



WATERCYCLE MANAGEMENT PLAN

Warra Warra Road, South Nowra

Site: Lot 224 DP 755952 & Lot 2 DP 1126288

Project: Planning Proposal – ‘R1’ General Residential

LGA: Shoalhaven City Council

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- Engineering Design Specifications
 - Shoalhaven AUS-SPEC
- Development Design Specifications
 - Shoalhaven Engineering Design Specifications (D1 – D8)
- Shoalhaven's DCP2014 and supporting technical guidelines.
- Engineering Standards / Specifications and Planning Guidelines
 - Australian Standards (various)
 - Austroads Guidelines (various)
- Australian Rainfall & Runoff – A Guide to Flood Estimation – 2019
- Landcom Managing Urban Stormwater Soil and Construction Volume 1 (4th Edition 2004) known as the "blue book".
- WaterNSW - NorBE Assessment Guidelines 2015
- WaterNSW - NorBE User Guide for Consultants 2015
- WaterNSW - Using MUSIC in Sydney's Drinking Water Catchments 2012
- WaterNSW - Development in the Sydney Drinking Water Catchment – Water Quality Information Requirements June 2018
- Planning Proposal Civil Engineering Plan Set: 24047 Rev P0 dated 24th March 2026 by CivPlan Pty Ltd
- Flood Impact and Risk Assessment prepared by CivPlan Pty Ltd



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1. Introduction

1.1 Purpose and Scope

This report has been prepared for Lysand Pty Ltd & Lyrock Pty Ltd. The purpose of this Water Cycle Management Plan (WCMP) is to provide support for Planning Proposal to rezone and develop Lot 224 DP 755952 & Lot 2 DP 1126288 which is situated between The Princes Highway on the West of the site, the unformed Old Southern Road casement along the North-Western fringe and the unsealed Warra Warra Road to the South of the site.

The scope of this WCMP includes assessment of the water cycle management requirements to support the Planning Proposal, to outline the findings of the analysis undertaken of the proposal and recommend treatments in accordance with Water Sensitive Urban Design (WSUD) best practice measures. The treatment measures recommended are to address overland flow, water quality and quantity requirements calculated from various modelling analysis. The report will include the findings of the analysis and propose best practice strategies.

2. Project Overview & Hydrology

2.1 Site Description

The site is located on Lot 224 DP 755952 & Lot 2 DP 1126288 between The Princes Highway, Warra Warra Road (unsealed), Old Southern Road (unformed) and Old Southern Road (formed) to the north within the Shoalhaven City Council LGA and the Shoalhaven Water catchment area. Access to the site is via Warra Warra Road which is aligned East – West along the site's Southern Boundary or via Old Southern Road at the northern extent of the site. Additionally, the Princes Highway runs North-South along the sites' Western boundary and an unformed road reserve for Old Southern Road runs along the North-western side of the site.

The surrounding area is a blend between general industrial land use (E3/E4, residential land (R1/R2/RU2) and vegetated areas (C2). There are currently no dwellings or structures on the site however, the site is burdened by high voltage electrical transmission lines running North-South on the western portion of the site. There is an approved development (SF10743) to the North of the site.

Lot 224 DP 755952 & Lot 2 DP 1126288 is approximately 32.4ha. The development SF10743 has constructed infrastructure (roads, drainage, reticulated sewer and water) however no dwellings have been constructed in the current stage.



Figure 1: Site and surrounding context (NSW Base Map)

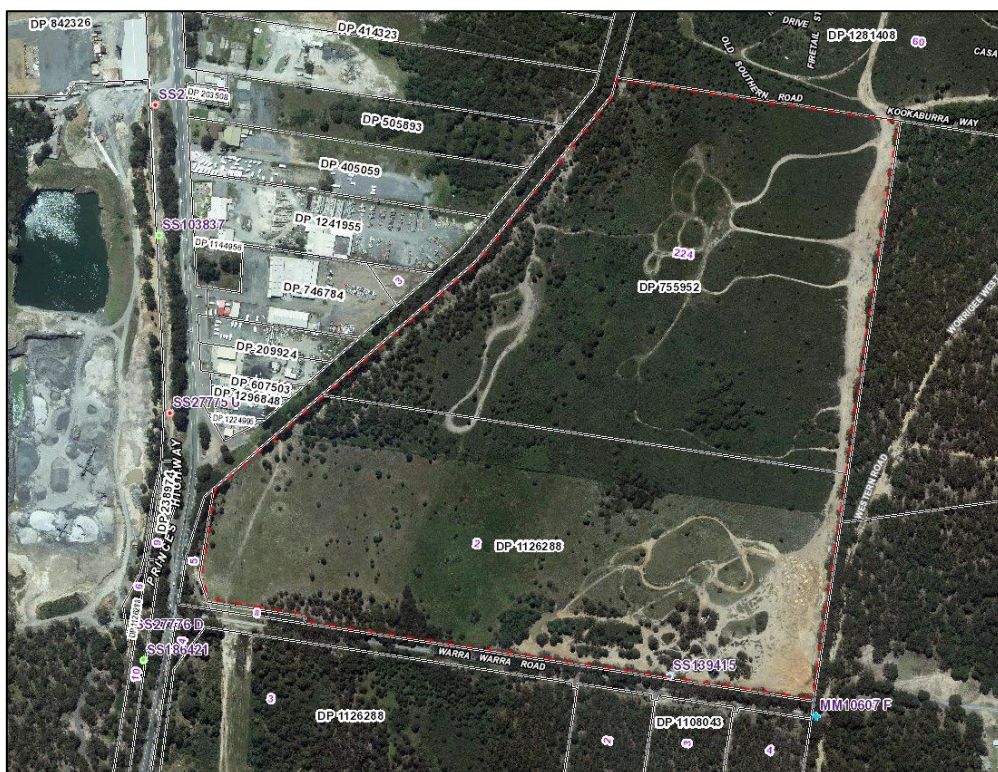


Figure 2: Site Location - NSW Imagery (SIX Maps)

Browns Creek runs through the site flowing from the South to the North, flowing into Nowra Creek and then to the Shoalhaven River. Browns Creek is a named waterway within a riparian corridor with fluctuating flows and the typical condition is a marshy swamp area.

The site is relatively flat, however generally dips towards Browns Creek which then flows towards the North of the site at 0.5% from the Southern extent at approximately RL40.5 to RL37.5 over approximately 660m. The Western portion of the site relative to Browns Creek falls from the Princes

Highway to the creek at approximately 3%. The Eastern portion of the site falls towards Browns Creek at 1.7%. There is a crest at RL43.5 in the South-Eastern corner of the site.

Figure 3 shows the extent and location of Browns Creek within the site. The portion of Browns Creek within the site sits within the upper to middle catchment area of the creek and at the starts of the 1% flood mapping.

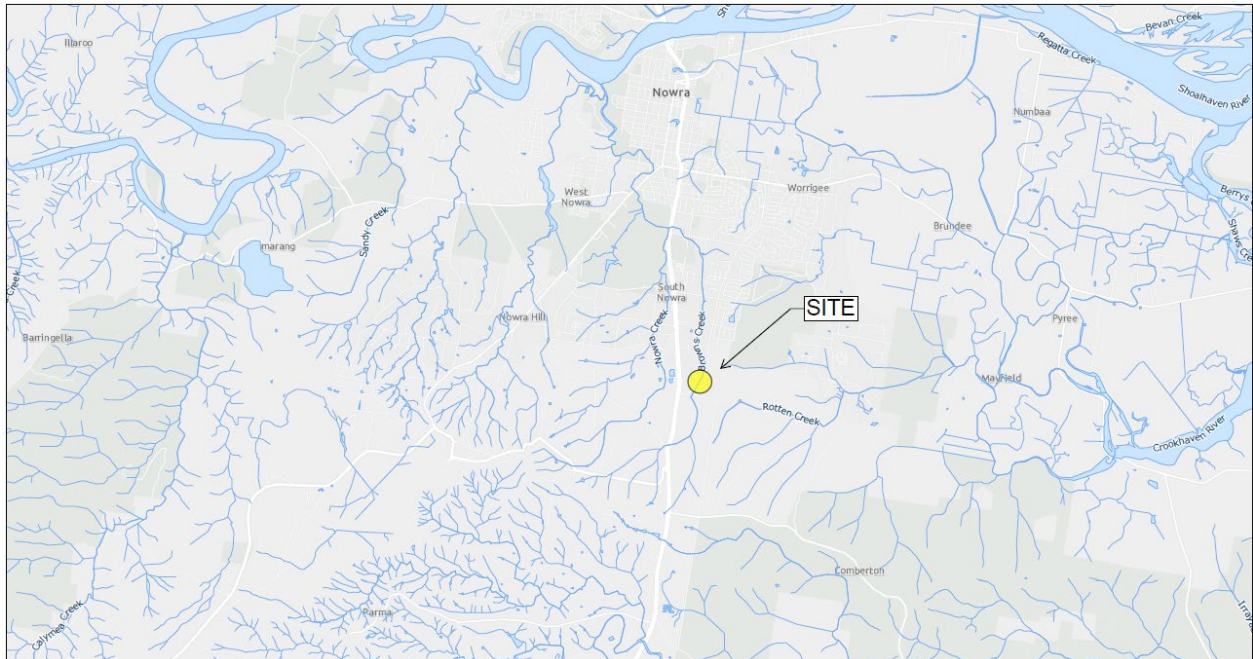


Figure 3: Surrounding Waterways - NSW Spatial Mapping (Hydrolines)

Analysis of the upstream catchment has been undertaken by CivPlan Pty Ltd and is available as part of the Flood Impact and Risk Assessment.

The site at present is zoned 'E3 Productivity Support' which is typically light industry, community facilities, recreational areas/facilities or warehouse/distribution centres.

There are portions of the site that are below the 1% AEP flood planning levels, this is primarily in the Browns Creek corridor, however an analysis of the flood patterns including flood levels has been undertaken by CivPlan Pty Ltd and is available as part of the Flood Impact and Risk Assessment.

2.2 Proposed Development

The Planning Proposal aims to rezone part of the site from being entirely 'E3' zoning to the following categories:

- R1 General Residential – 16.21Ha
- C2 Environmental Conservation – 9.3Ha

Figure 4 is a masterplan showing the location of the above changes to the zoning as part of the Planning Proposal.



Figure 4: Masterplan by Jervis Bay Town Planning Pty Ltd

The planning proposal aims to formalise and protect the Browns Creek catchment and biodiversity areas on the southern portion of the site through 'C2' zoning and to change the existing 'E3' zoning to 'R1' General Residential.

Given that this is a high-level planning proposal the discrete lots as part of the development are subject to a development application. However, an approximation of the future road network has been undertaken based on the masterplan in figure 4. A concept analysis of basins and the trunk stormwater network have also been undertaken along with an analysis of the upstream flows via the direct rainfall method to simulate flows through Browns Creek. Figure 5 below shows the General Arrangement of the civil concept.

2.3 Rainfall Data, Catchments & Hydrology

The rainfall data used to undertake the required modelling, analysis and design has been sourced from the ARR Data Hub and BoM using Australian Rainfall and Runoff 2019 (ARR19). The data taken from the nearest point to the subject site was a Latitude 34.9125 South and Longitude 150.6125 East.

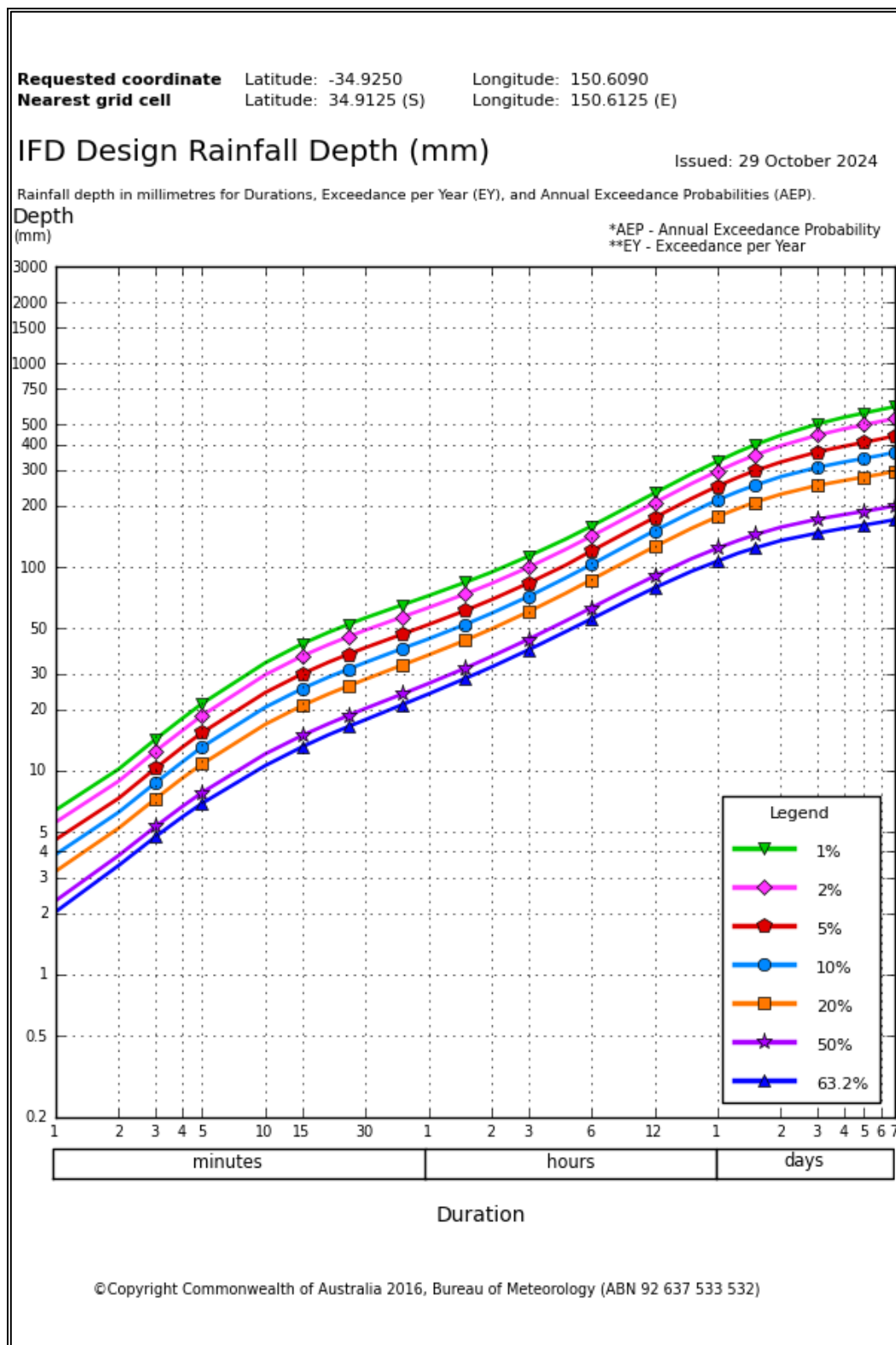


Figure 6: IFD Design Rainfall Intensity Data: Latitude 34.9125 South and Longitude 150.6125 East

The pre and post development catchment areas within the site, including impervious portions, are shown in Figure 7. To aid the analysis of the site, it was separated into two precincts which are divided by the Browns Creek corridor.

Warra Warra Rd - DRAINS Catchments				
Pre Development				
EASTERN PRECINCT	16.183	ha	0.0%	
Post Development				
EASTERN PRECINCT	16.183	ha	77% (ave)	

Figure 7: Subject site catchments Pre & Post development

The current land is primarily vegetated with sparse to moderate thickness and based on the observed overland flow surface condition from the inspection of the site, an average Manning's Roughness Coefficient of $n=0.025$ was applied for the pre-development scenario as there was a general channelisation of dirt/rock with sparse vegetation.

Land Use Type	Manning 'n'
Residential areas – high density	0.2 – 0.5
Residential areas – low density	0.1 – 0.2
Industrial/commercial	0.2 – 0.5
Open pervious areas, minimal vegetation (grassed)	0.03 – 0.05
Open pervious areas, moderate vegetation (shrubs)	0.05 – 0.07
Open pervious areas, thick vegetation (trees)	0.07 – 0.12
Land Use Type	Manning 'n'
Waterways/channels – minimal vegetation	0.02 – 0.04
Waterways/channels – vegetated	0.04 – 0.1
Concrete lined channels	0.015 – 0.02
Paved roads/car park/driveways	0.02 – 0.03
Lakes (no emergent vegetation)	0.015 – 0.35
Wetlands (emergent vegetation)	0.05 – 0.08
Estuaries/Oceans	0.02 – 0.04

Figure 8: Manning's 'n' Roughness Co-efficient (see ARR19 Book 6 Section 6.2.1 & 6.2.2)

The upstream areas have been modelled in Tuflow by CivPlan Pty Ltd, and the results can be found in the Flood Impact and Risk Assessment. The findings of the study have been incorporated into the analysis and concept.

The pre-development catchments are greater than 2Ha in size and have been modelled using an IL/CL hydrological model with RAFTS parameters and the post development catchments have also been modelled with IL/CL parameters. The development aims to reduce the post development flows to match the pre-development flows via OSD Basins. The pre-development DRAINS model can be seen in Figures 9 and 10.

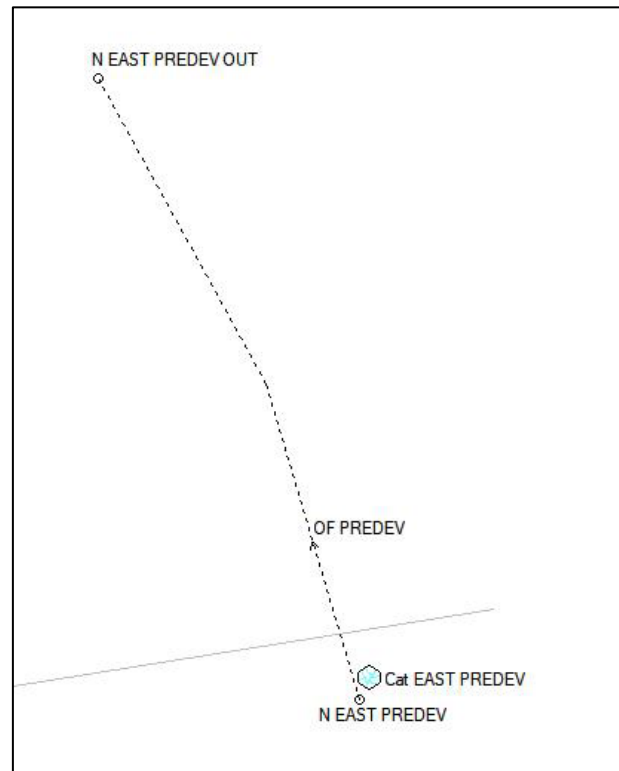


Figure 9: Pre-development DRAINS model

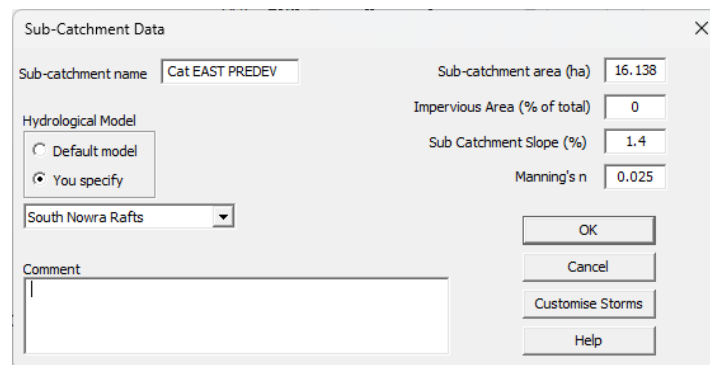


Figure 10: RAFTS parameters pre-development

Due to the nature of the development and the current level of analysis, at source detention for each lot and sub-catchment was not taken into consideration, instead the developments' flows were offset by the attenuation in the trunk pit and pipe network and 2 Basins.

The basins are modelled to capture the piped and overland flows for attenuation and offset the increased impervious area. All basins adhering to the parameters set out in section 2.2 of Shoalhaven City Councils Technical Stormwater Guidelines.

Site Flows (m3/sec)									
	Pre-Dev	Post-Dev	Flow Difference	% Flow Difference	Status	Water Level BASIN 1	Water Level BASIN 2	Freeboard BASIN 1	Freeboard BASIN 2
20% AEP	1.490	1.236	-0.254	-21%	ok	37.6	39.92	1.5	0.871
1% AEP	3.49	3.295	-0.195	-6%	ok	38.37	40.65	0.73	0.141

Figure 12: DRAINS modelling results

The results in Figure 12 above demonstrate that using a combination of the following measures, the post-development flows can be matched or reduced from the pre-development flows:

- Bioretention/ OSD basins with a storage capacity of approximately 1,980m³ and 2,210m³ both incorporate an outlet control orifice plate and overflow weir.
- Rainwater tanks for all residential and commercial lots which are to be connected to the roof drainage for each lot for reuse/BASIX requirements for each dwelling. Orifice size and centroid height for the rainwater tanks to be confirmed by a suitably qualified engineer, based on the final area and height of the dwelling rainwater tanks.

3.2 Flood Impact

Shoalhaven City Council have undertaken a flood study of the subject site and there are portions of the site that are below the 1% AEP flood planning levels, this is primarily in the Browns Creek corridor. The current site flood study mapping is shown in Figure 13.

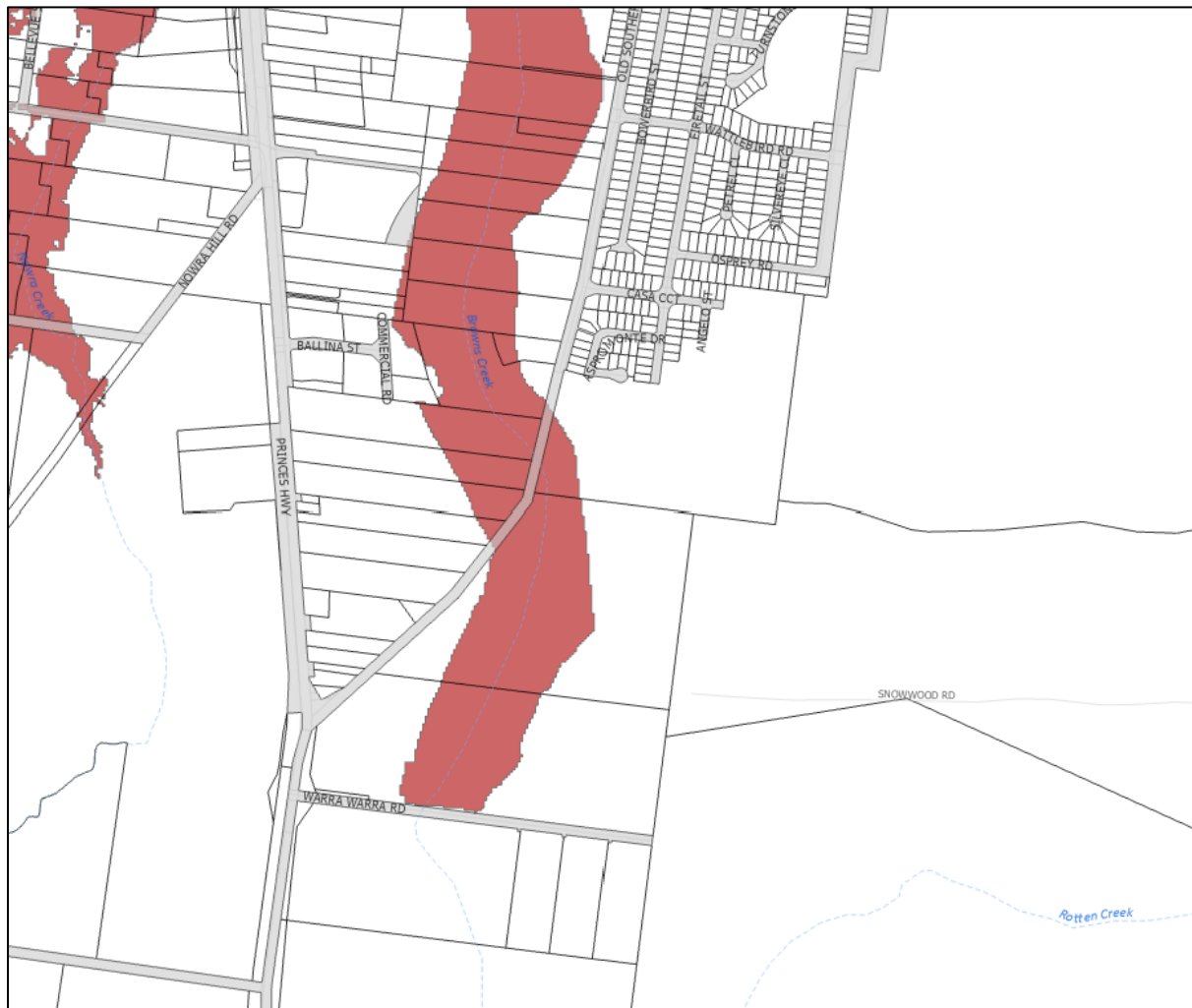


Figure 13: Flood Depths – (SCC GIS - Floodplain Study)

Further analysis of the flood patterns including flood levels has been undertaken by CivPlan Pty Ltd and can be found in the Flood Impact and Risk Assessment.

3.3 Interface and Tie in with Adjacent Properties

The attenuated stormwater outlet arrangement from the overall site will be into the proposed C2 zoning (Browns Creek) which runs through the site. The pipe network and overland flow will all flow towards this wetland via the proposed Basins.

4. Stormwater Quality Management

4.1 Pollution Reduction Targets

Shoalhaven City Councils' DCP 2014 Chapter G2 states the required pollution reduction target, which are:

Pollutant	Post Development average annual load reduction.
Gross Pollutants	End of stormwater network solution is to achieve the following: • Litter: Retention of litter greater than 40mm for flows up to the 4 exceedances per year (EY) event (3-month ARI peak flow) • Coarse sediment: Retention of sediment coarser than 0.125mm for flows up to the 4EY peak flow. 90%
Total Suspended Solids	80%
Total Phosphorous	45%
Total Nitrogen	45%

The subject site is outside of the Sydney Water Drinking Water Catchment.

4.2 Water Quality Modelling – MUSIC

The water quality modelling has been undertaken utilising Model for Urban Stormwater Improvement Conceptualisation (MUSIC-X) software using Shoalhaven City Council's DCP2014 Chapter G2, and the SCC Sustainable Stormwater Technical Guidelines.

The following figures show the input parameters for the MUSIC model. Modelling has been undertaken using the NSW MUSIC Modelling Guidelines including pollution generation parameters. Rainfall data has been obtained from the Shoalhaven City Councils' MUSIC data link to ensure the latest climate data has been used. The Potential Evapotranspiration (PET) data has been obtained from the SCC Sustainable Stormwater Technical Guidelines and is shown in figure 13.

Month	J	F	M	A	M	J	J	A	S	O	N	D
PET (mm)	151.7	112.6	103.9	85.4	79.5	54.8	74.8	87.1	115.1	141.0	141.3	154.4

Figure 14: Rainfall and Evapotranspiration Meteorological Data Statistics

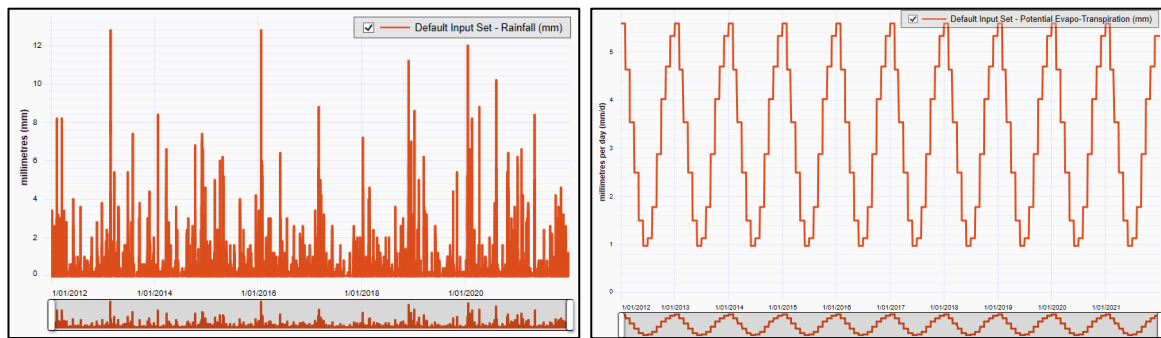


Figure 15: Climate Data provided by the SCC Data Link

Warra Warra Rd, South Nowra			
POST-DEVELOPMENT CATCHMENTS			
CATCHMENT 01			
Name	Description	Area (m2)	% Impervious
Lot Residual North		4.747	80%
Roof	Roof to 2.5kL RWT via pipe network	2.970	100%
Residential	Via Bioretention Basin	1.777	80%
Lot Residual South		4.832	80%
Roof	Roof to 2.5kL RWT via pipe network	3.240	100%
Residential	Via Swale	1.592	80%
CATCHMENT 02			
Name	Description	Area (m2)	% Impervious
Roads North	Via Bioretention Basin	3.450	90%
Roads South	Via Bioretention Basin	2.153	90%
CATCHMENT 03			
Name	Description	Area (m2)	% Impervious
Road North	Bypass	0.114	90%
Road South	Bypass	0.626	90%
CATCHMENT 04			
Name	Description	Area (m2)	% Impervious
OSD	Bypass	0.282	0%
TOTAL CATCHMENT		16.204	ha
2.5kL Rainwater Tanks per residential dwelling for stormwater reuse Reuse (Internal) based on 0.845kL/day/dwelling Reuse (External) based on 55kL/year/dwelling			

Figure 16: Site MUSIC Catchments

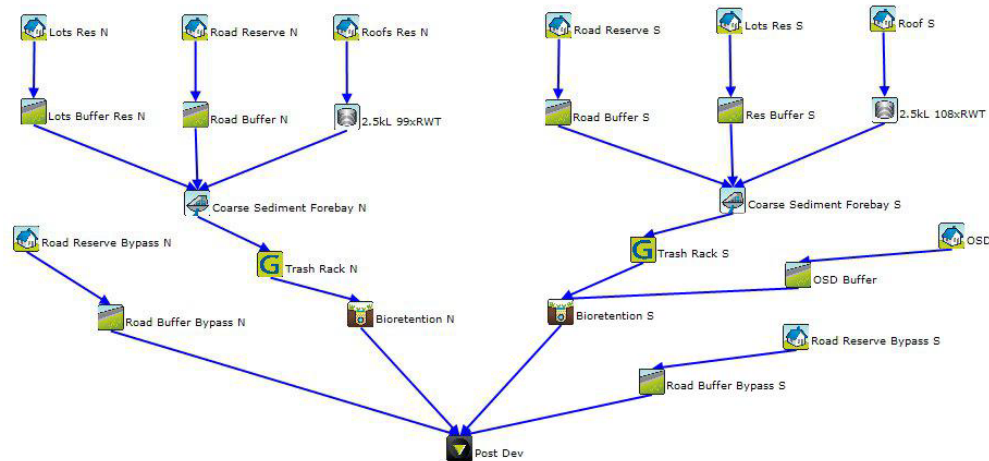


Figure 18: MUSIC Water Quality Model - Treatment Measures

4.4 Treatment Effectiveness

The treatment measures and subsequent treatment train effectiveness for the proposed development are in Figure 19.

Flow Reduction	None	None	8.273 %	✓
GP Reduction	90	None	95.771 %	✓
TN Reduction	45	None	57.64 %	✓
TP Reduction	45	None	72.563 %	✓
TSS Reduction	80	None	91.408 %	✓

Figure 19: MUSIC Water Quality Model - Treatment Train Effectiveness

It can be seen from the Treatment Train Effectiveness summary in Figure 19 that all the Shoalhaven City Council's reduction targets have been met with the proposed treatment measures.

5. Maintenance

5.1 Privately Owned Assets

The rainwater tanks utilising Smart Tank Technology to each lot, incorporating the water quality treatment (reuse) and quantity (OSD capacity) to each dwelling are to be installed and maintained by each lot/dwelling owner. The legal requirements are to be stipulated in the 88B Instrument for each lot. Refer to Appendix A, the maintenance management plan for detailed information in relation the inspection and maintenance requirements.

5.2 Publicly Owned Assets

The inspection and maintenance requirements for the publicly owned assets, namely the bioretention swales and associated pit and pipe network are detailed in Appendix A.

6. Soil & Water Management

6.1 Concept Design Plan Set

For details relating to the soil & water management plan and associated measures please refer to the Civil Engineering Design Plan Set for the detailed design by CivPlan Pty Ltd. The measures have been designed in accordance with the Landcom Managing Urban Stormwater Soil and Construction Volume 1 (4th Edition 2004) known as the “blue book”. Calculations for any temporary sedimentation basin(s) will be undertaken during the detail design.

7. Conclusion

In accordance with Shoalhaven City’s Council Engineering Design Standards, it can be concluded that all the criteria have been met, specifically the development:

- All bioretention is proposed to be above or outside of the 1% AEP flood area or proposed to be filled above the 1% AEP flood area.
- No clearing will be undertaken within the wetlands ‘Browns Creek’.
- Cut to fill requirements and associated disturbance has been minimised within wetlands ‘Browns Creek’ in relation to the proposed subdivision layout plan.
- OSD will be provided using basins and no at source OSD is relied upon.
- The outlet will be via the proposed C2 zone formalising ‘Browns Creek’.
- Re-use rates are in accordance with the guideline of the indicative amount of 0.1kL/day/100m² of roof area (internal use) & 20kL/yr/1000m² (external use) for commercial buildings and 0.845kL/day/dwelling (internal use) and 55kL/yr/dwelling was (external use) was assumed for residential lots.
- Each dwelling will have 2.5kL of RWT with Smart Tank Technology as reuse/BASIX for residential lots.
- Water quality treatment will be via pit, pipe and basin network. The treatments have been modelled in MUSIC to simulate post development conditions.
- The associated WSUD treatments have been designed in accordance with the requirements in DCP2014 Chapter G2 and the associated Sustainable Stormwater Technical Guidelines, therefore all related targets have been met.
- Soil and water management plan has been provided in the civil engineering concept and design plans.



APPENDIX A:

Maintenance Management Plan



MAINTENANCE MANAGEMENT PLAN

Warra Warra Road, South Nowra

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APPENDICES:

- Appendix 1: Bioretention Basin – Inspection & Maintenance Schedule/ Risk Assessment
- Appendix 2: Testing Requirements Extract

1. Introduction

1.1 Purpose and Scope

This report has been prepared for Lysand Pty Ltd & Lyrock Pty Ltd. The purpose of this Maintenance Management Plan (MMP) is to provide operation, inspection and maintenance guidelines for the water quantity and quality infrastructure for the proposed residential development, at Lot 224 DP 755952 & Lot 2 DP 1126288 at Warra Warra Rd, South Nowra

2. Project Overview & Hydrology

2.1 Site Description

The site is located on Lot 224 DP 755952 & Lot 2 DP 1126288 between The Princes Highway, Warra Warra Road (unsealed), Old Southern Road (unformed) and Old Southern Road (formed) to the north within the Shoalhaven City Council LGA and the Shoalhaven Water catchment area. Access to the site is via Warra Warra Road which is aligned East – West along the site’s Southern Boundary or via Old Southern Road at the northern extent of the site. Additionally, the Princes Highway runs North-South along the sites’ Western boundary and an unformed road reserve for Old Southern Road runs along the North-western side of the site.

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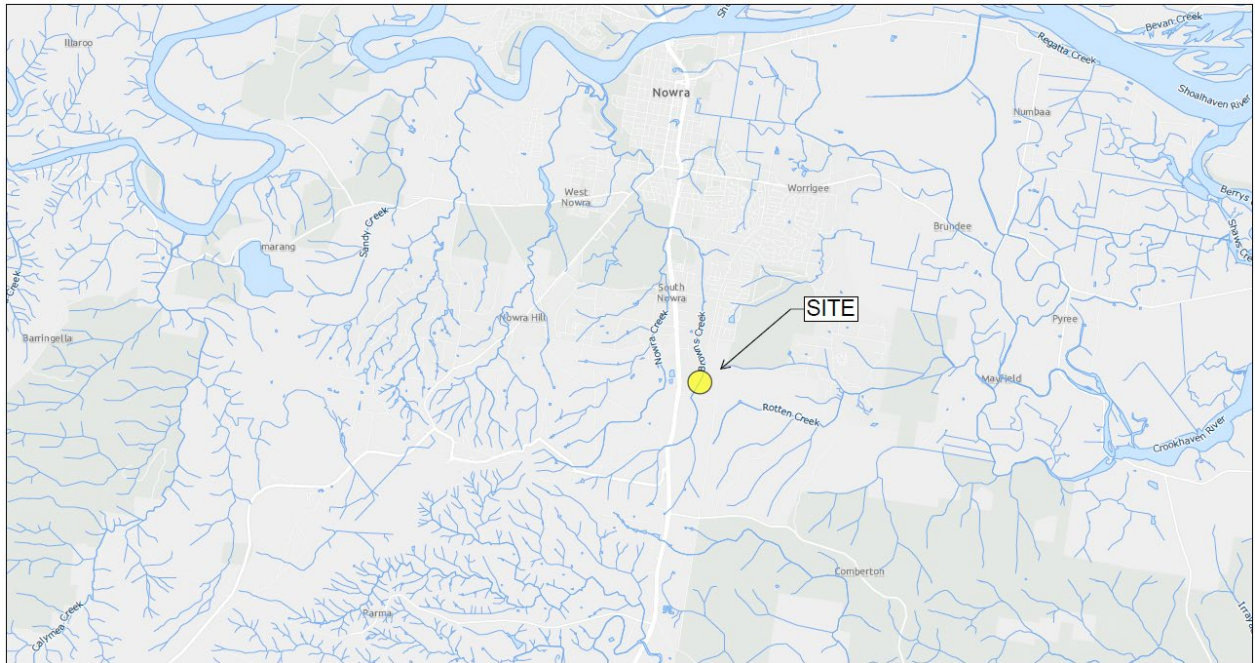


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- R1 General Residential – 16.21Ha
- C2 Environmental Conservation – 9.3Ha

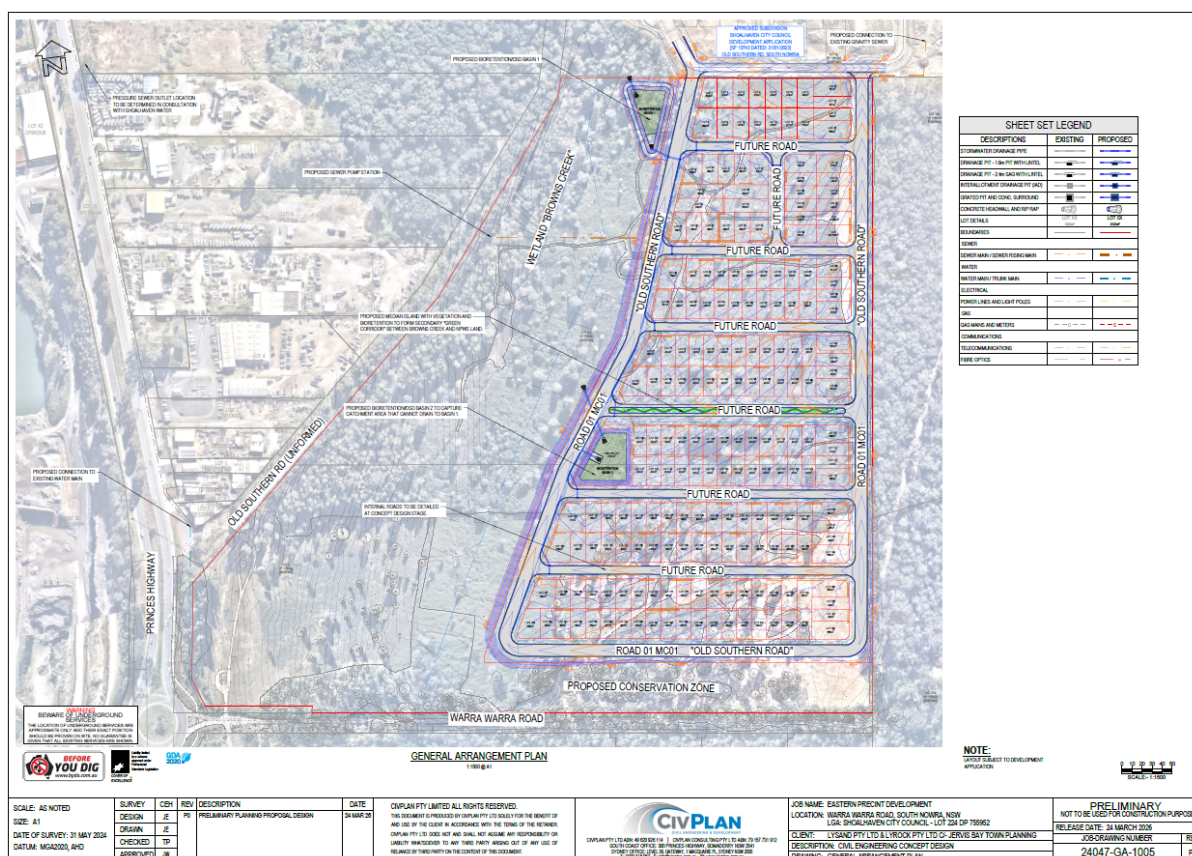
Figure 4 is a masterplan showing the location of the above changes to the zoning as part of the Planning Proposal.



Figure 4: Masterplan by Jervis Bay Town Planning Pty Ltd

The planning proposal aims to formalise and protect the Browns Creek catchment and biodiversity areas on the southern portion of the site through 'C2' zoning and to change the existing 'E3' zoning to 'R1' General Residential.

Given that this is a high-level planning proposal the discrete lots as part of the development are subject to a development application. However, an approximation of the future road network has been undertaken based on the masterplan in figure 4. A concept analysis of basins and the trunk stormwater network have also been undertaken along with an analysis of the upstream flows via the rain on grid method to simulate flows through Browns Creek. Figure 5 below shows the General Arrangement of the civil concept.



3. Operation, Inspections & Maintenance

3.1 Overview of Operations, Inspections & Maintenance

Inspection of the bioretention basins need to be undertaken by suitably trained, qualified, and equipped Council maintenance staff at least every 3 months to ensure that the bioretention basins are functional and assess what elements require cleaning, repair, or replacement. After major rainfall events the basins must be inspected. Specific details can be found in the checklist at Appendix 1.

Maintenance must only be undertaken during dry weather with no rainfall predicted, impending or underway. Rubbish, debris, sediment etc must be cleared from the basins. An operation, maintenance and inspection schedule and checklist can be found at Appendix 1. These documents need to be documented/completed and renewed each year. Additionally, they should be kept for the purposes of compliance and auditing.

The cost related to the maintenance of the bioretention zone within the basin is estimated to be \$5/yr/m² (source: Cooperative Research Centre for Water Sensitive Cities 2015).

Filter media will need to be re-evaluated every 5-10 years depending on the amount regular effective inspection and maintenance. If regular maintenance is undertaken on the filter media, the biofilters can last 15-20 years. In this instance of filter media replacement, a small truck (MR size) and earth moving machinery (such as a bobcat and up to a 4t excavator).

The nutrient removing plants to the bioretention basins and raingardens are critical to the overall system and its performance in terms of removing nutrients and maintaining saturated hydraulic conductivity. The best species of plants are: Carex, Melaleuca, Juncus, Goodenia and Fincinia planted at a density of 8-12/m².

The subsoil drainage network within the bioretention basins should be regularly flushed as part of the ongoing maintenance regime. In the event of a blockage, further flushing and if required rodding by a suitably qualified plumber should be undertaken to clear the blockage. The subsoil pipe should only be excavated, and relevant section replaced if all other avenues have failed, as this will cause the established filter media and nutrient removing plants to have their integrity compromised.

The bioretention basin need have an extended detention depth of 200mm - 300mm and to be maintained, with the depth of filter media, which is 500mm in this case, being determined from the top of sand filter media level vertically down to the top of the coarse sand transition layer. A typical section view can be seen in the figure below.

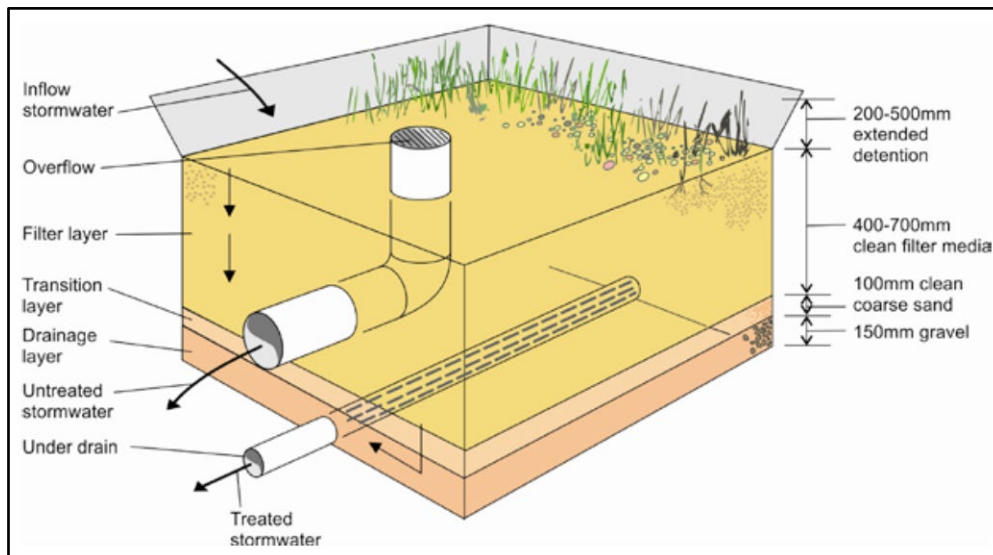


Figure 6 Typical Bioretention Section View

Testing requirements for the filter media are as follows:

- Saturated hydraulic conductivity 100-300mm/hr (test using ASTM F1815-06 see appendix 2 for further information)
- Total nitrogen content 400mg/kg or less
- Orthophosphate content 40mg/kg or less

Testing for this material can be undertaken directly at any NATA accredited geotechnical testing laboratory or via any supplier of this type of sand.

3.2 Individual Lot Rainwater Tanks

Landowners are required to adhere to legislative requirements to harvest rainwater captured from their dwelling roof runoff for the purposes of reuse. Basic maintenance of the associated rainwater tanks is required, including but not limited to first flush devices and leaf screening.

The rainwater tanks utilising Smart Tank Technology to each lot, incorporating the water quality treatment (reuse) and quantity (OSD capacity) to each dwelling are to be installed and maintained by each lot/dwelling owner.

3.3 Work, Health & Safety

All works associated with the operation, maintenance and inspection of the basin are to be undertaken in a safe manner, guided by and in accordance with the Work Health & Safety Act and Regulations 2017 and 2011 respectively. The following must be considered when undertaking tasks related to this OEMP:

- Weather conditions and the likelihood in impending rainfall, prior to conducting any works within the swales. Do not enter the swale or undertaken any works associated with the swale if rainfall is predicted, impending or underway during the conduct of works.
- Personal protective equipment (PPE) is to be worn during works including, but not limited to:
 - Hard hat.
 - Safety glasses / goggles.
 - Hi-visibility vest / long sleeve shirt and pants.
 - Steel capped enclosed boots.
 - Gloves that prevent puncture from sharp objects.
 - Hearing protection in the event of noisy work (mowing, edges etc).
 - Sunscreen and sun cover extension.



APPENDIX 1:

Bioretention Basin- Inspection &
Maintenance Schedule / Risk
Assessment

Operation, Inspection & Maintenance Schedule

Task	Frequency / Who	Requirement	Year: _____			
			Q1: Jan-Mar	Q2: Apr-Jun	Q3: Jul-Sep	Q4: Oct-Dec
			Date of Inspection	Date of Inspection	Date of Inspection	Date of Inspection
PIT/PIPE INFRASTRUCTURE AND BIORETENTION BASIN AND SWALE SURFACE STRUCTURE						
General Inspection	Every 3 months or after every significant/heavy rain event (10mm/hr or more) By Landowners or Council as required by asset ownership	Ensure that there is no excessive erosion, scouring or degradation of vegetation and that water is flowing with no ponding.				
Basin batters & turfing		Remove any sediment, rubbish or debris build up, checking that the upstream and downstream connections are performing as intended. Mow and weed as required, noting couch turf only to be used. Ensure that the entire basin perimeter is in good order. Ensure that there is no rutting or blockages				
Vegetation		Ensure that grass and vegetation is alive and in good order and not overgrown along footpath/cycleway/driveway. Prune vegetation and mow grass as required. Remove any weeds and debris.				
Pit and Pipe Network		Ensure that the outlet pipe and headwall is clear of debris, rubbish and sediment. Remove sediment, rubbish and debris from pits and the inlet/outlets. Ensure that the rip rap scour protection is in place and working effectively.				

BIORETENTION ELEMENTS						
Overflow Pit, Weir (extended detention zone) & Subsoil Drains	Every 3 months or after every significant/heavy rain event (10mm/hr or more) By Landowners or Council as required by asset ownership	Ensure that the overflow/outlet pit is clear of debris, rubbish and sediment and that the subsoils drain clear to the underdrain pipe. Inspect all the subsoil flushing point and flush the subsoils to ensure that the subsoils aren't blocked. Check the weir/outlet top of pit grate is unobstructed the following extended detention depths are unobstructed and maintained: - Basin 1 – 300mm - Basin 2 – 200mm - Swale – 50mm				
Vegetation		Check the health of all the nutrient capturing vegetation and ensure that the numbers match the required plan frequency of 8-12 per m². Remove weeds. Clear the bioretention zone of debris, rubbish and sediment.				
Filter Media		Clear the filter media of debris, rubbish and sediment. Hand tools may be used to weed etc and maintain the filter media. Check for any sediment build up, scour or excessive ponding, ensuring that the filter media is level. Remediate/repair as required, removing any sediment. Check that the filter media depth of 500mm has been maintained and is 500mm below top of weir/outlet pit grate. Top up with approved filter media sand as required. Appropriate filter media material must be used. <i>Testing of the filter media in accordance with the design plans in this BMP must be undertaken every 10 years (contact <u>Council for assistance</u>).</i>				

		<i>Visual Inspection of filter media (water ponding >12 hours). If so media replacement may be required (generally every 5 years)</i>				
Underdrains		Ensure that the underdrain from the bioretention zone is not blocked and flowing to the outlet pit. Flush the underdrain pipe to ensure that it is not blocked.				
RAINWATER TANK/COLLECTION SYSTEM						
Gutters	Every 3 months or after every significant/heavy rain event (10mm/hr or more) By Landowner	Clean leaves and debris from gutters. If water is ponding, repair gutter to ensure water flows to downpipe.				
Check for tree branches over the roof		Remove any overhanging branches				
Access covers		Secure any open access covers to prevent risk of entry				
Screens		Ensure screens on inlet, outlets, overflows and other openings do not have holes, are clear of debris and are securely fastened.				
Tank water		Check for and remove any infestation (animal/insect), identify point of entry and secure. Check outlet and orifice are clear of blockages				
Tank roof and coatings		Repair any leaks as necessary				
Mains supply valve		Service the mains supply valve annually.				
Signage		Check and replace signage as required.				

Bioretention Basin Risk Assessment

Likelihood: A – Almost Certain, B – Likely, C – Possible, D – Unlikely, E – Rare

Consequence: 5 – Disaster, 4 – Severe, 3 – Serious, 2 – Significant, 1 – Minor

<u>Procedure / Event / Activity</u>	<u>Hazard</u>	<u>Risk Rating</u>			<u>Control Measures</u>	<u>Residual Risk Rating</u>		
		<u>Likelihood</u>	<u>Consequence</u>	<u>Risk</u>		<u>Likelihood</u>	<u>Consequence</u>	<u>Risk</u>
Walking around or in the general vicinity of the roadside basin	Within the road reserve or C2 zone	C	5	High	Traffic control to be used when working within the road reserve Only authorised and trained personnel to undertake the maintenance works	E	4	Low
Accessing and egressing the roadside bioretention for maintenance purposes	Slips, trips and falls	B	2	Med	Only authorised and trained personnel to undertake the maintenance works, signage and fencing to be installed. Works only to be undertaken in dry weather conditions	B	1	Low
Unable to identify the base of the bioretention basin due to water nor gauge the waters depth	Drowning Slips, trips and falls	C	5	High	Works only to be undertaken in dry weather conditions Install signage of floodway hazard where required	D	3	Low

Cleaning and general maintenance of the basin	Slips, trips and falls Injury from waste items such as rubbish, sharp edges, needles etc	C	2	Low	Do not contact rubbish, sharp edges, needles directly, ensure that correct and relevant PPE and tools are utilised (gloves, rubbish clamps, shovels etc) Only authorised and trained personnel to undertake the maintenance works.	E	2	Low
Blockage of basin outlet and/or filter system	Water filling the basin rather than total outflow in a controlled manner	C	3	Medium	Undertake required maintenance in accordance with the maintenance plan	D	2	Low
Bioretention system becomes blocked or dysfunctional due to filter material loss or contamination	Untreated stormwater entering the downstream system	D	3	Low	Undertake required maintenance in accordance with the maintenance plan Test filter material and confirm its depth in accordance with the design parameters	E	2	Low

Highest Level of Control

Lowest Level of Control

Elimination Substitution Engineering Administration Personal Protective Equipment

PERSONAL CONSEQUENCE CATEGORIES

5. Disaster	Injuries that result in a fatality or multiple fatality.
4. Severe	Severe injury resulting in lost time.
3. Serious	Serious injury resulting in restricted work without lost time.
2. Significant	Significant injury resulting in medical treatment.
1. Minor	Minor injury requiring first aid treatment.

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Take five
TO STAY ALIVE



RISK SCORE MATRIX

		consequence				
		5 Disaster	4 Severe	3 Serious	2 Significant	1 Minor
likelihood	RISK RATING					
	A Certain	HIGH	HIGH	HIGH	MED	MED
	B Likely	HIGH	HIGH	MED	MED	LOW
	C Possible	HIGH	MED	MED	LOW	LOW
	D Unlikely	MED	MED	LOW	LOW	LOW
	E Rare	MED	LOW	LOW	LOW	LOW

Take five
TO STAY ALIVE





APPENDIX 2:

Testing Requirements Extract

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3 Testing requirements

3.1 Determination of hydraulic conductivity

The hydraulic conductivity of potential filter media should be measured using the ASTM F1815-11 method. This test method uses a compaction method that best represents field conditions and so provides a more realistic assessment of hydraulic conductivity than other test methods. **Do not use AS4419-2003** as this generally leads to overestimation of the in situ hydraulic conductivity.

Note: If a hydraulic conductivity lower than 100 mm/hr is prescribed, the level of compaction associated with the ASTM F1815-11 method may be too severe and so underestimate the actual hydraulic conductivity of the filter media under field conditions. However, this test method is considered to be an appropriately conservative test, and it is therefore recommended even for low conductivity media.

3.2 Particle size distribution

An appropriate PSD is required to provide a stable media (i.e. does not migrate downwards through the biofilter profile), enough water holding capacity to support healthy vegetation, while also allowing a sufficient infiltration rate. The filter media should be well-graded i.e., it should have all particle size ranges present from the 0.05 mm to the 3.4 mm sieve (as defined by (ASTM F1632-03(2010))).

Clay and silt are important for water retention and sorption of dissolved pollutants, however they substantially reduce the hydraulic conductivity of the filter media. This size fraction also influences the structural stability of the material (through migration of particles to block small pores and/or slump). It is essential that the total clay and silt mix is **less than 3% (w/w)**.

Particle size distribution (PSD) is of secondary importance compared with hydraulic conductivity. Further, a material whose PSD falls within the following recommended range does not preclude the need for hydraulic conductivity testing i.e., it does not guarantee that the material will have a suitable hydraulic conductivity. The PSD should be assessed by a horticultural expert for its suitability as a growing medium. **If a material cannot be sourced that meets both the hydraulic conductivity requirement and the suggested PSD below, it may still be suitable**, provided the hydraulic conductivity range is met, it is structurally stable and a horticulturalist deems the media as appropriate to support vegetation. The following composition range (percentage w/w) provides a **useful guide** for selecting an appropriate material:

Clay & Silt	< 3%	(<0.05 mm)
Very Fine Sand	5-30%	(0.05-0.15 mm)



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Business
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Centres Programme

Fine Sand	10-30%	(0.15-0.25 mm)
Medium Sand	40-60%	(0.25-0.5 mm)
Coarse Sand	< 25%	(0.5-1.0 mm)
Very Coarse Sand	0-10%	(1.0mm-2.0mm)
Fine Gravel	< 3%	(2.0-3.4 mm)

4 Once-off initial amelioration

The filter media is designed to be low in nutrient content, as over time incoming stormwater and the turnover of plant roots will provide nutrients and organic matter to support plant growth. However, at the very beginning, the **top 100 mm of the filter medium** needs be ameliorated with appropriate organic matter, fertiliser and trace elements (Table 3). This amelioration is a once-off application to aid initial plant establishment and is designed to last four weeks. Beyond this point, the plants receive adequate nutrients via incoming stormwater and no further fertilisation is generally necessary. The ameliorants will be supplied separately to the media and applied to the surface layer on-site (e.g. using a rotary-hoe).

Testing of the media for its nutrient content and advice from a horticulturalist will indicate the required amendment to support initial plant establishment. However, a general guide for amelioration of the top 100 mm is provided in Table 3.

Table 3. Recipe for ameliorating the top 100 mm of sand filter media

Constituent	Quantity (kg/100 m ² filter area)
Granulated poultry manure fines	50
Superphosphate	2
Magnesium sulphate	3
Potassium sulphate	2
Trace Element Mix	1
Fertilizer NPK (16.4.14)	4
Lime	20

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