


49 Blackbutts Road Development Application

Civil Engineering and Stormwater Report – Development Application



Prepared for Sekisui House Australia
Pty Ltd

01 April 2025



Document Information

Prepared by
Enspire Solutions Pty Ltd
Level 4, 153 Walker Street
North Sydney NSW 2060
ABN 71 624 801 690

© Enspire 2025. Copyright in the whole and every part of this document belongs to Enspire and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person other than by agreement with Enspire.

This document is produced by Enspire solely for the benefit and use by the client in accordance with the terms of the engagement. Enspire does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by any third party on the content of this document.

Document Title	49 Blackbutts Road Development Application
Document Subject	Civil Engineering and Stormwater Report – Development Application
Prepared For	Sekisui House Australia Pty Ltd
Project Name	49 Blackbutts Road, French Forest
Project Number	230057
File Name	REPT001-230057-01-Enspire-R04-250401-49 Blackbutts Road Civil Engineering and Stormwater Report.docx

Transmittal

Revision	Date	Prepared by	Checked by	Approved by
1	08/03/2024	L.Drake	M.Hodges	M.Hodges
		Issue for Development Application		
2	14/03/2024	L.Drake	M.Hodges	M.Hodges
		Issue for Development Application		
3	15/01/2025	A.Lim & J.Shelaymoon	M.Hodges	M.Hodges
		Reissued for Development Application: Update to figures, DRAINS, MUSIC results.		
4	01/04/2025	S.Acharya	A.Lim	M.Hodges
		Reissued for Development Application: Update to figures, DRAINS, MUSIC results.		



Contents

1	Introduction	5
2	Related Reports and Documents	6
3	The Development	7
3.1	Proposed Development Works	7
3.2	Existing Site Conditions	7
4	Erosion and Sediment Control	7
4.1	Sediment Basin	7
4.2	Sediment and Erosion Control Measures	8
5	Stormwater Management Strategy	9
5.1	Objectives and Controls	9
5.2	Proposed Stormwater Strategy	9
5.3	Existing Catchments and External Conveyance	9
5.4	Post Development Catchments	10
5.4.1	Stormwater Modelling	11
5.5	Stormwater Drainage Modelling Results	12
5.6	Stormwater Quality	13
5.6.1	Water Quality Strategy	13
5.6.2	Water Quality Objectives	13
5.6.3	Proprietary Products	13
5.6.4	Rainwater Tanks	14
5.6.5	MUSIC Modelling	14
5.6.6	Catchment Representation	15
5.6.7	MUSIC Model Results	15
6	Siteworks	16
6.1	General	16
6.2	Demolition	16
6.3	Earthworks	17
6.4	Road Types	18
6.5	Parking and Signage	18
6.6	Vertical and Horizontal Geometry	19
6.7	Pavement Design	19
6.8	Retaining Walls	19
7	Conclusion	20



List of Tables

Table 1 – Enspire Development Application Drawing Reference	6
Table 2 – OSD Tank Pre/Post-Development Flow Assessment	12
Table 3 - Water Quality Targets	13
Table 4 – MUSIC Node Details Summary	15
Table 5 - Estimated Average Annual Pollutant Load Reduction.....	16
Table 6 - Approximate Cut and Fill Volumes.....	17
Table 7 - Road Typical Sections	18
Table 8 - Retaining Wall Types	19

List of Figures

Figure 1 –Site Plan.....	5
Figure 2 - Existing Catchments	10
Figure 3 - Proposed Catchments	11
Figure 4 – Typical Ocean Protect Stormfilter	13
Figure 5 – Typical Ocean Protect OceanGuard Filter Basket	14
Figure 6 – Extract of MUSIC Modelling Layout	15
Figure 7 – Proposed Road Layout	16
Figure 8 – Cut Fill Depth Colours	18
Figure 9 – Retaining wall plan	19



1 Introduction

Enspire Solutions (**Enspire**) has been engaged by Sekisui House Australia Pty Ltd (**Client**) to prepare the Civil Engineering and stormwater management design and documentation in support of a Development Application (**DA**) submission to Northern Beaches Council for the proposed construction of a community title residential subdivision located at 49 Blackbutts Road as shown in **Figure 1**.

Works associated with this application include:

1. Implementation of erosion and sediment controls
2. Earthworks for proposed lots and community title road
3. Stormwater management
4. Road construction
5. Retaining wall construction

This report intends to inform Council of the parameters and assumptions adopted in the design and documentation of the following civil engineering elements:

- Sediment and Erosion Control
- Earthworks
- Stormwater Quantity
- Stormwater Quality
- Roadworks
- Retaining walls

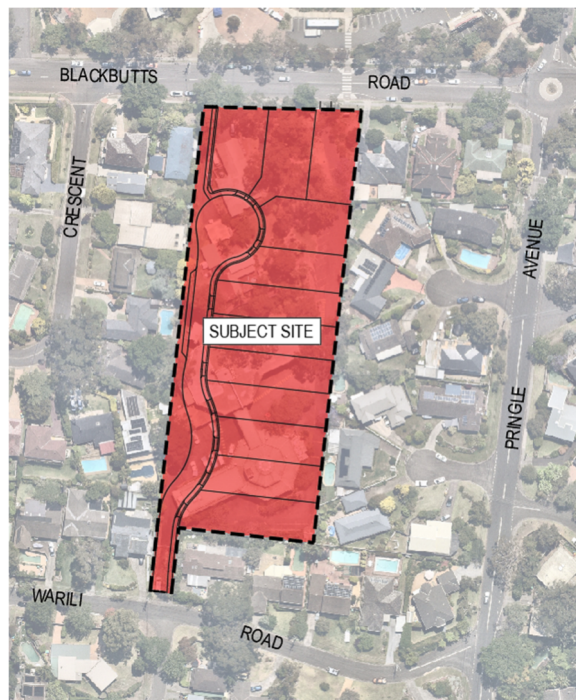


Figure 1 –Site Plan



2 Related Reports and Documents

This report is to be read in conjunction with the following reports and documents:

- 1) Development Application Documentation prepared by Enspire, refer Table 1:

Table 1 – Enspire Development Application Drawing Reference

Drawing Number	Drawing Title
230057-DA-C01.01	COVER SHEET AND DRAWING SCHEDULE
230057-DA-C01.21	SPECIFICATION NOTES - SHEET 01
230057-DA-C01.22	SPECIFICATION NOTES - SHEET 02
230057-DA-C01.41	GENERAL ARRANGEMENT PLAN
230057-DA-C03.01	EROSION AND SEDIMENTATION CONTROL PLAN
230057-DA-C03.21	EROSION AND SEDIMENTATION CONTROL DETAILS
230057-DA-C03.31	SEDIMENT BASIN PLAN AND SECTION
230057-DA-C04.01	EARTHWORKS CUT AND FILL PLAN
230057-DA-C04.21	EARTHWORKS CUT AND FILL SECTIONS
230057-DA-C05.01	SITEWORKS AND STORMWATER MANAGEMENT PLAN - SHEET 01
230057-DA-C05.02	SITEWORKS AND STORMWATER MANAGEMENT PLAN - SHEET 02
230057-DA-C06.01	ROAD TYPICAL CROSS SECTIONS
230057-DA-C07.01	ROAD LONGITUDINAL SECTIONS
230057-DA-C11.01	PAVEMENT, SIGNAGE AND LINEMARKING PLAN - SHEET 01
230057-DA-C11.02	PAVEMENT, SIGNAGE AND LINEMARKING PLAN - SHEET 02
230057-DA-C14.01	SITEWORKS DETAILS
230057-DA-C15.01	RETAINING WALL ELEVATIONS - SHEET 01
230057-DA-C15.02	RETAINING WALL ELEVATIONS - SHEET 02
230057-DA-C17.01	OSD TANK PLAN SECTION
230057-DA-C18.01	STORMWATER DETAILS
230057-DA-C20.01	PRE-DEVELOPMENT CATCHMENT PLAN
230057-DA-C20.21	POST-DEVELOPMENT CATCHMENT PLAN OVERALL
230057-DA-C22.01	TURNING PATH PLAN

- 2) Northern Beaches Council AUSPEC 1
- 3) Northern Beaches Council Minor Works Specification
- 4) Northern Beaches Council Water Management for Development Policy
- 5) Northern Beaches Council WSUD & MUSIC Modelling Guideline
- 6) Northern Beaches Council Pre DA Meeting Minutes
- 7) NSW MUSIC Modelling Guidelines by BMT WBM – August 2015
- 8) Using MUSIC in Sydney Drinking Water Catchment - A WaterNSW Standard, prepared by WaterNSW, 2019.



3 The Development

3.1 Proposed Development Works

The development site located within the Northern Beaches Council Local Government Area (LGA), is part of lots formally known as Lot 1 of DP1298188 and Lot 1 of DP524083. The site occupies approximately 1.02ha.

The development is generally bound by the following:

- Blackbutts Road to the north
- Warili Road to the south
- Existing residential allotments to the east and west.

The development, subject to this development application includes:

1. Establishment of a community title road and stormwater system to facilitate subdivision for 12 residential lots
2. Construction of one (1) on-site stormwater detention tank with an inbuilt water quality chamber
3. Connection to Warili Road
4. Construction of footpaths
5. Construction and commissioning of essential utilities.

3.2 Existing Site Conditions

The land to which this application applies was an existing commercial site with established buildings, accessways, footpaths, carparks and services. Four (4) existing buildings are present on the site with access from both Blackbutts Road and Warili Road.

The existing topography of the site includes a natural ridge along Blackbutts Road with the site naturally falling to the south-east. The site has a formalised pit and pipe network that discharges to the council drainage system in Warili Road.

4 Erosion and Sediment Control

The objectives of the erosion and sediment control for the development site are to ensure:

- Adequate erosion and sediment control measures are applied prior to the commencement of construction and are maintained throughout construction; and
- Construction site runoff is appropriately treated in accordance with Northern Beaches Council requirements.

As part of the works, the erosion and sedimentation control will be constructed in accordance with Council requirements and the NSW Department of Housing Manual, “Managing Urban Stormwater Soil & Construction” 2004 (Blue Book) prior to any earthworks commencing on site.

4.1 Sediment Basin

One (1) sediment basin is proposed to be utilised during bulk earthwork phase of works.

Due to the natural topography of the site it is proposed that the rear retaining wall for lots 5-13 and the southern retaining wall for lot 13 is constructed prior to the establishment of the sediment basin. Constructing the wall will allow for the south-east corner of the site to be filled and allow



the sediment basin to be constructed in a safer location which is closer to the ultimate discharge location. To ensure compliance to the Blue Book no more than 2500m² should be disturbed prior to the establishment of the sediment basin.

The sediment basin will be constructed as part of this subdivision development application and maintained through the construction of the subdivision. The sediment basin has been designed to capture site runoff during construction and have been located to coincide with the ultimate low points of the site.

As per Appendix C of the Blue Book, the expected soil texture group for the proposed development is Type C. The proposed sediment basins are designed and sized to represent this soil texture classification.

To ensure the sediment basins are working effectively it will be maintained throughout the construction works. Maintenance includes ensuring adequate settlement times or flocculation and pumping of clean water to reach the minimum storage volume at the lower level of the settling zone. The settling zone will be identified by pegs to clearly show the level at which design storage capacity is available. This methodology may vary if a perforated riser is incorporated to drain flows from the basin. Refer to “Type C Soil” sediment basin drawings, SD 6-1 – SD6-3, in Section 6 of the Blue Book for suitable basin configurations.

The pumped water from the sediment basins can be reused for dust control during construction.

An overflow weir is provided and will control overflows for rainfall events in excess of the design criteria.

4.2 Sediment and Erosion Control Measures

Sediment and erosion control measure shall be implemented generally in accordance with the Construction Certificate drawings and the “Blue Book”. The measures shown on the drawings are intended to be a minimum treatment only as the contractor will be required to modify and stage the erosion and sedimentation control measures to suit the construction program, sequencing, and techniques. These measures will include:

- A temporary site security/safety fence is to be constructed around the site
- Sediment fencing provided downstream of disturbed areas, including any topsoil stockpiles
- Dust control measures including covering stockpiles, installing fence hessian and watering exposed areas
- Placement of hay bales or mesh and gravel inlet filters around and along proposed catch drains and around stormwater inlets pits
- The construction of a sediment basin
- Stabilised site access at the construction vehicle entry/exits.

Any stockpiled material, including topsoil, shall be located as far away as possible from any associated natural watercourses or temporary overland flow paths. Sediment fences shall be installed to the downstream side of stockpiles and any embankment formation. All stockpiles and embankment formations shall be stabilised by hydroseeding or hydro mulching on formation.



5 Stormwater Management Strategy

5.1 Objectives and Controls

The stormwater strategy has been developed in accordance with the Northern Beaches Council Warringah DCP 2011 and Northern Beaches Council Engineering Guidelines.

The proposed strategy seeks to:

- a) Prevent damage by stormwater to the built and natural environment;
- b) Ensure that post development peak flows from the site do not exceed the existing pre-development peak flows for the 20%, 5% and 1% AEP storm events.
- c) Ensure that the piped post development peak flows generated from the site in the 20%, 5% and 1% AEP storm events do exceed the pre-developed 20% AEP peak flows prior to discharging to the council drainage network.
- d) Minimise nuisance flows of stormwater from the site to adjoining properties;
- e) Provide a stormwater system which can be maintained economically;
- f) Control flooding and enable access to allotments, stabilise the landform and control erosion; and
- g) Reduce post development runoff pollutants to watercourses through the implementation of WSUD devices.

5.2 Proposed Stormwater Strategy

The proposed Stormwater Management Strategy utilises an underground On-Site Detention (**OSD**) tank to satisfy the Northern Beaches Council requirements for water quantity. This OSD tank attenuates the post development flows to the pre-developed state for the 20%, 5% and 1% AEP storm events. In order to ensure the piped flows discharging from the site do not exceed the pre-developed 20% AEP flows for all required storm events up to and including the 1% AEP, an orifice plate has been proposed on the last privately owned pit prior to discharge to the council drainage network (Pit EX/01). This allows the private drainage network servicing the development to surcharge safely prior to discharging into the council drainage system.

To satisfy the Northern Beaches Council water quality requirements rainwater re-use tanks will be provided on every residential lot, a water quality chamber will be incorporated into the on-site detention tank, housing seven (7) Ocean Protect StormFilters. In addition, it is proposed to install eighteen (18) stormwater filter baskets within the privately owned stormwater network. Refer to Enspire's engineering drawing package for further details.

5.3 Existing Catchments and External Conveyance

As part of the stormwater management strategy, the site was assessed and deemed to have no external catchment with all flows being generated from within the site. The existing topography of the site falls south, with flows are generally discharging to Wiralli Road. The pre-development catchments for the development are shown in **Figure 2**.

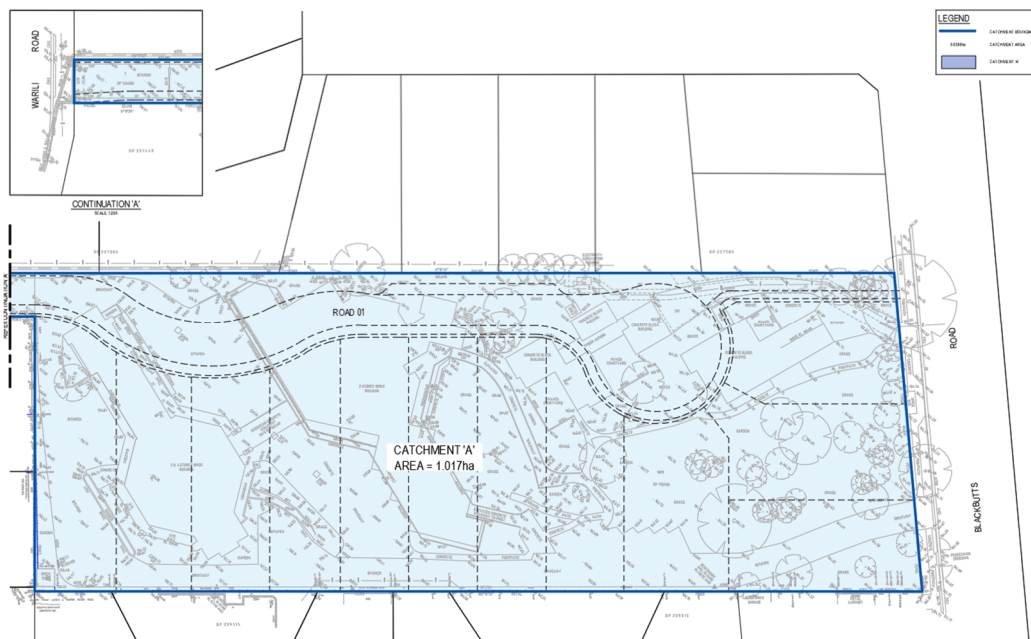


Figure 2 - Existing Catchments

5.4 Post Development Catchments

The proposed post-development catchments are consistent with the pre-developed catchments as discussed in Section 5.3.

The combined On-Site Detention (**OSD**) and Water Sensitive Urban Design (**WSUD**) tank has been sized to adequately cater for the entire site with approximately 2% of the total site bypassing the tank. The post development catchments for the development are shown in **Figure 3**.

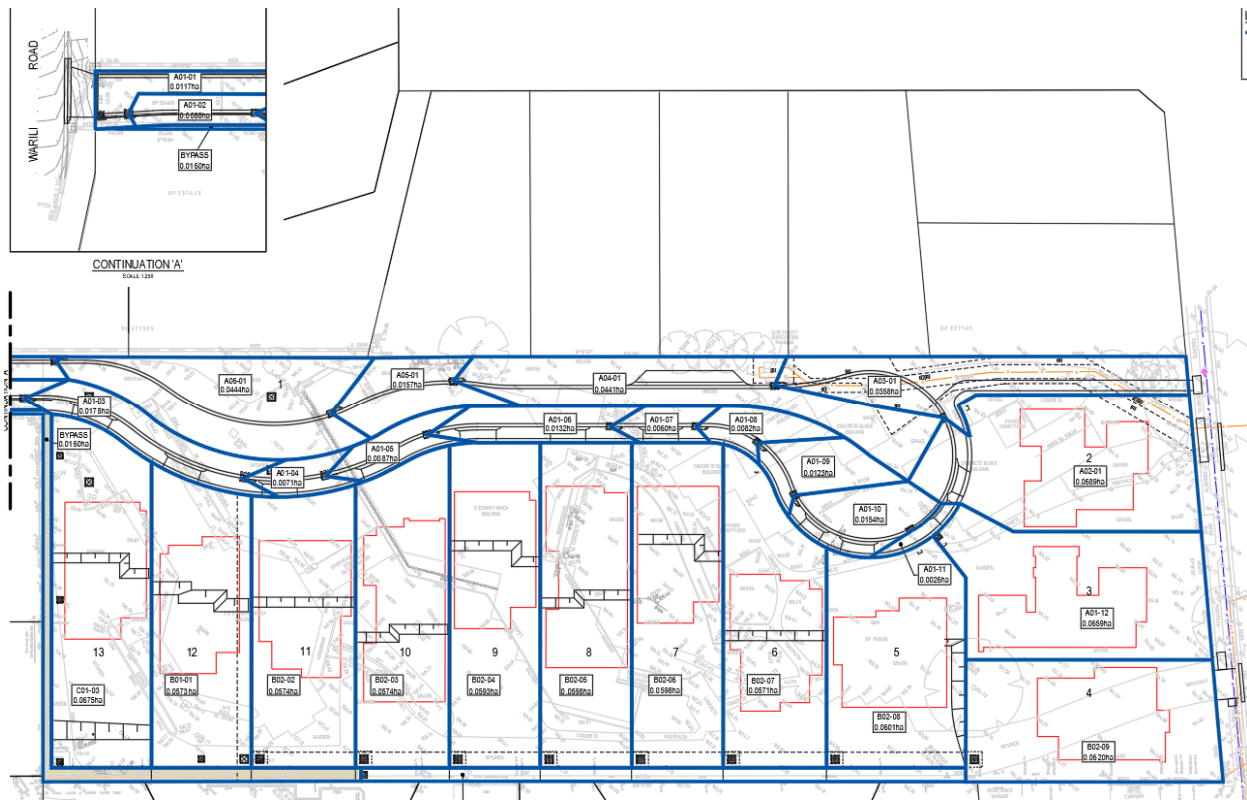


Figure 3 - Proposed Catchments

5.4.1 Stormwater Modelling

Pre-Developed Catchment

The pre-development catchment runoff has been modelled using Drains with ILSAX hydrological procedures. The rainfall data has been taken from Councils Water Management for Development Policy along with the catchment parameters. To satisfy council requirements the site has been restricted to the “state of nature” and as such has been modelled without any impervious area. The time of concentration has been calculated using the kinematic wave equation as advised throughout Councils guidelines.

The model includes the followings assumptions and key input parameters:

- Pre-development impervious fraction: 0%
- Pervious Time of Concentration 20% AEP, $T_c = 25$ minutes
- Pervious Time of Concentration 5% AEP, $T_c = 30$ minutes
- Pervious Time of Concentration 1% AEP, $T_c = 35$ minutes
- Depression storage:
 - o 1mm for paved area
 - o 5mm for grassed area
- Soil Type = 2.5
- Antecedent moisture condition = 3

Post-Developed Catchment

The proposed subdivision will be drained by an in-ground pit and pipe network designed to convey the 1% AEP (major) storm event from residential lots and the proposed road to the detention tank.



The on-site stormwater detention, pit and pipe network has been designed and modelled using the ILSAX module of DRAINS software (standard hydraulic model using Council rainfall inputs sourced from Councils Water Management for Development Policy).

The model includes the followings assumptions and key input parameters:

- Post Development Lot impervious fraction: 60%
- Post Development Road impervious fraction: 85%
- Depression storage:
 - o 1mm for paved area
 - o 5mm for grassed area
- Soil Type = 2.5
- Antecedence moisture condition 3
- Time of concentration 5mins for impervious areas, 10mins for pervious areas
- Ponding parameters 150mm max (minor event), 200mm max (major event)
- Velocity x depth product in gutter or overtopping roadway $< 0.4\text{m}^2/\text{s}$
- Minimum freeboard to HGL to ground level at each pit is 150mm (minor event)
- Blockage factor 20% on-grade pits, 50% for sag pits.

In order to satisfy council requirements in relation the quantity of piped flow leaving the site, tailwater assumptions were made in order to best model how the stormwater system will function in differing storm events. The following tailwater conditions have been assigned to the connecting council drainage system at the first grated stormwater pit.

- 20% AEP: Obvert of Outgoing Pipe
- 5% AEP: 150mm below existing stormwater pit grate level in Warila
- 1% AEP: stormwater pit grate level in Warila Road

For modelling purposes, the surcharge pit in DRAINS has been modelled as a single pit. For hydrological purposes and to ensure that the system has enough outlet capacity to surcharge the 1% AEP overland flow, two (2) grated kerb intel pits and grated trench drain have been provided (Pit A01/01, A01/02).

The Enspire drawing package identifies the pit and pipe network, design parameters for the tank and defines the discharge relationship input into the DRAINS modelling.

5.5 Stormwater Drainage Modelling Results

The stormwater drainage network associated with the proposed development was analysed and results recorded. A pre-development and post-development flow analysis was conducted for the proposed on-site stormwater detention tank, outlined in Table 2.

Table 2 –OSD Tank Pre/Post-Development Flow Assessment

AEP (%)	Pre-Development Flow (m ³ /s)	Piped Post-Development Flow (m ³ /s)	Overland Post-Development Flow (m ³ /s)	Bypass Flow (m ³ /s)	Total Post-Development Flow (m ³ /s)	Basin TWL (mAHD)	Basin Volume (m ³)
20	0.126	0.103	0.000	0.005	0.108	155.74	197.5
5	0.226	0.107	0.106	0.007	0.22	156.04	299.2
1	0.357	0.11	0.162	0.009	0.281	156.34	400.2



The above results indicate that the proposed tank have sufficient capacity to service the proposed development.

5.6 Stormwater Quality

5.6.1 Water Quality Strategy

To comply with the objectives, set out in Northern Beaches Council WSUD & MUSIC Modelling Guidelines, the following water sensitive urban design (WSUD) devices are proposed.

- Rainwater re-use tanks on every residential lot;
- Ocean Protect StormFilters installed within a dedicated water quality chamber; and
- Ocean Protect OceanGuard filter baskets installed within the private drainage network.

5.6.2 Water Quality Objectives

The Northern Beaches Council WSUD & MUSIC Modelling Guidelines provides water quality targets as presented in Table 3 below:

Table 3 - Water Quality Targets

Pollutant	% Reduction Post-Development Average Annual Load Reduction
Gross Pollutants	90
Total Suspended Solids (TSS)	85
Total Phosphorus (TP)	65
Total Nitrogen (TN)	45

5.6.3 Proprietary Products

The Ocean Protect StormFilter is a proven stormwater treatment system that uses self-cleaning, media-filled cartridges to absorb and retain pollutants from stormwater runoff including total suspended solids, hydrocarbons, nutrients, and other common pollutants. Refer to **Figure 4** for a product breakdown.

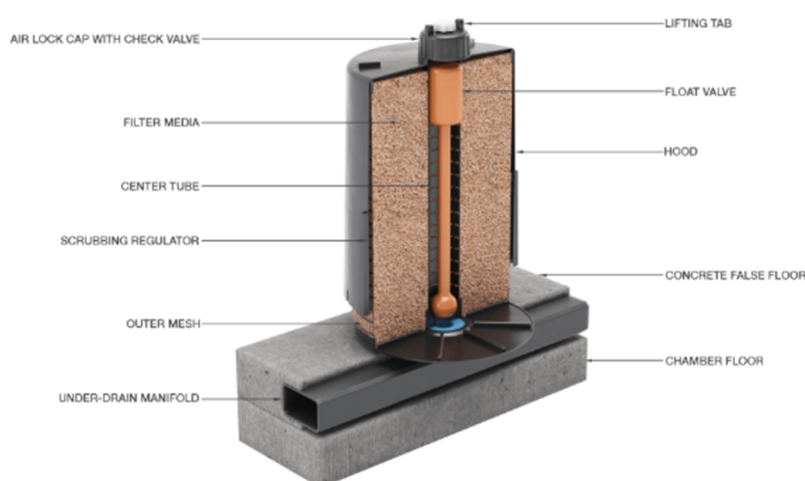


Figure 4 – Typical Ocean Protect Stormfilter

Source: Ocean Protect Technical Design Guide



5.6.3.1 Ocean Protect OceanGuard Filter Baskets

The Ocean Protect OceanGuard is a gully pit insert/basket designed to capture pollution that runs into stormwater networks. It is designed to remove gross pollutants and total suspended solids. Refer to **Figure 5** for a product breakdown.

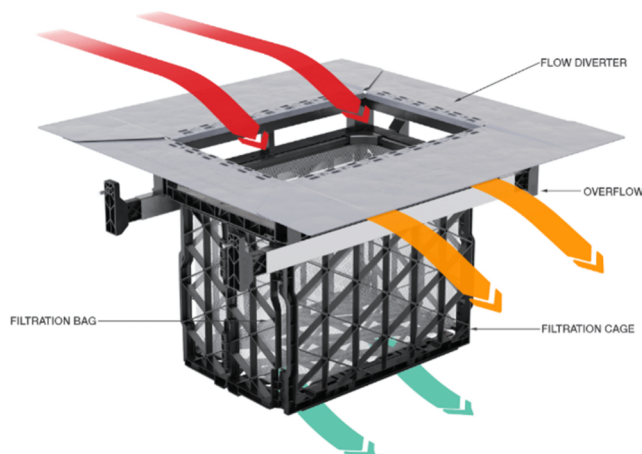


Figure 5 – Typical Ocean Protect OceanGuard Filter Basket

Source: Ocean Protect Technical Design Guide

5.6.4 Rainwater Tanks

Rainwater tanks have been modelled assuming the installation of a 3.0kL tank on each development lot but modelled in MUSIC with 2.5kL capacity taking into consideration storage inefficiencies.

It is noted rainwater tanks assist pollutant reduction through sedimentation and reuse. For this site the proposed tanks will typically be used for household non-potable water uses including toilet flushing, laundry, and garden irrigation.

5.6.5 MUSIC Modelling

A water quality analysis has been undertaken to assess the performance of the proposed WSUD strategy against the adopted stormwater quality targets. The stormwater quality analysis for this study was undertaken using the industry standard software model MUSIC (Model for Urban Stormwater Improvement Conceptualisation) Version 6.3.

Post-development catchment boundaries adopted for modelling are like those that have been adopted for stormwater quantity modelling but have been further broken down into land use categories to appropriately model pollutant quantities and the proposed treatment train. The catchment has been divided to illustrate the lots entering the water quality chamber and those that bypass the water quality chamber and are captured by the downstream filter baskets prior to discharging to the council drainage network.

MUSIC has been calibrated using the parameters and rainfall data recommended in the Northern Beaches Council WSUD & MUSIC Modelling Guidelines. Refer to **Figure 6** for the proposed MUSIC Model layout.

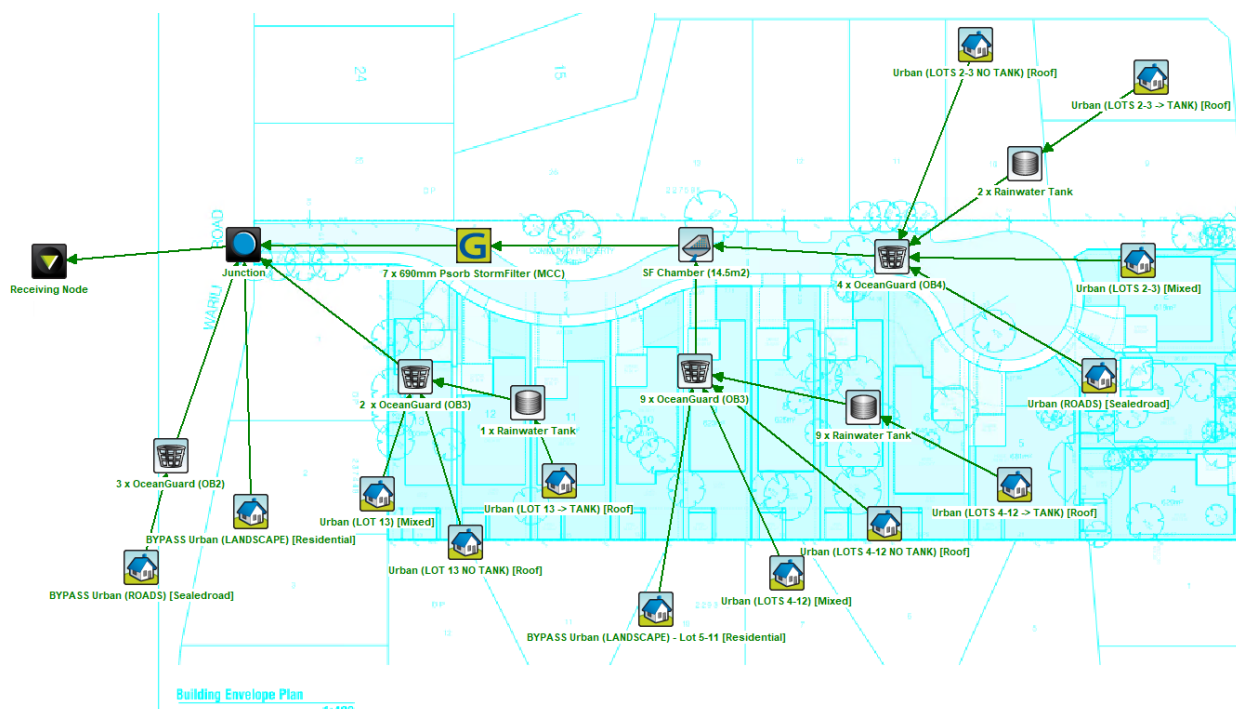


Figure 6 – Extract of MUSIC Modelling Layout

5.6.6 Catchment Representation

Post development catchments have been defined by the following general urban typologies:

- Roads
- Roofs
- Residential Lots

Table 4 details the land use breakdown adopted to generate nodes suitable for MUSIC modelling.

Table 4 – MUSIC Node Details Summary

Land Use	Sub Catchment	Adopted Impervious	Comments
Roads	N/A	85%	
Residential Lot	Roof (to rainwater tank)	100%	Roof area shown on civil plans. 80% of roof assumed to contribute to a rainwater tank.
	Roof (bypass)	100%	Roof area shown on civil plans. 20% of roof assumed to contribute to a rainwater tank.
	Lot Area	60%	Total percentage of residential lots equates to 60% impervious.

5.6.7 MUSIC Model Results

Table 5 summarises the average annual pollutant loads and reductions at the receiving node, located directly downstream of the proposed bio-retention basins.



Table 5 - Estimated Average Annual Pollutant Load Reduction

Control Node	Gross Pollutants (GP) Removal (%)	Total Suspended Solids (TSS) Removal (%)	Total Phosphorous (TP) Removal (%)	Total Nitrogen (TN) Removal (%)
Performance Target	90.0	85.0	65.0	45.0
Results	100.0	89.7	65.7	51.9

The results above demonstrate that the development meets Council's target reductions for pollutant loads at the discharge location.

6 Siteworks

6.1 General

The proposed development will comprise of one main entrance from Warili Road providing access to all residential allotments excluding lot 4. Lot 4 is proposed to front Blackbutts Road with the driveway to be constructed in the same location as the accessway to the existing commercial site. This configuration results in minimal change to Blackbutts Road and allows the significant tree identified in lot 4 to be retained. The existing brick bus stop on Blackbutts Road will be unaffected by the proposed changes, refer to the Enspire's engineering drawing package for further details.

The private road alignment has been designed to maximise the area along the western boundary for tree planting. To adequately design for the 10.5m waste vehicle, the road has been widened through the bend to allow a 10.5m waste vehicle to pass a B99 vehicle. The turning head has been designed with a radius of 12.2m from the face of kerb as to adequately allow a 10.5m waste vehicle to turn in a single movement, refer to the Enspire's engineering drawing package for further details. The road layout can be seen in **Figure 7**.

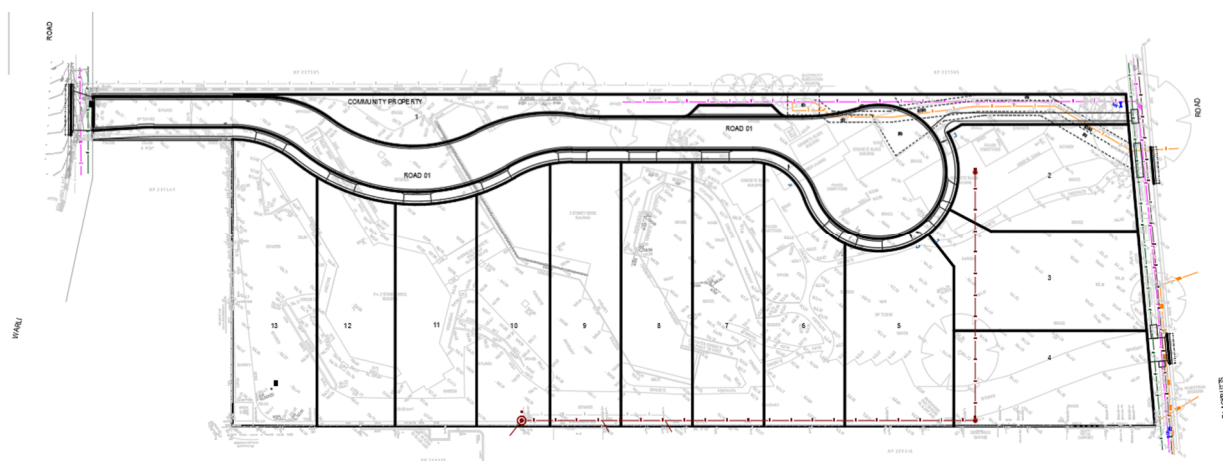


Figure 7 – Proposed Road Layout

6.2 Demolition

The proposed demolition works for the site have been documented in a separate development application. Refer to DA2024/0081 for all information regarding demolition works.



6.3 Earthworks

As part of subdivision works, earthworks on the site will generally consist of cut and fill operations to establish proposed road formations and site levels. The levels have been designed to generally maintain existing levels at the eastern and western site boundaries and provide an optimal interface with the roads to the north and south. The strategy includes proposed battering through the residential allotments in order to minimise the rear retaining.

Approximate cut to fill earthworks operations for the works subject to this development application are summarised in Table 6.

Table 6 - Approximate Cut and Fill Volumes

Earthworks	Volume (m ³)
Cut	2,294
Fill	4,133
Balance	1,839 (Import)

The cut and fill earthworks volumes provided are concept only and are subject to change pending final coordination and detailed civil design. It should be noted the cut and fill operations for each stage will be calculated based on the following assumptions:

- No allowance for earthworks bulking factors
- No allowance for spoil generated from utility service and stormwater drainage trenching
- Allowance for pavement depth of local roads
- Allowance for 100mm topsoil replacement across landscape areas in road verges and lots.

The cut fill colours can be seen in **Figure 8**.

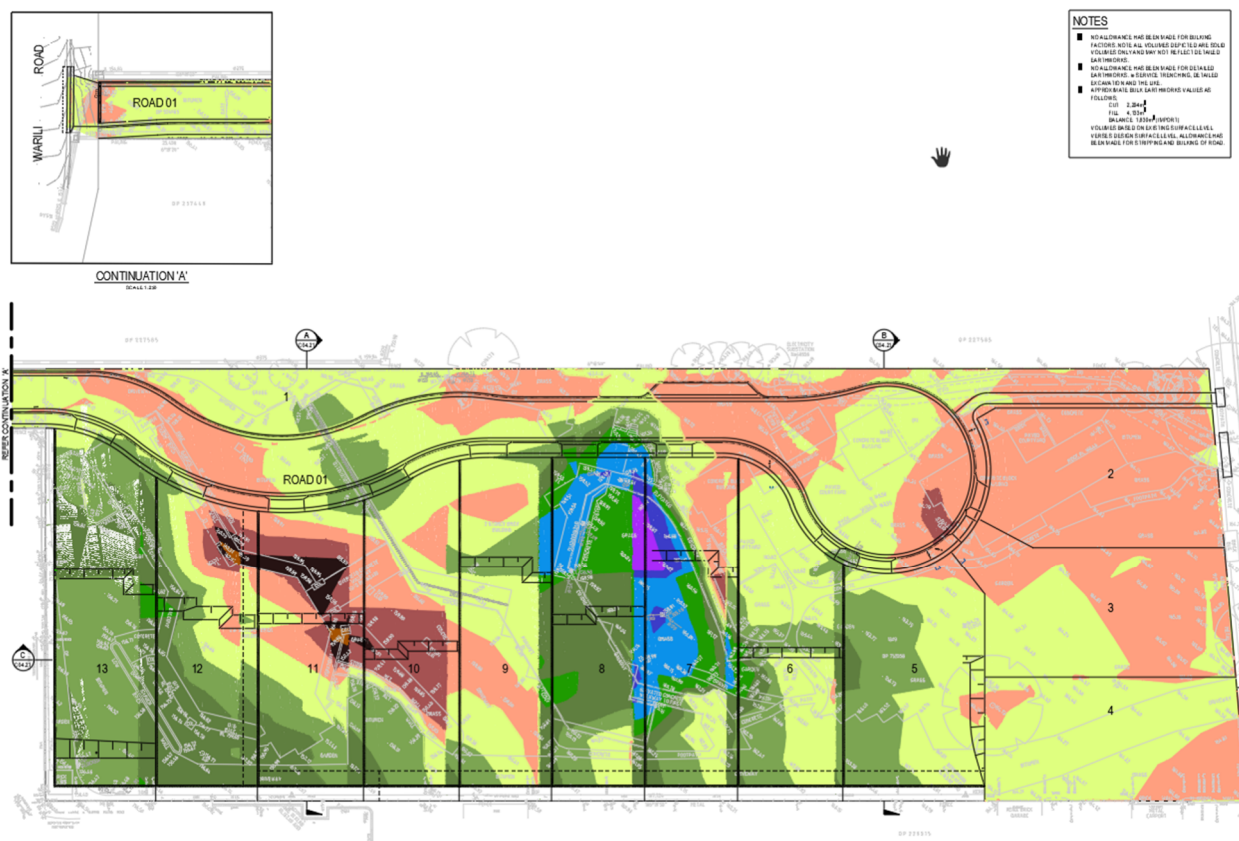


Figure 8 – Cut Fill Depth Colours

6.4 Road Types

It is proposed that internal road will be designed as per the categorisation and road profile in Table 7 below:

Table 7 - Road Typical Sections

Road	Category	Road Reserve Width	Typical Road Carriageway
ROAD 01	Private Road (Community Title)	Varies, refer to the Enspire's engineering drawing package for further details	Varies, refer to the Enspire's engineering drawing package for further details

6.5 Parking and Signage

On-road parking is to be generally restricted throughout the development, with parking only permitted in the provided indented parking bays. There are two (2) parking bays provided fronting lots 6 and 7. A detailed signage and line marking plan can be found within Enspire's engineering drawing package.



6.6 Vertical and Horizontal Geometry

The road geometry has been designed in accordance with AUSTROADS Guide to Road Design Part 3. The vertical and horizontal geometry has considered sight distance in accordance with AUSTROADS Guide to Road Design Part 3.

6.7 Pavement Design

Pavements for local roads have been designed generally in accordance with AUSTROADS Guide to the Design of New Pavements for light Traffic, Councils Engineering Design Specification.

Final pavement configuration is subject to in-situ CBR.

6.8 Retaining Walls

It is proposed to construct retaining walls as part of this package.

Table 8 nominates the wall types used in the documentation.

Table 8 - Retaining Wall Types

Wall Type	Details
Concrete Sleeper Wall	To be constructed using a proprietary concrete sleeper retaining wall system. Refer Enspire's drawing 230057-00-DA-C14.01 for details.

Figure 9 shows the retaining walls to be constructed as part of this package.

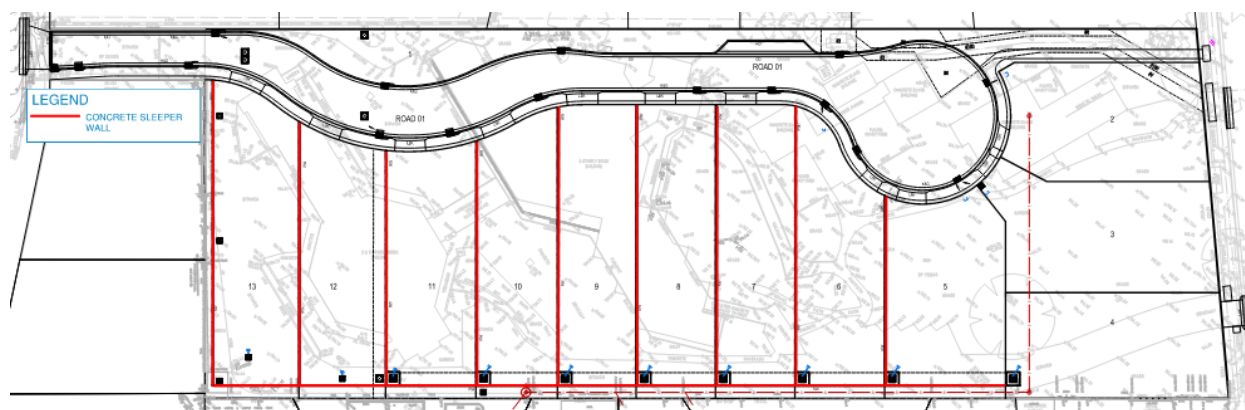


Figure 9 – Retaining wall plan



7 Conclusion

This Civil Engineering and Stormwater Management Report has been prepared to provide an understanding of the design assumptions, inputs and guide to the stormwater quantity and quality management techniques for the proposed development as depicted in **Figure 1**.

This report demonstrates that the stormwater drainage objectives as outlined in the Northern Beaches Council Guidelines are achieved.

The included stormwater quantity calculations demonstrate how peak flows from the proposed development site in post-development conditions are attenuated to no greater than the existing peak flows for all required design storms up to and including the 1% AEP event. Furthermore, the calculations demonstrate that the piped peak flow discharging to the council drainage network are attenuated to no greater than the 20% AEP existing peak flows for all required design storms up to and including the 1% AEP event.

The stormwater quality assessment demonstrates that a specifically tailored treatment system will be required in order to meet the pollutant removal targets as defined in the Northern Beaches Council WSUD & MUSIC Modelling Guidelines.

Proposed horizontal and vertical road alignments will meet the requirements of Council's Engineering Standards and Austroads Guidelines.