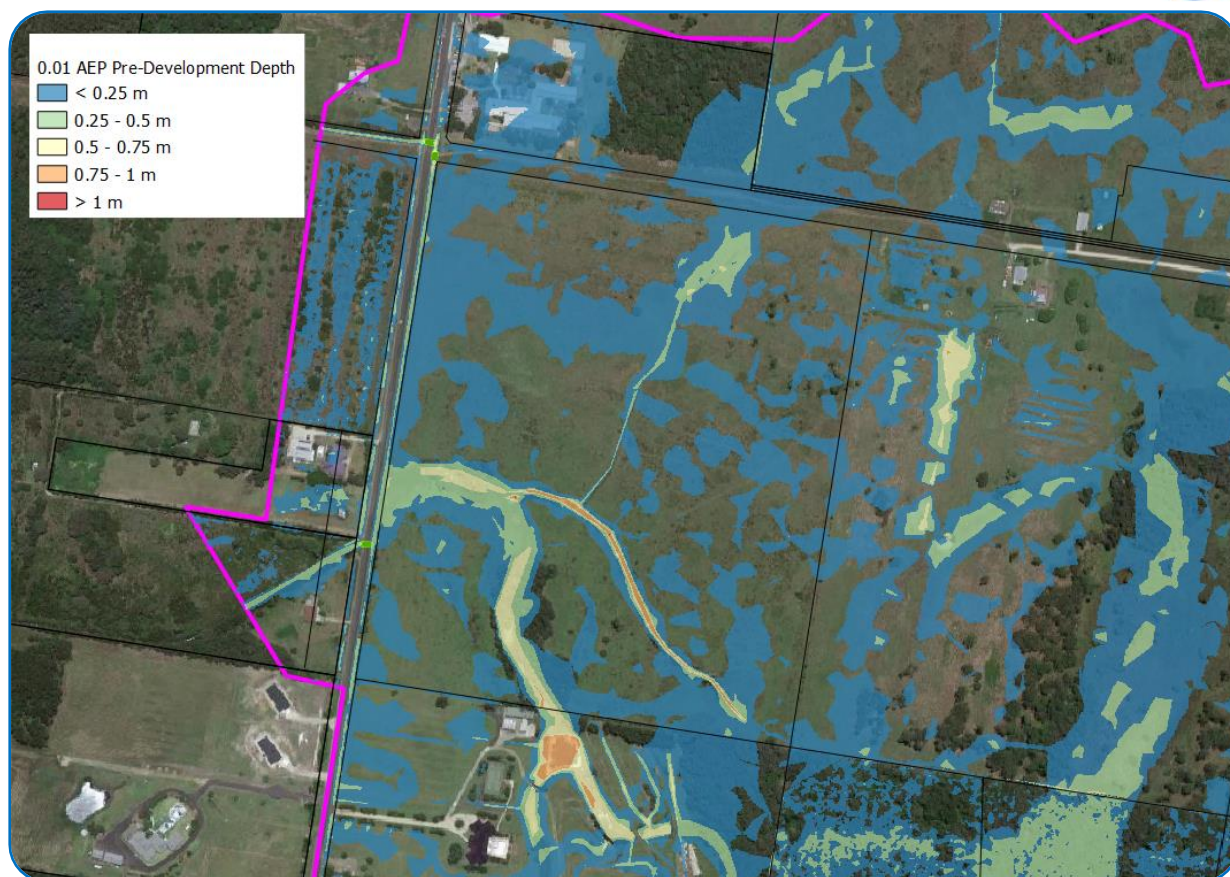


Figure 6.7 0.01 AEP Pre-Development Peak Flood Depth

Velocity through the site is generally less than 0.5 m/s due to the very flat nature of the site. Figure 6.8 below shows the 0.01 AEP peak velocity through the site and downstream catchment.

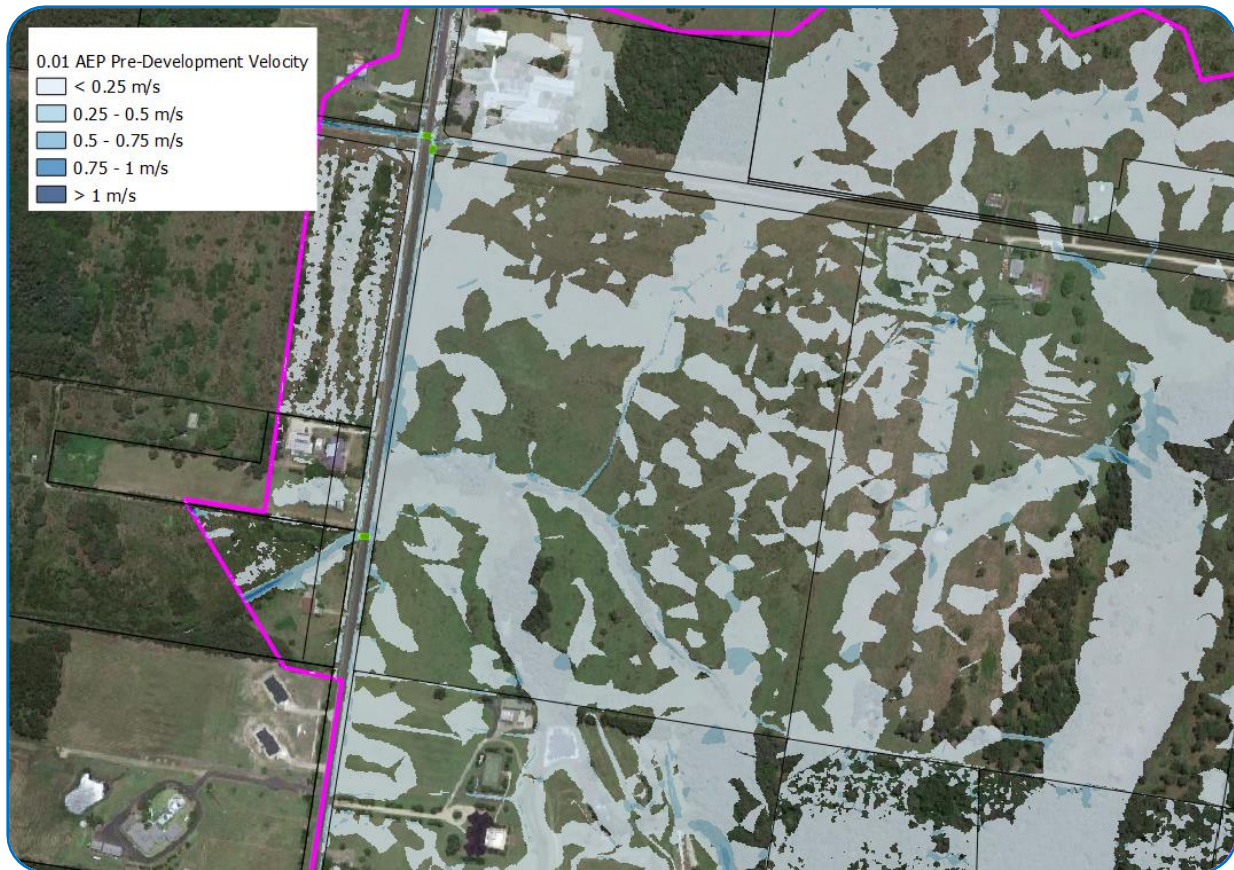


Figure 6.8 0.01 AEP Pre-Development Peak Flood Velocity

6.3.8 Post-Development *TUFLOW* Modelling Results

The flooding behaviour in the post-development scenario is similar in the lower catchment to the west of the site. Runoff from the earthworks pad is collected in an internal pipe network and directed to central detention basins. The western basin discharges to the existing watercourse and under Carrs Drive. The post-development TUFLOW model layout is shown on Figure 6.9.

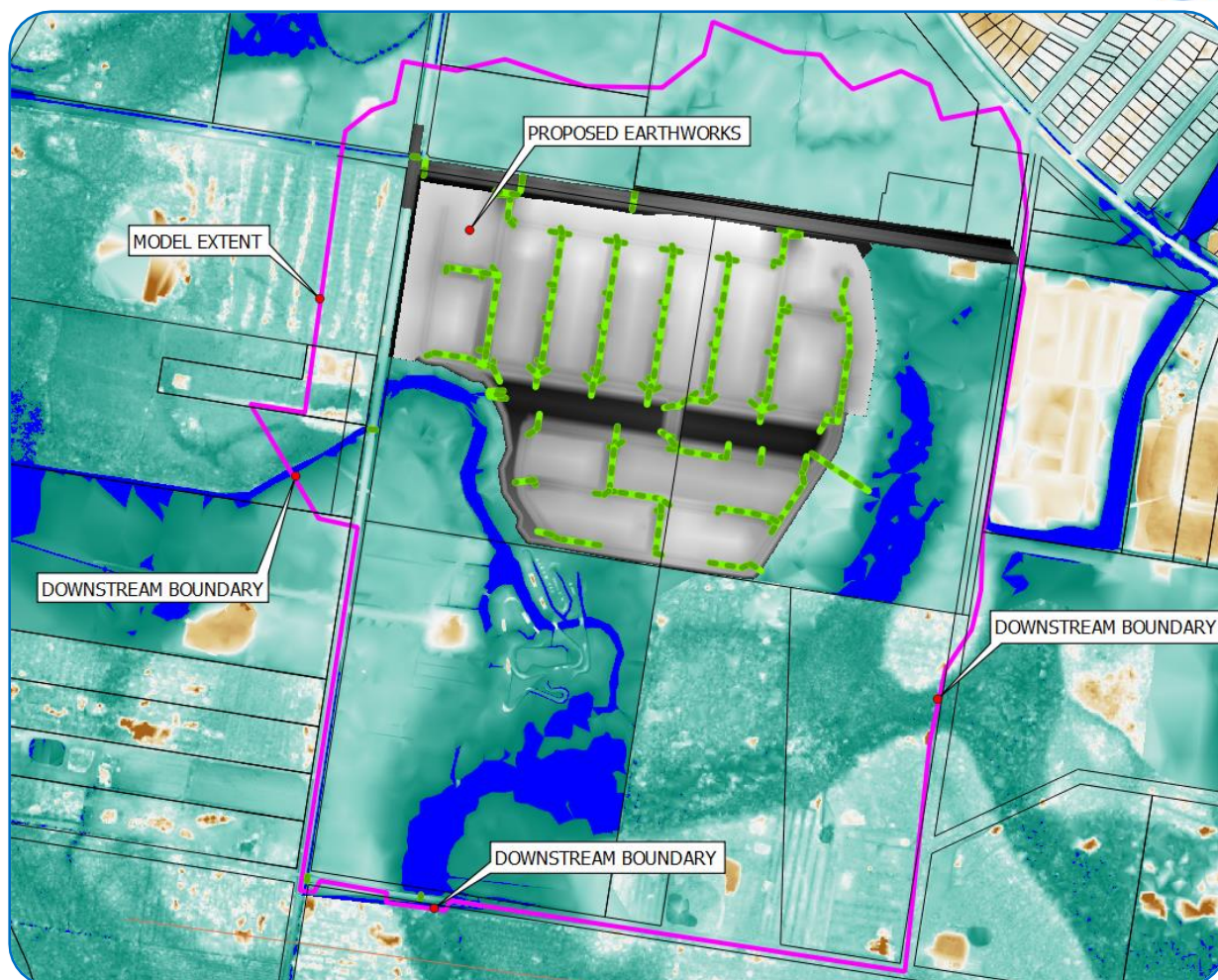


Figure 6.9 TUFLOW Post-Development Model Extent

The peak depth and velocity outside of the earthworks footprint is largely unchanged in the post-development scenario due to the included detention measures. Figure 6.10 shows the peak post-development 0.01 AEP flood depth and 6.11 shows velocity.



Figure 6.10 0.01 AEP Post-Development Peak Flood Depth



Figure 6.11 0.01 AEP Post-Development Peak Flood Velocity



6.3.9 Impact Assessment

In order to illustrate the impacts of the proposed development on flood levels external to the site, a spatial analysis of the pre and post-development results have been prepared for the 0.01 AEP.

The results of the modelling indicate that the proposed development will not impact on the extent or depth of flood inundation within private property. There are minor isolated velocity impacts surrounding the new headwalls to the north-west of the site due to the upgrading of Miles Street.

Figure 6.12 shows the flood level impact and Figure 6.13 shows the peak velocity impact.



Figure 6.12 1% AEP Flood Level Afflux Plot



Figure 6.13 1% AEP Velocity Afflux Plot

6.4 Lawful Point of Discharge

The criteria for determining a Lawful Point of Discharge (LPD) as specified within the Queensland Urban Drainage Manual (2016) is as follows:

- (i) Will the proposed development alter the site's stormwater discharge characteristics in a manner that may substantially damage a third party property?
 - If not, then no further steps are required to obtain tenure for a lawful point of discharge (assuming any previous circumstances and changes were lawful).
 - If there is a reasonable risk of such damage then consider (ii) or (iii).
- (ii) Is the location of the discharge from the development site under the lawful control of the local government or other statutory authority from whom permission to discharge has been received? This will include a park, watercourse, drainage or road reserve, stormwater registered drainage easement, or land held by local government (including freehold land).
 - If so, then no further steps are required to obtain tenure for a lawful point of discharge
 - If not, then consider issue (iii). A land owner or regulator may require that the developer obtain an authority to discharge as described in (iii) in order for the stormwater to ultimately flow to a location described in (ii).
- (iii) An authority to discharge over affected properties will be necessary. In descending order of certainty, an authority may be in the form of:



- Dedication of a drainage reserve or park;
- A registered easement for stormwater discharge/works; or
- Written approval.

Each point of discharge has been assessed against the above criteria and it is considered that a Lawful Point of Discharge will be achieved at each discharge location. Provided that the design measures set out in this report are implemented it is not anticipated that substantial damage will be caused to a third party property at any discharge point.



7 Stormwater Quality Management – Operational Phase

In order to ensure that the operational phase objectives outlined within Section 1.1 of this report can be achieved, a network of stormwater quality management measures are proposed for inclusion within the development.

To achieve these objectives, internal flows will need to be adequately treated prior to discharge to the site's points of discharge. The following sections outline how stormwater will be treated within the development prior to discharge.

7.1 Stormwater Quality Treatment Concepts

It is proposed that stormwater runoff from the development be collected within the kerb and channel of the internal roads during minor events and treated within street scape quality treatment measures. Flows will enter these measures via openings within the kerb. These measures have been designed to encourage 'at source treatment' of flows within the road reserves and to limit earthworks (fill) associated with a traditional piped network.

Post treatment stormwater flows from each streetscape measure will enter the underground piped network. Highflows above the piped network capacity are to be conveyed within the road reserves to the proposed detention basins within Catchments B and C.

An additional scenario (referred to as 'Option 2') has been included within this assessment to account for potential water quality benefits from the addition of rainwater tanks. In this scenario, a 3 kL rainwater tank would be connected to at least 50% of the roof catchment area within each allotment of the development.

7.2 Quality Control – Pollutant Reduction

In accordance with the CVC's Residential Zone DCP (2011) and Landcom's Water Sensitive Urban Design Strategy (2009), the proposed streetscape measures will need to achieve the minimum mean annual load based reductions of 85% for Total Suspended Solids (TSS); 65% for Total Phosphorus (TP), 45% for Total Nitrogen (TN), and 90% for Gross Pollutants (GP).

The Model for Urban Stormwater Improvement Conceptualisation (*MUSIC v6*) has been used to estimate the potential pollutant loads generated by the development and to size the proposed streetscape treatment measures. The following sections outline the parameters relied upon within the *MUSIC v6* modelling.

7.2.1 Rainfall and Evapotranspiration Data

Rainfall and evapotranspiration data has been obtained from the Bureau of Meteorology (BOM) and is included within Table 7.1 below. As requested by CVC, the Coff's MO Station (59040) has been used for modelling purposes.

Table 7.1 Meteorological and Rainfall Runoff Data Reporting

Station	Coffs MO (59040)
Period	1/01/1974 to 31/12/1983 (10 years)
Time step	6 minute
Mean annual rainfall (mm)	1,667
Evapotranspiration	1,456



7.2.2 Developed Case – Catchment Parameters

The developed site has been modelled as having an Urban Residential (Large Site) land use. For Option 1, the developable area (excluding the drainage reserve area) has been modelled as a single lumped catchment to gain an overall treatment filter area estimate for the entire site. In order to estimate the size individual streetscape treatment measures – a maximum sub-catchment area of 2,500 m² has been assumed per device (equivalent to the approximate catchment of a traditional stormwater pit).

For Option 2 as rainwater tanks are included within the treatment train the catchment has been split into roof, ground, and road source nodes with 50% of roof areas directed to a rainwater tank node (lumped). Catchment splits have been based on advice received from CVC (split of 35%, 25%, and 40% for roof, road, and ground level respectively of the development area).

For both Options 1 & 2, the catchments relative to the type of bioretention measure (i.e. Type 1, and Type 3 with 500mm and 400mm filters) have been further delineated.

Table 7.2 summarises the modelled catchment areas and Drawing DWG-210 – Appendix A presents the major stormwater quality treatment catchments for the site. The adopted pollutant export and runoff parameters for each sub catchment are based on data from the NSW MUSIC Modelling Guidelines (BMT WBM 2015), and advice received from CVC, as summarised in Tables 7.3 and 7.4.

Table 7.2 MUSIC v6 Sub-Catchment Areas

Modelling Scenario	Catchment ID	Land Use	Area (ha)	Total Impervious (%)
Option 1 – Streetscape Treatment Only	Total Area (to Type 3 Bio)	Urban Residential – Lumped Catchment	20.08	55
	Total Area (to HAT Constrained Type 3 Bio)	Urban Residential – Lumped Catchment	2.10	55
	Total Area (to Invert Constrained Type 1 Bio)	Urban Residential – Lumped Catchment	0.70	55
	Streetscape Bio Catchment	Urban Residential – Lumped Catchment	0.25	55
Option 2 – Rainwater Tanks + Streetscape Treatment	Total Area (to Type 3 Bio)	Urban Residential –Roof (to tank)	3.51	100
		Urban Residential –Roof (to bio)	3.51	100
		Urban Residential –Road	5.02	60
		Urban Residential –Ground	8.03	20
	Total Area (to HAT Constrained Type 3 Bio)	Urban Residential –Roof (to tank)	0.37	100
		Urban Residential –Roof (to bio)	0.37	100
		Urban Residential –Road	0.53	60
		Urban Residential –Ground	0.84	20
	Total Area (to Invert Constrained Type 1 Bio)	Urban Residential –Roof (to tank)	0.12	100
		Urban Residential –Roof (to bio)	0.12	100
		Urban Residential –Road	0.18	60
		Urban Residential –Ground	0.28	20
	Streetscape Bio Catchment	Urban Residential –Roof (to tank)	0.04	100
		Urban Residential –Roof (to bio)	0.04	100
		Urban Residential –Road	0.06	60
		Urban Residential –Ground	0.10	20

Table 7.3 Rainfall Runoff Parameters



Parameter	All Nodes
Landuse	Residential
Rainfall threshold (mm)	1
Soil storage capacity (mm)	54
Initial storage (% capacity)	25
Field capacity (mm)	51
Infiltration capacity coefficient a	180
Infiltration capacity exponent b	3
Initial depth (mm)	10
Daily recharge rate (%)	25
Daily baseflow rate (%)	25
Daily deep seepage rate (%)	0

Table 7.4 Pollutant Export Parameters (log mg/L)

Flow Type	Surface Type	Total Suspended Solids (log ₁₀ mg/L)		Total Phosphorous (log ₁₀ mg/L)		Total Nitrogen (log ₁₀ mg/L)	
		Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Residential							
Base Flow	Roof	N/A	N/A	N/A	N/A	N/A	N/A
	Road	1.00	0.34	-0.97	0.31	0.20	0.20
	Ground	1.00	0.34	-0.97	0.31	0.20	0.20
Storm Flow	Roof	1.30	0.39	-0.89	0.31	0.26	0.23
	Road	2.43	0.39	-0.30	0.31	0.26	0.23
	Ground	2.18	0.39	-0.47	0.31	0.26	0.23
Urban Residential							
Base Flow	Lumped	1.00	0.34	-0.97	0.31	0.20	0.20
Storm Flow	Lumped	2.18	0.39	-0.47	0.32	0.26	0.23

7.2.3 Treatment Measures

In order to determine the design requirements for the necessary stormwater treatment measures, key “Treatment Nodes” were added to the *MUSIC* v6 model. The following sections outline the modelling parameters relied upon for each “Treatment Node”.

Rainwater Tank Parameters (Option 2)

Rainwater tanks have been investigated as an alternative option to investigate if any reductions in the total area of streetscape systems can be achieved in an effort to reduce ongoing maintenance costs. In this scenario it has been assumed that a 3 kL rainwater tank would be connected to at least 50% of the roof catchment area within each allotment. Captured rainwater would be beneficially reused for indoor and outdoor use within each dwelling (toilet and laundry, and landscape irrigation) and overflows from the tank would be directed to the internal road.

Re-use rates for the tanks have been determined in accordance with the BMT WBM NSW *MUSIC* Modelling Guidelines (2015) and Water by Design *MUSIC* v6 Modelling Guidelines (2010). Conservative irrigation rates and some water saving fixtures have been assumed for all dwellings.



Table 7.5 summarises the input parameters applied to the *MUSIC* v6 model for rainwater tanks. Note for water quality modelling purposes, the rainwater tanks were clumped together as one tank.

Table 7.5 Rainwater Tank Parameters (Lumped)

Rainwater Tank Parameter	Rainwater Tanks - Parameter Settings	Rainwater Tanks (HAT constrained) - Parameter Settings	Rainwater Tanks (Invert Constrained) - Parameter Settings	Rainwater Tanks (Single Streetscape) - Parameter Settings
Volume below overflow pipe (kL).	274 x 3 kL = 822	27 x 3 kL = 81	3 x 9 kL = 27	3 x 3 kL = 9
Depth above overflow (m)	0.20	0.20	0.20	0.20
If tanks are lumped, is depth below overflow the same as a single tank and overflow pipe scaled accordingly?	Yes	Yes	Yes	Yes
Surface area (m ²).	411	40.5	13.5	4.5
Overflow pipe diameter (mm) = $90(\sqrt[3]{no. tanks})$.	1490	468	270	156
Stored water used for irrigation and other purposes PET PET – Rain	Yes PET – Rain	Yes PET – Rain	Yes PET – Rain	Yes PET – Rain
Indoor connections e.g. toilet, laundry etc.	Toilet & Washing Machine	Toilet & Washing Machine	Toilet & Washing Machine	Toilet & Washing Machine
Indoor demand / person (kL/day)	0.058*	0.058*	0.058*	0.058*
Persons per dwelling	2.7	2.7	2.7	2.7
Outdoor demand – single dwelling (kL/yr)	51.5	51.5	51.5	51.5
Daily demand/ single dwelling (kL/day)	0.157	0.157	0.157	0.157
Monthly distribution of annual demand (kL/day)	0.0	0.0	0.0	0.0
Confirmation that K and C* remain default?	Yes	Yes	Yes	Yes

*Table 6-1, BMT WBM NSW MUSIC Modelling Guidelines

Bioretention (Options 1 & 2)

It is proposed that streetscape bioretention measures be incorporated into the road reserves of the development layout to provide the necessary load based reductions. Bioretention systems operate by capturing and retaining water in an extended ponding area (no more than 400 mm deep for a maximum of four (4) days to prevent anaerobic conditions, plant death and insect breeding), before filtering through a soil media. The devices remove pollutants via the following physical processes:

- Sedimentation in the extended detention storage;
- Filtration by filter media;
- Nutrient uptake by biofilms;
- Nutrient adsorption and pollutant decomposition by soil bacteria; and
- Adsorption of metals and nutrients by filter particles (Somes & Crosby, 2007).



Bioretention - Site Constraints

As the site is within a low-lying coastal area, there are several constraints which require further consideration when setting design levels of the proposed treatment basins. Based on a desktop review and two (2) preliminary site investigations undertaken by Regional Geotechnical Solutions the following constraints have been identified;

- Potential Acid Sulfate Soils (PASS) are likely present on site as identified within the Acid Sulfate Soil Assessment undertaken by Regional Geotechnical Solutions (November 2018);
- Shallow Groundwater Levels were identified within the Preliminary Geotechnical Assessment undertaken by Regional Geotechnical Solutions (July 2018). At the time of investigation the estimated groundwater level ranged from 0.1-0.6 m AHD. It was also identified that seasonal variations, weather, and tidal influences would likely cause fluctuations in the groundwater levels onsite and hence further investigations would be required;
- Tidal interactions. In accordance with the Northern Rivers Handbook of Drainage Design, D5 (AUS-SPEC, 2018), Appendix D, the Mean High Water Springs (MHWS) level identified for Yamba is 0.6 m AHD (Iluka Port Datum). This indicates that parts of the site will be affected by the MHWS and the Highest Astronomical Tide (HAT) levels; and
- Invert Constraints. At the piped outlets to Miles Street to the north of the site (relative to Catchments A and C1), outlets are constrained to shallow depths (<1m) due to the swale invert and road access points required for the development.

The following tables identify bioretention design and level recommendations relative to the above identified constraints.

Table 7.6 Site Constraint Bioretention Design Recommendations

Constraint	Recommendations
Presence of PASS	Bioretention to be lined (liner specifications to be provided by Geotechnical Engineer) to prevent interaction with PASS.
Shallow Groundwater	Minimum design levels and freeboard contained within Table 4.6 (and Table 7 of Water By Design 'Bioretention Technical Guidelines – Version 1.1) are to be maintained. If required Bioretention to be lined to prevent interaction with Groundwater (liner specifications to be provided by Geotechnical Engineer)
HMWS/HAT	Minimum design levels and freeboard contained within Table 4.6 (and Table 7 of Water By Design 'Bioretention Technical Guidelines – Version 1.1) are to be maintained.
Invert Constrained	Consider Type 1 drainage profile configuration for Bioretention measures incorporating a saturated zone. (Refer to Section 3.5.1.3 of Water By Design 'Bioretention Technical Guidelines – Version 1.1)

Table 7.7 Recommended Bioretention Design Levels relative to Groundwater or Tidal Levels

Drainage Profile Type	Level Relative to Wet Season Groundwater Level (WSGL)	Level Relative to Highest Astronomical Tide (HAT)
Type 1 Saturated Zone	Impermeable liner extends ≥ 300 mm above WSGL	Impermeable liner extends ≥ 300 mm above HAT*
Type 2 Sealed	System will be completely sealed. No further Restrictions.	Base of transition layer ≥ 300 mm above HAT*
Type 3 Conventional	Base of underdrainage pipes ≥ 300 mm above WSGL	

*Based on a MHWS of 0.6 m AHD this equates to a level of 0.9 m AHD



In accordance with Water by Design Guidelines, Tables 7.8 and 7.9 summarises the treatment node parameters used in the *MUSIC* v6 modelling whilst Figure 7.1 provides typical design parameters for the proposed bioretention devices.

It is noted that several bioretention systems are constrained due to the required freeboard to the HAT and invert constraints. These bioretention systems have been designed with filter depths of 400 mm and with saturated zones respectively and modelled as separate nodes in *MUSIC*.

Table 7.8 Bioretention Parameters – Option 1

Bioretention Parameter	1 x Streetscape Bioretention	Total Streetscape Bioretention	Total Streetscape Bioretention – HAT Constrained	Total Streetscape Bioretention – Invert Constrained
Drainage Profile (Type 1 = Saturated Zone, Type 2 = Sealed, Type 3 = Conventional, Type 4 = Pipeless)	Type 3	Type 3	Type 3	Type 1
Surface area (m ²)	34	2,700	280	85
Extended detention depth (m)	0.2	0.2	0.2	0.1
Filter area (m ²)	34	2,700	280	85
Unlined filter media perimeter (m)	0.01	0.01	0.01	0.01
Saturated hydraulic conductivity (mm/hr)	200	200	200	200
Filter depth (m)	0.5	0.5	0.4	0.4
TN content of filter media (mg/kg)	400*	400*	400*	400*
Proportion of organic material in filter (%)	< 5	<5	<5	<5
Orthophosphate content of filter media (mg/kg)	40*	40.0*	40.0*	40.0*
Is the base lined?	Yes	Yes	Yes	Yes
Effectiveness of plant TN removal	Effective	Effective	Effective	Effective
Overflow weir width (m)	Surface Area/10	Surface Area/10	Surface Area/10	Surface Area/10
Exfiltration rate (mm/hr)	0.00	0.00	0.00	0.00
If an exfiltration rate has been used, have node water balance losses been used in calculation of treatment train effectiveness?	N/A	N/A	N/A	N/A
If exfiltration rate has been used, is the exfiltration rate justified?	N/A	N/A	N/A	N/A
Underdrain present?	Yes	Yes	Yes	Yes
Submerged zone with carbon present?	No	No	No	Yes
Depth of submerged zone (m)	N/A	N/A	N/A	0.4
Confirmation that K and C* remain default?	Yes	Yes	Yes	Yes
Sediment Forebay Required (>2 ha contributing catchment)	No	No	No	No

*As per NSW MUSIC Modelling Guidelines (BMT WBM 2015)



Table 7.9 Bioretention Parameters – Option 2 (including Rainwater Tanks)

Bioretention Parameter	1 x Streetscape Bioretention	Total Streetscape Bioretention	Total Streetscape Bioretention – HAT Constrained	Total Streetscape Bioretention – Invert Constrained
Drainage Profile (Type 1 = Saturated Zone, Type 2 = Sealed, Type 3 = Conventional, Type 4 = Pipeless)	Type 3	Type 3	Type 3	Type 1
Surface area (m ²)	28	2,350	240	110
Extended detention depth (m)	0.2	0.2	0.2	0.2
Filter area (m ²)	28	2,350	240	110
Unlined filter media perimeter (m)	0.01	0.01	0.01	0.01
Saturated hydraulic conductivity (mm/hr)	200	200	200	200
Filter depth (m)	0.5	0.5	0.4	0.4
TN content of filter media (mg/kg)	400*	400*	400*	400*
Proportion of organic material in filter (%)	< 5	<5	<5	<5
Orthophosphate content of filter media (mg/kg)	40*	40.0*	40.0*	40.0*
Is the base lined?	Yes	Yes	Yes	Yes
Effectiveness of plant TN removal	Effective	Effective	Effective	Effective
Overflow weir width (m)	Surface Area/10	Surface Area/10	Surface Area/10	Surface Area/10
Exfiltration rate (mm/hr)	0.00	0.00	0.00	0.00
If an exfiltration rate has been used, have node water balance losses been used in calculation of treatment train effectiveness?	N/A	N/A	N/A	N/A
If exfiltration rate has been used, is the exfiltration rate justified?	N/A	N/A	N/A	N/A
Underdrain present?	Yes	Yes	Yes	Yes
Submerged zone with carbon present?	No	No	No	Yes
Depth of submerged zone (m)	N/A	N/A	N/A	0.4
Confirmation that K and C* remain default?	Yes	Yes	Yes	Yes
Sediment Forebay Required (>2 ha contributing catchment)	No	No	No	No

*As per NSW MUSIC Modelling Guidelines (BMT WBM 2015)

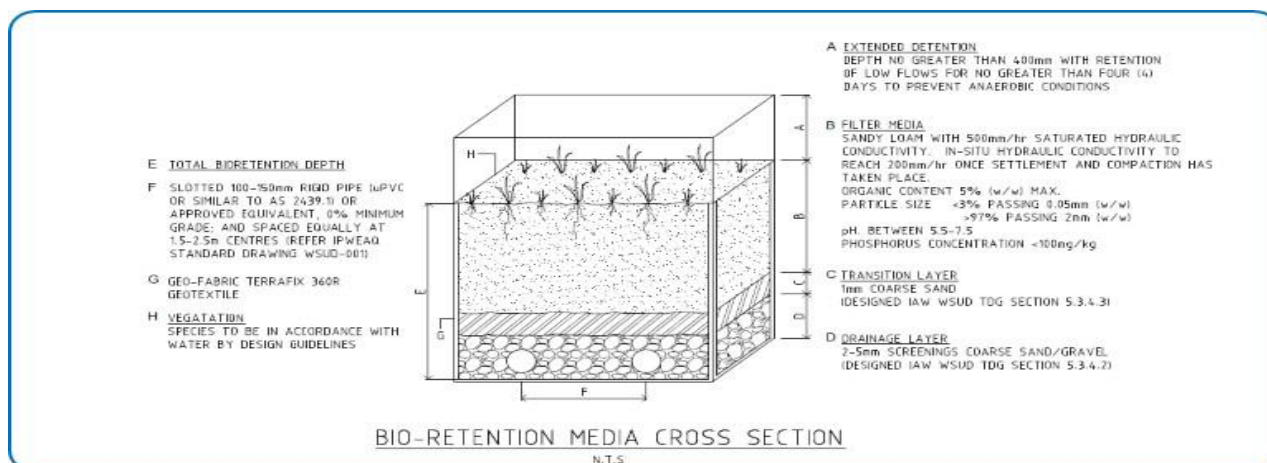


Figure 7.1 Bioretention specifications (Typical)



Coarse Sediment Treatment Requirements

As the contributing catchment to each bioretention measure will be less than 2 ha no coarse sediment forebay (As per Water By Design (2014) Bioretention Technical Design Guidelines Version 1.1) will be required however rock protection will be installed at each discharge point into the streetscape bioretentions to prevent scour of the filter media. Details of scour protection measures will be provided as part of the detailed design phase of the development.

7.2.4 Bioretention Basin Staged Construction and Establishment

In accordance with the Water by Design Construction and Establishment Guidelines: Swales Bioretention Systems and Wetlands (C & E Guidelines), inflow of sediment-laden runoff during the building stage is a major risk to the successful and long-term functioning of bioretention systems.

During the building phase of developments, sediment can seal the surface of the filter media, move into and clog the filter media and accumulate in the under-drainage. Within the C & E Guidelines, there are four (4) options recommended to overcome the challenges associated with delivering bioretention systems. These generally include the following options:

- Option 1: Surface Protection
- Option 2: Bypass flows and early establishment of vegetation;
- Option 3: Sediment basin and bioretention function; and
- Option 4: Leave as sediment basin.

In accordance with 3.6 of the C & E guidelines, Options 1 and 2 are the preferred construction method for Streetscape Bioretention systems. Either of these options would provide adequate protection of the bioretention during the building phase and are suitable for implementation.

The Option 1 method is progressed in three (3) stages as follows:

- | | |
|---------|--|
| Stage 1 | Civil Works – civil construction and installation of the functional elements of the bioretention system including under-drainage and media; |
| Stage 2 | Building Phase Protection <ul style="list-style-type: none">▪ installation of sediment fences around the perimeter of the filter media; and▪ installation of a protective layer on the surface of the filter media, allowing it to operate as a shallow sediment basin during the building phase. It is recommended that filter cloth (geofab), topsoil and turf be installed for surface protection. |
| Stage 3 | Landscape Establishment – when 80-90% of building in the catchment is complete, removal of the protective layers and planting and establishment of vegetation in the bioretention system. |

The Option 2 method for staged construction generally includes the following:

- Construction of the civil infrastructure, including under-drainage and media, for the bioretention system;
- Bypass stormwater around the bioretention systems or isolate from stormwater using a temporary bund; and
- When 80-90% of building in the catchment is complete, remove the temporary bypass system and the bioretention system is allowed to function as per design.

For details of the procedure and order of construction for Option 1 or 2 method please refer to Section 3.9 (Steps 1-40) of the C & E Guidelines. If an alternative option is found to be more



suitable for the site, construction methods and steps should be referenced from the C & E Guidelines.

It is noted that information contained within the SQMP are recommendations for planning purposes and relate to protection of the system within the building phase of the development (i.e. when the subdivision construction works are complete or near complete). It is assumed that in addition to the protection methods proposed, active building sites will also be required to maintain erosion and sediment control management measures to prevent/reduce sediment entrainment within stormwater runoff. Further details of bioretention construction staging will be provided in conjunction with the detailed design phase of the development.

7.2.5 Modelling Results

Results of the *MUSIC* v6 modelling for the treatment train effectiveness of both options are summarised in Table 7.10 and 7.11. The results indicate 85%, 65%, 45% and 90% reduction target for TSS, TP, TN and GP respectively are achieved for Option 1 for the rainfall data set simulated for all flows captured and conveyed to the proposed bioretention streetscape systems. It is noted that for Option 2, bioretention measures achieve the nutrient reduction targets however fall slightly lower in TSS removal efficiency (81.6% compared to 85%).

Whilst Option 2 falls short of the water quality objective for TSS, the inclusion of rainwater tanks reduces the overall bioretention filter area(asset) whilst maintaining TP and TN removal efficiencies. A comparison of total filter area differences between the two options is included as Table 7.12.

A screen capture of the *MUSIC* v6 modelling results is included as Figures 7.2-7.3 (individual streetscape measure catchment) and 7.4-7.5 (total streetscape filter area).

Table 7.10 Treatment Train Effectiveness – Option 1 (no rainwater tanks)

Catchment ID	Pollutant	Inflows (kg/yr)	Outflows (kg/yr)	Reduction (kg/yr)	Reduction (%)	Water Quality Objective (%)
2,500 m ² (1 x Streetscape bio)	TSS	545	79	465	85.4	85.0
	TP	0.86	0.30	0.6	65.8	65.0
	TN	6.42	3.00	3.4	53.2	45.0
TOTAL SITE	TSS	49,280	7,002	42,278	85.8	85.0
	TP	79.9	27.5	52.4	65.6	65.0
	TN	587.8	275.5	312.3	53.1	45.0

NOTE: All simulations have been run with pollutant export estimation set to "stochastic generation".

Table 7.11 Treatment Train Effectiveness – Option 2 (with RWT tanks)

Catchment ID	Pollutant	Inflows (kg/yr)	Outflows (kg/yr)	Reduction (kg/yr)	Reduction (%)	Water Quality Objective (%)
2,500 m ² (1 x Streetscape bio)	TSS	469.2	83.9	385.3	82.1	85.0
	TP	0.92	0.32	0.60	65.0	65.0
	TN	6.77	3.19	3.58	52.9	45.0
TOTAL SITE	TSS	45,316	8,358	36,958	81.6	85.0
	TP	88.6	30.6	58	65.5	65.0
	TN	652	299	353	54.2	45.0

NOTE: All simulations have been run with pollutant export estimation set to "stochastic generation".



Table 7.12 Comparison of Treatment train options

Stormwater Treatment Train Option	Total Bioretention Filter Area	Single Bioretention Filter Area for 2,500 m ² Catchment
Option 1 (Treatment Via Streetscape Bioretention)	3,065 m ²	34 m ²
Option 2 (Treatment Via Rainwater Tanks & Streetscape Bioretention)	2,700 m ²	28 m ²
Difference in Bioretention Area	365 m ²	6 m ²

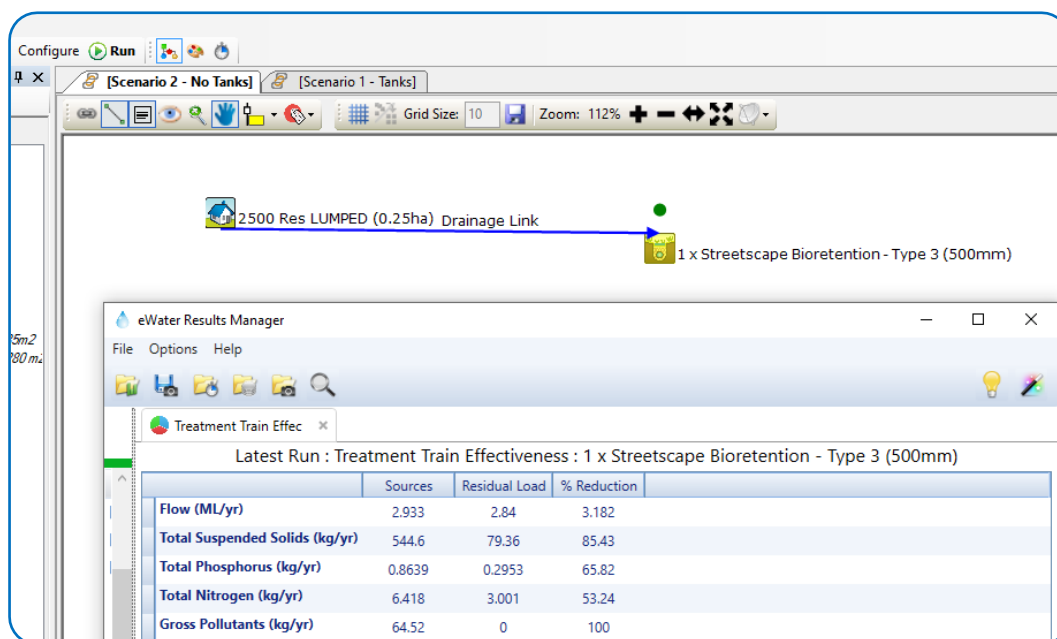


Figure 7.2 Screen Capture of MUSIC Modelling Results (1xStreetscape Bio – 2,500 m² Catchment) – Option 1

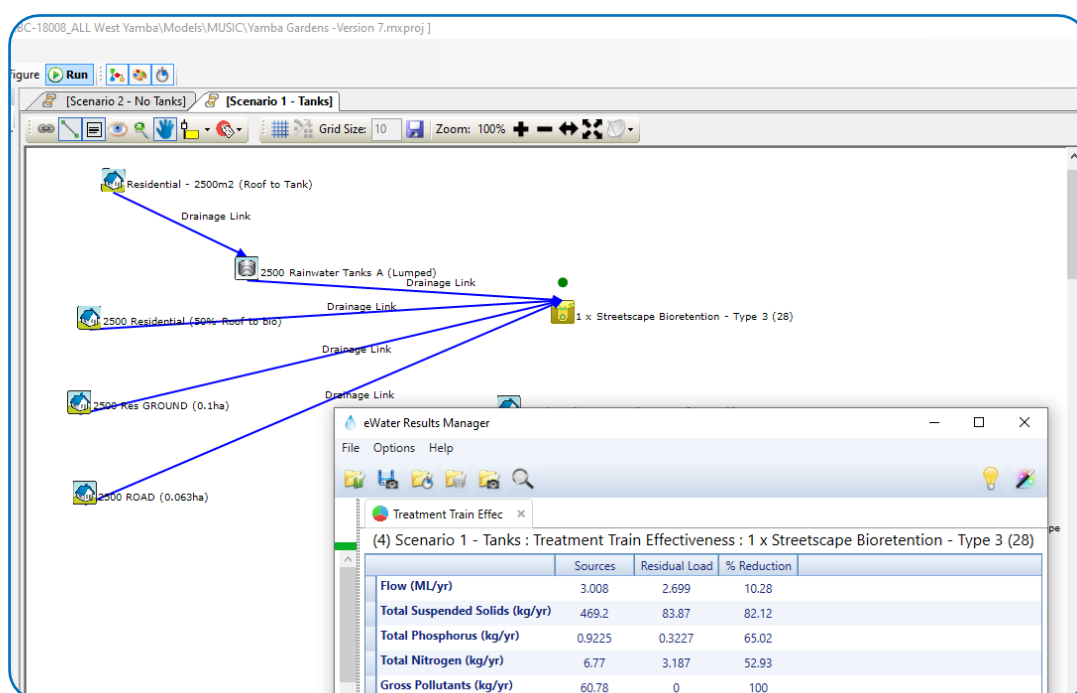


Figure 7.3 Screen Capture of MUSIC Modelling Results (1xStreetscape Bio – 2,500 m² Catchment) – Option 2

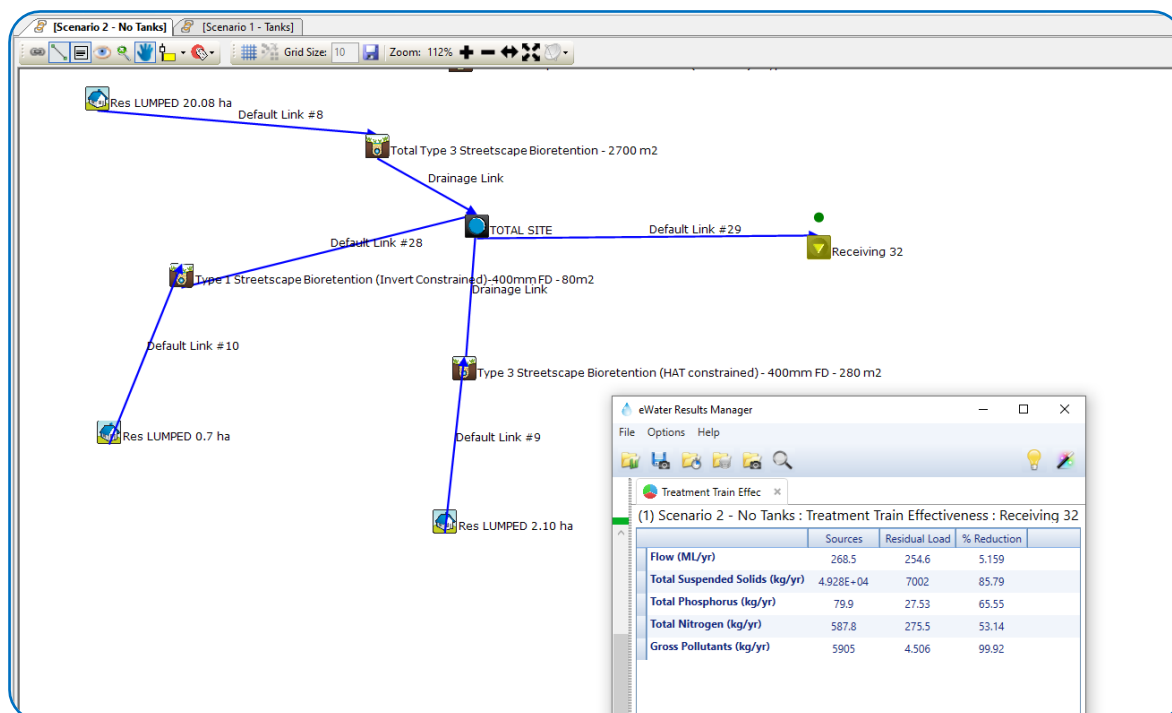


Figure 7.4 Screen Capture of MUSIC Modelling Results (Total) – Option 1

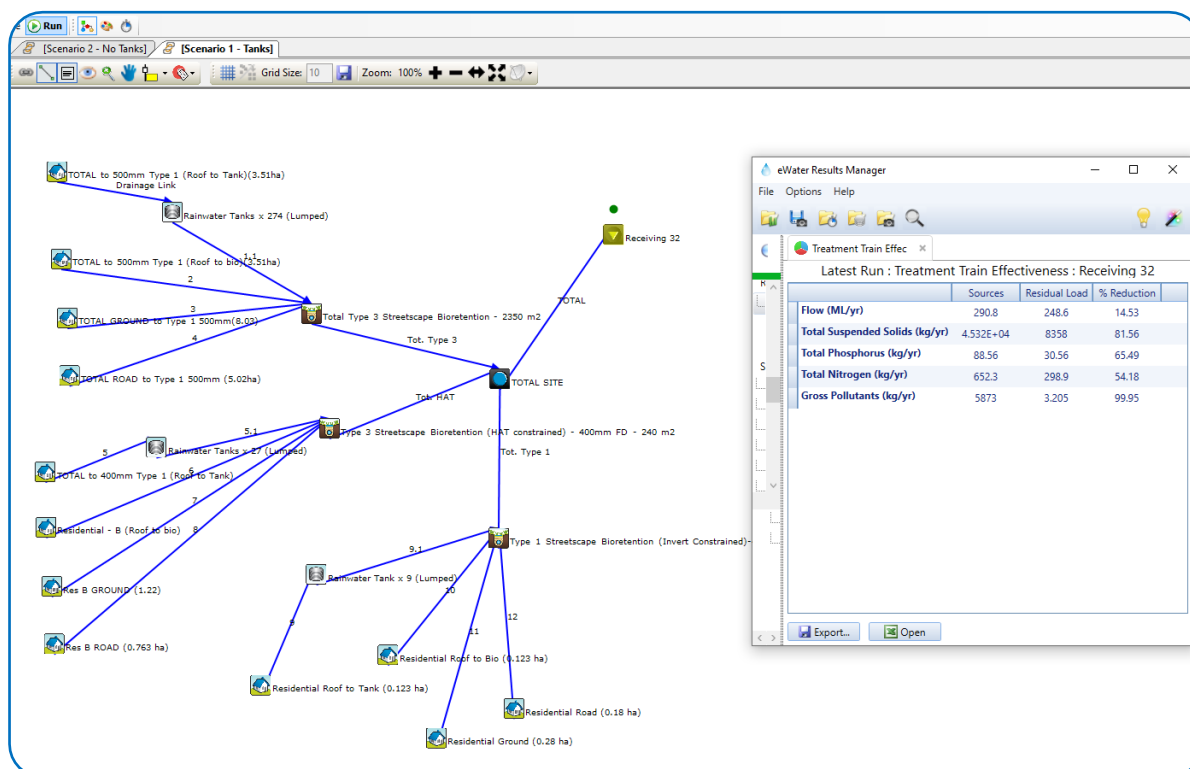


Figure 7.5 Screen Capture of MUSIC Modelling Results (Total) – Option 2



7.2.6 Modelling Results – Life Cycle Costing

In order to estimate the life cycle costing of the proposed streetscape stormwater treatment measures, Life Cycle Costing modelling was undertaken in MUSICv6 for both treatment train options. Table 7.13 below summarises the life cycle costing inputs whilst Table 7.14 summarises results of the life cycle costing. It is noted that costings are provided as a generic estimate and have been based on a single streetscape bioretention system for both options. This model does not account for cost savings that may occur as a result from maintaining multiple systems located within close proximity of each other (as discussed in “Guide to the Cost of Maintaining Bioretention Systems” (WaterByDesign, 2015)). For the full Life Cycle Costing Outputs – refer to Appendix F.

Table 7.13 Life Cycle Costing Inputs – 1 x Streetscape Bioretention Basin

Global Properties		
Real Discount Rate (%)	5.5	
Annual Inflation Rate (%)	2.0	
Base year for costing	2018	
Costing Element	1 x Streetscape Bioretention (Option 1)	1 x Streetscape Bioretention (Option 2)
Acquisition Cost (\$)	\$9,714	\$8,000
Annual Maintenance Cost (\$)	\$607	\$500
Annual Establishment Cost (\$)	\$911	\$750
Establishment Period (yrs)	1	1
Renewal/adaptation cost (\$)	\$6,254	\$5,150
Renewal/adaption period (yrs)	25	25
Decommissioning cost (\$)	\$5,003	\$4,120

Table 7.14 Life Cycle Costing Results – 1 x Streetscape Bioretention Basin

Costing Element	Costing Result (Option 1)	Costing Result (Option 2)
Life Cycle Cost of Streetscape Bioretention (\$)	\$23,216	\$19,119
Equivalent Annual Payment Cost of the Asset (\$/yr)	\$464	\$382.5



8 Water Quality Monitoring and Maintenance

In order to ensure that the stormwater management measures detailed within this management plan function correctly in the long term and to ensure that impacts to downstream receiving environments are mitigated, appropriate operational phase water maintenance and monitoring is to be undertaken. The following sections detail the minimum requirements for each specific control device.

8.1 Operational Phase Water Quality Monitoring

Monitoring during the operational phase will be undertaken to determine the impact of activities on the receiving waters. Surface water quality monitoring is to be undertaken at discharge points from the site. Samples should be collected for TSS, pH, dissolved oxygen (DO), TP, TN and hydrocarbons. Sampling is to be performed in accordance with procedures set out in the Environmental Protection Authority's Water Quality Sampling Manual. A NATA registered laboratory is to be used to analyse the collected samples.

Table 8.1 specifies the sampling parameters and frequencies required. Results of the monitoring program are to be compiled monthly into an ongoing Water Quality Monitoring Report. A copy of the report and monitoring data is to be maintained at all times.

Table 8.1 Operational Phase Water Quality Parameters and Sampling Frequencies

Sampling Parameter	Sampling Frequency
TSS	Water quality monitoring will be completed following a rainfall event of 25 mm or greater in any 24 hour period monthly for a minimum period of 12 months, or as specified by the Local Authority conditions of approval for the development.
pH	
Dissolved Oxygen (DO)	
TN	
TP	
Hydrocarbons	

Table 8.2 sets the water quality criteria for water discharged from the development site.

Table 8.2 Operational Phase Water Quality Discharge Criteria

Water Quality Parameter	Discharge Criteria
TSS	No net deterioration of the downstream receiving environment as a result of discharge from the development.
Turbidity (NTU)	
pH	
DO	
TN	
TP	
Hydrocarbons	

8.2 Operational Phase Device Maintenance

In order for each of the proposed stormwater treatment devices to achieve the necessary pollutant removal efficiencies regular maintenance is necessary. Poorly maintained devices will result in under performance and in some instances may cause leaching of pollutants to downstream receiving environments. Based on the proposed treatment train Table 8.3 details appropriate maintenance regimes for each treatment device. A typical Maintenance Checklist has been included as Appendix G.



Table 8.3 Operational Phase Device Maintenance Requirements

Treatment Device	Maintenance Action
Grassed Swales	Routine inspection to identify obvious increased sediment deposition. Remove sediment when flow within the swale is impeded or smothering of vegetation occurs. If necessary reprofile swale and revegetate.
	Regular watering of vegetation until plants are established.
	Mowing of grass or slashing of vegetation to preserve the optimal design height.
	Removal and management of invasive weeds.
	Removal and replacement of dead and dying vegetation.
	Regular inspection and removal of litter and gross pollutants.
Bioretention	Routine inspection to identify obvious increased sediment deposition. Remove sediment when flow within the bioretention is impeded or smothering of vegetation occurs.
	Routine inspection of inlet and outlet pit to identify any areas of scour, litter build up or blockages.
	Tilling of the bioretention surface if there is evidence of clogging.
	Regular watering of vegetation until plants are established.
	Removal and management of invasive weeds.
	Removal and replacement of dead and dying vegetation.
	Regular inspection and removal of litter and gross pollutants.
Detention Basins	Resetting (i.e. complete reconstruction) of the bioretention will be required if the flow within the bioretention system is reduced by 25% due to an accumulation of sediment.
	Routine inspection to identify obvious increased sediment deposition. Remove sediment if there is any sign of smothering of vegetation. If necessary reprofile base and revegetate.
	Routine inspection of inlet and outlet structures to identify any areas of scour, litter build up or blockages.
	Regular watering of vegetation until plants are established.
	Removal and management of invasive weeds.
	Removal and replacement of dead and dying vegetation.
	Regular inspection and removal of litter and gross pollutants.

All material removed during maintenance, whether solid or liquid, is to be disposed of in a manner that does not cause ongoing soil erosion or environmental harm.



9 Conclusions

The report has been prepared on behalf of Kahuna No.1 Pty Ltd and presents a comprehensive review of available Stormwater Quality Improvement Devices (SQID) and stormwater Best Management Practices (BMP) to ensure that the proposed development adequately addresses the management of stormwater quantity and quality during the operational phase of the development. Additionally, this report also includes a hydraulic impact assessment (velocities and peak depths) to ensure the development does not impose any hydraulic impacts upon the western downstream drainage network (relevant to Lot 46) as requested by Clarence Valley Council.

In order to address the management of stormwater quantity during the operational phase of the development, two (2) formal stormwater detention basins have been proposed. These basins include purpose-built outlet structures and detention volume to control discharge from the site. In addition to the basins, detention storage will also be provided within the drainage swale along the northern boundary of the site adjacent to Miles Street. Modelling of the proposed detention measures and their associated outlet structures indicate that pre-developed flows can be maintained for all nominated ARI events at PD-A, PD-B and PD-C. It is estimated that a total detention volume of 20,194 m³ (for the 1% AEP) is required and has been provided to mitigate peak flows from the site.

TUFLOW modelling of the downstream discharge locations of Lot 46 has demonstrated that the proposed development will not adversely affect neighbouring properties or materially change the hydraulic impacts on the downstream drainage structures of Carrs Drive. It is noted the impacts associated with the eastern floodway (Lot 47) and general filling of the West Yamba development area has previously been investigated as part of the Hydraulic Impact Assessment undertaken by BMT. As such this report will not cover these items.

In order to address the management of stormwater quality for the development, numerous streetscape bioretention systems (pods) have been proposed for incorporation within the road reserve areas of the development. This design concept will promote at source treatment of runoff from the road network, with treatment measures replacing traditional pit locations along the road. Two treatment train options have been investigated as part of this assessment.

Option 1

This option is consistent with the previous version of this SMP (Version 2) and includes stormwater treatment provided solely via a network of streetscape bioretention systems. MUSIC v6 modelling suggests that a total bioretention filter area of 3,065 m² (within an estimated 140 pods for Stages 1-10) is required to achieve pollutant removal efficiencies of 85%, 65%, 45% and 90% for TSS, TP, TN and gross pollutants respectively for the site.

Option 2

The second option includes rainwater tanks (for the beneficial reuse of stormwater) connected to the roof catchment area within each allotment and overflows directed to the internal road. This option has been included to investigate if any reductions in the total area of streetscape systems can be achieved in an effort to reduce ongoing maintenance costs.

MUSIC v6 modelling indicates that inclusion of rainwater tanks within each allotment could reduce the total bioretention filter area to 2,700 m², whilst achieving the required pollutant removal efficiencies of 65%, 45% and 90% for TP, TN and gross pollutants respectively. It should be noted however that a lower TSS pollutant removal efficiency of 81.6% is achieved.

Based on a life cycle costing analysis (MUSIC V6) the reduction in filter area has the potential to result in an annual maintenance cost saving to Council.





10 RPEQ Certification

I am aware that Council may rely upon the contents and findings of this assessment for the purposes of development assessment. In my opinion, the Council can rely upon the information contained within the report and there are no reservations or qualifications in respect to the information other than set out in the report.

I confirm that if the design parameters set out in this report are included within the development:

- there should be no worsening in peak discharge, as a result of the proposed development that would result in actionable damage to downstream properties; and
- stormwater pollutant load reductions in accordance with best practice should be achieved.

Brad Comley

RPEQ 17706

03-06-21

DATE



11 References

ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

AUS-SPEC 2013. New South Wales Development Design Specification – D5 – Stormwater Drainage Design. Northern Rivers Local Government.

AUS-SPEC 2018. Handbook of Stormwater Drainage Design. Northern Rivers Local Government.

BMT WBM. 2015. NSW MUSIC Modelling Guidelines, BMT WBM Pty Ltd.

Department of Environment and Resource Management 2009, Queensland Water Quality Guidelines September 2009.

Department of Energy and Water Supply 2013, Queensland Urban Drainage Manual, Department of Energy and Water Supply, Brisbane, QLD.

Healthy Land and Water 2017. Stormwater Compliance: MUSIC Modelling. Available (online): <http://hlw.org.au/initiatives/waterbydesign/water-sensitive-urban-design-wsud> (15.05.17)

Healthy Waterways Partnership 2006, WSUD Technical Guidelines for South East Queensland.

Institute of Public Works Engineering Australasia, Queensland 2017. Queensland Urban Drainage Manual (Fourth Edition), Institute of Public Works Engineering Australasia, Queensland (IPWEAQ).

International Erosion Control Association (2008), Best Practice Erosion and Sediment Control. International Erosion Control Association.

Landcom 2003. Water Sensitive Urban Design Strategy - Design Philosophy and Case Study Report, report prepared for Landcom, NSW

Manly Hydraulics Laboratory, 2018. NSW Ocean and River Entrance Tidal Levels Annual Summary 2017–2018 Report MHL2618 December 2018

State of NSW and Office of Environment and Heritage, 2019. Floodplain Risk Management Guide – Incorporating 2016 Australian Rainfall and Runoff Studies. Sydney, NSW.

Sydney Catchment Authority 2012. Using MUSIC in Sydney's Drinking Water Catchment ISBN: 978-0-9874680-0-0 Published by Sydney Catchment Authority, Penrith, December 2012

Water by Design, 2009. Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands, South East Queensland Healthy Waterways Partnership, Brisbane, Queensland.

Water by Design, 2010. MUSIC Modelling Guidelines. South East Queensland Healthy Waterways Partnership, Brisbane, Queensland.

Water by Design, 2014. Bioretention Technical Design Guidelines (Version 1.1), Healthy Waterways Ltd, Brisbane.

Water by Design, 2015. Guide to the Cost of Maintaining Bioretention Systems (Version 1), Healthy Waterways Ltd, Brisbane.

Water by Design, 2012. Maintaining Vegetated Stormwater Assets (Version 1), Healthy Waterways Ltd, Brisbane.



Appendix A

Stormwater Management Drawings

CONCEPTUAL STORMWATER MANAGEMENT DESIGN DRAWINGS

Yamba Gardens - Stage 1-10
Lot 46 & 47 on DP751395
52-54 Miles Street, Yamba

for
Kahuna No.1 Pty Ltd

Project No: BC-18008
May 2021

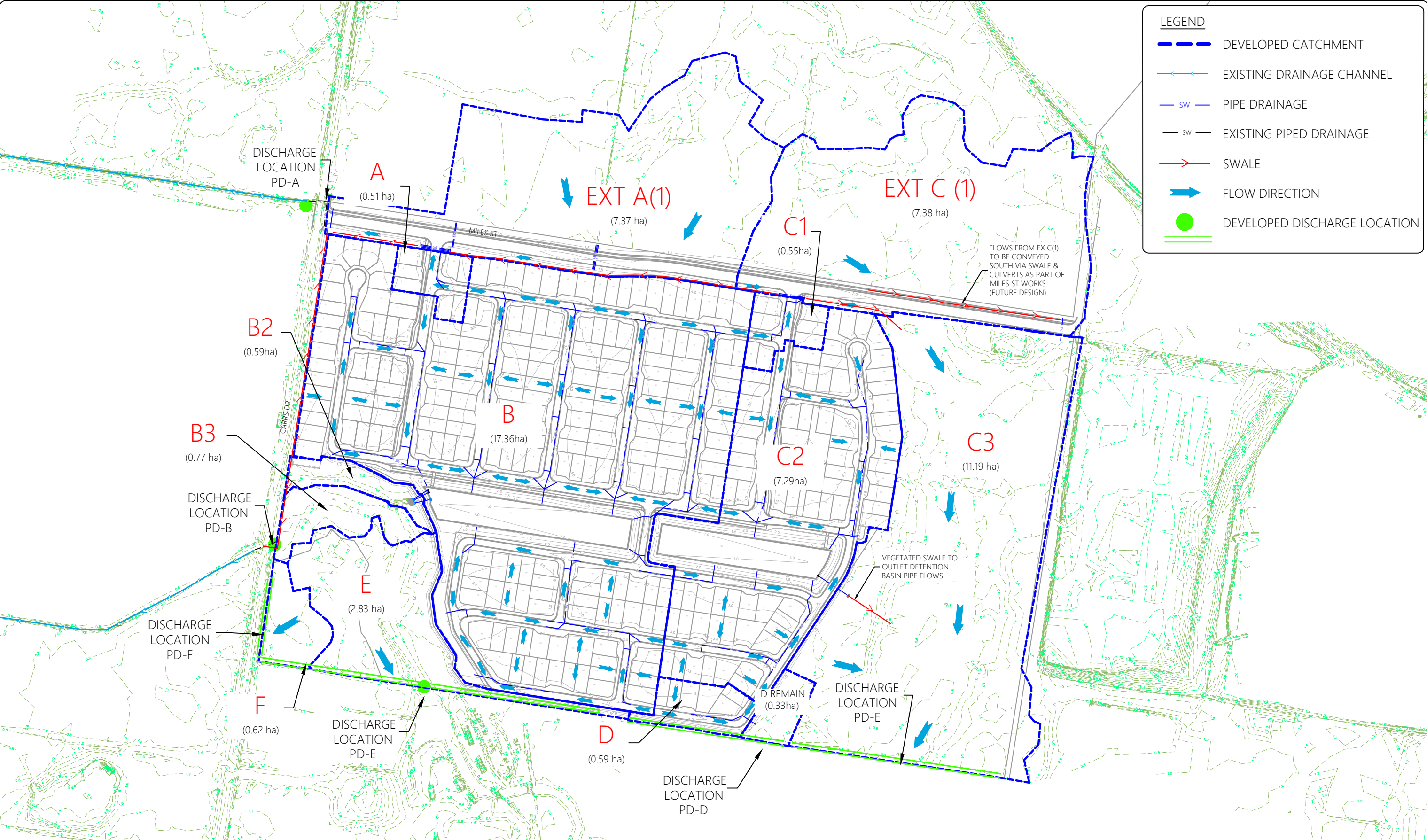


Site Location

BIOME Consulting Pty Ltd
Unit 30201, Southport Central Tower 3,
9 Lawson St, Southport QLD 4215
PO Box 3469, Australia Fair, Southport
O 07 5532 7779
M 0415 935 222
E brad@BIOMEconsulting.com.au
W www.BIOMEconsulting.com.au
ABN 86 166 087 476

SCHEDULE OF DRAWINGS

Drawing No.	Drawing Title
DWG-100	LOCALITY AND DRAWING INDEX PLAN
DWG-200	EXISTING CATCHMENT PLAN
DWG-201	DEVELOPED CATCHMENT PLAN
DWG-210	MUSIC CATCHMENT PLAN
DWG-300	OPERATIONAL CONTROL PLAN
DWG-310	BIO-POD LAYOUT PLAN - SHEET 1
DWG-311	BIO-POD LAYOUT PLAN - SHEET 2
DWG-312	DETENTION BASIN B LAYOUT PLAN & TYPICAL SECTION
DWG-313	DETENTION BASIN C LAYOUT PLAN & TYPICAL SECTION
DWG-320	BIO-POD SECTION DETAILS - SHEET 1
DWG-321	BIO-POD SECTION DETAILS - SHEET 2
DWG-322	OPTION 2 - RAINWATER TANKS & BIO-PODS - TYPICAL LAYOUT & SECTIONS
DWG-330	BIO-POD - FILTER MEDIUM & UNDERDRAINAGE DETAILS - SHEET 1
DWG-331	BIO-POD - FILTER MEDIUM & UNDERDRAINAGE DETAILS - SHEET 2
DWG-350	BIORETENTION STANDARD NOTES



DATE
30.05.21

PROJECT No.:
BC-18008

DRAWING No.:
DWG-300

REVISION No.:
A

PROJECT
YAMBA GARDENS - STAGES 1-10

DRAWING TITLE
OPERATIONAL CONTROL PLAN

CLIENT
KAHUNA NO.1 PTY LTD

ADDRESS:
52 - 54 MILES STREET, YAMBA

DRAFTED BY : TP / KP	DESIGNED BY : AK	CHECKED BY : BC	PAPER SIZE : A3	SCALE : AS SHOWN
-------------------------	---------------------	--------------------	--------------------	---------------------

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD

RPEQ No. :

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		30.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposes only and are not for construction purposes.

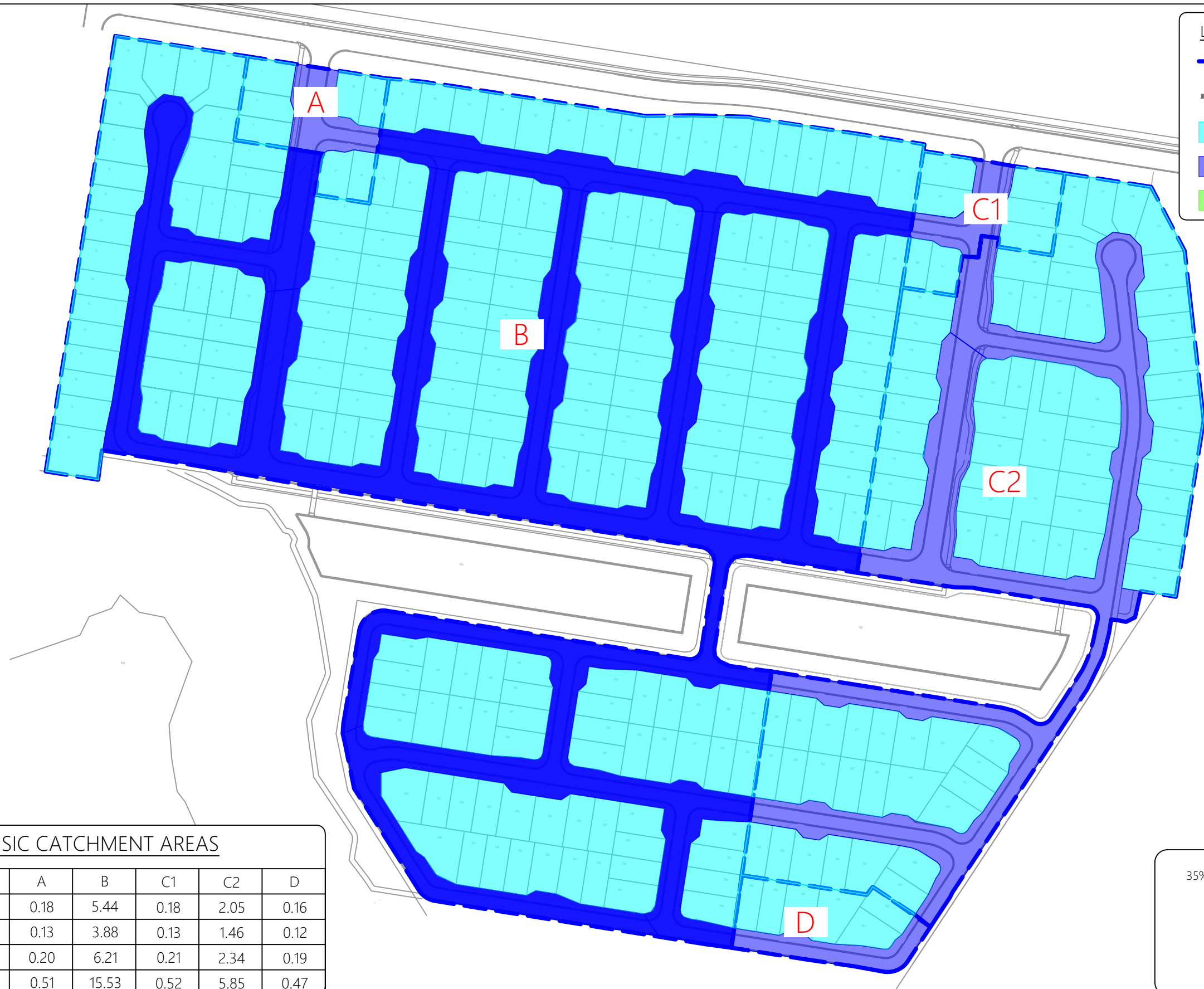
BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

40 0 40 80 120 160 200

1 : 4000 (FULL SIZE) (metres)

CERTIFIED BY



LEGEND

MUSIC CATCHMENT

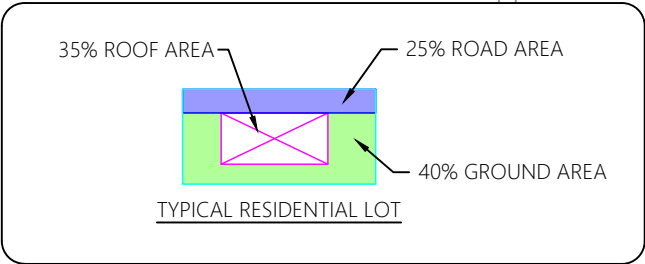
STAGE BOUNDARY

LOT

ROAD AND CARPARK

GROUND

MUSIC CATCHMENT AREAS					
CATCH ID	A	B	C1	C2	D
ROOF (ha)	0.18	5.44	0.18	2.05	0.16
ROAD & CARPARK (ha)	0.13	3.88	0.13	1.46	0.12
GROUND (ha)	0.20	6.21	0.21	2.34	0.19
TOTAL (ha)	0.51	15.53	0.52	5.85	0.47



DATE

30.05.21

PROJECT No. :

BC-18008

DRAWING No. :

DWG-210

REVISION No. :

A

PROJECT

YAMBA GARDENS - STAGES 1-10

DRAWING TITLE

MUSIC CATCHMENT PLAN

CLIENT

KAHUNA NO.1 PTY LTD

ADDRESS:

52 - 54 MILES STREET, YAMBA

DRAFTED BY :
TP / LD

DESIGNED BY :
AK

CHECKED BY :
BC

PAPER SIZE :
A3

SCALE :
AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD

ACN 166 087 476

RPEQ No. :

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		30.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.



BIOME
WATER AND ENVIRONMENTAL CONSULTING

BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

25

0

25

50

75

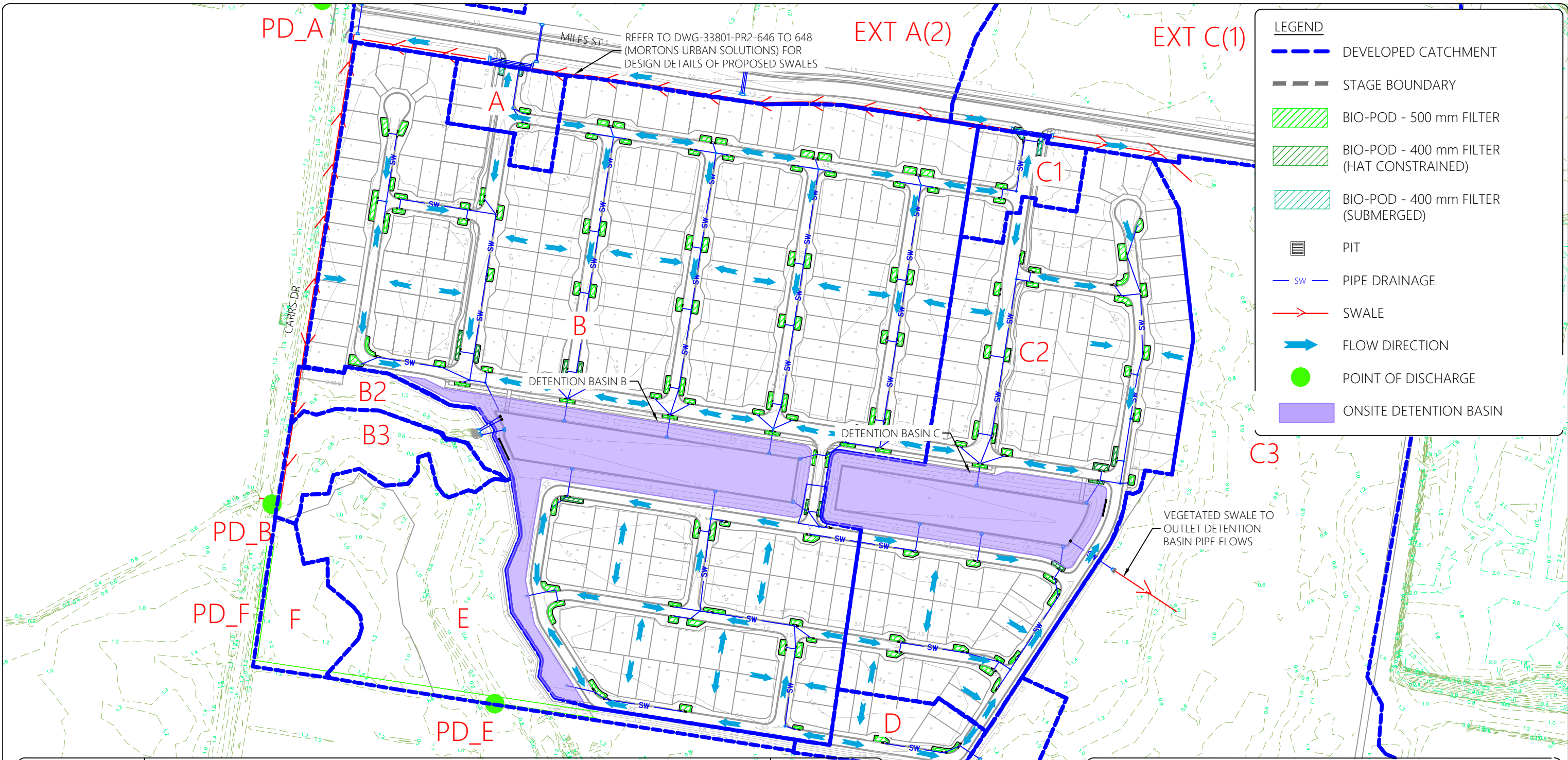
100

125

1 : 2500 (FULL SIZE) (metres)

CERTIFIED BY





TREATMENT SCENARIO	BIO-POD CHARACTERISTICS				RAINWATER TANKS
	MEASURE ID	BIO-POD (400mm FILTER DEPTH)	BIO-POD (500mm FILTER DEPTH)	BIO-POD - SUB. (400mm FILTER DEPTH)	
BIO-PODS ONLY	TOTAL FILTER AREA (m ²)	280	2,700	85	-
BIO-PODS & RAINWATER TANKS	TOTAL FILTER AREA (m ²)	240	2,350	110	3KL/DETACHED DWELLING
NO. OF BIO-PODS		11	125	4	

DETENTION BASIN CHARACTERISTICS		
MEASURE ID	BASIN B	BASIN C
1% AEP DETENTION VOL. (m ³)	11,089	9,105
1% AEP DETENTION DEPTH (m)	1.21	1.26

DATE
30.05.21

PROJECT No.:
BC-18008

DRAWING No.:
DWG-300

REVISION No.:
A

PROJECT
YAMBA GARDENS - STAGES 1-10

DRAWING TITLE
OPERATIONAL CONTROL PLAN

CLIENT
KAHUNA NO.1 PTY LTD

ADDRESS:
52 - 54 MILES STREET, YAMBA

DRAFTED BY: TP / KP

DESIGNED BY: AK

CHECKED BY: BC

PAPER SIZE: A3

SCALE: AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD

RPEQ No.:

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		30.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

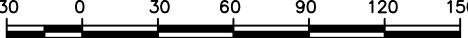
Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.



BIOME
WATER AND ENVIRONMENTAL CONSULTING

BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

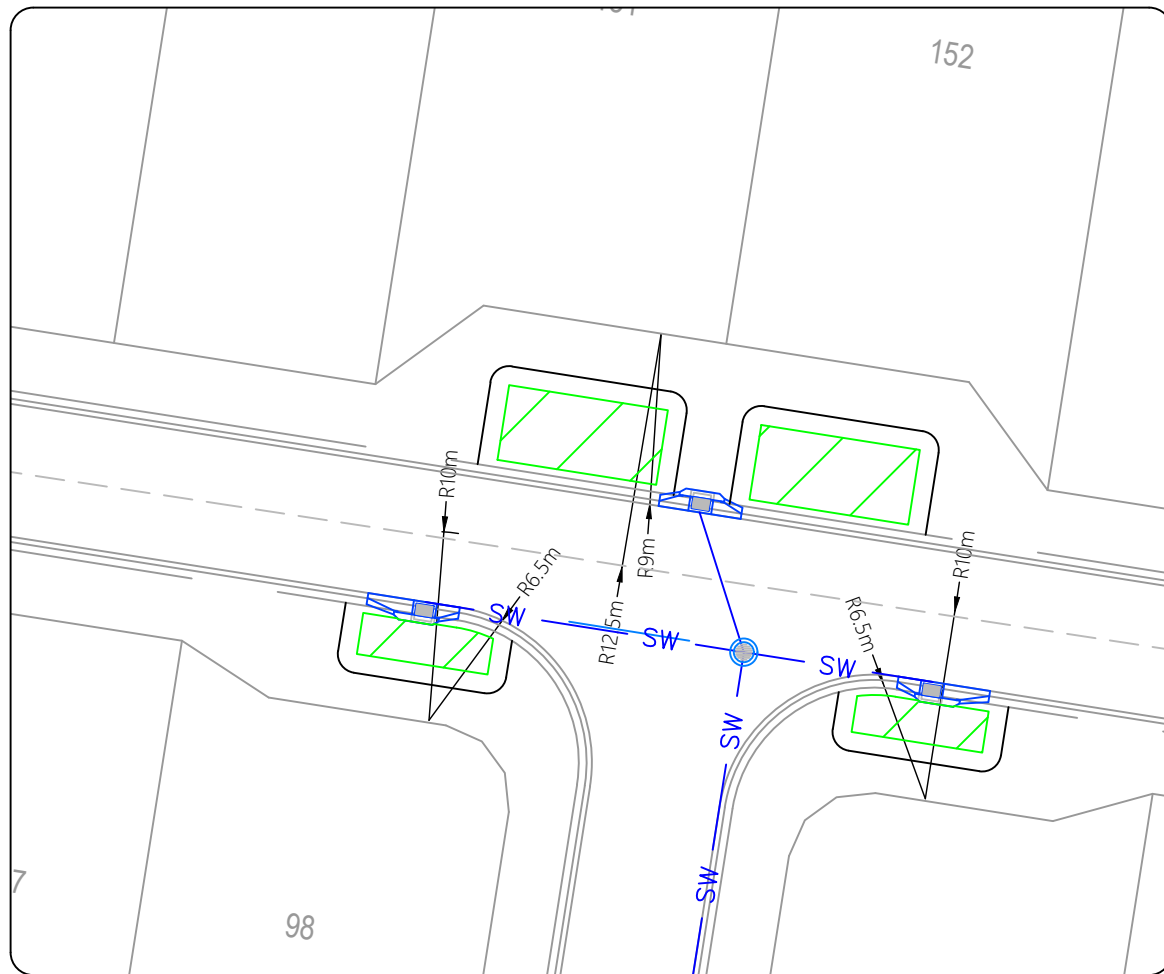
ORIGINAL SCALE BEFORE REDUCTION



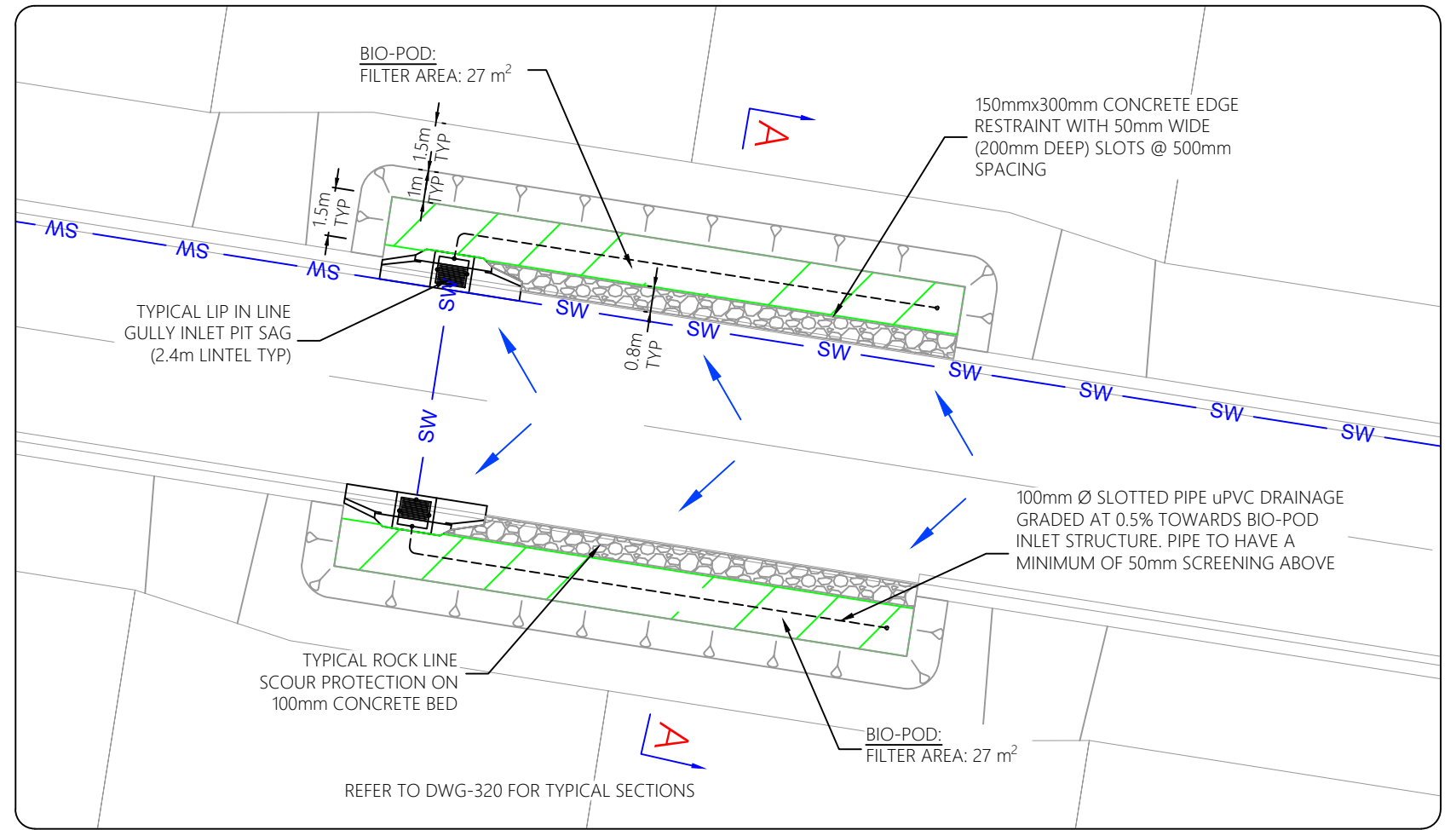
1 : 3000 (FULL SIZE) (metres)

CERTIFIED BY

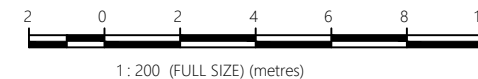




TEE BIO-POD PLAN VIEW (TYPICAL)



BIO-POD PLAN (TYPICAL)



NOTE: FOR FURTHER DETAILS REFER TO MORTONS URBAN SOLUTIONS DRAWINGS:

- 33801-PR2-660-A 'STORMWATER TYPICAL BIO-POD PLAN SHEET 01';
- 33801-PR2-661-A 'STORMWATER TYPICAL BIO-POD PLAN SHEET 02';
- 33801-PR2-663-A 'STORMWATER TYPICAL BIO-POD TYPICAL DETAILS'; &
- 33801-PR2-660-A 'CONCEPT BIO-POD END OF LINE TREATMENT'.

DATE 30.05.21	PROJECT YAMBA GARDENS - STAGES 1-10			
PROJECT No.: BC-18008	DRAWING TITLE BIO-POD LAYOUT PLAN - SHEET 1			
DRAWING No.: DWG-310	CLIENT KAHUNA NO.1 PTY LTD			
REVISION No.: A	ADDRESS: 52 - 54 MILES STREET, YAMBA			
DRAFTED BY: TP / KP	DESIGNED BY: AK	CHECKED BY: BC	PAPER SIZE: A3	SCALE: AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD			
RPEQ No. :			
VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		30.05.21

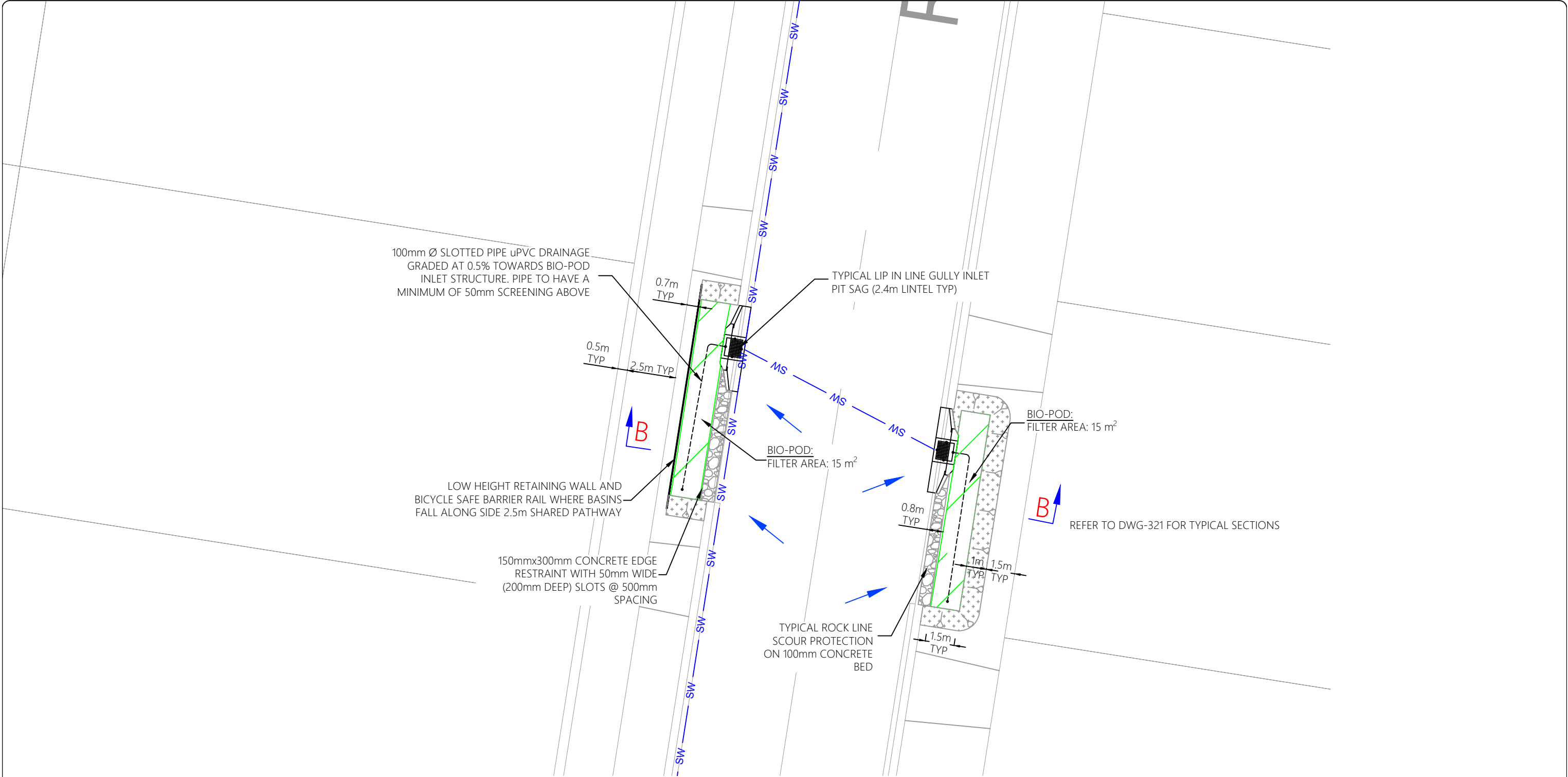
COPYRIGHT
 Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.
 Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.
 Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

BIOME
 WATER AND ENVIRONMENTAL CONSULTING

BIOME Consulting Pty Ltd
 PO Box 3469, Australia Fair, Southport
 M 0415 935 222
 E brad@BIOMEconsulting.com.au
 ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

CERTIFIED BY



NOTE: FOR FURTHER DETAILS REFER TO MORTONS URBAN SOLUTIONS DRAWINGS:

- 33801-PR2-660-A 'STORMWATER TYPICAL BIO-POD PLAN SHEET 01';
- 33801-PR2-661-A 'STORMWATER TYPICAL BIO-POD PLAN SHEET 02';
- 33801-PR2-663-A 'STORMWATER TYPICAL BIO-POD TYPICAL DETAILS'; &
- 33801-PR2-660-A 'CONCEPT BIO-POD END OF LINE TREATMENT'.

DATE
30.05.21

PROJECT No. :
BC-18008

DRAWING No. :
DWG-311

REVISION No. :
A

PROJECT
YAMBA GARDENS - STAGES 1-10

DRAWING TITLE
BIO-POD LAYOUT PLAN - SHEET 2

CLIENT
KAHUNA NO.1 PTY LTD

ADDRESS:
52 - 54 MILES STREET, YAMBA

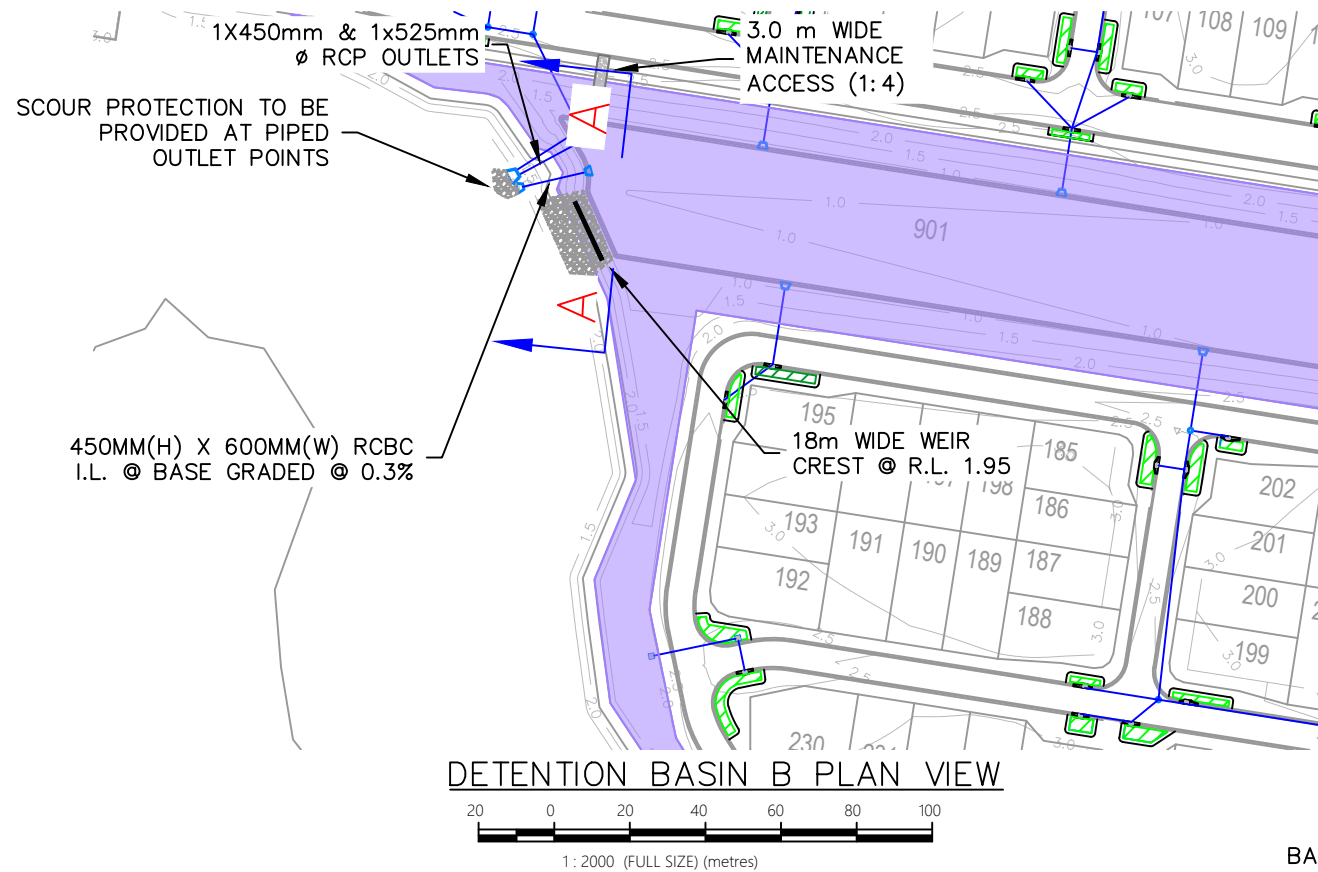
DRAFTED BY : TP / KP	DESIGNED BY : AK	CHECKED BY: BC	PAPER SIZE : A3	SCALE : AS SHOWN
-------------------------	---------------------	-------------------	--------------------	---------------------

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD
ACN 166 087 476
RPEQ No. :
VER. DESCRIPTION APPR. DATE
A ORIGINAL ISSUE 30.05.21

COPYRIGHT
Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.
Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.
Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

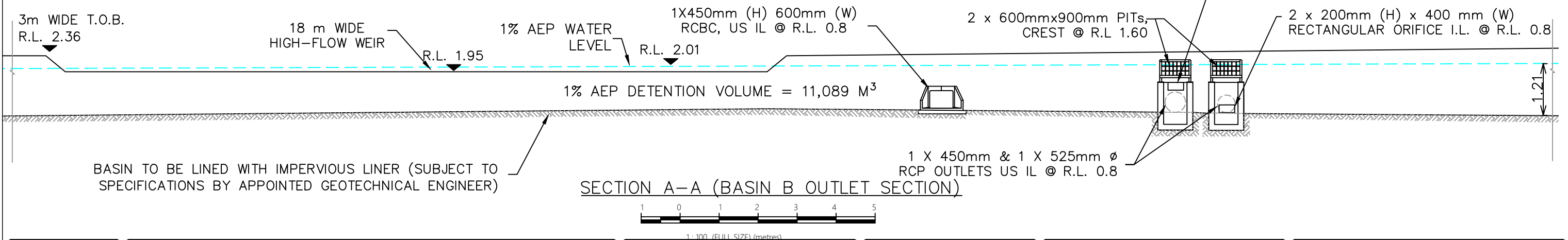
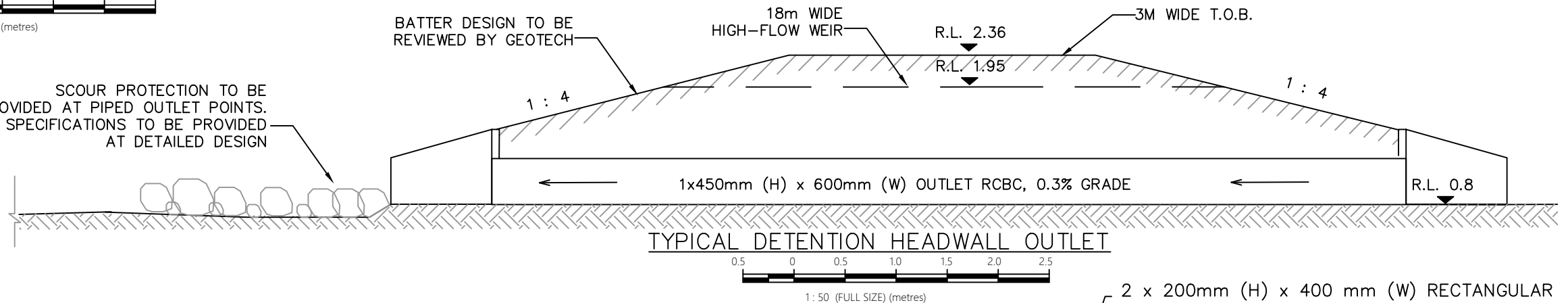
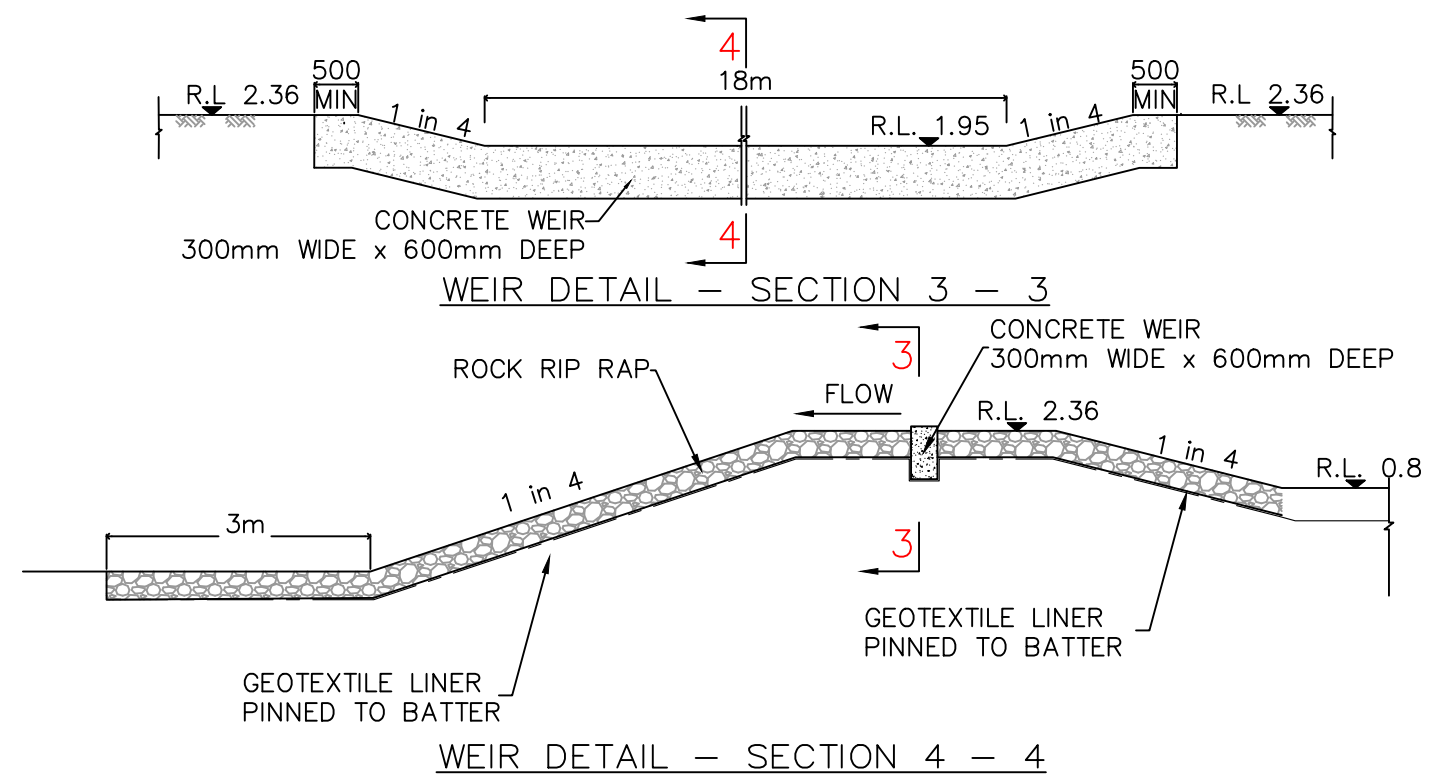

BIOME
WATER AND ENVIRONMENTAL CONSULTING
BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION
2 0 2 4 6 8 10
1 : 200 (FULL SIZE) (metres)
CERTIFIED BY

NOTE: REFER TO MORTONS URBAN SOLUTIONS DRAWINGS 33801-PR2-666-A & 33801-PR2-667-A FOR LONG SECTIONS OF THE PROPOSED DETENTION BASIN

SCOUR PROTECTION TO BE PROVIDED AT PIPED OUTLET POINTS. SPECIFICATIONS TO BE PROVIDED AT DETAILED DESIGN



DATE 30.05.21	PROJECT YAMBA GARDENS - STAGES 1-10				
PROJECT No.: BC-18008	DRAWING TITLE DETENTION BASIN B TYPICAL DETAILS				
DRAWING No.: DWG-312	CLIENT KAHUNA NO.1 PTY LTD				
REVISION No.: A	ADDRESS: 52 - 54 MILES STREET, YAMBA				
DRAFTED BY: TP / KP	DESIGNED BY: AK	CHECKED BY: BC	PAPER SIZE: A3	SCALE: AS SHOWN	

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD			
RPEQ No.:			
VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		30.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

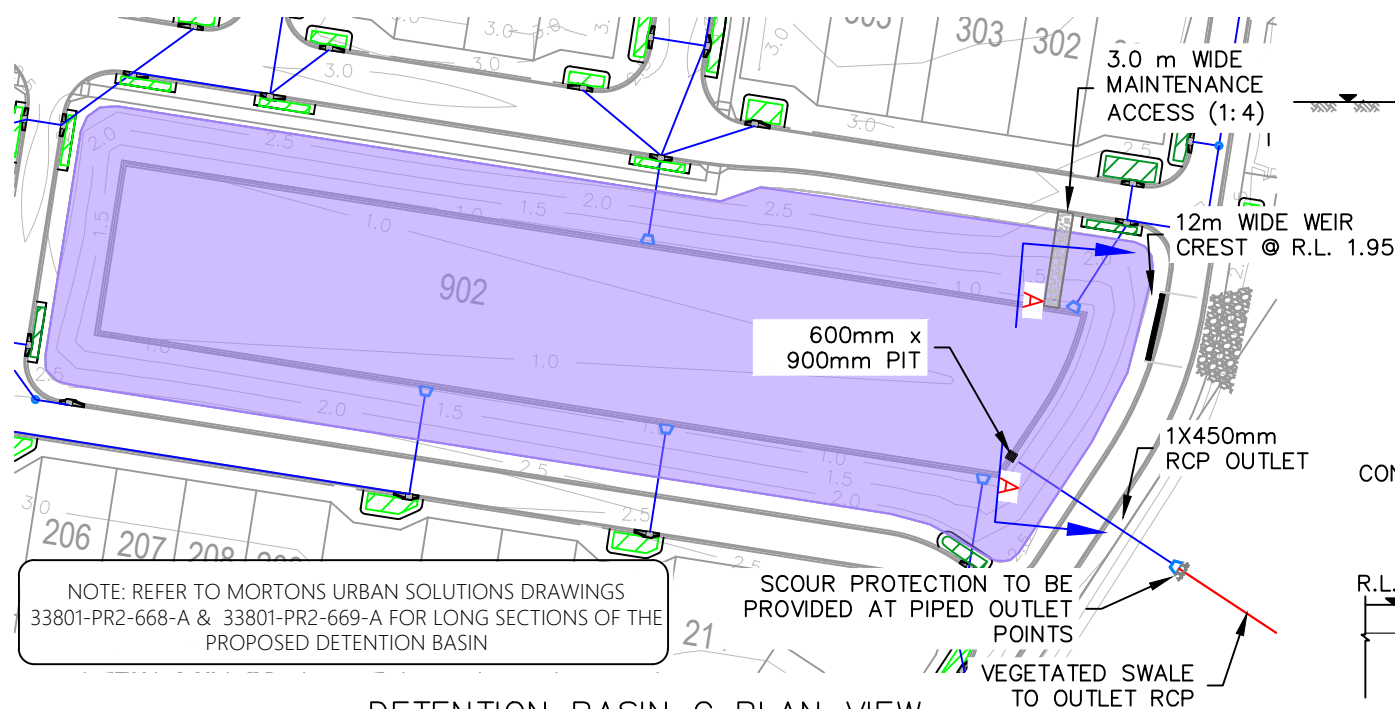
Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

BIOME
WATER AND ENVIRONMENTAL CONSULTING

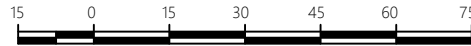
BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

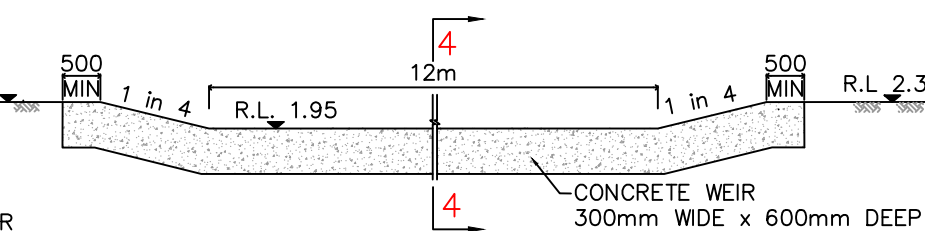
CERTIFIED BY



DETENTION BASIN C PLAN VIEW



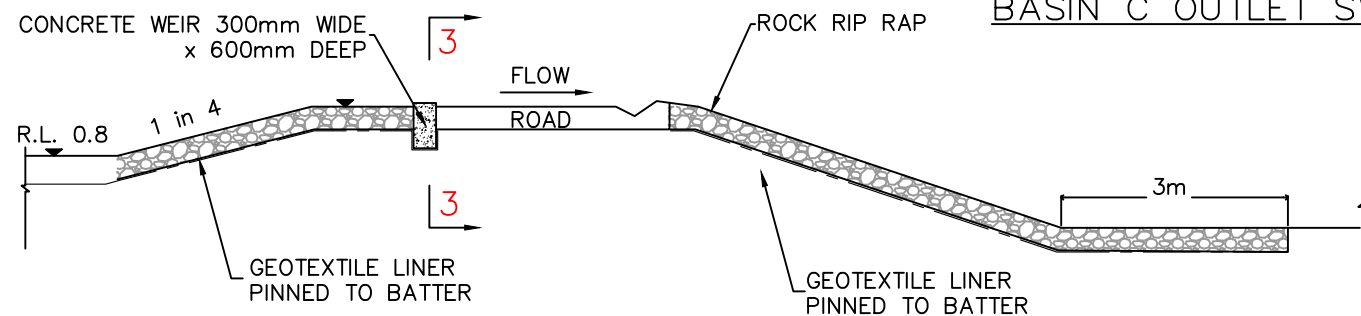
1: 1500 (FULL SIZE) (metres)



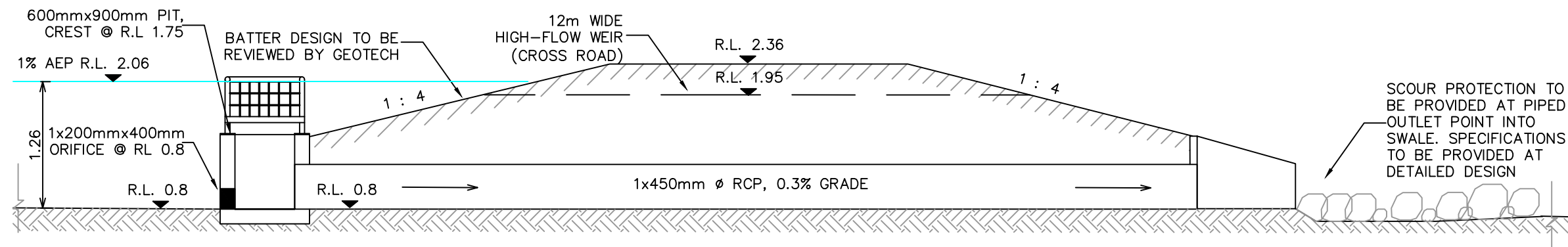
WEIR DETAIL - SECTION 3 - 3

Design Storm:	0.01 AEP	Design	
Flow (m³/s):	0.50	Design	
Flow Depth (m)	0.25	Design	
Mannings 'n':	0.035	Design	
Channel Slope 1:	250	Design	
Freeboard (m):	0.25	Design	
Depth + Freeboard (m)	0.5	Design	
Left Batter Slope 1:	3	Design	
Width (m) =	1.5	Design	
Base Width (m)	2.50	Design	
Right Batter Slope 1:	3	Design	
Width (m) =	1.5	Design	
Total Width (m) =	5.50	Design	
Flow Area (m²) =	0.813	Design	
Hydraulic Radius (m) =	0.199	Design	
Capacity (m³/s) =	0.501	Design	
Velocity (m/s) =	0.616	Design	
d*v (m²/s) =	0.15	Design	

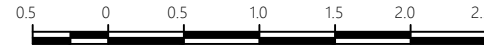
BASIN C OUTLET SWALE DESIGN



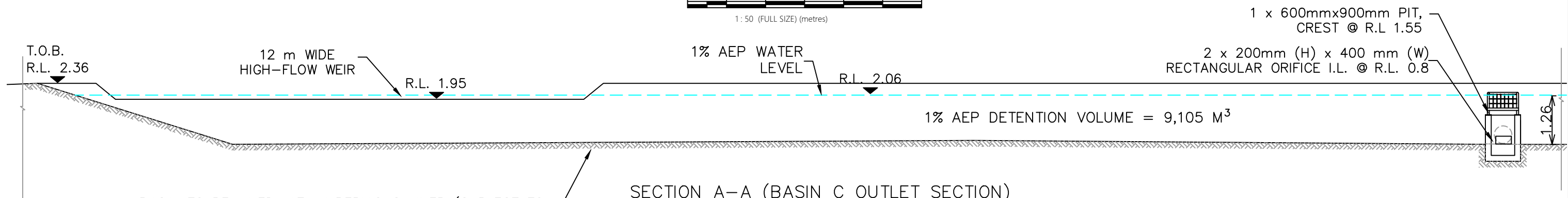
WEIR DETAIL - SECTION 4 - 4



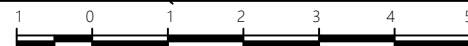
TYPICAL BASIN C OUTLET



1: 50 (FULL SIZE) (metres)



SECTION A-A (BASIN C OUTLET SECTION)



1: 100 (FULL SIZE) (metres)

BASIN TO BE LINED WITH IMPERVIOUS LINER (SUBJECT TO SPECIFICATIONS BY APPOINTED GEOTECHNICAL ENGINEER)

DATE	30.05.21
PROJECT	YAMBA GARDENS - STAGES 1-10
DRAWING TITLE	DETENTION BASIN C TYPICAL DETAILS
CLIENT	KAHUNA NO.1 PTY LTD
ADDRESS:	52 - 54 MILES STREET, YAMBA
DRAFTED BY:	TP / KP
DESIGNED BY:	AK
CHECKED BY:	BC
PAPER SIZE:	A3
SCALE:	AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD			
ACN 166 087 476			
RPEQ No. :			
VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		30.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

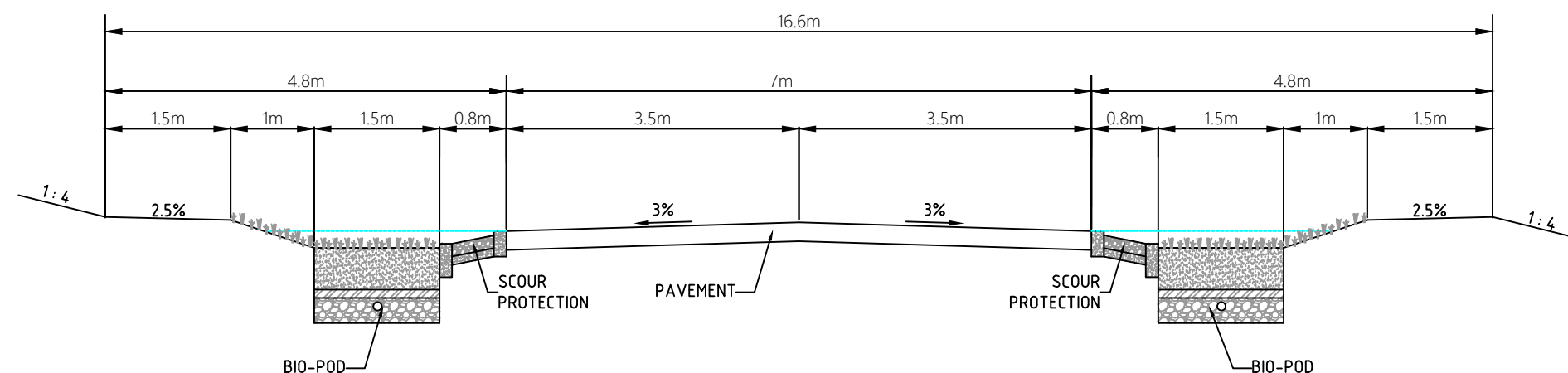
BIOME
WATER AND ENVIRONMENTAL CONSULTING

BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

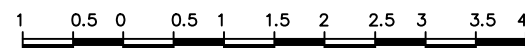
ORIGINAL SCALE BEFORE REDUCTION

CERTIFIED BY

NOT FOR CONSTRUCTION
All hydraulic details and levels
T.B.C as part of detailed design



SECTION A - A



DATE 30.05.21	PROJECT YAMBA GARDENS - STAGES 1-10			
PROJECT No. : BC-18008	DRAWING TITLE BIO-POD - SECTION DETAILS - SHEET 1			
DRAWING No. : DWG-320	CLIENT KAHUNA NO.1 PTY LTD			
REVISION No. : A	ADDRESS: 52 - 54 MILES STREET, YAMBA			
DRAFTED BY : TP / KP	DESIGNED BY : AK	CHECKED BY: BC	PAPER SIZE : A3	SCALE : AS SHOWN

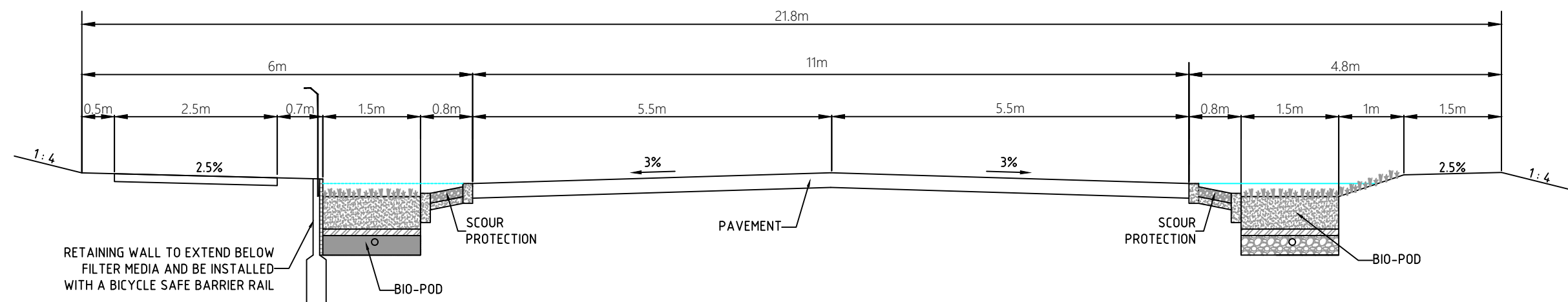
APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD			
ACN 166 087 476			
RPEQ No. :			
VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		30.05.21

COPYRIGHT
Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.
Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.
Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

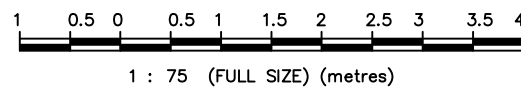
BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION
CERTIFIED BY

NOT FOR CONSTRUCTION
All hydraulic details and levels
T.B.C as part of detailed design



SECTION B - B



DATE

30.05.21

PROJECT No. :

BC-18008

DRAWING No. :

DWG-321

REVISION No. :

A

PROJECT

YAMBA GARDENS - STAGES 1-10

DRAWING TITLE

BIO-POD - SECTION DETAILS - SHEET 2

CLIENT

KAHUNA NO.1 PTY LTD

ADDRESS:

52 - 54 MILES STREET, YAMBA

DRAFTED BY :
TP / KP

DESIGNED BY :
AK

CHECKED BY:
BC

PAPER SIZE :
A3

SCALE :
AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING
PTY LTD

ACN 166 087 476

RPEQ No. :

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		30.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

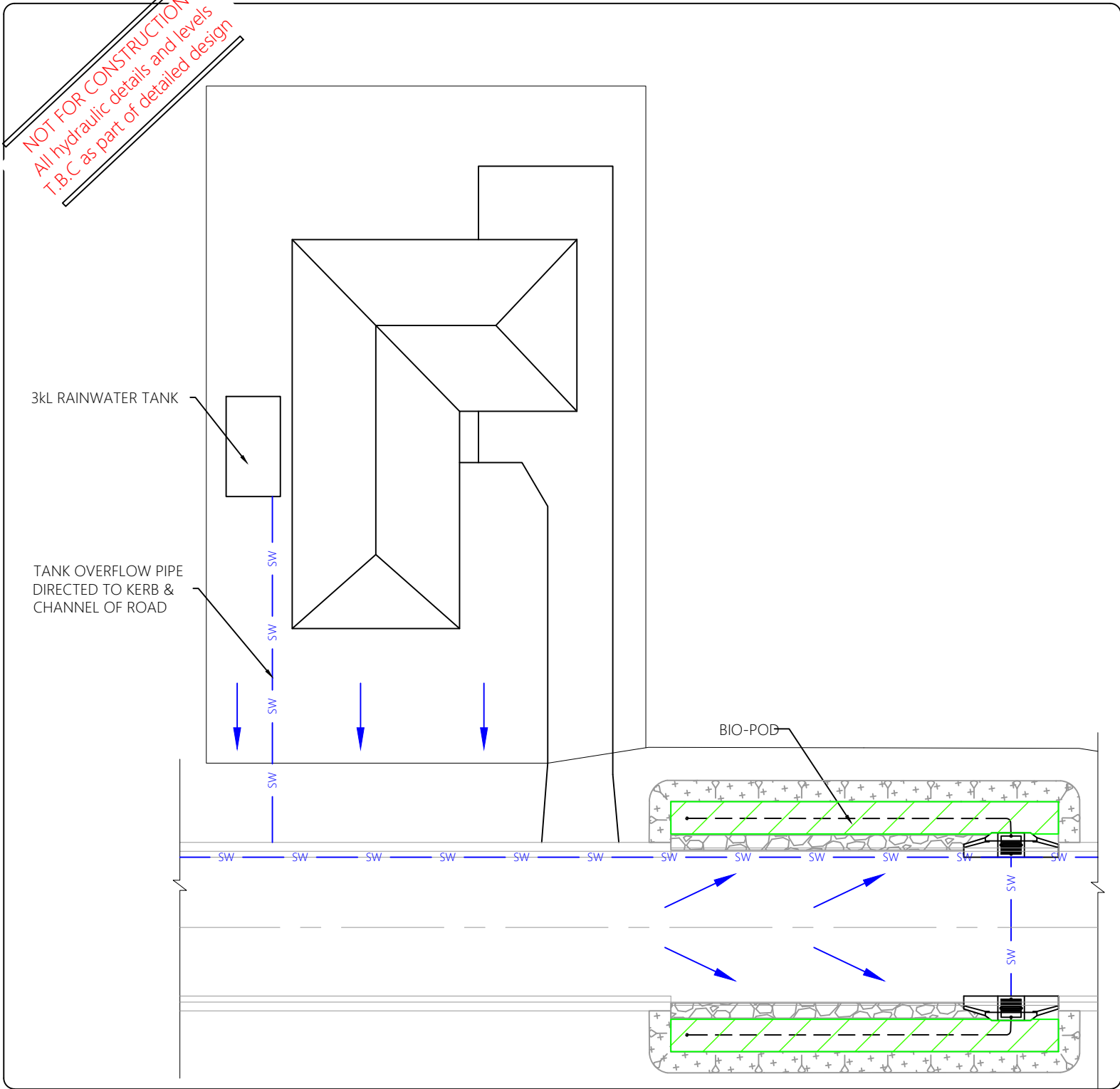


BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

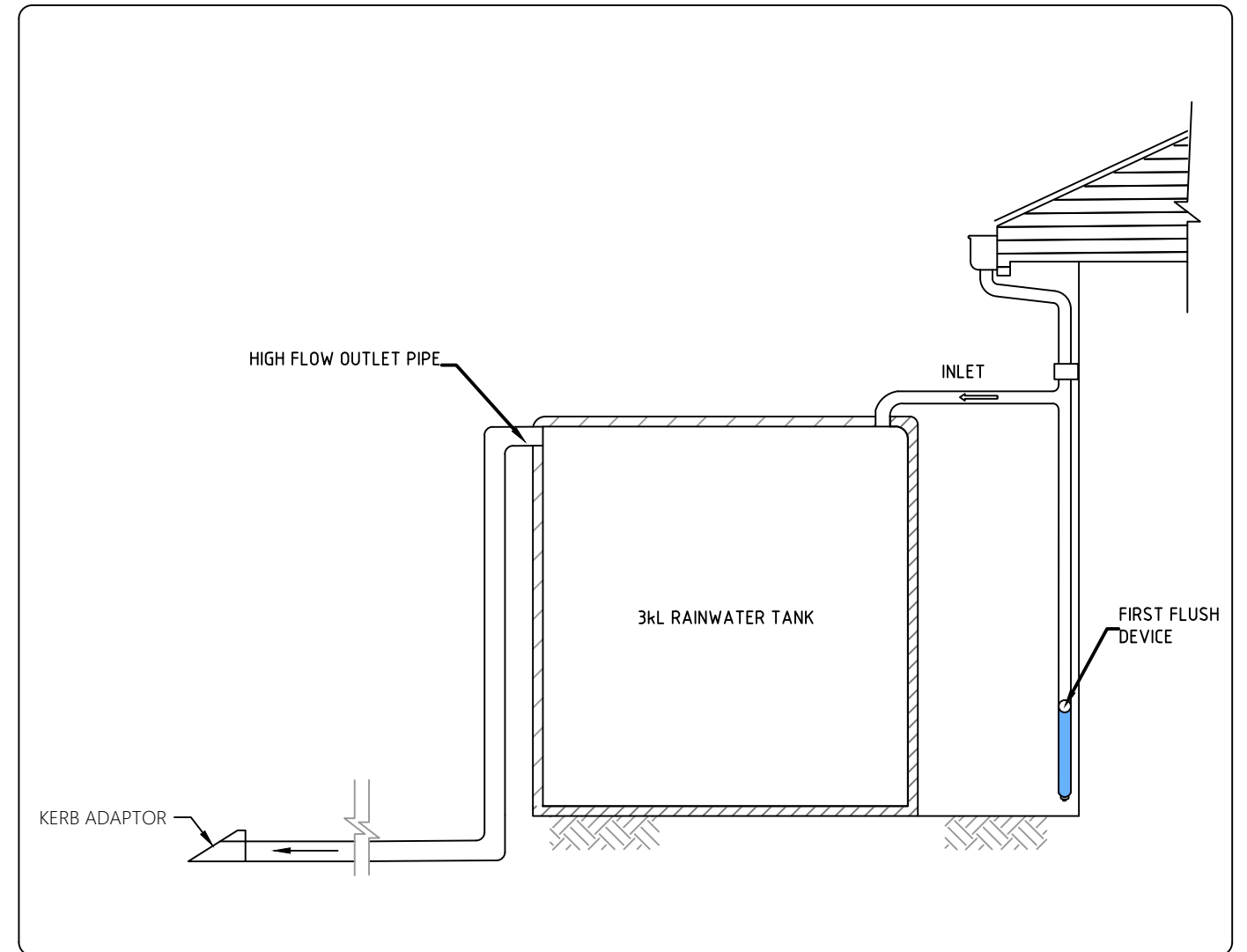
CERTIFIED BY

NOT FOR CONSTRUCTION
All hydraulic details and levels
T.B.C as part of detailed design



STORMWATER TREATMENT TRAIN SCENARIO -
RAINWATER TANKS WITH BIO-PODS (TYPICAL LAYOUT)

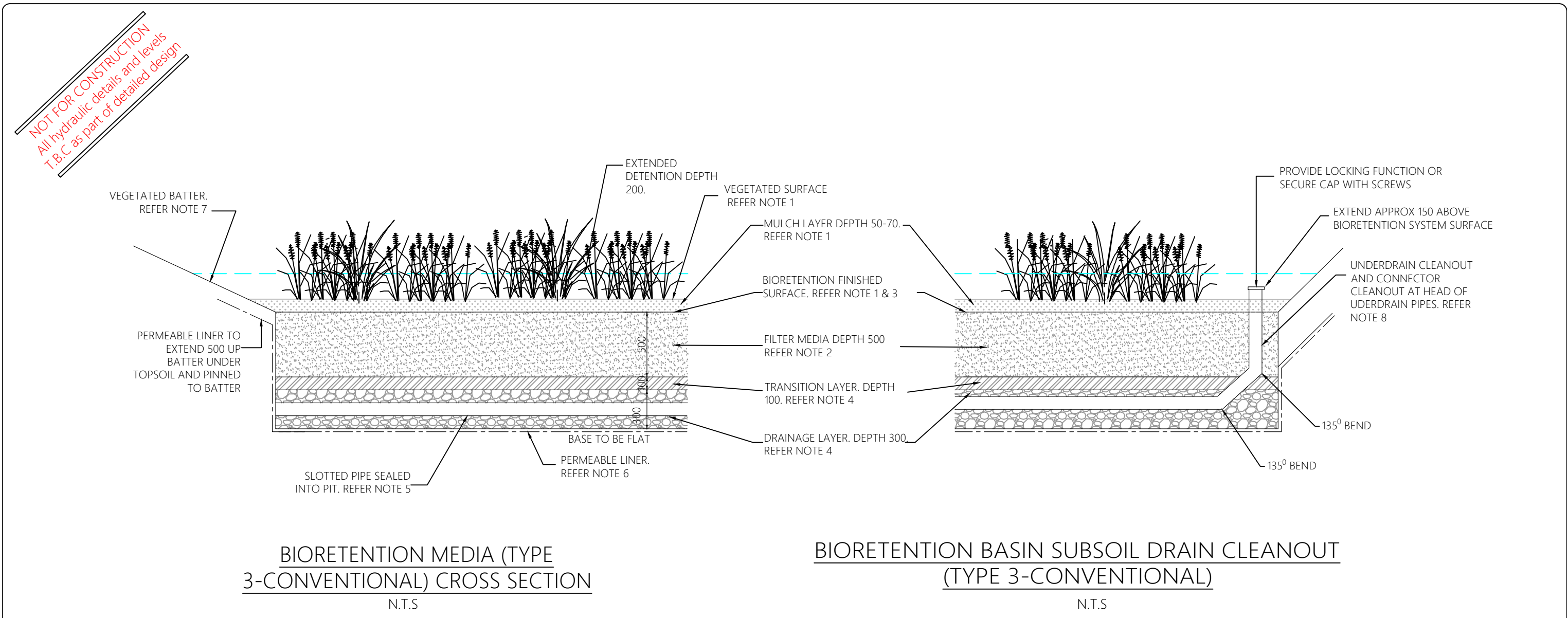
N.T.S



RAINWATER TANK SECTION (TYPICAL)

N.T.S

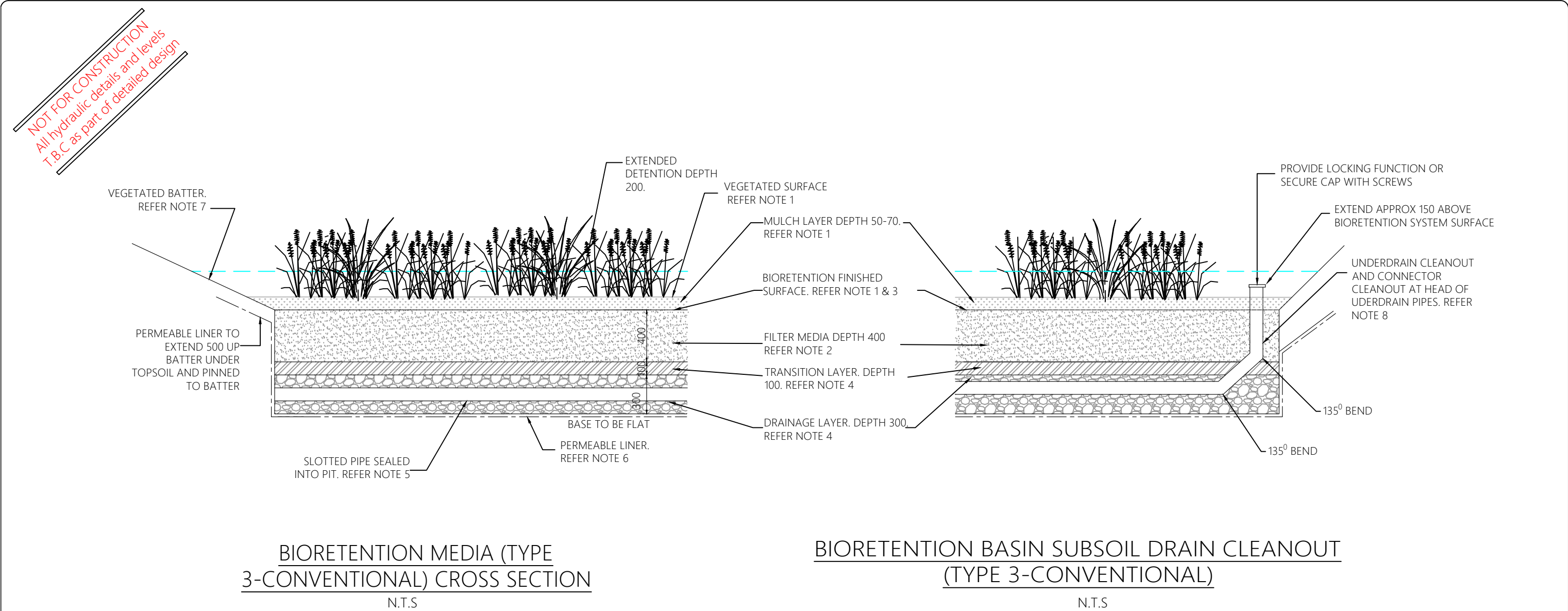
DATE 30.05.21	PROJECT YAMBA GARDENS - STAGES 1-10					APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD ACN 166 087 476				COPYRIGHT Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.		 BIOME WATER AND ENVIRONMENTAL CONSULTING	ORIGINAL SCALE BEFORE REDUCTION
PROJECT No. : BC-18008	DRAWING TITLE STORMWATER TREATMENT TRAIN SCENARIO – RAINWATER TANKS & BIO-PODS – TYPICAL LAYOUT & SECTIONS					RPEQ No. : 				Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.			CERTIFIED BY
DRAWING No. : DWG-322	CLIENT KAHUNA NO.1 PTY LTD					VER. DESCRIPTION APPR. DATE				Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.			
REVISION No. : A	ADDRESS: 52 - 54 MILES STREET, YAMBA					A ORIGINAL ISSUE 30.05.21							
DRAFTED BY : TP / KP		DESIGNED BY : AK		CHECKED BY : BC		PAPER SIZE : A3		SCALE : AS SHOWN					



NOTES (IN ACCORDANCE WITH IPWEAQ STANDARD DRAWINGS DS-070 AND DS-073):

1. BIORETENTION SYSTEM SURFACE. SURFACE LEVEL IS TOP OF FILTER MEDIA. SURFACE TO BE MULCHED AND PLANTED AS PER THE 'BIORETENTION TECHNICAL DESIGN GUIDELINES' (WATER BY DESIGN).
2. FILTER MEDIA SPECIFICATION SHALL BE IN ACCORDANCE WITH THE 'ADOPTION GUIDELINES FOR STORMWATER BIOFILTRATION SYSTEMS (CRC FOR WATER SENSITIVE CITIES) AND THE BIORETENTION TECHNICAL DESIGN GUIDELINES (WATER BY DESIGN). BIORETENTION HYDRAULIC CONDUCTIVITY SHALL BE IN ACCORDANCE WITH PRACTICE NOTE 1: IN SITU MEASUREMENT OF HYDRAULIC CONDUCTIVITY' (FAWB). THE NUMBER OF SAMPLES TO BE TESTED SHALL BE IN ACCORDANCE WITH THE 'CONSTRUCTION AND ESTABLISHMENT GUIDELINES - SWALES, BIORETENTION SYSTEMS AND WETLANDS' (WATER BY DESIGN).
3. CONSTRUCTION TOLERANCES SHALL BE IN ACCORDANCE WITH THE 'CONSTRUCTION AND ESTABLISHMENT GUIDELINES -SWALES, BIORETENTION SYSTEMS AND WETLANDS' (WATER BY DESIGN)
4. TRANSITION LAYER AND DRAINAGE LAYER. DEPTHS AND SPECIFICATION TO BE IN ACCORDANCE WITH THE 'BIORETENTION TECHNICAL DESIGN GUIDELINES' (WATER BY DESIGN)
5. UNDERDRAIN. SLOTTED RIGID PIPE LAID FLAT. PIPE SHOULD NOT BE INSTALLED WITH A FILTER SOCK SURROUNDING PIPE. UNDERDRAIN PIPES SHALL BE SEALED INTO PITS USING GROUT OR OTHER APPROVED WATERTIGHT SEAL.
6. PERMEABLE LINER. NON-WOVEN GEOTEXTILE FILTER CLOTH TO BASE AND SIDES OF BIORETENTION SYSTEM. FILTER CLOTH NOT TO BE PLACED BETWEEN ANY FILTER LAYERS. PERMEABLE LINER AS PER "BIORETENTION TECHNICAL DESIGN GUIDELINES" (WATER BY DESIGN).
7. VEGETATED BATTER. SLOPE AND PLANTING TO BE IN ACCORDANCE WITH 'BIORETENTION TECHNICAL DESIGN GUIDELINES' (WATER BY DESIGN).
8. INSPECTION/CLEANOUT POINT. VERTICAL SOLID PIPE SECTION ATTACHED TO THE END OF EACH UNDERDRAIN IN ACCORDANCE WITH THE 'BIORETENTION TECHNICAL DESIGN GUIDELINES'(WATER BY DESIGN)
9. FILTER CLOTH TO BE FIXED TO PERIMETER OF PIT TO AVOID RUNNELLING OF WATER BETWEEN PIT AND SOIL INTERFACE. BEGIN FILTER CLOTH 100 ABOVE SURFACE. EXTEND TO 100 BELOW SURFACE. CONTINUE 300 HORIZONTALLY INTO FILTER MEDIA.
10. FOR GENERAL DESIGN AND CONSTRUCTION NOTES REFER TO DS-078
11. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.

DATE 30.05.21 PROJECT No. : BC-18008 DRAWING No. : DWG-330 REVISION No. : A	PROJECT YAMBA GARDENS - STAGES 1-10 DRAWING TITLE BIO-POD – FILTER MEDIUM & UNDERDRAINAGE DETAILS - SHEET 1 CLIENT KAHUNA NO.1 PTY LTD ADDRESS: 52 - 54 MILES STREET, YAMBA DRAFTED BY : TP / LD DESIGNED BY : AK CHECKED BY: BC PAPER SIZE : A3 SCALE : AS SHOWN	APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD ACN 166 087 476 RPEQ No. : <table><tr><th>VER.</th><th>DESCRIPTION</th><th>APPR.</th><th>DATE</th></tr><tr><td>A</td><td>ORIGINAL ISSUE</td><td></td><td>30.05.21</td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr></table>	VER.	DESCRIPTION	APPR.	DATE	A	ORIGINAL ISSUE		30.05.21																													COPYRIGHT Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd. Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended. Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.	 BIOME WATER AND ENVIRONMENTAL CONSULTING BIOME Consulting Pty Ltd PO Box 3469, Australia Fair, Southport M 0415 935 222 E brad@BIOMEconsulting.com.au ABN 86 166 087 476	ORIGINAL SCALE BEFORE REDUCTION CERTIFIED BY
VER.	DESCRIPTION	APPR.	DATE																																						
A	ORIGINAL ISSUE		30.05.21																																						



1 Referenced documents

2. Abbreviations and definitions
 - 2.1. The bioretention system specification consists of the following abbreviations and definitions:
 - 2.2. Filter soil layer which acts as a pollutant filter and supports plant growth.
 - 2.3. Impermeable liners: the liner that prevents water movement between the filter and the surrounding soils and defines the edge of the system.
 - 2.4. Transition layer: layer to separate filter layer from the drainage layer to avoid migration of soils from the filter to the drainage layer
 - 2.5. Drainage layer relatively free of clogging material to convey infiltrated water to the underdrainage.
 - 2.6. Under-drains: slotted drains collect treated stormwater from the drainage layer at the base of the bioretention system.

3.1. The following test methods and standards are to be used as specified in the

4. Materials
- 4.1. Materials shall meet the required specifications detailed in Section 8 Filter media, Section 9 Transition layer, Section 10 Drainage layer, Section 11 Under drainage. Section 12 Permeable liner. Section 13 Impermeable liner end section 14 landscaping of this document.
- 4.2. All materials must be certified by the supplier with certification and delivery supply dockets shall be provided on request to certify the material delivered is the material tested.

5.1. The timing of civil and landscape works for bioretention systems must be carefully planned to ensure that both the bioretention system and the downstream waterways, are not impacted by stormwater and sediment (e.g. through best practice erosion and sediment control). In particular, the drainage layer, transition layer and filter media must not be placed until the risk of high sediment loading from upstream construction activities has been mitigated. The construction sequence must be approved by the superintendent

- 6.1. The construction of hydraulic structures must ensure the design levels are achieved. Bunds/ embankments surrounding the system shall be at correct levels. The below table summarises the construction tolerances for each element of a typical bioretention system.

7. Maintenance access.
Maintenance access is provided in accordance with the design drawings.

- | Parameter | Test method in accordance with | Requirement |
|----------------------------------|--------------------------------|---|
| Saturated hydraulic conductivity | ASTM f1815 -11 | 50 - 500 mm/hr (200 preferred) |
| pH | AS 4419 | 5.5 - 7.5 |
| Electrical conductivity | AS 4419 | <1.2 dS/m |
| Nitrogen content | AS 4419 | <800 mg/kg |
| Phosphorus content | AS 4419 | <40 mg/kg |
| Organic content | AS 4419 | 3%-10%.
Where organic content is below this threshold, the filter media may be ameliorated by adding 50mm of compost and tining it into the top 150mm of filter media. |
| Particle size distribution | AS 1289.3.6.1 - 1995 | Clay & silt 3-6% (<0.05mm)
Very fine sand 5-30% (0.05-0.15mm)
Fine sand 10-30% (0.15-0.25mm)
Medium to coarse sand 40-60% (0.25 -1.0mm)
Coarse sand 7-10% (1.0-2.0mm)
Fine gravel <3% (2.0-3.4%) |

8.2. Testing frequency
Suitable filter media can be delivered to site or imported sand can be ameliorated to meet the above specification. In either case, the media shall be tested against the above parameters at one sample per 500m³ of filter media. For soil supplied to site, testing must be undertaken on the actual material to be delivered to the bioretention system. The supplier and contractor will be responsible for ensuring the filter media meets the specification and the correct material is delivered to site prior to installation.

- 9. Transition layer
- 9.1. Transition layers prevent filter media migrating into the drainage layer.
- 9.1.1. Materials

12. Permeable liner (where specified)
- 12.1. A permeable geotextile liner fabric must be used to line the outside of the bioretention system.
- 12.2. The liner must extend at least 500mm beyond the top of the sides and must be keyed into batter and covered by at least 200mm of topsoil.
- 12.3. The liner must be resistant to all soil acids and alkalis, resistant to microorganisms and comply with the requirements of AS 3706.12 and AS 3706.13.

- 14.0. Landscaping
- 14.0. Refer to landscape design drawings.
- 14.1. Batter slopes must have min 200mm topsoil which must be tested by a NATA-accredited laboratory in accordance with AS 4419.
- 14.2. Subsoils to be cultivated to 150mm prior to placing topsoil on batter slopes.
- 14.3. Planting densities and species must be consistent with the landscape design drawings. No substitutions should be made unless approved by the superintendent.
- 14.4. Plants supplied to site must:

15. Certification and chain of custody
15.1. The following certification and the chain of custody applies to bioretention media:
 - 15.1.1. The supplier and contractor are responsible for ensuring the bioretention media meets the specifications outlined in these guidelines and that the correct material is delivered to site. The supplier must arrange for testing of the filter media by a soil laboratory certified for the methods in accordance with the requirements listed above. On the basis of the testing, the soil laboratory and supplier must certify the material meets these specifications. The supplier must provide the certification and laboratory test results to the contractor with the supply docket.
 - 15.1.2. The contractor provides a copy of the supplier's certification, test results and supply docket to the site superintendent or bioretention designer for review.
 - 15.1.3. Following review of the certification, test results and the supply docket, the site superintendent or bioretention designer approves installation of the bioretention media.
 - 15.1.4. The relevant sections of the bioretention media sign-off form as per the construction and establishment guidelines (Water by Design) should be completed and signed. This sign-off form is provided as part of the construction certification by the site superintendent or bioretention designer.

17. Compliance testing (for on-maintenance or off-maintenance)
17.1. Compliance testing must be in accordance with chapter 5 of Transferring Ownership of Vegetated Stormwater Assets (Water by Design). Checklists must be completed and signed by the superintendent.



BIOME
WATER AND ENVIRONMENTAL CONSULTING

BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@biomeconsulting.com.au
ABN 86 166 087 476

[illegible]

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of as-built conditions for use only and are not for construction purposes.

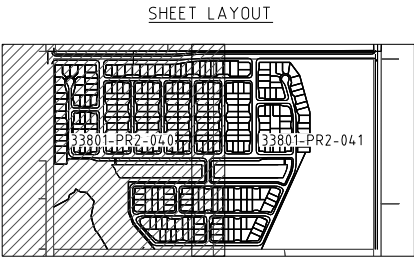
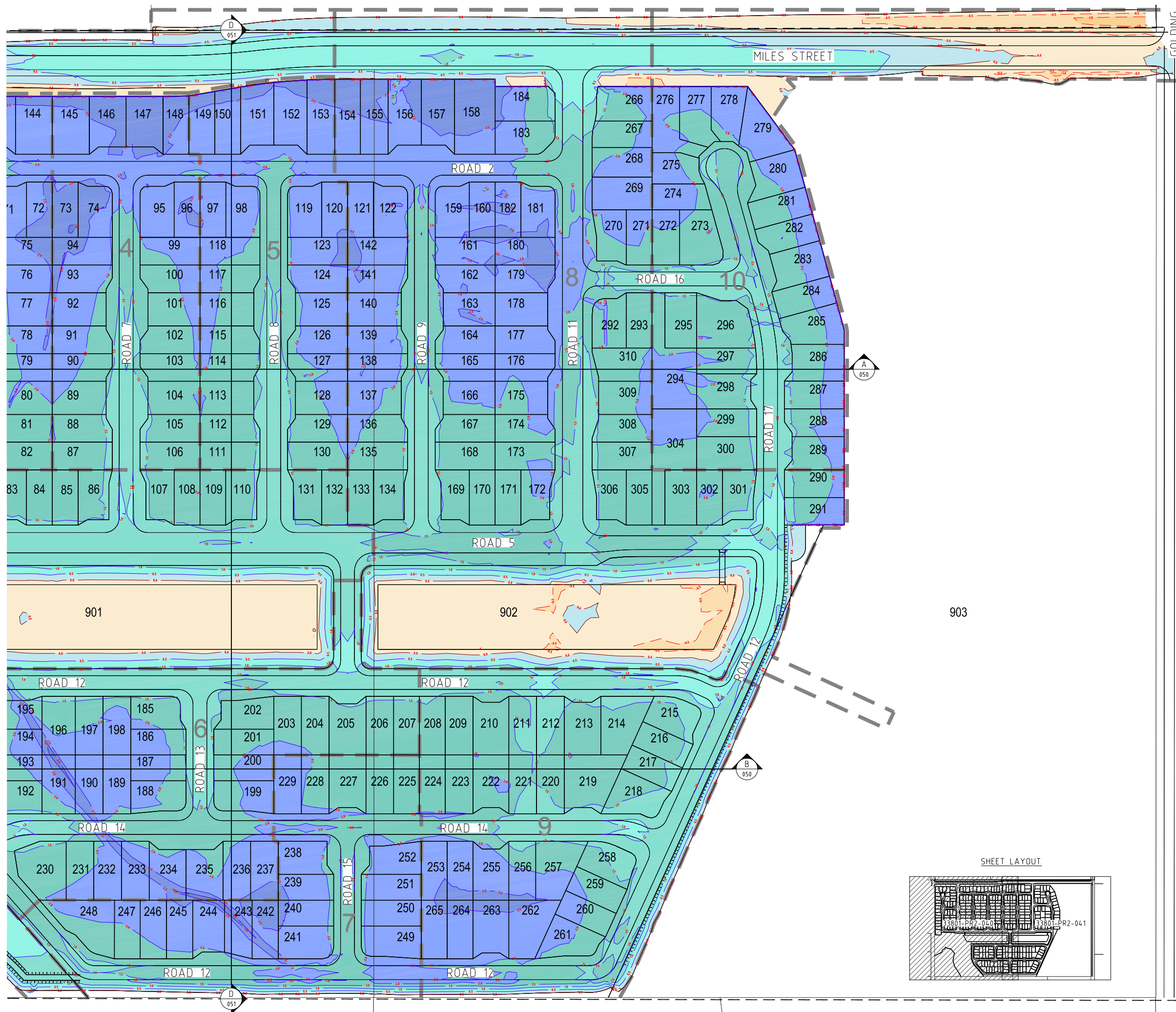
ORIGINAL SCALE BEFORE REDUCTION

CERTIFIED BY



Appendix B

Preliminary Civil Design Drawings - Mortons Urban Solutions



PROJECT NAME

YAMBA GARDENS

PRELIMINARY

RP DESCRIPTION
Lot 46 & 47 on DP751395,
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT

**KAHUNA NO. 1
PTY LTD**

0 10 20 30 40 50m
Scale 1:1000 - A1 (1:2000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	
CONSTRUCTION	

A	28-05-21	ISSUED FOR APPROVAL
PRE DATE		AMENDMENT

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND
WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION.
COPYRIGHT MORTONS URBAN SOLUTIONS 2000 .
DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS

BIOME
WATER AND ENVIRONMENTAL CONSULTING

DRAWING TITLE

**BULK EARTHWORKS
CUT AND FILL
PLAN
SHEET 02**

MORTONS
urbansolutions
Urban & Regional Planning
Civil Engineering
Project Coordination

MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN: 39 116 375 065
mortons@urbansolutions.net.au
www.urbansolutions.net.au
Tel: 07 55711 1099

Postal Address:
PO Box 2484
Southport QLD 4215

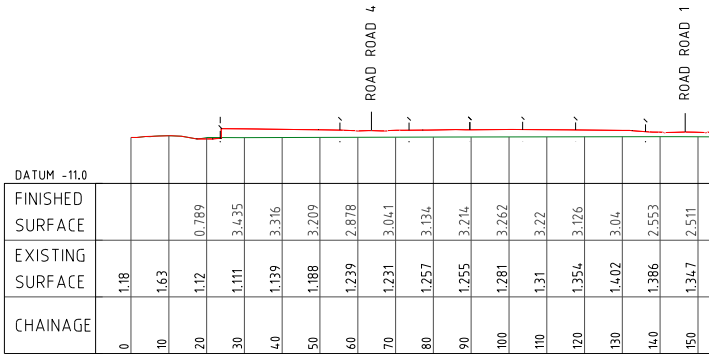
Gold Coast Office:
Suite 9, 19 Short St
Southport QLD 4215

DESIGNED PP	DRAWN SF
APPROVED	REQ 4706 DATE 28-05-21
DRAWING NUMBER 33801-PR2-041	AMEND. A



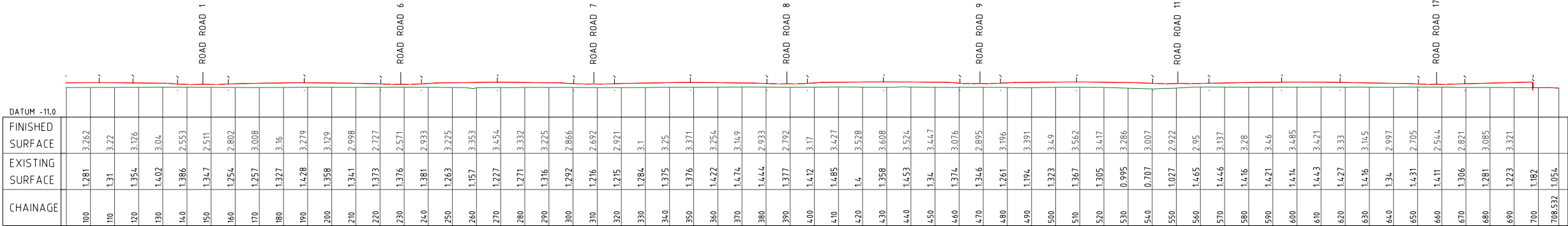
SECTION B

HORIZONTAL SCALE 1:1000 - A1 (1:2000 - A3)
VERTICAL SCALE 1:1000 - A1 (1:2000 - A3)



SECTION A (CONTINUED)

HORIZONTAL SCALE 1:1000 - A1 (1:2000 - A3)
VERTICAL SCALE 1:1000 - A1 (1:2000 - A3)

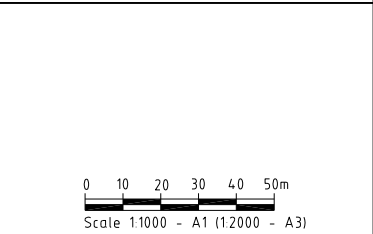


SECTION A

HORIZONTAL SCALE 1:1000 - A1 (1:2000 - A3)
VERTICAL SCALE 1:1000 - A1 (1:2000 - A3)

PROJECT NAME
YAMBA GARDENS
PRELIMINARY
RP DESCRIPTION
Lot 46 & 47 on DP751395,
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT
KAHUNA NO. 1 PTY LTD



ISSUES	DATE	
TENDER		
COUNCIL		
CONSTRUCTION	..	

A	28-05-21	COUNCIL ISSUE
PRE DATE		AMENDMENT

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION. COPYRIGHT MORTONS URBAN SOLUTIONS 2000 . DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS

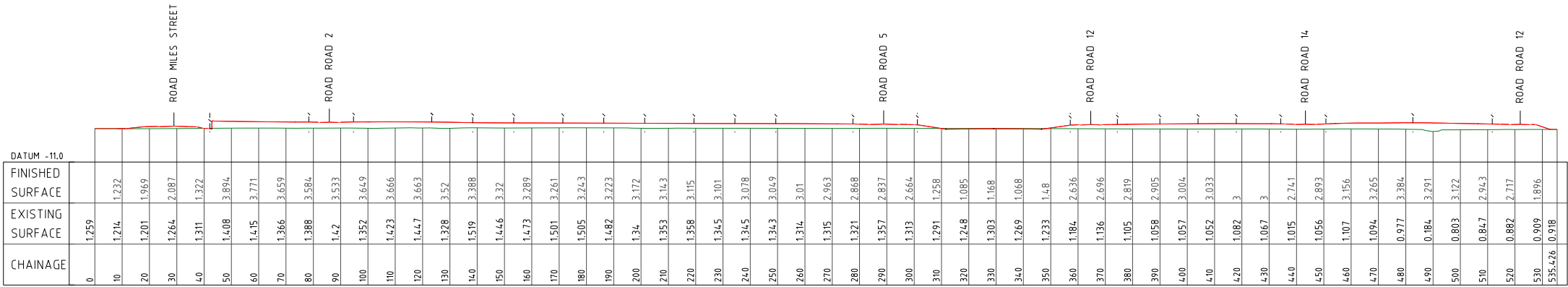


DRAWING TITLE

BULK EARTHWORKS SECTIONS SHEET 01

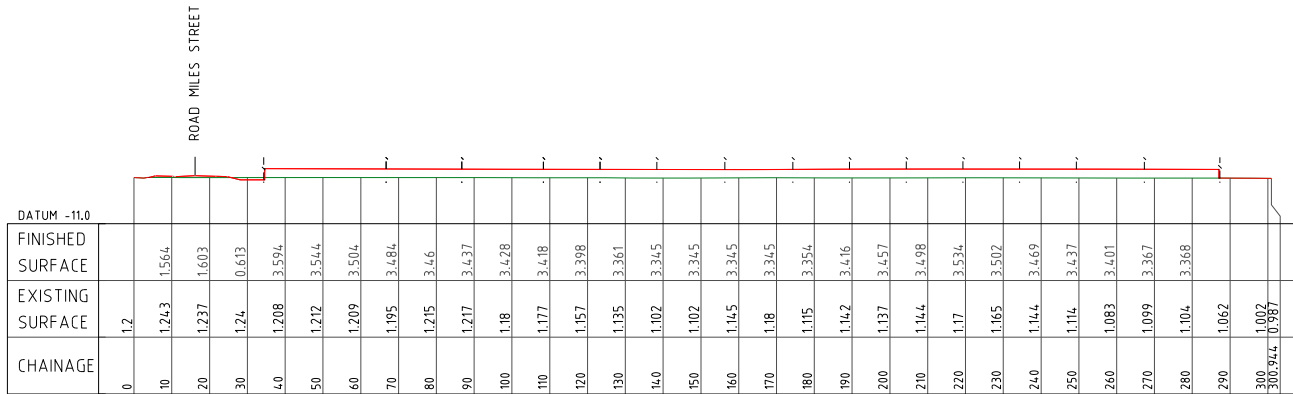
MORTONS
urbansolutions
Urban & Regional Planning
Civil Engineering
Project Coordination
MUS Pty Ltd T/As: Postal Address
Mortons-Urban Solutions PO Box 2484
ABN 39 116 375 065 Southport QLD 4215
mortons@urbansolutions.net.au
www.urbansolutions.net.au Gold Coast Office
Tel 07 55711 1099 Suite 9, 19 Short St
Southport QLD 4215

DESIGNED PP	DRAWN SF
APPROVED <i>Dr K. M.</i>	RPEQ 4706 DATE 28-05-21
DRAWING NUMBER 33801-PR2-050	AMEND. A



SECTION D

HORIZONTAL SCALE 1:1000 - A1 (1:2000 - A3)
VERTICAL SCALE 1:1000 - A1 (1:2000 - A3)

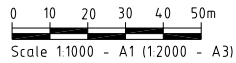


SECTION C

HORIZONTAL SCALE 1:1000 - A1 (1:2000 - A3)
VERTICAL SCALE 1:1000 - A1 (1:2000 - A3)

PROJECT NAME
YAMBA GARDENS
PRELIMINARY
RP DESCRIPTION
Lot 46 & 47 on DP751395,
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT
KAHUNA NO. 1 PTY LTD



ISSUES	DATE	
TENDER		
COUNCIL		
CONSTRUCTION	..	

A	28-05-21	COUNCIL ISSUE
PRE DATE		AMENDMENT

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION. COPYRIGHT MORTONS URBAN SOLUTIONS 2000 . DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS

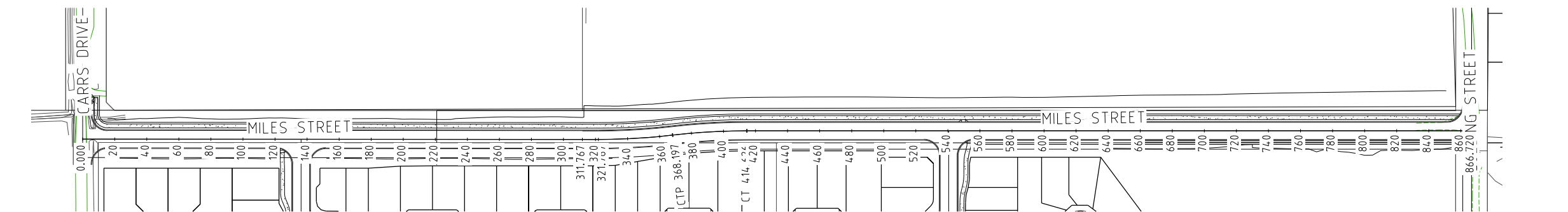


DRAWING TITLE

BULK EARTHWORKS SECTIONS SHEET 02

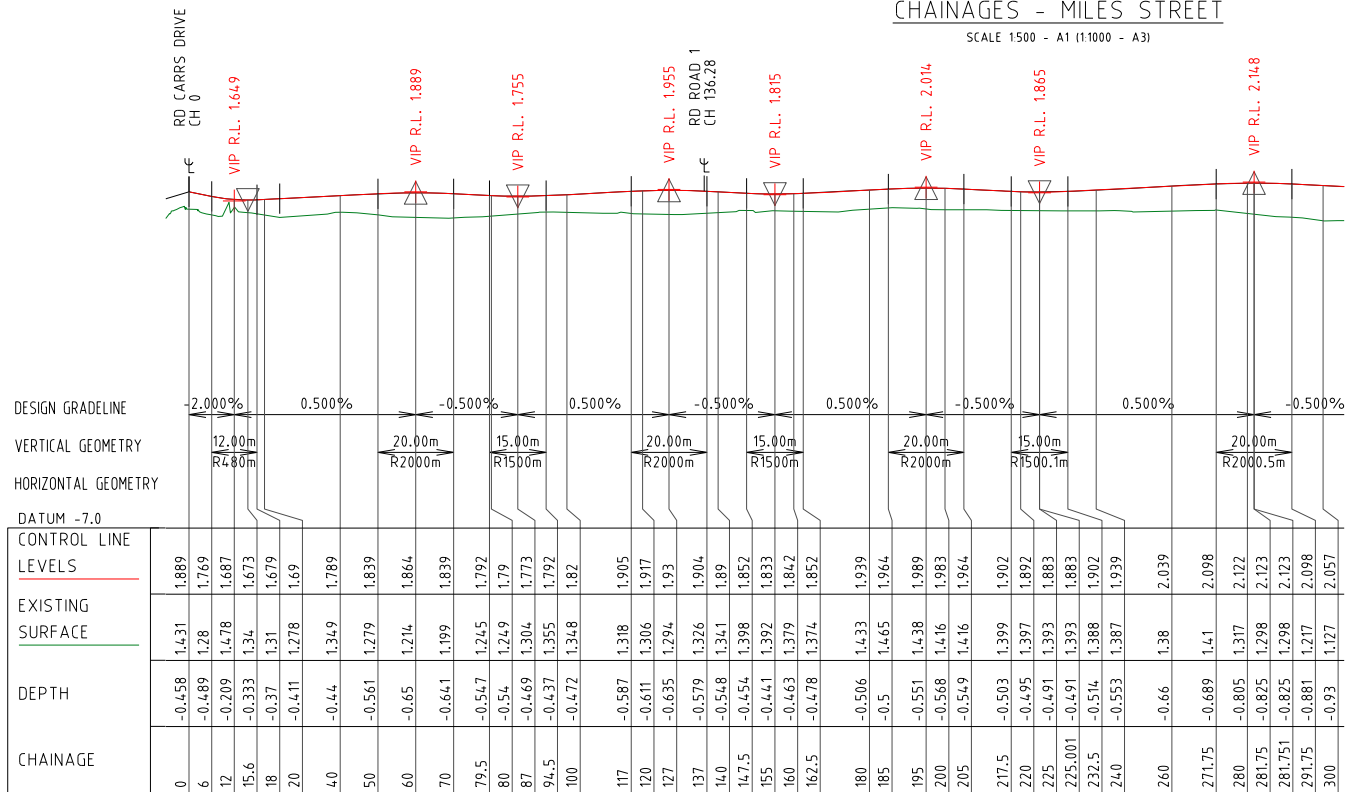
MORTONS
urbansolutions
Urban & Regional Planning
Civil Engineering
Project Coordination
MUS Pty Ltd T/As: Mortons-Urban Solutions
ABN: 39 116 375 065
mortons@urbansolutions.net.au
www.urbansolutions.net.au
Tel 07 55711 1099
Postal Address
PO Box 2484
Southport QLD 4215
Gold Coast Office
Suite 9, 19 Short St
Southport QLD 4215

DESIGNED PP	DRAWN SF	
APPROVED <i>[Signature]</i>	RPE4 4706	DATE 28-05-21
DRAWING NUMBER 33801-PR2-051	AMEND. A	



CHAINAGES - MILES STREET

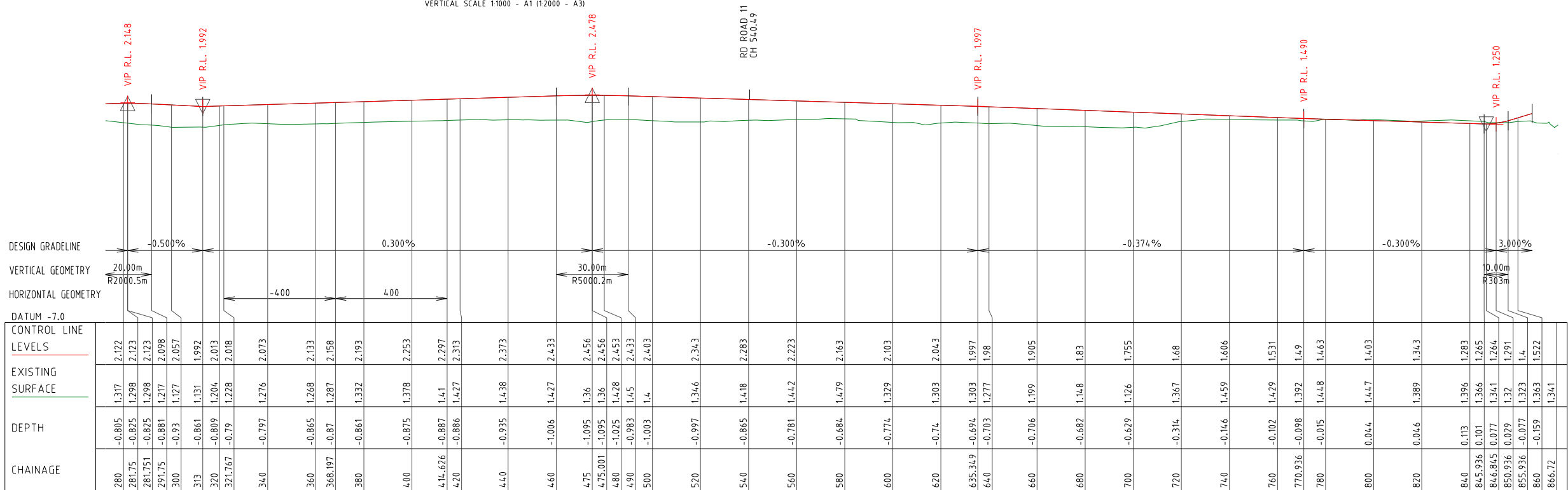
SCALE 1:500 - A1 (1:1000 - A3)



LONGITUDINAL SECTION MILES STREET (CONTINUED)

HORIZONTAL SCALE 1:1000 - A1 (1:2000 - A3)

VERTICAL SCALE 1:1000 - A1 (1:2000 - A3)



LONGITUDINAL SECTION MILES STREET

HORIZONTAL SCALE 1:1000 - A1 (1:2000 - A3)

VERTICAL SCALE 1:1000 - A1 (1:2000 - A3)

PROJECT NAME

YAMBA GARDENS

PRELIMINARY

RP DESCRIPTION

Lot 46 & 47 on DP751395,
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT

**KAHUNA NO. 1
PTY LTD**

0 5 10 15 20 25m

Scale 1:500 - A1 (1:1000 - A3)

0 10 20 30 40 50m

Scale 1:1000 - A1 (1:2000 - A3)

ISSUES	DATE	
TENDER		
COUNCIL		
CONSTRUCTION	..	

A	28-05-21	COUNCIL ISSUE
PRE DATE		AMENDMENT

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND
WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION.
COPYRIGHT MORTONS URBAN SOLUTIONS 2000 .
DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS



DRAWING TITLE

**LONGITUDINAL
SECTION
MILES STREET**



MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN: 39 116 375 065
mortons@urbansolutions.net.au
www.urbansolutions.net.au
Tel 07 5571 1099

Postal Address
PO Box 2484
Southport QLD 4215

Gold Coast Office
Suite 9, 19 Short St
Southport QLD 4215

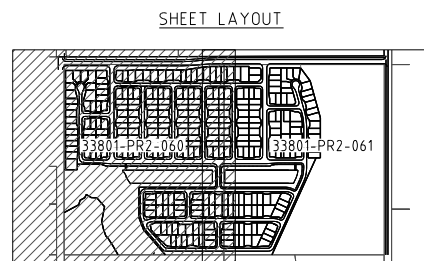
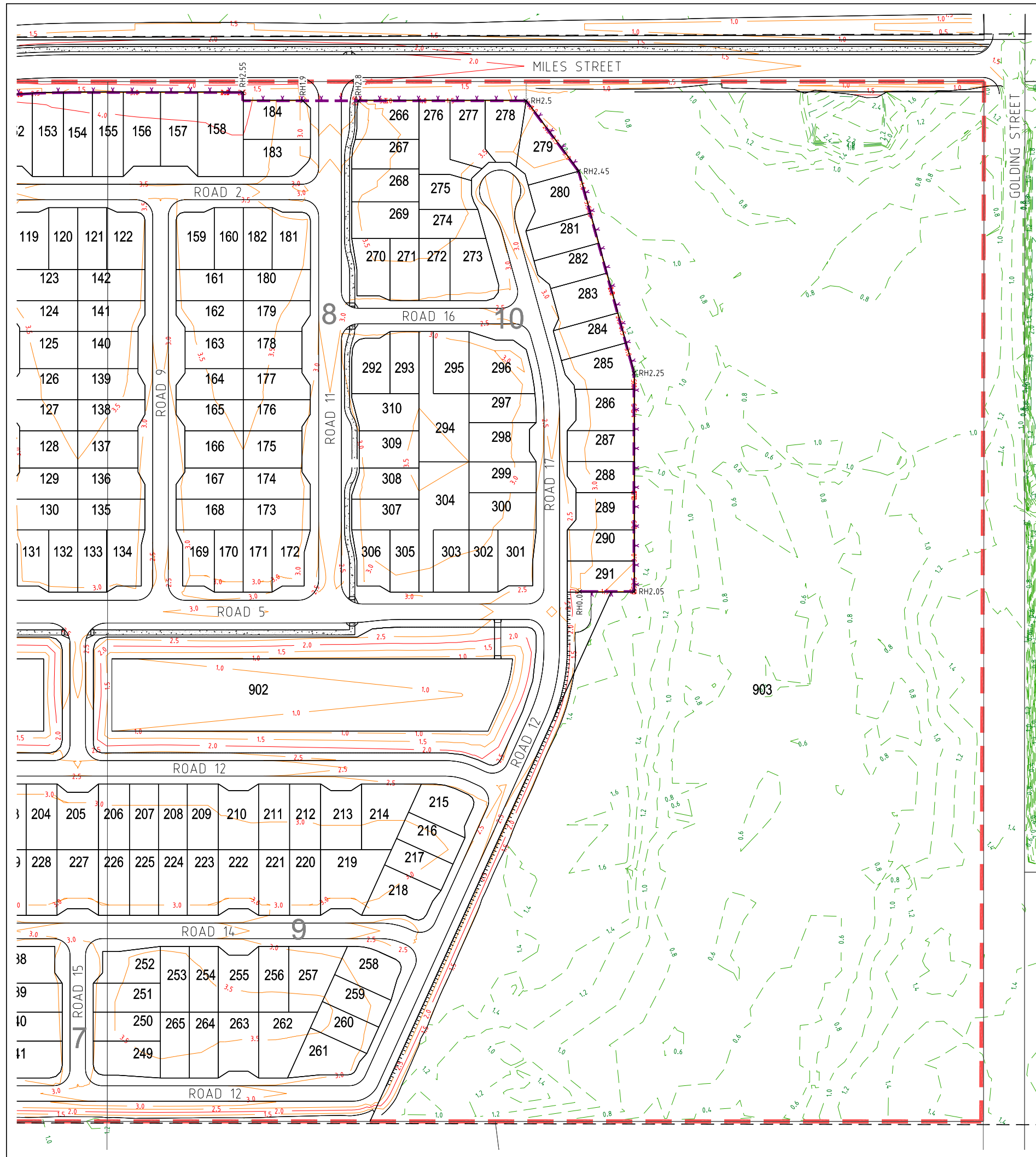
DESIGNED PP	DRAWN SF
APPROVED <i>[Signature]</i>	RPE 4706 DATE 28-05-21

DRAWING NUMBER

33801-PR2-052

AMEND.

A



PROJECT NAME

YAMBA GARDENS

PRELIMINARY

RP DESCRIPTION

Lot 46 & 47 on DP751395,
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT

KAHUNA NO. 1 PTY LTD



0 5 10 15 20 25m

Scale 1:500 - A1 (1:1000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	****/****/****
CONSTRUCTION	

A	28-05-21	ISSUED FOR APPROVAL
PRE DATE		AMENDMENT

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION.
 COPYRIGHT MORTONS URBAN SOLUTIONS 2000 .
 DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS



DRAWING TITLE

GRADING AND
 RETAINING WALL PLAN
 SHEET 02

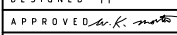


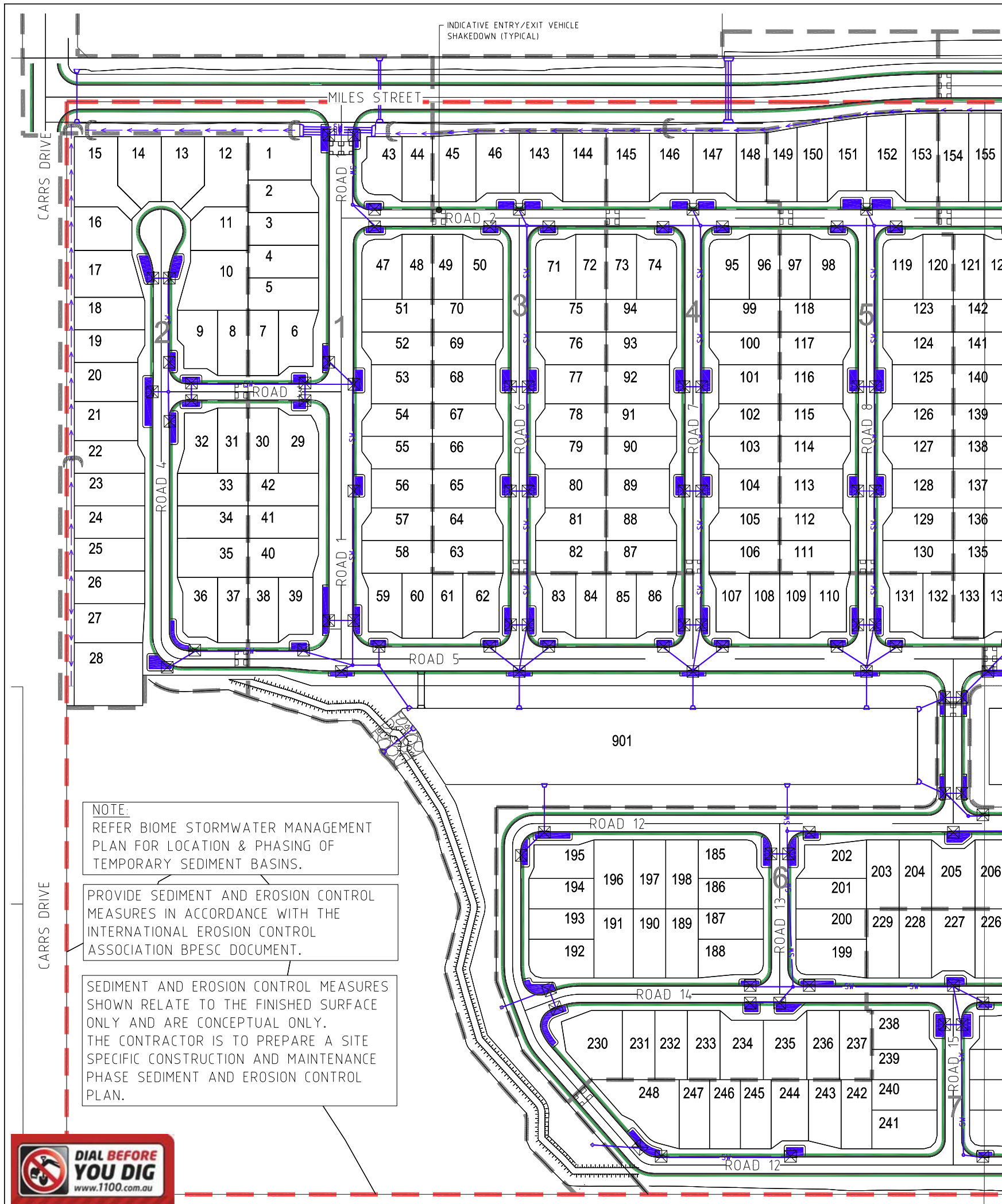
Urban & Regional Planning
 Civil Engineering
 Project Coordination

MUS Pty Ltd T/As:
 Mortons-Urban Solutions
 ABN: 39 116 375 065
 mortons@urbansolutions.net.au
 www.urbansolutions.net.au
 Tel: 07 5571 1099

Postal Address
 PO Box 2484
 Southport QLD 4215

 Gold Coast Office
 Suite 9, 19 Short St
 Southport QLD 4215

DESIGNED PP	DRAWN SF
APPROVED 	REQ 4706 DATE 28-05-21
DRAWING NUMBER	AMEND.
33801-PR2-061	A



SEDIMENT AND EROSION

- THE EROSION & SEDIMENT CONTROL DEVICES SHOWN ON THESE DRAWINGS ARE INDICATIVE & PROVIDED FOR SUBMISSION TO LOCAL AUTHORITY ONLY. NOTWITHSTANDING THE EROSION & CONTROL DEVICES SHOWN ON THESE DRAWINGS, THE CONTRACTOR MUST PREPARE & FOLLOW A SITE SPECIFIC EROSION & SEDIMENT CONTROL PLAN TO MEET ALL LOCAL & STATE GOVERNMENT LEGISLATION INCLUDING BUT NOT LIMITED TO:
 - ENVIRONMENTAL PROTECTION ACT WITH SPECIFIC REFERENCE TO PARTS S440G & S319
 - STATE PLANNING POLICYPREScribed WATER CONTAMINANTS (AS DEFINED IN THE ENVIRONMENTAL PROTECTION ACT 1994) MUST NOT BE RELEASED FROM THE SITE OR TO WATERS WITHIN THE SITE, OR BE LIKELY TO BE RELEASED SHOULD RAINFALL OCCUR, UNLESS ALL REASONABLE & PRACTICABLE MEASURES ARE TAKEN TO PREVENT OR MINIMISE THE RELEASE & CONCENTRATION OF CONTAMINATION. THE ESC PLAN MUST BE DESIGNED, IMPLEMENTED & MAINTAINED IN ACCORDANCE WITH "BEST PRACTICE EROSION & SEDIMENT CONTROL" PUBLISHED BY THE INTERNATIONAL EROSION CONTROL ASSOCIATION (AUSTRALASIAN CHAPTER) (IECA, 2008).
- TO COMPLY WITH THE REQUIREMENTS OF THE EP ACT & BEST PRACTICE DESIGN, THE SEDIMENT BASINS ON THE SITE MUST BE DESIGNED & IMPLEMENTED TO ACHIEVE THE FOLLOWING:

SEDIMENT BASINS ARE TO BE DESIGNED, IMPLEMENTED & MAINTAINED TO A STANDARD WHICH WOULD ACHIEVE AT LEAST 80% OF THE AVERAGE ANNUAL RUNOFF VOLUME OF THE CONTRIBUTING CATCHMENT TREATED (I.E. 80% HYDROLOGIC EFFECTIVENESS) TO 50MG/L TSS OR LESS & PH IN THE RANGE 6.5-8.5

THIS WILL REQUIRE THE INSTALLATION & OPERATION OF A HIGH-EFFICIENCY SEDIMENT BASIN(S) DESIGNED IN ACCORDANCE WITH THE SPECIFICATIONS CONTAINED IN THE "BEST PRACTICE EROSION & SEDIMENT CONTROL - APPENDIX B SEDIMENT BASIN DESIGN & OPERATION" PUBLISHED BY THE INTERNATIONAL EROSION CONTROL ASSOCIATION (AUSTRALASIAN CHAPTER) (IECA, 2016, DRAFT)
- THE EROSION & SEDIMENT CONTROL PLAN MUST BE PREPARED & CERTIFIED BY A CERTIFIED PROFESSIONAL IN EROSION & SEDIMENT CONTROL & FOLLOW THE REQUIREMENTS OUTLINED IN IECA'S BEST PRACTICE EROSION & SEDIMENT CONTROL DOCUMENT & THE QUEENSLAND URBAN DRAINAGE MANUAL.
- PRIOR TO THE COMMENCEMENT OF WORKS ONSITE THE CONTRACTOR MUST MAKE THEMSELVES AWARE OF ALL PREVIOUS GEOTECHNICAL REPORTS & DETERMINE THE DISPERSIVE CHARACTERISTICS OF THE SOIL (INCLUDING PERFORMING ANY SOIL TESTS IF REQUIRED). THE RESULTS OF THIS REVIEW & ANY TESTS MUST BE INCLUDED IN THE CONTRACTOR'S EROSION & SEDIMENT CONTROL PLAN. A COPY OF ALL TEST RESULTS MUST BE PROVIDED TO THE SUPERINTENDENT.
- THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO CONTROL EROSION & DOWNSTREAM SEDIMENTATION DURING ALL STAGES OF CONSTRUCTION (INCLUDING THE MAINTENANCE PERIOD). NOTWITHSTANDING THE CONTROL MEASURES OR FINISHED EARTHWORKS DESIGN SHOWN ON THESE DRAWINGS, THE CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING ADDITIONAL OR ALTERNATIVE EROSION & SEDIMENT CONTROL MEASURES TO MINIMISE SEDIMENT ACROSS OR LEAVING THE SITE.
- AT ALL TIMES THE CONTRACTOR SHALL MONITOR THE PREVAILING WEATHER CONDITIONS (INCLUDING WEEKENDS & PUBLIC HOLIDAYS) & AT ALL TIMES REMAINS RESPONSIBLE TO:
 - CLEAN & REPAIR CONTROL DEVICES WHENEVER THE ACCUMULATED SEDIMENT REDUCES THEIR CAPACITY BY 50%.
 - MAINTAIN POSITIVE GRADES OF ALL PERIMETER BANKS & SWALES TO AN OUTLET.
 - PROTECT ANY DOWNSTREAM CONSTRUCTION.
 - CONTROLLING DUST.
 - MEASURES HAVE BEEN INSTALLED IN ACCORDANCE WITH DETAILS OUTLINED IN THEIR EROSION & SEDIMENT CONTROL PLAN & AS DIRECTED BY THE SUPERINTENDENT.
- THE CONTRACTOR'S PLAN SHALL ALLOW FOR SUITABLE ACCESS TO ALLOW MAINTENANCE OF ALL SEDIMENT CONTROL DEVICES. NO ADDITIONAL VEGETATION CLEARING IS PERMITTED FOR GAINING ACCESS UNLESS APPROVED BY THE SUPERINTENDENT.
- THE CONTRACTOR MAY REQUEST APPROVAL FROM THE SUPERINTENDENT TO REUSE THE STOCKPILED MULCH FOR STABILISING BATTERS ONLY IN LOCATIONS WHERE THE APPROVED LANDSCAPE OPW DESIGN REQUIRES MULCH ULTIMATELY.
- CONSTRUCTION STOCKPILING:
 - TOPSOIL SHALL BE STRIPPED & STOCKPILED IN LOCATIONS NOMINATED ON THE CONSTRUCTION DRAWINGS OR IN LOCATIONS AGREED WITH THE SUPERINTENDENT.
 - ADDITIONAL VEGETATION CLEARING IS NOT PERMITTED TO FACILITATE THE STOCKPILING OF MATERIALS UNLESS SHOWN ON THE APPROVED VEGETATION MANAGEMENT PLAN.
 - ANY STOCKPILE SITE MUST BE CLEAR OF ADJACENT PROPERTY BOUNDARIES SO AS NOT TO CAUSE A NUISANCE TO ADJOINING PROPERTIES.
 - NO STOCKPILES ARE TO BE LOCATED WITHIN THE TREE PROTECTION ZONE OF VEGETATION.
 - A TEMPORARY SILT FENCE IS TO BE ERRECTED APPROXIMATELY 5m FROM TOE OF BATTER ON LOW SIDE OF STOCKPILING.
- NOTWITHSTANDING THE DETAILS SHOWN IN THE CONTRACTOR'S EROSION & SEDIMENT CONTROL PLAN, DURING CONSTRUCTION THE CONTRACTOR MUST:
 - SIZE ALL TEMPORARY SEDIMENT BASINS APPROPRIATELY TO TREAT THE UPSTREAM CATCHMENT. NOTE THAT THE PERMANENT BIO BASINS SHOWN ON THESE DRAWINGS ARE SIZED FOR THE ULTIMATE CATCHMENT NOT FOR THE CONSTRUCTION PHASE.
 - PLACE A ROCK BUND AROUND ALL HEADWALLS DURING CONSTRUCTION.
 - PROVIDE KERB INLET PROTECTION TO ALL GULLIES.
 - PLACE A MINIMUM 1.0m WIDE TURF STRIP BEHIND ALL KERBS & IN A HERRINGBONE LAYOUT WITHIN THE ROAD VERGE.
 - MAINTENANCE (INCLUDING FLOCCULATION IF REQUIRED & PUMP OUT) OF ALL CONSTRUCTION SEDIMENT BASINS (WHETHER EXISTING OR NEW).
 - CLEAN OUT OF ALL GROSS POLLUTANT TRAPS, SEDIMENT FOREBAYS & ALL OTHER PERMANENT SEDIMENT CONTROL DEVICES AT BOTH ON & OFF MAINTENANCE.
- CONTRACTOR TO CONFIRM THE EXTENTS OF REQUIRED GRASSING TREATMENTS WITH THE SUPERINTENDENT AT LEAST 7 DAYS PRIOR TO FINAL TRIMMING.
- THE CONTRACTOR IS RESPONSIBLE FOR ENSURING THAT GRASSING STRIKE RATES ARE ACHIEVED AT THE ON & OFF MAINTENANCE INSPECTIONS IN ACCORDANCE WITH COUNCIL REQUIREMENTS. THIS INCLUDES THE SUPPLY & INSTALLATION OF ANY REQUIRED CHEMICAL/FERTILISER AMELIORATION TO ACHIEVE THE SPECIFIED GRASS STRIKE RATES.
- GEOTEXTILE LINING OF CHANNELS & CHECK DAMS MAY BE REQUIRED SUBJECT TO THE SITE CONDITIONS. BATTERS WITHIN PUBLIC OPEN SPACE TO BE VEGETATED IN ACCORDANCE WITH APPROVED OPEN SPACE MANAGEMENT PLAN & LANDSCAPING OPW. CONTRACT DOCUMENTATION WILL SPECIFY WHETHER THIS IS THE CIVIL CONTRACTOR OR THE LANDSCAPE CONTRACTOR'S RESPONSIBILITY TO SUPPLY & INSTALL. THE CIVIL CONTRACTOR IS RESPONSIBLE FOR PROVIDING SUITABLE ACCESS FOR THE LANDSCAPE CONTRACTOR TO PERFORM THEIR WORKS.
- MAINTENANCE PERIOD (PRE TO POST CONSTRUCTION)
 - ALL PROTECTION MEASURES ARE TO BE INSPECTED & MAINTAINED REGULARLY
 - REPAIRS ARE TO BE EFFECTED IMMEDIATELY.
 - SILT AFTER RAIN IS TO BE CLEANED FROM STREETS & ALLOTMENTS IMMEDIATELY & CORRECTIVE ACTION TAKEN TO AVOID A RE-OCCURRENCE.
 - AT OFF-MAINTENANCE & ONLY WHEN DIRECTED BY COUNCIL, REMOVE & DISPOSE OFFSITE ALL TEMPORARY EROSION & SEDIMENT CONTROL DEVICES.

LEGEND

- 1.0 — EXISTING CONTOURS
- — SITE BOUNDARY
- — STAGE BOUNDARY
- — PROPOSED PROPERTY LINE
- SW — PROPOSED STORMWATER
- 1.0 — DESIGN CONTOURS
- — TURF STRIP
- ☒ STORMWATER INLET FILTER
- — ROCK CHECK DAM
- ☒ VEHICLE SHAKEDOWN (AT ALL SITE ENTRANCES MIN.)

PROJECT NAME

YAMBA GARDENS

PRELIMINARY

RP DESCRIPTION

Lot 46 & 47 on DP751395,
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT

KAHUNA NO. 1 PTY LTD



0 10 20 30 40 50m
Scale 1:1000 - A1 (1:2000 - A3)

ISSUES	DATE
TENDER	
COUNCIL	
CONSTRUCTION	

A	28-05-21	ISSUED FOR APPROVAL
PRE	DATE	AMENDMENT

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION. COPYRIGHT MORTONS URBAN SOLUTIONS 2000 . DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS



DRAWING TITLE

FINAL SURFACE AND SEDIMENT AND EROSION PLAN SHEET 01



MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN 39 116 375 065
mortons@urbansolutions.net.au
www.urbansolutions.net.au
Tel 07 5571 1099

Postal Address
PO Box 2484
Southport QLD 4215

Gold Coast Office
Suite 9, 19 Short St
Southport QLD 4215

DESIGNED PP	DRAWN SF
APPROVED <i>[Signature]</i>	REQ 4706 DATE 28-05-21

DRAWING NUMBER

33801-PR2-080

AMEND.

A



STORMWATER

- ALL FIELD GULLIES SHALL CONTAIN A 150mm DIA STUB 600mm BELOW GRADE LEVEL FOR FUTURE ROOFWATER DRAINAGE.
- MANHOLES TO BE IN ACCORDANCE WITH IPWEAQ STANDARD DRAWING No DS-010, DS-015, DS-018, DS-019, DS-020, DS-021 OR STRUCTURAL DRAWINGS (STRUCTURAL DRAWINGS TAKE PRECEDENCE).
- OUTLET HEADWALLS TO BE IN ACCORDANCE WITH LOCAL COUNCIL STANDARD DRAWINGS.
- ALL HEADWALLS WITH A FALL GREATER THAN 900mm HIGH REQUIRE INSTALLATION OF PEDESTRIAN SAFETY FENCES.
- PIPE JOINT TYPES TO BE IN ACCORDANCE WITH LOCAL AUTHORITY REQUIREMENTS.
- ALL ALLOTMENTS TO BE GRADED SUCH THAT FUTURE ROOFWATER DRAINAGE DISCHARGES TO KERB OR TO PIPED DRAINAGE SYSTEM.
- ALL PIPE 300mm DIA & GREATER SHALL BE CONSTRUCTED USING SRC OR FRC PIPES. CONTRACTOR MAY ELECT TO USE PVC PIPES WITHIN ALLOTMENTS FOR PIPES SMALLER THAN 300mm DIA.
- FOR SETOUT DETAILS REFER TO 640 SERIES DRAWINGS (PROFILES & PIT DETAILS).
- GULLY PITS TO BE IN ACCORDANCE WITH IPWEAQ STANDARD DRAWING No DS-060, DS-061, DS-062, DS-063. WHERE PITS ARE CONSTRUCTED AS DRAINWAY PITS, TO BE IN ACCORDANCE WITH IPWEAQ STANDARD DRAWINGS No 05-068.
- LOTS WHICH CAN DRAIN OVERLAND FLOW TO THE STREET SWALE / DRAINAGE WITHOUT FLOWING THROUGH ADJOINING PROPERTIES NEED TO PROVIDE FOR Q100 OVERLAND FLOW TO THE ROAD.
- LOT EARTHWORKS DURING BUILDING CONSTRUCTION MUST NOT CHANGE FLOW PATH DIRECTION UNLESS IT IS REPLACED WITH ANOTHER FLOW PATH DRAINING TO THE ROAD SWALE / DRAINAGE.
- THE CONTRACTOR IS TO INCLUDE ROCK EXCAVATION AS PART OF THEIR STORMWATER RATE.
- PIPE CLASS - PIPE CLASSES/TRENCH BEDDING SHOWN ON THE DRAWINGS ARE SUBJECT TO THE CONTRACTORS PREFERRED INSTALLATION METHOD. THE CONTRACTOR IS RESPONSIBLE FOR INSTALLING THE APPROPRIATE PIPE CLASSES & BEDDING, & CONSIDERING CONSTRUCTION LOADING.
- KERB ADAPTORS ARE TO BE INSTALLED TO AUTHORITIES REQUIREMENTS.
- ALL RBCB SLABS ARE TO BE CAST INSITU.

LEGEND

	EXISTING KERB (INVERT)		MANHOLE
	EXISTING KERB (LIP & BACK)		FIELD INLET
	EXISTING PROPERTY LINE		KERB INLET (ON GRADE) PIT
	EXISTING RETAINING WALL		KERB INLET (SAG) PIT
	EXISTING STORMWATER		HEADWALL
	EXISTING ROOFWATER		SCOUR PROTECTION
	EXISTING SUBSOIL		
	EXISTING CONTOURS		
	FUTURE KERB		
	FUTURE PROPERTY LINE		
	FUTURE RETAINING WALL		
	FUTURE STORMWATER		
	FUTURE ROOFWATER		
	FUTURE SUBSOIL		
	SITE BOUNDARY		
	STAGE BOUNDARY		
	CONTROL LINE / CENTER OF ROAD		
	PROPOSED KERB (INVERT)		
	PROPOSED KERB (LIP & BACK)		
	PROPOSED PROPERTY LINE		
	PROPOSED RETAINING WALL		
	DESIGN CONTOURS		
	PROPOSED STORMWATER		
	PROPOSED ROOFWATER		
	PROPOSED SWALE		
	PROPOSED SUBSOIL		

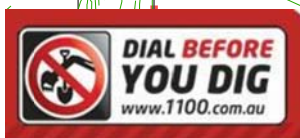
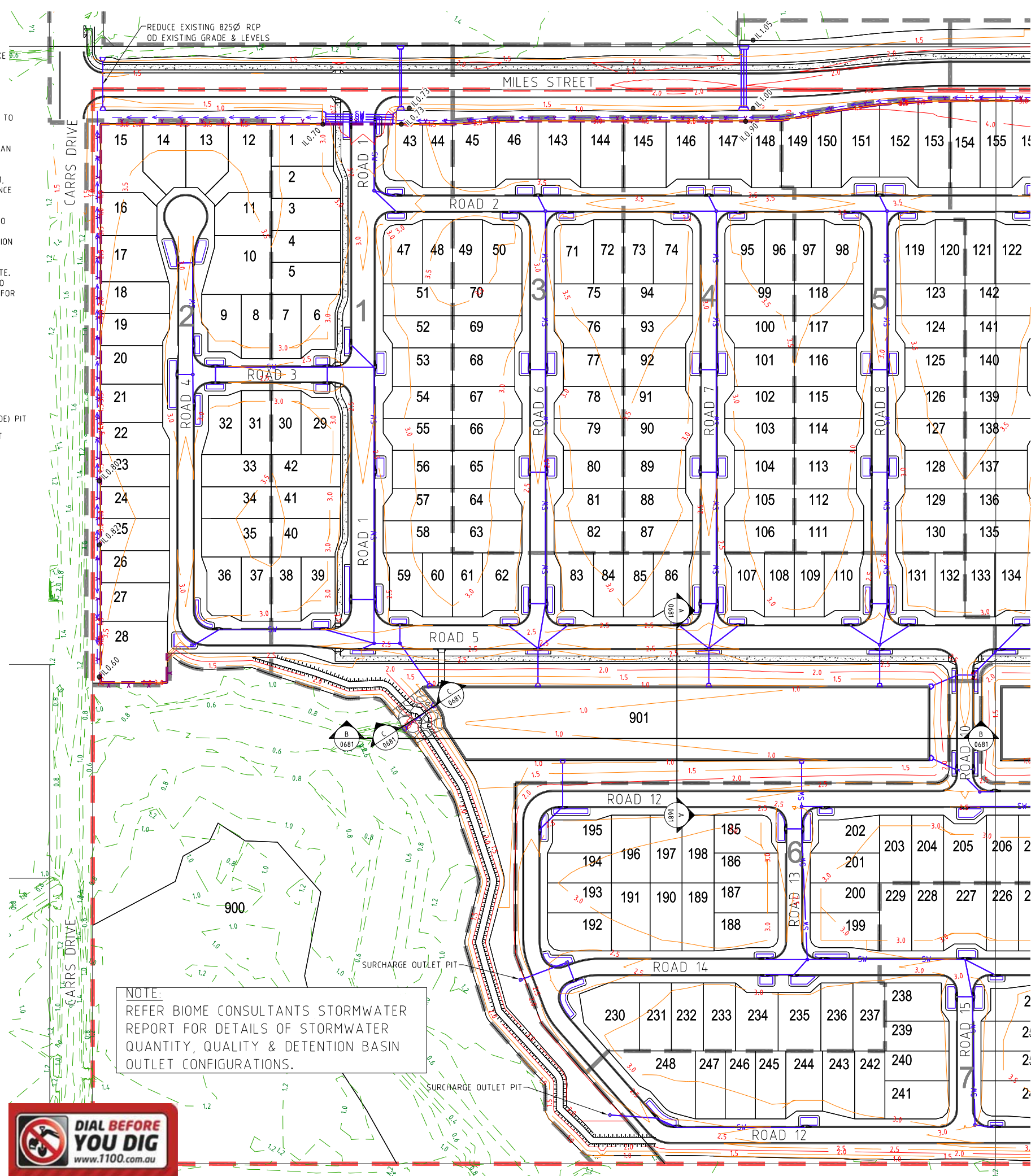
NOTE:

- PRELIMINARY SERVICE LAYOUTS ARE SUBJECT TO CHANGE DURING DETAILED DESIGN AT CONSTRUCTION CERTIFICATE STAGE.
- EXTENSION TO SERVICE ADJACENT DEVELOPMENT SITES BY OTHERS.

REFERENCE POINT LOCATION FOR DRAINAGE STRUCTURES

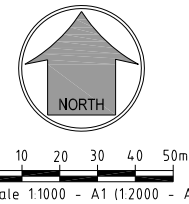
STRUCTURE TYPE	HORIZONTAL CONTROL (Reference Point Location)	VERTICAL CONTROL (Reference Level)
MANHOLE / GRATED PIT	 CENTRE OF MANHOLE / PIT	FINISHED SURFACE LEVEL
GULLY PIT	 LIP AT CENTRE OF PIT	FINISHED SURFACE LEVEL (LIP OF CHANNEL)
HEADWALL	 INTERSECTION OF HEADWALL FACE & PIPE CENTRELINE	INVERT LEVEL

REFER TO DWG SERIES 640 FOR ALL DRAINAGE STRUCTURE SETOUT AND/OR CUSTOM DETAILS.



PROJECT NAME
YAMBA GARDENS
PRELIMINARY
RP DESCRIPTION
Lot 46 & 47 on DP751395,
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT
KAHUNA NO. 1 PTY LTD



ISSUES	DATE
TENDER	
COUNCIL	
CONSTRUCTION	

A	28-05-21	ISSUED FOR APPROVAL
PRE DATE		AMENDMENT
COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION. COPYRIGHT MORTONS URBAN SOLUTIONS 2000 . DO NOT SCALE FROM THIS DRAWING.		

ASSOCIATED CONSULTANTS
BIOME
WATER AND ENVIRONMENTAL CONSULTING

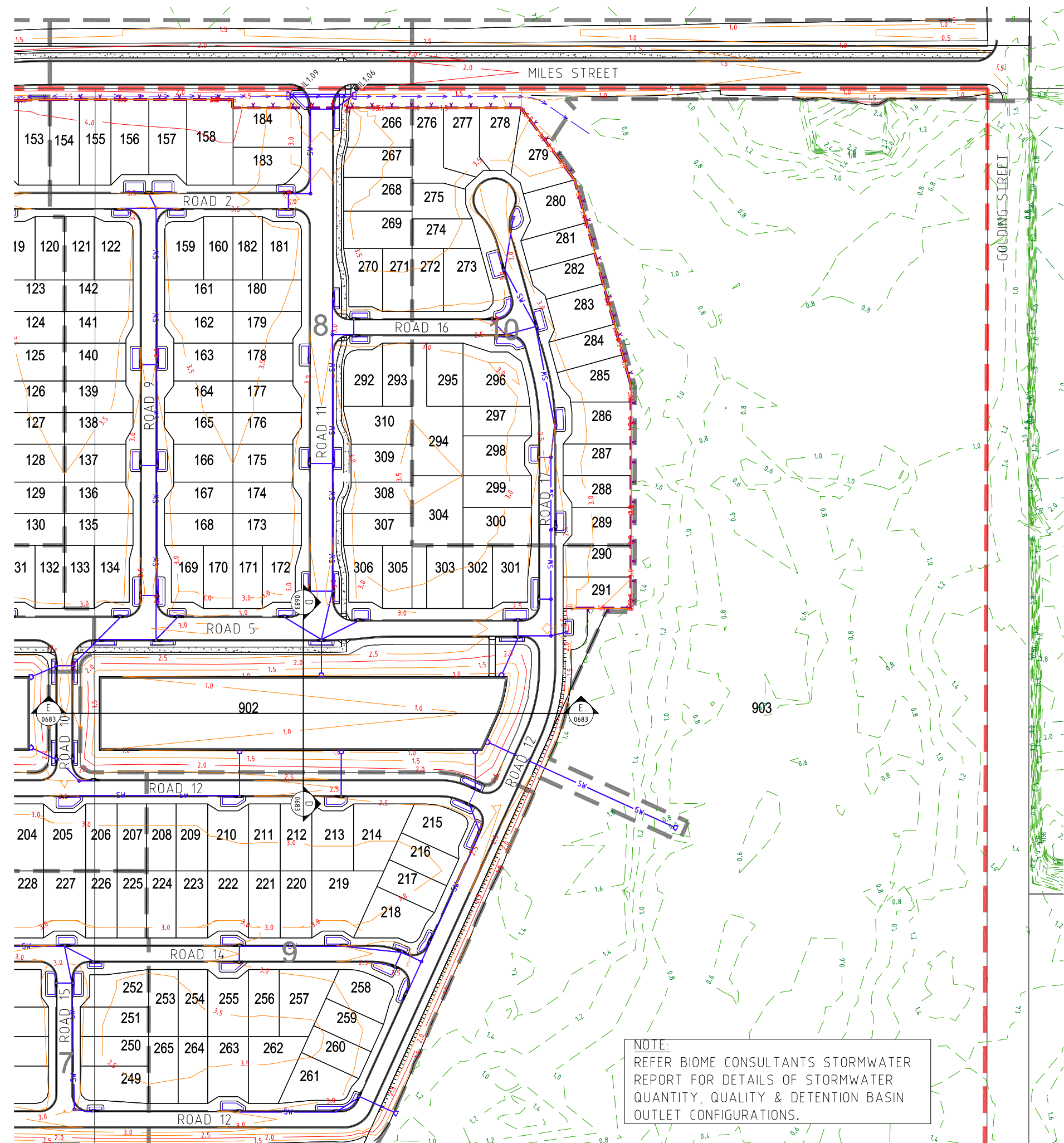
DRAWING TITLE

STORMWATER DRAINAGE PLAN
SHEET 01

PRELIMINARY ISSUE

MORTONS
urbansolutions
Urban & Regional Planning
Civil Engineering
Project Coordination
MUS Pty Ltd T/As:
Mortons-Urban Solutions
ABN: 39 116 375 065
mortons@urbansolutions.net.au
www.urbansolutions.net.au
Tel: 07 5571 1099
Postal Address:
PO Box 2484
Southport QLD 4215
Gold Coast Office
Suite 9, 19 Short St
Southport QLD 4215

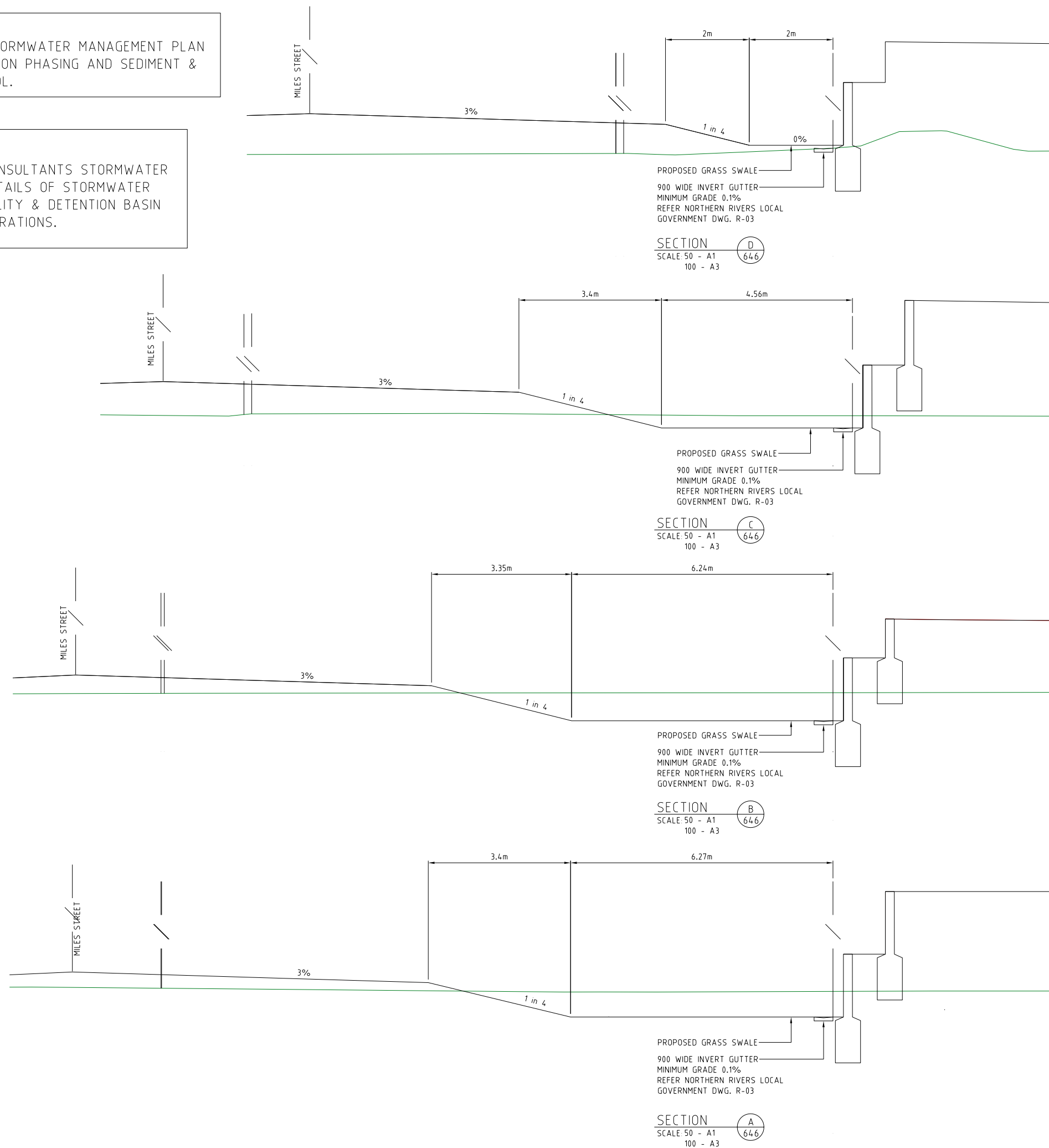
DESIGNED PP	DRAWN SF
APPROVED	REP 4706 DATE 28-05-21
DRAWING NUMBER 33801-PR2-600	AMEND. A



28-05-21

AMEND.
A

NOTE:
REFER BIOME CONSULTANTS STORMWATER
REPORT FOR DETAILS OF STORMWATER
QUANTITY, QUALITY & DETENTION BASIN
OUTLET CONFIGURATIONS.



PROJECT NAME

**YAMBA
GARDENS**

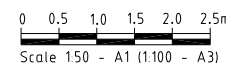
PRELIMINARY

RP DESCRIPTION

Lot 46 & 47 on DP751395.
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT

**KAHUNA NO. 1
PTY LTD**

[illegible]

A	28-05-21	ISSUED FOR APPROVAL
P R E	D A T E	A M E N D M E N T

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND
 WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION.
 COPYRIGHT MORTONS URBAN SOLUTIONS 2000 .
 DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS



D R A W I N G T I T L E

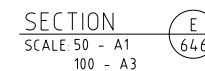
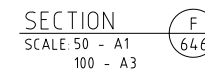
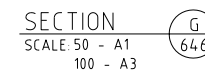
STORMWATER
SWALES AND STRUCTURES
CONSTRUCTION CERTIFICATE
EARTHWORKS
SECTIONS SHEET 01



MUS Pty Ltd T/As: Postal Address
Mortons-Urban Solutions PO Box 248
ABN: 39 116 375 065 Southport QLD 4211
mortons@urbansolutions.net.au
www.urbansolutions.net.au Gold Coast Office
Tel 07 5571 1099 Suite 9, 19 Short St
Southport QLD 4211

DESIGNED PP	DRAWN SF	
APPROVED <i>W.K. mott</i>	RPEQ 4706	DATE 28-05-21

DRAWING NUMBER	AMEND
33801-PR2-647	A



NOTE:
REFER BIOME CONSULTANTS STORMWATER
REPORT FOR DETAILS OF STORMWATER
QUANTITY, QUALITY & DETENTION BASIN
OUTLET CONFIGURATIONS.

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND
WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION.
COPYRIGHT MORTONS URBAN SOLUTIONS 2000 .
DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS

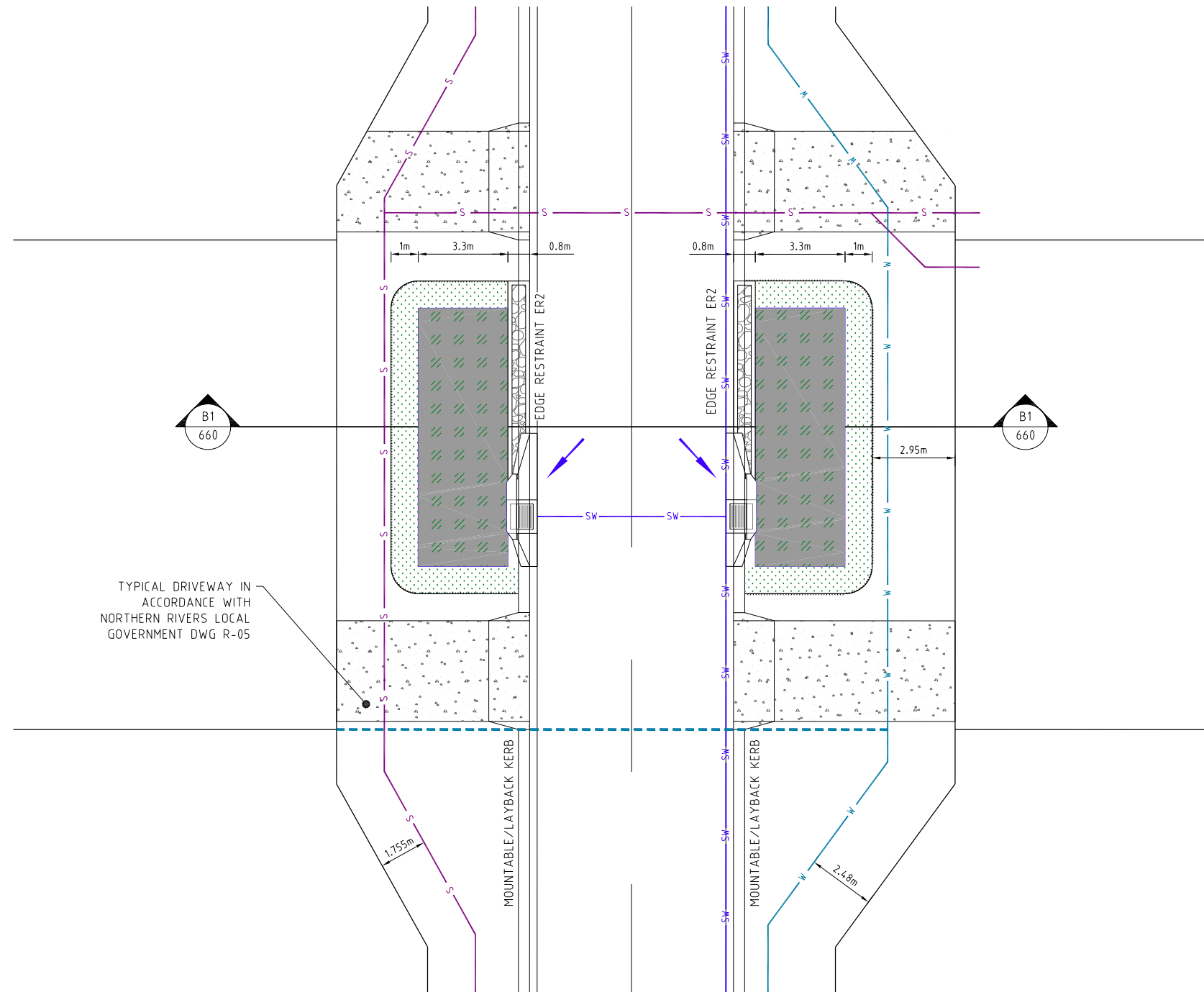


D R A W I N G T I T L E

STORMWATER
SWALES AND STRUCTURES
CONSTRUCTION CERTIFICATE
EARTHWORKS
SECTIONS SHEET 02



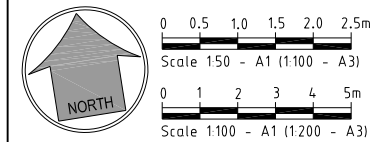
DESIGNED	PP	DRAWN	SF
APPROVED	<i>[Signature]</i>	RPEQ 4706	DATE 28-05-21
DRAWING NUMBER			AMEND.
33801-PR2-648			A



- LEGEND**
- PROPOSED PROPERTY LINE
 - S PROPOSED RISING MAIN
 - SW PROPOSED STORMWATER
 - W PROPOSED WATER
 - SERVICE CONDUIT
 - PROPOSED ROCK SCOUR PROTECTION
 - PROPOSED FILTER MATERIAL
 - PROPOSED LANDSCAPED BATTER
 - PROPOSED CONCRETE
 - PROPOSED FLOW DIRECTION

BIO FILTRATION NOTES

- BIO FILTRATION BASIN TO BE EXCAVATED TO LEVEL BELOW FILTRATION MEDIA
- UNSUITABLE MATERIAL TO BE REMOVED OFF SITE AND BASIN TRIMMED TO FINAL PROFILE PRIOR TO PLACEMENT OF FILTER MEDIA AT 80% COMPLETION OF HOUSING



ISSUES	DATE	
TENDER		
COUNCIL	****/****/****	
CONSTRUCTION		

A	28-05-21	ISSUED FOR APPROVAL
PRE	DATE	AMENDMENT

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION. COPYRIGHT MORTONS URBAN SOLUTIONS 2000 . DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS



DRAWING TITLE

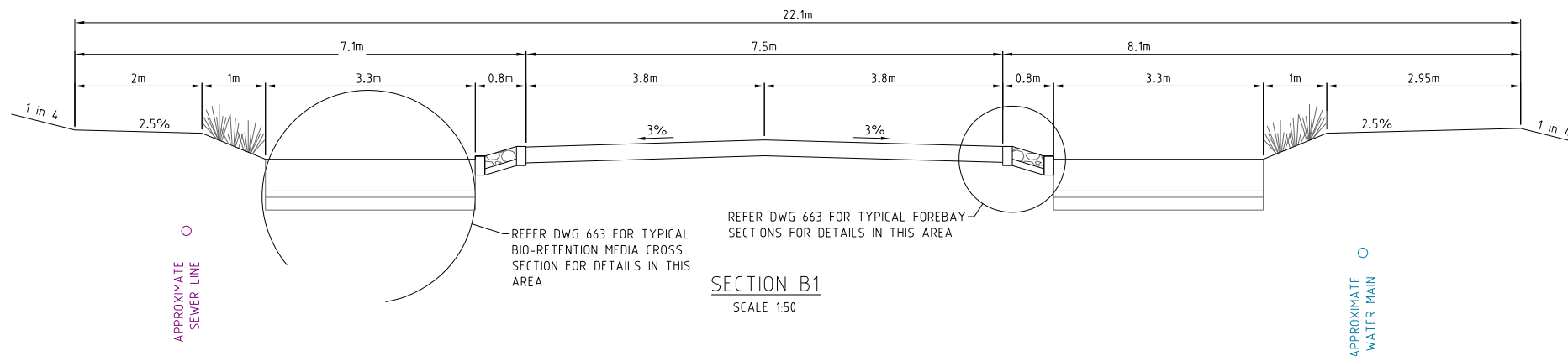
STORMWATER
TYPICAL BIO-POD
PLAN
SHEET 01



MUS Pty Ltd T/As: Postal Address
Mortons-Urban Solutions PO Box 2484
ABN: 39 116 375 065 Southport QLD 4215
mortons@urbansolutions.net.au
www.urbansolutions.net.au Gold Coast Office
Tel 07 5571 1099 Suite 9, 19 Short St
Southport QLD 4215

DESIGNED PP	DRAWN SF
APPROVED <i>[Signature]</i>	RPEQ 4706 DATE 28-05-21

DRAWING NUMBER 33801-PR2-660	AMEND. A
---------------------------------	-------------



SECTION B2

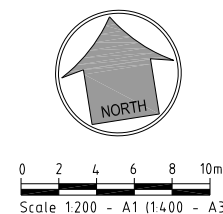
SCALE 1:50

PRELIMINARY

RP DESCRIPTION
Lot 46 & 47 on DP751395.
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT

**KAHUNA NO. 1
PTY LTD**

[illegible]

A	28-05-21	ISSUED FOR APPROVAL
PRE	DATE	AMENDMENT

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND
 WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION.
 COPYRIGHT MORTONS URBAN SOLUTIONS 2000 .
 DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS



D R A W I N G T I T L E

CONCEPT
BIO-POD vrs
END OF LINE TREATMENT

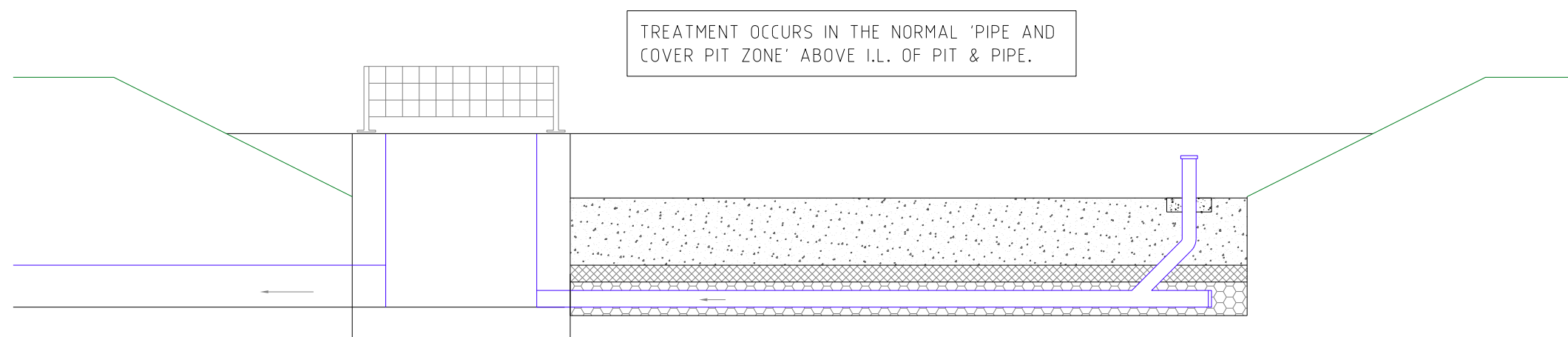


Project Coordination

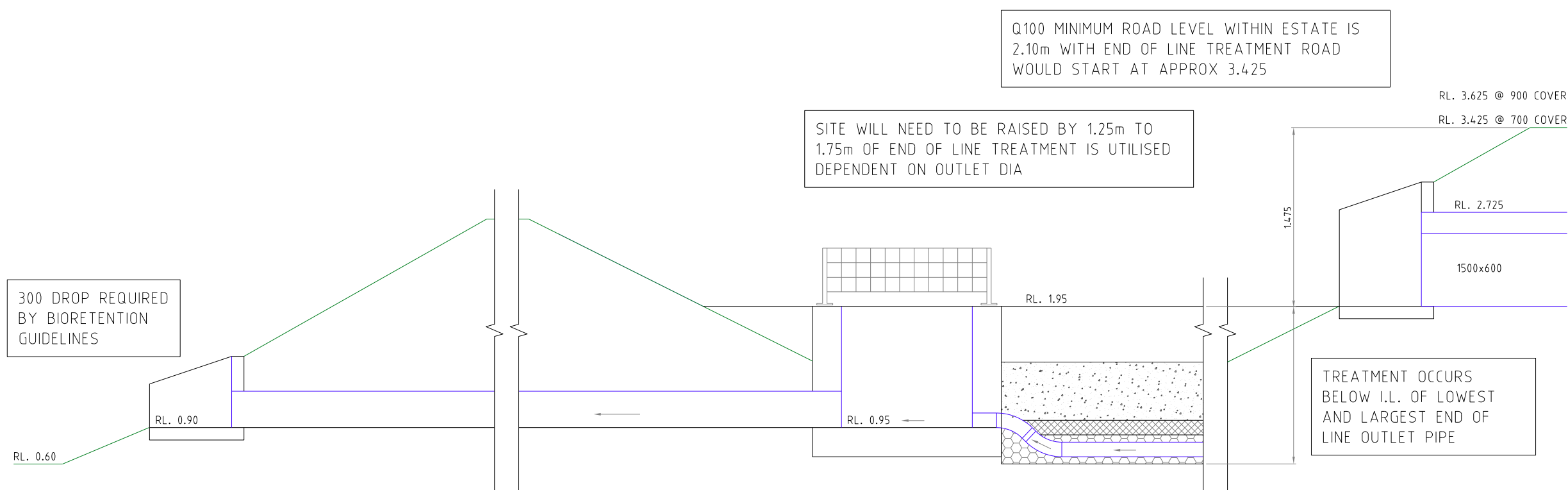
MUS Pty Ltd T/As: Postal Address
Mortons-Urban Solutions PO Box 248
ABN: 39 116 375 065 Southport QLD 4211
mortons@urbansolutions.net.au
www.urbansolutions.net.au Gold Coast Office
Tel 07 5571 1099 Suite 9, 19 Short St
Southport QLD 4211

DESIGNED PP	DRAWN SF	
APPROVED <i>W.K. Smith</i>	RPEQ 4706	DATE 28-05-21

DRAWING NUMBER	AMEND
33801-PR2-664	A



TYPICAL BIO-POD TREATMENT ARRANGEMENT
N.T.S.

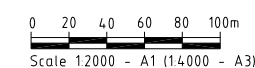


TYPICAL END OF LINE TREATMENT ARRANGEMENT
N.T.S.

Lot 46 & 47 on DP751395.
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT

**KAHUNA NO. 1
PTY LTD**



ISSUES	DATE	
TENDER		
COUNCIL	****-****-****	
CONSTRUCTION		

A	28-05-21	ISSUED FOR APPROVAL
PRE DATE	AMENDMENT	

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND
WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION.
COPYRIGHT MORTONS URBAN SOLUTIONS 2000 .
DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS



D R A W I N G T I T L E

DETENTION BASINS OVERALL PLAN

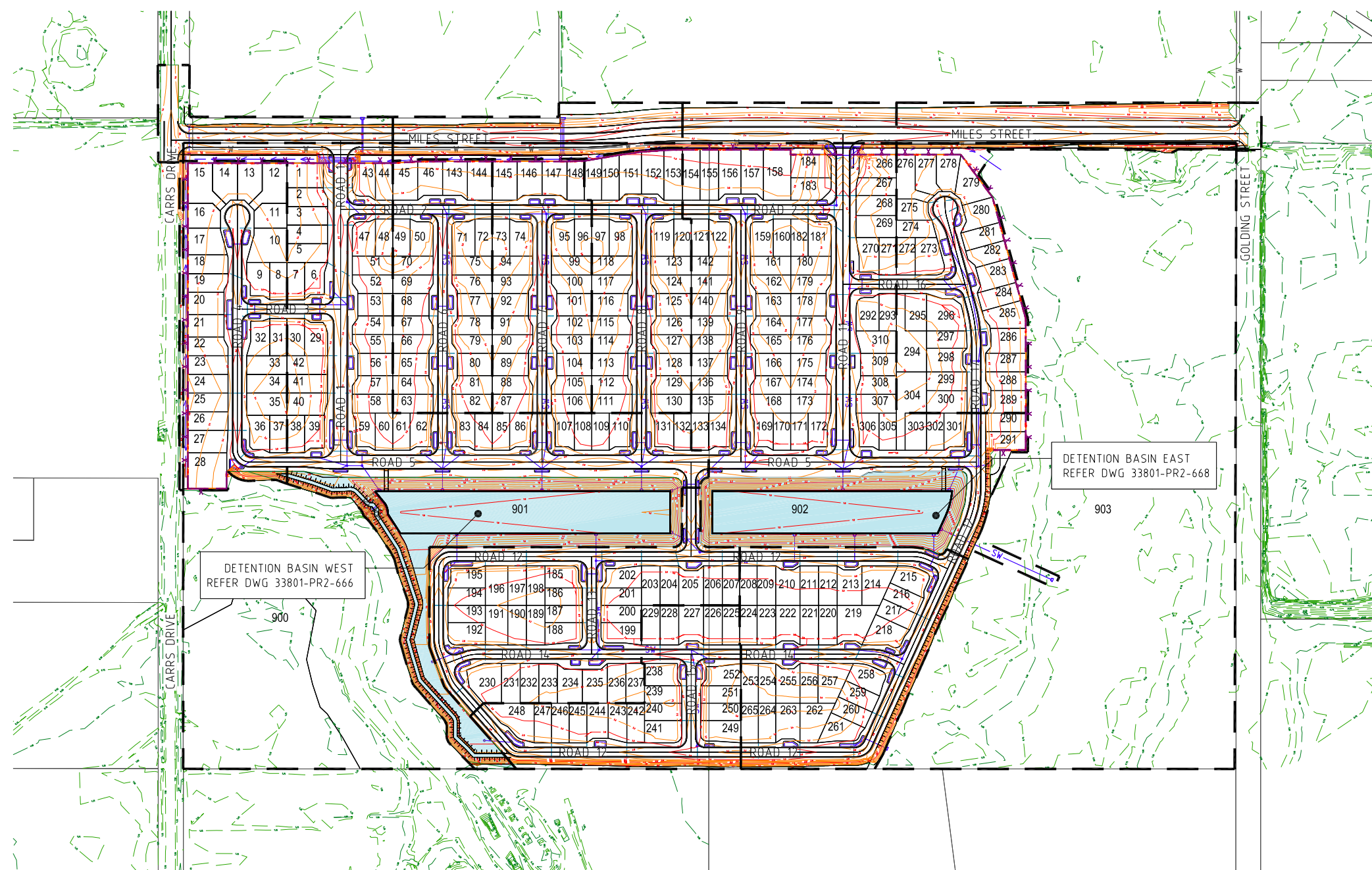


MUS Pty Ltd T/As: Postal Address
Mortons-Urban Solutions PO Box 248
ABN 39 116 375 065 Southport QLD 4211
mortons@urbansolutions.net.au
www.urbansolutions.net.au Gold Coast Office
Tel 07 5571 1099 Suite 9, 19 Short St
Southport QLD 4211

DESIGNED PP	DRAWN SF	
APPROVED <i>W.K. Morte</i>	RPEQ 4706	DATE 28-05-2

DRAWING NUMBER
33801-PR2-60

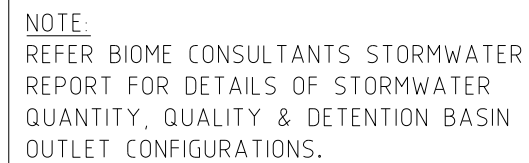
AMEND
A



NOTE:
REFER BIOME CONSULTANTS STORMWATER
REPORT FOR DETAILS OF STORMWATER
QUANTITY, QUALITY & DETENTION BASIN
OUTLET CONFIGURATIONS.

LEGEND

-
- 1.0 — EXISTING CONTOURS
 — EXISTING PROPERTY LINE
 — PROPOSED PROPERTY LINE
 — 1.0 — DESIGN CONTOURS
 — CATCHMENT BOUNDARY (MAJOR)
 — SW — PROPOSED STORMWATER
 DETENTION BASIN



PROJECT NAME

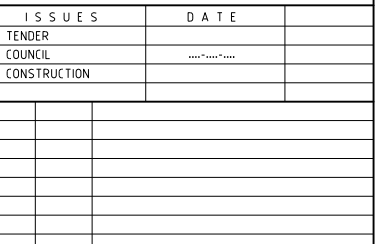
**YAMBA
GARDENS**

PRELIMINARY

RP DESCRIPTION

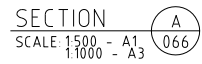
Lot 46 & 47 on DP751395.
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

**KAHUNA NO. 1
PTY LTD**



PRE	DATE	AMENDMENT
-----	------	-----------

ASSOCIATED CONSULTANTS



DETENTION BASIN
WEST
SECTIONS



MUS Pty Ltd T/As: Postal Address
Mortons-Urban Solutions PO Box 2484
ABN 39 116 375 065 Southport QLD 4215
mortons@urbansolutions.net.au
www.urbansolutions.net.au Gold Coast Office
Tel 07 5571 1099 Suite 9, 19 Short St
Southport QLD 4215

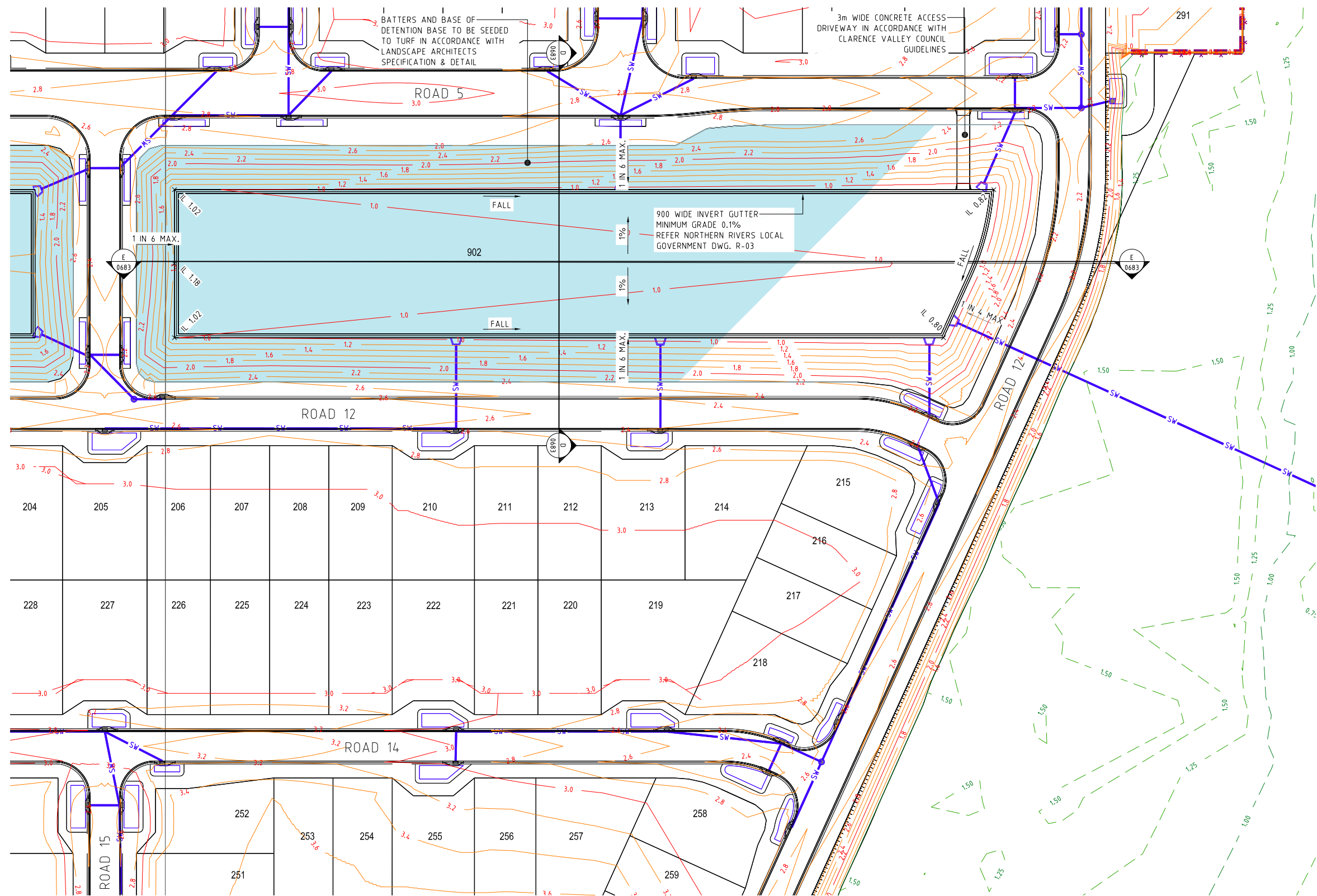
DESIGNED PP	DRAWN SF
-------------	----------

APPROVED <i>W.K. mott</i>	RPEQ 4706	DATE 28-05-21
---------------------------	-----------	---------------

DRAWING NUMBER
33801-PR2-667

M E N D.

A



DETENTION BASIN - EAST
1:500

NOTE:
REFER BIOME CONSULTANTS STORMWATER
REPORT FOR DETAILS OF STORMWATER
QUANTITY, QUALITY & DETENTION BASIN
OUTLET CONFIGURATIONS.

- LEGEND
- 1.0--- EXISTING CONTOURS
 - EXISTING PROPERTY LINE
 - PROPOSED PROPERTY LINE
 - 1.0--- DESIGN CONTOURS
 - SW --- PROPOSED STORMWATER

PROJECT NAME
**YAMBA
GARDENS**
PRELIMINARY
RP DESCRIPTION
Lot 46 & 47 on DP751395,
MILES ST, YAMBA NSW 2464
LOCALITY OF CLARENCE VALLEY
LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

CLIENT
**KAHUNA NO. 1
PTY LTD**



0 15 30 45 60 75m
Scale 1:1500 - A1 (1:3000 - A3)

ISSUES	DATE	
TENDER		
COUNCIL	****/****/****	
CONSTRUCTION		

A	28-05-21	ISSUED FOR APPROVAL
PRE	DATE	AMENDMENT

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND
WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION.
COPYRIGHT MORTONS URBAN SOLUTIONS 2000 .
DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS



DRAWING TITLE

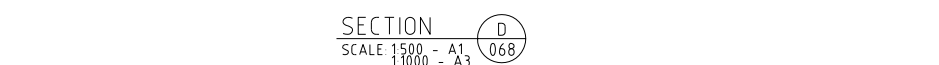
**DETENTION BASIN
EAST
PLAN & DETAILS**

MORTONS
urbansolutions
Urban & Regional Planning
Civil Engineering
Project Coordination

MUS Pty Ltd T/As: Post Address
Mortons-Urban Solutions PO Box 2484
ABN: 39 116 375 065 Southport QLD 4215
mortons@urbansolutions.net.au
www.urbansolutions.net.au Gold Coast Office
Tel: 07 5571 1099 Suite 9, 19 Short St
Southport QLD 4215

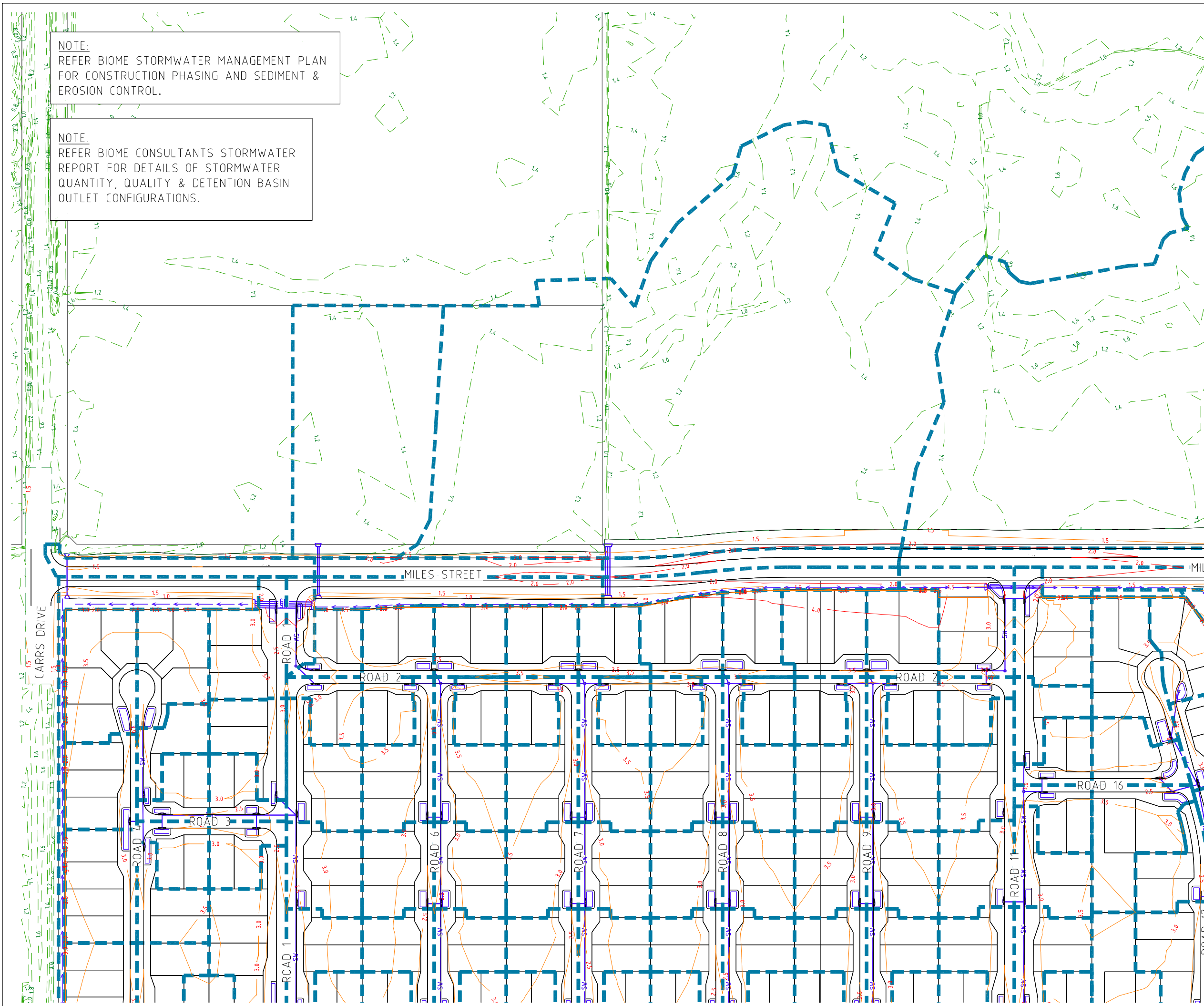
DESIGNED PP	DRAWN SF
APPROVED <i>[Signature]</i>	RPEQ 4706 DATE 28-05-21

DRAWING NUMBER
33801-PR2-668
AMEND.
A



PROJECT NAME YAMBA GARDENS PRELIMINARY RP DESCRIPTION Lot 46 & 47 on DP751395. MILES ST, YAMBA NSW 2464 LOCALITY OF CLARENCE VALLEY LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL		
CLIENT KAHUNA NO. 1 PTY LTD		
 Scale 1:500 - A1 (1:1000 - A3)		
ISSUES	DATE	
TENDER		
COUNCIL	****/****/****	
CONSTRUCTION		
A	28-05-21	ISSUED FOR APPROVAL
PRE DATE	AMENDMENT	
COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION. COPYRIGHT MORTONS URBAN SOLUTIONS 2000 . DO NOT SCALE FROM THIS DRAWING.		
ASSOCIATED CONSULTANTS 		
DRAWING TITLE DETENTION BASIN EAST SECTIONS		
 MORTONS urbansolutions Urban & Regional Planning Civil Engineering Project Coordination MUS Pty Ltd T/As: Mortons-Urban Solutions ABN: 39 116 375 065 mortons@urbansolutions.net.au www.urbansolutions.net.au Tel: 07 5571 1099 Postal Address PO Box 2484 Southport QLD 4215 Gold Coast Office Suite 9, 19 Short St Southport QLD 4215		
DESIGNED PP	DRAWN	SF
APPROVED <i>AK</i>	RPEG 4706	DATE 28-05-21
DRAWING NUMBER		AMEND.
33801-PR2-669		A

NOTE:
REFER BIOME CONSULTANTS STORMWATER
REPORT FOR DETAILS OF STORMWATER
QUANTITY, QUALITY & DETENTION BASIN
OUTLET CONFIGURATIONS.



PROJECT NAME

**YAMBA
GARDENS**

PRELIMINARY

RP DESCRIPTION

Lot 46 & 47 on DP751395.

MILES ST, YAMBA NSW 2464

LOCALITY OF CLARENCE VALLEY

LOCAL AUTHORITY - CLARENCE VALLEY COUNCIL

KAHUNA NO. 1
PTY LTD



0 10 20 30 40 50m
Scale 1:1000 - A1 (1:2000 - A3)

ISSUES		DATE
TENDER		
COUNCIL		
CONSTRUCTION		
A	28-05-21	ISSUED FOR APPROVAL
PRE	DATE	AMENDMENT

COPYRIGHT IS VESTED IN MORTONS URBAN SOLUTIONS AND
WRITTEN CONSENT IS REQUIRED PRIOR TO REPRODUCTION.
COPYRIGHT MORTONS URBAN SOLUTIONS 2000 .
DO NOT SCALE FROM THIS DRAWING.

ASSOCIATED CONSULTANTS



D R A W I N G T I T L E

STORMWATER
CATCHMENT PLAN
MINOR
SHEET 01



DESIGNED PP		DRAWN SF	
APPROVED <i>W.K. [Signature]</i>		RREQ 4706	DATE 28-05-21
DRAWING NUMBER			AMEND.
33801-PR2-673			A



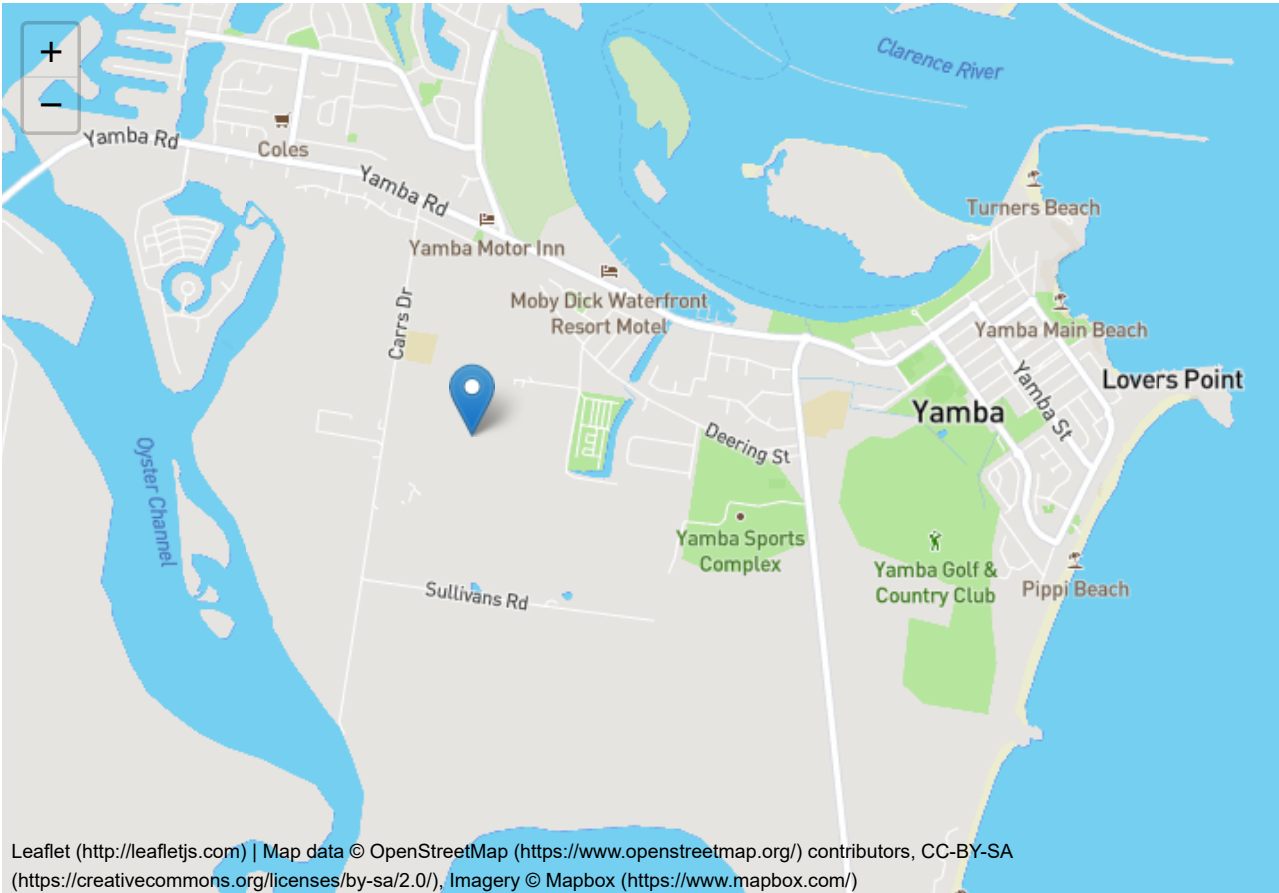
Appendix C

ARR Data Hub Summary Output

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	153.336
Latitude	-29.441
Selected Regions (clear)	
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
BOM IFDs	show
Median Preburst Depths and Ratios	show
10% Preburst Depths	show
25% Preburst Depths	show
75% Preburst Depths	show
90% Preburst Depths	show
Probability Neutral Burst Initial Loss (./nsw_specific)	show



Data

ARF Parameters

$$ARF = Min \left\{ 1, \left[1 - a \left(Area^b - c \log_{10} Duration \right) Duration^{-d} \right. \right. \\ \left. \left. + e Area^f Duration^g (0.3 + \log_{10} AEP) \right. \right. \\ \left. \left. + h 10^{i Area \frac{Duration}{1440}} (0.3 + \log_{10} AEP) \right] \right\}$$

Zone	a	b	c	d	e	f	g	h	i
East Coast North	0.327	0.241	0.448	0.36	0.00096	0.48	-0.21	0.012	-0.0013

Short Duration ARF

$$ARF = Min \left[1, 1 - 0.287 \left(Area^{0.265} - 0.439 \log_{10}(Duration) \right) . Duration^{-0.36} \right. \\ \left. + 2.26 \times 10^{-3} \times Area^{0.226} . Duration^{0.125} (0.3 + \log_{10}(AEP)) \right. \\ \left. + 0.0141 \times Area^{0.213} \times 10^{-0.021 \frac{(Duration-180)^2}{1440}} (0.3 + \log_{10}(AEP)) \right]$$

Layer Info

Time Accessed	05 May 2021 09:33AM
Version	2016_v1

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR DIRECT USE** in urban areas

Note: As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (.nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. The continuing storm loss information from the ARR Datahub provided below should only be used where relevant under the loss hierarchy (level 5) and where used is to be multiplied by the factor of 0.4.

ID	16670.0
Storm Initial Losses (mm)	24.0
Storm Continuing Losses (mm/h)	3.6

Layer Info

Time Accessed	05 May 2021 09:33AM
Version	2016_v1

Temporal Patterns | Download (.zip) (static/temporal_patterns/TP/ECsouth.zip)

code	ECsouth
Label	East Coast South

Layer Info

Time Accessed	05 May 2021 09:33AM
----------------------	---------------------

Version	2016_v2
----------------	---------

Areal Temporal Patterns | Download (.zip)
(./static/temporal_patterns/Areal/Areal_ECsouth.zip)

code	ECsouth
-------------	---------

arealabel	East Coast South
------------------	------------------

Layer Info

Time Accessed	05 May 2021 09:33AM
----------------------	---------------------

Version	2016_v2
----------------	---------

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-29.441&longitude=153.336&sdmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	05 May 2021 09:33AM
----------------------	---------------------

Median Preburst Depths and Ratios

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	1.5 (0.040)	4.2 (0.085)	6.3 (0.109)	8.3 (0.125)	6.4 (0.081)	6.1 (0.069)
90 (1.5)	4.7 (0.106)	6.2 (0.108)	7.3 (0.108)	8.3 (0.107)	12.4 (0.135)	15.5 (0.150)
120 (2.0)	6.6 (0.137)	10.3 (0.163)	12.8 (0.172)	15.1 (0.176)	19.2 (0.188)	22.3 (0.193)
180 (3.0)	11.4 (0.207)	19.2 (0.261)	24.3 (0.280)	29.2 (0.290)	35.0 (0.290)	39.3 (0.286)
360 (6.0)	8.2 (0.116)	21.9 (0.228)	31.0 (0.269)	39.7 (0.293)	60.8 (0.370)	76.6 (0.407)
720 (12.0)	9.5 (0.102)	24.5 (0.189)	34.5 (0.218)	44.1 (0.234)	63.1 (0.274)	77.3 (0.292)
1080 (18.0)	7.2 (0.066)	16.2 (0.104)	22.1 (0.115)	27.8 (0.121)	51.2 (0.183)	68.8 (0.213)
1440 (24.0)	6.4 (0.052)	14.4 (0.081)	19.7 (0.090)	24.8 (0.095)	37.6 (0.117)	47.1 (0.128)
2160 (36.0)	1.5 (0.010)	7.0 (0.033)	10.7 (0.041)	14.2 (0.045)	27.1 (0.071)	36.9 (0.085)
2880 (48.0)	0.1 (0.000)	3.9 (0.017)	6.5 (0.022)	8.9 (0.026)	18.1 (0.043)	25.0 (0.052)
4320 (72.0)	0.0 (0.000)	1.3 (0.005)	2.2 (0.007)	3.1 (0.008)	6.6 (0.014)	9.3 (0.017)

Layer Info

Time Accessed	05 May 2021 09:33AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	05 May 2021 09:33AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

25% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.001)	0.2 (0.004)	0.3 (0.006)	0.4 (0.007)	0.2 (0.003)	0.2 (0.003)
90 (1.5)	0.2 (0.004)	0.3 (0.006)	0.4 (0.006)	0.5 (0.006)	0.5 (0.006)	0.5 (0.005)
120 (2.0)	0.0 (0.000)	0.2 (0.004)	0.4 (0.005)	0.6 (0.007)	0.7 (0.007)	0.8 (0.007)
180 (3.0)	0.0 (0.000)	1.4 (0.018)	2.3 (0.026)	3.1 (0.031)	2.3 (0.019)	1.7 (0.012)
360 (6.0)	0.0 (0.000)	3.1 (0.032)	5.1 (0.044)	7.0 (0.052)	9.3 (0.057)	11.0 (0.058)
720 (12.0)	0.0 (0.000)	4.8 (0.037)	8.1 (0.051)	11.1 (0.059)	20.0 (0.087)	26.7 (0.101)
1080 (18.0)	0.0 (0.000)	2.0 (0.013)	3.3 (0.017)	4.6 (0.020)	10.2 (0.036)	14.5 (0.045)
1440 (24.0)	0.0 (0.000)	1.2 (0.007)	2.0 (0.009)	2.7 (0.010)	11.5 (0.036)	18.0 (0.049)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	1.8 (0.005)	3.1 (0.007)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	1.1 (0.003)	2.0 (0.004)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	05 May 2021 09:33AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	54.0 (1.415)	39.5 (0.792)	40.7 (0.699)	41.9 (0.627)	34.5 (0.438)	36.9 (0.418)
90 (1.5)	51.9 (1.186)	47.8 (0.833)	45.1 (0.671)	42.5 (0.550)	70.9 (0.774)	92.2 (0.893)
120 (2.0)	44.5 (0.924)	51.1 (0.807)	55.5 (0.746)	59.8 (0.695)	97.9 (0.957)	126.5 (1.093)
180 (3.0)	54.0 (0.981)	72.2 (0.985)	84.2 (0.971)	95.7 (0.951)	122.0 (1.012)	141.7 (1.034)
360 (6.0)	64.7 (0.918)	81.1 (0.842)	91.9 (0.796)	102.2 (0.753)	131.5 (0.800)	153.5 (0.815)
720 (12.0)	39.3 (0.425)	68.3 (0.525)	87.5 (0.553)	106.0 (0.562)	142.5 (0.619)	169.9 (0.641)
1080 (18.0)	39.5 (0.361)	73.9 (0.474)	96.7 (0.505)	118.5 (0.517)	126.9 (0.452)	133.1 (0.413)
1440 (24.0)	30.4 (0.247)	51.3 (0.290)	65.2 (0.299)	78.4 (0.300)	98.4 (0.307)	113.3 (0.308)
2160 (36.0)	16.2 (0.112)	32.0 (0.152)	42.5 (0.164)	52.5 (0.168)	81.0 (0.213)	102.3 (0.235)
2880 (48.0)	7.0 (0.043)	25.6 (0.109)	37.9 (0.131)	49.8 (0.143)	69.2 (0.164)	83.8 (0.174)
4320 (72.0)	0.1 (0.000)	12.7 (0.048)	21.1 (0.064)	29.1 (0.074)	47.3 (0.100)	60.9 (0.113)

Layer Info

Time Accessed	05 May 2021 09:33AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	151.8 (3.978)	130.9 (2.624)	120.5 (2.068)	110.5 (1.655)	143.8 (1.827)	220.7 (2.500)
90 (1.5)	151.3 (3.458)	156.7 (2.732)	160.3 (2.386)	163.8 (2.119)	219.6 (2.398)	261.4 (2.533)
120 (2.0)	167.0 (3.471)	172.7 (2.726)	176.5 (2.370)	180.1 (2.096)	210.4 (2.057)	233.1 (2.015)
180 (3.0)	135.3 (2.456)	171.9 (2.346)	196.1 (2.263)	219.3 (2.180)	265.5 (2.202)	300.1 (2.190)
360 (6.0)	127.4 (1.805)	146.3 (1.521)	158.9 (1.377)	170.9 (1.260)	253.0 (1.539)	314.6 (1.671)
720 (12.0)	77.9 (0.841)	128.6 (0.989)	162.1 (1.024)	194.3 (1.031)	250.7 (1.088)	293.0 (1.106)
1080 (18.0)	96.0 (0.877)	132.2 (0.847)	156.2 (0.816)	179.2 (0.782)	206.9 (0.738)	227.7 (0.706)
1440 (24.0)	99.2 (0.805)	127.7 (0.721)	146.5 (0.672)	164.6 (0.629)	187.5 (0.585)	204.7 (0.555)
2160 (36.0)	73.6 (0.508)	90.7 (0.432)	102.0 (0.394)	112.9 (0.362)	160.8 (0.423)	196.8 (0.451)
2880 (48.0)	41.9 (0.260)	67.2 (0.287)	83.8 (0.290)	99.9 (0.288)	135.2 (0.320)	161.8 (0.335)
4320 (72.0)	24.7 (0.134)	49.2 (0.184)	65.4 (0.199)	81.0 (0.206)	90.9 (0.191)	98.3 (0.182)

Layer Info

Time Accessed	05 May 2021 09:33AM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Probability Neutral Burst Initial Loss

min (h)\AEP(%)	50.0	20.0	10.0	5.0	2.0	1.0
60 (1.0)	11.8	7.3	8.4	7.9	7.5	4.5
90 (1.5)	11.5	7.6	8.4	7.8	6.2	3.1
120 (2.0)	11.4	7.4	7.9	6.8	6.6	2.2
180 (3.0)	10.2	6.3	6.7	6.6	6.6	2.1
360 (6.0)	10.8	6.7	6.6	6.5	7.8	2.8
720 (12.0)	12.8	7.1	6.5	6.7	6.4	4.1
1080 (18.0)	14.4	8.8	9.7	8.3	8.3	4.6
1440 (24.0)	15.8	10.5	10.0	9.6	7.7	5.6
2160 (36.0)	19.1	12.9	13.5	11.4	11.8	5.9
2880 (48.0)	21.8	14.7	15.0	12.5	13.9	6.5
4320 (72.0)	24.4	18.2	17.4	13.8	17.3	7.0

Layer Info

Time Accessed	05 May 2021 09:33AM
Version	2018_v1

Note As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

Download TXT (downloads/f6535101-12c4-429e-b6fc-2cd0015f631c.txt)

Download JSON (downloads/6a2123df-4c9c-42b1-a6be-f9a362098097.json)

Generating PDF... (downloads/a4e37d56-d998-4139-8e0b-bcf70a722eef.pdf)

Location

Label: Yamba Gardens

Latitude: -29.441 [Nearest grid cell: 29.4375 (S)]

Longitude: 153.336 [Nearest grid cell: 153.3375 (E)]

IFD Design Rainfall Intensity (mm/h)

Issued: 05 May 2021

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).

[FAQ for New ARR probability terminology](#)

Duration	Annual Exceedance Probability (AEP)						
	63.2%	50%#	20%*	10%	5%	2%	1%
1 min	160	177	232	271	311	364	406
2 min	136	149	192	223	255	301	338
3 min	126	139	180	210	240	282	317
4 min	119	131	171	200	229	269	301
5 min	113	125	164	191	219	257	287
10 min	90.9	101	133	155	178	208	232
15 min	76.6	84.9	112	131	149	175	194
20 min	66.5	73.6	96.8	113	129	151	168
25 min	59.0	65.3	85.6	99.9	114	134	149
30 min	53.2	58.8	77.0	89.9	103	120	134
45 min	41.6	45.9	60.0	70.0	80.2	94.2	105
1 hour	34.6	38.1	49.9	58.3	66.8	78.7	88.3
1.5 hour	26.4	29.2	38.2	44.8	51.5	61.0	68.8
2 hour	21.8	24.1	31.7	37.2	43.0	51.1	57.8
3 hour	16.6	18.4	24.4	28.9	33.5	40.2	45.7
4.5 hour	12.7	14.1	19.0	22.7	26.5	32.0	36.5
6 hour	10.5	11.8	16.0	19.2	22.6	27.4	31.4
9 hour	8.13	9.17	12.7	15.4	18.2	22.2	25.5
12 hour	6.81	7.72	10.8	13.2	15.7	19.2	22.1
18 hour	5.33	6.08	8.67	10.6	12.7	15.6	17.9
24 hour	4.48	5.13	7.38	9.09	10.9	13.4	15.4
30 hour	3.91	4.49	6.50	8.01	9.63	11.8	13.5
36 hour	3.50	4.02	5.83	7.20	8.65	10.6	12.1
48 hour	2.91	3.36	4.88	6.02	7.23	8.80	10.1
72 hour	2.22	2.56	3.71	4.57	5.46	6.60	7.49
96 hour	1.80	2.07	3.00	3.67	4.38	5.25	5.92
120 hour	1.51	1.74	2.51	3.06	3.63	4.33	4.86
144 hour	1.30	1.50	2.15	2.61	3.10	3.67	4.10
168 hour	1.13	1.31	1.87	2.28	2.69	3.17	3.53

Note:

The 50% AEP IFD **does not** correspond to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.

* The 20% AEP IFD **does not** correspond to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

This page was created at **9:37 on Wednesday 05 May 2021 (AEST)**

© [Copyright](#) Commonwealth of Australia 2021, Bureau of Meteorology (ABN 92 637 533 532) | CRICOS Provider 02015K | [Disclaimer](#) | [Privacy](#) | [Accessibility](#)



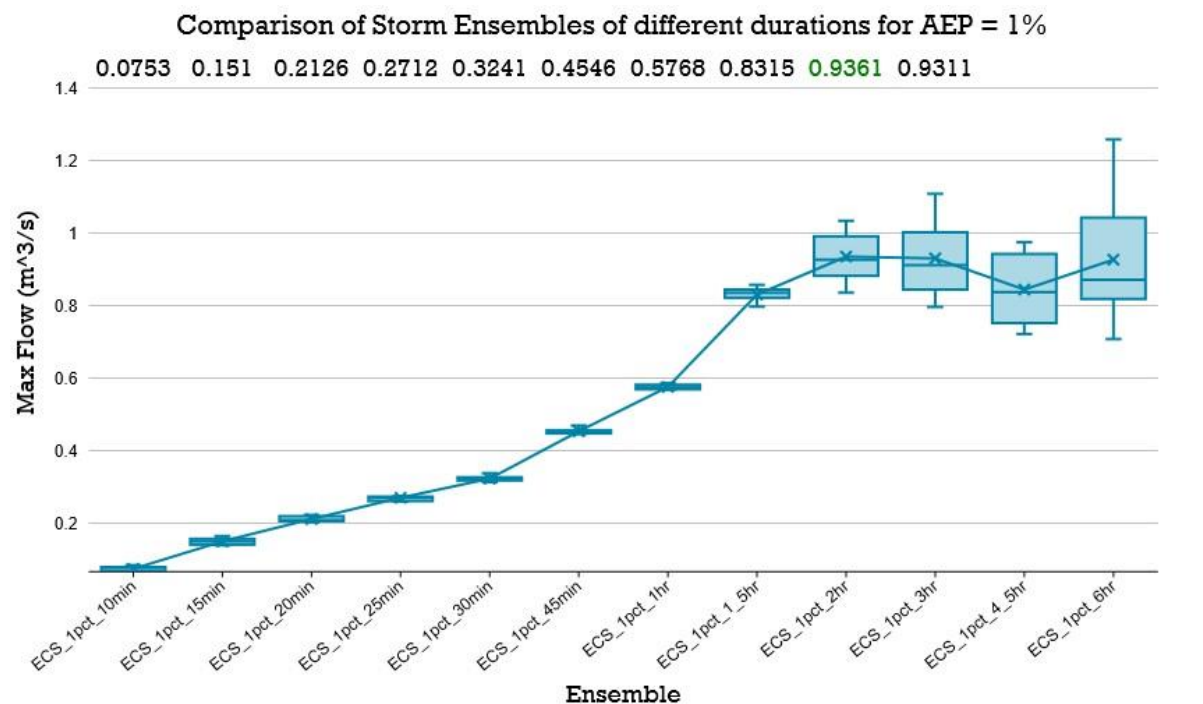
Appendix D

1 % AEP Box and Whisker Plots for Modelled Durations

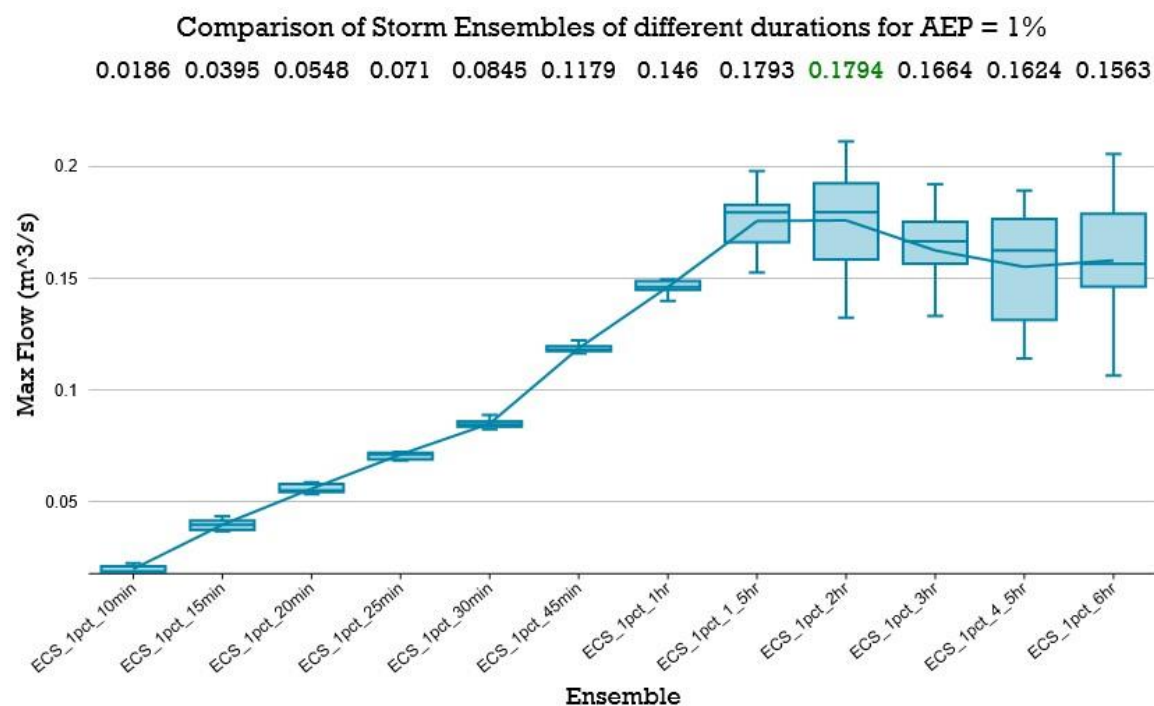


PD-A Catchments (Existing Case)

Ext A(1)

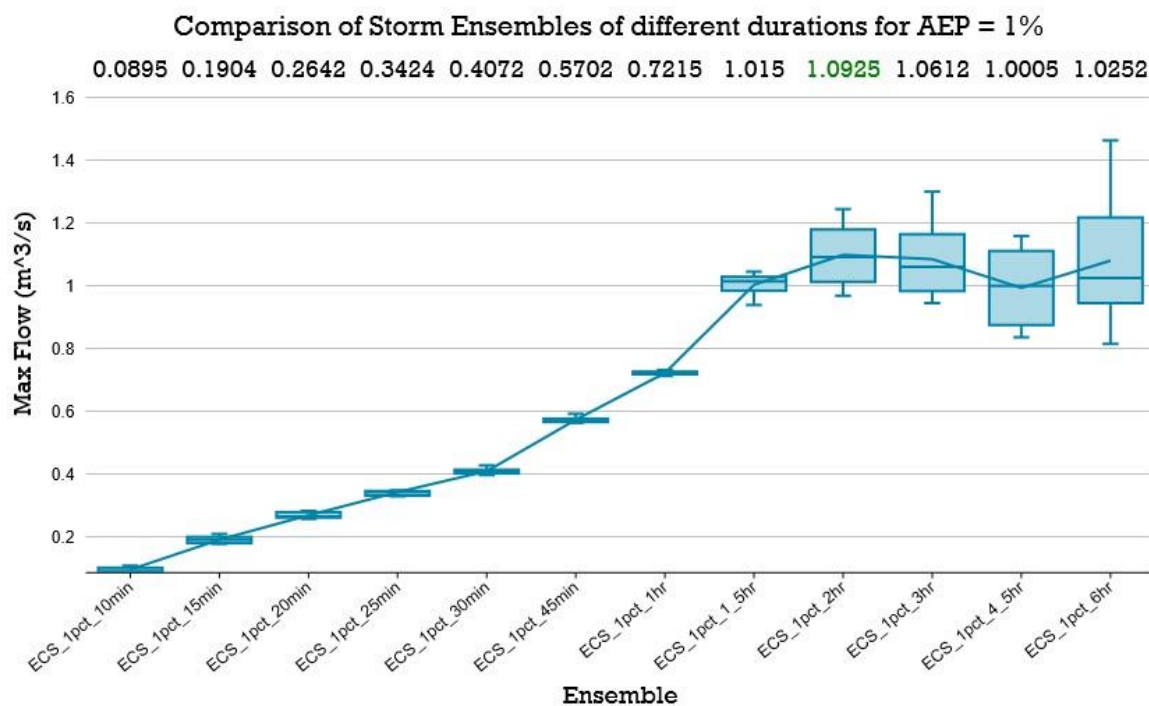


A



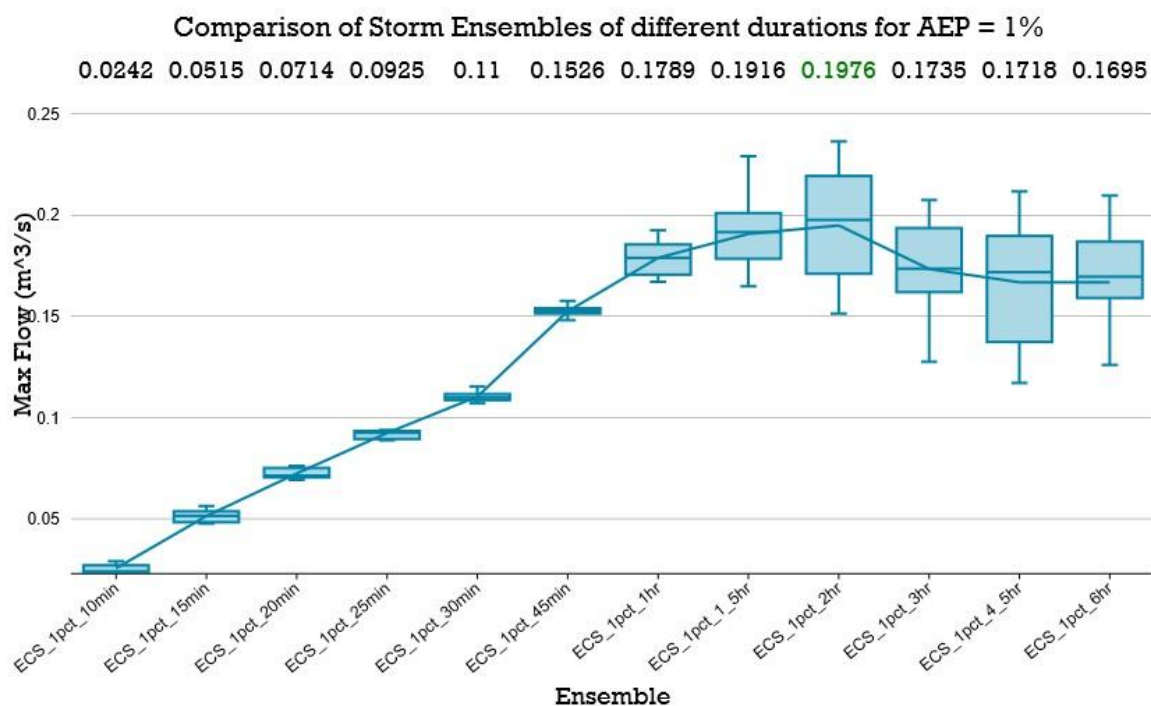


PD-A



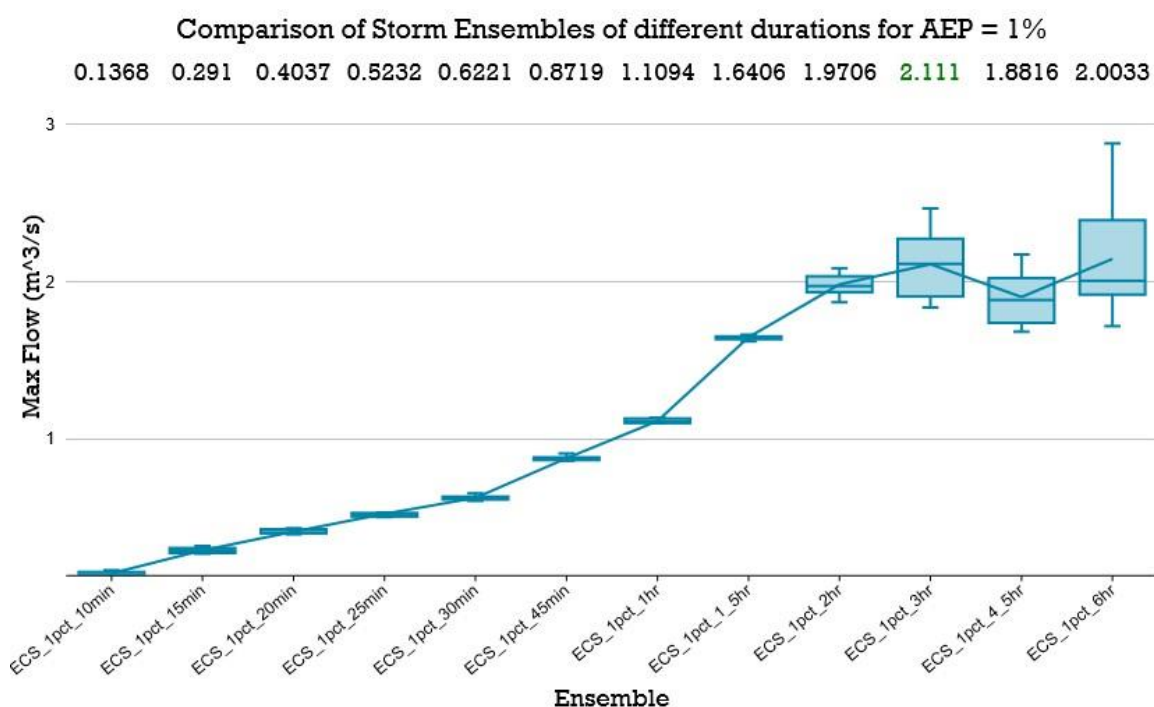
PD-B Catchments (Existing Case)

B1

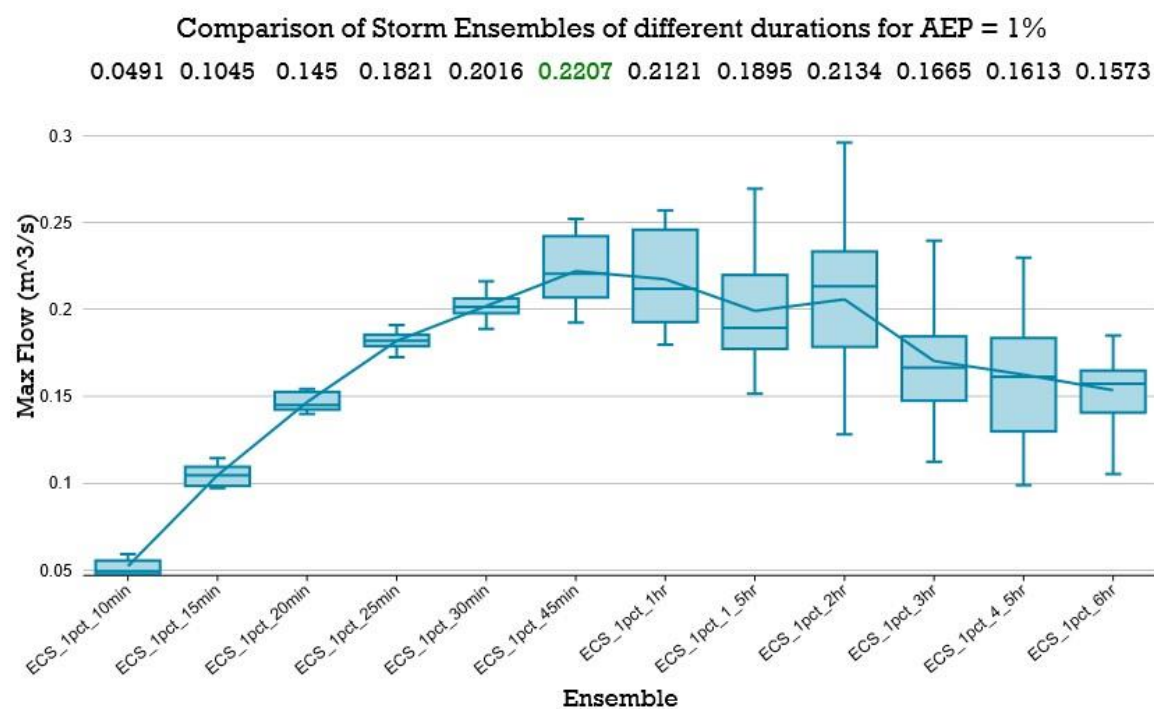




B2

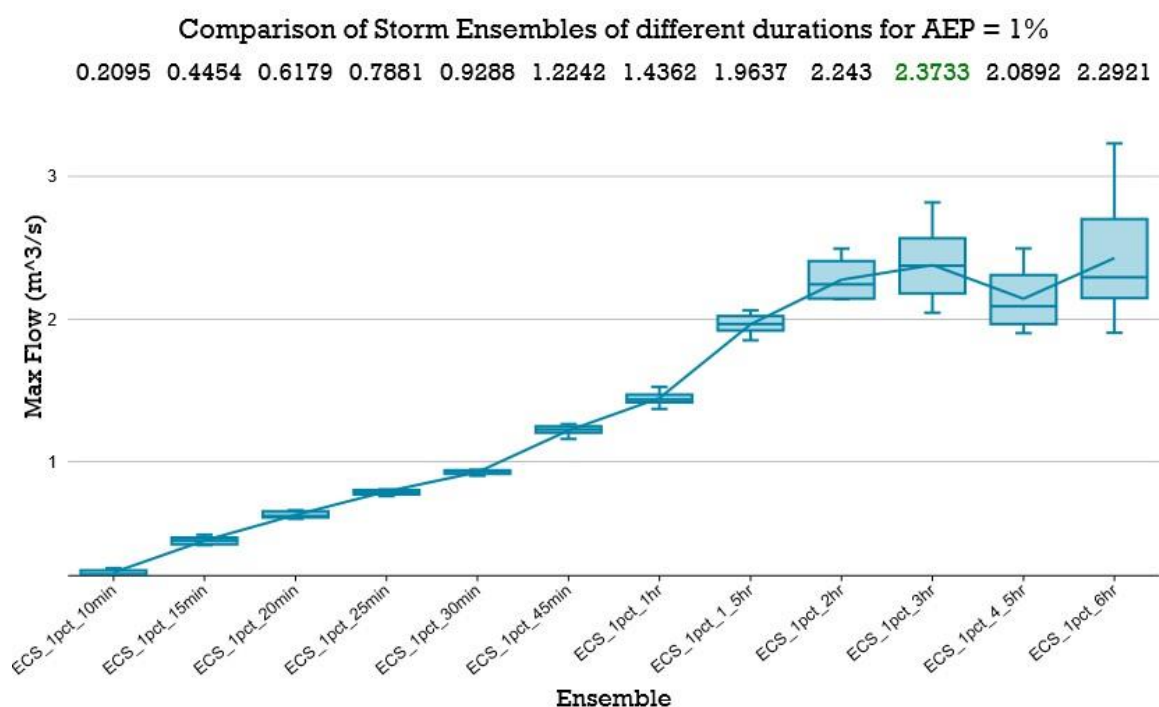


B3



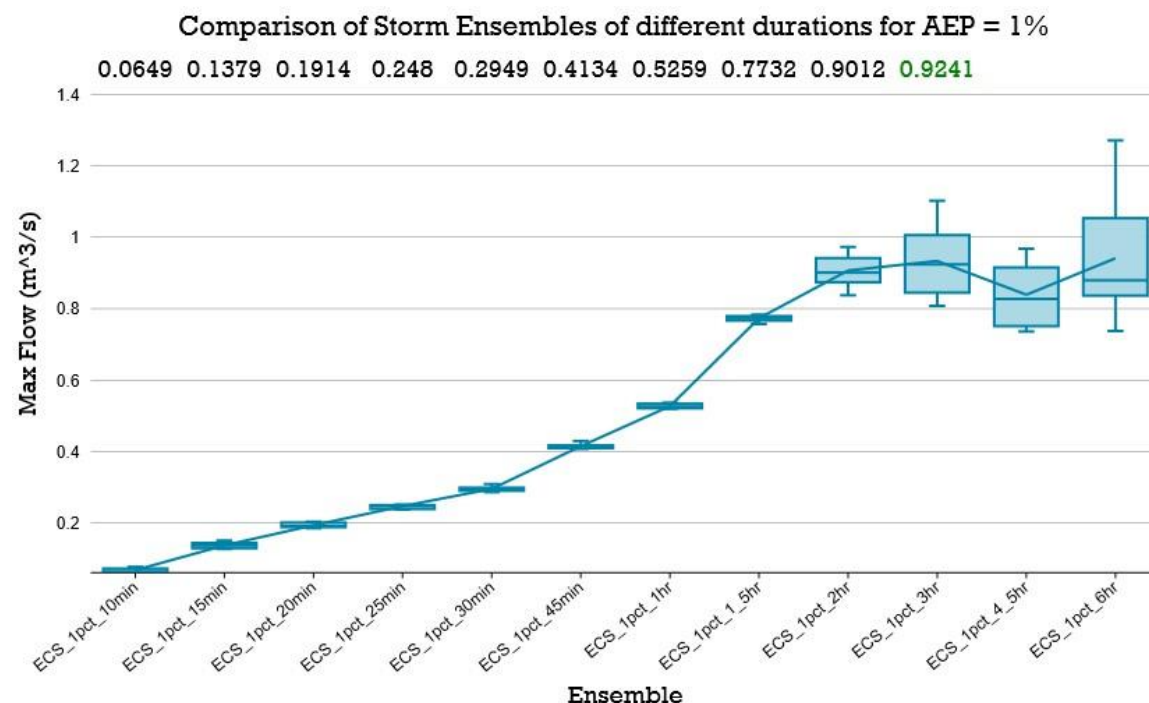


PD-B



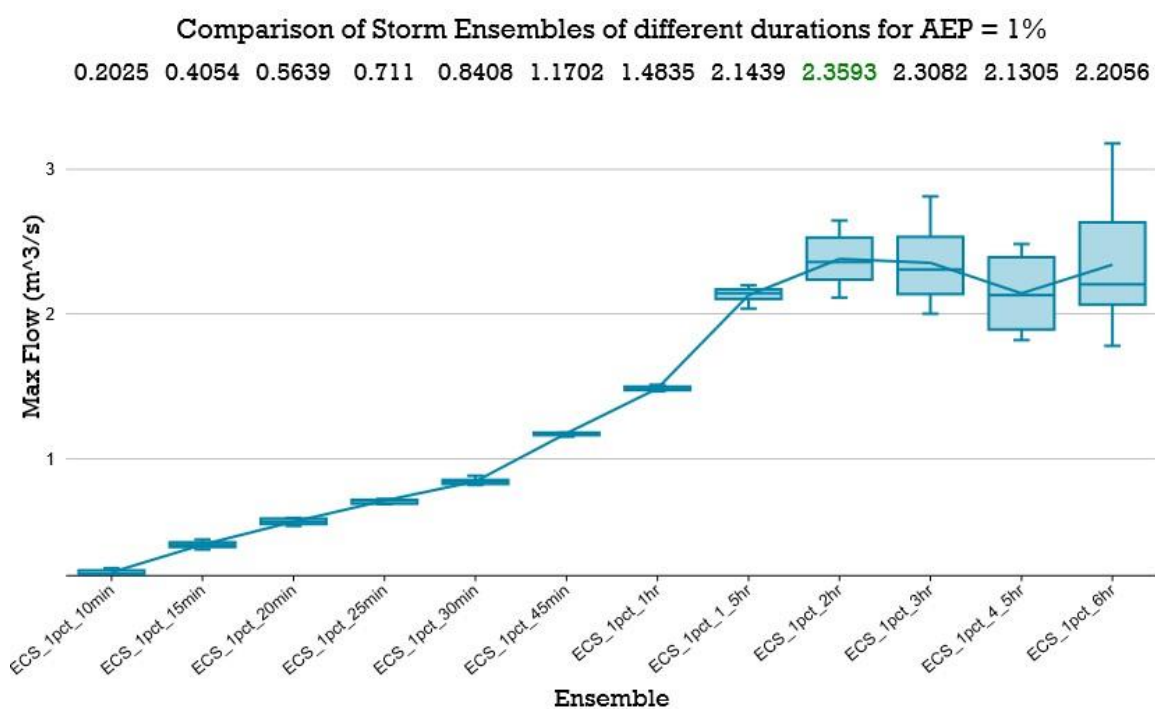
PD-C Catchments (Existing Case)

Ext C(1)

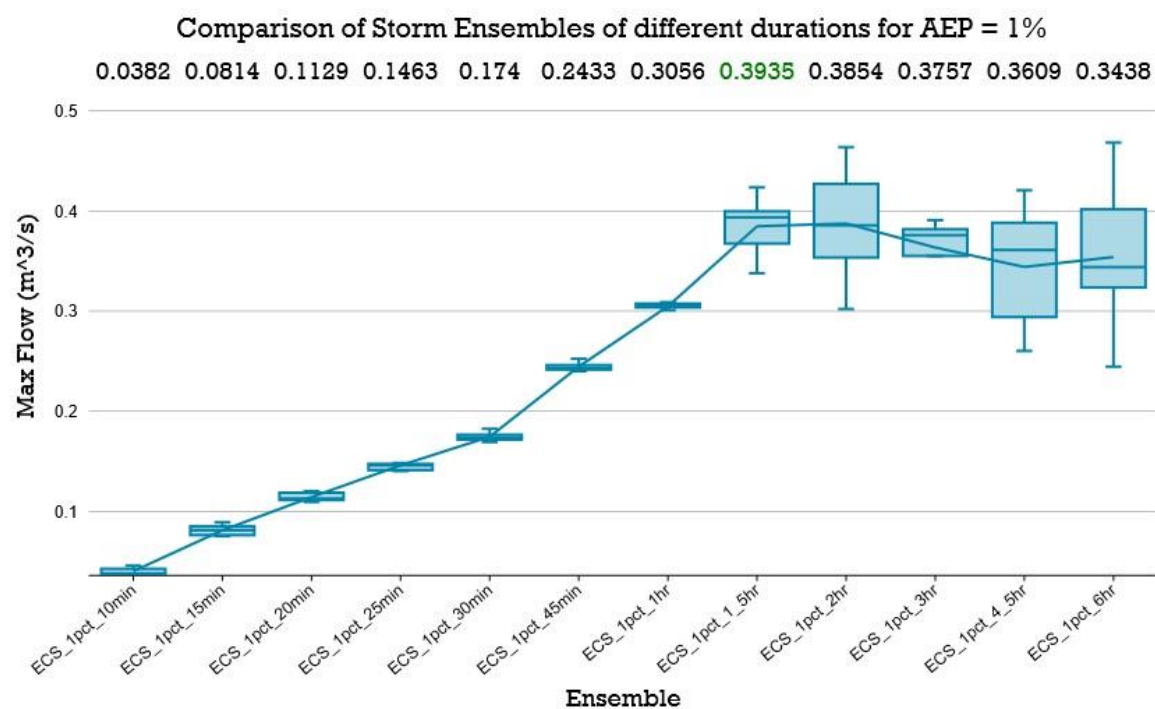




C

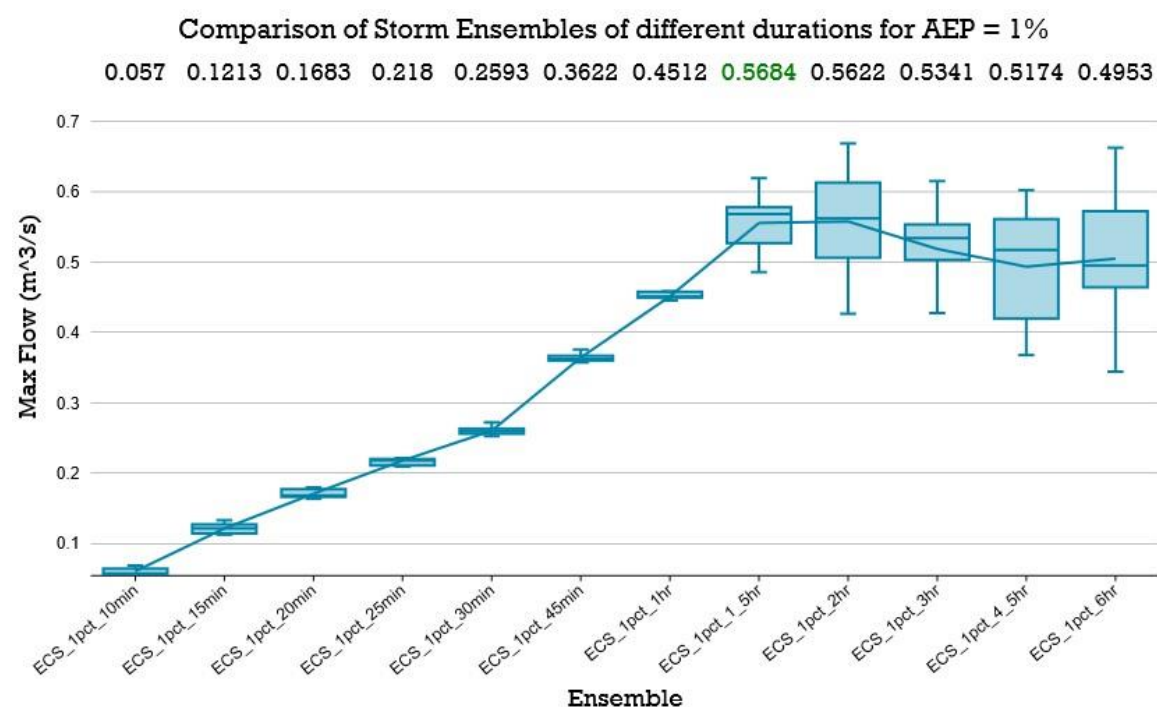


D (Existing Case)

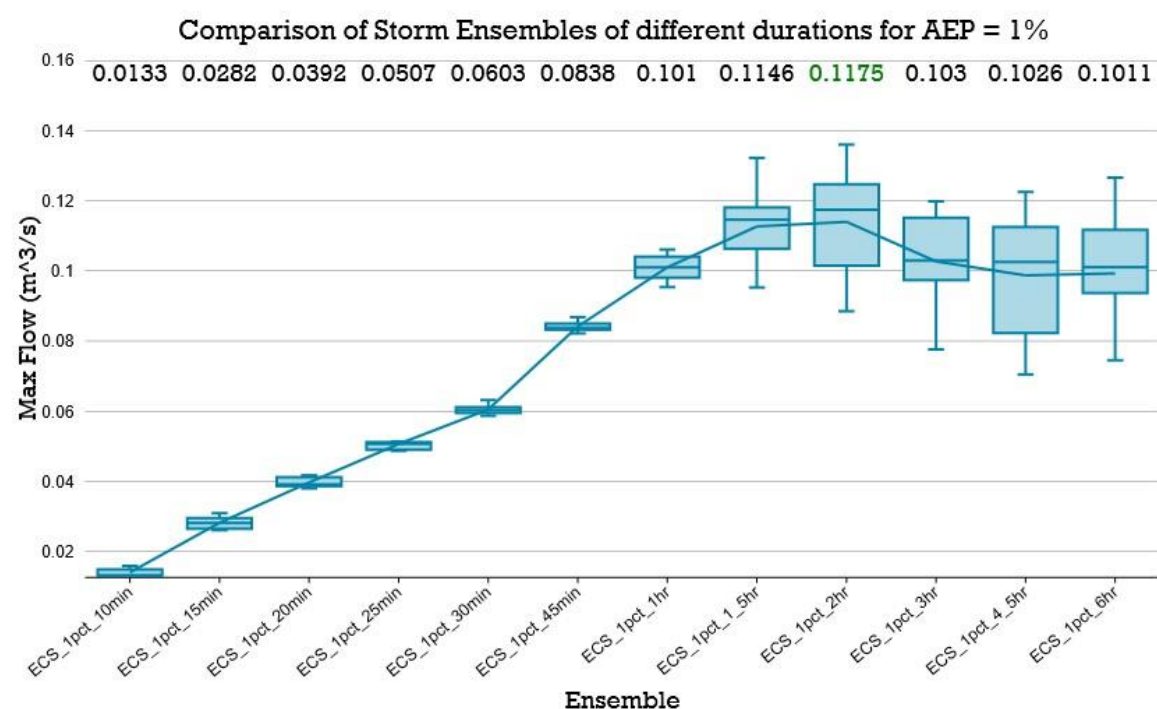




E (Existing Case)



F(Existing Case)





Appendix E

Rational Method Model Validation



The Rational Method has been relied upon to validate the flows reported within *xpstorm* for both the pre and post development cases. In accordance with QUDM 2016 Section 4, the Rational Method provides a simple means of estimating peak discharge and is therefore considered suitable for validation purposes. Equation 4.2 from QUDM has been relied upon.

$$Q_y = (C_y \cdot I_y \cdot A)/360$$

where:

Q_y	=	peak flow rate (m ³ /s) for annual exceedance probability (AEP) of 1 in 'y' years
C_y	=	coefficient of discharge for AEP of 1 in 'y' years
A	=	area of catchment (ha)
I_i	=	average rainfall intensity (mm/h) for a design duration of 't' hours and an AEP of 1 in 'y' years
t	=	the nominal design storm duration as defined by the time of concentration (t)

Coefficient of Discharge

Based on the infiltration characteristics of the internal and external catchments, the following discharge coefficients have been calculated using the method presented within Book 8 of Australian Rainfall and Runoff (1998) and based on Equation 4.3 from QUDM (2016).

$$C_y = F_y \cdot C_{10}$$

where:

C_y	=	coefficient of discharge for AEP of 1 in 'y' years
F_y	=	frequency factor for AEP of 1 in 'y' years
C_{10}	=	10 year discharge coefficient value for Tables 4.5.3 and 4.5.4 of QUDM

Fraction impervious (f_i) values for the existing and developed catchments were derived from aerial photography and development plans, respectively. Using these values, and the local I_{10} (1 hour rainfall intensity for the 10 year ARI) value sourced from BOM, the C_{10} for each catchment was determined and utilised to calculate the runoff coefficients for each nominated event. C_{10} values have been based on QUDM values for land of good grass cover with medium to high soil permeability.

The fraction impervious and coefficient of discharge values for the nominated AEP's for the existing case and developed case are contained within Tables C.1 and C.2, respectively.

Table C.1 Coefficient of Discharge – Existing Case

Catchment ID	f_i	C_2	C_5	C_{10}	C_{20}	C_{50}	C_{100}
Ext A(1)	0.00	0.34	0.38	0.40	0.42	0.46	0.48
Ext C(1)	0.00	0.34	0.38	0.40	0.42	0.46	0.48
A	0.00	0.34	0.38	0.40	0.42	0.46	0.48
B1	0.00	0.34	0.38	0.40	0.42	0.46	0.48
B2	0.00	0.34	0.38	0.40	0.42	0.46	0.48
B3	0.00	0.34	0.38	0.40	0.42	0.46	0.48
C	0.00	0.34	0.38	0.40	0.42	0.46	0.48
D	0.00	0.34	0.38	0.40	0.42	0.46	0.48
E	0.00	0.34	0.38	0.40	0.42	0.46	0.48
F	0.00	0.34	0.38	0.40	0.42	0.46	0.48



Table C.2 Coefficient of Discharge – Developed Case

Catchment ID	f_i	C_2	C_5	C_{10}	C_{20}	C_{50}	C_{100}
A	0.70	0.67	0.75	0.79	0.83	0.91	0.95
B	0.70	0.67	0.75	0.79	0.83	0.91	0.95
C1	0.70	0.67	0.75	0.79	0.83	0.91	0.95
C2	0.70	0.67	0.75	0.79	0.83	0.91	0.95
C3	0.00	0.34	0.38	0.40	0.42	0.46	0.48
D	0.70	0.67	0.75	0.79	0.83	0.91	0.95
E	0.00	0.34	0.38	0.40	0.42	0.46	0.48
B2(Remain)	0.00	0.34	0.38	0.40	0.42	0.46	0.48
Ext A(1)	0.22	0.52	0.58	0.61	0.64	0.70	0.73
Ext C(1)	0.13	0.40	0.45	0.47	0.49	0.54	0.56

Time of Concentration

The time of concentration (t_c) for each catchment was calculated in accordance with Section 4.6 of QUDM (2016).

A standard inlet time of concentration of 5 min has been adopted within the relevant developed catchments as per Table 4.6.2 of QUDM.

The time of concentration (t_c) for the overland flow length within the undeveloped catchments and the relevant developed catchments was estimated using Friend's Equation for overland flow (QUDM Section 4.6.6).

$$t_c = (107nL^{0.333})/S^{0.2}$$

where:

t_c	=	Time of concentration (min)
n	=	Horton's roughness value (estimated using QUDM Table 4.6.5)
L	=	Overland sheet flow path length (m)
S	=	Slope (%)

For channel flow, times were estimated using Manning's equation as provided in the Technical notes for Figure 4.6 of QUDM, shown below:

$$t_c = 0.025L/S^{0.5}$$

where:

t_c	=	Time of concentration (min)
L	=	Length of gutter flow (m)
S	=	Slope (%)

Tables C.3 and C.4 below present the parameters relied upon to calculate the time of concentration (t_c) to the discharge point of each catchment (site's PD) for the existing and developed case, respectively.



Table C.3 t_c Parameters – Existing Case

Parameter	Ext A(1)	Ext C(1)	A	B1	B2	B3	D	E	F
Standard Inlet Time									
t (min)	-	-	-	-	-	-	-	-	-
Sheet Flow									
Flow Length (m)	200	200	90	66	200	46	200	85	90
Horton's Roughness Value	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
Slope (%)	0.3	0.2	0.2	0.3	0.3	1.2	0.3	0.2	0.2
t (min)	37.1	38.4	28.9	25.2	36.3	16.6	36.0	30.5	28.9
Channel Flow									
Flow Length (m)	300	94	0	0	111	0	21	140	0
Velocity (m/s)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Slope (%)	0.3	0.2	0.2	0.3	0.4	1.2	0.3	0.6	0.0
t (min)	16.7	5.2	0.0	0.0	6.2	0.0	1.2	7.8	0.0
TOTAL t_c (min)	53.8	43.6	28.9	25.2	42.4	16.6	37.2	38.3	28.9

Table C.4 t_c Parameters – Developed Case

Parameter	A	B	C1	C2	C3	D	E	B2(Remain)	Ext A(1)	Ext C(1)
Standard Inlet Time										
t (min)	5	5	5	5	0	5	-	-	-	-
Sheet Flow										
Flow Length (m)	-	-	-	-	110	-	85	31	140	200
Horton's Roughness Value	-	-	-	-	0.045	-	0.045	0.045	0.045	0.045
Slope (%)	-	-	-	-	110	-	85	31	140	200
t (min)	-	-	-	-	24.9	-	30.5	13.93	32.9	38.4
Channel Flow										
Flow Length (m)	25	-	105	-	425	-	140	120	360	94
Velocity (m/s)	0.3	-	0.3	-	0.3	-	0.3	0.3	0.3	0.3
Slope (%)	0.3	-	0.3	-	0.1	-	0.6	0.3	0.3	0.2
t (min)	1.4	-	5.8	-	23.6	-	7.8	6.7	20.0	5.2
Pipe Flow										
Flow Length (m)	100	500	85	250	-	115	-	-	-	-
Velocity (m/s)	1.0	1.0	1.0	1.0	-	1.0	-	-	-	-
Slope (%)	1.0	1.0	1.0	1.0	-	1.0	-	-	-	-
t (min)	1.7	8.3	1.4	4.2	-	1.9	-	-	-	-
TOTAL t_c (min)	8.1	13.3	12.3	9.2	48.5	7.8	38.3	20.60	52.9	43.6



Rainfall Intensity

Based on the calculated t_c for each catchment, Intensity-Frequency-Duration data (IFD) has been obtained from the Bureau of Meteorology for nominated AEP's and the existing and developed cases are presented in Tables C.5 and C.6, respectively.

Table C.5 Rainfall Intensity (mm/h) – Existing Case

Catchment ID	I_2	I_5	I_{10}	I_{20}	I_{50}	I_{100}
Ext A(1)	45.9	55.2	63.2	72.4	85.1	95.2
Ext C(1)	52.3	62.8	71.8	82.3	96.6	107.6
A	66.9	80.5	92.1	105.4	123.1	137.3
B1	72.1	86.9	99.4	113.5	133.3	148.3
B2	53.5	64.2	73.4	84.1	98.6	110.0
B3	90.4	109.2	125.4	142.8	167.5	185.9
D	58.5	70.3	80.4	92.1	107.7	120.1
E	57.4	69.0	78.9	90.4	105.8	118.0
F	66.9	80.5	92.1	105.4	123.1	137.3

Table C.6 Rainfall Intensity (mm/h)– Developed Case

Catchment ID	I_2	I_5	I_{10}	I_{20}	I_{50}	I_{100}
A	122.5	147.4	169.0	193.9	227.0	253.3
B	100.2	121.0	139.0	158.7	186.0	206.7
C1	104.0	125.6	144.2	165.0	193.2	214.9
C2	116.5	140.3	161.0	184.8	216.1	241.1
C3	49.0	58.8	67.3	77.1	90.6	101.1
D	124.2	149.4	171.2	196.5	230.1	256.8
E	57.4	69.0	78.9	90.4	105.8	118.0
B2(Remain)	80.3	96.9	110.8	126.6	148.1	164.9
Ext A(1)	46.4	55.7	63.8	73.1	86.0	96.2
Ext C(1)	52.3	62.8	71.8	82.3	96.6	107.6

Peak Discharge

Based on the above parameters, estimates of the expected peak discharge generated for the site's existing and developed catchments for nominated AEP's have been calculated, and are presented in Tables C.7 and C.8, respectively.

Table C.7 Peak Discharge (m³/s) – Existing Case

Catchment ID		Annual Exceedance Probability (AEP)					
		0.393 (2 yr ARI)	0.181 (5 yr ARI)	0.095 (10 yr ARI)	0.049 (20 yr ARI)	0.02 (50 yr ARI)	0.01 (100 yr ARI)
External	Ext A(1)	0.299	0.401	0.483	0.582	0.749	0.875
	Ext C(1)	0.357	0.478	0.576	0.693	0.891	1.036
Internal	A	0.064	0.087	0.104	0.125	0.160	0.187
	B1	0.069	0.092	0.111	0.133	0.172	0.199
	B2	0.853	1.145	1.379	1.658	2.130	2.478
	B3	0.065	0.088	0.107	0.128	0.164	0.190
	D	0.130	0.174	0.210	0.253	0.323	0.377
	E	0.179	0.241	0.290	0.349	0.447	0.520
	F	0.039	0.052	0.063	0.076	0.097	0.113
	Ext A(1)	0.299	0.401	0.483	0.582	0.749	0.875
	Ext C(1)	0.357	0.478	0.576	0.693	0.891	1.036



Table C.8 Peak Discharge (m³/s) – Developed Case

Catchment ID		Annual Exceedance Probability (AEP)					
		0.393 (2 yr ARI)	0.181 (5 yr ARI)	0.095 (10 yr ARI)	0.049 (20 yr ARI)	0.02 (50 yr ARI)	0.01 (100 yr ARI)
Internal	A	0.114	0.154	0.185	0.223	0.286	0.334
	B	3.244	4.379	5.295	6.346	8.148	9.447
	C1	0.106	0.144	0.174	0.209	0.267	0.311
	C2	1.584	2.133	2.576	3.105	3.977	4.630
	C3	0.518	0.695	0.836	1.006	1.295	1.509
	D	0.138	0.185	0.223	0.269	0.345	0.402
	E	0.153	0.206	0.248	0.299	0.382	0.445
	B2(Remain)	0.044	0.060	0.072	0.087	0.111	0.129
	Ext A(1)	0.491	0.659	0.794	0.955	1.230	1.436
	Ext C(1)	0.428	0.574	0.692	0.832	1.069	1.244



Appendix F

MUSIC Modelling - Life Cycle Costing Results



RESULTS SUMMARY

Option 1

Street Scape Bioretention (1) - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	25	Renewal/Adaptation Cost	\$206	Real Discount Rate (%)	5.50
Acquisition Cost	\$8,000	Renewal Period (yrs)	1	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	\$500	Decommissioning Cost	\$4,120	Base Year for Costing	2018
Annual Establishment Cost	\$750	Establishment Period (yrs)	1		

Costing Results

Life Cycle Cost of Street Scape Bioretention (1) (\$2018)	\$19,119
Equivalent Annual Payment Cost of the Asset (\$2018/annum)	\$765
Equivalent Annual Payment per m3/s maximum flow reduction	invalid
Equivalent Annual Payment/ML flow reduction/annum	\$10,575.40
Equivalent Annual Payment/kg Total Suspended Solids/annum	\$2.61
Equivalent Annual Payment/kg Total Phosphorus/annum	\$2,092.72
Equivalent Annual Payment/kg Total Nitrogen/annum	\$351.12
Equivalent Annual Payment/kg Gross Pollutant/annum	\$16.39

Close

Option 2

1 x Streetscape Bioretention - Type 3 - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	\$3,770	Real Discount Rate (%)	5.50
Acquisition Cost	\$5,855	Renewal Period (yrs)	25	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	\$450	Decommissioning Cost	\$3,015	Base Year for Costing	2018
Annual Establishment Cost	\$675	Establishment Period (yrs)	1		

Costing Results

Life Cycle Cost of 1 x Streetscape Bioretention - Type 3 (\$2018)	\$15,326
Equivalent Annual Payment Cost of the Asset (\$2018/annum)	\$307
Equivalent Annual Payment per m3/s maximum flow reduction	invalid
Equivalent Annual Payment/ML flow reduction/annum	\$4,970.85
Equivalent Annual Payment/kg Total Suspended Solids/annum	\$1.32
Equivalent Annual Payment/kg Total Phosphorus/annum	\$890.92
Equivalent Annual Payment/kg Total Nitrogen/annum	\$156.53
Equivalent Annual Payment/kg Gross Pollutant/annum	\$9.29

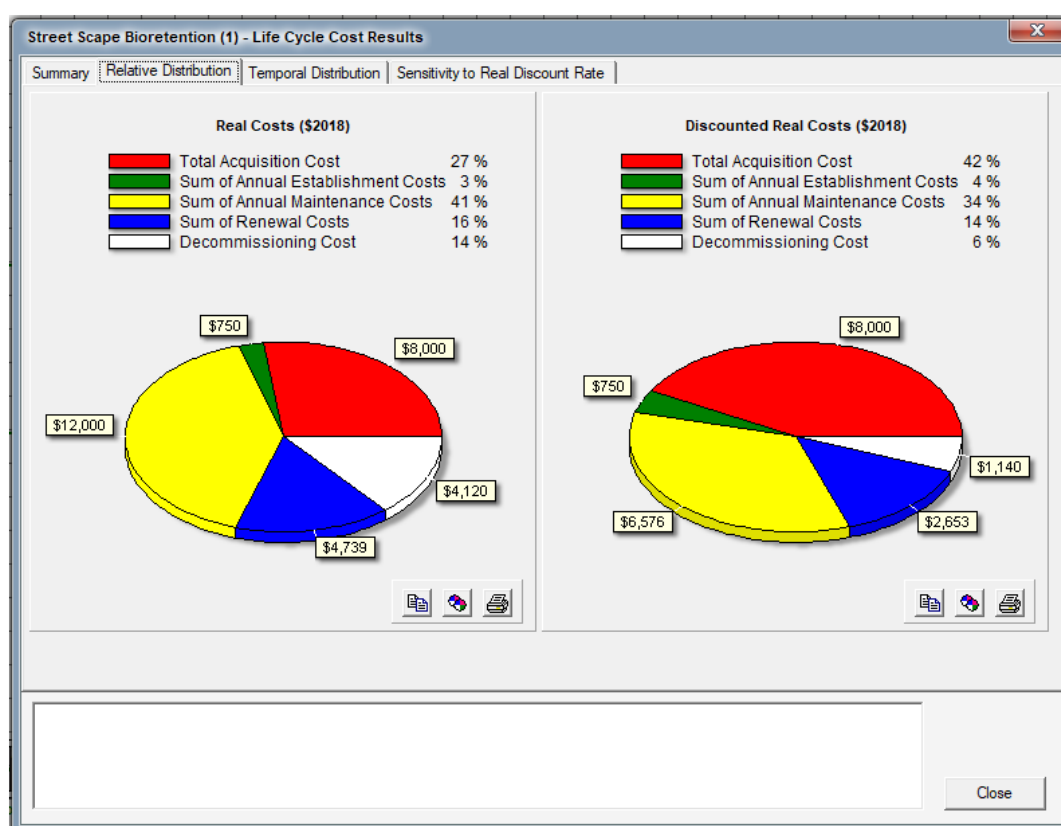
Close

RELATIVE DISTRIBUTION RESULTS



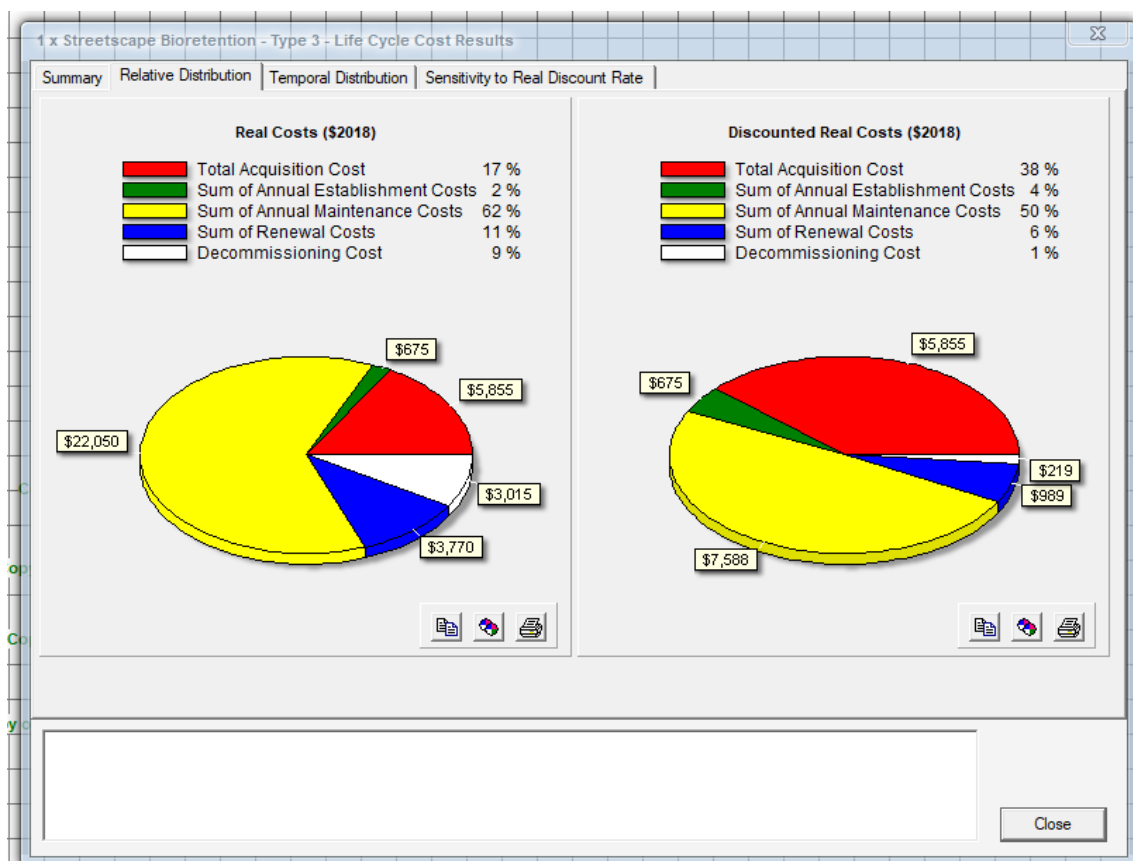
Option 1

Real Costs (\$2018)	Cost (\$)	% of Total Cost
Total Acquisition Cost	\$8,000	27%
Sum of Annual Establishment Costs	\$750	3%
Sum of Annual Maintenance Costs	\$12,000	41%
Sum of Renewal Costs	\$4,739	16%
Decommissioning Cost	\$4,120	14%
TOTAL	\$29,609	100%
Discounted Real Costs (\$2018)	Cost (\$)	% of Total Cost
Total Acquisition Cost	\$8,000	42%
Sum of Annual Establishment Costs	\$750	4%
Sum of Annual Maintenance Costs	\$6,576	34%
Sum of Renewal Costs	\$2,653	14%
Decommissioning Cost	\$1,140	6%
Total	\$19,119	100%



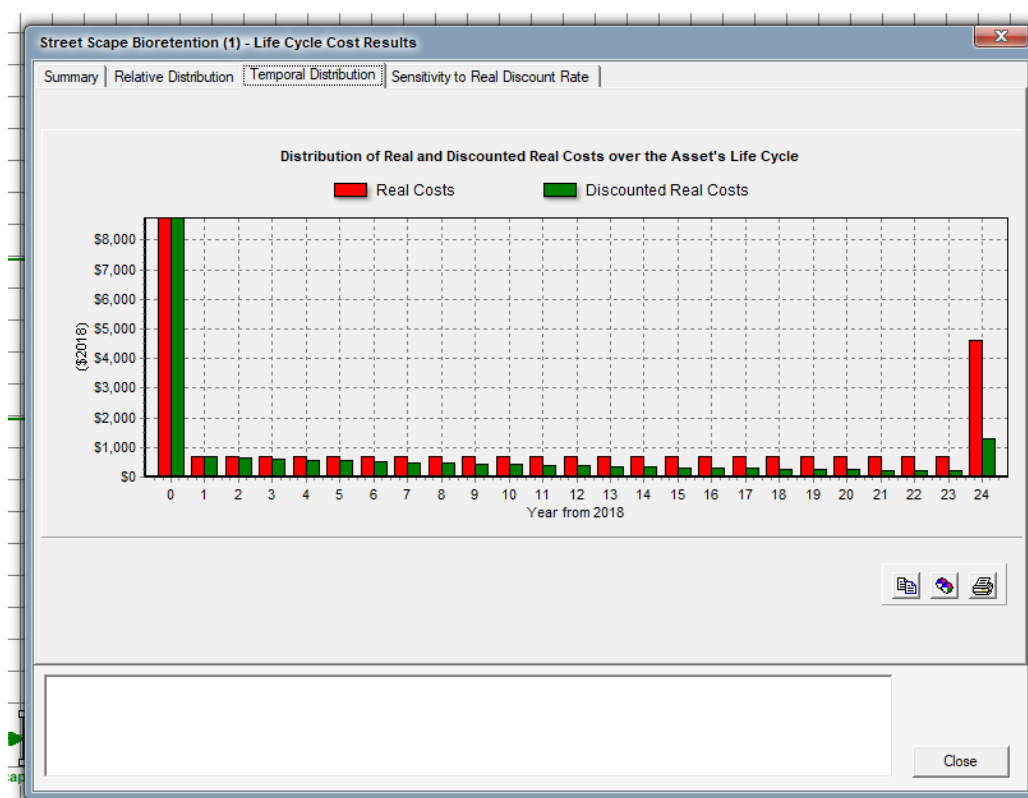
Option 2

Real Costs (\$2018)	Cost (\$)	% of Total Cost
Total Acquisition Cost	\$5,855	17%
Sum of Annual Establishment Costs	\$675	2%
Sum of Annual Maintenance Costs	\$22,050	62%
Sum of Renewal Costs	\$3,770	11%
Decommissioning Cost	\$3,015	9%
TOTAL	\$35,366	
Discounted Real Costs (\$2018)	Cost (\$)	% of Total Cost
Total Acquisition Cost	\$5,855	38%
Sum of Annual Establishment Costs	\$675	4%
Sum of Annual Maintenance Costs	\$7,588	50%
Sum of Renewal Costs	\$989	6%
Decommissioning Cost	\$219	1%
Total	\$15,326	



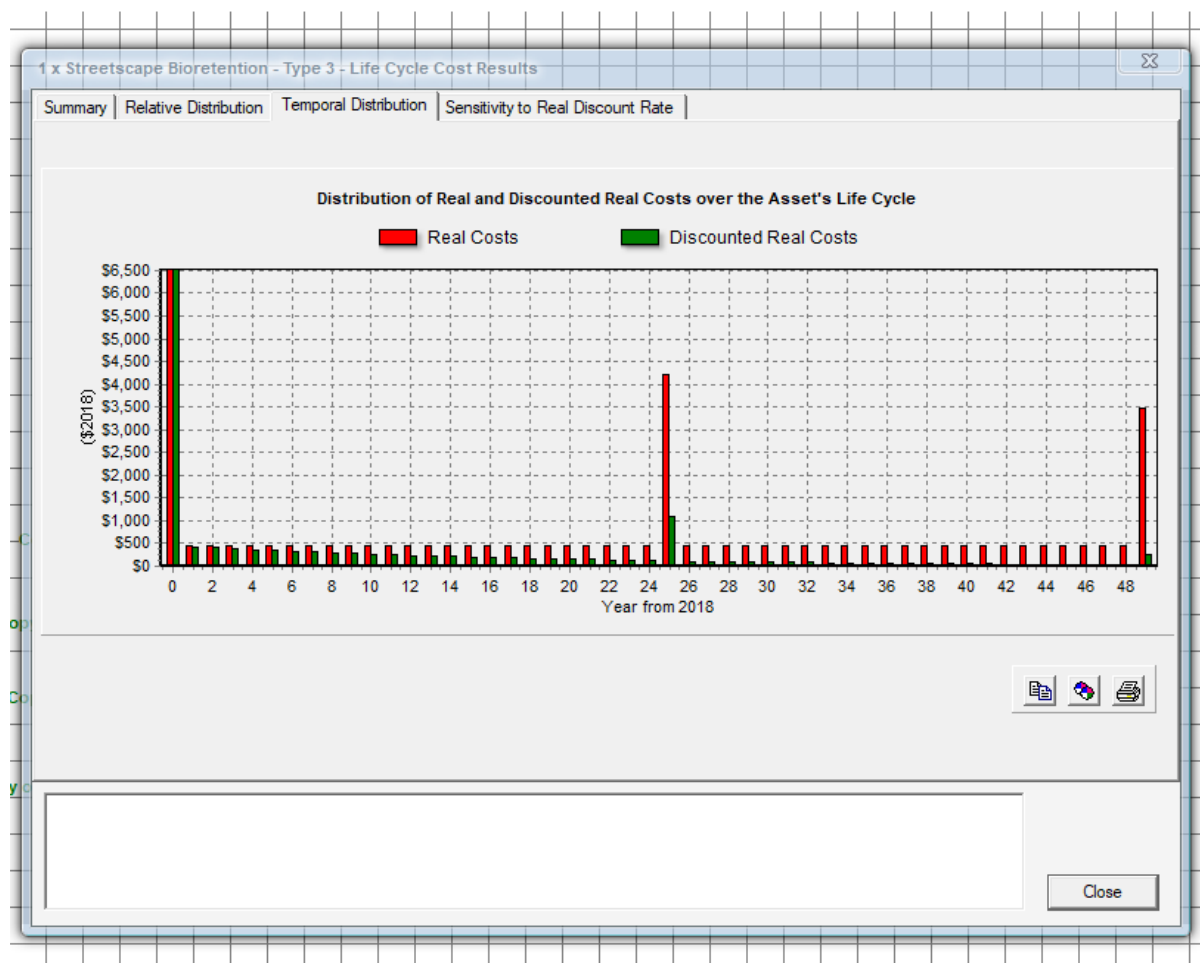
TEMPORAL DISTRIBUTION COSTS

Option 1



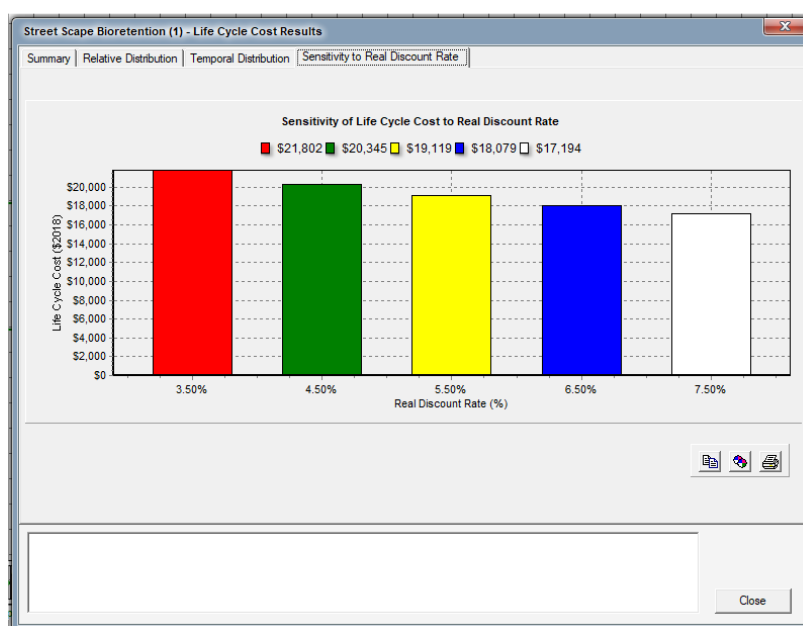


Option 2



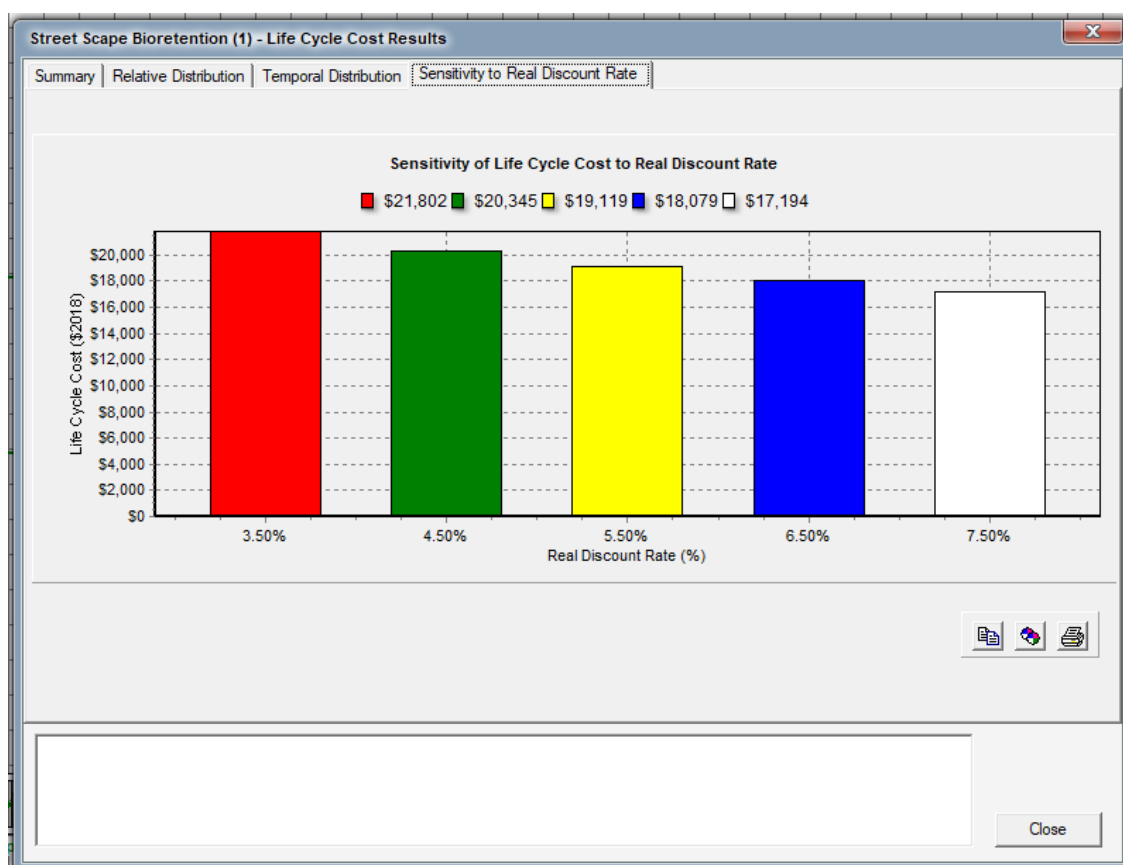
SENSITIVITY TO REAL DISCOUNT RATE

Option 1





Option 2





Appendix G

Bioretention System Maintenance Checklist

Bioretention System Maintenance Checklist			
Inspection frequency		Date of Visit	
Date of last rainfall		Weather	
Location		Asset ID	
Site visit by		Signature	
Asset Plan: 			
Site Photo Explanatory notes: 1. 2. 3. 4. 5. 6.			
General Comments/Sketches 			



What to Look For	Performance Indicator	Condition Rating*	Maintenance Undertaken**	Additional Work Needed
SURROUNDS				
Damage or removed structures	No damage that poses a risk to public or structural integrity.	.		
INLET				
Erosion	Inlet is structurally sound and there is no evidence of erosion or subsidence/settlement.			
Damage or removed structures	No damage that poses a risk to public or structural integrity.			
Sediment, litter or debris	No blockage.			
COARSE SEDIMENT/ ROCK SCOUR PAD				
Erosion	Minor erosion only that does not pose a risk to public safety or structural integrity and would not worsen if left unattended.			
Sediment	<75% full and no litter.			
BATTER SLOPES AND BASE INVERT				
Erosion	Minor erosion only that does not pose a risk to public safety or structural integrity and would not worsen if left unattended.			
Crust of fine sediment	No surface crusting.			
Depression or mounds	No surface depressions or mounds > 100 mm.			
Hydraulic conductivity or permeability	Filter media is draining freely, whereby water is not ponded on the surface for more than 12 hours after rainfall and there is no obvious impermeable or			



What to Look For	Performance Indicator	Condition Rating*	Maintenance Undertaken**	Additional Work Needed
	clay-like surface on the filter media.			
Underdrains/clean out points	Clean out points not damaged and end caps securely in place.			
Litter	Maximum 1 piece per 4 m ² .			
Unusual odours, colours or substances (e.g. oil and grease)	None Detected.			
Vegetation	Minimum 95% vegetation cover.			
	Plants healthy and free from disease.			
	Average plant height > 500 mm.			
	No declared weeds.			
	Maximum 10% cover weeds.			
Algal or moss growth	Maximum 10% of surface covered in algae.			
	No Moss growth.			
OUTLET				
Erosion	Outlet is structurally sound and there is no evidence of erosion or subsidence/settlement, including around edges or rock protection or toe of weir.			
Damage or removed structures	No damage that poses a risk to public or structural integrity.			
Sediment, litter debris	No blockage.			
Outlet Freely Draining	No downstream impediments to the release of water, no erosion or damage to the outfall structure and no evidence of malfunction.			

* 1 = PI met; 2 = PI met after maintenance activity undertaken; 3 = Additional maintenance needed; 4 = Rectification may be needed; NI = not inspected; NA = not applicable

** Quantify where possible e.g. amount of sediment or litter removed

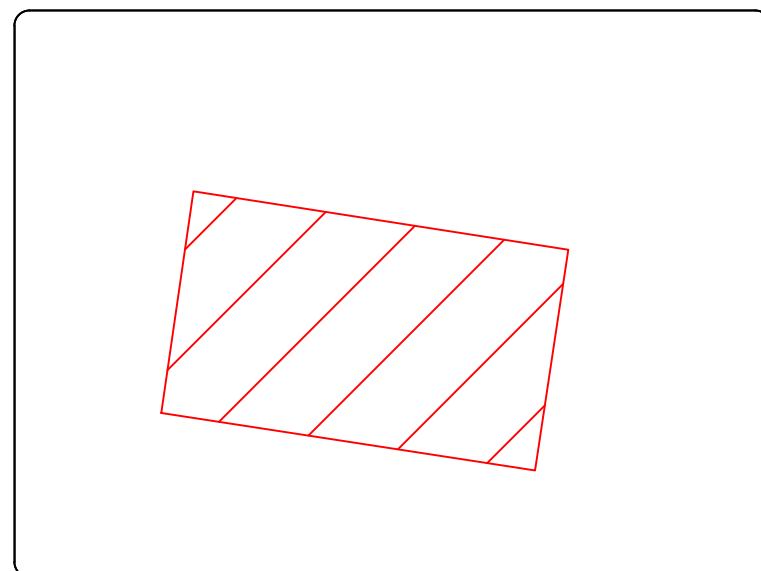
EROSION AND SEDIMENT CONTROL DRAWINGS

YAMBA GARDENS - Earthworks Phases 2-4
52-54 Miles Street, Yamba

for
Kahuna No. 1 Pty Ltd

Project No: BC-18008

May 2021



Site Location

BIOME Consulting Pty Ltd
Unit 30201, Southport Central Tower 3,
9 Lawson St, Southport QLD 4215
PO Box 3469, Australia Fair, Southport
O 07 5532 7779
M 0415 935 222
E brad@BIOMEconsulting.com.au
W www.BIOMEconsulting.com.au
ABN 86 166 087 476

SCHEDULE OF DRAWINGS

Drawing No.	Drawing Title
DWG-000	LOCALITY AND DRAWING INDEX PLAN
DWG-100	GENERAL NOTES, DESIGN STANDARDS
DWG-101	ESC PROGRAM TABLE
DWG-102	EXISTING SITE DRAWING
DWG-201	EARTHWORKS - STAGE 3
DWG-300	CATCHMENT PLAN (PRE-EARTHWORKS)
DWG-301	SEDIMENT/DETENTION BASIN CATCHMENT PLAN
DWG-400	EROSION & SEDIMENT CONTROL - SITE COMPOUND
DWG-401	EROSION & SEDIMENT CONTROL - PHASE 2
DWG-402	EROSION & SEDIMENT CONTROL - PHASE 3 (S1-3)
DWG-403	EROSION & SEDIMENT CONTROL - PHASE 3 (S4-6)
DWG-404	EROSION & SEDIMENT CONTROL - PHASE 4
DWG-405	EARTHWORKS FINISHED SURFACE TREATMENTS
DWG-500	STOCKPILE MANAGEMENT PLAN
DWG-501	ESC TYPICAL DETAILS SHEET
DWG-502	DETENTION BASIN B TYPICAL DETAILS
DWG-503	DETENTION BASIN C TYPICAL DETAILS
DWG-504	SEDIMENT BASIN, CWD/ CATCH DRAIN SIZING
DWG-600	MAINTENANCE AND MONITORING
DWG-700	ESC CHECKLIST

CERTIFIED BY


BRAD CONLEY
CPESC NO. 9328



GENERAL NOTES:

1. PRIOR TO THE COMMENCEMENT OF SITE WORKS, THE LOCATION OF THE SITE ACCESS POINTS MUST BE VERIFIED WITH THE LOCAL AUTHORITY.
2. SITE EXIT POINTS MUST BE APPROPRIATELY MANAGED TO MINIMISE THE RISK OF SEDIMENT BEING TRACKED ONTO SEALED, PUBLIC ROADWAYS.
3. THE NUMBER OF SITE ACCESS POINTS IS TO BE KEPT TO A MINIMUM WHERE REASONABLE AND PRACTICABLE.
4. STOCKPILES (WHERE APPLICABLE) ARE TO BE LOCATED AT LEAST 5M AWAY FROM TOP OF WATERCOURSE BANKS.
5. ADEQUATE STOCKPILES OF EMERGENCY EROSION AND SEDIMENT CONTROL (ESC) MATERIALS ARE TO BE KEPT ON SITE.
6. THE CONTRACTOR IS TO ENSURE THE SITE IS ADEQUATELY PREPARED FOR ANTICIPATED WEATHER CONDITIONS.
7. THE CONTRACTOR IS TO ENSURE ALL EROSION AND SEDIMENT CONTROL MEASURES ARE MAINTAINED IN PROPER WORKING ORDER AND FUNCTIONING AS DESIGNED.
8. THE CONTRACTOR IS TO ENSURE SITE PERSONNEL ARE MADE AWARE OF THE EROSION AND SEDIMENT CONTROL REQUIREMENTS AND HAVE READY ACCESS TO THE APPROVED EROSION AND SEDIMENT CONTROL PLAN (ESCP).
9. ALL ESC MEASURES ARE TO BE INSTALLED IN ACCORDANCE WITH APPROVED SEQUENCING.
10. TO MINIMISE THE RISK OF SEDIMENTATION, PERMANENT ROADS ARE TO BE PROGRAMMED FOR SEALING AS SOON AS REASONABLE AND PRACTICABLE.
11. STOCKPILES OF ERODIBLE MATERIAL THAT HAVE THE POTENTIAL TO CAUSE ENVIRONMENTAL HARM IF DISPLACED MUST BE APPROPRIATELY PROTECTED FROM WIND, RAIN, CONCENTRATED SURFACE FLOW AND EXCESSIVE UP-SLOPE STORMWATER SURFACE FLOWS.
12. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO CONTROL AND MINIMISE EROSION AND DOWNSTREAM SEDIMENTATION DURING ALL STAGES OF CONSTRUCTION.
13. THE CONTRACTOR IN CONJUNCTION WITH THE ENVIRONMENTAL ENGINEER IS TO MAINTAIN A WATER QUALITY. THE LOG SHALL NOMINATE DATE, TESTS UNDERTAKEN, RESULTS, NOTES AND CORRECTIVE ACTIONS UNDERTAKEN.
14. PLANS AND ALL CALCULATIONS HAVE BEEN CONDUCTED IN ACCORDANCE WITH THE INTERNATIONAL EROSION CONTROL ASSOCIATION (IECA) BEST PRACTICE EROSION AND SEDIMENT CONTROL GUIDELINES, NOVEMBER 2008, LANDCOM (2004) MANAGING URBAN STORMWATER: SOILS AND CONSTRUCTION (4TH EDITION), AND NORTHERN RIVERS – LOCAL GOVERNMENT (2013), DEVELOPMENT DESIGN SPECIFICATION – D7, EROSION CONTROL AND STORMWATER MANAGEMENT.
15. SUITABLE ALL-WEATHER MAINTENANCE ACCESS MUST BE PROVIDED TO ALL SEDIMENT CONTROL DEVICES.
16. ALL SEDIMENT CONTROL DEVICES MUST BE DE-SILTED AND MADE FULLY OPERATIONAL AS SOON AS REASONABLE AND PRACTICABLE AFTER A SEDIMENT PRODUCING EVENT, WHETHER NATURAL OR ARTIFICIAL, IF THE DEVICE’S SEDIMENT RETENTION CAPACITY FALLS BELOW 75% OF ITS DESIGN RETENTION CAPACITY.
17. ALL UNSTABLE OR DISTURBED SOIL SURFACES MUST BE ADEQUATELY STABILISED AGAINST EROSION (MINIMUM 70% OR AS SPECIFIED BY COUNCIL) PRIOR TO THE REMOVAL OR DISCONTINUATION OF EROSION & SEDIMENT CONTROLS.

TABLE B1 - SEDIMENT CONTROL STANDARD (DEFAULT) BASED ON SOIL LOSS RATE

CATCHMENT AREA (m ²) ^[1]	SOIL LOSS (t/ha/yr) ^[2]			SOIL LOSS (t/ha/month) ^[3]		
	TYPE 1	TYPE 2	TYPE 3	TYPE 1	TYPE 2	TYPE 3
250	N/A	N/A	[4]	N/A	N/A	[4]
1000	N/A	N/A	ALL CASES	N/A	N/A	ALL CASES
2500	N/A	> 75	75	N/A	> 6.25	6.25
> 2500	> 150	150	75	> 12.5	12.5	6.25
> 10,000	> 75	N/A	75	> 6.25	N/A	6.25

NOTES:

- [1] AREA IS DEFINED BY THE CATCHMENT AREA DRAINING TO A GIVEN SITE DISCHARGE. SUB-DIVIDING A GIVEN DRAINAGE CATCHMENT SHALL NOT REDUCE ITS 'EFFECTIVE AREA' IF RUNOFF FROM THESE SUB-AREAS ULTIMATELY DISCHARGES FROM THE SITE AT THE SAME GENERAL LOCATION. THE 'AREA' DOES NOT INCLUDE ANY 'CLEAN' WATER CATCHMENT THAT BYPASSES THE SEDIMENT TRAP. THE CATCHMENT AREA SHALL BE DEFINED BY THE 'WORST CASE' SCENARIO, I.E. THE LARGEST EFFECTIVE AREA THAT EXISTS AT ANY INSTANCE DURING THE SOIL DISTURBANCE.
- [2] SOIL LOSS DEFINES THE MAXIMUM ALLOWABLE SOIL LOSS RATE (BASED ON RUSLE ANALYSIS) FROM A GIVEN CATCHMENT AREA. A SLOPE LENGTH OF 80 M SHOULD BE ADOPTED WITHIN THE RUSLE ANALYSIS UNLESS PERMANENT DRAINAGE OR LANDSCAPE FEATURES REDUCE THIS LENGTH.
- [3] RUSLE ANALYSIS ON A MONTHLY BASIS SHALL ONLY APPLY IN CIRCUMSTANCES WHERE THE TIMING OF THE SOIL DISTURBANCE IS/SHALL BE REGULATED BY ENFORCEABLE DEVELOPMENT APPROVAL CONDITIONS. WHEN CONDUCTING MONTHLY RUSLE CALCULATIONS, USE THE WORST-CASE MONTHLY R-FACTOR DURING THE NOMINATED PERIOD OF DISTURBANCE.
- [4] REFER TO THE RELEVANT REGULATORY AUTHORITY FOR ASSESSMENT PROCEDURES. THE DEFAULT STANDARD IS A TYPE 3 SEDIMENT TRAP.
- [5] EXCEPTIONS TO THE USE OF SEDIMENT BASINS SHALL APPLY IN CIRCUMSTANCES WHERE IT CAN BE DEMONSTRATED THAT THE CONSTRUCTION AND/OR OPERATION OF A SEDIMENT BASIN IS NOT PRACTICAL, SUCH AS IN MANY FORMS OF LINEAR CONSTRUCTION WHERE THE AVAILABLE WORK SPACE OR RIGHT OF WAY DOES NOT PROVIDE SUFFICIENT LAND AREA. IN THESE INSTANCES, THE FOCUS MUST BE EROSION CONTROL USING TECHNIQUES TO ACHIEVE AN EQUIVALENT OUTCOME. THE 'INTENT' SHALL ALWAYS BE TO TAKE ALL REASONABLE AND PRACTICABLE MEASURES TO PREVENT OR MINIMISE POTENTIAL ENVIRONMENTAL HARM.

IECA TABLE 4.3.1 - DRAINAGE DESIGN STANDARD FOR TEMPORARY DRAINAGE WORKS

DRAINAGE STRUCTURE	ANTICIPATED DESIGN LIFE		
	<12 MONTHS	12-24 MONTHS	> 24 MONTHS
TEMPORARY DRAINAGE STRUCTURES ⁽¹⁾ QUEENSLAND, NORTHERN TERRITORY, AND NORTHERN WESTERN AUSTRALIA	1 IN 2 YEAR	1 IN 5 YEAR	1 IN 10 YEAR
TEMPORARY DRAINAGE STRUCTURES ⁽¹⁾ NEW SOUTH WALES, VICTORIA, TASMANIA, SOUTH AUSTRALIA AND SOUTHERN WESTERN AUSTRALIA	1 IN 5 YEAR	1 IN 10 YEAR	1 IN 10 YEAR
TEMPORARY DRAINAGE STRUCTURES (E.G. CATCH DRAIN, FLOW DIVERSION BANK) LOCATED IMMEDIATELY UP-SLOPE OF AN OCCUPIED PROPERTY THAT WOULD BE ADVERSELY AFFECTED BY THE FAILURE OR OVERTOPPING OF THE STRUCTURE. ^{(1),(2)}	1 IN 10 YEAR	1 IN 10 YEAR	1 IN 10 YEAR
TEMPORARY CULVERT CROSSING	MINIMUM 1 IN 1 YEAR ARI HYDRAULIC CAPACITY WHEREVER REASONABLE AND PRACTICABLE.		

DESIGN EVENT

- NOTES: [1] DESIGN CAPACITY EXCLUDES MINIMUM 150mm FREEBOARD.
- [2] DESIGN FLOW RATE BASED ON UP-SLOPE DRAINAGE STRUCTURES OPERATING IN ACCORDANCE WITH THEIR DESIGN CAPACITY EXCLUDING FREEBOARD, I.E. ANY CONSTRUCTED FREEBOARD IS ASSUMED TO HAVE BEEN WASHED AWAY OR OTHERWISE DEACTIVATED.

TYPICAL OPERATIONAL CONDITIONS OF TYPE D SEDIMENT BASINS

ARRTIBUTE	TYPE D
DESIRABLE BASIN WATER LEVEL BEFORE STORM	FULLY DRAINED SETTLING ZONE
ALLOWABLE INTER-STORM BASIN WATER LEVEL DURING SPECIFIC WEATHER CONDITIONS	BASIN TO BE EMPTIED WITHIN 5 DAYS. UNDER CERTAIN CONDITIONS, <u>MUST</u> BE DE-WATERED PRIOR TO AN IMMINENT STORM. THESE 'CONDITIONS' MAY INCLUDE A SPECIFIED WET SEASON, OR WHEN WEATHER FORECASTING PREDICTS A STORM EVENT.
DE-WATERING SYSTEM	N/A
CHEMICAL TREATMENT	AS REQUIRED, APPLICATION TYPE & METHODOLOGIES TO BE GENERALLY IN ACCORDANCE WITH APPENDIX E OF SOILS & CONSTRUCTION (4TH EDITION, LANDCOM 2004)

DATE

25.05.21

PROJECT No. :

BC-18008

DRAWING No. :

DWG-100

REVISION No. :

A

PROJECT

YAMBA GARDENS - EARTHWORKS PHASES 2-4

DRAWING TITLE

GENERAL NOTES

CLIENT

KAHUNA NO.1 PTY LTD

ADDRESS:

52-54 MILES ST, YAMBA

DRAFTED BY :
AK

DESIGNED BY :
AK

CHECKED BY:
BC

PAPER SIZE :
A3

SCALE :
AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD ACN 166 087 476 RPEQ No. :			
VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT
Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.



BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

CERTIFIED BY



TABLE 1 : ESC INSTALLATION SEQUENCING/PROGRAM

Item	Dwg	Installed	Removed
Limit of Works			
Mark Limits of disturbance/No Go Areas	33801-PR2-030-A	Prior to prestart meeting	Post construction works
Site Establishment			
Formalise Construction Entry/ Exits	BC-18008-DWG-400	Day 1	On competition of construction works
Formalise Site Compound	BC-18008-DWG-400	Day 1	On competition of construction works
Phase 2			
Progressive Revegetation of Existing Phase 1 Earthworks area	-	Day 1	Maintained until construction/building works commence
Finalise Construction of Detention Basin B	BC-18008-DWG-401 & BC-18008-DWG-502	Day 1	Maintained and formalised as part of future site works.
CWD-1	BC-18008-DWG-401	Day 1	CD-1 Reshaped to form CWD-1. Flows to be conveyed to Detention basin. Removed once catchment fully stabilised.
CD-1	BC-18008-DWG-401	Day 1	CD-1 Reshaped to form CWD-1
SF-1	BC-18008-DWG-401	Day 1 establish at limit of stage works	On completion of works once batters are fully stabilised.
SB-1	BC-18008-DWG-401	Works to Commence Day 1	Removed once contributing catchment fully stabilised (i.e. vegetated/surface covered)
Stabilisation of Stage 1 & 2 Earthworks	BC-18008-DWG-401 & BC-18008-DWG-405	Immediately following completion of relevant stage earthworks.	Maintained until construction/building works commence.
Phase 3			
Progressive Revegetation of Phase 2 Earthworks area	BC-18008-DWG-401 & BC-18008-DWG-405	Day 1	Maintained until construction/building works commence
Construction of Detention Basin C			
CWD-2-6	BC-18008-DWG-402 & BC-18008-DWG-403	Day 1	CD-2-6 Reshaped to form CWD-2-6. Flows to be conveyed to Detention basin (Execpt CD-6). Removed once catchment fully stabilised.
CD-2-6	BC-18008-DWG-402	Day 1	CD-2-6 Reshaped to form CWD-2-6 in relevant stage
SF	BC-18008-DWG-402	Day 1 establish at limit of stage works	On completion of works once batters are fully stabilised.
SB-2 & SB-3	BC-18008-DWG-402 & BC-18008-DWG-403	Works to Commence prior to relevant stage works	Removed once contributing catchment fully stabilised (i.e. vegetated/surface covered)
Stabilisation of Stages 1-6 Earthworks	BC-18008-DWG-402,403 & BC-18008-DWG-405	Immediately following completion of relevant stage earthworks.	Maintained until construction/building works commence.
Phase 4			
Progressive Revegetation of Phase 3 Earthworks area	BC-18008-DWG-402, 403 & BC-18008-DWG-405	Day 1	Maintained until construction/building works commence
CWD-1-2	BC-18008-DWG-404	Day 1	CD-1-2 Reshaped to form CWD-1-2. Flows to be conveyed to Detention basin C. Removed once catchment fully stabilised.
CD-1-2	BC-18008-DWG-404	Day 1	CD-1-2 Reshaped to form CWD-1-2 in relevant stage
SF	BC-18008-DWG-404	Day 1 establish at limit of stage works	On completion of works once batters are fully stabilised.
SB-4	BC-18008-DWG-404	Works to Commence Day 1	Removed once contributing catchment fully stabilised (i.e. vegetated/surface covered)
Stabilisation of Stages 1-2 Earthworks	BC-18008-DWG-404 & BC-18008-DWG-405	Immediately following completion of relevant stage earthworks.	Maintained until construction/building works commence.

NOTE PRELIMINARY PROGRAM SUBJECT TO REVIEW FROM APPOINTED CIVIL CONTRACTOR

DATE
25.05.21

PROJECT No. :
BC-18008

DRAWING No. :
DWG-101

REVISION No. :
A

PROJECT
YAMBA GARDENS - EARTHWORKS PHASES 2-4

DRAWING TITLE
ESC PROGRAM TABLE

CLIENT
KAHUNA NO.1 PTY LTD

ADDRESS:
52-54 MILES ST, YAMBA

DRAFTED BY :
AK

DESIGNED BY :
AK

CHECKED BY:
BC

PAPER SIZE :
A3

SCALE :
AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD
ACN 166 087 476
RPEQ No. :

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT
Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.
Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.
Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

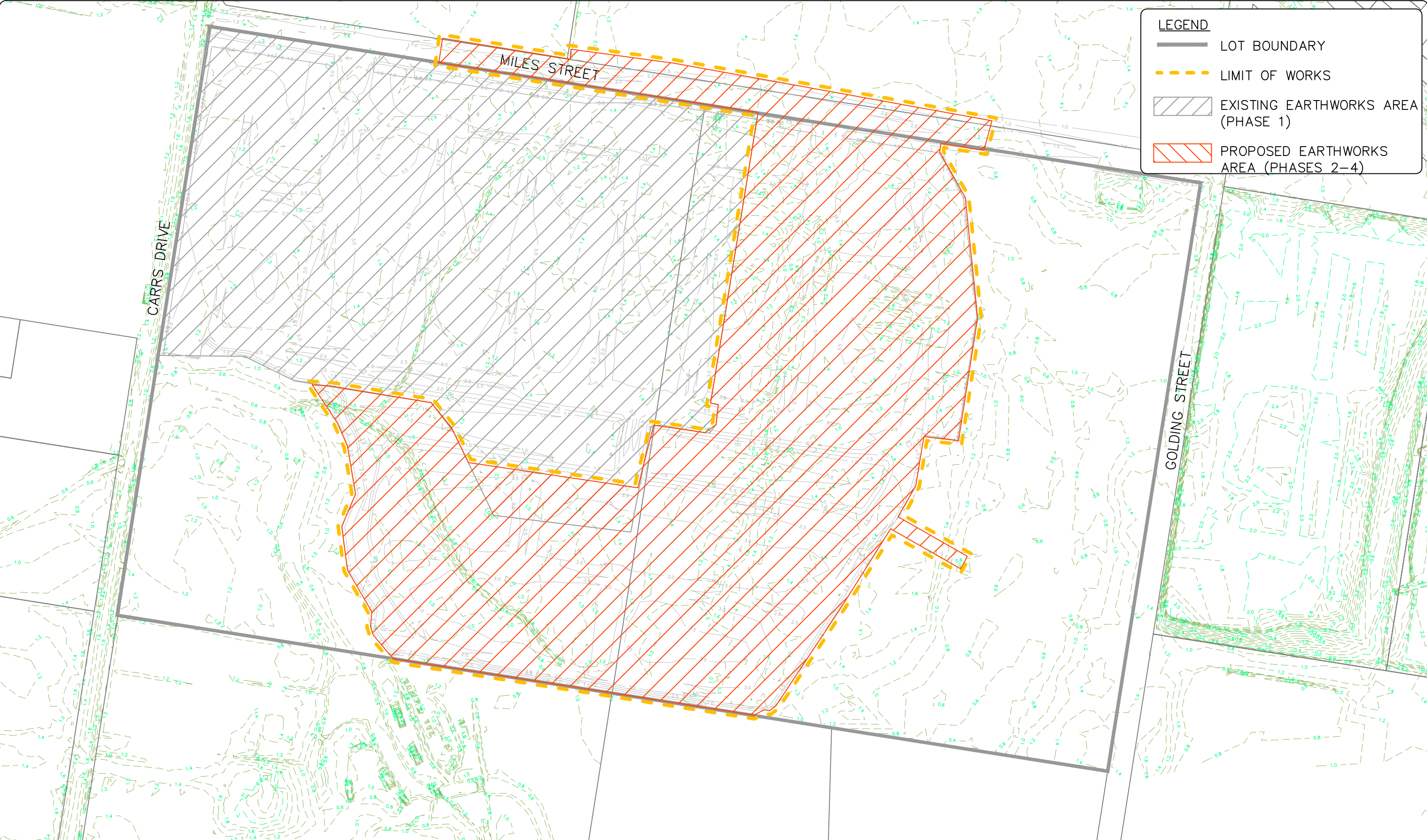


BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

CERTIFIED BY





DATE
25.05.21

PROJECT No. :
BC-18008

DRAWING No. :
DWG-102

REVISION No. :
A

PROJECT
YAMBA GARDENS - EARTHWORKS PHASES 2-4

DRAWING TITLE
EXISTING SITE DRAWING

CLIENT
KAHUNA NO.1 PTY LTD

ADDRESS:
52-54 MILES ST, YAMBA

DRAFTED BY : AK	DESIGNED BY : AK	CHECKED BY : BC	PAPER SIZE : A3	SCALE : AS SHOWN
---------------------------	----------------------------	---------------------------	---------------------------	----------------------------

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD
ACN 166 087 476
RPEQ No. :

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT
Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposes only and are not for construction purposes.



BIOME
WATER AND ENVIRONMENTAL CONSULTING

BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

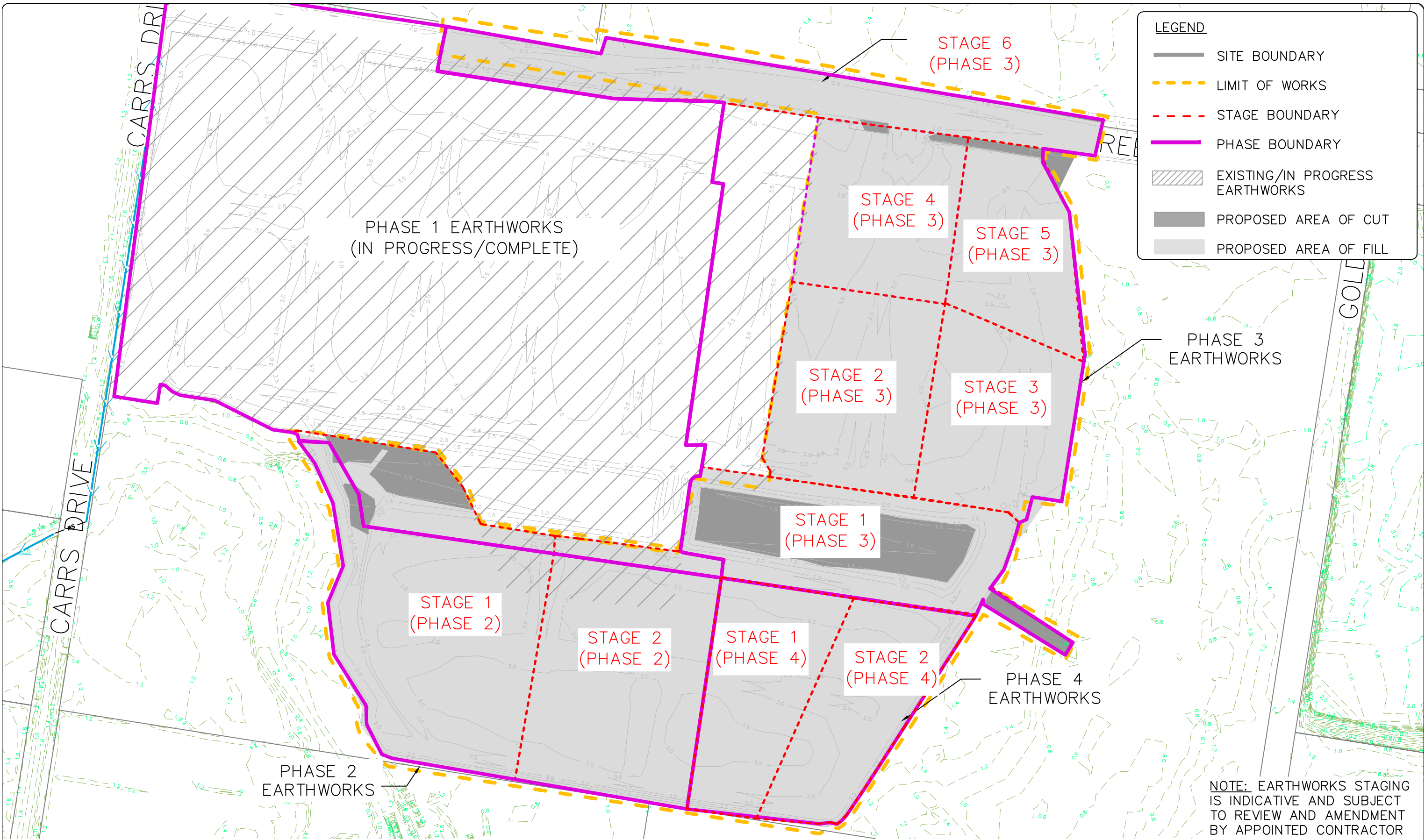
ORIGINAL SCALE BEFORE REDUCTION

40 0 40 80 120 160 200

1 : 4000 (FULL SIZE) (metres)

CERTIFIED BY





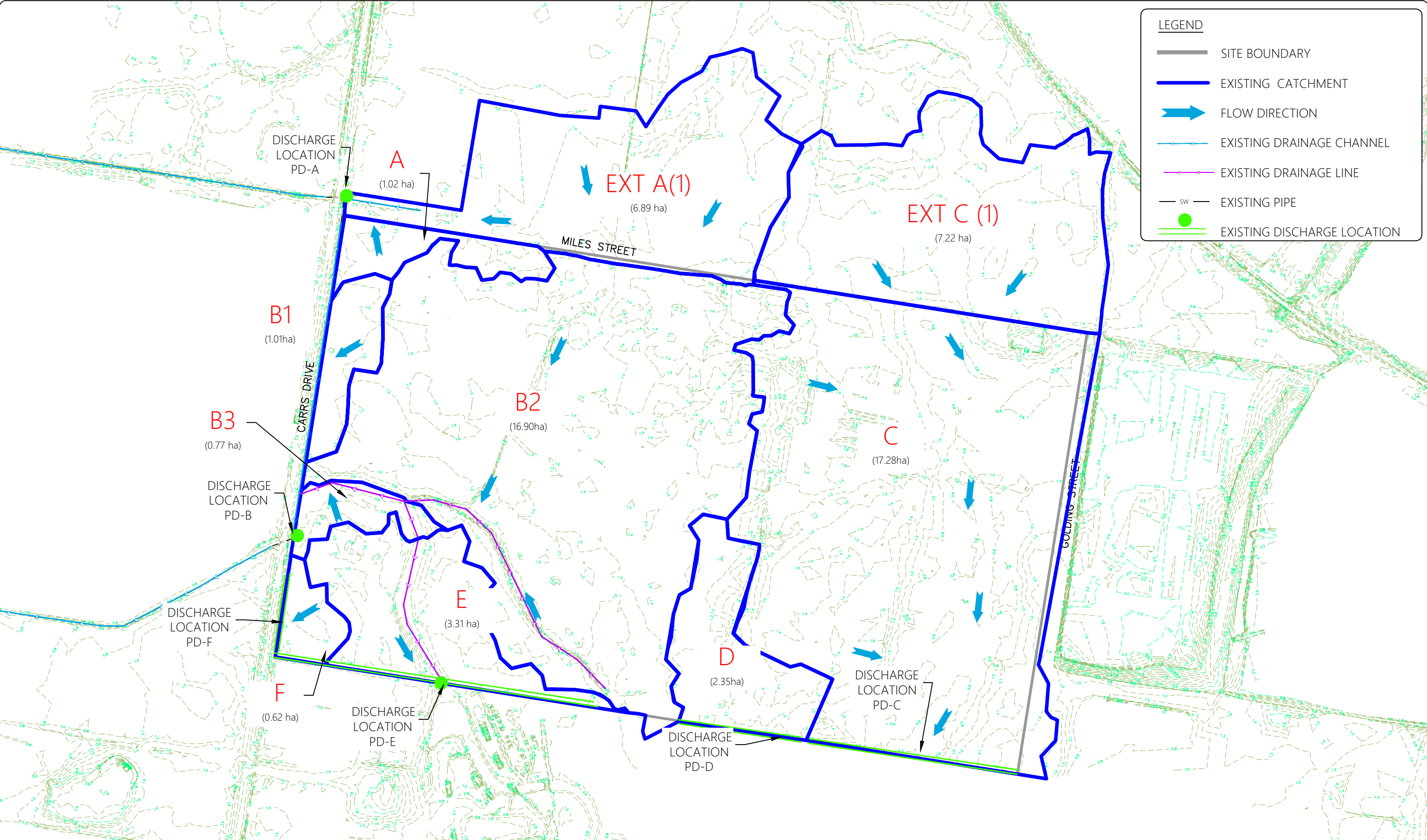
NOTE: EARTHWORKS STAGING IS INDICATIVE AND SUBJECT TO REVIEW AND AMENDMENT BY APPOINTED CONTRACTOR

DATE 25.05.21		PROJECT YAMBA GARDENS - EARTHWORKS PHASES 2-4		APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD ACN 166 087 476 RPEQ No. :		COPYRIGHT Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.		ORIGINAL SCALE BEFORE REDUCTION 25 0 25 50 75 100 125 1 : 2500 (FULL SIZE) (metres)	
PROJECT No. : BC-18008		DRAWING TITLE EARTHWORKS - STAGES				Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.		CERTIFIED BY	
DRAWING No. : DWG-200		CLIENT KAHUNA NO.1 PTY LTD				Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.			
REVISION No. : A		ADDRESS: 52-54 MILES ST, YAMBA							
DRAFTED BY : AK		DESIGNED BY : AK		CHECKED BY : BC		PAPER SIZE : A3			
						SCALE : AS SHOWN			

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21



BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476



DATE
25.05.21

PROJECT No. :
BC-18008

DRAWING No. :
DWG-200

REVISION No. :
A

PROJECT
YAMBA GARDENS - EARTHWORKS PHASES 2-4

DRAWING TITLE
EXISTING CATCHMENT PLAN

CLIENT
KAHUNA NO.1 PTY LTD

ADDRESS:
52-54 MILES ST, YAMBA

DRAFTED BY :
AK

DESIGNED BY :
AK

CHECKED BY :
BC

PAPER SIZE :
A3

SCALE :
AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD ACN 166 087 476 RPEQ No. :			
VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT
Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

BIOME
WATER AND ENVIRONMENTAL CONSULTING

BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

40

0

40

80

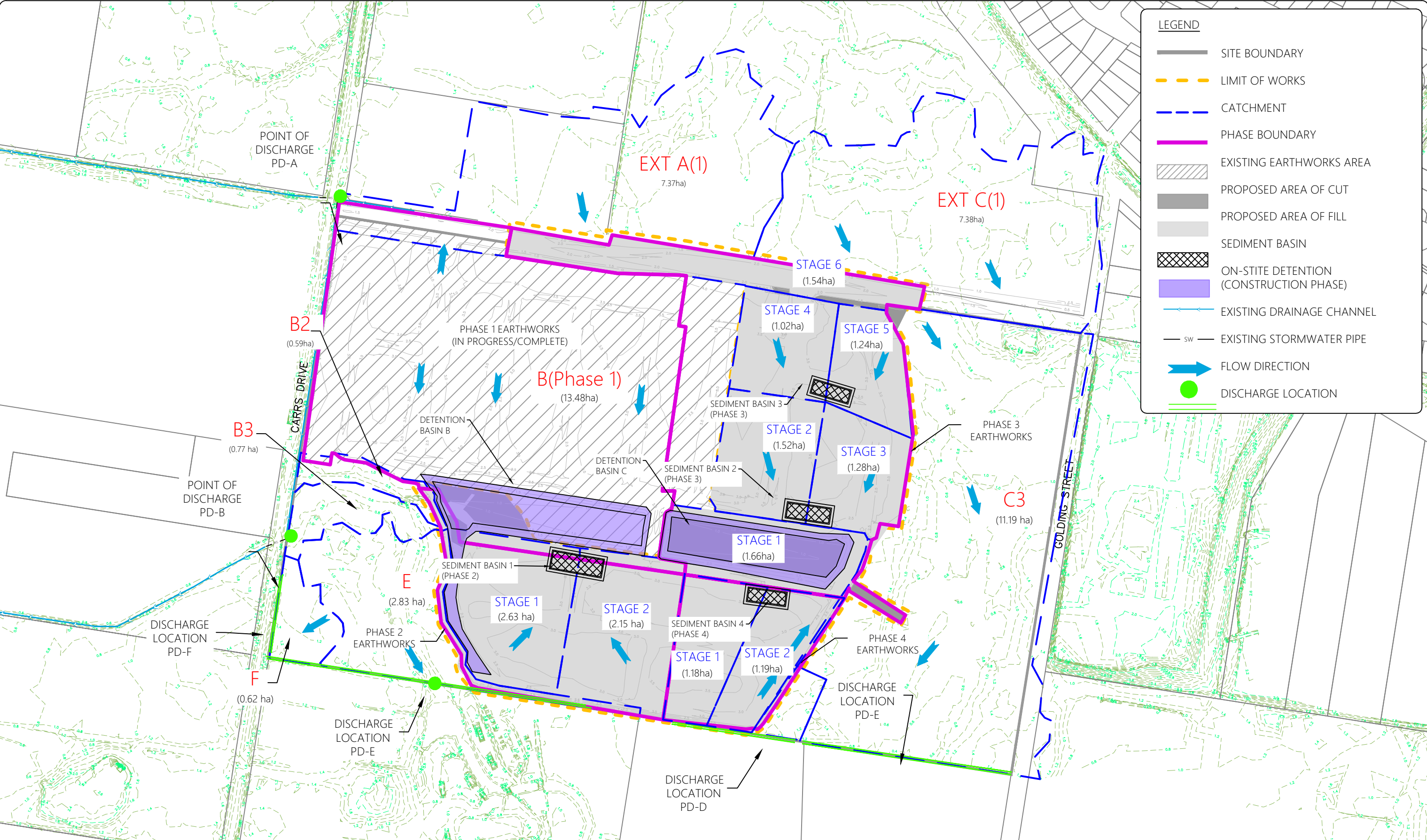
120

160

200

1 : 4000 (FULL SIZE) (metres)

CERTIFIED BY



- LEGEND**
- SITE BOUNDARY
 - LIMIT OF WORKS
 - CATCHMENT
 - PHASE BOUNDARY
 - EXISTING EARTHWORKS AREA
 - PROPOSED AREA OF CUT
 - PROPOSED AREA OF FILL
 - SEDIMENT BASIN
 - ON-SITE DETENTION (CONSTRUCTION PHASE)
 - EXISTING DRAINAGE CHANNEL
 - EXISTING STORMWATER PIPE
 - FLOW DIRECTION
 - DISCHARGE LOCATION

DATE
25.05.21

PROJECT No.:
BC-18008

DRAWING No.:
DWG-301

REVISION No.:
A

PROJECT
YAMBA GARDENS - EARTHWORKS PHASES 2-4

DRAWING TITLE
SEDIMENT BASIN CATCHMENT PLAN

CLIENT
KAHUNA NO.1 PTY LTD

ADDRESS:
52-54 MILES ST, YAMBA

DRAFTED BY: AK
DESIGNED BY: AK
CHECKED BY: BC
PAPER SIZE: A3
SCALE: AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD
ACN 166 087 476
RPEQ No.:

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

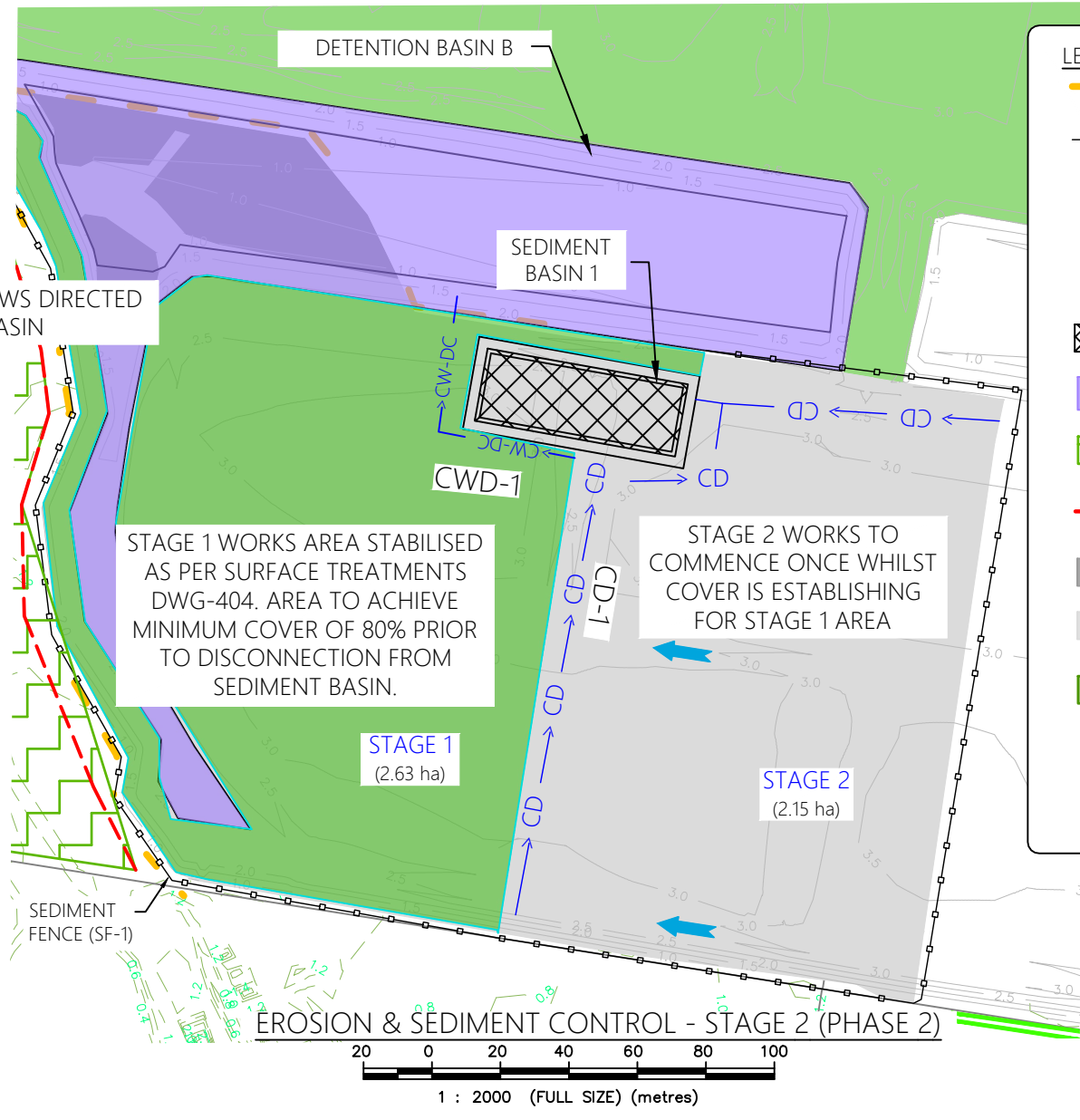
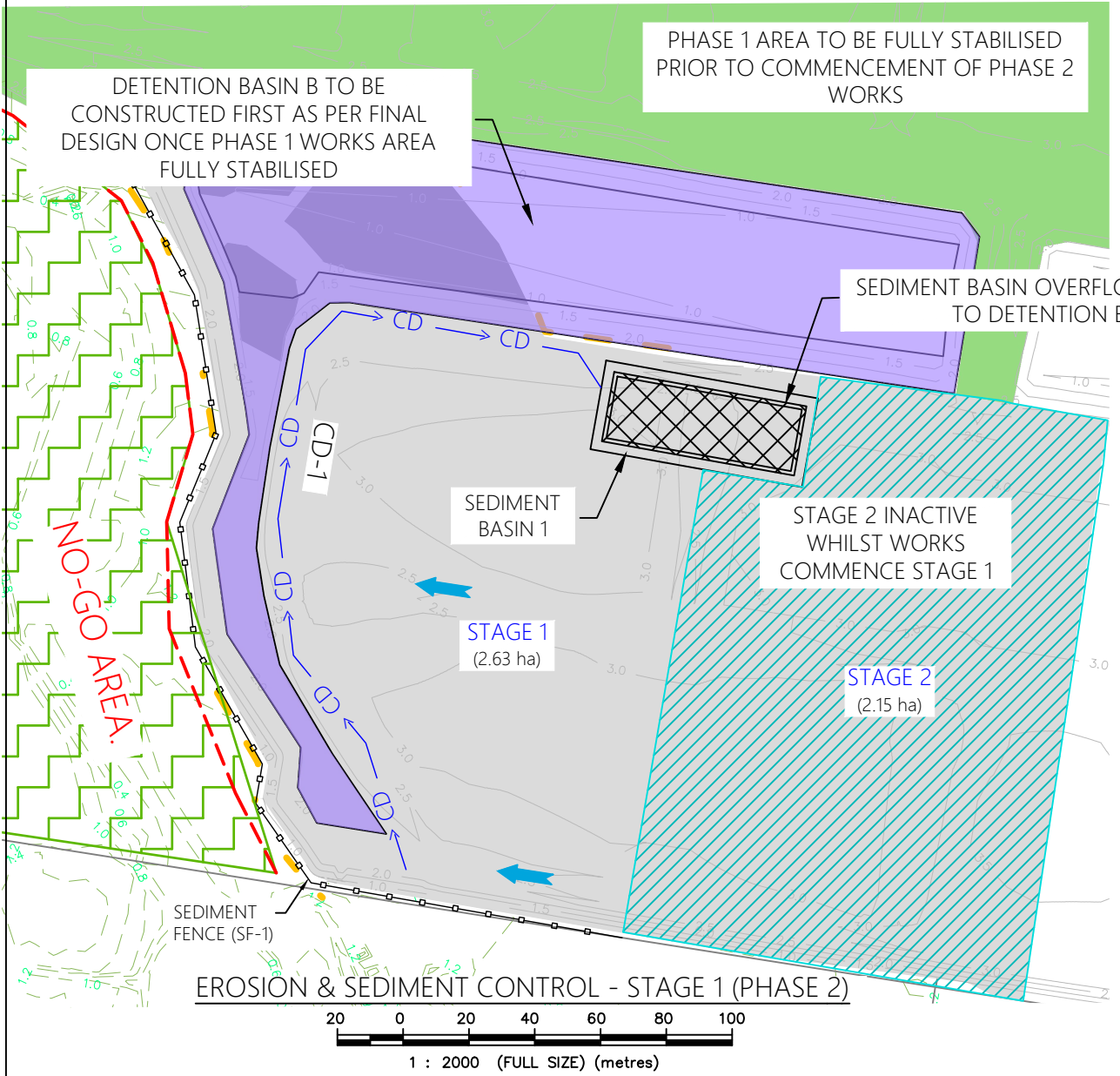
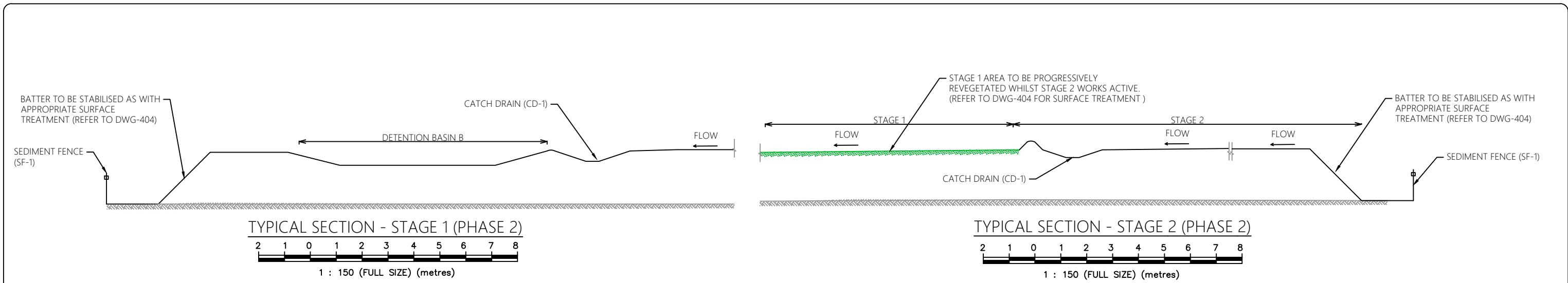
COPYRIGHT
Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.
Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.
Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposes only and are not for construction purposes.

BIOME
WATER AND ENVIRONMENTAL CONSULTING

BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

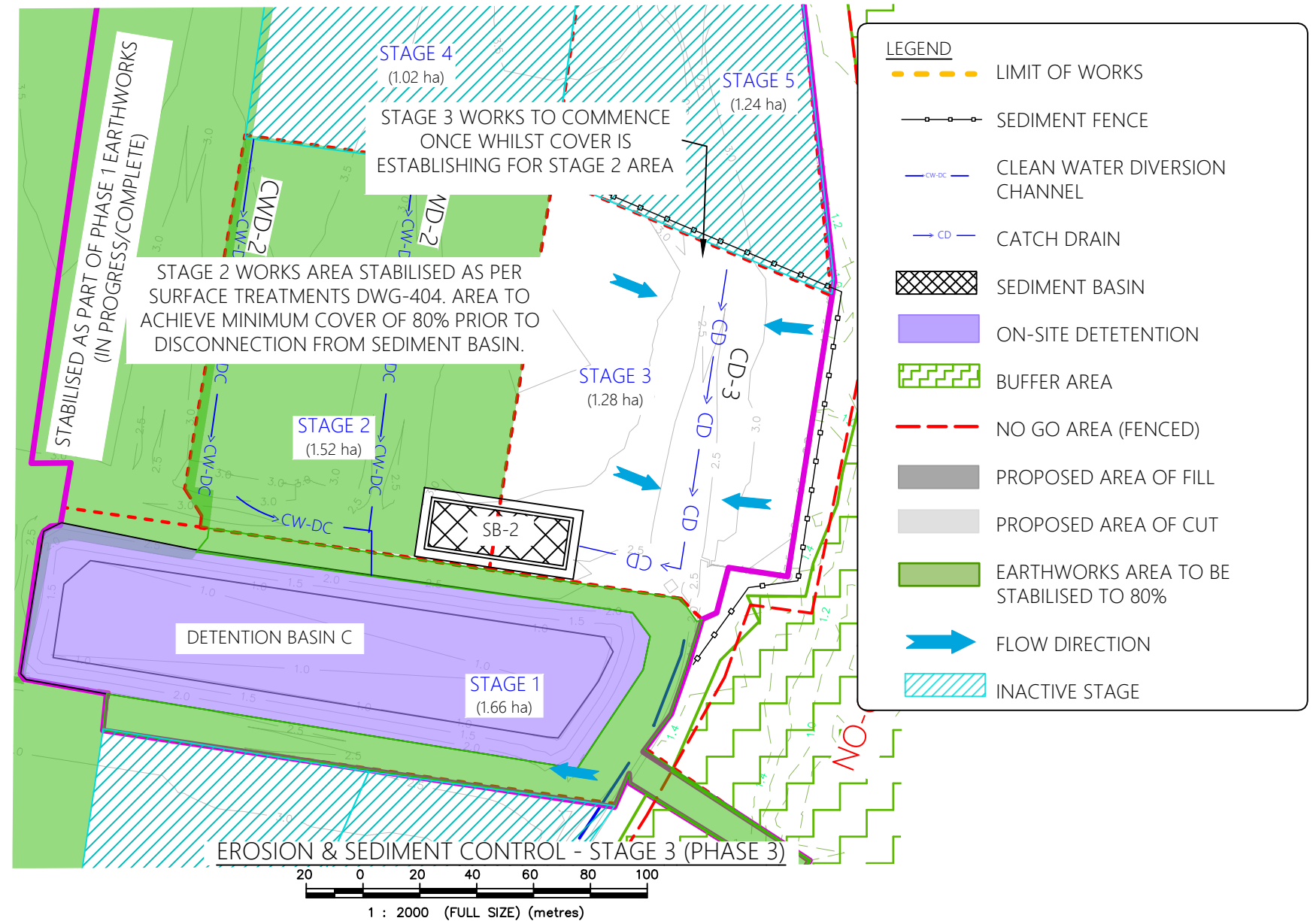
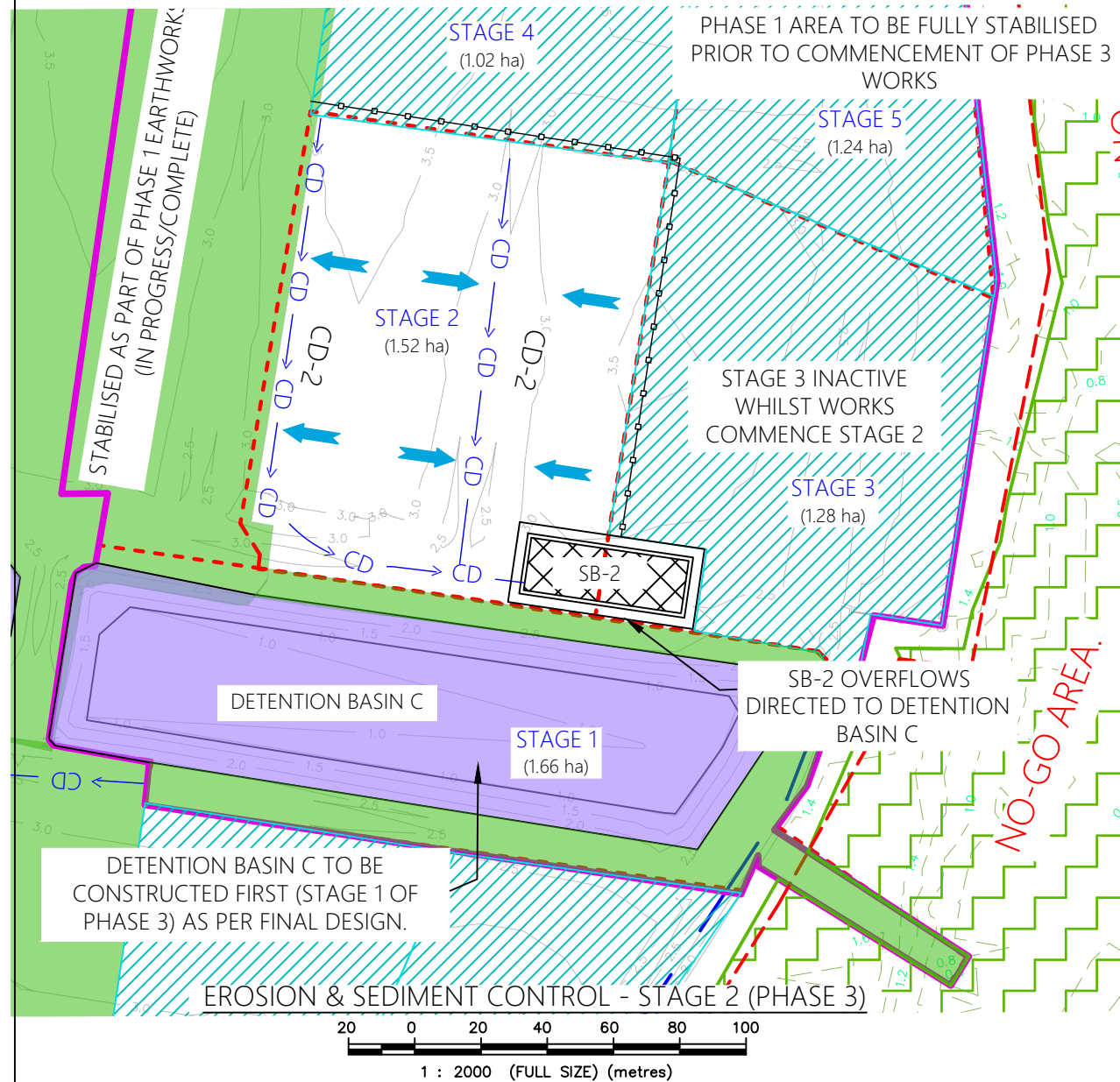
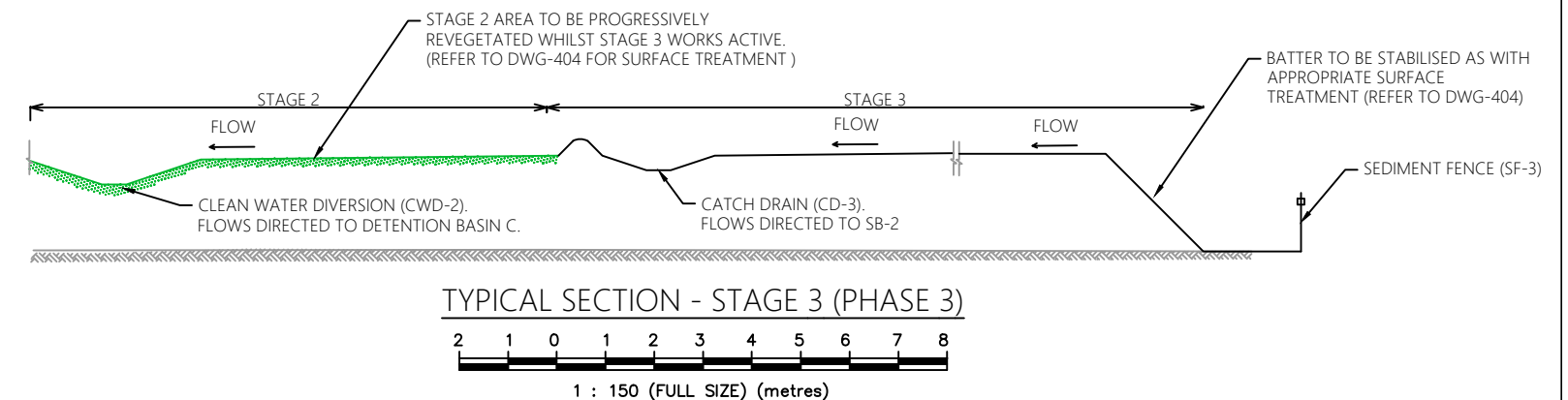
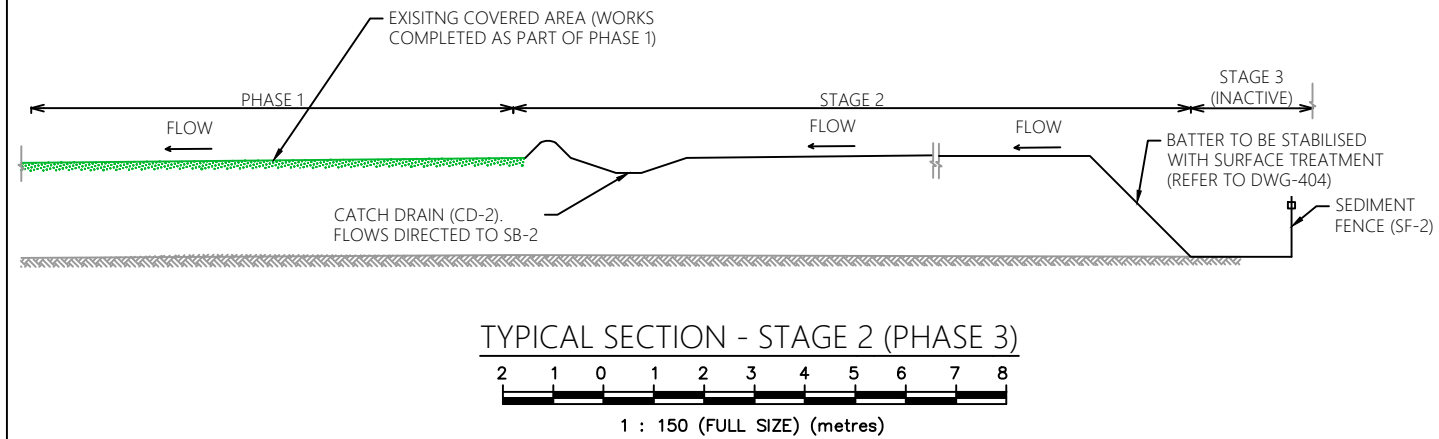
ORIGINAL SCALE BEFORE REDUCTION
40 0 40 80 120 160 200
1 : 4000 (FULL SIZE) (metres)
CERTIFIED BY

BRAD COMLEY
CPESC NO. 8308



- LEGEND**
- LIMIT OF WORKS
 - SEDIMENT FENCE
 - CW-DC CLEAN WATER DIVERSION CHANNEL
 - CD CATCH DRAIN
 - ▨ SEDIMENT BASIN
 - ON-SITE DETENTION
 - ▤ BUFFER AREA
 - NO GO AREA (FENCED)
 - PROPOSED AREA OF FILL
 - PROPOSED AREA OF CUT
 - EARTHWORKS AREA TO BE STABILISED TO 80%
 - ➡ FLOW DIRECTION
 - ▨ INACTIVE STAGE

DATE 25.05.21	PROJECT YAMBA GARDENS - EARTHWORKS PHASES 2-4				APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD ACN 166 087 476 RPEQ No. :				COPYRIGHT Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.																																	
PROJECT No. : BC-18008	DRAWING TITLE ESC - PHASE 2 EARTHWORKS								Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.																																	
DRAWING No. : DWG-401	CLIENT KAHUNA NO.1 PTY LTD				<table border="1"><thead><tr><th>VER.</th><th>DESCRIPTION</th><th>APPR.</th><th>DATE</th></tr></thead><tbody><tr><td>A</td><td>ORIGINAL ISSUE</td><td></td><td>25.05.21</td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr></tbody></table>				VER.	DESCRIPTION	APPR.	DATE	A	ORIGINAL ISSUE		25.05.21																									Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purpose only and are not for construction purposes.	
VER.	DESCRIPTION	APPR.	DATE																																							
A	ORIGINAL ISSUE		25.05.21																																							
REVISION No. : A	ADDRESS: 52-54 MILES ST, YAMBA				BIOME WATER AND ENVIRONMENTAL CONSULTING BIOME Consulting Pty Ltd PO Box 3469, Australia Fair, Southport M 0415 935 222 E brad@BIOMEconsulting.com.au ABN 86 166 087 476				ORIGINAL SCALE BEFORE REDUCTION 40 0 40 80 120 160 200 1 : 4000 (FULL SIZE) (metres) CERTIFIED BY  BRAD COMLEY CPESC NO. 8238																																	
DRAFTED BY : AK	DESIGNED BY : AK	CHECKED BY : BC	PAPER SIZE : A3	SCALE : AS SHOWN																																						



- LEGEND**
- LIMIT OF WORKS
 - SEDIMENT FENCE
 - CWD-DC CLEAN WATER DIVERSION CHANNEL
 - CD CATCH DRAIN
 - ▨ SEDIMENT BASIN
 - ON-SITE DETENTION
 - ▤ BUFFER AREA
 - - - NO GO AREA (FENCED)
 - PROPOSED AREA OF FILL
 - PROPOSED AREA OF CUT
 - EARTHWORKS AREA TO BE STABILISED TO 80%
 - ➔ FLOW DIRECTION
 - ▨ INACTIVE STAGE

DATE 25.05.21		PROJECT YAMBA GARDENS - EARTHWORKS PHASES 2-4	
PROJECT No.: BC-18008		DRAWING TITLE ESC - PHASE 3 EARTHWORKS (STAGES 2 & 3)	
DRAWING No.: DWG-402		CLIENT KAHUNA NO.1 PTY LTD	
REVISION No.: A		ADDRESS: 52-54 MILES ST, YAMBA	
DRAFTED BY: AK	DESIGNED BY: AK	CHECKED BY: BC	PAPER SIZE: A3
SCALE: AS SHOWN			

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD			
ACN 166 087 476			
RPEQ No.:			
VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purpose only and are not for construction purposes.

BIOME
WATER AND ENVIRONMENTAL CONSULTING

BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

40 0 40 80 120 160 200

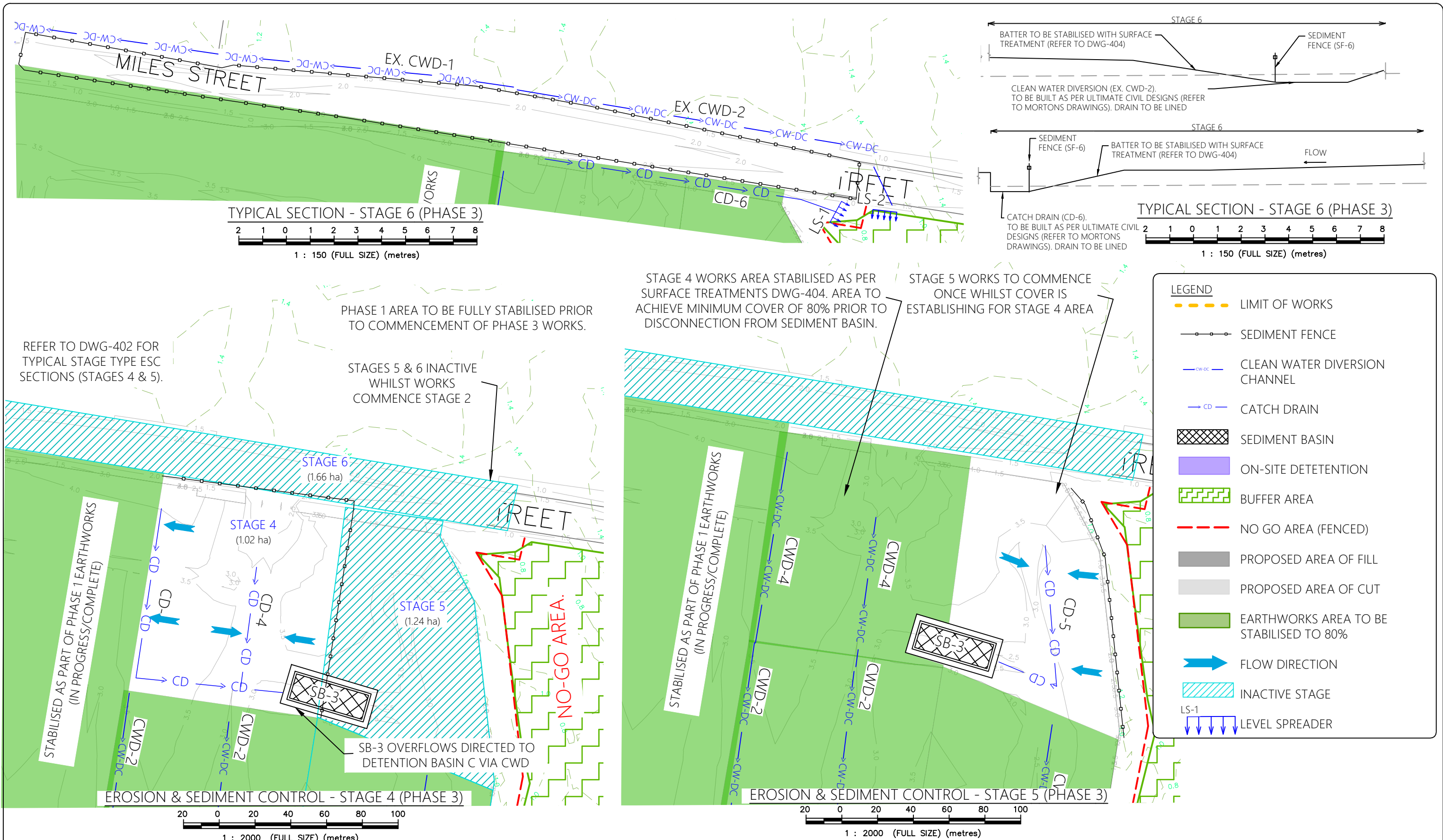
1 : 4000 (FULL SIZE) (metres)

CERTIFIED BY

[Signature]

CPESC

N



DATE
25.05.21

PROJECT No. :
BC-18008

DRAWING No. :
DWG-403

REVISION No. :
A

PROJECT
YAMBA GARDENS - EARTHWORKS PHASES 2-4

DRAWING TITLE
ESC - PHASE 3 EARTHWORKS (STAGES 4-6)

CLIENT
KAHUNA NO.1 PTY LTD

ADDRESS:
52-54 MILES ST, YAMBA

DRAFTED BY : AK	DESIGNED BY : AK	CHECKED BY : BC	PAPER SIZE : A3	SCALE : AS SHOWN
--------------------	---------------------	--------------------	--------------------	---------------------

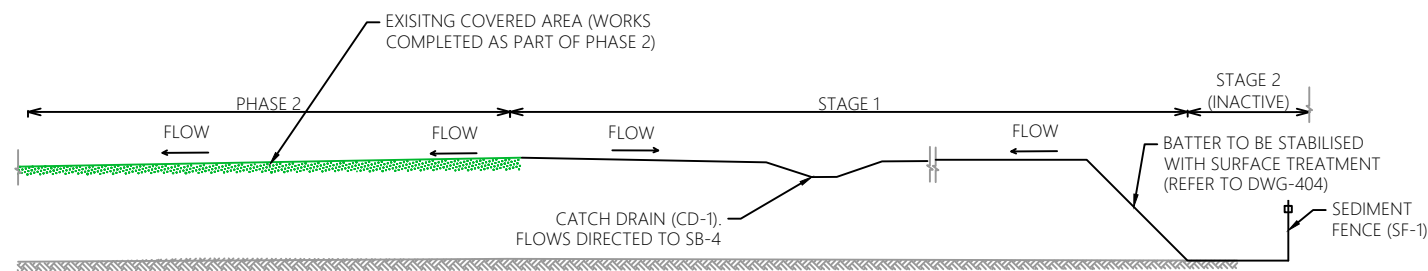
APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD
ACN 166 087 476
RPEQ No. :
VER. DESCRIPTION APPR. DATE
A ORIGINAL ISSUE

COPYRIGHT
Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.
Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.
Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

BIOME
WATER AND ENVIRONMENTAL CONSULTING
BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION
40 0 40 80 120 160 200
1 : 4000 (FULL SIZE) (metres)
CERTIFIED BY

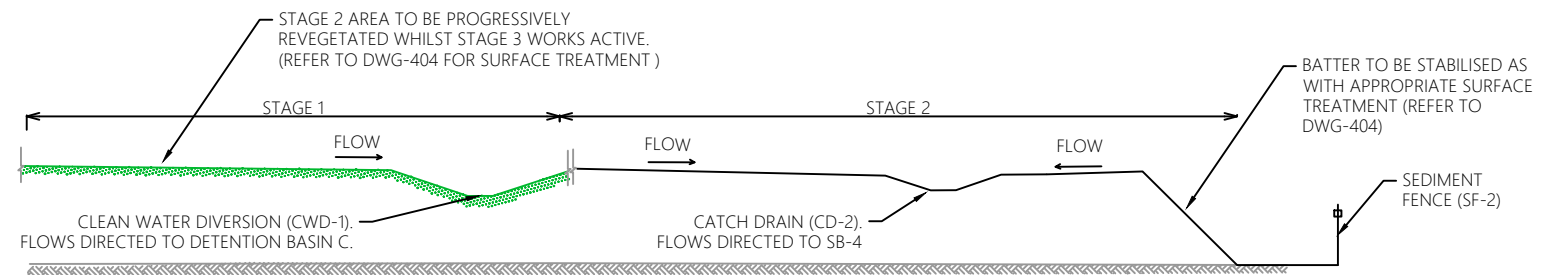
CPESC NO. 8238



TYPICAL SECTION - STAGE 1 (PHASE 4)

2 1 0 1 2 3 4 5 6 7 8

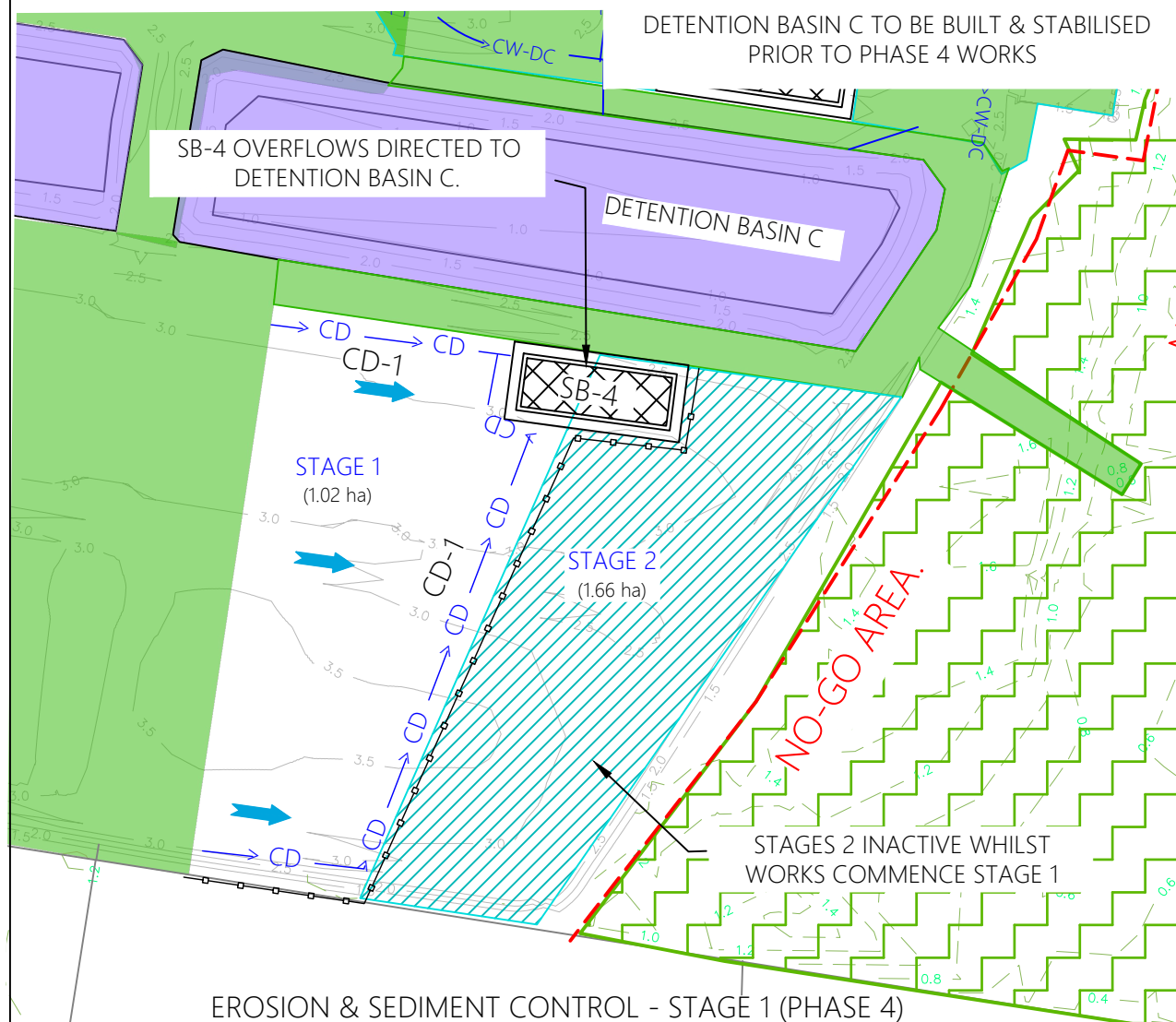
1 : 150 (FULL SIZE) (metres)



TYPICAL SECTION - STAGE 2 (PHASE 4)

2 1 0 1 2 3 4 5 6 7 8

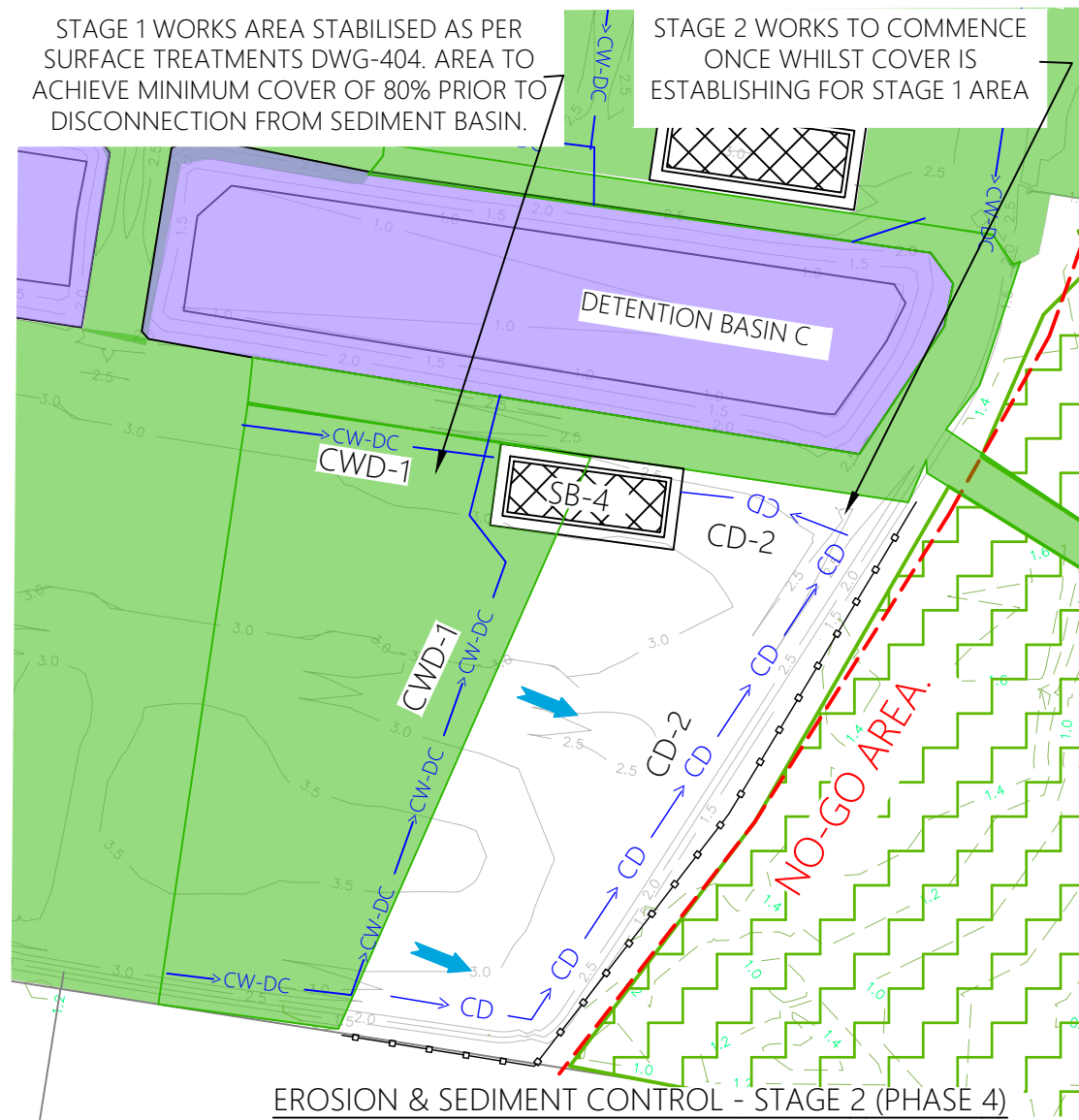
1 : 150 (FULL SIZE) (metres)



EROSION & SEDIMENT CONTROL - STAGE 1 (PHASE 4)

20 0 20 40 60 80 100

1 : 2000 (FULL SIZE) (metres)



EROSION & SEDIMENT CONTROL - STAGE 2 (PHASE 4)

20 0 20 40 60 80 100

1 : 2000 (FULL SIZE) (metres)

- LEGEND**
- LIMIT OF WORKS
 - SEDIMENT FENCE
 - CLEAN WATER DIVERSION CHANNEL
 - CATCH DRAIN
 - SEDIMENT BASIN
 - ON-SITE DETENTION
 - BUFFER AREA
 - NO GO AREA (FENCED)
 - PROPOSED AREA OF FILL
 - PROPOSED AREA OF CUT
 - EARTHWORKS AREA TO BE STABILISED TO 80%
 - FLOW DIRECTION
 - INACTIVE STAGE
 - LS-1 --- LEVEL SPREADER

DATE 25.05.21	PROJECT YAMBA GARDENS - EARTHWORKS PHASES 2-4				
PROJECT No. : BC-18008	DRAWING TITLE ESC - PHASE 4 EARTHWORKS				
DRAWING No. : DWG-404	CLIENT KAHUNA NO.1 PTY LTD				
REVISION No. : A	ADDRESS: 52-54 MILES ST, YAMBA				
DRAFTED BY : AK	DESIGNED BY : AK	CHECKED BY : BC	PAPER SIZE : A3	SCALE : AS SHOWN	

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD			
ACN 166 087 476			
RPEQ No. :			
VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purpose only and are not for construction purposes.

BIOME
WATER AND ENVIRONMENTAL CONSULTING

BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

40 0 40 80 120 160 200

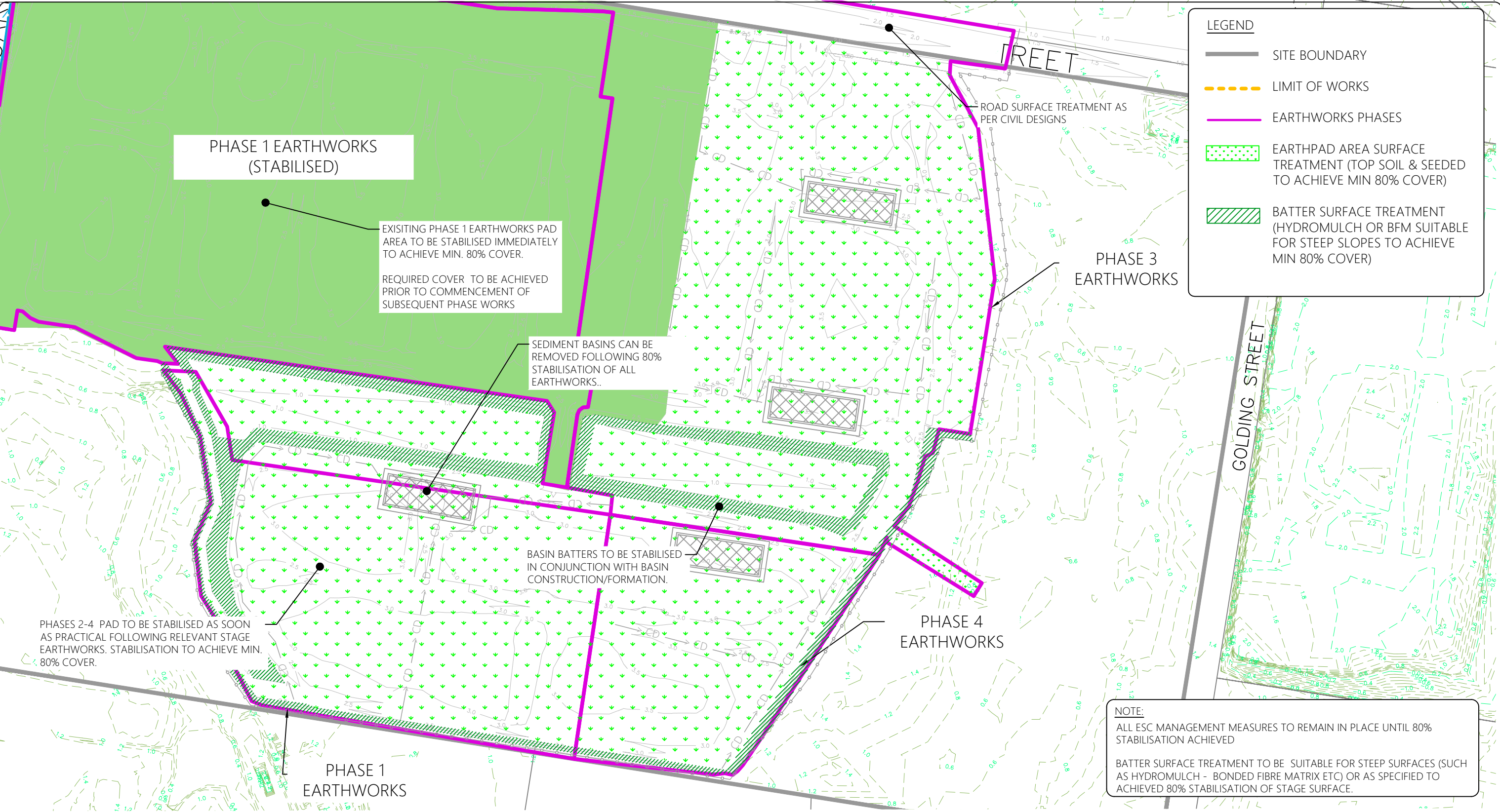
1 : 4000 (FULL SIZE) (metres)

CERTIFIED BY

[Signature]

CPESC

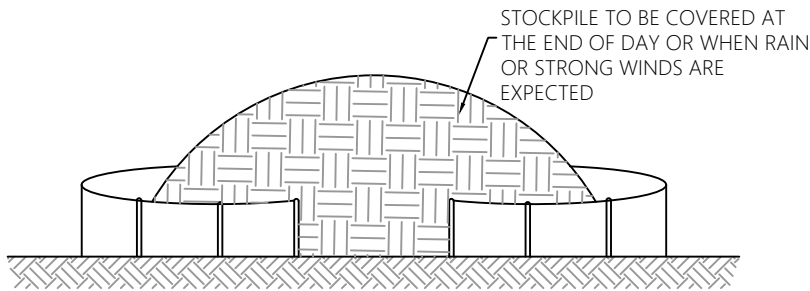
N



EROSION & SEDIMENT CONTROL - STAGE 1 (PHASE 1)



DATE 25.05.21 PROJECT No. : BC-18008 DRAWING No. : DWG-405 REVISION No. : A	PROJECT YAMBA GARDENS - EARTHWORKS PHASES 2-4 DRAWING TITLE EARTHWORKS SURFACE TREATMENT CLIENT KAHUNA NO.1 PTY LTD ADDRESS: 52-54 MILES ST, YAMBA <table><tr><td>DRAFTED BY :</td><td>DESIGNED BY :</td><td>CHECKED BY:</td><td>PAPER SIZE :</td><td>SCALE :</td></tr><tr><td>AK</td><td>AK</td><td>BC</td><td>A3</td><td>AS SHOWN</td></tr></table>	DRAFTED BY :	DESIGNED BY :	CHECKED BY:	PAPER SIZE :	SCALE :	AK	AK	BC	A3	AS SHOWN	APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD ACN 166 087 476 RPEQ No. : <table><tr><th>VER.</th><th>DESCRIPTION</th><th>APPR.</th><th>DATE</th></tr><tr><td>A</td><td>ORIGINAL ISSUE</td><td></td><td>25.05.21</td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr><tr><td> </td><td> </td><td> </td><td> </td></tr></table>	VER.	DESCRIPTION	APPR.	DATE	A	ORIGINAL ISSUE		25.05.21																									COPYRIGHT Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd. Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended. Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.	BIOME WATER AND ENVIRONMENTAL CONSULTING BIOME Consulting Pty Ltd PO Box 3469, Australia Fair, Southport M 0415 935 222 E brad@BIOMEconsulting.com.au ABN 86 166 087 476	ORIGINAL SCALE BEFORE REDUCTION 1 : 4000 (FULL SIZE) (metres) CERTIFIED BY
DRAFTED BY :	DESIGNED BY :	CHECKED BY:	PAPER SIZE :	SCALE :																																											
AK	AK	BC	A3	AS SHOWN																																											
VER.	DESCRIPTION	APPR.	DATE																																												
A	ORIGINAL ISSUE		25.05.21																																												



STOCKPILE 3D SECTION

N.T.S.

GENERAL NOTES:

- MATERIAL STOCKPILES TO BE LOCATED AWAY FROM CONCENTRATED OVERLAND FLOW PATHS.
- STOCKPILES ARE TO BE CONSTRUCTED ON THE CONTOUR AT LEAST 2M FRO HAZARD AREAS AND STABILIZED IF THEY ARE TO BE IN PLACE >20 DAYS)
- STOCKPILES ARE TO BE PROTECTED FROM WIND AND RAIN WHEREVER POSSIBLE (REFER TO TABLE 1).
- FLOW DIVERSION BANKS OR CATCH DRAINS TO BE PLACED UP-SLOPE OF STOCKPILE TO DIRECT ALL UP-SLOPE/UPSTREAM FLOWS. FLOW DIVERSION MEASURES ARE RECOMMENDED WHERE:
 - * PERIODS OF RAINFALL ARE EXPECTED;
 - * THE AVERAGE MONTHLY RAINFALL IS > 45 mm; AND
 - * THE UP-SLOPE CATCHMENT AREA IS > 1,500m²
- ALL STOCKPILES ARE TO REMAIN IN A FREE DRAINING CONDITION TO AVOID SOIL SATURATION.
- SOIL IS TO BE REMOVED FROM STOCKPILES IN A MANNER THAT AVOIDS VEHICLES TRAVELLING OVER THE STOCKPILE.
- ALL SOIL STOCKPILE AREAS ARE TO BE REHABILITATED AS SOON AS REASONABLE AND PRACTICABLE AFTER MATERIAL HAS BEEN REMOVED.

TABLE 1 - PROTECTION OF SAND AND SOIL STOCKPILES FROM WIND AND RAINFALL

(SOURCE: STOCKPILE MANAGEMENT-GENERAL CONSTRUCTION PRACTICE BY CATCHMENTS & CREEKS PTY LTD (VERSION 1-APRIL 2010))

Material	Stockpile cover ^[1]	Comments
Sand	No cover	• When wind erosion and dust control is not an issue.
	Synthetic cover, porous or not porous	• When the control of wind erosion is essential for reasons of safety.
Soil	No cover	• When wind erosion and dust control are not an issue.
	Mulching, vegetative cover, chemical stabilisers, soil binders, or impervious blanket ^[2]	• Long-term (>20 days) stockpiling of dispersive soils. • Long-term (>20 days) stockpiles of clayey soils when turbidity control is desirable. • Long-term (>5/10 days) soil stockpiles during months of Extreme/High erosion risk. • Short and long-term stockpiles of clayey soils when turbidity control is essential.

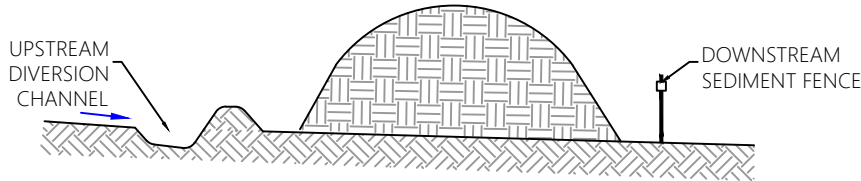
[1] Applicable only when displacement of the stockpiled material has the potential to cause environmental harm. The practice of covering stockpiles may need to be modified if theft or damage to covers becomes excessive.

[2] Mulching is normally applied at the first opportunity that mulch or hydromulch can be introduced to the site. Minimum 70% cover is required for both mulch and vegetative covers. Though still desirable, a cover may not be required if runoff from the stockpile is directed to a sediment basin.

TABLE 2 - SEDIMENT CONTROL PRACTICES DOWN-SLOPE OF STOCKPILES

(SOURCE: STOCKPILE MANAGEMENT-GENERAL CONSTRUCTION PRACTICE BY CATCHMENTS & CREEKS PTY LTD (VERSION 1-APRIL 2010))

Material	Sediment control	Comments
Sand or gravel	Woven sediment fence or equivalent	• Sediment control is only required if stockpiled material could be displaced and cause safety risks or environmental harm.
Topsoil	Woven sediment fence or equivalent	• If the topsoil is moderately to highly erodible and is likely to release significant clay-rich (turbid) runoff, refer to the recommendations below for subsoil stockpiles.
Subsoil	Woven sediment fence or equivalent	• Stockpiles located up-slope of suitably grassed areas that will allow for the infiltration of stormwater runoff from the stockpile (minimum 15m of flow length), or all runoff is directed to a Type 1 or Type 2 sediment trap.
	Compost berm, filter fence, composite (non- woven) sediment fence, or equivalent	• Stockpiles not located up-slope of a suitable grassed area, or Type 1 or Type 2 sediment trap. • Soil stockpiles located adjacent permanent drainage channels or waterways.



STOCKPILE SECTION

N.T.S.

TABLE 3 - SEDIMENT CONTROL PRACTICES FOR DE-WATERING STOCKPILES

(SOURCE: STOCKPILE MANAGEMENT-GENERAL CONSTRUCTION PRACTICE BY CATCHMENTS & CREEKS PTY LTD (VERSION 1-APRIL 2010))

Material	Sediment control	Comments
Non-clayey material	Grass filter beds or equivalent	• Ensure grassed area remains unsaturated during de-watering operation.
Clayey material	Filter fence (non- woven filter cloth)	• Filter cloth must be supported by wire mesh, or aggregate berm. • Woven sediment fence fabric must not be used."
	Compost berm or Mulch berm or Filter sock	• Ensure the berm/sock is placed along the contour to ensure flow is distributed evenly along the length of the berm/sock. • Ensure water does not bypass around the end of the berm or sock."
Contaminated material	Not applicable	• Seek expert advice on case-by-case basis.

TABLE 4 - MANAGEMENT OF TOPSOIL STOCKPILES

(SOURCE: STOCKPILE MANAGEMENT-GENERAL CONSTRUCTION PRACTICE BY CATCHMENTS & CREEKS PTY LTD (VERSION 1-APRIL 2010))

Condition of topsoil	Recommended stockpiling requirements
Topsoils containing valuable plant seed content that needs to be preserved for re- establishment.	• Upper 50mm of soil stockpiled separately in mounds 1 to 1.5m high. • Topsoil more than 50mm below the surface stockpiled in mounds no higher than 1.5 to 3m. • The duration of stockpiling should be the minimum practicable, but ideally less than 12 months."
Imported topsoil, or in-situ topsoil containing minimal desirable or undesirable seed content.	• Maximum desirable stockpile height of 2m. • The duration of stockpiling should be the minimum practicable, but ideally less than 12 months."
Topsoils containing significant undesirable seed content.	• Ideally replace soil with alternative local topsoil free of weed seed content (seek expert advice). • Depending on expert advice, stripped topsoil may be appropriately treated to prevent germination of weed seed content, covered with clear plastic sheeting to help burn-off the weed seed content, or buried under a minimum 100mm of soil.
Topsoils containing weed seed of a declared noxious or otherwise highly undesirable plant species.	• Suitably bury the topsoil on-site, or remove the soil from the site for further treatment (in accordance with local and State laws). • Stripped soil must not be transported off-site without appropriate warnings and identification."
Previously disturbed sites where the surface soils consist of a mixture of topsoil and dispersive subsoil.	• Mix the soil with gypsum, lime or other appropriate ameliorants prior to stockpiling in either high or low mounds according to required protection of seed content. • Choice of chemical treatment of the dispersive soil depends on desired pH adjustments (seek expert advice)."

DATE

25.05.21

PROJECT No. :

BC-18008

DRAWING No. :

DWG-500

REVISION No. :

A

PROJECT

YAMBA GARDENS - EARTHWORKS PHASES 2-4

DRAWING TITLE

STOCKPILE MANAGEMENT DETAILS

CLIENT

KAHUNA NO.1 PTY LTD

ADDRESS:

52-54 MILES ST, YAMBA

DRAFTED BY :

AK

DESIGNED BY :

AK

CHECKED BY:

BC

PAPER SIZE :

A3

SCALE :

AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD

ACN 166 087 476

RPEQ No. :

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

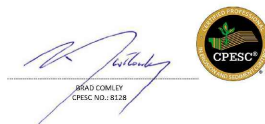
Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

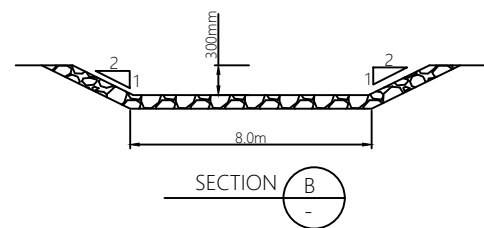
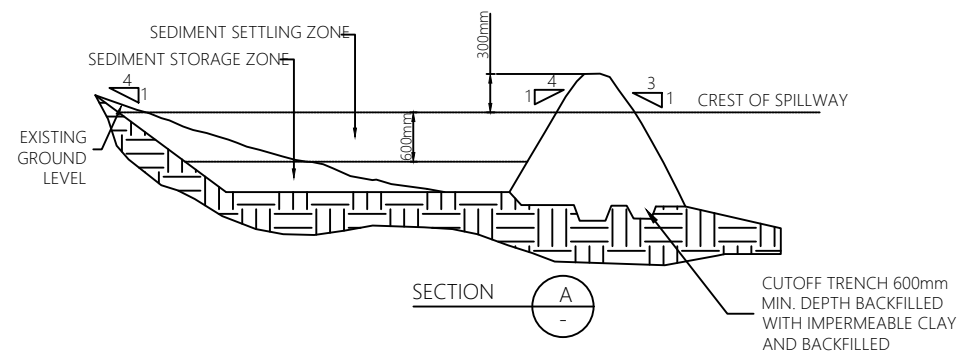
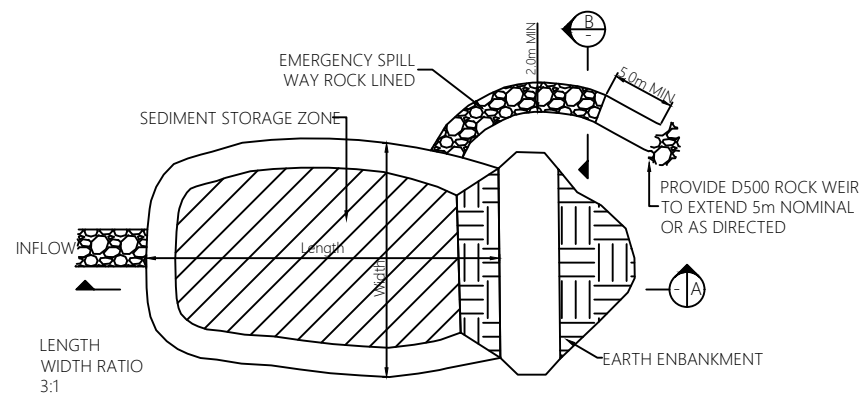


BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

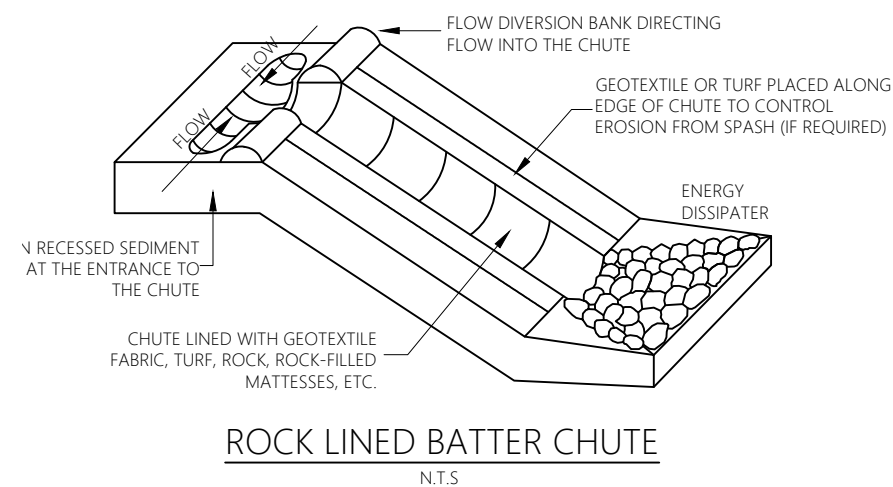
ORIGINAL SCALE BEFORE REDUCTION

CERTIFIED BY

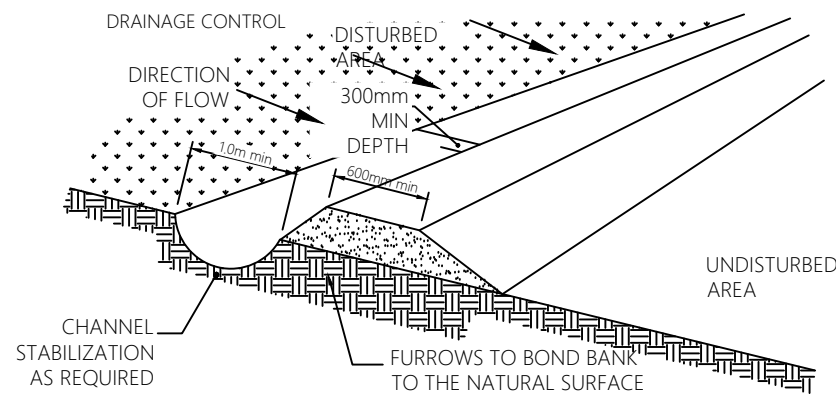




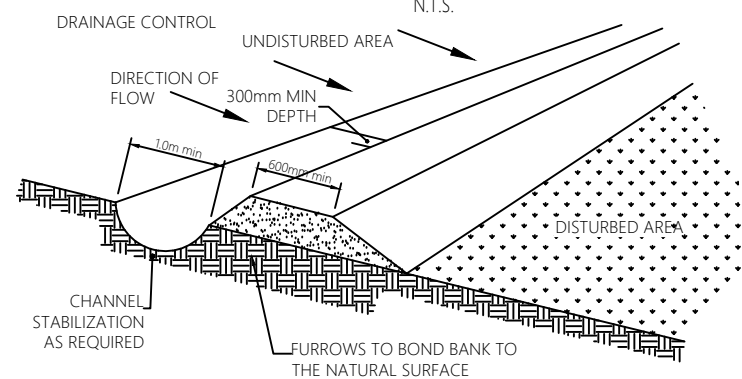
TYPE F/D (WET) SEDIMENT BASIN (TYPICAL)
N.T.S.



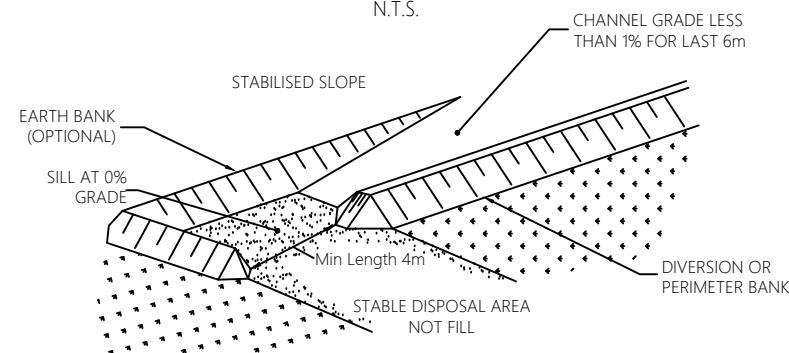
ROCK LINED BATTER CHUTE
N.T.S.



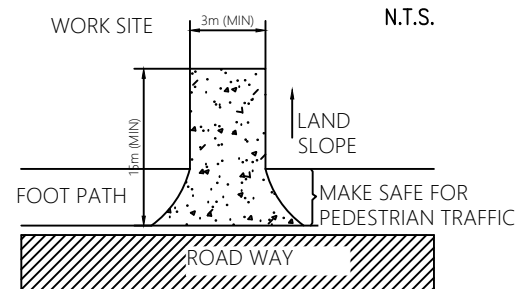
CATCH DRAIN
N.T.S.



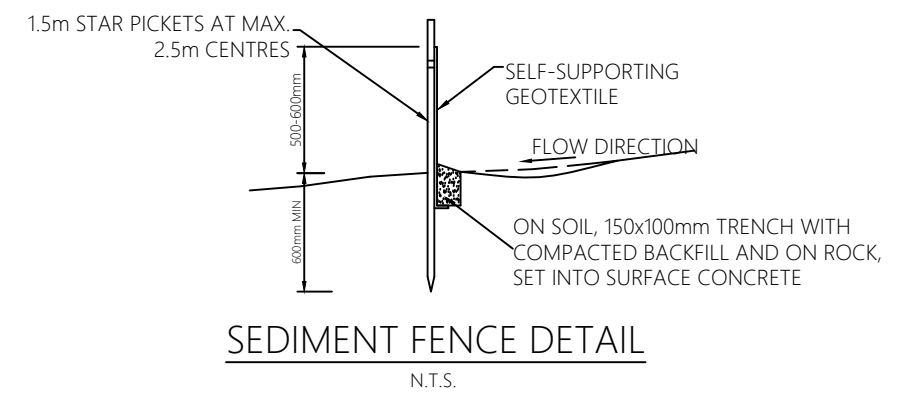
CLEAN WATER DIVERSION CHANNEL
N.T.S.



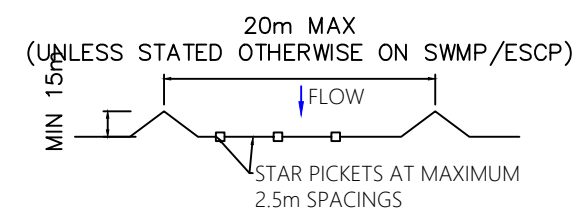
LEVEL SPREADER (TYPICAL)
N.T.S.



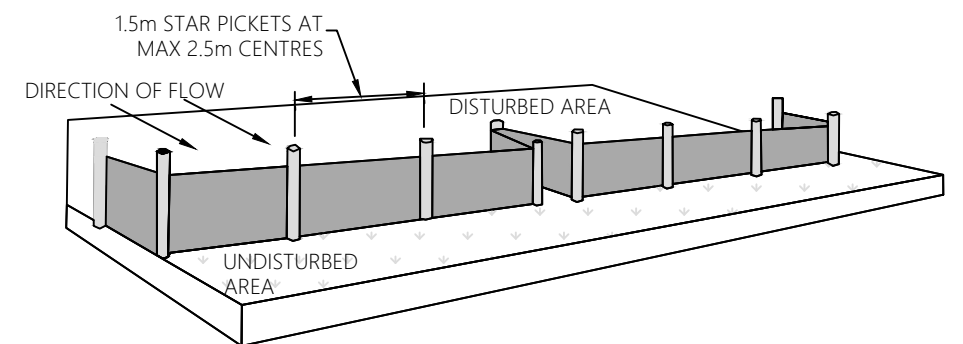
ROCK PAD SLOPING AWAY FROM ROAD
N.T.S.



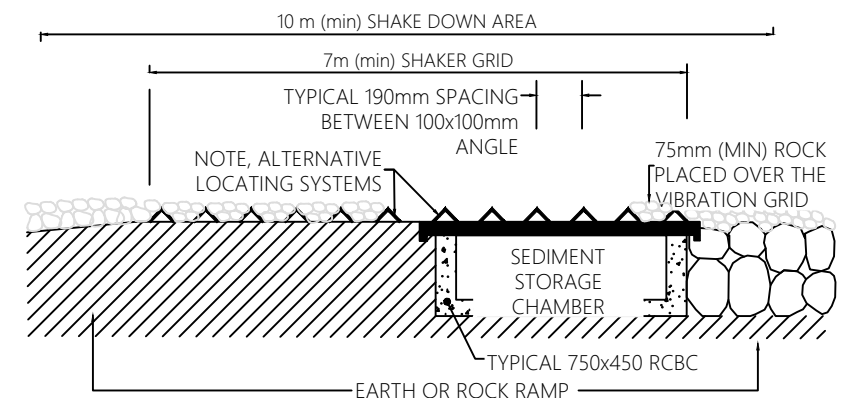
SEDIMENT FENCE DETAIL
N.T.S.



SEDIMENT FENCE SETOUT DETAIL
N.T.S.



INSTALLATION OF SEDIMENT FENCE
N.T.S.



CONSTRUCTION ENTRY/EXIT ARRANGEMENT (TYPICAL)
N.T.S.

DATE 25.05.21	PROJECT YAMBA GARDENS - EARTHWORKS PHASES 2-4			
PROJECT No.: BC-18008	DRAWING TITLE ESC TYPICAL DETAILS			
DRAWING No.: DWG-501	CLIENT KAHUNA NO.1 PTY LTD			
REVISION No.: A	ADDRESS: 52-54 MILES ST, YAMBA			
DRAFTED BY: AK	DESIGNED BY: AK	CHECKED BY: BC	PAPER SIZE: A3	SCALE: AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD ACN 166 087 476 RPEQ No.:			
VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT
Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.
Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.
Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.

BIOME
WATER AND ENVIRONMENTAL CONSULTING

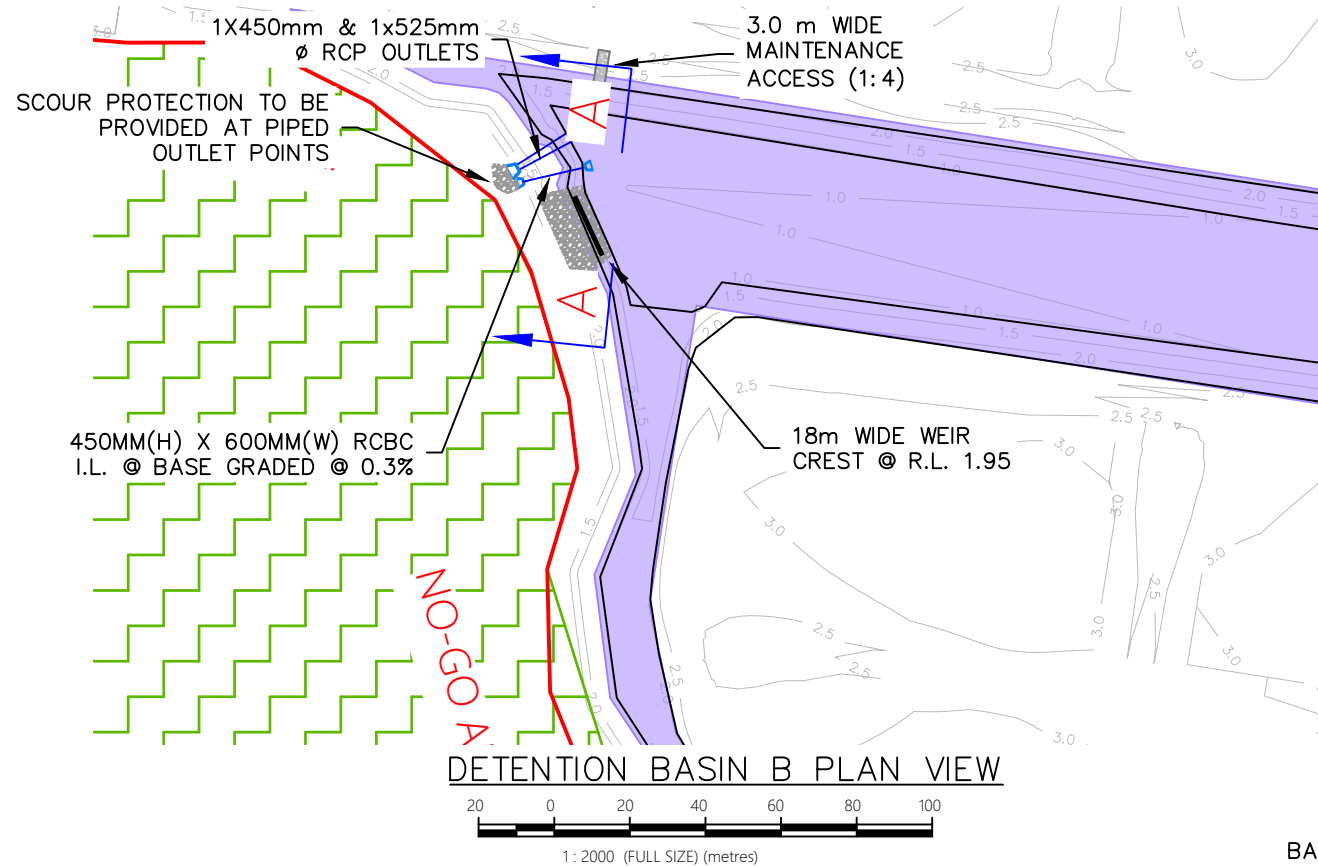
BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

CERTIFIED BY

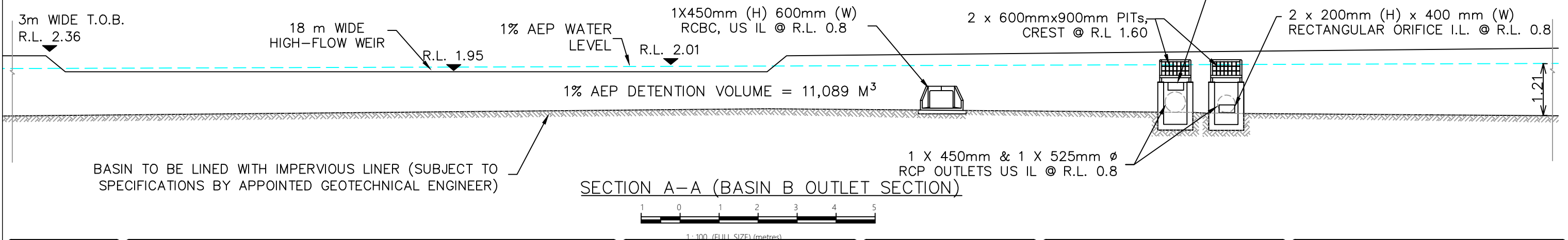
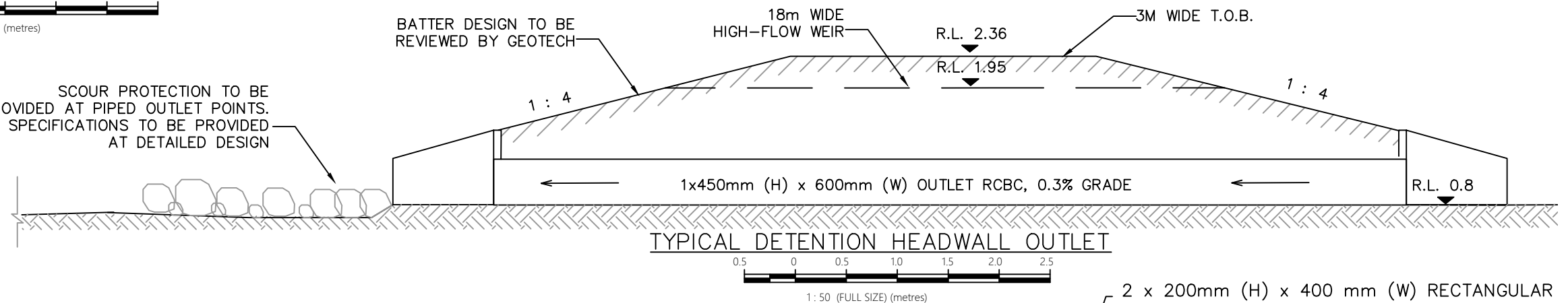
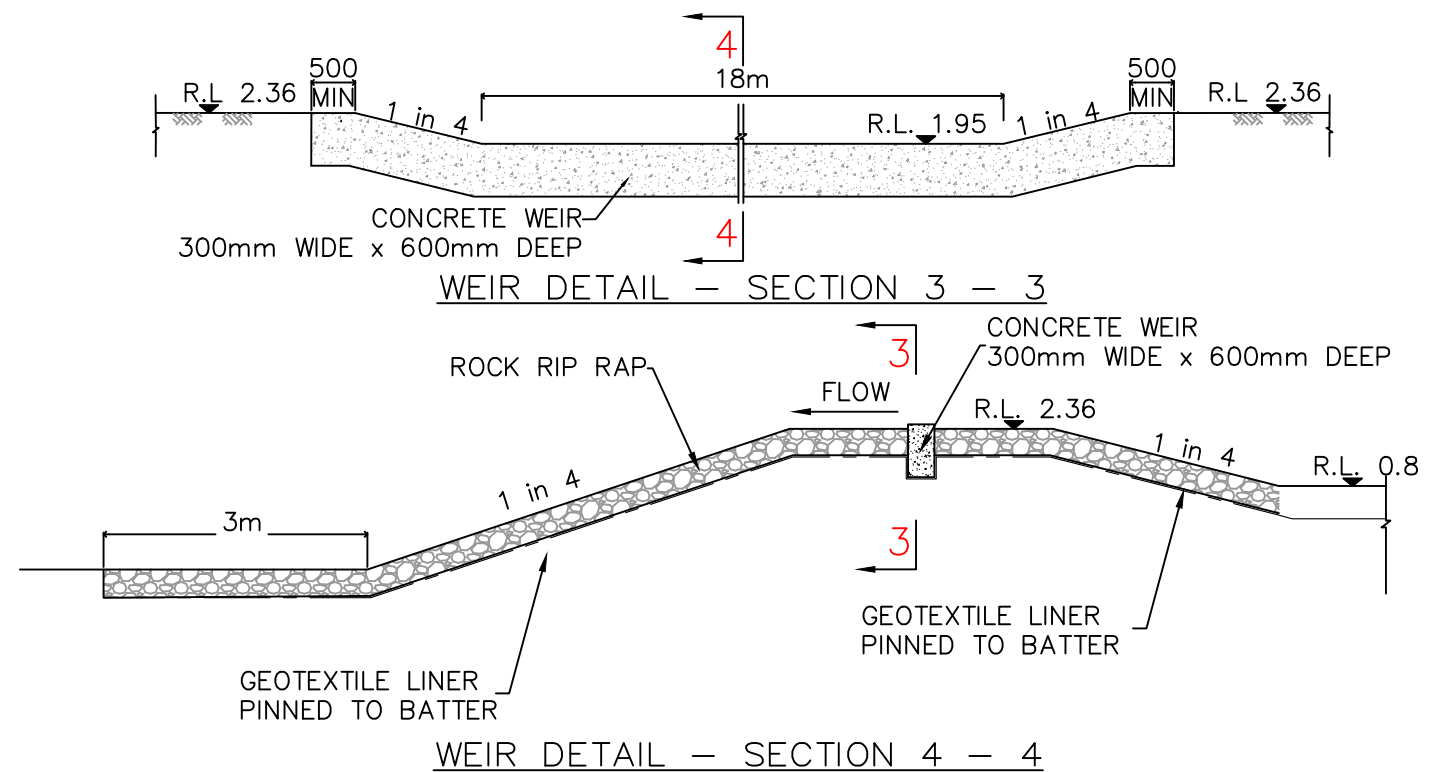
Brad Conley

CPESC



NOTE: REFER TO MORTONS URBAN SOLUTIONS DRAWINGS 33801-PR2-666-A & 33801-PR2-667-A FOR LONG SECTIONS OF THE PROPOSED DETENTION BASIN

SCOUR PROTECTION TO BE PROVIDED AT PIPED OUTLET POINTS. SPECIFICATIONS TO BE PROVIDED AT DETAILED DESIGN



DATE 25.05.21	PROJECT YAMBA GARDENS - EARTHWORKS PHASES 2-4
PROJECT No.: BC-18008	DRAWING TITLE DETENTION BASIN B TYPICAL DETAILS
DRAWING No.: DWG-502	CLIENT KAHUNA NO.1 PTY LTD
REVISION No.: A	ADDRESS: 52-54 MILES ST, YAMBA
DRAFTED BY: AK	DESIGNED BY: AK
CHECKED BY: BC	PAPER SIZE: A3
SCALE: AS SHOWN	

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD			
ACN 166 087 476			
RPEQ No.:			
VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposes only and are not for construction purposes.

BIOME
WATER AND ENVIRONMENTAL CONSULTING

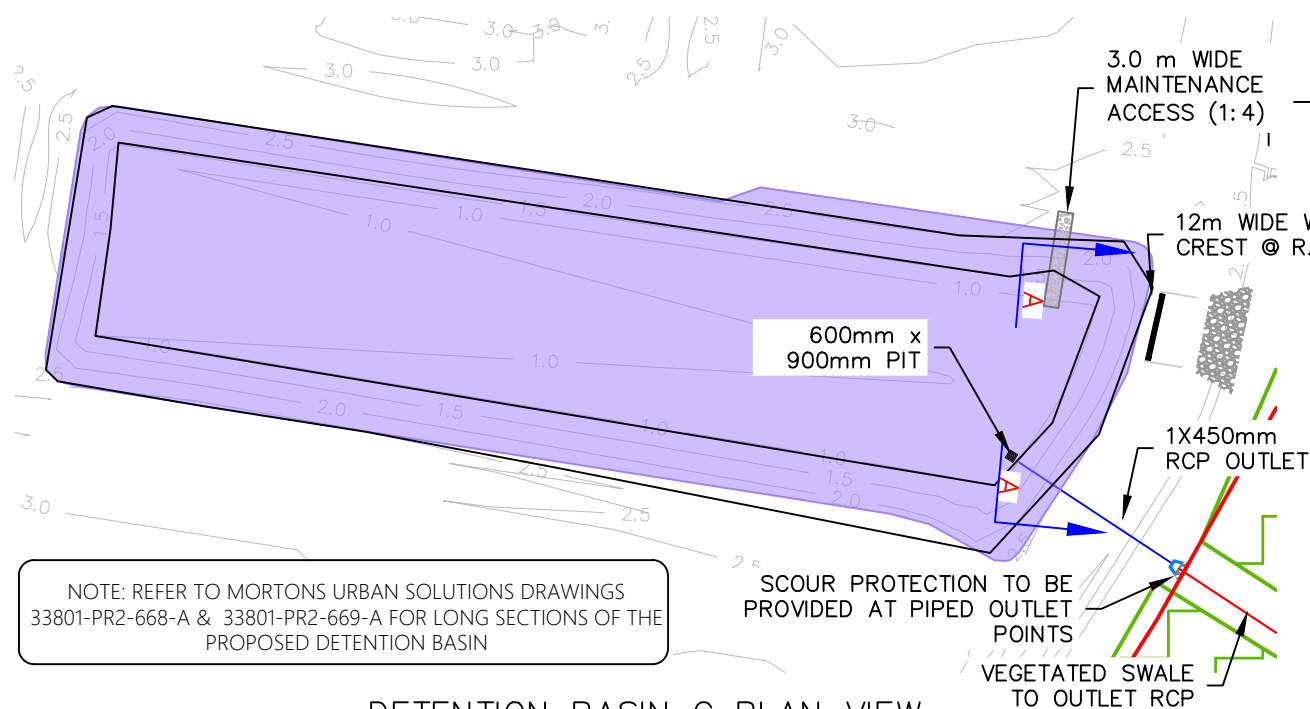
BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

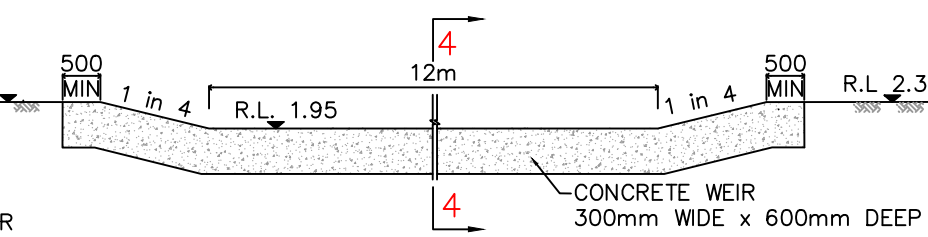
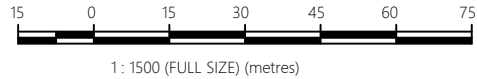
CERTIFIED BY

[Signature]

[CPESC Logo]



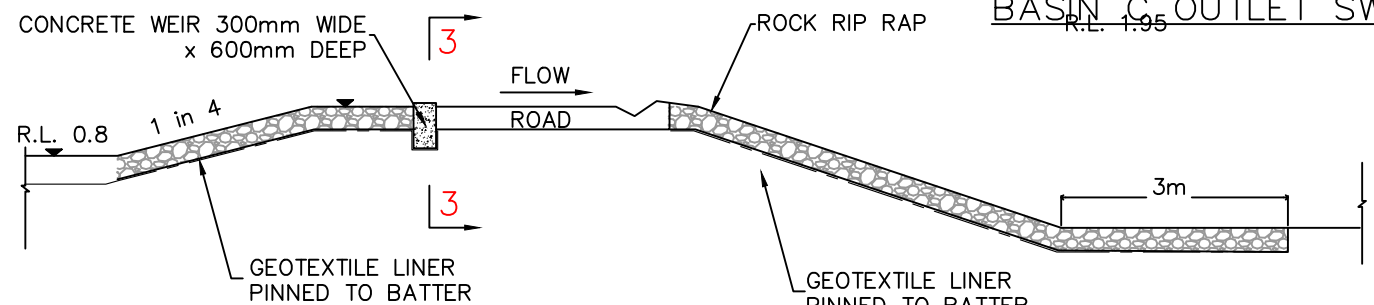
DETENTION BASIN C PLAN VIEW



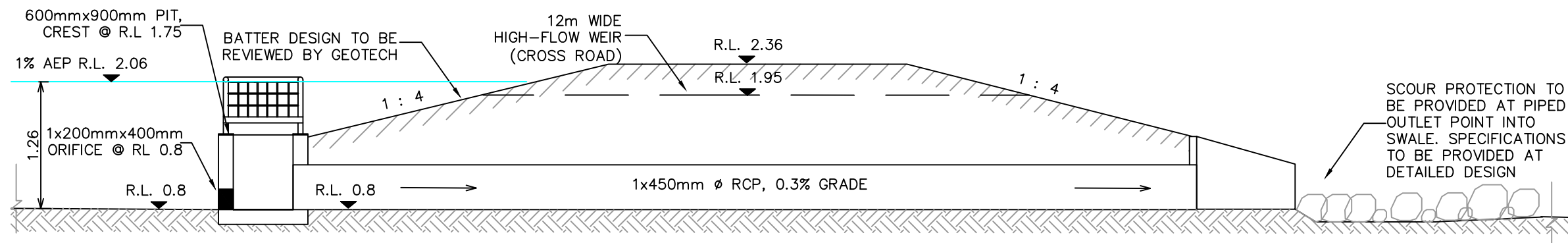
WEIR DETAIL - SECTION 3 - 3

Design Storm:	0.01 AEP	Design	
Flow (m³/s):	0.50	Design	
Flow Depth (m)	0.25	Design	
Mannings 'n':	0.035	Design	
Channel Slope 1:	250	Design	
Freeboard (m):	0.25	Design	
Depth + Freeboard (m)	0.5	Design	
Left Batter Slope 1:	3	Design	
Width (m) =	1.5	Design	
Base Width (m)	2.50	Design	
Right Batter Slope 1:	3	Design	
Width (m) =	1.5	Design	
Total Width (m) =	5.50	Design	
Flow Area (m²) =	0.813	Design	
Hydraulic Radius (m) =	0.199	Design	
Capacity (m³/s) =	0.501	Design	
Velocity (m/s) =	0.616	Design	
d*v (m²/s) =	0.15	Design	

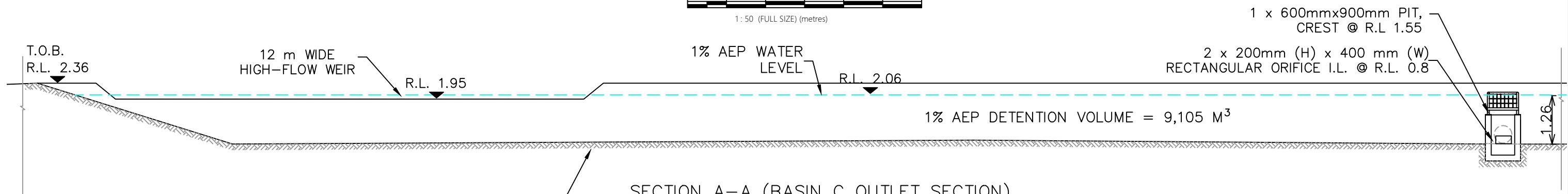
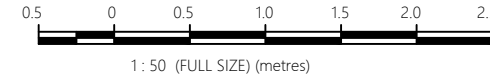
BASIN C OUTLET SWALE DESIGN



WEIR DETAIL - SECTION 4 - 4



TYPICAL BASIN C OUTLET



SECTION A-A (BASIN C OUTLET SECTION)



BASIN TO BE LINED WITH IMPERVIOUS LINER (SUBJECT TO SPECIFICATIONS BY APPOINTED GEOTECHNICAL ENGINEER)

DATE 25.05.21	PROJECT YAMBA GARDENS - EARTHWORKS PHASES 2-4				APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD ACN 166 087 476 RPEQ No. :				COPYRIGHT Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd. Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended. Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.				ORIGINAL SCALE BEFORE REDUCTION										
PROJECT No. : BC-18008	DRAWING TITLE DETENTION BASIN C TYPICAL DETAILS				VER.				DESCRIPTION				APPR.				DATE						
DRAWING No. : DWG-503	CLIENT KAHUNA NO.1 PTY LTD				A				ORIGINAL ISSUE								25.05.21						
REVISION No. : A	ADDRESS: 52-54 MILES ST, YAMBA																						
DRAFTED BY : AK		DESIGNED BY : AK		CHECKED BY : BC		PAPER SIZE : A3		SCALE : AS SHOWN															
BIOME Consulting Pty Ltd PO Box 3469, Australia Fair, Southport M 0415 935 222 E brad@BIOMEconsulting.com.au ABN 86 166 087 476																				CERTIFIED BY			

TABLE 1 – INTERNAL CATCHMENT PEAK FLOW (CATCH DRAIN)

Phase ID	Stage ID	Area (ha)	Fall (m)	Length (m)	Slope (%)	Manning' s n	T of C (min)	Intensity (mm/hr)	C factor	Flow (m³/s)
2	1	2.63	1.00	200	0.5	0.025	17.9	120.6	0.68	0.60
	2	2.15	0.80	160	0.5	0.025	16.7	124.9	0.68	0.51
3	1	1.66	1.00	200	0.5	0.025	17.9	120.6	0.68	0.38
	2	1.52	0.70	140	0.5	0.025	15.9	127.8	0.68	0.37
	3	1.28	0.70	140	0.5	0.025	15.9	127.8	0.68	0.31
	4	1.02	0.63	125	0.5	0.025	15.3	129.9	0.68	0.25
	5	1.24	0.55	110	0.5	0.025	14.7	132.4	0.68	0.31
	6	1.54	0.15	30	0.5	0.025	9.5	158.6	0.68	0.46
4	1	1.19	0.75	150	0.5	0.025	16.3	126.3	0.68	0.29
	2	1.18	0.60	120	0.5	0.025	15.1	130.6	0.68	0.29

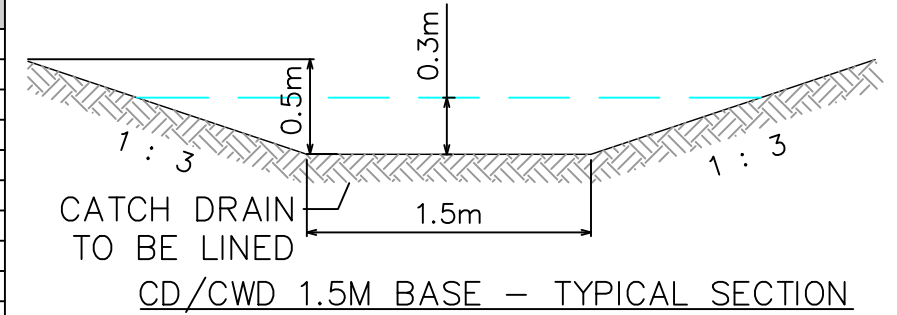
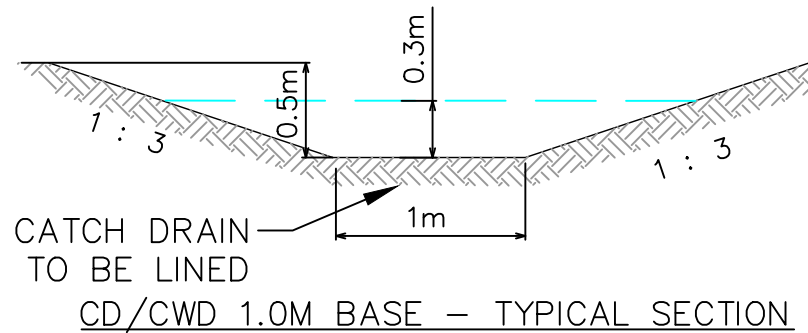


TABLE 2 – CATCH DRAIN CAPACITY

Phase ID	Stage ID	Drain ID/Type	Length (m)	Fall (m)	Slope (m/m)	Base Width (m)	Mannings n	Freeboard (m)	Flow Depth (m)	Total Depth (m)	Flow Area (m²)	Wetted Perimeter	Hydraulic Radius	Velocity (m/s)	Capacity (m³/s)
2	1	CD-1	200	1	0.005	1.5	0.025	0.2	0.3	0.5	0.72	3.40	0.21	1.01	0.72
	2	CD-2	200	1	0.005	1.5	0.025	0.25	0.25	0.5	0.56	3.08	0.18	0.91	0.51
3	1	CD-1	200	1	0.005	1.5	0.025	0.25	0.25	0.5	0.56	3.08	0.18	0.91	0.51
	2	CD-2	200	1	0.005	1.0	0.025	0.25	0.25	0.5	0.44	2.58	0.17	0.87	0.38
	3	CD-3	200	1	0.005	1.0	0.025	0.25	0.25	0.5	0.44	2.58	0.17	0.87	0.38
	4	CD-4	200	1	0.005	1.0	0.025	0.25	0.25	0.5	0.44	2.58	0.17	0.87	0.38
	5	CD-5	200	1	0.005	1.0	0.025	0.25	0.25	0.5	0.44	2.58	0.17	0.87	0.38
	6	CD-6	200	1	0.005	1.5	0.025	0.25	0.25	0.5	0.44	2.58	0.17	0.87	0.38
4	1	CD-1	200	1	0.005	1.0	0.025	0.25	0.25	0.5	0.44	2.58	0.17	0.87	0.38
	2	CD-2	200	1	0.005	1.0	0.025	0.25	0.25	0.5	0.44	2.58	0.17	0.87	0.38

TABLE 3 – EXTERNAL CATCHMENT PEAK FLOW (DIVERSION DRAIN)

Catchment ID	Area (ha)	Fall (m)	Length (m)	Slope (%)	Manning' s n	T of C (min)	Intensity (mm/hr)	C factor	Flow (m³/s)
EXT A(1)	7.43	0.25	200	0.13	0.05	42.6	73.2	0.47	0.71
EXT A(1)	7.22	0.53	200	0.21	0.05	41.29	74.9	0.47	0.71

TABLE 4 – DIVERSION DRAIN CAPACITY

Drain ID	Length (m)	Fall (m)	Slope (m/m)	Base Width (m)	Freeboard (m)	Flow Depth (m)	Total Depth (m)	Flow Area (m²)	Wetted Perimeter (m)	Hydraulic Radius (m)	Velocity (m/s)	Capacity (m³/s)
Ex. CWD-1	300	1.5	0.005	1.5	0.2	0.3	0.5	0.72	3.4	0.21	1.01	0.72
Ex. CWD-2	230	1.15	0.005	1.5	0.2	0.3	0.5	0.72	3.4	0.21	1.01	0.72

TABLE 5 – SEDIMENT BASIN SIZING

Basin ID	Area (ha)	Vs (m³)	Top Width (m)	Top Length (m)	Settling Zone Depth (m)	Sediment Storage Volume (m³)	Storage Depth (m)	Total Depth (m)	Total Volume (m³)
SB-1	2.63	464	19	57	0.6	232	0.56	1.16	696
SB-2	1.66	293	16	48	0.6	146	0.63	1.23	439
SB-3	1.24	219	14	42	0.6	109	0.79	1.39	328
SB-4	1.19	210	14	42	0.6	105	0.76	1.36	315

DATE

25.05.21

PROJECT No. :

BC-18008

DRAWING No. :

DWG-504

REVISION No. :

A

PROJECT

YAMBA GARDENS - EARTHWORKS PHASES 2-4

DRAWING TITLE

SEDIMENT BASIN, DIVERSION & CATCH DRAIN SIZING

CLIENT

KAHUNA NO.1 PTY LTD

ADDRESS:

52-54 MILES ST, YAMBA

DRAFTED BY :
TP / KPDESIGNED BY :
AKCHECKED BY :
BCPAPER SIZE :
A3SCALE :
AS SHOWNAPPROVED FOR AND ON BEHALF OF BIOME CONSULTING
PTY LTD

ACN 166 087 476

RPEQ No. :

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.



BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

CERTIFIED BY

BRAD CONLEY
CPESC NO. 8308

MAINTENANCE AND MONITORING REQUIREMENTS

IN ORDER TO ENSURE THAT THE EROSION & SEDIMENT CONTROL MEASURES DETAILED WITHIN THIS MANAGEMENT PLAN ARE FUNCTIONING CORRECTLY AND TO ENSURE THAT IMPACTS TO DOWNSTREAM RECEIVING ENVIRONMENTS ARE MITIGATED, APPROPRIATE CONSTRUCTION PHASE WATER QUALITY MONITORING IS TO BE UNDERTAKEN. THE FOLLOWING SECTIONS DETAIL THE MINIMUM REQUIREMENTS FOR SURFACE WATER MONITORING AND CONTROL DEVICE MAINTENANCE.

1. CONSTRUCTION PHASE WATER QUALITY MONITORING
PRIOR TO THE COMMENCEMENT OF ANY SITE ACTIVITIES, IT IS RECOMMENDED THAT BACKGROUND WATER QUALITY DATA BE COLLECTED. THIS DATA WILL ASSIST IN DEMONSTRATING COMPLIANCE DURING THE CONSTRUCTION PHASE. SAMPLING SHOULD BE TAKEN AT APPROPRIATE LOCATIONS BOTH UPSTREAM AND DOWNSTREAM OF THE DISCHARGE POINTS FROM THE DEVELOPMENT AND SHOULD COMPRISE OF THE COLLECTION OF WATER SAMPLES AFTER THE FOLLOWING RAINFALL EVENTS:

- 3 STORM EVENTS OF GREATER THAN 25mm; AND
- 3 SMALLER RAINFALL EVENTS.

SAMPLES SHOULD BE COLLECTED FOR TOTAL SUSPENDED SOLIDS (TSS), PH, DISSOLVED OXYGEN (DO) AND HYDROCARBONS. SAMPLING IS TO BE PERFORMED IN ACCORDANCE WITH PROCEDURES SET OUT IN THE ENVIRONMENTAL PROTECTION AUTHORITY'S WATER QUALITY SAMPLING MANUAL. A NATA REGISTERED LABORATORY IS TO BE USED TO ANALYSE THE COLLECTED SAMPLES.

MONITORING DURING THE CONSTRUCTION PHASE SHOULD BE TAKEN AT THE OUTLET OF SEDIMENT CONTROL MEASURES AND AT THE SITES DISCHARGE POINT/S. TABLE A SPECIFIES THE PARAMETERS AND SAMPLING FREQUENCIES REQUIRED. RESULTS OF THE MONITORING PROGRAM ARE TO BE COMPILED MONTHLY INTO AN ONGOING WATER QUALITY MONITORING REPORT. A COPY OF THE REPORT AND MONITORING DATA IS TO BE MAINTAINED ONSITE BY THE CIVIL WORKS CONTRACTOR.

TABLE A CONSTRUCTION PHASE WATER QUALITY SAMPLING FREQUENCIES

SAMPLING PARAMETER	SAMPLING FREQUENCY
TOTAL SUSPENDED SOLIDS (TSS)	MONTHLY FOLLOWING A SINGLE RAIN EVENT IN EXCESS OF 25mm PER DAY UNTIL THE SITE IS FULLY STABILISED.
pH	
DISSOLVED OXYGEN (DO)	
HYDROCARBONS	

NOTE - IT IS RECOMMENDED THAT A SITE-SPECIFIC RELATIONSHIP BETWEEN TURBIDITY AND SUSPENDED SOLIDS IS DETERMINED FOR EACH SEDIMENT BASIN. ONCE A CORRELATION BETWEEN SUSPENDED SOLIDS AND TURBIDITY HAS BEEN ESTABLISHED FOR A SEDIMENT BASIN, TESTING STORMWATER FOR COMPLIANCE WITH RELEASE LIMITS, PRIOR TO RELEASE, CAN BE DONE ON SITE WITH A TURBIDITY TUBE OR CALIBRATED TURBIDITY METER. THIS HAS THE ADVANTAGE OF PROVIDING IMMEDIATE ASSESSMENT TO JUSTIFY A RELEASE RATHER THAN WAITING FOR LABORATORY RESULTS TO CONFIRM CONCENTRATIONS LEVELS AND COMPLIANCE. NOTE THAT POST- RELEASE TSS VALIDATION IS APPROPRIATE TO DEMONSTRATE THAT THE NTU/TSS CORRELATIONS IS BEING MAINTAINED.

TABLE B SETS THE RECOMMENDED WATER QUALITY CRITERIA FOR DISCHARGE WATER RELEASED FROM THE DEVELOPMENT SITE (SUBJECT TO COUNCIL REQUIREMENTS).

TABLE B CONSTRUCTION PHASE WATER QUALITY DISCHARGE CRITERIA/RELEASE LIMITS

WATER QUALITY PARAMETER	DISCHARGE CRITERIA
TOTAL SUSPENDED SOLIDS (TSS)	< 50 mg/L ⁽¹⁾
TURBIDITY (NTU)	NOT > 10% OF BACKGROUND RECEIVING WATER TURBIDITY ⁽²⁾
pH	6.5 - 8.5 ⁽³⁾
DO	MINIMUM OF 6 mg/L
HYDROCARBONS	NO VISIBLE OIL OR GREASE SHEEN ON RELEASED WATERS

(1) OR AS SPECIFIED BY COUNCIL

(2) BACKGROUND REFERS TO RECEIVING WATERS IMMEDIATELY UPSTREAM OF SITE WATER ENTRY POINTS AT TIME OF RELEASE. WHERE THERE IS NO IMMEDIATE UPSTREAM RECEIVING WATER AT THE LOCATION AND TIME OF THE RELEASE, THEN THE TURBIDITY RELEASE LIMIT(NTU) WILL BE EQUAL TO THE RELEASE LIMIT FOR 50MG/L TOTAL SUSPENDED SOLIDS (TSS) BASED UPON THE ONSITE CORRELATION BETWEEN TSS AND NTU.

EXCEPT WHERE, AND TO THE EXTENT THAT, THE NATURAL RECEIVING WATERS LIE OUTSIDE THIS RANGE.

(3) WHERE CAPTURED DISCHARGE DOES NOT MEET THE DISCHARGE CRITERIA AS SET OUT IN TABLE B, THE FOLLOWING CORRECTIVE ACTIONS ARE RECOMMENDED:

TSS -ARTIFICIAL FLOCCULATION IS TO BE APPLIED ON RETAINED RUNOFF TO ASSIST IN THE SETTLING PROCESS. APPLICATION OF GYPSUM BY HAND BROADCAST OVER THE SURFACE IS RECOMMENDED, ENSURING AN EVEN SPREAD OVER THE BASIN SURFACE AT A RATE OF 32KG PER 100m³ OF WATER. GYPSUM SHOULD BE APPLIED WITHIN 24 HOURS OF THE CONCLUSION OF ANY STORM EVENT AND BEFORE ANY PUMP OUT OF TO RECEIVING WATERS;

PH - ADDITION OF HYDRATED LIME TO RAISE OR LOWER PH TO WITHIN DESIRED DISCHARGE CRITERIA. TO BE UNDERTAKEN IN ACCORDANCE WITH THE DOSING RATES SPECIFIED IN APPENDIX E OF SOILS & CONSTRUCTION (4TH EDITION), LANDCOM 2004

DO - MECHANICAL AERATION UNTIL DO REACHES DESIRED DISCHARGE CRITERIA; AND

HYDROCARBONS - LOCATE SOURCE OF HYDROCARBONS TO PREVENT FURTHER CONTAMINATION AND COMMISSION A LICENSED WASTE CONTRACTOR TO REMOVE FROM CONTAMINATED WATER. A FLOATING BOOM MAY BE REQUIRED TO CONTAIN SPILLS AND PREVENT DISCHARGE TO DOWNSTREAM RECEIVING ENVIRONMENTS.

FOR ALL OTHER STORMWATER RELEASES, FLOWS AND DISCHARGE FROM THE SITE, THE RELEASE LIMITS PRESCRIBED IN TABLE C ABOVE MUST NOT BE EXCEEDED UNLESS OTHERWISE SPECIFIED BY LOCAL COUNCIL/STATE AUTHORITY.

2. CONSTRUCTION PHASE DEVICE MAINTENANCE

ALL EROSION AND SEDIMENT CONTROL DEVICES MUST BE MAINTAINED IN PROPER WORKING ORDER AT ALL TIMES, THIS INCLUDES ENSURING THAT THE HYDRAULIC CAPACITY OF EACH DEVICE IS NOT COMPROMISED AT ANY TIME. TABLE C DETAILS THE MAINTENANCE REQUIREMENTS FOR THE SPECIFIC EROSION AND SEDIMENT CONTROLS.

TABLE C EROSION AND SEDIMENT DEVICE MAINTENANCE REQUIREMENTS

DEVICE/CONTROL MEASURE	MAINTENANCE TRIGGER	ACTION
SEDIMENT BASINS	WHEN SETTLED SEDIMENT EXCEEDS THE VOLUME OF THE SEDIMENT STORAGE ZONE. SEDIMENT STORAGE DEPTH IS GENERAL EQUAL TO 1/3 OF THE BASIN DEPTH.	REMOVE ACCUMULATED SEDIMENT AS SOON AS REASONABLE AND PRACTICABLE, BUT WITHIN 5 DAYS OF THE INSPECTION.
OTHER ESC MEASURES	THE CAPACITY OF THE DEVICES FALLS BELOW 75% OF ITS DESIGN CAPACITY.	BY END OF THE DAY DURING ANY STAY IN RAINFALL.

ALL MATERIAL REMOVED DURING MAINTENANCE, WHETHER SOLID OR LIQUID, IS TO BE DISPOSED OF IN A MANNER THAT DOES NOT CAUSE ONGOING SOIL EROSION OR ENVIRONMENTAL HARM.

3. CONTRUCTION PHASE SEDIMENT BASIN DEWATERING

ALL SEDIMENT BASINS ARE TO BE MANAGED DURING THE CONSTUCTION PHASE IN ACCORDANCE WITH THE REQUIREMENTS SET OUT IN TABLE D.

TABLE D TYPICAL OPERATIONAL CONDITIONS OF TYPE D SEDIMENT BASIN

ARRTIBUTE	TYPE D
DESIRABLE BASIN WATER LEVEL BEFORE STORM	FULLY DRAINED SETTLING ZONE
ALLOWABLE INTER-STORM BASIN WATER LEVEL DURING SPECIFIC WEATHER CONDITIONS	BASIN TO BE EMPTIED WITHIN 4 DAYS. UNDER CERTAIN CONDITIONS, <u>MUST</u> BE DE-WATERED PRIOR TO AN IMMINENT STORM. THESE 'CONDITIONS' MAY INCLUDE A SPECIFIED WET SEASON, OR WHEN WEATHER FORECASTING PREDICTS A STORM EVENT.
DE-WATERING SYSTEM	N/A
CHEMICAL TREATMENT	AS REQUIRED, APPLICATION TYPE & METHODOLOGIES TO BE GENERALLY IN ACCORDANCE WITH APPENDIX E OF SOILS & CONSTRUCTION (4TH EDITION, LANDCOM 2004)

DATE
25.05.21

PROJECT No. :
BC-18008

DRAWING No. :
DWG-600

REVISION No. :
A

PROJECT
YAMBA GARDENS - EARTHWORKS PHASES 2-4

DRAWING TITLE
MAINTENANCE AND MONITORING

CLIENT
KAHUNA NO.1 PTY LTD

ADDRESS:
52-54 MILES ST, YAMBA

DRAFTED BY :
AK

DESIGNED BY :
AK

CHECKED BY:
BC

PAPER SIZE :
A3

SCALE :
AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD
ACN 166 087 476
RPEQ No. :

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT
Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.
Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.
Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.



BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

CERTIFIED BY



GENERAL INSPECTION ITEMS		ASSESSMENT
1	PUBLIC ROADWAYS CLEAR OF SEDIMENT	
2	ENTRY/EXIT PADS CLEAR OF EXCESSIVE SEDIMENT DEPOSITION	
3	ENTRY/EXIT PADS HAVE ADEQUATE VOID SPACING TO TRAP SEDIMENT	
4	THE CONSTRUCTION SITE IS CLEAR OF LITTER AND UNCONFINED RUBBISH	
5	ADEQUATE STOCKPILES OF EMERGENCY ESC MATERIALS EXIST ON SITE	
6	SITE DUST IS BEING ADEQUATELY CONTROLLED	
7	APPROPRIATE DRAINAGE AND SEDIMENT CONTROLS HAVE BEEN INSTALLED PRIOR TO NEW AREAS BEING CLEARED OR DISTURBED	
8	UP-SLOPE "CLEAN" WATER IS BEING APPROPRIATELY DIVERTED AROUND/THROUGH THE SITE	
9	DRAINAGE LINES ARE FREE OF SOIL SCOUR AND SEDIMENT DEPOSITION	
10	NO AREAS OF EXPOSED SOIL ARE IN NEED OF EROSION CONTROL	
11	EARTH BATTERS ARE FREE OF 'RILL' EROSION	
12	EROSION CONTROL SURFACING IS NOT BEING DISPLACED BY WIND OR WATER	
13	LONG-TERM SOIL STOCKPILES ARE PROTECTED FROM WIND, RAIN AND STORMWATER FLOW WITH APPROPRIATE DRAINAGE AND EROSION CONTROLS	
14	SEDIMENT FENCES ARE FREE FROM DAMAGE	
15	SEDIMENT-LADEN STORMWATER IS NOT SIMPLY FLOWING AROUND THE SEDIMENT FENCES OR OTHER SEDIMENT TRAPS	
16	SEDIMENT CONTROLS PLACED UP-SLOPE/AROUND STORMWATER INLETS APPROPRIATE FOR THE TYPE OF INLET STRUCTURE	
17	ALL SEDIMENT TRAPS ARE FREE OF EXCESSIVE SEDIMENT DEPOSITION	
18	THE SETTLED SEDIMENT LAYER WITHIN A SEDIMENT BASIN IS CLEARLY VISIBLE THROUGH THE SUPERNATANT PRIOR TO DISCHARGE SUCH WATER	
19	ALL REASONABLE AND PRACTICABLE MEASURES ARE BEING TAKEN TO CONTROL SEDIMENT RUNOFF FROM THE SITE	
20	ALL SOIL SURFACES ARE BEING APPROPRIATELY PREPARED (I	
21	STABILISED SURFACES HAVE A MINIMUM 70% SOIL COVERAGE	
22	THE SITE IS ADEQUATELY PREPARED FOR IMMINENT STORMS	
23	ALL ESC MEASURES ARE IN PROPER WORKING ORDER	

SPECIFIC ESC DEVICE INSPECTION ITEMS		ASSESSMENT
1	ENTRY/EXIT POINTS:	
	A. CONTROL MEASURES ARE APPROPRIATE FOR THE SITE CONDITIONS;	
	B. CONTROL MEASURES ARE CONSTRUCTED TO APPROPRIATE STANDARDS;	
	C. EXCESSIVE SEDIMENT REMOVED FROM SEDIMENT TRAPS;	
	D. EXCESSIVE SEDIMENTATION IS NOT EVIDENT ON ROADWAY;	
	E. STORMWATER DRAINAGE IS CONTROLLED SUCH THAT SEDIMENT IS NOT BEING WASHED ONTO THE ADJACENT ROADWAY	
2	CATCH DRAINS:	
	A. DEQUATE DEPTH/WIDTH;	
	B. ADEQUATE FLOW CAPACITY IS BEING MAINTAINED;	
	C. STABILISED AGAINST SCOUR;	
	D. CLEAR OF SEDIMENT DEPOSITION;	
	E. APPROPRIATE GRASS LENGTH AND/OR LINING IS BEING MAINTAINED	
	F. WATER DISCHARGES VIA STABLE OUTLET	
3	CHANNEL LININGS:	
	A. LINING IS WELL ANCHORED;	
	B. MATS OVERLAP IN DIRECTION OF FLOW;	
	C. NO DAMAGE TO THE MAT BY LATERAL FLOWS;	
	D. LINING IS APPROPRIATE FOR FLOW CONDITIONS	
4	CHECK DAMS:	
	A. FLOW IS PASSING <u>OVER</u> THE DAMS AND NOT AROUND THEM;	
	B. CHECK DAMS ARE <u>NOT</u> CAUSING EXCESSIVE CHANNEL RESTRICTION;	
	C. ROCK CHECK DAMS ARE NOT USED IN SHALLOW DRAINS; CHECK DAMS ARE APPROPRIATELY SPACED DOWN THE DRAIN	
5	LEVEL SPREADERS:	
	A. OUTLET WEIR IS LEVEL AND UNDAMAGED;	
	B. NO SEDIMENT DEPOSITION WITHIN LEVEL SPREADER; DISCHARGES SHEET FLOW TO A STABLE, WELL GRASSED OUTLET	
6	TEMPORARY CULVERT CROSSINGS:	
	A. CROSSING TYPE IS APPROPRIATE FOR UPSTREAM FLOW	
	B. DEBRIS TRAPPED ON OR UPSTREAM OF CROSSING IS REMOVED	
	C. LIKELY DAMAGE CAUSED BY CONSTRUCTION TRAFFIC IS REPAIRED. A MINIMUM OF 200mm COVER OVER CULVERTS IS BEING MAINTAINED	

SPECIFIC ESC DEVICE INSPECTION ITEMS		ASSESSMENT
	D. DAMAGE CAUSED BY EROSION IS REPAIRED (I.E. ON EMBANKMENTS/APPROACH ROAD)	
	E. FLOW DIVERSION CHANNELS/BANKS DIVERTING FLOWS TO THE TCC ARE OPERATING	
7	SEDIMENT FENCES & U-SHAPED SEDIMENT TRAP	
	A. CHOICE OF SEDIMENT TRAP IS APPROPRIATE;	
	B. BOTTOM OF FABRIC IS SECURELY BURIED;	
	C. FABRIC IS APPROPRIATELY OVERLAPPED AT JOINTS;	
	D. FABRIC IS APPROPRIATELY ATTACHED TO POSTS;	
	E. SUPPORT POSTS ARE AT CORRECT SPACING (2m OR 3m WITH BACKING);	
	F. SEDIMENT FENCE DOES NOT CAUSE FLOW DIVERSION/BYPASS;	
	G. SEDIMENT FENCE HAS REGULAR RETURNS;	
	H. LOWER END(S) OF FENCE IS/ARE RETURNED UP THE SLOPE;	
	I. SEDIMENT FENCES ARE FREE OF DAMAGE;	
	J. ALL FENCES ARE ADEQUATELY SPACED FROM TOE OF FILL BANKS	
	K. WHEN MAKING REPAIRS TO U-SHAPED SEDIMENT TRAP, ENSURE ORIGINAL CONFIGURATION IS MAINTAINED	
	L. IF FABRIC IS SAGGING BETWEEN STAKES INSTALL ADDITIONAL SUPPORT POSTS/STAKES	
	M. ACCUMULATED SEDIMENT IS REMOVED FROM U-SHAPED SEDIMENT TRAP IF IT EXCEEDS 150mm DEPTH.	
8	SEDIMENT BASIN(S):	
	A. BASIN GEOMETRY AND LAYOUT MATCH DESIGN DETAILS;	
	B. 'AS CONSTRUCTED' PLANS HAVE BEEN PREPARED;	
	C. THE BASIN DOES NOT REPRESENT A SAFETY RISK;	
	D. DE-WATERING IS CONDUCTED IN ACCORDANCE WITH BEST PRACTICE;	
	E. EXCESSIVE SEDIMENT REMOVED FROM BASIN;	
	F. SEDIMENT DEPTH MARKER IS INSTALLED AND MAINTAINED;	
	G. PRIMARY OUTLET STRUCTURE IS FREE FROM SEDIMENT BLOCKAGE;	
	H. FLOW CONDITIONS ARE NOT COMPROMISED ACROSS THE SPILLWAY;	
	I. EMERGENCY SPILLWAY HAS ADEQUATE SCOUR CONTROL;	
	J. ADEQUATE QUANTITIES OF FLOCCULANT (IF REQUIRED) EXIST ON-SITE;	
	K. SOIL EROSION IS ADEQUATELY CONTROLLED AT INLET POINTS;	
	L. THE SETTLED SEDIMENT LAYER IS CLEARLY VISIBLE THROUGH PONDED WATER PRIOR TO DISCHARGE SUCH WATER	

DATE

25.05.21

PROJECT No. :

BC-18008

DRAWING No. :

DWG-700

REVISION No. :

A

PROJECT

YAMBA GARDENS - EARTHWORKS PHASES 2-4

DRAWING TITLE

ESC CHECKLIST

CLIENT

KAHUNA NO.1 PTY LTD

ADDRESS:

52-54 MILES ST, YAMBA

DRAFTED BY :

AK

DESIGNED BY :

AK

CHECKED BY:

BC

PAPER SIZE :

A3

SCALE :

AS SHOWN

APPROVED FOR AND ON BEHALF OF BIOME CONSULTING PTY LTD

ACN 166 087 476

RPEQ No. :

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		25.05.21

COPYRIGHT

Designs and information presented on these drawings are copyright and the property of BIOME Consulting Pty Ltd and are not to be reproduced or used without permission from BIOME Consulting Pty Ltd.

Drawings are only to be used for the purpose of which they were intended and BIOME Consulting will not accept liability for any unauthorised use or for any purpose by a third party for which they were not intended.

Unless the checked section of the document are signed and approved the drawings are uncontrolled and issued for information purposes only. Drawings have been prepared of assessment purposed only and are not for construction purposes.



BIOME Consulting Pty Ltd
PO Box 3469, Australia Fair, Southport
M 0415 935 222
E brad@BIOMEconsulting.com.au
ABN 86 166 087 476

ORIGINAL SCALE BEFORE REDUCTION

CERTIFIED BY

