Clarence Property

Stormwater Management Plan: Proposed Subdivision, 15 Torakina Road, Brunswick Heads, NSW

P2008063JR01V05
March 2023

martens consulting engineers

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

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

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Author(s)	Reviewer(s)	Project Manager	Signature
Thomas Wright	Stanley Leung	Gray Taylor	

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

Contents

1 Background

1.1 Overview

This concept stormwater management plan has been prepared by Martens & Associates Pty Ltd (MA) for a residential subdivision at 15 Torakina Road, Brunswick Heads, NSW ('the site'). This report is to be read in conjunction with the Concept Stormwater Management Planset (Ref: P2008063PS03R09) prepared by MA and CivilTech Consulting Engineers' civil engineering planset.

1.2 Project Scope and Objectives

Project scope and objectives are:

- Documentation of a water quality assessment completed using Model for Urban Stormwater Improvement Conceptualisation (MUSIC).
- Description of a treatment specification to achieve nominated water quality objectives.
- Documentation of the on-site detention (OSD) requirements for the development.
- Documentation of water quantity assessment modelling and results to achieve nominated water quantity objectives.

1.3 Relevant Planning Controls and Design Principles

The proposed development is subject to the following planning controls, engineering controls and design principles:

- Byron Shire Council (BSC) *(2011) Development Control Plan, Part N – Stormwater Management.*
- Northern Rivers Local Government (NRLG*) (2018) Handbook of Stormwater Drainage Design, D5 Stormwater Drainage Design.*
- Water by Design (2010) *MUSIC Modelling Guidelines.*
- Water by Design (2014) *Bioretention Technical Design Guideline.*
- State Environmental Planning Policy (SEPP) (2018) – *Coastal Wetlands.*

1.4 Proposed Development

Proposed site development is generally described below:

- Creation of residential lots, predominantly single and duplex dwelling allotments and three medium density lots.
- Internal road network connecting the proposed development to Kingsford Drive and Torakina road.
- Associated reticulated utilities and stormwater drainage infrastructures.
- Retention of the existing north-south drain.
- Creation of a new drain east of the existing north-south drain.
- Retention of various Wallum Froglet habitats and creation of additional Wallum Froglet habitat.

Details of the concept development layout with the proposed stormwater management system are provided in the CivilTech Consulting Engineers' Stormwater plans.

2 Site Descriptions

2.1 Site Description and Location

Existing site description summary is provided in Table 1.

Table 1: Site description summary

Address	15 Torakina Road, Brunswick Heads, NSW.
Lot / DP	Lot 13 DP 1251383
Site Area	Approximately 31 ha.
Local Government Area (LGA)	Byron Shire Council (BSC).
Current Land Use	Undeveloped. The majority of the site is dominated by low heath, which is maintained by slashing, with an area of forest to the east of the site.
Current Zoning	DM – Deferred Matters by NSW Planning Portal. 2(a) Residential, 7(a) Environmental Protection (Wetlands) and 7(b) Coastal Habitat by Byron Local Environmental Plan (1988).
Surrounding Land Uses	Urban residential area to the north, rural residential allotments to the west, Simpsons Creek to the east and vacant land with forest to the south.
Topography	The majority of the site consists of shallow undulating depressions from remnant back-barrier dunes, with two low, flat ridges running north south on the eastern and western side. Approximately 3 mAHD in the depressions and 6 mAHD at the top of dunes.
Site Drainage	The majority of the site drains to the south along an existing open drain which ultimately flows into Simpson Creek. The area east of the low eastern ridge drains towards the coastal zone and the existing canal adjacent to the north. The area west of the western ridge generally drains south and west into the adjacent lower lying areas.

3 Stormwater Quality Assessment

3.1 Adopted Stormwater Quality Objectives

The proposed development is subject to BSC DCP and SEPP (Coastal Management) 2018 water quality objectives to maintain the integrity of downstream sensitive receiving water bodies. SEPP (Coastal Management) mapping is provided in Attachment A demonstrating the development on land partially within proximity to a coastal wetland and within the coastal environment area.

3.1.1 BSC DCP

BSC DCP (2011) Section N7 requires the following pollutant reduction criteria, for all stormwater flows up to 25% of the 1 year ARI peak flow, be achieved at minimum:

- 80% reduction in total suspended solids (TSS).
- 45% reduction in total phosphorus (TP).
- 45% reduction in total nitrogen (TN).
- 90% reduction in gross pollutants (GP).

3.1.2 SEPP (Coastal Management) 2018

An extract of the SEPP requirements pertaining to stormwater is provided in Table 2. Given the sensitive nature of Wallum Froglet habitats, a water quality strategy was developed to achieve a Neutral or Beneficial Effect (NorBE) on water quality for each existing and proposed Wallum Froglet habitat.

Table 2: SEPP (Coastal Management) 2018 requirements for the development site

Development Controls for Coastal Management Areas
Clause 11 Development on land in proximity to coastal wetlands or littoral rainforest (1) requires developments in proximity to coastal wetlands to not significantly impact on: a) the biophysical, hydrological and ecological integrity of the coastal wetland or; b) the quantity and quality of surface and groundwater flows to and from the adjacent coastal wetland.
Clause 13 Development on land within the coastal environment area (1) requires developments within the coastal use area to avoid, minimise or mitigate an adverse impact on: a) the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment. b) coastal environment values and natural coastal processes.

Development Controls for Coastal Management Areas
c) the water quality of marine estate, in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes. d) marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms. e) Existing public open space and safe access to and along the foreshore, beach headland or rock platform for members of the public. f) aboriginal cultural heritage practices and places. g) the use if the surf zone.
Clause 15 Development in coastal zone generally *Clause 15* of SEPP requires all developments in coastal management areas to not increase the risk of coastal hazards on that land or other land.

In addition, an assessment of flows entering the groundwater system has been undertaken to ensure the proposed development does not significantly impact on groundwater quality.

3.2 Modelling Methodology

3.2.1 Overview

Model for Urban Stormwater Improvement Conceptualisation (*MUSIC*, Version 6.3) developed by the CRC for Catchment Hydrology was utilised to determine the TSS, TP, TN and Gross Pollutants of the following modelling scenarios:

1. Pre Development – the existing site conditions
2. Post Development (untreated) – the developed site without any water quality structures
3. Post Development (treated)– the developed site with proposed water quality structures

Pre development and post development MUSIC model layouts are provided in MA planset P2008063PS03. Modelling was undertaken in accordance with Water by Design MUSIC modelling Guidelines (2010) and included water quality treatment devices required to achieve adopted objectives.

3.2.2 Approach

Modelling has been completed based on the proposed sizes and locations of stormwater treatment devices provided by CivilTech Consulting Engineers are included in the proposed development modelling and satisfy the nominated objective in Section 3.1.

3.2.3 Rainfall Data

MUSIC was run using the Federal Post Office pluviograph data and average monthly evaporation data obtained from *ewater*. The data was run on a 6-minute time step from 01/01/1966 – 31/12/1975.

3.2.4 Input Parameters

Input parameters for source and treatment nodes are consistent with MUSIC modelling guidelines and are provided in Attachment B.

3.2.5 Catchment Areas

Catchment areas were subdivided in accordance with Water by Design (2010) and include roofs, sealed roads, residential and forest land uses.

t\The NorBE MUSIC model has been split into each of the 5 development stages to effectively demonstrate the proposed treatment train meets the water quality objectives defined in Section 3.1. Catchment area details for both the TTE and NorBE assessments are provided in MA planset P2008063PS03.

The percentage of impervious areas for each lot type modelled in MUSIC is summarised in Table 3.

Table 3: %impervious for each lot type modelled in MUSIC.

Lot Type	% Impervious
Single dwelling lot	60%
Duplex dwelling lot	65%
Medium density dwelling lot	70%

3.3 Treatment Train Philosophy

The stormwater treatment strategy for the site uses combination of 'at – source' and 'end – of – line' controls to ensure treatment objectives are satisfied. The proposed stormwater quality improvement devices (SQIDs) are outlined in the following section.

3.3.1 Rainwater Tanks

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

- 3 kL rainwater tank for each of the anticipated lots.

- An annual external reuse rate of 0.411 kL/year/m^2 (pervious ground level of lot) was applied and scaled by potential evapotranspiration variations.

- An annual internal reuse rate of 0.220 kL/day/dwelling was applied.

3.3.2 Bioretention Basins

Stormwater runoff from the proposed development shall be directed to the proposed bioretention basins located along the perimeter of the proposed roads with a one-way cross falling towards the basins. Refer to CivilTech Consulting Engineer's plan for the location of the bioretention basins proposed within the site.

Proposed bioretention basins will be generally flat. The base will be unlined to allow treated low flows to percolate into the surrounding soils and restore groundwater. As the Road 2 West bioretention basin encountered shallow groundwater, it was designed as a 'lined' system. This was necessary to prevent interception with the filter material and allow for the discharge of treated flows to lower discharge points. Refer to CivilTech Consulting Engineer's plan for the location and type of the proposed bioretention basins.

The biofiltration systems shall generally be designed in accordance with the proposed parameters nominated below and are subject to detailed design:

- Extended detention depth: 0.3 m.

- Filter area: See Attachment B for size of individual basin.

- Typical filter depth: 0.40 m.

- Saturated Hydraulic Conductivity: 200 mm/hr.

- Exfiltration rate: 5 mm/hr.

3.4 Results

3.4.1 MUSIC modelling results (TTE)

MUSIC modelling results for the development are provided in Table 4.

Table 4: MUSIC TTE results for the development site.

Parameter	Sources	Residual Load	Achieved Reduction	Required Reduction	Complies (Y/N)
TSS (kg/year)	33600	2550	92.4%	80%	Y
TP (kg/year)	67.4	25.6	61.9%	45%	Y
TN (kg/year)	379	143	62.2%	45%	Y
Gross Pollutants (kg/year)	3430	0	100%	90%	Y

The results indicate that post development water quality requirements by BSC DCP will be met by the proposed stormwater treatment train by way of the SQID's nominated in Section 3.1.1. Given high levels of performance, at detailed design there will be scope to either include or exclude internal reuse.

3.4.2 MUSIC modelling results (NorBE)

MUSIC modelling results for the site and each Wallum Froglet habitat are provided for each of the development stages in Table 5 – Table 22. These indicate that each stage of the development will not degrade receiving water quality.

Stage 1 NorBE Assessment:

Table 5: Stage 1 Overall MUSIC NorBE results.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	26700	15300	11400	-43%
TP (kg/year)	53.6	38.9	14.7	-27%
TN (kg/year)	288	235	53	-18%
GP (kg/year)	580	0	580	0%

Table 6: Stage 1 MUSIC NorBE results: Pre and Post development for Wallum Froglet Habitat 03.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	10300	6090	4210	-41%
TP (kg/year)	19.5	14.2	5.3	-27%
TN (kg/year)	99.6	90.4	9.2	-9%
GP (kg/year)	285	0	285	0%

Table 7: Stage 1 MUSIC NorBE results: Pre and Post development for the NS drain.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	16400	9220	7180	-44%
TP (kg/year)	34.1	24.7	9.4	-28%
TN (kg/year)	188	145	43	-23%
GP (kg/year)	295	0	295	0%

Stage 2 NorBE Assessment:

Table 8: Stage 2 Overall MUSIC NorBE results.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	26700	13200	13500	-51%
TP (kg/year)	54.8	36.7	18.1	-33%
TN (kg/year)	285	224	61	-21%
GP (kg/year)	580	0	580	0%

Table 9: Stage 2 MUSIC NorBE results: Pre and Post development for Wallum Froglet Habitat 03.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	10200	5610	4590	-45%
TP (kg/year)	19.9	13.9	6	-30%
TN (kg/year)	99.2	90.7	8.5	-9%
GP (kg/year)	285	0	285	0%

Table 10: Stage 2 MUSIC NorBE results: Pre and Post development for the NS drain.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	16500	7580	8920	-54%
TP (kg/year)	34.9	22.8	12.1	-35%
TN (kg/year)	186	134	52	-28%
GP (kg/year)	295	0	295	0%

Stage 3 NorBE Assessment:

Table 11: Stage 3 Overall MUSIC NorBE results.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	26800	9670	17130	-64%
TP (kg/year)	54.3	33.4	20.9	-38%
TN (kg/year)	285	209	76	-27%
GP (kg/year)	580	0	580	0%

Table 12: Stage 3 MUSIC NorBE results: Pre and Post development for Wallum Froglet Habitat 03.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	10100	5290	4810	-48%
TP (kg/year)	19.8	13.8	6	-30%
TN (kg/year)	99.7	94	5.7	-6%
GP (kg/year)	285	0	285	0%

Table 13: Stage 3 MUSIC NorBE results: Pre and Post development for the NS drain.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	16700	4380	12320	-74%
TP (kg/year)	34.5	19.5	15	-43%
TN (kg/year)	186	115	71	-38%
GP (kg/year)	295	0	295	0%

Stage 4 NorBE Assessment:

Table 14: Stage 4 Overall MUSIC NorBE results.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	27700	8460	19240	-69%
TP (kg/year)	57	36.2	20.8	-36%
TN (kg/year)	299	210	89	-30%
GP (kg/year)	580	0	580	0%

Table 15: Stage 4 MUSIC NorBE results: Pre and Post development for Wallum Froglet Habitat 03.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	10300	5320	4980	-48%
TP (kg/year)	19.9	13.9	6	-30%
TN (kg/year)	99.2	94.3	4.9	-5%
GP (kg/year)	285	0	285	0%

Table 16: Stage 4 MUSIC NorBE results: Pre and Post development for the NS drain.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	16600	3100	13500	-81%
TP (kg/year)	35.1	19.6	15.5	-44%
TN (kg/year)	188	107	81	-43%
GP (kg/year)	295	0	295	0%

Stage 5 NorBE Assessment:

Table 17: Stage 5 Overall MUSIC NorBE results.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	34100	11800	22300	-65%
TP (kg/year)	69.7	46.3	23.4	-34%
TN (kg/year)	378	268	110	-29%
GP (kg/year)	619	0	619	0%

Table 18: Stage 5 MUSIC NorBE results: Pre and Post development for Wallum Froglet Habitat 01.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	2250	1500	750	-33%
TP (kg/year)	5.08	4.75	0.33	-6%
TN (kg/year)	30.6	27.7	2.9	-9%
GP (kg/year)	0	0	0	0%

Table 19: Stage 5 MUSIC NorBE results: Pre and Post development for Wallum Froglet Habitat 02.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	3700	2320	1380	-37%
TP (kg/year)	8.09	5.5	2.59	-32%
TN (kg/year)	45.8	32.5	13.3	-29%
GP (kg/year)	39.1	0	39.1	0%

Table 20: Stage 5 MUSIC NorBE results: Pre and Post development for Wallum Froglet Habitat 03.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	10300	5340	4960	-48%
TP (kg/year)	19.6	13.9	5.7	-29%
TN (kg/year)	101	94.2	6.8	-7%
GP (kg/year)	285	0	285	0%

Table 21: Stage 5 MUSIC NorBE results: Pre and Post development for the NS drain.

Parameter	Pre-Development	Post-Development	Reduction	% Change
TSS (kg/year)	16900	2140	14760	-87%
TP (kg/year)	34.6	18.5	16.1	-47%
TN (kg/year)	188	99	89	-47%
GP (kg/year)	295	0	295	0%

3.4.3 MUSIC modelling results (groundwater)

Site groundwater quality sampling has been undertaken at 10 monitoring wells as part of the MA's groundwater assessment. Full results of the groundwater quality data are provided in MA's report Preliminary Hydrogeological Assessment - P2008063JR02V01. A comparison of the sampling data and MUSIC's results at the location of the Wallum Froglet habitat is summarised in Table 22.

Table 22: MUSIC results: groundwater quality for each Wallum Froglet habitat.

Parameter	Wallum Froglet 01		Wallum Froglet 02		Wallum Froglet 03	
	Mean Concentration	Sampling Results (MW 102)	Mean Concentration	Sampling results (MW 103 & 107)	Mean Concentration	Sampling results (MW 104 & 109)
TP (mg/L)	0.218	0.290	0.294	0.336	0.240	0.425
TN (mg/L)	1.252	1.238	1.773	6.184	1.608	4.302

The results indicate that the stormwater discharging into the groundwater system will have concentrations lower than the existing conditions. Therefore, the proposed development will not have any adverse impacts on groundwater quality of the Wallum Froglet habitats.

3.5 Conclusion

The proposed management system is consistent with the principles of Water Sensitive Urban Design (WSUD) as the proposed treatment strategy utilises 'at source' controls and a 'treatment train' rather than relying solely on large end of line structures.

Results indicate that Byron Shire Council and SEPP (Coastal Management) 2018 water quality objectives will be met at each stage of the development by the proposed stormwater treatment train. Further refinement of the model at detailed design stage may alter the sizes and locations of proposed treatment structures; however, performance outcomes of the final design are to achieve the water quality objectives adopted in this report.

4 Stormwater Quantity Assessment

4.1 Stormwater Quantity Objectives

Stormwater quantity management is to comply with the objectives of Northern Rivers Local Government (NRLG*) (2018), Handbook of Stormwater Drainage Design, D5 Stormwater Drainage Design* which requires "the peak flow from the proposed development for the 5, 10, 20, 50 and 100 ARI events, for durations from 5 minutes to 3 hours, does not exceed the existing peak from the site".

Given the sensitive nature of Wallum Froglet habitats, a water quantity assessment has been undertaken to ensure no overflow from the proposed OSD basins to Wallum Froglet habitats for the 15 minute storm duration for any events 5 year ARI or smaller (based on advice from Australian Wetlands Consulting Pty Ltd (AWC), the project ecologist). This is to ensure the most of the runoff from the proposed development is captured by the OSD basins.

4.2 Modelling Methodology and Approach

4.2.1 Overview

The DRAINS hydrological and hydraulic software package (version 2020.061) was used with the ILSAX engine to determine the overall site flow under existing and developed conditions and overflows from each individual basin upstream of the Wallum Froglet habitats area.

4.2.2 Approach

The following drainage structures proposed by CivilTech Consulting Engineering have been included in the proposed model for stormwater detention:

- Storage within extended detention depth of each of the proposed bioretention basins.
- Proposed main drain east of the existing north-south drain with a weir structure in the southern end and 3 x 600mm diameter low flow outlet pipe.

Modelling was undertaken for a range of storm durations between 5 min and 3 hours of the following storms:

- 1 YR ARI.
- 2 YR ARI.
- 5 YR ARI.
- 10 YR ARI.
- 20 YR ARI.
- 50 YR ARI.
- 100 YR ARI.

4.2.3 Hydrological Model

The full computation method was used to assess OSD basins for this site. The hydrological model was built using the prescribed inputs found in the NRLG's Handbook of Stormwater Drainage Design (2018).

4.2.4 Rainfall/IFD Data

Intensity Frequency Duration (IFD) parameters were obtained from NRLG (2018), for the storm events and durations specified by BSC.

4.2.5 Catchment Areas

Catchment delineation (see MA planset P2008063PS03-E600) was developed using site survey data and the concept stormwater management plan (prepared by CivilTech). Conservative assumptions of percentage of roof and lot impervious area have adopted in the model and summarised below for each lot type:

- Single lots: Roof = 50% and Lot impervious area = 60%
- Duplex lots: Roof = 45% and Lot impervious area = 65%
- Medium density lots: Roof = 55% and Lot impervious area = 70%

4.2.6 OSD Structures

The proposed bio-retention basins and the proposed main drain will be functioned as OSD structures to reduce runoffs generated by the development site in accordance with the criteria outlined in Section 4.1.

In accordance with the North-South drain plan and sections prepared by CivilTech, the main drain has been modelled with an OSD weir at RL 3.6 with 3 x 600mm RCP. OSD modelling results for the pre and post development scenarios are provided in Section 4.2.8.

4.2.7 On-lot infiltration drainage, Rain Gardens and Street Trees

In addition to the proposed bioretention basins, on-lot infiltration drainage, raingardens and street trees have been proposed to increase infiltration throughout the catchment. These drainage infrastructures have not been included in the model and would help to achieve a better outcome than the what the current model suggested.

4.2.8 OSD Modelling Results

A summary of the critical storm runoff results from DRAINS model for the 1 to 100 year ARI storm events are provided in Table 23, Table 24 and Table 25 with full results provided in MA planset P2008063PS03-E600. Results indicate that existing peak flows for the development are not exceeded in any of the design events considered.

Table 23: DRAINS modelling results: Pre development.

Storm Event	1	2	5	10	20	50	100
5 min	0.438	1.532	2.756	4.103	5.036	6.806	7.708
10 min	1.164	2.838	4.834	7.173	8.718	11.723	13.204
15 min	1.469	3.594	6.175	9.263	11.094	14.732	16.469
20 min	2.042	4.286	7.253	10.476	12.686	16.346	18.328
25 min	2.135	4.594	7.696	11.153	13.397	16.266	18.165
30 min	1.891	4.332	7.282	10.667	12.866	15.784	17.799
45 min	1.897	4.192	7.142	10.358	12.430	15.685	17.625
1 hour	2.838	5.233	8.014	11.243	13.324	16.144	18.197
1.5 hours	3.117	5.764	8.628	11.180	13.138	15.542	17.392
2 hours	3.323	6.346	9.415	11.817	13.769	16.272	18.280
3 hours	1.718	4.534	6.865	8.980	10.632	12.396	13.857

Table 24: DRAINS modelling results: Post development.

Storm Event	1	2	5	10	20	50	100
5 min	0.225	0.835	1.517	2.277	2.941	4.538	5.219
10 min	0.637	1.604	3.143	4.887	6.431	9.966	11.558
15 min	0.923	2.581	4.511	7.697	9.547	12.218	13.576
20 min	1.275	3.112	6.169	9.117	11.125	13.783	15.316
25 min	1.496	3.490	6.989	9.987	12.012	14.136	15.682
30 min	1.440	3.284	6.518	9.483	11.482	13.681	15.319
45 min	1.540	3.203	6.403	9.027	10.783	13.349	14.896
1 hour	2.218	4.476	7.838	10.373	12.139	14.294	16.020
1.5 hours	2.530	5.536	8.564	10.576	12.236	14.150	16.409
2 hours	2.668	5.999	8.822	10.710	12.293	14.813	17.318
3 hours	1.562	3.595	6.710	8.362	9.725	11.153	12.658

Table 25: DRAINS modelling results: Change in pre development and post development flows.

Storm Event	1	2	5	10	20	50	100
5 min	-0.213	-0.697	-1.239	-1.826	-2.095	-2.268	-2.489
10 min	-0.527	-1.234	-1.691	-2.286	-2.287	-1.757	-1.646
15 min	-0.546	-1.013	-1.664	-1.566	-1.547	-2.514	-2.893
20 min	-0.767	-1.174	-1.084	-1.359	-1.561	-2.563	-3.012
25 min	-0.639	-1.104	-0.707	-1.166	-1.385	-2.130	-2.483
30 min	-0.451	-1.048	-0.764	-1.184	-1.384	-2.103	-2.480
45 min	-0.357	-0.989	-0.739	-1.331	-1.647	-2.336	-2.729
1 hour	-0.620	-0.757	-0.176	-0.870	-1.185	-1.850	-2.177
1.5 hours	-0.587	-0.228	-0.064	-0.604	-0.902	-1.392	-0.983
2 hours	-0.655	-0.347	-0.593	-1.107	-1.476	-1.459	-0.962
3 hours	-0.156	-0.939	-0.155	-0.618	-0.907	-1.243	-1.199

DRAINS modelling concludes that the 2 hour duration storm is the critical 100 year ARI event with a maximum water level at RL 3.81 (below the proposed levels of the roads and bioretention basin spillways). Results of the maximum water depth and discharge rates of the proposed main drain are provided in Table 26.

Table 26: Maximum water depth and discharge rates of the proposed main drain

Maximum Water Depth (m)	Discharge Rate through Pipes (m^3/s)	Discharge Rate through Weir (m^3/s)
1.31	2.21	1.89

4.2.9 Modelling Results (AWC)

DRAINS modelling results of overflows from the proposed bioretention basins (road 7 east, road 7 west and road 2 east) to Wallum Froglet habitats are summarised in Table 27.

Table 27: DRAINS modelling results for each Wallum Froglet habitat.

Storm Event (ARI)	Wallum Froglet 01			Wallum Froglet 02			Wallum Froglet 03		
	1	2	5	1	2	5	1	2	5
5 min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10 min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15 min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20 min	0.000	0.000	0.167	0.000	0.000	0.170	0.000	0.000	0.293
25 min	0.000	0.000	0.242	0.000	0.000	0.244	0.000	0.000	0.415
30 min	0.000	0.021	0.201	0.000	0.026	0.203	0.000	0.073	0.349
45 min	0.000	0.103	0.199	0.000	0.103	0.199	0.000	0.181	0.340
1 hour	0.000	0.120	0.344	0.000	0.119	0.341	0.026	0.207	0.575
1.5 hours	0.038	0.191	0.434	0.039	0.193	0.429	0.069	0.340	0.714

Storm Event (ARI)	Wallum Froglet 01			Wallum Froglet 02			Wallum Froglet 03		
	1	2	5	1	2	5	1	2	5
2 hours	0.054	0.206	0.408	0.053	0.206	0.403	0.090	0.357	0.670
3 hours	0.062	0.101	0.255	0.062	0.104	0.251	0.107	0.196	0.418

Modelling demonstrates that flows would be contained within the proposed bioretention basins and would not overtop into the Wallum Froglet habitats for the 15 minutes storms (or shorter) in the 1, 2 and 5 year ARI events.

4.3 Conclusion

Hydraulic modelling has been undertaken to assess OSD design for the proposed development. Preliminary hydraulic modelling demonstrates compliance with NRLG (2018) and impacts to the Wallum Froglet habitats have been minimised.

5 References

Byron Shire Council (BSC) *(2011) Development Control Plan, Part N – Stormwater Management.*

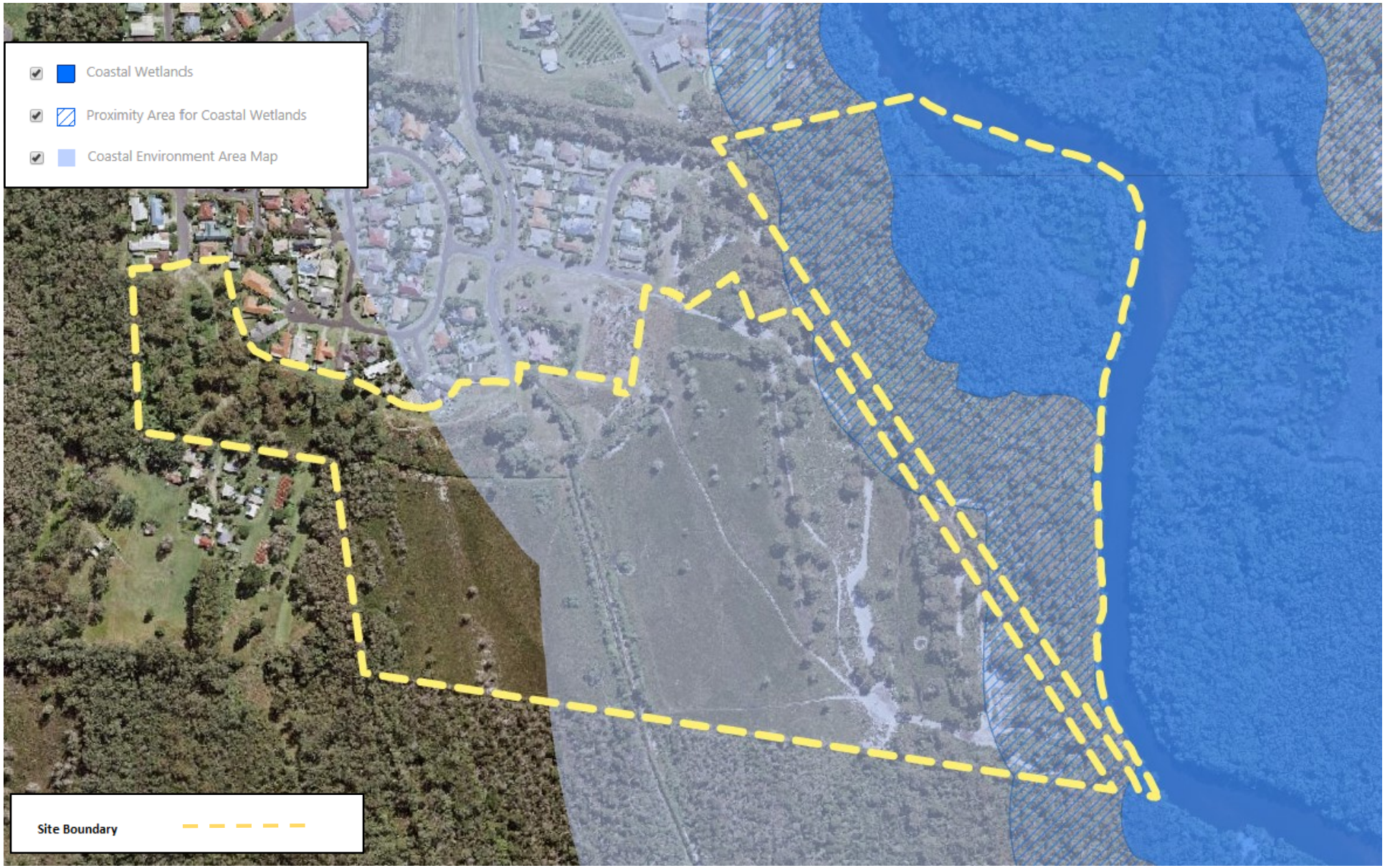
Northern Rivers Local Government (NRLG*) (2018) Handbook of Stormwater Drainage Design, D5 Stormwater Drainage Design.*

State Environmental Planning Policy (SEPP) (2018) – *Coastal Wetlands.*

Water by Design (2010) *MUSIC Modelling Guidelines.*

Water by Design (2014) *Bioretention Technical Design Guideline*.

6 Attachment A – SEPP (Coastal Management) Mapping



martens

		Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	TW	15 Torakina Road, Brunswick Heads, NSW Source: SEPP (coastal management) 2018 - maps	Drawing No: **FIGURE 1**
Approved:	SL		
Date:	March 2023		
Scale:	Not to Scale		Job No: P2008063

7 Attachment B – Summary of MUSIC Input Parameters

Element	Factor	Input	Source
Setup	Climate File	Federal Post Office Station Pluviograph. 6-minute time step from 01/01/1966 – 31/12/1975	ewater
Source nodes	Node Type	Roofs, sealed road, residential and forest areas	Layout plan
	Rainfall-Runoff Parameters	Based on land use type as specified in Table 3.7 of Water by Design MUSIC Modelling Guidelines (2010)	
	EMC's	Based on Table 3.9 of Water by Design MUSIC Modelling Guidelines (2010)	Water by Design MUSIC Modelling Guidelines (2010)
	Estimation Method	Stochastically generated	Water by Design MUSIC Modelling Guidelines (2010)
3 kL rainwater tank for each dwelling	Low Flow Bypass	0 m³/s	
	High Flow Bypass	100 m³/s	Water by Design MUSIC Modelling Guidelines (2010)
	Volume below overflow	3 kL	Water by Design MUSIC Modelling Guidelines (2010)
	Depth above overflow	0.2 m	Tank design
	Surface Area	1.5 m2	Cumulative surface area for tanks based on number of tanks
	Initial Volume	3 kL	Tank design
	Overflow pipe diameter	90 mm per tank	Tank design
	Reuse	0.22 kL/day/dwelling for internal reuse; 0.411 kL/year/m2 (pervious ground level of lot) for external reuse.	Tank design
Biofiltration basin (Road 7 West)	Low Flow Bypass	0 m³/s	Water by Design MUSIC Modelling Guidelines (2010)
	High Flow Bypass	100 m³/s	Online so no bypass
	Extended Detention Depth	0.3 m	By design.

Element	Factor	Input	Source
	Surface Area	1225 m^2	By design.
	Filter Area	475 m^2	By design.
	Unlined Filter Area	504 m	By design.
	Saturated Hydraulic Conductivity	200 mm/hr	Water by Design MUSIC Modelling Guidelines (2010)
	Filter Depth	0.4 m	By design.
	TN Content of Filter media	800 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Orthophosphate Content of Filter Media	55 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Exfiltration Rate	5 mm/hr	By design.
	Is Base Lined?	No	By design.
	Vegetation Properties	Vegetated with effective nutrient removal plants	By design.
	Overflow Weir Width	220	By design.
	Underdrain Present?	Yes	By design.
	Submerged Zone with Carbon Present?	No	By design.
Biofiltration basin (Road 7 East)	Low Flow Bypass	0 m^3/s	Water by Design MUSIC Modelling Guidelines (2010)
	High Flow Bypass	100 m^3/s	Online so no bypass
	Extended Detention Depth	0.3 m	By design.
	Surface Area	1168 m^2	By design.
	Filter Area	481 m^2	By design.
	Unlined Filter Area	462 m	By design.
	Saturated Hydraulic Conductivity	200 mm/hr	Water by Design MUSIC Modelling Guidelines (2010)

Element	Factor	Input	Source
	Filter Depth	0.4 m	By design.
	TN Content of Filter media	800 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Orthophosphate Content of Filter Media	55 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Exfiltration Rate	5 mm/hr	By design.
	Is Base Lined?	No	By design.
	Vegetation Properties	Vegetated with effective nutrient removal plants	By design.
	Overflow Weir Width	220	By design.
	Underdrain Present?	Yes	By design.
	Submerged Zone with Carbon Present?	No	By design.
Biofiltration basin (Road 2 East)	Low Flow Bypass	0 m^3/s	Water by Design MUSIC Modelling Guidelines (2010)
	High Flow Bypass	100 m^3/s	Online so no bypass
	Extended Detention Depth	0.3 m	By design.
	Surface Area	1906 m^2	By design.
	Filter Area	847 m^2	By design.
	Unlined Filter Area	711 m	By design.
	Saturated Hydraulic Conductivity	200 mm/hr	Water by Design MUSIC Modelling Guidelines (2010)
	Filter Depth	0.4 m	By design.
	TN Content of Filter media	800 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Orthophosphate Content of Filter Media	55 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Exfiltration Rate	5 mm/hr	By design.

Element	Factor	Input	Source
	Is Base Lined?	No	By design.
	Vegetation Properties	Vegetated with effective nutrient removal plants	By design.
	Overflow Weir Width	340	By design.
	Underdrain Present?	No	By design.
	Submerged Zone with Carbon Present?	No	By design.
Biofiltration basin (Road 2 West)	Low Flow Bypass	0 m^3/s	Water by Design MUSIC Modelling Guidelines (2010)
	High Flow Bypass	100 m^3/s	Online so no bypass
	Extended Detention Depth	0.3 m	By design.
	Surface Area	2320 m^2	By design.
	Filter Area	1450 m^2	By design.
	Unlined Filter Area	590 m	By design.
	Saturated Hydraulic Conductivity	200 mm/hr	Water by Design MUSIC Modelling Guidelines (2010)
	Filter Depth	0.4 m	By design.
	TN Content of Filter media	800 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Orthophosphate Content of Filter Media	55 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Exfiltration Rate	5 mm/hr	By design.
	Is Base Lined?	Yes	By design.
	Vegetation Properties	Vegetated with effective nutrient removal plants	By design.
	Overflow Weir Width	290	By design.
	Underdrain Present?	Yes	By design.

Element	Factor	Input	Source
	Submerged Zone with Carbon Present?	No	By design.
Biofiltration basin (Road 7 North)	Low Flow Bypass	0 m^3/s	Water by Design MUSIC Modelling Guidelines (2010)
	High Flow Bypass	100 m^3/s	Online so no bypass
	Extended Detention Depth	0.3 m	By design.
	Surface Area	270 m^2	By design.
	Filter Area	111 m^2	By design.
	Unlined Filter Area	110 m	By design.
	Saturated Hydraulic Conductivity	200 mm/hr	Water by Design MUSIC Modelling Guidelines (2010)
	Filter Depth	0.4 m	By design.
	TN Content of Filter media	800 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Orthophosphate Content of Filter Media	55 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Exfiltration Rate	5 mm/hr	By design.
	Is Base Lined?	No	By design.
	Vegetation Properties	Vegetated with effective nutrient removal plants	By design.
	Overflow Weir Width	50	By design.
	Underdrain Present?	Yes	By design.
	Submerged Zone with Carbon Present?	No	By design.
Biofiltration basin (Road 2 South)	Low Flow Bypass	0 m^3/s	Water by Design MUSIC Modelling Guidelines (2010)
	High Flow Bypass	100 m^3/s	Online so no bypass
	Extended Detention Depth	0.3 m	By design.

Element	Factor	Input	Source
	Surface Area	684 m^2	By design.
	Filter Area	114 m^2	By design.
	Unlined Filter Area	381 m	By design.
	Saturated Hydraulic Conductivity	200 mm/hr	Water by Design MUSIC Modelling Guidelines (2010)
	Filter Depth	0.4 m	By design.
	TN Content of Filter media	800 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Orthophosphate Content of Filter Media	55 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Exfiltration Rate	5 mm/hr	By design.
	Is Base Lined?	No	By design.
	Vegetation Properties	Vegetated with effective nutrient removal plants	By design.
	Overflow Weir Width	180	By design.
	Underdrain Present?	Yes	By design.
	Submerged Zone with Carbon Present?	No	By design.
Biofiltration basin (Road 6 West)	Low Flow Bypass	0 m^3/s	Water by Design MUSIC Modelling Guidelines (2010)
	High Flow Bypass	100 m^3/s	Online so no bypass
	Extended Detention Depth	0.3 m	By design.
	Surface Area	1102 m^2 (Stage 3)	By design.
	Filter Area	162 m^2 (Stage 3)	By design.
	Unlined Filter Area	326 m (Stage 3)	By design.
	Saturated Hydraulic Conductivity	200 mm/hr	Water by Design MUSIC Modelling Guidelines (2010)

Element	Factor	Input	Source
	Filter Depth	0.4 m	By design.
	TN Content of Filter media	800 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Orthophosphate Content of Filter Media	55 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Exfiltration Rate	5 mm/hr	By design.
	Is Base Lined?	No	By design.
	Vegetation Properties	Vegetated with ineffective nutrient removal plants	By design.
	Overflow Weir Width	162	By design.
	Underdrain Present?	Yes	By design.
	Submerged Zone with Carbon Present?	No	By design.
Biofiltration basin (Road 6 East)	Low Flow Bypass	0 m^3/s	Water by Design MUSIC Modelling Guidelines (2010)
	High Flow Bypass	100 m^3/s	Online so no bypass
	Extended Detention Depth	0.3 m	By design.
	Surface Area	500 m^2 (Stage 3)	By design.
	Filter Area	167 m^2 (Stage 3)	By design.
	Unlined Filter Area	225 m (Stage 3)	By design.
	Saturated Hydraulic Conductivity	200 mm/hr	Water by Design MUSIC Modelling Guidelines (2010)
	Filter Depth	0.4 m	By design.
	TN Content of Filter media	800 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Orthophosphate Content of Filter Media	55 mg/kg	Water by Design MUSIC Modelling Guidelines (2010)
	Exfiltration Rate	5 mm/hr	By design.

Element	Factor	Input	Source
	Is Base Lined?	No	By design.
	Vegetation Properties	Vegetated with effective nutrient removal plants	By design.
	Overflow Weir Width	100	By design.
	Underdrain Present?	Yes	By design.
	Submerged Zone with Carbon Present?	No	By design.