Flood Impact and Risk Assessment

16 Macpherson Street, Warriewood

NW30291-304600235

Prepared for
Warrimac Pty Ltd

5 May 2023

Stantec

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Executive Summary

Previous Flood Assessments

Flood Risk Precinct

This report details the assessment of the flooding extent and behaviour to inform the redevelopment of 16 Macpherson Street, Warriewood.

The development application seeks approval for the construction of 28 dwellings, infrastructure, roadworks, landscaping, community title subdivision and dedication of the creekline corridor to Council.

The objective of the study is to address the following considerations for planned redevelopment of 16 Macpherson Street, Warriewood:

- Flood risks on and near the site;
- The impact of the planned redevelopment;
- Flood emergency response;
- Flood warning and evacuation;
- Compliance with requirements of Pittwater LEP 2014 and Pittwater 21 DCP.

Previous Flood Assessments

Flooding investigations have been previously completed for the Narrabeen Creek floodplain in the vicinity of the subject property. The flooding context is provided in several studies as follows:

- BMT WBM (2013) “Narrabeen Lagoon Flood Study”, Final Report, Version 4, prepared for Warringah Council and Pittwater Council, September.
- Cardno (2019) “Narrabeen Lagoon Flood Risk Management Study and Plan”, Final report, Version 3, prepared for Northern Beaches Council, April.
- Cardno Lawson Treloar (2013) “Pittwater Overland Flow Mapping and Flood Study”, Final Report, Version 4, 2 Vols, prepared for Pittwater Council, October.
- WMAwater (2019) “Ingleside, Elanora and Warriewood Overland Flow Flood Study”, Final Report, Version 4, prepared for Northern Beaches Council, June.

Flood Risks

The comprehensive flood information provided by Council in response to a request is attached in **Appendix E**. This flood information is based on the results of the 2019 Ingleside, Elanora and Warriewood Overland Flow Flood Study prepared by WMAwater.

The 2019 study was undertaken prior to the approval and construction of the current housing development on 18 Macpherson Street, Warriewood.

Consequently the 2019 floodplain model was modified to create a floodplain model of Benchmark Conditions that are representative of current conditions.

Based on the guidance provided by Council (refer Section 1.3.4 and Appendix E) the following events were run under Benchmark Conditions:

- 50% AEP + 30%CC
- 20%AEP + 30%CC
- 1% AEP
- 1% AEP + 30%CC
- PMF
- PMF + 30%CC

Flood Levels, Velocities and Hazard Categories

The flood levels and extent, depths, velocities and hazard categories for each of these events under Benchmark Conditions are attached in Appendix A**.**

Flood Risk Precinct

Council has mapped almost all of the subject property as Medium Risk with High Risk encroaching into the property along the creekline.

Flood Planning Levels

Based on the 1%AEP + 30%CC flood levels estimated under Benchmark Conditions, the Flood Planning Levels were updated as set out in **Appendix F**.

Risk to Life

The variation of the indicative velocity and depth at Locations P6, P7 and P8 (refer **Figure 11**) during the six floods that have been assessed in comparison to the hazard zones are plotted respectively in **Figures 12, 13** and **14** respectively.

It is noted from **Figure E16** that in a 1% AEP + 30%CC flood the flood hazard category varies across the property from no hazard to H1, H2, H3 and H4 across the northern end of the property.

It is noted from **Figure E24** that in a PMF + 30%CC flood the flood hazard category varies across the property from H3 to H4 to H5.

Warning Times and Periods of Isolation

Table 1 summarises the time it takes from the onset of a major storm for unsafe conditions to develop at Locations P6, P7 and P8 (refer Figure 11) for small vehicles and 4WD vehicles.

The conditions encountered at the Brands Lane roundabout during floods and the impact on emergency access to or from the site are summarised as follows:

- It is expected that the roundabout would be trafficable at all times in events up to a 50% + 30%CC event (equivalent to a 20% AEP flood at this time);
- In events from the 20% AEP + 30%CC event up to the 1% AEP + 30%CC event the available time from the commencement of the storm burst until it becomes unsafe for small vehicles at the roundabout reduces from around 4 hours to around 2 hours;
- In the case of large vehicles the available time remains around 4 hours in these events;

- In events from the 20% AEP + 30%CC event up to the 1% AEP + 30%CC event if emergency access to or from the site is by small vehicles only then the period of isolation increases from greater than 3 hours to greater than 7 hours; however if emergency access to or from the site is by large vehicles then the period of isolation reduces to less than 3 hours;
- In the case of extreme floods (PMF and PMF + 30%CC) the onset of unsafe conditions is extremely rapid and less than 10 mins.
- In the case of extreme floods (PMF and PMF + 30%CC) the period of isolation is no more than 1.5 hours.

Flood Impact Assessment

Considerable options testing was undertaken to arrive at the preferred development layout and levels. The various combinations of measures that were assessed are summarised in **Table 2**.

Future Conditions

Based on the outcomes of the various assessments the preferred development layout and levels was based on Des07A in combination with final grading of the site and incorporation of stormwater management measures.

The assessment of flooding under Future Conditions was undertaken by modifying the TUFLOW model of Benchmark Conditions to represent the planned development as described in the plans attached in **Appendix G**.

The flood levels and extent, depths, velocities and hazard categories for each of these events under Future Conditions are attached in **Appendix B.**

Flood Impact Assessment

When considering the flood impacts assessed under the four climate change events it should be noted that the likelihood that these events would be experienced under current day conditions is lower than suggested by the AEP of the event. This was assessed by determining the severity of the design rainfall intensities which were increased by 30%. Conversely, the timeframe over which the design rainfall intensities might increase by 30% was assessed by extrapolating the climate change increases advised by the ARR2019 Datahub under RCP4.5 and RCP8.5 scenarios. It was estimated that under RCP8.5 that a 30% increase may occur over the next 110 years while under RCP4.5 it would take around 5,000 years to achieve a 30% increase.

The likelihood of the flood events that have been assessed are summarised for these two scenarios in **Table 3**.

It is concluded that the proposed development has a negligible adverse impact on flood levels in the 50%AEP + 30%CC, 20%AEP + 30%CC, 1%AEP + 30%CC and PMF + 30%CC events.

While in the 1% AEP + 30%CC event the velocity increases in Brands Lane, the peak velocity remains below 1 m/s. These velocity are not of concern in relation to scour.

Given the probability of a PMF + 30%CC flood at this time (1 in 40,000,000 AEP) or in 110 years to 5,000 years time (1 in 10,000,000 AEP) and while the increase in velocity to parts of Brands Lane may be of possible concern in relation to scour, it is no more so than elsewhere in the locality, including the creek corridor and Macpherson Street under both Benchmark and Future Conditions and for this reason the exceedances above the DCP impact criterion are considered minor and acceptable.

Flood Storage

The flood storage calculations were based on the 1% AEP + 30%CC flood levels. The calculated flood storage volumes under Benchmark Conditions and Future Conditions respectively were 5,482 m^3 and 3,763 m^3.

Emergency Planning

The hierarchy of plans which guide the planning for floods in NSW and in the Northern Beaches LGA are overviewed and include:

- 2017 NSW State Flood Plan
- North West Metropolitan Regional Emergency Management Plan
- Northern Beaches Local Emergency Management Plan
- Northern Beaches Flood Emergency Sub Plan

Flood Emergency Response

As described in Section 9.3.2 RM02: Flood Warning and Emergency Response Strategies in WMAwater, 2018:

> *… The Northern Beaches Flood Warning System is a joint venture between Northern Beaches Council (formerly, Pittwater, Warringah and Manly Councils), with support from the Bureau of Meteorology (BoM) and the Office of Environment and Heritage (OEH).*
>
> *The aim is to provide a basic flash flood warning system to the community, through live publishing of rainfall and water level gauges. As part of the project, additional gauges have been installed across the area. The information is provided on a public website (http://www.mhl.nsw.gov.au/users/NBFloodWarning/).*
>
> *As well as publishing live and historical gauge information the website provides some emergency planning information. Current advice is to watch out for 70mm rainfall in 3 hours and/or 150mm rainfall in 24 hours and states that "when flash flooding is likely, leave low-lying homes and businesses well before any flooding begins. Evacuation is the best action to take, but only if it is safe to do so". …….*

The Pittwater 21 DCP requires, in part, under Control E1 Emergency Response in B3.11 Flood Prone Land:

> *If the property is affected by a Flood Life Hazard Category of H3 or higher, then Control E1 applies and a Flood Emergency Assessment must be included in the Flood Management Report.*

While within the proposed residential areas on the subject property the flood hazard categories are:

- Not present in the 1% AEP + 30%CC event;
- H1 and H2 in the PMF; and
- H1, H2 and pockets of H3 in the PMF + 30%CC

the flood hazard categories on Brands Lane and Macpherson Street are:

- H3 in the 1% AEP + 30%CC event;
- H4 and H5 in the PMF; and
- H4 and H5 in in the PMF + 30%CC

Under these conditions it would be unsafe to attempt to evacuate by vehicles along Brands Lane and Macpherson Street and it will be far safer for residents to shelter in place until flooding of Brands Lane and Macpherson Street subsides to safe levels (H1 for small vehicles and H2 for large vehicles).

The two storey dwellings offer a suitable refuge for all residents.

Compliance Assessment

The assessment of the compliance of the proposed development with the Pittwater LEP 2014 is attached in **Appendix D**.

The proposed residential development would be classified as located within a Medium Risk Precinct.

Section 3.12 Climate Change (Sea Level Rise and Increased Rainfall Volume) describes climate change considerations where *'intensification of development' is proposed.*

Control C6.1 states that *"The filling of land will only be permitted where it can be demonstrated within the Water Management Report that:*

- *there is no net decrease in the floodplain volume of the floodway or flood storage area within the property, for any flood event up to the 1% AEP flood event and the PMF event including climate change considerations for both design events; and/or*
- *there is no additional adverse flood impact on the subject and surrounding properties and flooding processes for any flood event up to the PMF event including climate change impacts".*

The compliance assessment has been based on the second approach and where the flood impacts are described in **Section 4.2**.

The assessment of the compliance of the proposed development with Section B3.11 Flood Prone Land of the Pittwater 21 DCP controls for residential development in a Medium Risk Precinct is attached in **Appendix D**. This assessment is based on the impacts on flood levels and velocities for the designated events assessed under Council's adopted 30%CC scenario (in accordance with Controls C6.1 and B3.12 of the Pittwater 21 DCP).

The mapping of the 1% AEP, 1% AEP + 30%CC, PMF and PMF + 30%CC events under both Benchmark Conditions (refer Appendix A) and Future Conditions (refer Appendix B) has been undertaken to satisfy the Warriewood Valley Urban Land Release Water Management Specification.

It is concluded that while the flood impacts of the proposed residential development exceed the adverse impact criteria identified in Section A1.9 of the Pittwater 21 DCP in some of the assessed flood events, that the impact of any exceedances are considered minor and acceptable (refer Section 4.2) and that the proposed development satisfies the intent of the flooding requirements of the Pittwater DCP 2014, Pittwater 21 DCP (refer Appendix D) and the Warriewood Valley Urban Land Release Water Management Specification.
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Table of Contents

Appendices

List of Tables

List of Figures

List of Figures Continued

Benchmark Conditions (Appendix A)

List of Figures Continued

Future Conditions (Appendix B)

List of Figures Continued

Flood Impacts (Appendix C)

1 Introduction

1.1 Background

This report details the assessment of the flooding extent and behaviour to inform the redevelopment of 16 Macpherson Street, Warriewood.

The development application seeks approval for the construction of 28 dwellings, infrastructure, roadworks, landscaping, community title subdivision and dedication of the creekline corridor to Council.

The location of the subject property is indicated in **Figure 1**.

Figure 1 Location of 16 Macpherson Street, Warriewood

1.2 Objective

The objective of the study is to address the following considerations for planned redevelopment of 16 Macpherson Street, Warriewood:

- Flood risks on and near the site;
- The impact of the planned redevelopment;
- Flood emergency response;
- Flood warning and evacuation;
- Compliance with requirements of Pittwater LEP 2014 and Pittwater 21 DCP.

1.3 Planning Context

1.3.1 2001 Warriewood Valley Urban Land Release Water Management Specification

The specification covers the following aspects of water management within a total catchment management approach:

- *Water cycle management - maintaining and enhancing the balance of water*
- *Water quality management - considering the current quality of the flow in terms of pollutant concentrations and loads and ensuring the development process only enhances the waterways by reducing concentrations and loads to acceptable levels for healthy ecosystem functioning*
- *Watercourse and corridor management - seizing the opportunity to preserve, rehabilitate or remediate waterways and the associated corridor*
- *Floodplain management - providing an appropriate channel area to convey large floods without endangering life or property within the context of the watercourse and corridor management.*
- *An overview of basic design guidelines and references to suitable approaches has been provided to aid the reader in determining the suitability of their design approach.*

…. The redevelopment of the Valley affords the opportunity for appropriate development within the floodplain with a policy of ensuring that the 1%AEP flood is carried within the creekline corridor (i.e. no residential development or significant amenities be placed within the 1%AEP flood extent). In addition to this, the Probable Maximum Flood (PMF) needs to be considered with its implications for flood hazards and flood evacuation.

This document provides specific requirements for supporting documentation to be prepared by Applicants in their preparation of Rezoning applications, development applications, Construction Certificates, Subdivision Certificates and Handover documentation and outlines what levels of expertise will be required for certification to meet the requirements of the Warriewood Valley Development Control Plan (DCP No 20, 1998).

The 2001 Warriewood Valley Urban Land Release Water Management Specification requires, in part:

4.4. Watercourse and Creekline Corridor Preservation/Restoration

4.4.1. Overview and Objectives

Note that to ensure continuity of the creek system and to prevent an ad-hoc approach, Council has engaged a consultant to prepare a concept design of the watercourse and creekline corridor for Narrabeen Creek and Fern Creek. This design can be made available to Applicants on request for the purposes of comparison with designs for each Sector. It is expected that Sector design's should adhere to this concept design except in certain circumstances which are to be identified by the Applicant. ……..

4.4.4. Creek Design Requirements

An overview of basic design guidelines and references to suitable approaches has been provided to aid the reader in determining the suitability of their design approach.

There are a number of essential design requirements that need to be fulfilled. These are:

- *Corridor width requirements*
- *Environmental flow and flood conveyance requirements*
- *Channel section and batter slope requirements*
- *Planting and integration with the Landscape Master Plan*
- *Fencing restrictions*
- *Details for cycleway and road crossings*
- *Details for stormwater discharge points.*

Basic Design Guidelines

The design of 'natural channels' is an extension of stream restoration, involving the creation of channels with the attributes of natural watercourses. These attributes include:

- *A meandering plan form in dynamic equilibrium with site characteristics.*
- *A main channel with a floodplain (principally in middle and lower reaches).*
- *A series of pools and riffle zones (rapids).*
- *Native riparian and floodplain vegetation.*

…. Concept Plans showing the expected aspect of the corridor are provided in Figures 2, 3, 4 and 5. Figure 2 shows a concept plan figure of a creekline corridor; Figure 3 shows a typical concept section of a creekline corridor. Figures 4 and 5 show examples of detailed plans. Figure 6 provides general details of landscape treatments required within the creek and corridor.

Planting and Integration with the Landscape Master Plan

This aspect of the Water Management Report is to be prepared in close consultation with the Landscape Masterplan and Design Guidelines (December, 2000). Table 4.2 outlines the important aspects of vegetation management and planting.

4.5. Flood Protection

…. The redevelopment of the Valley affords the opportunity for appropriate development within the floodplain with a policy of ensuring that the 1%AEP flood is carried within the creekline corridor (i.e. no residential development or significant amenities be placed within the 1%AEP flood extent). In addition to this, the Probable Maximum Flood (PMF) needs to be considered with its implications for flood hazards and flood evacuation. ……

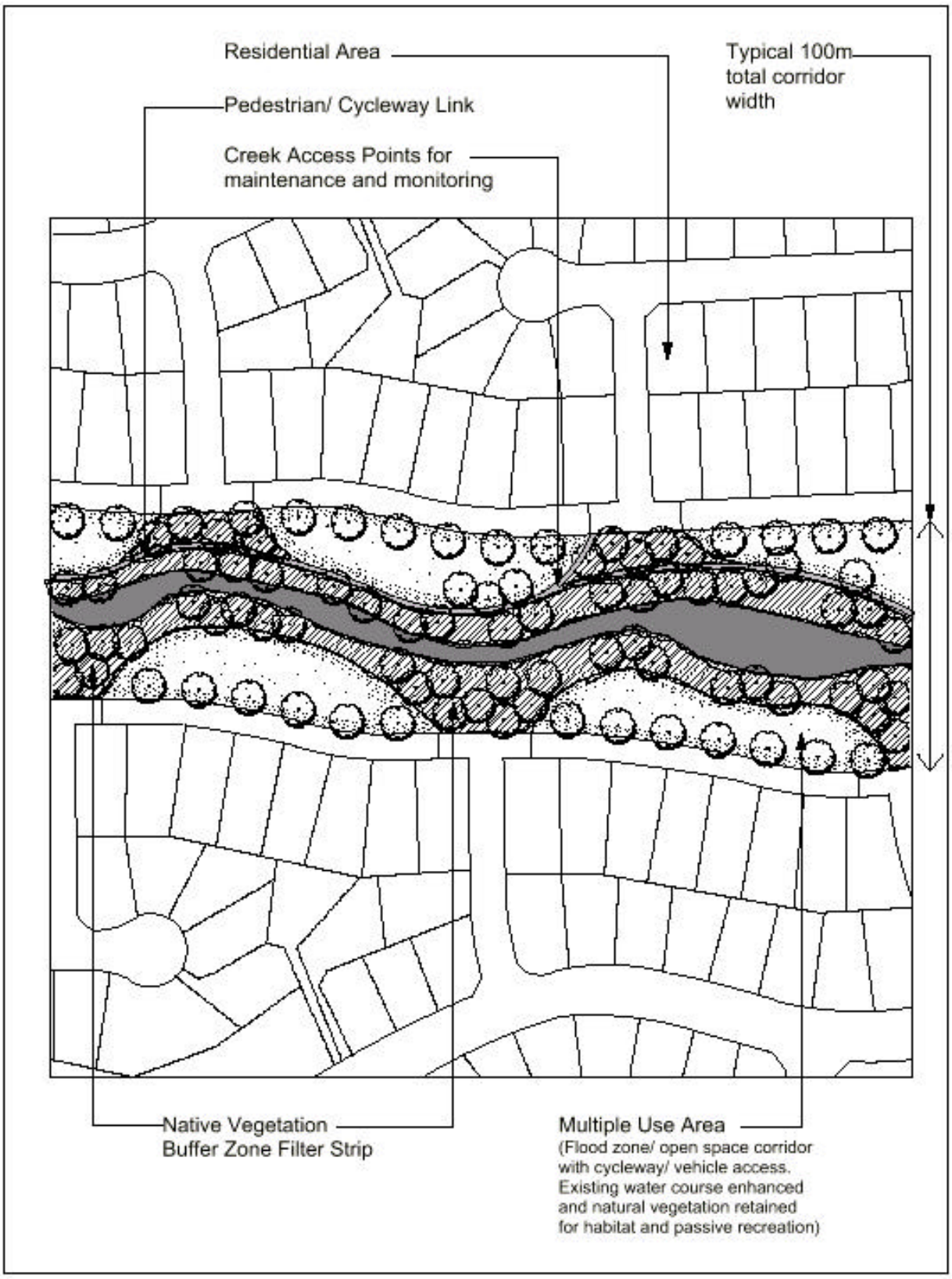


Figure 2: Concept Plan - Typical Creekline Corridor
(adapted from Sharpin et al, 1995)

Source: 2001 Warriewood Valley Urban Land Release Water Management Specification

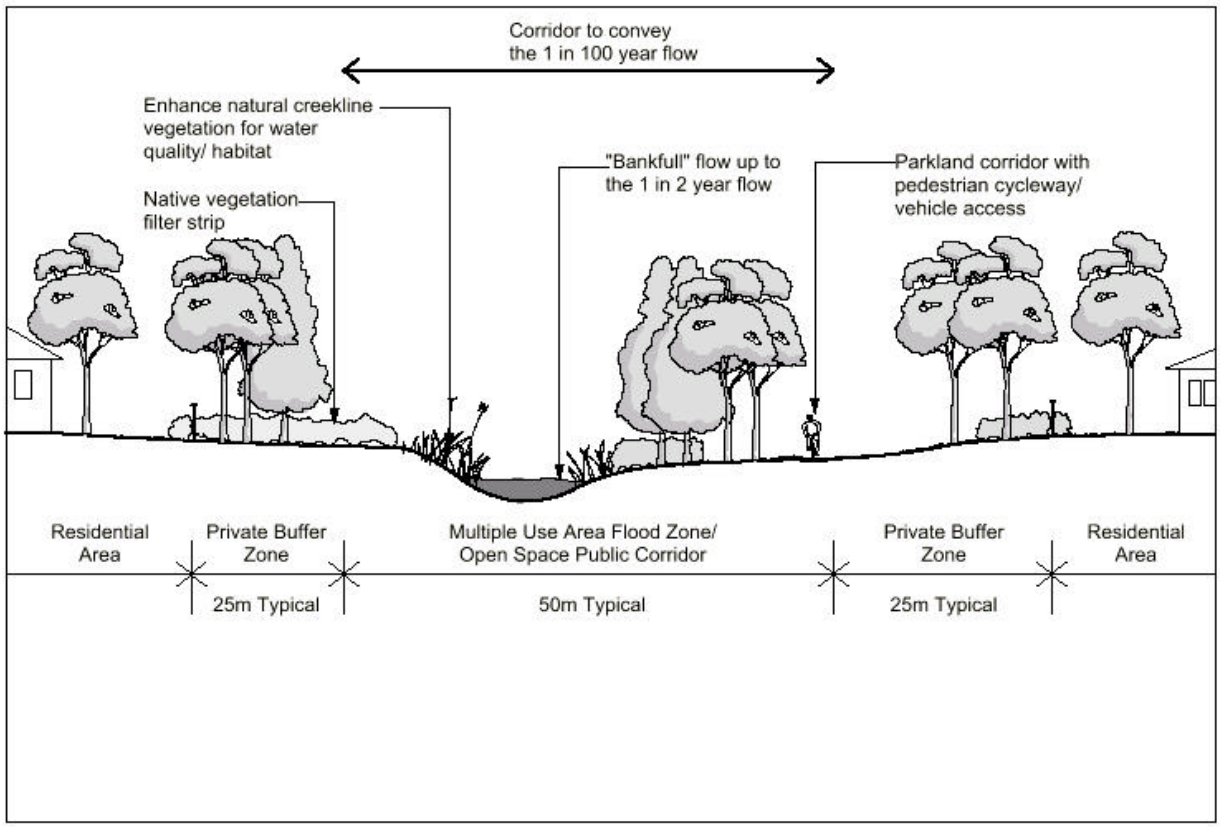


Figure 3: Typical Section - Creekline Corridor

Source: 2001 Warriewood Valley Urban Land Release Water Management Specification

4.5.2 Flood Planning and Design Levels for Development

To ensure that flooding at the downstream end of the Valley creeks is not worsened, the requirement for design flood levels is to ensure that there is a zero increase in the 1%AEP flood levels over existing conditions (except at the regional detention basin site upstream of Sector 1 where ponding is required to activate channel storage) and in special circumstances as determined by Council. ……

It is imperative to note that the direction of state floodplain management policy in NSW is to consider all floods up to and including the Probable Maximum Flood (PMF) under the Draft Floodplain Management Manual (1999). The implications of this policy direction is that properties that lie within the extent of the Probable Maximum Flood may attract a notation on their Section 149 Certificate.

Consequently, the PMF and the 1%AEP flood extents are required to be plotted in plan to indicate any property areas that lie within the floodplain. This is required even if the PMF will be contained within the creekline corridor.

Flood planning levels and the requirements for various design events are shown in Table 4.3.

Table 4.3 Flood Planning Levels

Design Level	*Requirement*
50%AEP (1 in 2 year ARI)	• *50%AEP flow to be carried in-bank*
20%AEP (1 in 5 year ARI)	• *The level of walkways and cycleways adjacent to the creeks are to be above the 20%AEP flood level except under special circumstances (and exposed for only short duration's)* • *Water quality control ponds, filter strips and structures are to be above the 20%AEP flood level, and can be below the 1%AEP flood level but must lie within the private buffer area as outlined in Section 4.3.2.*
1%AEP (1 in 100 year ARI)	• *1%AEP flows are to be carried within the public space corridors, and are to be further designed such that floodplain management and hazard management guidelines are accommodated to minimise risk to life* • *Flood extent to be mapped* • *Floor levels for properties adjacent to the creek are to be set at least 0.5 m above the 1%AEP level* • *Obverts of bridge decks of evacuation routes are to be set at least 0.5 m above the 1% AEP level*
Probable Maximum Flood	• *Evacuation Planning* • *Flood hazards and risk to life* • *Flood extent to be mapped*

4.5.5 Reporting

The section of the Water Management Report relating to Flood Protection is to provide information on:

- *Design flood modelling undertaken including model cross sections and assumptions*
- *Plans showing design flood levels (as described in Section 4.4)*
- *The application of any flood planning levels*
- *Interim flood protection works*
- *A flood evacuation plan.*

….. Tables of data and sections are to indicate the peak flood levels for various design events of the 50% AEP, 20% AEP, 5% AEP, 1% AEP and the PMF.

1.3.2 Northern Beaches Council Water Management for Development Policy

This policy supports Councils commitment to protecting and enhancing the aquatic and terrestrial natural environment while ensuring protection of public and property across the Northern Beaches. The application of these principles, and corresponding planning controls, will deliver effective integrated management of stormwater, rainwater, groundwater and wastewater.

11.2 Development on Land Subject to Overland Flows

(a) *For development on properties subject to overland flow that has not been identified as being flood affected must comply with flood related development controls in the relevant planning instruments.*

(b) *Overland flow paths designed to contain a 1% AEP storm flow are to be provided over all pipelines that are not designed to cater for this flow. The design of the overland flow path must consider the velocity-depth hazard.*

(c) *An overland flow path shall be defined, and not impeded, even where the 1% AEP storm flows can be maintained within the underground-piped drainage system.*

(d) *Overland flow paths are to be kept free of obstruction and must not be landscaped with loose material that could be removed during a storm event, such as wood chip or pine bark.*

11.3 Subdivisions on Lots Affected by Overland Flow

Proposed land subdivisions of lots affected by overland flow will not be approved unless the applicant can demonstrate that future development can comply with the requirements of the relevant planning instruments.

1.3.3 Pittwater LEP 2014

Section 5.21 Flood Planning of the Warringah LEP 2014 is as follows:

(1) The objectives of this clause are as follows—

(a) to minimise the flood risk to life and property associated with the use of land,
(b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,
(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,
(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.

(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development

(a) is compatible with the flood function and behaviour on the land, and
(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and
(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and
(d) incorporates appropriate measures to manage risk to life in the event of a flood, and
(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.

(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—

(a) the impact of the development on projected changes to flood behaviour as a result of climate change,
(b) the intended design and scale of buildings resulting from the development,
(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,
(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.

(4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.

(5) In this clause—

***Considering Flooding in Land Use Planning Guideline** means the Considering Flooding in Land Use Planning Guideline published on the Department's website on 14 July 2021.*

***flood planning area** has the same meaning as it has in the Floodplain Development Manual.*

***Floodplain Development Manual** means the Floodplain Development Manual (ISBN 0 7347 5476 0) published by the NSW Government in April 2005.*

The Pittwater LEP 2014 does not define the expression Flood Planning Level.

The 2021 Considering Flooding in Land Use Planning Guideline defines the Flood Planning Level as:

> ***Flood planning level (FPL)** is the combination of the flood level from the defined flood event and freeboard selected for flood risk management purposes*

The 2005 Floodplain Development Manual defines Flood Planning Area and Flood Planning Levels as follows:

> ***flood planning area:** the area of land below the FPL and thus subject to flood related development controls. The concept of flood planning area generally supersedes the "flood liable land" concept in the 1986 Manual.*
>
> ***flood planning levels (FPLs):** are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the "standard flood event" in the 1986 manual.*

1.3.4 Pittwater 21 DCP

Section A1.9 of the Pittwater 21 DCP, in part, provides the following definitions:

> ***Adverse impacts** (for the purposes of the Flood Prone Land clause only) means, the proposed development:*
>
> - *Will result in less than 0.02m increase in the 1% AEP*
> - *Will result in less than a 0.05m increase in the PMF*
> - *Will result less than a 10% increase in PMF peak velocity*
> - *Will have no loss in flood storage or flood way in the 1% AEP*

If these criteria are satisfied, then the development is deemed to not generate adverse impacts.

> ***Flood Planning Levels** (FPL) has the same meaning as provided in the Manly LEP 2013, Warringah LEP 2011 and Pittwater LEP 2014.*
>
> *A reduced freeboard will be considered on its merits for properties impacted by peak flood depths less than 0.3 m and velocity depths less than 0.3 m^2/s. The reduced freeboard must be appropriately justified in a Flood Management Report prepared by a suitably qualified professional.*

The Pittwater 21 DCP requires, in part:

B3.11 Flood Prone Land

Applies to Land

Land identified as being affected by flooding on the Flood Risk Precinct Maps, or as otherwise determined by Council.

The Flood Risk Precincts mapped by Council in the vicinity of the subject site are shown in **Figure 2.**

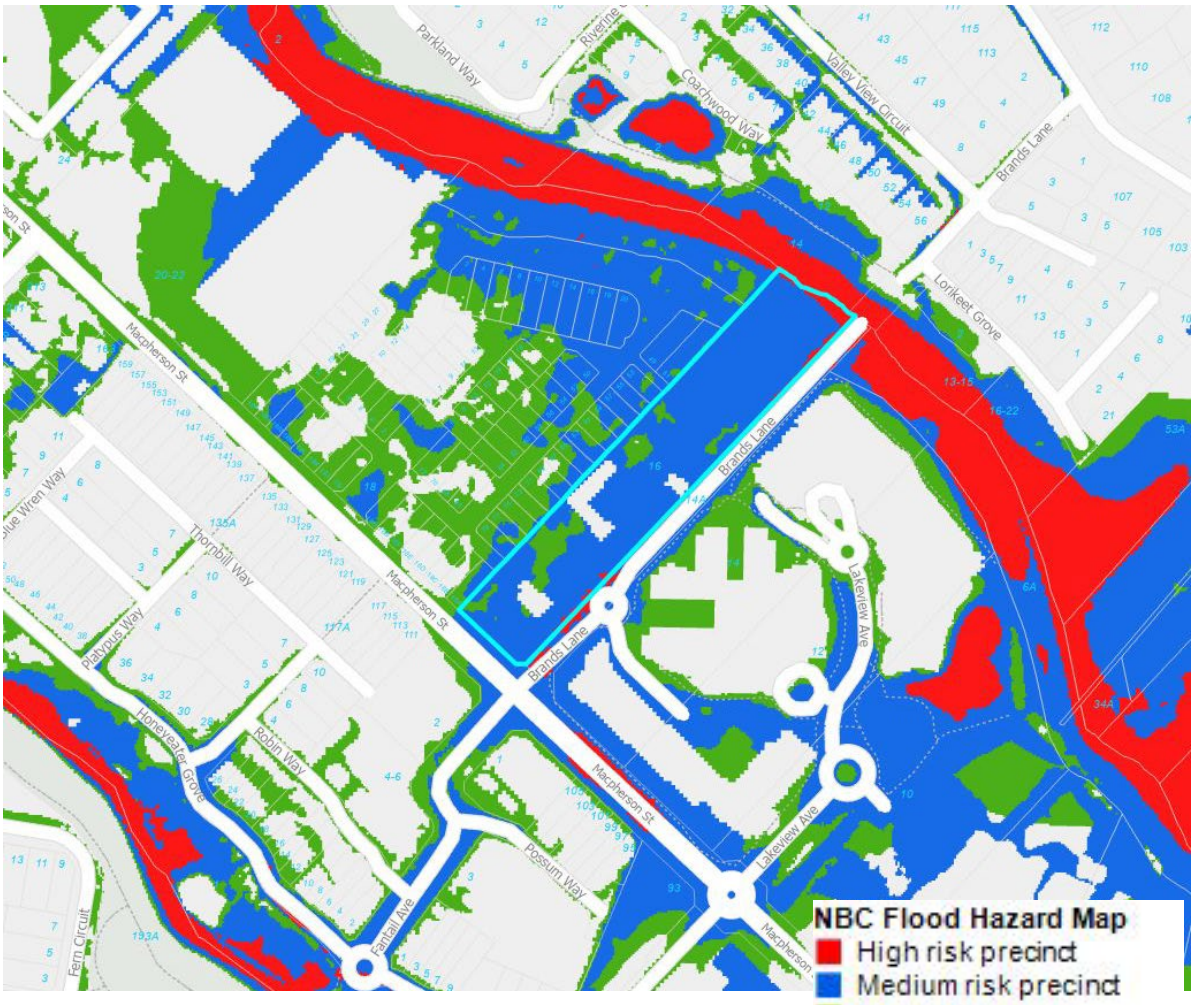


Figure 2 Flood Risk Precincts (Source: Northern

Uses to which this control applies

Land use groups are shown in Table 1, below the Development Control Matrix.

Objectives

- *Protection of people.*
- *Protection of the natural environment.*
- *Protection of private and public infrastructure and assets.*

Requirements

1. *Development must comply with the prescriptive controls set out in the Matrix below. Where a property is affected by more than one Flood Risk Precinct, or has varying Flood Life Hazard Category across it, the assessment must consider the controls relevant at each location on the property.*
2. *Development on flood prone land requires the preparation of a Flood Management Report by a suitably qualified professional.*

		Medium Flood Risk Precinct				
		Vulnerable & Critical Use	Residential Use	Business & Industrial Use	Recreational & Environmental Use	Subdivision & Civil Works
A	**Flood effects caused by Development**	A1 A2	A1 A2	A1 A2	A1 A2	A1 A2
B	**Building Components & Structural**	B1 B2 B3	B1 B2 B3	B1 B2 B3	B1 B2 B3	
C	**Floor Levels**	C2 C3	C1 C3 C4 C6	C1 C3 C4 C6 C7	C3	C5
D	**Car Parking**	D1 D2 D3 D4 D7	D1 D2 D3 D4 D5 D6	D1 D2 D3 D4 D5 D6	D1 D2 D3 D4 D5 D6	D1
E	**Emergency Response**	E1 E2	E1	E1	E1	E3
F	**Fencing**	F1	F1	F1	F1	F1
G	**Storage of Goods**	G1	G1	G1	G1	
H	**Pools**	H1	H1	H1	H1	H1

A. *Flood Effects Caused by Development*

A1	*Development shall not be approved unless it can be demonstrated in a Flood Management Report that it has been designed and can be constructed so that in all events up to the 1% AEP event:* (a) *There are no adverse impacts on flood levels or velocities caused by alterations to the flood conveyance; and* (b) *There are no adverse impacts on surrounding properties; and* (c) *It is sited to minimise exposure to flood hazard.* *Major developments and developments likely to have a significant impact on the PMFflood regime will need to demonstrate that there are no adverse impacts in the Probable Maximum Flood.*

A2	*Development shall not be approved unless it can be demonstrated in a Flood Management Report that in all events up to the 1% AEP event there is no net loss offlood storage.* *Consideration may be given for exempting the volume of standard piers from floodstorage calculations.* *If Compensatory Works are proposed to balance the loss of flood storage from thedevelopment, the Flood Management Report shall include detailed calculations to demonstrate how this is achieved.*

B. *Building Components and Structural Soundness*

B1	*All buildings shall be designed and constructed with flood compatible materials in accordance with "Reducing Vulnerability of Buildings to Flood Damage: Guidance on Building in Flood Prone Areas", Hawkesbury-Nepean Floodplain Management Steering Committee (2006).*
B2	*All new development must be designed and constructed to ensure structural integrity up to the Flood Planning Level, taking into account the forces of floodwater, wave action, flowing water with debris, buoyancy and immersion. Where shelter-in-place refuge is required, the structural integrity for the refuge is to be up to the Probable Maximum Flood level. Structural certification shall be provided confirming the above.*
B3	*All new electrical equipment, power points, wiring, fuel lines, sewerage systems or any other service pipes and connections must be waterproofed and/or located above the Flood Planning Level. All existing electrical equipment and power points located below the Flood Planning Level within the subject structure must have residual current devices installed that turn off all electricity supply to the property when flood waters are detected.*

C. *Floor Levels*

C1	*New floor levels within the development shall be at or above the Flood Planning Level.*
C2	*All floor levels within the development shall be at or above the Probable Maximum Flood level orFlood Planning Level, whichever is higher.*
C3	*All new development must be designed and constructed so as not to impede the floodway or flood conveyance on the site, as well as ensuring no net loss of floodstorage in all events up to the 1% AEP event.* *For suspended pier/pile footings:* *(a) The underfloor area of the dwelling below the 1% AEP flood level is to be designed and constructed to allow clear passage of floodwaters, taking into account the potential for small openings to block; and* *(b) At least 50% of the perimeter of the underfloor area is of an open design fromthe natural ground level up to the 1% AEP flood level; and* *(c) No solid areas of the perimeter of the underfloor area would be permitted in a floodway*

C4	*A one-off addition or alteration below the Flood Planning Level of less than 30 square metres (in total, including walls) may be considered only where:* *(a) it is an extension to an existing room; and* *(b) the Flood Planning Level is incompatible with the floor levels of the existingroom; and* *(c) out of the 30 square metres, not more than 10 square metres is below the 1%AEP flood level.* *This control will not be permitted if this provision has previously been utilised since the making of this Plan.* *The structure must be floodproofed to the Flood Planning Level, and the Flood Management Report must demonstrate that there is no net loss of flood storage in all events up to the 1% AEP event.*
C5	*The applicant must demonstrate that future development following a subdivisionproposal can be undertaken in accordance with this Development Control Plan.*
C6	*Consideration may be given to the retention of an existing floor level below the Flood Planning Level when undertaking a first floor addition provided that:* (a) *it is not located within a floodway; and* (b) *the original foundations are sufficient to support the proposed final structureabove them. The Flood Management Report must include photos and the structural certification required as per Control B2 must consider whether theexisting foundations are adequate or should be replaced; and* (c) *none of the structural supports/framing of existing external walls of are to be removed unless the building is to be extended in that location; and* (d) *the ground floor is floodproofed.*
C7	*Consideration may be given to a floor level below the Flood Planning Level within the first 5 metres from the street front in an existing business zone provided it can be demonstrated that:* (a) *The minimum floor level is no lower than the adjacent footpath level, and* (b) *The maximum internal distance from the front of the building is 5 metres,which can only apply to one side of an individual premises, and* (c) *The maximum area for the floor area to be below the Flood Planning Level for an individual premise is 30 square metres, and* (d) *There is direct internal access between areas above and below the Flood Planning Level for each individual premises*

D. *Car Parking*

D1	*Open carpark areas and carports shall not be located within a floodway.*
D2	*The lowest floor level of open carparks and carports shall be constructed no lower than the natural ground levels, unless it can be shown that the carpark or carport is free draining with a grade greater than 1% and that flood depths are not increased.*
D3	*Carports must be of open design, with at least 2 sides completely open such that flow is not obstructed up to the 1% AEP flood level. Otherwise it will be considered to be enclosed.When undertaking a like-for-like replacement and the existing garage/carport is located on the street boundary and ramping is infeasible, consideration may be given for dry flood proofing up to the 1% AEP flood level.*

D4	*Where there is more than 300mm depth of flooding in a car park or carport during a 1% AEP flood event, vehicle barriers or restraints are to be provided to prevent floating vehicles leaving the site. Protection must be provided for all events up to the 1% AEP flood event*
D5	*Enclosed Garages must be located at or above the 1% AEP level*
D6	*All enclosed car parks (including basement carparks) must be protected from inundation up to the Flood Planning Level. All access, ventilation, driveway crests and any other potential water entry points to any enclosed car parking shall be above the Flood Planning Level.* *Where a driveway is required to be raised it must be demonstrated that there is no net loss to available flood storage in any event up to the 1% AEP flood event and no impact on flood conveyance through the site.* *Council will not accept any options that rely on electrical, mechanical or manual exclusion of the floodwaters from entering the enclosed carpark*
D7	*All enclosed car parks must be protected from inundation up to the Probable Maximum Flood levelor Flood Planning Level whichever is higher. For example, basement carpark driveways must be provided with a crest at or above the relevant Probable Maximum Flood level or Flood Planning Level whichever is higher. All access, ventilation and any other potential water entry points to any enclosed car parking shall be at or above the relevant Probable Maximum Flood level or Flood Planning Level whichever is higher.*

E. *Emergency Response*

E1	*If the property is affected by a Flood Life Hazard Category of H3 or higher, then Control E1 applies and a Flood Emergency Assessment must be included in the Flood Management Report.* *If the property is affected by a Flood Life Hazard Category of H6, then development is not permitted unless it can be demonstrated to the satisfaction of the consent authority that the risk level on the property is or can be reduced to a level below H6 or its equivalent.* *If the property is flood affected but the Flood Life Hazard Category has not been mapped by Council, then calculations for its determination must be shown in the Flood Management Report, in accordance with the "Technical Flood Risk Management Guideline: Flood Hazard", Australian Institute for Disaster Resilience (2012).* *Where flood-free evacuation above the Probable Maximum Flood level is not possible, new development must provide a shelter-in-place refuge where:* a) *The floor level is at or above the Probable Maximum Flood level; and* b) *The floor space provides at least 2m^2 per person where the flood duration is long (6 ormore hours) in the Probable Maximum Flood event, or 1m^2 per person for less than 6 hours;* c) *It is intrinsically accessible to all people on the site, plainly evident, and self-directing,with sufficient capacity of access routes for all occupants without reliance on an elevator; and* d) *It must contain as a minimum: sufficient clean water for all occupants; portable radiowith spare batteries; torch with spare batteries; and a first aid kit*

	Class 10 classified buildings and structures (as defined in the Building Codes of Australia) are excluded from this control. *In the case of change of use or internal alterations to an existing building, a variation to this control may be considered if justified appropriately by a suitably qualified professional.* *Note that in the event of a flood, occupants would be required to evacuate if ordered by Emergency Services personnel regardless of the availability of a shelter-in-place refuge.*
E2	*If a shelter-in-place refuge is required, it must contain as a minimum: sufficient clean water for all occupants; portable radio with spare batteries; torch with spare batteries; a first aid kit; emergency power; and a practical means of medical evacuation.*
E3	*It must be demonstrated that evacuation or a shelter-in-place refuge in accordance with the requirements of this DCP will be available for any potential development arising from a Torrens title subdivision.*

F. *Fencing*

F1	*Fencing, (including pool fencing, boundary fencing, balcony balustrades and accessway balustrades) shall be designed so as not to impede the flow of flood watersand not to increase flood affectation on surrounding land. At least 50% of the fence must be of an open design from the natural ground level up to the 1% AEP flood level.Less than 50% of the perimeter fence would be permitted to be solid. Openings shouldbe a minimum of 75 mm x 75mm.*

G. *Storage of Goods*

G1	*Hazardous or potentially polluting materials shall not be stored below the Flood Planning Levelunless adequately protected from floodwaters in accordance with industry standards.*

H. *Pools*

H1	*Pools located within the 1% AEP flood extent are to be in-ground, with coping flush with natural ground level. Where it is not possible to have pool coping flush with natural ground level, it must be demonstrated that the development will result in no net loss of flood storage and no impact on flood conveyance on or from the site.* *All electrical equipment associated with the pool (including pool pumps) is to be waterproofed and/or located at or above the Flood Planning Level.* *All chemicals associated with the pool are to be stored at or above the Flood Planning Level.*

The 1% AEP Flood Life Hazard Categories in the vicinity of the subject property are plotted in **Figure 7** while PMF Flood Life Hazard Categories are plotted in **Figure 8**.

3.12 Climate Change (Sea Level Rise and Increased Rainfall Volume)

Controls

When this control applies:

This control applies where 'intensification of development' is proposed. 'Intensification of development' includes but may not be limited to:

- *an increase in the number of dwellings (but excluding dual occupancies and secondary dwellings);*
- *an increase in commercial or retail floor space.*

Climate Change Scenarios

The following climate change scenarios shall be considered:

- *Scenario 1: Impacts of sea level rise only:*
- *Scenario 2: Impacts of sea level rise combined with increased rainfall volume:*

1 Climate Change Assessment for Land Identified as Beach Management Area on the Coastal Hazards Map

The impacts of climate change on land identified as Beach Management Area on the Coastal Hazards Map, involving development to which this control applies, shall be assessed in accordance with Clause B3.3 Coastline (Beach) Hazard and Appendix 6 - Coastline Risk Management Policy for Development in Pittwater.

2. Climate Change Assessment for Land Identified on Flood Hazard Map.

For land identified on Council's Flood Hazard Maps involving development to which this control applies, a Flood Risk Management Report shall be prepared in accordance with Appendix 8 - Flood Risk Management Policy for Development in Pittwater, which includes an assessment of climate change. This assessment shall include the impacts of climate change on the property over the life of the development and the adaptive measures to be incorporated in the design of the project. The following climate change scenarios shall be considered:

- *Scenario 1: Impacts of sea level rise only*
- *Scenario 2: Impacts of sea level rise combined with increased rainfall volume*

Flood Planning Levels for Scenario 1 and 2 have not been adopted by Council to date.

Applicants should contact Council to be directed to the source of the best available information to determine the likely increase in Flood Planning Levels as a result of climate change.

3. Climate Change Assessment for Land Identified within the Warriewood Valley Land Release Area

For land identified within the Warriewood Valley Land Release Area involving development to which this control applies, a climate change assessment shall be incorporated in the Water Management Report as required by Clause C6.4 Flood - Warriewood Valley Residential Sectors, Buffer Areas or Development Sites, Clause C6.5 Flood - Warriewood Valley Employment Generating Sectors, Buffer Areas or Development Sites and in accordance with Council's Warriewood Valley Urban Land Release Water Management Specification (February 2001 or as amended). The climate change assessment shall include the impacts of climate change on the property over the life of the development and the adaptive measures to be incorporated in the design of the project. The following climate change scenarios shall be considered:

- *Scenario 1: Impacts of sea level rise only*
- *Scenario 2: Impacts of sea level rise combined with increased rainfall volume*

Flood Planning Levels for Scenario 1 and 2 have not been adopted by Council to date. Applicants should contact Council to be directed to the source of the best available information to determine the likely increase in Flood Planning Levels as a result of climate change.

4. Climate Change Assessment for Land Identified on the Estuarine Hazard Map,

For land identified on Council's Estuarine Hazard Maps involving development to which this control applies, an assessment of climate change shall be undertaken as part of the Estuarine Risk Management described in Appendix 7 - Estuarine Risk Management Policy for Development in Pittwater. This assessment shall include the impacts of climate change on the property over the life of the development and the adaptive measures to be incorporated in the design of the project. The following climate change scenarios shall be considered:

- *Scenario 1: Impacts of sea level rise only*

Estuarine Planning Levels for Scenario 1 have not been adopted by Council to date.

Applicants should contact Council to be directed to the source of the best available information to determine the likely increase in Estuarine Planning Levels as a result of climate change.

Section C Development Control Types, C6 Design Criteria for Warriewood Valley Release Area

Section C6.1 Integrated Water Cycle Management requires, in part:

The Water Management Report, submitted with the application, must demonstrate how the water cycle will be managed and integrated with the development. The Water Management Report is to be prepared by appropriately qualified professionals and certified by an experienced and qualified engineer specialising in hydraulics. It is to be in accordance with Council's Warriewood Valley Urban Land Release Water Management Specification (February 2001 as amended) and relevant legislation considering the Narrabeen Lagoon Flood Study (September 2013 as amended) and the Pittwater Overland Flow Flood Study (2013 as amended). …….

Flooding

The flood levels are to be determined as part of the Water Management Report. The information to be obtained includes:

- *the 50% Annual Exceedance Probability (AEP) flood levels with climate change impacts including sea level rise combined with increase rainfall volume;*
- *the 20% AEP flood levels with climate change impacts including sea level rise combined with increase rainfall volume;*
- *the 1% AEP flood levels with climate change impacts including sea level rise combined with increase rainfall volume;*
- *the Flood Planning Level (FPL) - equal to the 1% AEP flood level plus freeboard (as defined within clause A1.9 of this DCP) with climate change impacts including sea level rise combined with increase rainfall volume;*
- *the Probable Maximum Flood (PMF) level with climate change impacts including sea level rise combined with increase rainfall volume;*
- *the flow velocities for the 1% AEP flood and Probable Maximum Flood with climate change impacts including sea level rise combined with increase rainfall volume; and*
- *the Flood Category and Flood Hazard Classification as defined in clause A1.9 of this DCP with climate change impacts including sea level rise combined with increase rainfall volume.*

Likely flood impacts from the development must also be assessed and where required, mitigated.

The filling of land will only be permitted where it can be demonstrated within the Water Management Report that

- *there is no net decrease in the floodplain volume of the floodway or flood storage area within the property, for any flood event up to the 1% AEP flood event and the PMF event including climate change considerations for both design events; and/or*
- *there is no additional adverse flood impact on the subject and surrounding properties and flooding processes for any flood event up to the PMF event including climate change impacts.*

The Water Management Report must identify the minimum floor level requirements for development in accordance with the Flood Hazard and Flood Category applicable to the proposed land use specified in Flood Risk Management Policy.

The subdivision of land requires the building platforms for each additional allotment to be created at or above the Flood Planning Level (plus climate change). The Plan of Subdivision is to include the Flood Planning Level (plus climate change) for each new allotment created.

1.3.5 Council Guidance

On 2 February 2023, Council provided the following advice in relation to the flood events to be assessed (refer Attachment E4 in **Appendix E**):

We recognise that there are discrepancies between the documents, which makes it complex to work out what is required for a DA.

As far as flooding is concerned, please address Control C6.1 (in conjunction with Control B3.12) of the Pittwater DCP first, which require that climate change (CC) should be included in all flood assessment.

Consideration of climate change only needs to include a 30% increase in rainfall intensity, as this property is considered to be upstream of the impact of Narrabeen Lagoon even in the PMF. Sea level rise and tailwater levels do not need to be considered.

Controls C6.1 and B3.12 of the Pittwater DCP:

Adverse impacts on flood levels: 50% AEP, 20% AEP, 1% AEP, PMF - all including CC
Adverse impacts on flood velocities: 1% AEP, PMF - both including CC

Flood Category: for 1% +CC
Flood Hazard Category: for PMF +CC

Floor levels: FPL +CC
Building platform: FPL +CC

Control C6.1 states that "The filling of land will only be permitted where it can be demonstrated within the Water Management Report that:

- *there is no net decrease in the floodplain volume of the floodway or flood storage area within the property, for any flood event up to the 1% AEP flood event and the PMF event including climate change considerations for both design events; and/or*
- *there is no additional adverse flood impact on the subject and surrounding properties and flooding processes for any flood event up to the PMF event including climate change impacts".*

In this statement, please note the "and/or" – I'd suggest that the second bullet point would be the more appropriate method of demonstration for this development.

Adverse impacts are defined in Section A1.9 of the DCP and require that "the proposed development:

Will result in less than 0.02m increase in the 1% AEP
Will result in less than a 0.05m increase in the PMF
Will result less than a 10% increase in PMF peak velocity
Will have no loss in flood storage or flood way in the 1% AEP".

For this property, where adverse impacts need to be assessed for a broader range of design floods, assessment should show that the proposed development:

Will result in less than 0.02m increase in the 1% AEP, 20% AEP and 50% AEP – all including CC
Will result in less than a 0.05m increase in the PMF – including CC
Will result in less than a 10% increase in the PMF and 1% AEP peak velocities – including CC
Will have no loss in flood storage or flood way in the 1% AEP – including CC.

As per the comment above, if the second method of demonstration is selected then there does not have to be zero loss of flood storage or floodway in the 1% AEP event.

Impact mapping is required for each aspect of the impact assessment.

Warriewood Valley Urban Land Release Water Management Specification:

The Warriewood Valley Urban Land Release Water Management Specification was prepared in 2001. It contains no mention of climate change, as it was prepared before Council had any requirements for inclusion of climate change in flood modelling.

Climate change does not need to be included (but can be if you think it appropriate or simpler) for the design level requirements listed in Table 4.3 except where climate change needs to be considered as identified above, ie for the FPL, floor levels, and flood hazard in the PMF. The Specification calls for mapping of the 1% AEP and PMF flood extents – please map both with and without CC. If the post-development flood hazard is H3 or larger, shelter in place refuge is required above the PMF+CC level.

1.4 Terminology

Book 1, Chapter 2, Section 2.2.5. Adopted Terminology in Australian Rainfall & Runoff, 2016 describes the adopted terminology as follows:

To achieve the desired clarity of meaning, technical correctness, practicality and acceptability, the National Committee on Water Engineering has decided to adopt the terms shown in Figure 1.2.1 and the suggested frequency indicators.

Navy outline indicates preferred terminology. Shading indicates acceptable terminology which is depends on the typical use. For example, in floodplain management 0.5% AEP might be used while in dam design this event would be described as a 1 in 200 AEP.

As shown in the third column of Figure 1.2.1, the term Annual Exceedance Probability (AEP) expresses the probability of an event being equalled or exceeded in any year in percentage terms, for example, the 1% AEP design flood discharge. There will be situations where the use of percentage probability is not practicable; extreme flood probabilities associated with dam spillways are one example of a situation where percentage probability is not appropriate. In these cases, it is recommended that the probability be expressed as 1 in X AEP where 100/X would be the equivalent percentage probability.

For events more frequent than 50% AEP, expressing frequency in terms of annual exceedance probability is not meaningful and misleading, as probability is constrained to a maximum value of 1.0 or 100%. Furthermore, where strong seasonality is experienced, a recurrence interval approach would also be misleading. An example of strong seasonality is where the rainfall occurs predominately during the Summer or Winter period and as a consequence flood flows are more likely to occur during that period. Accordingly, when strong seasonality exists, calculating a design flood flow with a 3 month recurrence interval is of limited value as the expectation of the time period between occurrences will not be consistent throughout the year. For example, a flow with the magnitude of a 3 month recurrence interval would be expected to occur or be exceeded 4 times a year; however, in situations where there is strong seasonality in the rainfall, all of the occurrences are likely to occur in the dominant season.

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very Frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.5
	1	63.21	1.58	1
Frequent	0.69	50	2	1.44
	0.5	39.35	2.54	2
	0.22	20	5	4.48
	0.2	18.13	5.52	5
	0.11	10	10	9.49
Rare	0.05	5	20	20
	0.02	2	50	50
	0.01	1	100	100
Very Rare	0.005	0.5	200	200
	0.002	0.2	500	500
	0.001	0.1	1000	1000
	0.0005	0.05	2000	2000
Extreme	0.0002	0.02	5000	5000
			PMP/ PMPDF	

Figure 1.2.1. Australian Rainfall and Runoff Preferred Terminology

Consequently, events more frequent than 50% AEP should be expressed as X Exceedances per Year (EY). For example, 2 EY is equivalent to a design event with a 6 month recurrence interval when there is no seasonality in flood occurrence.

The terminology adopted herein depends on the edition of Australian Rainfall and Runoff provide the IFD data. In the case of assessments based on ARR1987 the ARI terminology was adopted design floods. In the case of assessments based on ARR2019 the AEP terminology was adopted design floods.

2 Previous Studies

The proposed development on 16 Macpherson Street, Warriewood is potentially subject to flooding by floodwaters spilling from the Narrabeen Creek and by overland flows. It is noted that flooding investigations have been previously completed for the Narrabeen Creek floodplain in the vicinity of the subject property. The flooding context is provided in several studies as follows:

- BMT WBM (2013) "Narrabeen Lagoon Flood Study", Final Report, Version 4, prepared for Warringah Council and Pittwater Council, September.
- Cardno (2019) "Narrabeen Lagoon Flood Risk Management Study and Plan", Final report, Version 3, prepared for Northern Beaches Council, April.
- Cardno Lawson Treloar (2013) "Pittwater Overland Flow Mapping and Flood Study", Final Report, Version 4, 2 Vols, prepared for Pittwater Council, October.
- WMAwater (2019) "Ingleside, Elanora and Warriewood Overland Flow Flood Study", Final Report, Version 4, prepared for Northern Beaches Council, June.

These studies are overviewed as follows.

2.1 Pittwater Overland Flow Mapping and Flood Study

Cardno Lawson Treloar (Cardno) undertook Pittwater Overland Flow Mapping and Flood Study (2012) on behalf of Pittwater Council. This study aimed to identify properties and areas potentially affected by overland flow for those areas outside Pittwater's Primary (or "mainstream") Floodplain Areas, Category 1 and 2. A full dynamic two-dimensional (2D) SOBEK hydraulic model was developed in this study to define the overland flow behaviour under existing conditions.

A range of flood events were considered, including the 20% Annual Exceedance Probability (AEP), 5% AEP, 1% AEP and Probable Maximum Flood (PMF). In addition, an analysis on the potential impacts of Climate Change was undertaken and provided in the report.

2.2 2013 Narrabeen Lagoon Flood Study

In 2013 BMT WBM prepared the Narrabeen Lagoon Flood Study for the former Warringah Council and Pittwater Council, to define the 'mainstream' flood behaviour in the catchment. The Narrabeen Lagoon Flood Study (BMT WBM, 2013) was adopted by both Councils prior to their merger with Manly Council in 2016 to form Northern Beaches Council.

The flooding context is provided in the 2013 Manly Lagoon Flood Study. This study is outlined as follows.

As described by BMT WBM, 2013:

> *The Narrabeen Lagoon Flood Study has been prepared for Warringah and Pittwater Councils (The Councils) to define the existing flood behaviour in the Narrabeen Lagoon catchment and establish the basis for subsequent floodplain management activities.*
>
> *This study updates previous studies on the Lagoon including the Narrabeen Lagoon Flood Study (PWD, 1990) and studies of the individual tributary streams, providing a holistic assessment of flooding within the catchment. The current Flood Study considers land use changes subsequent to previous modelling investigations, the influence of the Narrabeen Lagoon entrance on flood behaviour and the influence of potential climate change.*

The primary objective of this Flood Study is to define the flood behaviour under historical, existing and future conditions (incorporating potential impacts of climate change) in the Narrabeen Lagoon catchment for a full range of design flood events. The study provides information on flood levels and depths, velocities, flows, hydraulic categories and provisional hazard categories. The Flood Study has also identified the impact on flood behaviour as a result of future climate change and potential changes in the catchment and lagoon entrance. Specifically, the study incorporates:

The primary objective of this Flood Study is to define the flood behaviour under historical, existing and future conditions (incorporating potential impacts of climate change) in the Manly Lagoon catchment for a full range of design flood events. The study provides information on flood levels and depths, velocities, flows, hydraulic categories and provisional hazard categories. The Flood Study has also identified the impact on flood behaviour as a result of future climate change and potential changes in the catchment and lagoon entrance. Specifically, the study incorporates:

- *Compilation and review of existing information pertinent to the study and acquisition of additional data including survey as required;*
- *Undertaking of a community consultation and participation program to identify local flooding concerns, collect information on historical flood behaviour and engage the community in the on-going floodplain management process;*
- *Development and calibration of appropriate hydrological and hydraulic models;*
- *Determination of design flood conditions for a range of design events including the Probable Maximum Flood (PMF), 0.1%, 0.2%, 0.5%, 1%, 2%, 5%, 10%, 20% and 50% AEP events for catchment derived flooding and the 0.5%, 1%, 2%, 5%, 10% and 20% AEP events for ocean derived flooding; and*
- *Assessment of potential impact of climate change using the latest guidelines.*

….

Provided below is a summary of the key findings of the Flood Study, in particular some of the important considerations for future floodplain risk management in the catchment:

- *The design flood conditions documented in the report typically provide for a small increase in previously adopted design flood conditions for Narrabeen Lagoon. The main contributing factor to this change is the way the entrance condition has been modelled. In addition to advances in the software to simulate entrance breakout response, the initial conditions in respect to berm elevations and initial water levels in the Lagoon have been represented more conservatively in the current study.*
- *Longer duration events (9-36 hours) typically provide for the worst case flooding conditions in Narrabeen Lagoon. With the Lagoon waterbody being a significant flood storage, events of longer duration are required to generate sufficient flood runoff volumes from the catchment to elevate Lagoon water levels. In the lower reaches of all the tributary catchments, flood levels are dominated by the Lagoon flooding conditions. The peak flood water level in the Lagoon extends a significant distance up the tributary channels. In the upper reaches of the tributary catchments, shorter duration events of the order of 2-hours provide the critical flood condition in terms of peak flood water level.*

- *The rise in flood water levels can be relatively fast from the catchment's response to rainfall. Even for the longer duration events providing for the highest peak flood water levels in the Lagoon, the main period of rise in Lagoon water level can occur over a few hours. The April 1998 flood event (used for model calibration in the current study) is an example of such a response in the catchment. Flood levels in the tributary catchments may also rise significantly faster owing to the shorter critical durations in these catchments. This potentially rapid inundation has implications for flood warning and emergency response, particularly in flood situations where property and access roads may be quickly inundated.*
- *Catchment derived flooding events represent the dominant flooding mechanism in Narrabeen Lagoon. Whilst some ocean flooding scenarios will provide for inundation of some foreshore areas, the extent and severity of flooding is significantly less than the corresponding catchment derived event magnitude. The entrance condition has some influence on catchment flood behaviour with higher entrance berm levels providing for higher peak flood levels. The existing entrance management policy provides for manual breakout of the Lagoon entrance at defined trigger levels in preparation for imminent flooding. Irrespective of the successful implementation of a manual entrance breakout, significant flood inundation may be expected during major catchment flood events.*
- *There are a number of areas within the Narrabeen Lagoon catchment which represent the most significant flood risk exposure to existing property. The worst affected areas are typically in the lower parts of the catchment and most severely impacted on by major flooding in Narrabeen Lagoon. These areas include the foreshore areas of the Lagoon (e.g. Lakeside Park, Wimbledon Avenue, west of Lagoon Street) and the low-lying floodplain areas adjacent to Nareen Creek (e.g. Gondola Road, Nareen Parade) and Mullet Creek (e.g. Garden Street, Warraba Road).*
- *Peak design flood water levels are expected to progressively increase as the impacts of climate change manifest. For the Narrabeen Lagoon catchment, potential sea level rise will provide for a worsening of existing flood conditions through higher ocean water levels (tide and storm surge), higher entrance berm and higher initial water levels in the Lagoon. Robust land use planning and development policies will be required to ensure future flood risks are not unduly exacerbated in light of predicted flood behaviour under potential climate change scenarios.*
- *Warringah Council's existing Entrance Management OMS is to open the entrance at a defined trigger water level (currently 1.3m AHD). With potential sea level rise, normal tide levels in the Lagoon will approach and eventually exceed the current trigger levels. Future openings would need to be at significantly higher trigger levels to be effective. Low-lying land currently impacted by flooding may also be subject to regular (or permanent) tidal inundation at some time in the future.*

2.3 2019 Narrabeen Lagoon Floodplain Risk Management Study and Plan

The Narrabeen Lagoon Flood Study (BMT WBM, 2013) was later used by Cardno (2019) as the key input to the 2019 Flood Risk Management Study and Plan (FRMS&P).

As described by Cardno, 2019 in an Executive Summary:

> ***Flood Behaviour***
>
> *During flood events the peak water level in Narrabeen Lagoon is generally similar across the entire waterbody, with very little water level gradient. Accordingly, the foreshore inundation can be tied to a representative lagoon water level. At the downstream end of the lagoon small flood water level gradients are generated from Pittwater Road Bridge through to the entrance. In high magnitude low frequency events, the Ocean Street Bridge becomes an influence, controlling the amount of flow that can be discharged through the entrance.*
>
> *Longer duration (volume driven) events are typically more significant for peak flood levels in the lagoon. The 9 hour, 18 hour and 24 hour rainfall events all result in similar peak flood levels in Narrabeen Lagoon.*
> *While the critical flood levels in Narrabeen Lagoon may be controlled by longer duration rainfall events, flood waters in the upper floodplain have the potential to rise quickly. Consequently, there may be little opportunity for warning or assistance before or during a flood. Depending on entrance conditions and ocean levels, flood waters can remain elevated for many hours.*
>
> *In the upper catchment flooding in some areas is confined to the channel with limited overbank flow (e.g. Narrabeen and Mullet Creeks), whereas in other areas overbank and overland flow poses greater concern (e.g. the Warriewood Valley and lower reaches of South creek). Flash flooding is an issue in the upper catchment, as is overtopping of roads and the limited capacity of some culverts and other structures to convey larger magnitude events.*
> *Impact of Flooding*
>
> *The number of properties considered to be "flood affected" in the Narrabeen Lagoon Catchment ranges from 2,200 for the 20% AEP event, to 3,013 for the 1% AEP event. Of these, 229 and 659 properties for each event respectively, are expected to experience above-floor flooding. Based on a total damage assessment using residential, commercial and industrial damage curves, the average annual damage for the Narrabeen Lagoon floodplain under existing conditions is $11,540,886.*
>
> ***Emergency Response Arrangements***
>
> *Flooding in the Narrabeen Lagoon catchment generally occurs as flash flooding, that is, inundation occurs quickly from increased water levels that may be elevated for relatively short periods of time. A publicly accessible webpage hosted by Manly Hydraulics Laboratory (MHL) is available to inform the public via real-time water level gauge data, advise of flood trigger levels and where flooding may be occurring. Alarms and trigger levels on selected gauges are used to send an SMS to relevant personnel in NSW SES and Councils to prompt response action.*

This study has demonstrated that the existing road network for the Narrabeen Lagoon floodplain is not suited for regional evacuation of residents in the event of flooding, because most evacuation routes overtop in frequent flood events (less than 50% AEP in most cases). Examples include both the major regional roads: Wakehurst Parkway and Pittwater Road. The overall time required for evacuation of the Narrabeen Lagoon floodplain was estimated to be a minimum of 5 hours, whereas critical flood levels in parts of the catchment can occur in less than 1 hour. Evacuation is not suitable for some flood affected locations even when considering the 20% AEP instead of the usual PMF. The duration of inundation is generally sub-daily for the majority of the floodplain, however, thus shelter-in-place is a feasible option where flood free refuges are available. ……...

Outcomes and Recommendations

A Multi-Criteria Assessment (MCA) was used to investigate the performance of both structural and non-structural options based on a range of social, environmental, and economic factors. The MCA scores for the emergency management and flood modification options have been combined to produce a ranking of options and an implementation preference list (see table below).

The highest ranked option is Option FM4 representing the current practice for Narrabeen Lagoon entrance management of mechanical dredging of the shoals upstream and downstream of Ocean Street. In terms of economic performance this option was one of the best two options, with the other being the alternative dredging approach of constructing a permanent pipeline for placement of dredged material (Option FM4a). While the economic benefits were slightly higher for the Option FM4a alternative, the social and economic scores for the current approach were far higher and the environmental impacts were well understood. Comparatively, the alternative dredging approach scored worse in the social and environmental criteria resulting in an overall ranking of 18th.

The four options ranked 2nd to 5th highest are all small scale structural works proposed within the lagoon tributaries in the upper catchment to protect residential properties in the local area up to the 1% AEP design event. These options are:

- *FM9 - Waroon Road Levee (South Creek);*
- *FM10 – Wabash Avenue Levee (South Creek);*
- *FM6 – Alkira Circuit Drainage Upgrade (Narrabeen Creek); and*
- *FM14 - Ponderosa Parade Drainage Upgrade (South Creek).*

These options all have reasonably good economic performance; as the scope of works involved is relatively minor, the cost of implementation is low, and the reduction in flood damages up to the 1% AEP is significant. These options are expected to have good community support due to their low cost and the tangible benefits they provide to the community in the local area. The relatively minor scope of works means that limited social disruption is anticipated and the expected environmental impacts are expected to be minor.

The five emergency management options all score well, with all five ranking between 6th and 11th based on the outcomes of the MCA. Though these options produce negligible reductions in flood damages and therefore tangible economic benefits, these options score well due to significant reduction in risk to life, low costs, ease of implementation, and strong community support.

2.4 2019 Ingleside, Elanora and Warriewood Overland Flow Flood Study

As described, in part, by WMAwater, 2019 in the Executive Summary:

The Ingleside, Elanora and Warriewood Overland Flow Flood Study catchment area (Figure 1) is within the Northern Beaches Council (NBC) local government area (LGA) and includes the suburbs of North Narrabeen, Warriewood, Elanora Heights and part of Ingleside. The catchment is located north of Narrabeen Lagoon and drains to the ocean, with an entrance at Narrabeen Head. The study area covers an area of approximately 1,650 hectares (16.5 km^2). The major components of the study are:

- *the collection and collation of existing information relevant to the study - this includes the data already held by Council as well as other information, such as rainfall data;*
- *the collection of additional survey data, particularly cross-sections and major culvert structures, to supplement Council's database;*
- *the preparation of a hydrologic and hydraulic models capable of defining the flood behaviour for the study area for a wide range of design flood probabilities;*
- *the interpretation and presentation of model results to describe and categorise flood behaviour and hazard for a range of design storm events for the existing catchment conditions, including road flood affectation information for the SES;*
- *analysis of hot-spots;*
- *flood control lot mapping and ground truthing;*
- *undertaking sensitivity analysis;*
- *properties at risk analysis;*
- *risk to life analysis;*
- *investigating and determining the Flood Planning Area (FPA)……*

Model Calibration

The models were calibrated against historical flood data to provide robust design flood data. The June 2016 and August 1998 events were chosen for model calibration and the process was undertaken against quantitative gauge data and qualitative community data.

Overview of Flood Behaviour

In the upper portion of the catchment as a result of the steep terrain and low development density, there are few major overland flow paths with significant concentration of flow, outside of the creek channels. These channels contain most of the catchment runoff even in more severe storms like a 1% Annual Exceedance Probability (AEP) flood event. The most notable flood issues are the Ingleside Road and Powderworks Road crossings at Mullet Creek, which are likely to be overtopped relatively frequently.

The southern part of the mid-catchment comprises the residential area of Elanora Heights, draining primarily to Nareen Creek, while the northern part is remnant bushland, draining to Mullet, Fern and Narrabeen Creeks. The catchment is very steep through these areas, resulting in widespread shallow overland flow, with relatively few concentrated flow paths apart from the creek channels. The most notable flood issues in the mid-catchment area are the corner of Powderworks Road and Elanora Road at the outlet of the Elanora Country Club golf course, and the Ponderosa Parade crossing at Narrabeen Creek.

In the lower reaches of the catchment, flooding is significantly more widespread than in the upper areas of the catchment, due to:

- *flatter topography;*
- *relatively small creek channels with regard to the upper catchment area;*
- *the influence of Warriewood wetlands, and*
- *backwater influences from Narrabeen Lagoon.*

There are large areas of flood storage, subject to significant inundation depths in severe storm events. Flooding of all creeks is out of bank in even relatively small events. The most significant overland flooding in the urbanised catchment areas occurs along the stretches where Nareen Creek is piped, with heavy inundation between Tatiara Crescent and Nareen Parade as well as between Narroy Road and Pittwater Road (although this is exacerbated by the flooding of the wetlands below Nareen Parade).

The 2019 Ingleside, Elanora and Warriewood Overland Flow Flood Study (OFFS) considered overland flooding flows independent of flooding from Narrabeen Lagoon as the two situations can occur independently. The design events investigated include the Probable Maximum Flood (PMF), 0.1%, 0.2%, 0.5%,1%, 2%, 5%, 10% and 20% AEP flood events.

The 1% AEP flood depths in the vicinity of the subject property are plotted in **Figure 3.** The PMF depths are plotted in **Figure 4**. Note the depth filter is 0.15 m.

The effect of climate change on the study area was modelled, in part, as follows (WMAwater, 2019):

- 1% AEP design storm event with a 10% increase or 30% in rainfall plus 0.9 m sea level rise;
- PMF storm event with a 10% or 30% increase in rainfall plus 0.9 m sea level rise;

The impacts of a 30% increase in rainfall on 1% AEP and PMF levels are plotted respectively in **Figures 5** and **6**.

The hazard maps using the Australian Emergency Management Institute (AEMI) classification are presented in **Figures 7** and **8** for the 1% AEP and PMF events respectively.

For this study, hydraulic categories were defined by the following criteria, which correspond in part with the criteria proposed by Howells et al, 2003 (WMAwater, 2019):

- Floodway is defined as areas where:
  - the peak value of velocity multiplied by depth (V x D) > 0.25 m^2/s AND peak velocity > 0.25 m/s, OR
  - peak velocity > 1.0 m/s

The remainder of the floodplain is either Flood Storage or Flood Fringe,

- Flood Storage comprises areas outside the floodway where peak depth > 0.2 m; and
- Flood Fringe comprises areas outside the Floodway where peak depth < 0.2 m.

Hydraulic categories for the 1% AEP and PMF events are displayed on **Figures 9** and **10.**

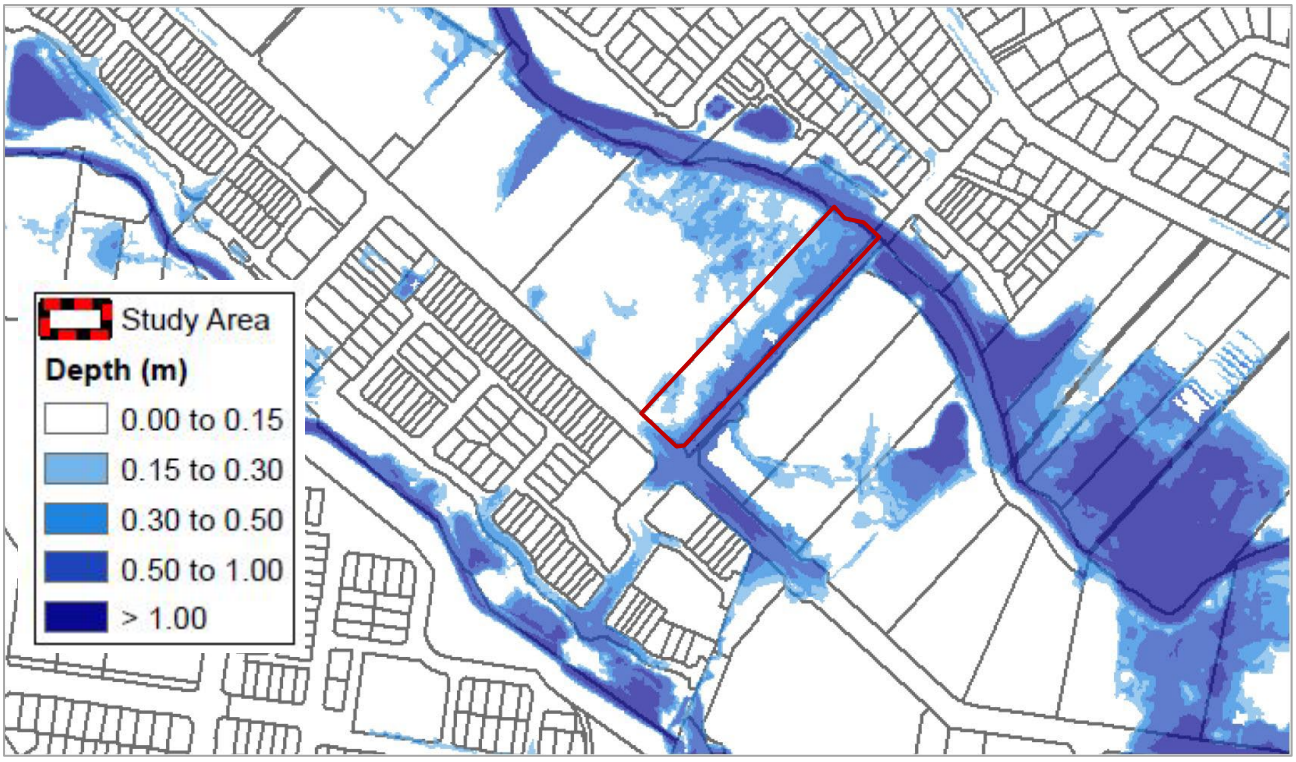


Figure 3 1% AEP Flood Depths (Source: Figure B5, WMAwater, 2019)

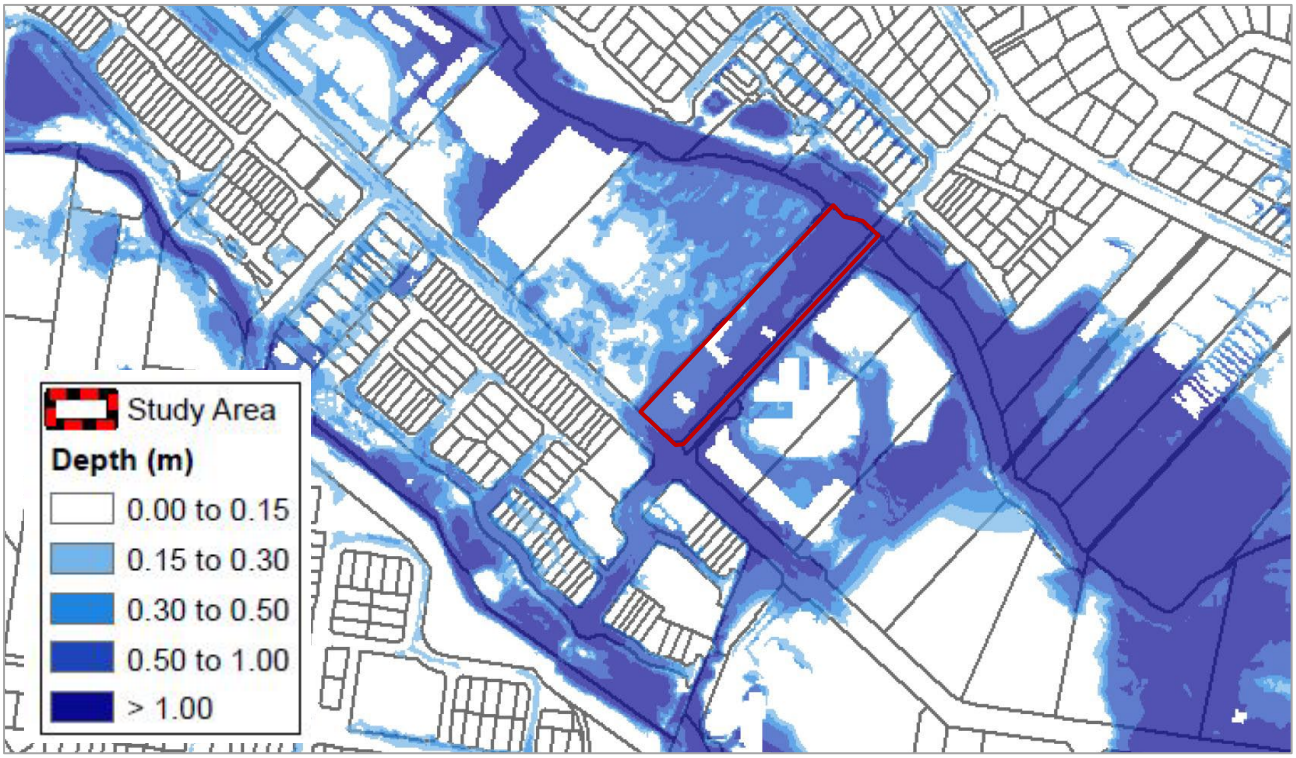


Figure 4 PMF Depths (Source: Figure B9, WMAwater, 2019)

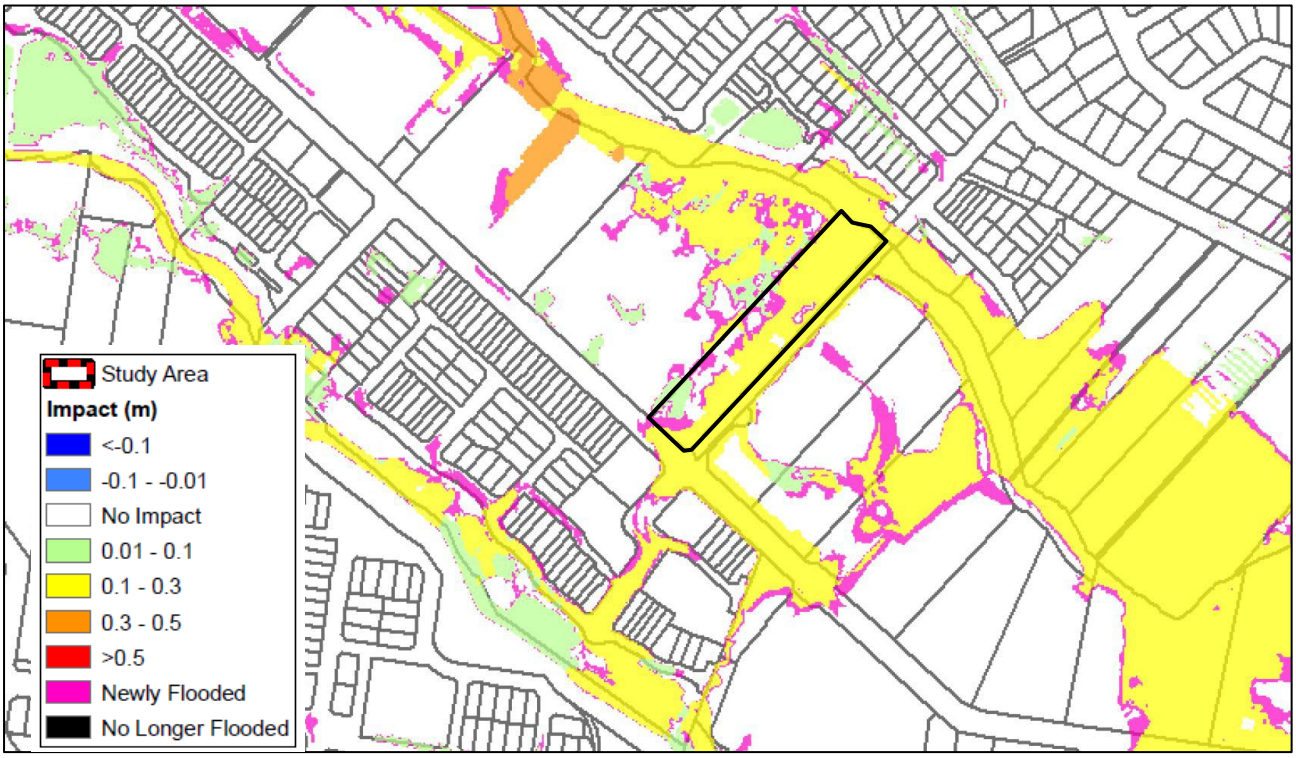


Figure 5 Impact of 30% rainfall Increase on 1% AEP Flood Levels
(Source: Figure D7, WMAwater, 2019)

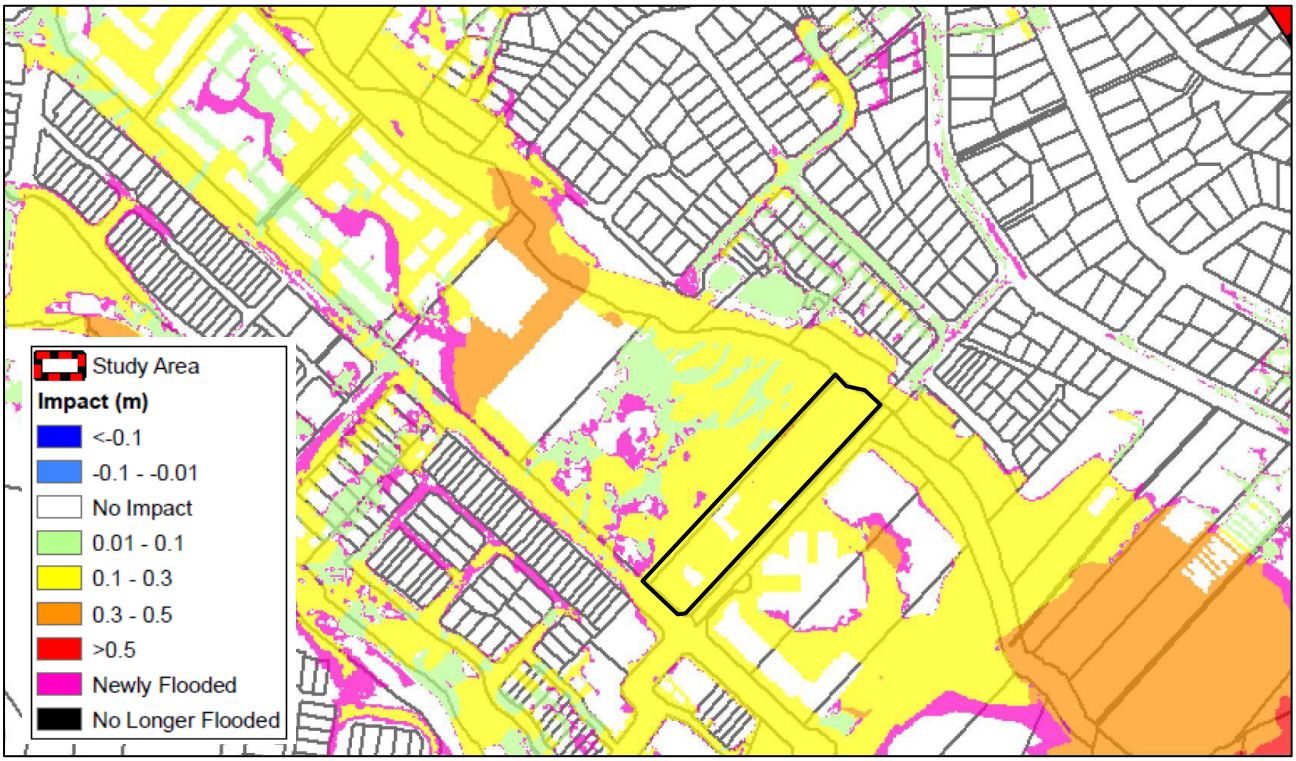


Figure 6 Impact of 30% rainfall Increase on PMF Levels
(Source: Figure D10, WMAwater, 2019)

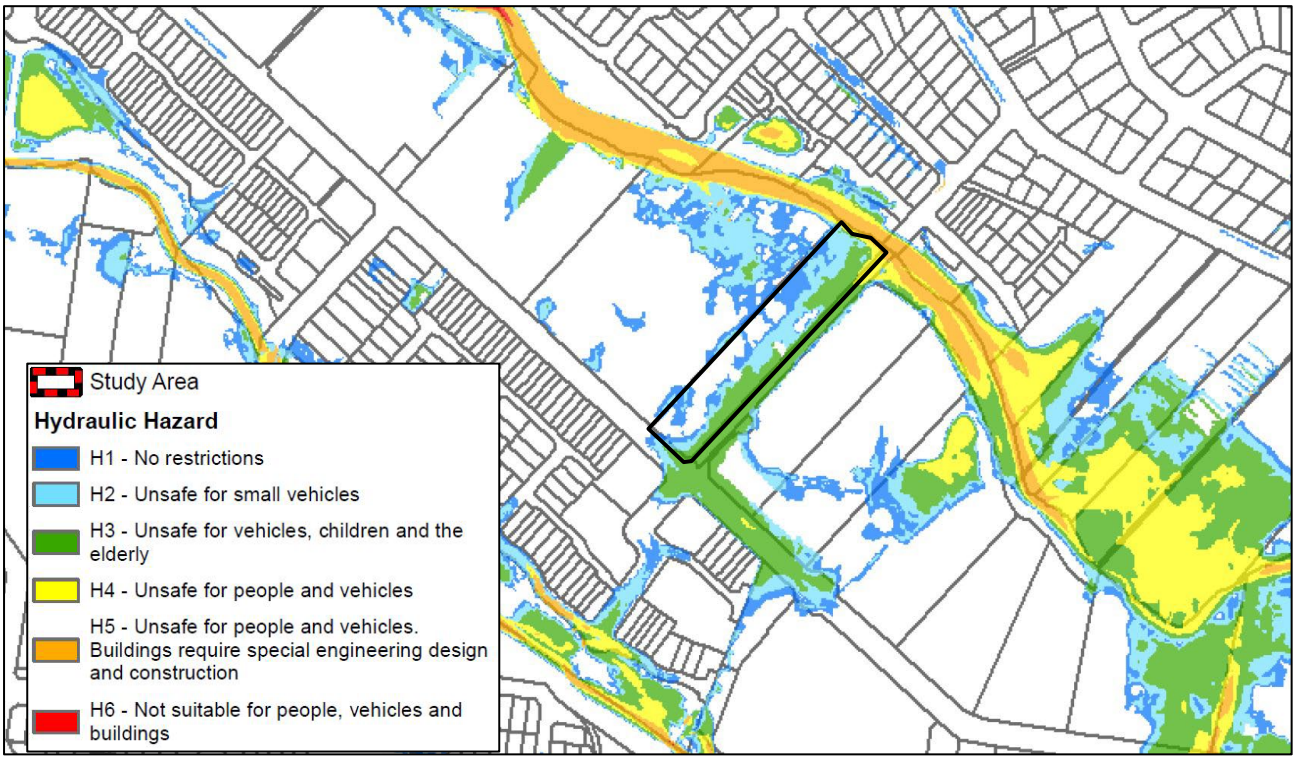


Figure 7 Risk to Life in a 1% Flood (AEMI Hazards)
(Source: Figure B26, WMAwater, 2019)

Figure 8 Risk to Life in a PMF (AEMI Hazards)
(Source: Figure B27, WMAwater, 2019)

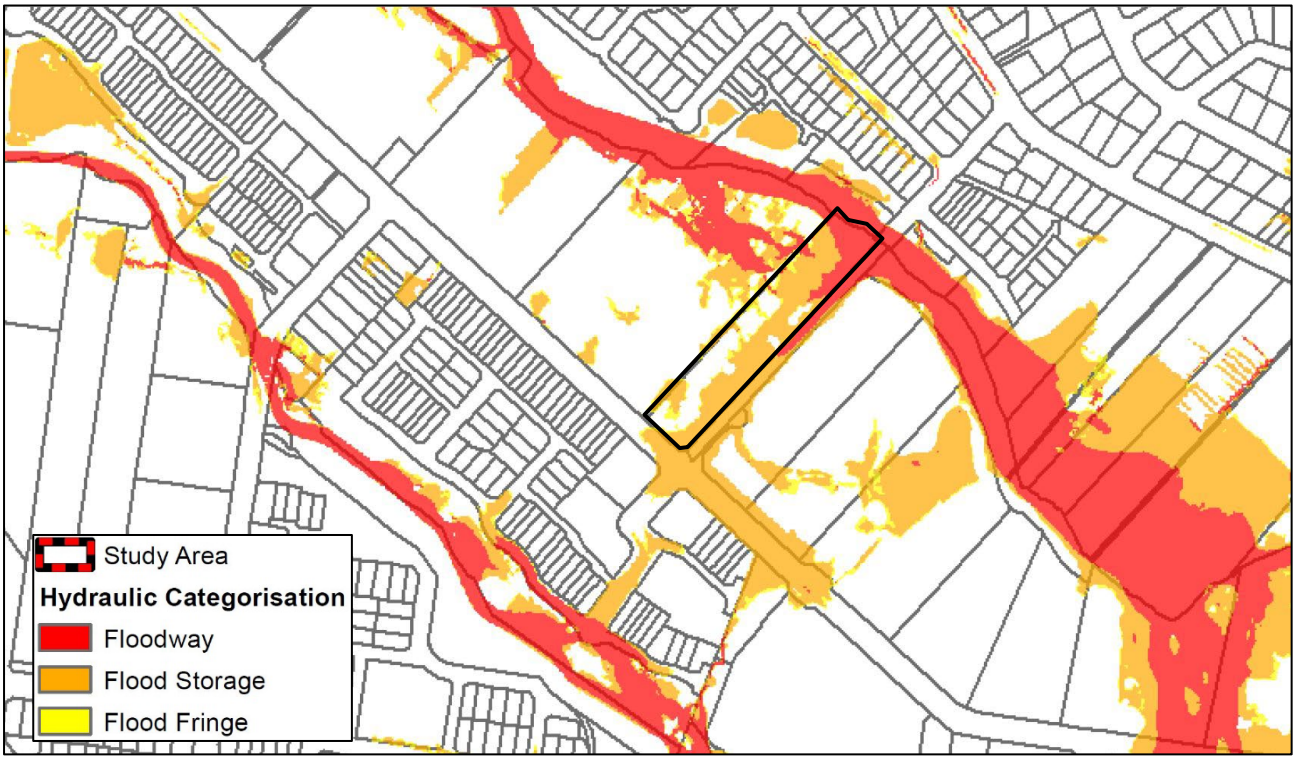


Figure 9 Hydraulic Categories in a 1% AEP Flood
(Source: Figure B24, WMAwater, 2019)

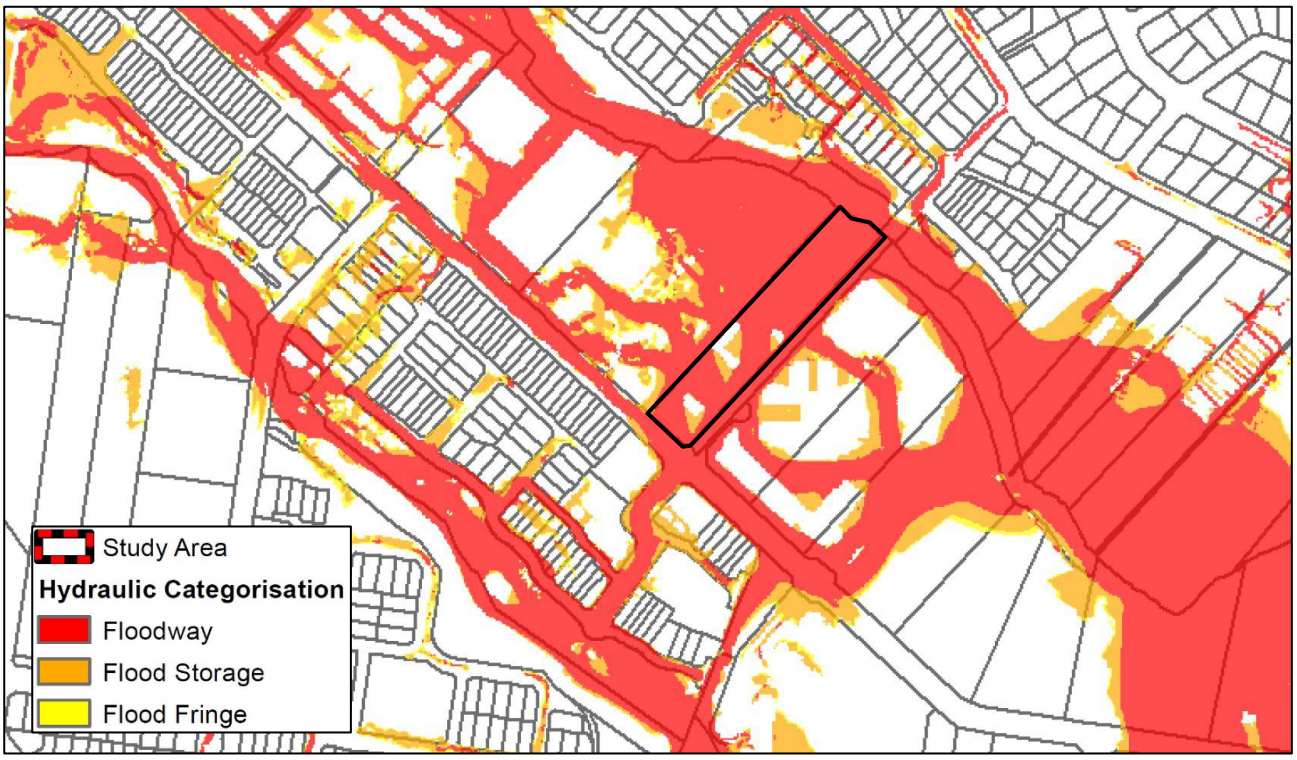


Figure 10 Hydraulic Categories in a PMF
(Source: Figure B25, WMAwater, 2019)

3 Flood Risks

The flood risks experienced on 16 Macpherson Street, Warriewood under current conditions are discussed as follows.

3.1 Flood Information

The comprehensive flood information provided by Council in response to a request is attached in **Appendix E** (refer Attachments E1, E2 and E3 in **Appendix E**).

The flood information is based on the results of the 2019 Ingleside, Elanora and Warriewood Overland Flow Flood Study prepared by WMAwater. This study is overviewed in Section 2.4.

The 2019 study was undertaken prior to the approval and construction of the current housing development on 18 Macpherson Street, Warriewood.

3.2 Benchmark Conditions

The assessment of flooding in the vicinity of the 16 Macpherson Street, Warriewood under Benchmark and Future Conditions was based on the hydrology adopted in the 2019 Ingleside, Elanora and Warriewood OFFS and on a copy of the 2019 floodplain model licensed by Council.

The 2019 study was undertaken prior to the approval and construction of the current housing development on 18 Macpherson Street, Warriewood. Consequently the 2019 floodplain model was modified to create a floodplain model of Benchmark Conditions that are representative of current conditions. The modifications included incorporation of:

- site survey of ground levels across 16 Macpherson Street;
- survey and/or works as executed ground levels for 18 Macpherson Street;
- footprints of houses constructed on 18 Macpherson Street;
- adjusted roughness zones for works undertaken adjacent to the creek on 18 Macpherson Street; and
- minor adjustment of vegetated roughness zones at end of Brands Lane on the northern side of Narrabeen Creek.

Based on the guidance provided by Council (refer Section 1.3.4 and Appendix E) the following events were run under Benchmark Conditions:

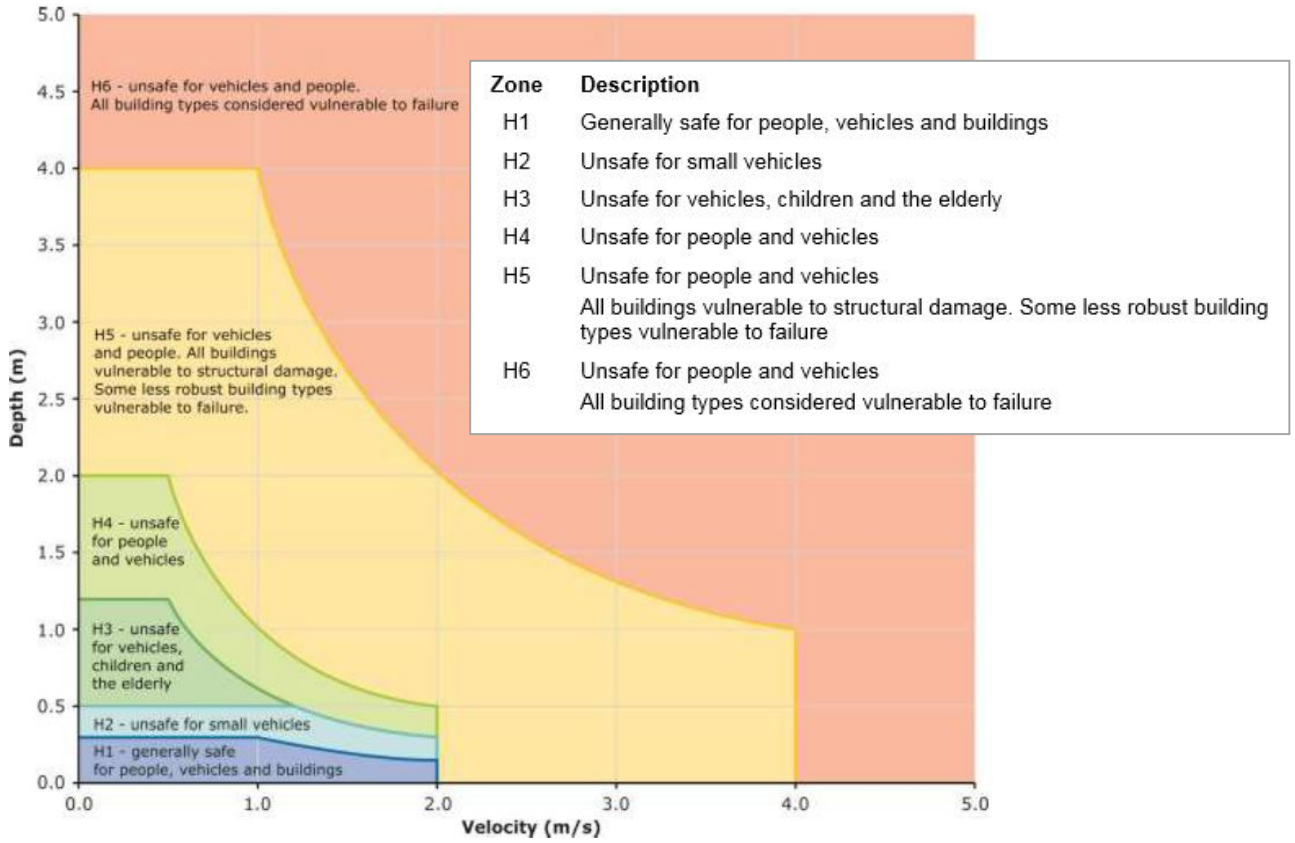
- 50% AEP + 30%CC
- 20%AEP + 30%CC
- 1% AEP
- 1% AEP + 30%CC
- PMF
- PMF + 30%CC

3.2.1 50% AEP + 30%CC

The estimated 50% AEP + 30%CC flood levels and extent, depths and velocities under Benchmark Conditions are plotted respectively in **Figures E1, E2** and **E3** in Appendix A.

The 2013 AEMHS Handbook 7 "Managing the floodplain: a guide to best practice in flood risk management in Australia "*has been developed with consideration of the National strategy for disaster resilience (COAG 2011), and the findings of recent State and national reviews following the multiple flood events of 2010 to 2012 that resulted in widespread flooding. It is intended to provide broad advice on all important aspects in managing flood risk in Australia"*.

The supporting document titled "Technical flood risk management guideline: Flood Hazard" includes a plot of flood hazard vulnerability curves based on six hazard categories H1 – H6 as follows.



The estimated 50% AEP + 30%CC flood hazard categories under Benchmark Conditions are plotted in **Figure E4** in Appendix A.

3.2.2 20%AEP + 30%CC

The estimated 20%AEP +30%CC flood levels and extent, depths, velocities and hazard categories under Benchmark Conditions are plotted respectively in **Figures E5, E6, E7** and **E8** in Appendix A.

3.2.3 1% AEP

The estimated 1%AEP flood levels and extent, depths, velocities and hazard categories under Benchmark Conditions are plotted respectively in **Figures E9, E10, E11** and **E12** in Appendix A.

3.2.4 1% AEP + 30%CC

The estimated 1%AEP + 30%CC flood levels and extent, depths, velocities and hazard categories under Benchmark Conditions are plotted respectively in **Figures E13, E14, E15** and **E16** in Appendix A.

3.2.5 PMF

The estimated PMF levels and extent, depths, velocities and hazard categories under Benchmark Conditions are plotted respectively in **Figures E17, E18, E19** and **E20** in Appendix A**.**

3.2.6 PMF + 30%CC

The estimated PMF + 30%CC levels and extent, depths, velocities and hazard categories under Benchmark Conditions are plotted respectively in **Figures E21, E22, E23**and **E24** in Appendix A**.**

3.3 Flood Risk Precincts

The Flood Risk Precincts mapped by Council in the vicinity of the subject site are shown in **Figure 2.** Council has mapped almost all of the subject property as Medium Risk with High Risk encroaching into the property along the creekline.

3.4 Flood Planning Levels

The comprehensive flood information provided by Council in response to a request which is attached in **Appendix E** including Flood Planning Levels which are based on conditions prior to the approval and construction of the current housing development on 18 Macpherson Street, Warriewood.

Based on the 1%AEP + 30%CC flood levels estimated under Benchmark Conditions, the Flood Planning Levels were updated as set out in **Appendix F**.

3.5 Risk to Life

The variation of the indicative velocity and depth at Locations P6, P7 and P8 (refer **Figure 11**) during the six floods that have been assessed in comparison to the hazard zones are plotted respectively in **Figures 12, 13** and **14** respectively.

It is noted from **Figure E16** that in a 1% AEP + 30%CC flood the flood hazard category varies across the property from no hazard to H1, H2, H3 and H4 across the northern end of the property.

It is noted from **Figure E24** that in a PMF + 30%CC flood the flood hazard category varies across the property from H3 to H4 to H5.

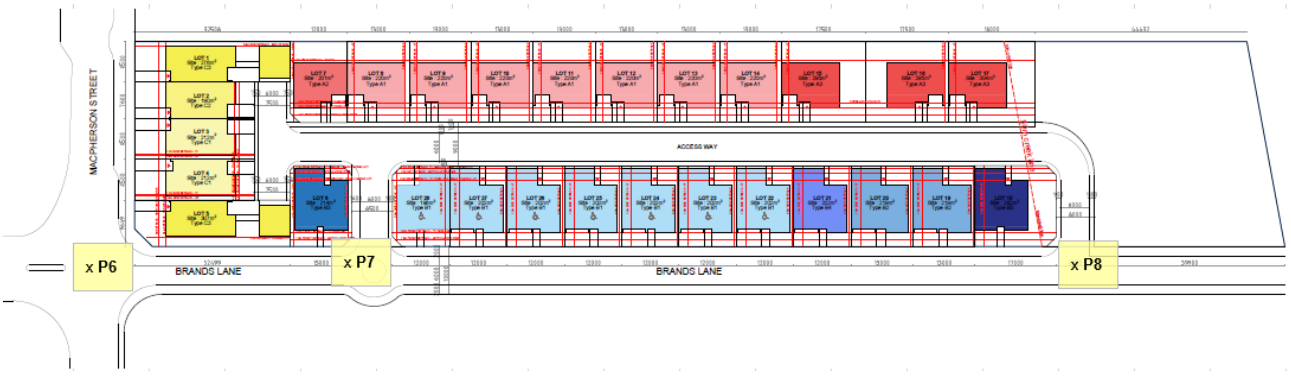


Figure 11 Reference Locations P6, P7 and P8

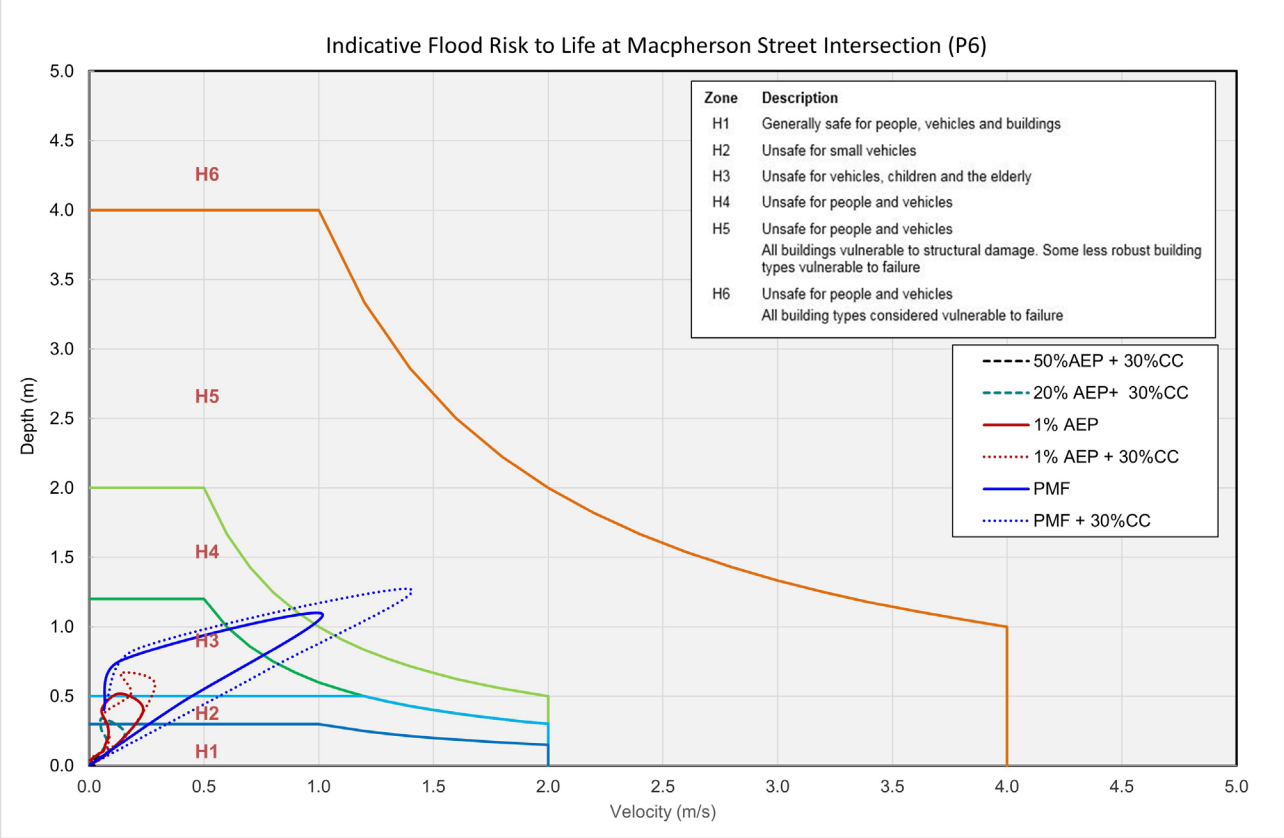


Figure 12 Variations in Flood Risk to Life with Flood Severity at Location P6

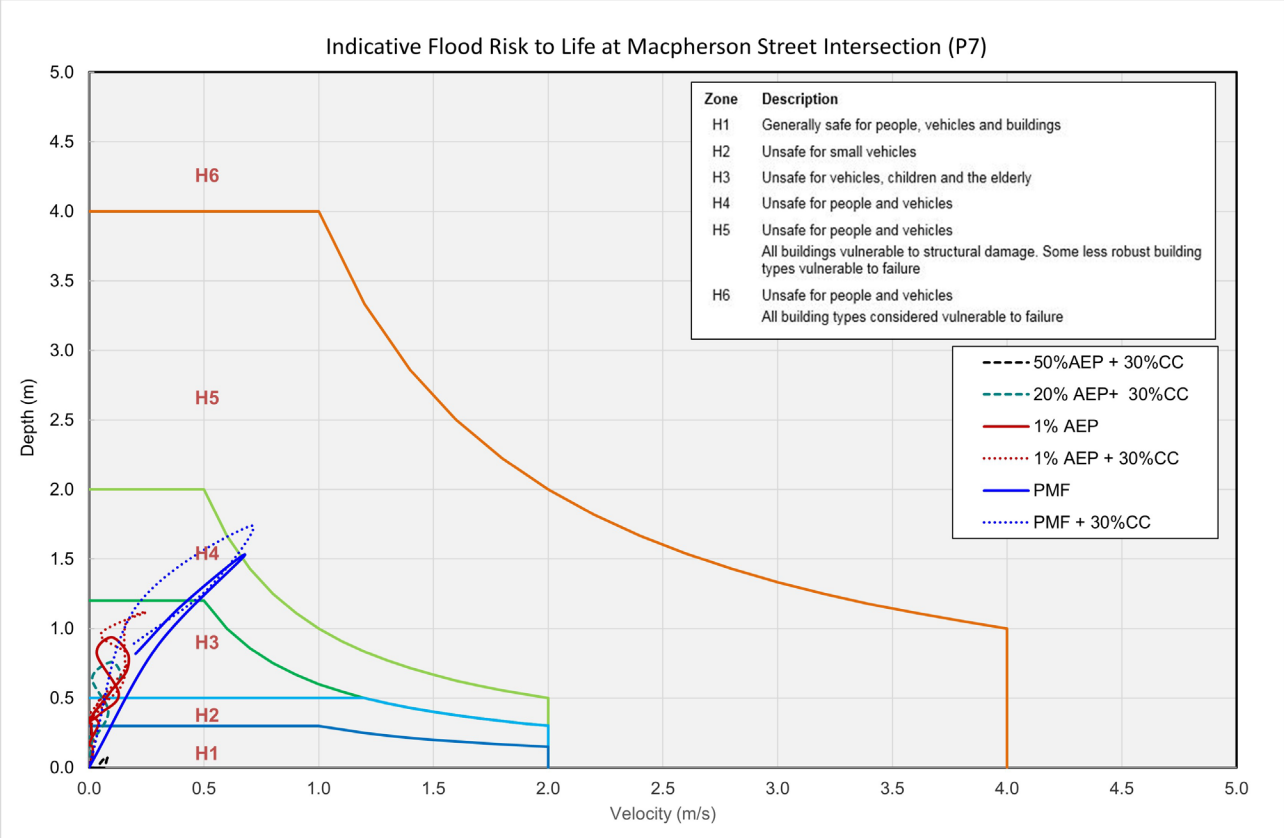


Figure 13 Variations in Flood Risk to Life with Flood Severity at Location P7

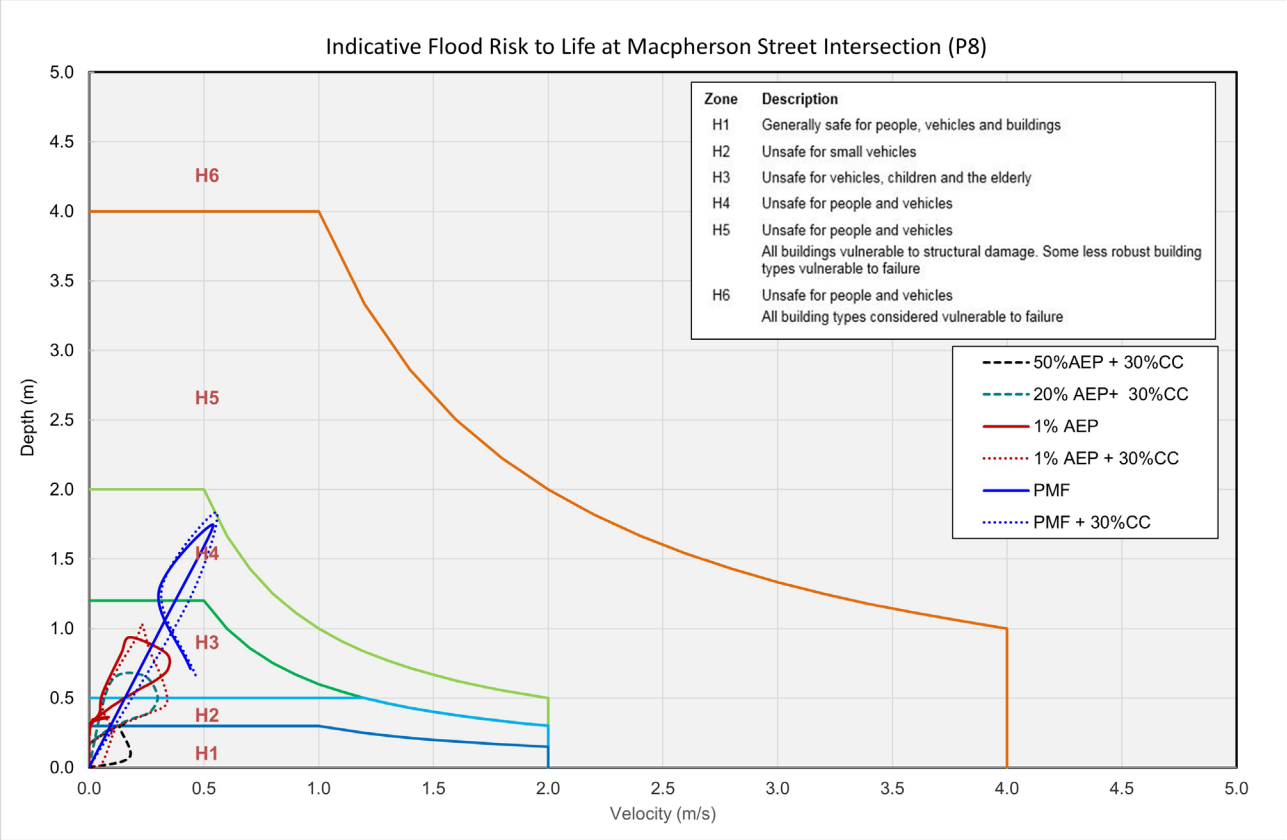


Figure 14 Variations in Flood Risk to Life with Flood Severity at Location P8

3.6 Warning Times and Periods of Isolation

The available warning times and duration of isolation will be governed not by inundation within the proposed development but rather by flooding in Brands Lane and Macpherson Street which will curtail vehicular entry or exit from the site due to the development of unsafe conditions for small and large vehicles. The western access road connection to the Brands Lane roundabout would be the preferred entry and exit from the site during floods.

Table 1 summarises the time it takes from the onset of a major storm for unsafe conditions to develop at Locations P6, P7 and P8 (refer Figure 11) for small vehicles and 4WD vehicles.

Table 1 Available Warning Time and Periods of Isolation

Warning Times at Location P6 from start of Storm

	Unsafe for Small Vehicles		Unsafe for Large Vehicles	
Flood	(mins)	(hrs)	(mins)	(hrs)
50% AEP + 30%CC				
20% AEP + 30%CC	295	4.92		
1% AEP	280	4.67	300	5.00
1% AEP + 30%CC	275	4.58	280	4.67
PMF	10	0.17	15	0.25
PMF + 30%CC	7	0.12	10	0.17

Duration of Isolation due to Unsafe Vehicular Conditions at Location P6

	Unsafe for Small Vehicles		Unsafe for Large Vehicles	
Flood	(mins)	(hrs)	(mins)	(hrs)
50% AEP + 30%CC				
20% AEP + 30%CC	15	0.25		
1% AEP	50	0.83	5	0.08
1% AEP + 30%CC	65	1.08	35	0.58
PMF	55	0.92	40	0.67
PMF + 30%CC	63	1.05	50	0.83

Trafficable at all times

Warning Times at Location P7 from start of Storm

	Unsafe for Small Vehicles		Unsafe for Large Vehicles	
Flood	(mins)	(hrs)	(mins)	(hrs)
50% AEP + 30%CC				
20% AEP + 30%CC	260	4.33	275	4.58
1% AEP	175	2.92	265	4.42
1% AEP + 30%CC	110	1.83	250	4.17
PMF	5	0.08	10	0.17
PMF + 30%CC	5	0.08	10	0.17

Duration of Isolation due to Unsafe Vehicular Conditions at Location P7

	Unsafe for Small Vehicles		Unsafe for Large Vehicles	
Flood	(mins)	(hrs)	(mins)	(hrs)
50% AEP + 30%CC				
20% AEP + 30%CC	220	3.67	85	1.42
1% AEP	340	5.67	125	2.08
1% AEP + 30%CC	455	7.58	175	2.92
PMF	85	1.42	70	1.17
PMF + 30%CC	90	1.50	75	1.25

Trafficable at all times

Warning Times at Location P8 from start of Storm

	Unsafe for Small Vehicles		Unsafe for Large Vehicles	
Flood	(mins)	(hrs)	(mins)	(hrs)
50% AEP + 30%CC	315	5.25		
20% AEP + 30%CC	275	4.58	275	
1% AEP	175	2.92	270	4.50
1% AEP + 30%CC	195	3.25	270	4.50
PMF	5	0.08	7	0.12
PMF + 30%CC	5	0.08	7	0.12

Duration of Isolation due to Unsafe Vehicular Conditions at Location P8

	Unsafe for Small Vehicles		Unsafe for Large Vehicles	
Flood	(mins)	(hrs)	(mins)	(hrs)
50% AEP + 30%CC	40	0.67		
20% AEP + 30%CC	110	1.83	45	0.75
1% AEP	335	5.58	115	1.92
1% AEP + 30%CC	235	3.92	70	1.17
PMF	65	1.08	58	0.97
PMF + 30%CC	65	1.08	58	0.97
		Trafficable at all times		

The conditions encountered at the Brands Lane roundabout during floods and the impact on emergency access to or from the site are summarised as follows:

- It is expected that the roundabout would be trafficable at all times in events up to a 50% + 30%CC event (equivalent to a 20% AEP flood at this time);
- In events from the 20% AEP + 30%CC event up to the 1% AEP + 30%CC event the available time from the commencement of the storm burst until it becomes unsafe for small vehicles at the roundabout reduces from around 4 hours to around 2 hours;
- In the case of large vehicles the available time remains around 4 hours in these events;
- In events from the 20% AEP + 30%CC event up to the 1% AEP + 30%CC event if emergency access to or from the site is by small vehicles only then the period of isolation increases from greater than 3 hours to greater than 7 hours; however if emergency access to or from the site is by large vehicles then the period of isolation reduces to less than 3 hours;
- In the case of extreme floods (PMF and PMF + 30%CC) the onset of unsafe conditions is extremely rapid and less than 10 mins.
- In the case of extreme floods (PMF and PMF + 30%CC) the period of isolation is no more than 1.5 hours.

4 Flood Impact Assessment

Considerable options testing was undertaken to arrive at the preferred development layout and levels. The various measures which were assessed included:

(i) Various creek profiles including a complying profile, a profile to maximse flood storage and a profile with intermediate flood storage;

(ii) An additional culvert to reduce the 20%AEP+30%CC impacts in Macpherson St and Brands Lane;

(iii) A culvert branch connecting to the additional culvert to reduce PMF + 30%CC impacts in the eastern laneway on 18 Macpherson Street;

(iv) A second culvert conveying overland flow from the eastern laneway on 18 Macpherson St to the Brands Lane roundabout to reduce PMF + 30%CC impacts in the eastern laneway on 18 Macpherson St;

(v) A short wall to locally reduce spill of floodwaters from the creek corridor along the rear (northern) boundary in PMF + 30%CC

(vi) Lowering of the internal road to create a shallow flowpath in the PMF + 30%CC event;

(vii) A corridor through from the rear (northern) boundary to the internal road that matches the eastern laneway on 18 Macpherson to reduce PMF + 30%CC impacts.

The various combinations of measures that were assessed are summarised in **Table 2**.

Table 2 Combinations of Measures assessed to limit Flood Impacts

Scenario	Summary Description
Des01	Concept development ground levels with subject property
Des02	Des01 with roughness updated - complying creek profile
Des03	Updated design with lowered creek profile -maximised flood storage profile
Des04	Adjusted creek profile – flood storage reduced from Des03
Des04a	Des04 + Additional culvert to reduce the 20%AEP+30%CC impacts
Des04b	Des04a + Additional culvert branch + wall
Des04c	Des04a + Second culvert + short wall
Des05	Des02 + Additional culvert to reduce the 20%AEP+30%CC impacts
Des05b	Des05 + Additional culvert branch + short wall
Des05c	Des05 + Second culvert + short wall
Des06	Des02+ Lowered internal road
Des07	Des02 + a corridor through to the internal road that matches the eastern laneway on 18 Macpherson St
Des07a	Des07 + Additional culvert to reduce the 20%AEP+30%CC impacts
Des08	Des02 + Des06 + Des05+ Des07
Des09	Des07 but with a 2m gap between the buildings as an alternative to the eastern laneway

4.1 Future Conditions

Based on the outcomes of the various assessments the preferred development layout and levels was based on Des07A in combination with final grading of the site and incorporation of stormwater management measures.

The assessment of flooding under Future Conditions was undertaken by modifying the TUFLOW model of Benchmark Conditions to represent the planned development as described in the plans attached in **Appendix G**.

4.1.1 50%AEP + 30%CC

The estimated 50%AEP +30%CC flood levels and extent, depths, velocities and hazard categories under Future Conditions are plotted respectively in **Figures F1, F2, F3** and **F4** in Appendix B.

4.1.2 20%AEP + 30%CC

The estimated 20%AEP +30%CC flood levels and extent, depths, velocities and hazard categories under Future Conditions are plotted respectively in **Figures F5, F6, F7** and **F8** in Appendix B.

4.1.3 1% AEP

The estimated 1%AEP flood levels and extent, depths, velocities and hazard categories under Benchmark Future are plotted respectively in **Figures F9, F10, F11** and **F12** in Appendix B.

4.1.4 1% AEP + 30%CC

The estimated 1%AEP + 30%CC flood levels and extent, depths, velocities and hazard categories under Future Conditions are plotted respectively in **Figures F13, F14, F15** and **F16** in Appendix B.

4.1.5 PMF

The estimated PMF levels and extent, depths, velocities and hazard categories under Future Conditions are plotted respectively in **Figures F17, F18, F19** and **F20** in Appendix B**.**

4.1.6 PMF + 30%CC

The estimated PMF + 30%CC levels and extent, depths, velocities and hazard categories under Future Conditions are plotted respectively in **Figures F21, F22, F23**and **F24** in Appendix B**.**

4.2 Flood Impacts

When considering the flood impacts assessed under the four climate change events it should be noted that the likelihood that these events would be experienced under current day conditions is lower than suggested by the AEP of the event. This was assessed by determining the severity of the design rainfall intensities which were increased by 30%. Conversely, the timeframe over which the design rainfall intensities might increase by 30% was assessed by extrapolating the climate change increases advised by the ARR2019 Datahub under RCP4.5 and RCP8.5 scenarios. It was estimated that under RCP8.5 that a 30% increase may occur over the next 110 years while under RCP4.5 it would take around 5,000 years to achieve a 30% increase.

The likelihood of the flood events that have been assessed are summarised for these two scenarios in **Table 3**.

Table 3 Estimated Likelihood of four Climate Change Events Now and in the Future

Flood	Estimated Current Likelihood	1 in X AEP	Likelihood in 110 years to 5,000 years time	1 in X AEP
50%AEP + 30%CC	19%	5.2	50%	2
20%AEP + 30%CC	6%	18	20%	5
1%AEP + 30%CC	0.11%	871	1%	100
PMF + 30%CC	0.0000025%	40,000,000	0.000010%	10,000,000

4.2.1 Flood Level Impacts

The estimated impacts of the proposed development on 50%AEP + 30%CC, 20%AEP + 30%CC, 1%AEP + 30%CC and PMF + 30%CC flood levels (in comparison to Benchmark Conditions) are plotted in respectively **Figures D1, D2, D3** and **D6**.

The flood levels and flood level differences at Locations P1, P2, P3, P4, P5 and P6 (refer **Figure 15**) during the six floods that have been assessed are summarised in **Table 4.**

Figure 15 Reference Locations P1 - P6

Table 4 Flood Levels and Differences at Selected Locations

	Benchmark			Future		
Location	Ground Level	Flood Level (m AHD)	Depth (m)	Flood Level (m AHD)	Difference (m)	Depth (m)
50% AEP + 30%CC						
P1	6.48	-		-		
P2	4.70	-		-		
P3	5.45	-		-		
P4	5.15	-		-		
P5	4.70	-		-		
P6	4.71	4.81	0.10	4.73	-0.08	0.02
20% AEP + 30%CC						
P1	6.48	-		-		
P2	4.70	5.05	0.35	5.02	-0.03	0.32
P3	5.45	-		-		
P4	5.15	-		-		
P5	4.70	-		-		
P6	4.71	5.08	0.37	5.03	-0.05	0.32
1% AEP						
P1	6.48	-		-		
P2	4.70	5.24	0.54	5.22	-0.02	0.52
P3	5.45	-		-		
P4	5.15	-		-		
P5	4.70	-		-		
P6	4.71	5.25	0.54	5.22	-0.03	0.51
1% AEP + 30%CC						
P1	6.48	-		-		
P2	4.70	5.47	0.77	5.44	-0.03	0.74
P3	5.45	-		-		
P4	5.15	-		-		
P5	4.70	-		-		
P6	4.71	5.41	0.70	5.36	-0.05	0.65
PMF						
P1	6.48	6.78	0.30	6.80	0.02	0.32
P2	4.70	6.04	1.34	6.03	-0.01	1.33
P3	5.45	5.66	0.21	5.73	0.07	0.28
P4	5.15	5.42	0.27	5.48	0.06	0.33
P5	4.70	5.26	0.56	5.30	0.04	0.60
P6	4.71	5.83	1.12	5.77	-0.06	1.06
PMF + 30%CC						
P1	6.48	6.93	0.45	6.92	-0.01	0.44
P2	4.70	6.27	1.57	6.28	0.01	1.58
P3	5.45	5.90	0.44	5.97	0.07	0.52
P4	5.15	5.61	0.46	5.67	0.06	0.52
P5	4.70	5.47	0.77	5.51	0.04	0.81
P6	4.71	6.02	1.31	5.94	-0.08	1.23

Figure D1 discloses that the proposed development reduces 50% AEP + 30%CC flood levels in Brands Lane and Macpherson Street while there is a small area of local increases located within the creekline corridor adjacent to the property. **Figure D2** discloses that the proposed development reduces 20% AEP + 30%CC flood levels in Brands Lane and Macpherson Street while there are areas of local increases located within the creekline corridor adjacent to the property.

Figure D3 discloses that the proposed development reduces 1% AEP + 30%CC flood levels in Brands Lane and Macpherson Street and through 6-14 Macpherson Street. There are local increases located within the creekline corridor adjacent to the property as well as a zone of local increases that are slightly greater than 0.02 m located within the creek corridor downstream of Brands Lane. There is also a small area of local increases greater than 0.05 m just downstream of Brands Lane. These local increase within the creek corridor do not adversely impact on any existing dwellings.

Figure D6 discloses that the proposed development reduces PMF + 30%CC flood levels in Brands Lane and Macpherson Street, through 6-14 Macpherson Street and in Fantail Avenue, Possum Way, Bandicoot Close and Ghania Drive by more than 0.05 m. There are local increases less than 0.05 m located within the creekline corridor downstream of Brands Lane as well as a zone of local increases that are slightly greater than 0.05 m within the creek corridor downstream of Brands Lane. As indicated in Table 4 these increases are around 0.06 – 0.07 m in the vicinity of existing dwellings. There is also a very small area of greater local increase downstream of Brands Lane. Given the probability of a PMF + 30%CC flood at this time (1 in 40,000,000 AEP) these local impacts of greater than 0.05 m within the creek corridor are considered to be negligible.

It is concluded that the proposed development has a negligible adverse impact on 50%AEP + 30%CC, 20%AEP + 30%CC, 1%AEP + 30%CC and PMF + 30%CC flood levels.

4.2.2 Flood Velocity Impacts

The estimated impacts of the proposed development on 1%AEP + 30%CC and PMF + 30%CC flood velocities (in comparison to Benchmark Conditions) are plotted in respectively **Figures D4, D5, D7** and **D8**.

In the case of the 1%AEP + 30%CC the change in velocities (in m/s) are mapped in **Figure D4** while the change in velocities (in %) are mapped in **Figure D5**. **Figure D5** identifies increase that exceed 10% primarily in Brands Lane and at the intersection with Macpherson Street with scattered impacts elsewhere. **Figures E15** and **F15** disclose that while the velocity increases in Brands Lane the peak velocity remains below 1 m/s. These velocity are not of concern in relation to scour.

In the case of the PMF + 30%CC the change in velocities (in m/s) are mapped in **Figure D7** while the change in velocities (in %) are mapped in **Figure D8**. **Figure D8** identifies increase that exceed 10% within the subject property and primarily in Brands Lane and within a section of Macpherson St with scattered impacts elsewhere.

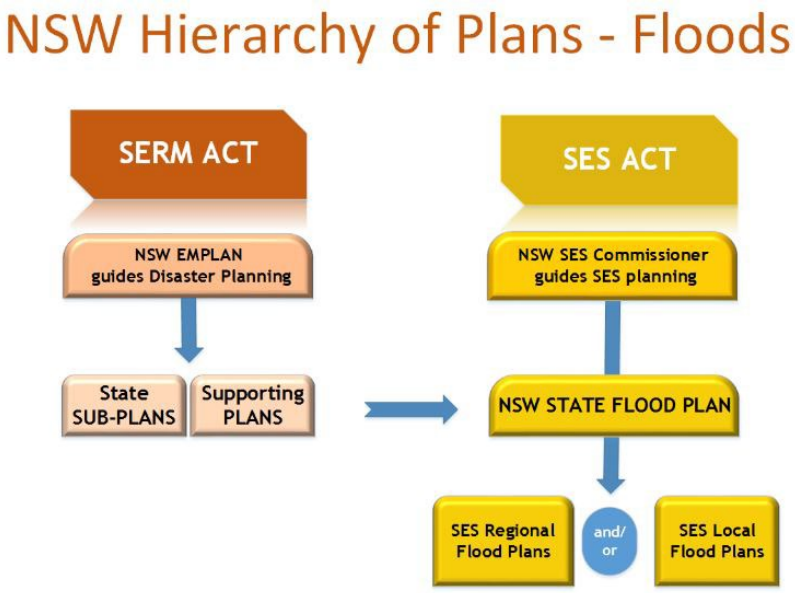
Figure E23 discloses that velocities exceed 1m/s extensively throughout the locality, including in the creek corridor, Macpherson Street and parts of Brands Lane under Benchmark Conditions. **Figure F23** discloses that the area on Brands Lane where velocities exceed 1m/s increases under Future Conditions. While the increase in velocity to parts of Brands Lane may be of possible concern in relation to scour, it is no more so than elsewhere in the locality, including the creek corridor and Macpherson Street under both Benchmark and Future Conditions and for this reason the exceedances above the DCP impact criterion are considered minor and acceptable.

4.2.3 Flood Storage

The flood storage calculations were based on the 1% AEP + 30%CC flood levels. The calculated flood storage volumes under Benchmark Conditions and Future Conditions respectively were 5,482 m^3 and 3,763 m^3.

5 Emergency Planning

The hierarchy of plans which guide the planning for floods in NSW is as follows:



5.1 2017 NSW State Flood Plan

The NSW State Flood Plan is a sub plan of the State Emergency Management Plan (EMPLAN) (NSW Government, 2017). It has been prepared in accordance with the provisions of the State Emergency Service Act 1989 (NSW) and is authorised by the State Emergency Management Committee in accordance with the provisions of the State Emergency and Rescue Management Act 1989 (NSW).

The latest plan was provisionally endorsed by the State Emergency Management Committee at Meeting 107 held on 5 December 2017.

The purpose of this plan is to set out the arrangements for the emergency management of flooding in New South Wales

As described by the Plan:

> *The Plan sets out the emergency management aspects of prevention; preparation; response and initial recovery arrangements for flooding and the responsibilities of individuals, agencies and organisations with regards to these functions.*
>
> *The Plan recognises the existence of the problem of coastal inundation and erosion caused by severe weather. The management system for dealing with episodes of coastal erosion is described in the New South Wales State Storm Plan.*
>
> *The Plan recognises the existence of the threat posed by tsunami to NSW coastal communities. The arrangements for the emergency management of tsunami are contained within the State Tsunami Emergency Sub Plan.*

This Plan is intended to be read in conjunction with:

(a) The New South Wales State Emergency Management Plan (EMPLAN), of which the State Flood Sub Plan is a sub-plan;
(b) The New South Wales State Storm Plan, which covers arrangements relating to severe storm events; and
(c) NSW Floodplain Development Manual.

5.2 North West Metropolitan Regional Emergency Management Plan

The North West Metropolitan Regional Emergency Management Plan dated May 2018 was prepared by the North West Metropolitan Regional Emergency Management Committee in compliance with the State Emergency & Rescue Management Act 1989.

The purpose of the plan is to detail *arrangements for, prevention of, preparation for, response to and recovery from emergencies within the Emergency Management Region covered by this plan.*

It encompasses arrangements for:

- *emergencies controlled by combat agencies;*
- *emergencies controlled by combat agencies and supported by the Regional Emergency Operations Controller (REOCON);*
- *emergency operations for which there is no combat agency;*
- *circumstances where a combat agency has passed control to the REOCON; and,*
- *demobilisation and transition of control from response to recovery.*

The objectives of this plan are to:

- *support Local Emergency Management Plans (EMPLANs) and augment them when required;*
- *identify trigger points for regional level activation, escalation and demobilisation;*
- *define participating organisation and Functional Area roles and responsibilities in preparation for, response to and recovery from emergencies;*
- *set out the control, co-ordination, support and liaison arrangements at the Regional level;*
- *detail activation and alerting arrangements for involved agencies at the Regional level; and*
- *detail arrangements for the acquisition and co-ordination of resources at the Regional level.*

The plan describes the arrangements at Regional level to prevent, prepare for, respond to and recover from emergencies and also provides policy direction for the preparation of Sub Plans and Supporting Plans. Further:

- *This plan relies on effective implementation of the Governance framework for Emergency Management;*
- *Arrangements detailed in this plan are based on the assumption that the resources upon which the plan relies are available when required; and*
- *The effectiveness of arrangements detailed in this plan are dependent upon all involved agencies preparing, testing and maintaining appropriate internal instructions, and/or standing operating procedures ……*

The following Local Government Areas are within North West Metropolitan Region: Blacktown, Blue Mountains, City of Parramatta, Hawkesbury, Hornsby, Hunters Hill, Ku Ring Gai, Lane Cove, Mosman, Northern Beaches, North Sydney, Ryde, Penrith, The Hills and Willoughby

5.3 Northern Beaches Local Emergency Management Plan

The Northern Beaches Local Emergency Management Plan dated March 2021 details arrangements for, prevention of, preparation for, response to and recovery from emergencies within the Local Government Area(s) covered by the plan.

It encompasses arrangements for.

- *emergencies controlled by combat agencies;*
- *emergencies controlled by combat agencies and supported by the Local Emergency Operations Controller (LEOCON);*
- *emergency operations for which there is no combat agency; and*
- *circumstances where a combat agency has passed control to the LEOCON……*

There are four main types of flood risks, varying by location type, which may require emergency evacuation and road closures.

- *Overland flow (flash flooding) risk from large rain events is present in urbanised areas with high impervious surfaces and steeper terrain which concentrate water flows, such as Mona Vale, Avalon, Newport, Brookvale, Beacon Hill, Forestville, Davidson and Belrose.*
- *Mainstream creek and lagoon flood risk from large rain events is present in low lying (floodplain) suburbs, often in areas associated with coastal lagoons and wetlands, such as Warriewood, Narrabeen Lagoon, South Creek (including Cromer), Dee Why Lagoon, Curl Curl Lagoon, and Manly Lagoon. A number of key arterial roads including Wakehurst Parkway, Condamine Street and Pittwater Road are flood affected and require specific consideration regarding closure and traffic diversion.*
- *Ocean inundation from large storm events may coincide with high rainfall and will be present in similar locations as mainstream lagoon flooding described above.*
- *Tidal inundation risk from increased ocean levels is possible within open waterways such as Pittwater and Middle Harbour, potentially affecting foreshore properties.*

5.4 Northern Beaches Flood Emergency Sub Plan

The Northern Beaches Flood Emergency Flood Plan is a Sub Plan of the Local Emergency Management Plan (EMPLAN) which was endorsed by the Northern Beaches Emergency Management Committee on the 26th April 2021

The purpose of this plan is to set out the multi-agency arrangements for the emergency management of flooding in the Northern Beaches Council LGA

As described, in part, in the Plan:

1.4.3 The Plan sets out the local emergency management arrangements for prevention, preparation, response and initial recovery for flooding in the Northern Beaches Council LGA. An Overview of the Flood Hazard and Risk information can be found under Section 2 of this document.

1.4.4 In this plan a flood is defined as a relatively high water level which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves (including tsunami) overtopping coastline defences.

3.4 Development of Warning Systems

Strategy

3.4.1 Develop, maintain, and prepare systems for the provision of flood warnings and associated warning services.

Actions

a. All levels of government work in partnership to develop and maintain flood warning infrastructure.

b. NSW SES maintains a list of the requirements for flood warnings for flood gauges in NSW (including flood classifications, warning times required and key statistics) and can be found in the supplementary document to the State Flood Plan (see Section 1.8).

c. The NSW SES will recommend new warning services and changes to warning alert levels for gauges to the NSW Flood Warning Consultative Committee.

d. The State Government, in partnership with Local Government, is responsible for developing and maintaining flash flood warning systems for local catchments where required.

e. MHL hosts and maintains an online flood information system for the LGA on behalf of the Northern Beaches Council.

f. Dam Owners will provide Dam Failure Warning Systems (where required) and consult NSW SES on alert levels and messaging. Alert level definitions are listed in Dam Safety Emergency Plans.

g. NSW SES will maintain through State Operations Centre a dedicated dam failure hotline and procedures to ensure priority dissemination of dam failure warnings; and

h. NSW SES will develop and maintain warning and flood information products by:

- *Utilising flood intelligence data.*
- *Developing pre-written warning and flood information products.*
- *Continuously reviewing warning and flood information products; and*
- *Consulting with affected communities, key stakeholders, the Dam Safety Committee, and the NSW Flood Warning Consultative Committee; and Operational Readiness*

4 RESPONSE

4.1 Introduction

4.1.1 Flood response operations will begin:

a. On receipt of a Bureau Severe Weather Warning or Thunderstorm Warning that includes heavy rain or storm surge; or

b. On the receipt of a Bureau Flood Watch or Flood Warning; or

c. On receipt of warnings for flash flood; or

d. On receipt of a dam failure alert; or

e. When other evidence leads to an expectation of flooding.

4.4 Provision of Information and Warnings to the Community

Strategy

4.4.1 Timely and effective warnings are distributed to the community.

Actions

a. The Bureau issues public weather and flood warning products before and during a flood. These may include:

- *Severe Thunderstorm Warnings with reference to heavy rainfall*
- *Regional Severe Thunderstorm Warnings with reference to heavy rainfall*
- *Detailed Severe Thunderstorm Warnings (for Sydney / Newcastle / Wollongong) with reference to heavy rainfall,*
- *Severe Weather Warnings with reference to heavy rainfall and/or storm surge,*
- *Flood Watches, and*
- *Flood Warnings.*

b. Northern Beaches Council uses the established Northern Beaches flood Information System (provided by MHL) to provide information to NSW SES, key stakeholders, and the community. MHL hosts and maintains a public online flood information system for the LGA on behalf of the Northern Beaches Council. This system provides alerts on heights and rainfall to NSW SES and key stakeholders.

c. Dam Owners will utilise Dam Failure Warning Systems to provide warnings and information to NSW SES and communities (where appropriate).

d. NSW SES Incident Controllers will issue the following NSW SES flood information products incorporating warnings from the above, expected consequences and safety messages:

- *Livestock and Equipment Warnings*
- *Local Flood Advices*
- *Flood Bulletins*
- *NSW SES Evacuation Warning*
- *NSW SES Evacuation Order*
- *NSW SES All Clear*

e. NSW SES will contact the Bureau of Meteorology to discuss the development of flood warnings as required.

f. NSW SES will provide alerts and deliver flood information to affected communities using a combination of some of the following methods:

- *Mobile and fixed public address systems.*
- *Two-way radio.*
- *Emergency Alert (SMS and voice message alerting system).*
- *Telephony (including Auto dial systems).*
- *Facsimile*
- *Standard Emergency Warning Signal.*
- *Doorknocking.*
- *Mobile and fixed sirens.*
- *Variable message signs.*
- *Community notices in identified hubs.*
- *Distribution through established community liaison networks, partnerships, and relationships; and*
- *NSW SES social media and website https://www.emergency.nsw.gov.au/ Pages/for-the-community/alert- NSW /SEWS.aspx*

g. NSW SES may request supporting agencies redistribute NSW SES alerts and information, including through the provision of doorknocking teams.

h. Road closure information will be provided to the community through the following agencies/methods:

- *Transport for NSW 'Live Traffic' website: www.livetraffic.com or 'Transport Info Line': 131 500. Additionally, Transport NSW fixed Variable Message Boards on the road network may also be used.*
- *Northern Beaches Council variable message boards may be used.*
- *The Public Information and Inquiry Centre will be established by the NSW Police Force where required to provide information regarding evacuees and emergency information.*
- *The Disaster Welfare Assistance Line will be established by Disaster Welfare Services where required to provide information on welfare services and assistance. ……*

10. Ingleside, Elanora, and Warriewood (upper catchment) - Flash Flooding

10.1 The "Ingleside, Elanora and Warriewood" covers the upper catchment of Narrabeen Lagoon, north of the lagoon. Critical storm duration is around 1 - 2 hours.

10.2 The most notable flood locations in this area are the corner of Powderworks Road and Elanora Road at the outlet of the Elanora Country Club golf course, the Ponderosa Parade crossing at Narrabeen Creek, along the stretches where Nareen Creek is piped, with heavy inundation between Tatiara Crescent and Nareen Parade as well as between Narroy Road and Pittwater Road.

6 Flood Emergency Response

6.1 Northern Beaches Flash Flooding Warning System

As described in Section 9.3.2 RM02: Flood Warning and Emergency Response Strategies in WMAwater, 2018:

> *The Northern Beaches Flood Warning System is a joint venture between Northern Beaches Council (formerly, Pittwater, Warringah and Manly Councils), with support from the Bureau of Meteorology (BoM) and the Office of Environment and Heritage (OEH).*
>
> *The aim is to provide a basic flash flood warning system to the community, through live publishing of rainfall and water level gauges. As part of the project, additional gauges have been installed across the area. The information is provided on a public website (http://www.mhl.nsw.gov.au/users/NBFloodWarning/).*
>
> *As well as publishing live and historical gauge information the website provides some emergency planning information. Current advice is to watch out for 70mm rainfall in 3 hours and/or 150mm rainfall in 24 hours and states that "when flash flooding is likely, leave low-lying homes and businesses well before any flooding begins. Evacuation is the best action to take, but only if it is safe to do so". ……..*
>
> *The biggest shortfall with the current flood warning system is the lack of integration with flood risk or consequence, i.e., flooding implications at particular gauge records. Providing some linkages between gauge recordings and key locations such as access roads or predictors of property inundation would greatly improve the system.*

6.2 Evacuation versus Shelter-in-Place

As described in Section 9.3.2 RM02: Flood Warning and Emergency Response Strategies in WMAwater, 2018:

> *… response modification measures aim to reduce risk to life and property in the event of flooding. This includes provisions to facilitate flood emergency response. There are two main forms of flood emergency response that may be adopted by people living within the floodplain:*
>
> - *Evacuation: the movement of occupants out of the floodplain before the property and access roads becomes flood affected; and*
> - *Shelter-in-place: the movement of occupants to a building that provides vertical refuge on the site or near the site before their property becomes flood affected.*
>
> *Early evacuation is the NSW SES's preferred emergency response for flooding. This reflects the understanding that the safest place to be in a flood is well away from the affected area (Reference 5). Evacuation should be the primary strategy where the available warning time and resources permit (Reference 5). The alternative to evacuating is shelter-in-place which is to shelter in a building within the floodplain.*
>
> *The SES contends that sheltering in a building that does not have a habitable floor level above the level of the PMF is not low risk and does present a number of concerns:*
>
> - *floodwater reaching the place of shelter (unless the shelter is above the PMF level);*

- *structural collapse of the building that is providing the place of shelter (unless the building has been designed to withstand the forces of floodwater, buoyancy and debris in a PMF);*
- *isolation, with possible loss of power, water and sewerage;*
- *people's unpredictable behaviour (e.g. drowning if they change their mind and attempt to evacuate through flooded roads);*
- *people's mobility (not being able to reach the highest part of the building);*
- *people's safety (fire and accident); and*
- *people's health (pre-existing condition or sudden onset e.g. heart attack).*

…. As described in Section 6.4.2, the evacuation potential of the Manly Lagoon catchment in the event of flooding is limited. Accordingly, it was concluded that safe evacuation is not possible for a large number of properties within the catchment, and in some instances may actually exacerbate risk by increasing the chance of motorists entering flood waters. This conclusion is in accordance with the Australasian Fire and Emergency Service Authorities Council (2013, Reference 5) guideline which states that evacuation is the most effective strategy, provided that evacuation can be safely implemented. Additionally, a review of flood fatalities in Australia has found that the large majority (76%) of fatalities occurred not in the home, but outside when people have entered flood waters (Reference 8). A key issue with shelter-in-place is whether floor levels are sufficiently high to be above the level of the PMF and what hazard classification is experienced at the property for various events.

…. Due to the short available warning times and the various factors described in the previous sections, the provision of an effective flood warning service for flooding in the Manly Lagoon catchment is difficult. Issuing evacuation orders in many cases may actually exacerbate risk by requiring people to leave their homes leading to an increased risk of motorists attempting to traverse floodwaters

These considerations are equally relevant to 16 Macpherson Street, Warriewood.

6.3 Shelter-in-Place in Warriewood Valley

The Pittwater 21 DCP requires, in part, under Control E1 Emergency Response in B3.11 Flood Prone Land:

If the property is affected by a Flood Life Hazard Category of H3 or higher, then Control E1 applies and a Flood Emergency Assessment must be included in the Flood Management Report.

Where flood-free evacuation above the Probable Maximum Flood level is not possible, new development must provide a shelter-in-place refuge where:

a) *The floor level is at or above the Probable Maximum Flood level; and*
b) *The floor space provides at least 2m^2 per person where the flood duration is long (6 or more hours) in the Probable Maximum Flood event, or 1m^2 per person for less than 6 hours;*
c) *It is intrinsically accessible to all people on the site, plainly evident, and self-directing, with sufficient capacity of access routes for all occupants without reliance on an elevator; and*
d) *It must contain as a minimum: sufficient clean water for all occupants; portable radio with spare batteries; torch with spare batteries; and a first aid kit ……*

Note that in the event of a flood, occupants would be required to evacuate if ordered by Emergency Services personnel regardless of the availability of a shelter-in-place refuge.

As outlined in Section 1.3.4, on 2 February 2023, Council provided, in part, the following advice in relation to the requirements under the Warriewood Valley Urban Land Release Water Management Specification (refer Attachment E4 in **Appendix E**).

> *The Warriewood Valley Urban Land Release Water Management Specification was prepared in 2001. It contains no mention of climate change, as it was prepared before Council had any requirements for inclusion of climate change in flood modelling.*
>
> *Climate change does not need to be included (but can be if you think it appropriate or simpler) for the design level requirements listed in Table 4.3 except where climate change needs to be considered as identified above, ie for the FPL, floor levels, and flood hazard in the PMF. The Specification calls for mapping of the 1% AEP and PMF flood extents – please map both with and without CC. If the post-development flood hazard is H3 or larger, shelter in place refuge is required above the PMF+CC level.*

While within the proposed residential areas on the subject property the flood hazard categories are:

- Not present in the 1% AEP + 30%CC event;
- H1 and H2 in the PMF; and
- H1, H2 and pockets of H3 in the PMF + 30%CC

the flood hazard categories on Brands Lane and Macpherson Street are:

- H3 in the 1% AEP + 30%CC event;
- H4 and H5 in the PMF; and
- H4 and H5 in in the PMF + 30%CC

Under these conditions it would be unsafe to attempt to evacuate by vehicles along Brands Lane and Macpherson Street and it will be far safer for residents to shelter in place until flooding of Brands Lane and Macpherson Street subsides to safe levels (H1 for small vehicles and H2 for large vehicles).

The two storey dwellings offer a suitable refuge for all residents.

7 Compliance Assessment

7.1 Pittwater LEP 2014

Section 6.3 Flood Planning of the Pittwater LEP 2014 was repealed on 14 July 2021 and replaced by Section 5.21 Flood Planning.

The assessment of the compliance of the proposed development with the Pittwater LEP 2014 is attached in **Appendix D**.

7.2 Pittwater 21 DCP

Section B3.11 Flood Prone Land of the Pittwater 21 DCP describes the development controls on land to which Pittwater Local Environmental Plan 2014, Clause 5.21 Flood planning, applies and to land that is identified by Council as located within Low, Medium or High Risk Precincts.

The Flood Risk Precincts mapped by Council in the vicinity of the subject site are shown in **Figure 2.** Council has mapped almost all of the subject property as Medium Risk with High Risk encroaching into the property along the creek.

The proposed residential development would be classified as located within a Medium Risk Precinct.

Section 3.12 Climate Change (Sea Level Rise and Increased Rainfall Volume) describes climate change considerations where *'intensification of development' is proposed.*

Control C6.1 states that *"The filling of land will only be permitted where it can be demonstrated within the Water Management Report that:*

- *there is no net decrease in the floodplain volume of the floodway or flood storage area within the property, for any flood event up to the 1% AEP flood event and the PMF event including climate change considerations for both design events; and/or*
- *there is no additional adverse flood impact on the subject and surrounding properties and flooding processes for any flood event up to the PMF event including climate change impacts".*

The compliance assessment has been based on the second approach and where the flood impacts are described in **Section 4.2**.

The assessment of the compliance of the proposed development with Section B3.11 Flood Prone Land of the Pittwater 21 DCP controls for residential development in a Medium Risk Precinct is attached in **Appendix D**. This assessment is based on the impacts on flood levels and velocities for the designated events assessed under Council's adopted 30%CC scenario (in accordance with Controls C6.1 and B3.12 of the Pittwater 21 DCP).

7.3 Warriewood Valley Urban Land Release Water Management Specification

As advised by Council, in part, on 2 February 2023 (refer Section 1.3.4):

> *The Warriewood Valley Urban Land Release Water Management Specification was prepared in 2001. It contains no mention of climate change, as it was prepared before Council had any requirements for inclusion of climate change in flood modelling.*
>
> *Climate change does not need to be included (but can be if you think it appropriate or simpler) for the design level requirements listed in Table 4.3 except where climate change needs to be considered as identified above, ie for the FPL, floor levels, and flood hazard in the PMF. The Specification calls for mapping of the 1% AEP and PMF flood extents – please map both with and without CC. If the post-development flood hazard is H3 or larger, shelter in place refuge is required above the PMF+CC level.*

The mapping of the 1% AEP, 1% AEP + 30%CC, PMF and PMF + 30%CC events under both Benchmark Conditions (refer Appendix A) and Future Conditions (refer Appendix B) has been undertaken to satisfy the Specification.

7.4 Conclusion

It is concluded that while the flood impacts of the proposed residential development exceed the adverse impact criteria identified in Section A1.9 of the Pittwater 21 DCP in some of the assessed flood events, that the impact of any exceedances are considered minor and acceptable (refer Section 4.2) and that the proposed development satisfies the intent of the flooding requirements of the Pittwater DCP 2014, Pittwater 21 DCP (refer Appendix D) and the Warriewood Valley Urban Land Release Water Management Specification.

8 Summary and Conclusions

This report details the assessment of the flooding extent and behaviour to inform the redevelopment of 16 Macpherson Street, Warriewood.

The development application seeks approval for the construction of 28 dwellings, infrastructure, roadworks, landscaping, community title subdivision and dedication of the creekline corridor to Council.

The objective of the study is to address the following considerations for planned redevelopment of 16 Macpherson Street, Warriewood:

- Flood risks on and near the site;
- The impact of the planned redevelopment;
- Flood emergency response;
- Flood warning and evacuation;
- Compliance with requirements of Pittwater LEP 2014 and Pittwater 21 DCP.

8.1 Previous Flood Assessments

Flooding investigations have been previously completed for the Narrabeen Creek floodplain in the vicinity of the subject property. The flooding context is provided in several studies as follows:

- BMT WBM (2013) “Narrabeen Lagoon Flood Study”, Final Report, Version 4, prepared for Warringah Council and Pittwater Council, September.
- Cardno (2019) “Narrabeen Lagoon Flood Risk Management Study and Plan”, Final report, Version 3, prepared for Northern Beaches Council, April.
- Cardno Lawson Treloar (2013) “Pittwater Overland Flow Mapping and Flood Study”, Final Report, Version 4, 2 Vols, prepared for Pittwater Council, October.
- WMAwater (2019) “Ingleside, Elanora and Warriewood Overland Flow Flood Study”, Final Report, Version 4, prepared for Northern Beaches Council, June.

8.2 Flood Risks

The comprehensive flood information provided by Council in response to a request is attached in **Appendix E**. This flood information is based on the results of the 2019 Ingleside, Elanora and Warriewood Overland Flow Flood Study prepared by WMAwater.

The 2019 study was undertaken prior to the approval and construction of the current housing development on 18 Macpherson Street, Warriewood.

Consequently the 2019 floodplain model was modified to create a floodplain model of Benchmark Conditions that are representative of current conditions.

Based on the guidance provided by Council (refer Section 1.3.4 and Appendix E) the following events were run under Benchmark Conditions:

- 50% AEP + 30%CC
- 20%AEP + 30%CC

- 1% AEP
- 1% AEP + 30%CC
- PMF
- PMF + 30%CC

8.2.1 Flood Levels, Velocities and Hazard Categories

The flood levels and extent, depths, velocities and hazard categories for each of these events under Benchmark Conditions are attached in Appendix A**.**

8.2.2 Flood Risk Precinct

Council has mapped almost all of the subject property as Medium Risk with High Risk encroaching into the property along the creekline.

8.2.3 Flood Planning Levels

Based on the 1%AEP + 30%CC flood levels estimated under Benchmark Conditions, the Flood Planning Levels were updated as set out in **Appendix F**.

8.2.4 Risk to Life

The variation of the indicative velocity and depth at Locations P6, P7 and P8 (refer **Figure 11**) during the six floods that have been assessed in comparison to the hazard zones are plotted respectively in **Figures 12, 13** and **14** respectively.

It is noted from **Figure E16** that in a 1% AEP + 30%CC flood the flood hazard category varies across the property from no hazard to H1, H2, H3 and H4 across the northern end of the property.

It is noted from **Figure E24** that in a PMF + 30%CC flood the flood hazard category varies across the property from H3 to H4 to H5.

8.2.5 Warning Times and Periods of Isolation

Table 1 summarises the time it takes from the onset of a major storm for unsafe conditions to develop at Locations P6, P7 and P8 (refer Figure 11) for small vehicles and 4WD vehicles.

The conditions encountered at the Brands Lane roundabout during floods and the impact on emergency access to or from the site are summarised as follows:

- It is expected that the roundabout would be trafficable at all times in events up to a 50% + 30%CC event (equivalent to a 20% AEP flood at this time);
- In events from the 20% AEP + 30%CC event up to the 1% AEP + 30%CC event the available time from the commencement of the storm burst until it becomes unsafe for small vehicles at the roundabout reduces from around 4 hours to around 2 hours;
- In the case of large vehicles the available time remains around 4 hours in these events;
- In events from the 20% AEP + 30%CC event up to the 1% AEP + 30%CC event if emergency access to or from the site is by small vehicles only then the period of isolation increases from greater than 3 hours to greater than 7 hours; however if emergency access to or from the site is by large vehicles then the period of isolation reduces to less than 3 hours;

- In the case of extreme floods (PMF and PMF + 30%CC) the onset of unsafe conditions is extremely rapid and less than 10 mins.
- In the case of extreme floods (PMF and PMF + 30%CC) the period of isolation is no more than 1.5 hours.

8.3 Flood Impact Assessment

Considerable options testing was undertaken to arrive at the preferred development layout and levels. The various combinations of measures that were assessed are summarised in **Table 2**.

8.3.1 Future Conditions

Based on the outcomes of the various assessments the preferred development layout and levels was based on Des07A in combination with final grading of the site and incorporation of stormwater management measures.

The assessment of flooding under Future Conditions was undertaken by modifying the TUFLOW model of Benchmark Conditions to represent the planned development as described in the plans attached in **Appendix G**.

The flood levels and extent, depths, velocities and hazard categories for each of these events under Future Conditions are attached in **Appendix B.**

8.3.2 Flood Impact Assessment

When considering the flood impacts assessed under the four climate change events it should be noted that the likelihood that these events would be experienced under current day conditions is lower than suggested by the AEP of the event. This was assessed by determining the severity of the design rainfall intensities which were increased by 30%. Conversely, the timeframe over which the design rainfall intensities might increase by 30% was assessed by extrapolating the climate change increases advised by the ARR2019 Datahub under RCP4.5 and RCP8.5 scenarios. It was estimated that under RCP8.5 that a 30% increase may occur over the next 110 years while under RCP4.5 it would take around 5,000 years to achieve a 30% increase.

The likelihood of the flood events that have been assessed are summarised for these two scenarios in **Table 3**.

It is concluded that the proposed development has a negligible adverse impact on flood levels in the 50%AEP + 30%CC, 20%AEP + 30%CC, 1%AEP + 30%CC and PMF + 30%CC events.

While in the 1% AEP + 30%CC event the velocity increases in Brands Lane, the peak velocity remains below 1 m/s. These velocities are not of concern in relation to scour.

Given the probability of a PMF + 30%CC flood at this time (1 in 40,000,000 AEP) or in 110 years to 5,000 years time (1 in 10,000,000 AEP) and while the increase in velocity to parts of Brands Lane may be of possible concern in relation to scour, it is no more so than elsewhere in the locality, including the creek corridor and Macpherson Street under both Benchmark and Future Conditions and for this reason the exceedances above the DCP impact criterion are considered minor and acceptable.

8.3.3 Flood Storage

The flood storage calculations were based on the 1% AEP + 30%CC flood levels. The calculated flood storage volumes under Benchmark Conditions and Future Conditions respectively were 5,482 m^3 and 3,763 m^3.

8.4 Emergency Planning

The hierarchy of plans which guide the planning for floods in NSW and in the Northern Beaches LGA are overviewed and include:

- 2017 NSW State Flood Plan
- North West Metropolitan Regional Emergency Management Plan
- Northern Beaches Local Emergency Management Plan
- Northern Beaches Flood Emergency Sub Plan

8.5 Flood Emergency Response

As described in Section 9.3.2 RM02: Flood Warning and Emergency Response Strategies in WMAwater, 2018:

> *… The Northern Beaches Flood Warning System is a joint venture between Northern Beaches Council (formerly, Pittwater, Warringah and Manly Councils), with support from the Bureau of Meteorology (BoM) and the Office of Environment and Heritage (OEH).*
>
> *The aim is to provide a basic flash flood warning system to the community, through live publishing of rainfall and water level gauges. As part of the project, additional gauges have been installed across the area. The information is provided on a public website (http://www.mhl.nsw.gov.au/users/NBFloodWarning/).*
>
> *As well as publishing live and historical gauge information the website provides some emergency planning information. Current advice is to watch out for 70mm rainfall in 3 hours and/or 150mm rainfall in 24 hours and states that "when flash flooding is likely, leave low-lying homes and businesses well before any flooding begins. Evacuation is the best action to take, but only if it is safe to do so". ……..*

The Pittwater 21 DCP requires, in part, under Control E1 Emergency Response in B3.11 Flood Prone Land:

> *If the property is affected by a Flood Life Hazard Category of H3 or higher, then Control E1 applies and a Flood Emergency Assessment must be included in the Flood Management Report.*

While within the proposed residential areas on the subject property the flood hazard categories are:

- Not present in the 1% AEP + 30%CC event;
- H1 and H2 in the PMF; and
- H1, H2 and pockets of H3 in the PMF + 30%CC

the flood hazard categories on Brands Lane and Macpherson Street are:

- H3 in the 1% AEP + 30%CC event;
- H4 and H5 in the PMF; and
- H4 and H5 in in the PMF + 30%CC

Under these conditions it would be unsafe to attempt to evacuate by vehicles along Brands Lane and Macpherson Street and it will be far safer for residents to shelter in place until flooding of Brands Lane and Macpherson Street subsides to safe levels (H1 for small vehicles and H2 for large vehicles).

The two storey dwellings offer a suitable refuge for all residents.

8.6 Compliance Assessment

The assessment of the compliance of the proposed development with the Pittwater LEP 2014 is attached in **Appendix D**.

The proposed residential development would be classified as located within a Medium Risk Precinct.

Section 3.12 Climate Change (Sea Level Rise and Increased Rainfall Volume) describes climate change considerations where *'intensification of development' is proposed.*

Control C6.1 states that *"The filling of land will only be permitted where it can be demonstrated within the Water Management Report that:*

- *there is no net decrease in the floodplain volume of the floodway or flood storage area within the property, for any flood event up to the 1% AEP flood event and the PMF event including climate change considerations for both design events; and/or*
- *there is no additional adverse flood impact on the subject and surrounding properties and flooding processes for any flood event up to the PMF event including climate change impacts".*

The compliance assessment has been based on the second approach and where the flood impacts are described in **Section 4.2**.

The assessment of the compliance of the proposed development with Section B3.11 Flood Prone Land of the Pittwater 21 DCP controls for residential development in a Medium Risk Precinct is attached in **Appendix D**. This assessment is based on the impacts on flood levels and velocities for the designated events assessed under Council's adopted 30%CC scenario (in accordance with Controls C6.1 and B3.12 of the Pittwater 21 DCP).

The mapping of the 1% AEP, 1% AEP + 30%CC, PMF and PMF + 30%CC events under both Benchmark Conditions (refer Appendix A) and Future Conditions (refer Appendix B) has been undertaken to satisfy the Warriewood Valley Urban Land Release Water Management Specification.

It is concluded that while the flood impacts of the proposed residential development exceed the adverse impact criteria identified in Section A1.9 of the Pittwater 21 DCP in some of the assessed flood events, that the impact of any exceedances are considered minor and acceptable (refer Section 4.2) and that the proposed development satisfies the intent of the flooding requirements of the Pittwater DCP 2014, Pittwater 21 DCP (refer Appendix D) and the Warriewood Valley Urban Land Release Water Management Specification.

9 References

BMT WBM (2013) “Narrabeen Lagoon Flood Study”, Final Report, Version 4, prepared for Warringah Council and Pittwater Council, September.

Cardno (2019) “Narrabeen Lagoon Flood Risk Management Study and Plan”, Final report, Version 3, prepared for Northern Beaches Council, April.

Cardno Lawson Treloar (2013) “Pittwater Overland Flow Mapping and Flood Study”, Final Report, Version 4, 2 Vols, prepared for Pittwater Council, October.

WMAwater (2018) ”Manly Lagoon Floodplain Risk Management Study and Plan”, *Final Report,* prepared for Northern Beaches Council, October, 86 pp + Apps.

WMAwater (2019) “Ingleside, Elanora and Warriewood Overland Flow Flood Study”, Final Report, Version 4, prepared for Northern Beaches Council, June.

16 Macpherson Street, Warriewood

APPENDIX A
BENCHMARK CONDITIONS

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16 Macpherson Street, Warriewood NSW

50% AEP + 30% CC Flood Levels and Extents

Legend

- Site Boundary
- 0.1m Water Level Contour
- Flood Extent
- Cadastre

FIGURE E1

1:2,000 Scale at A3

m

0 25 50

Stantec

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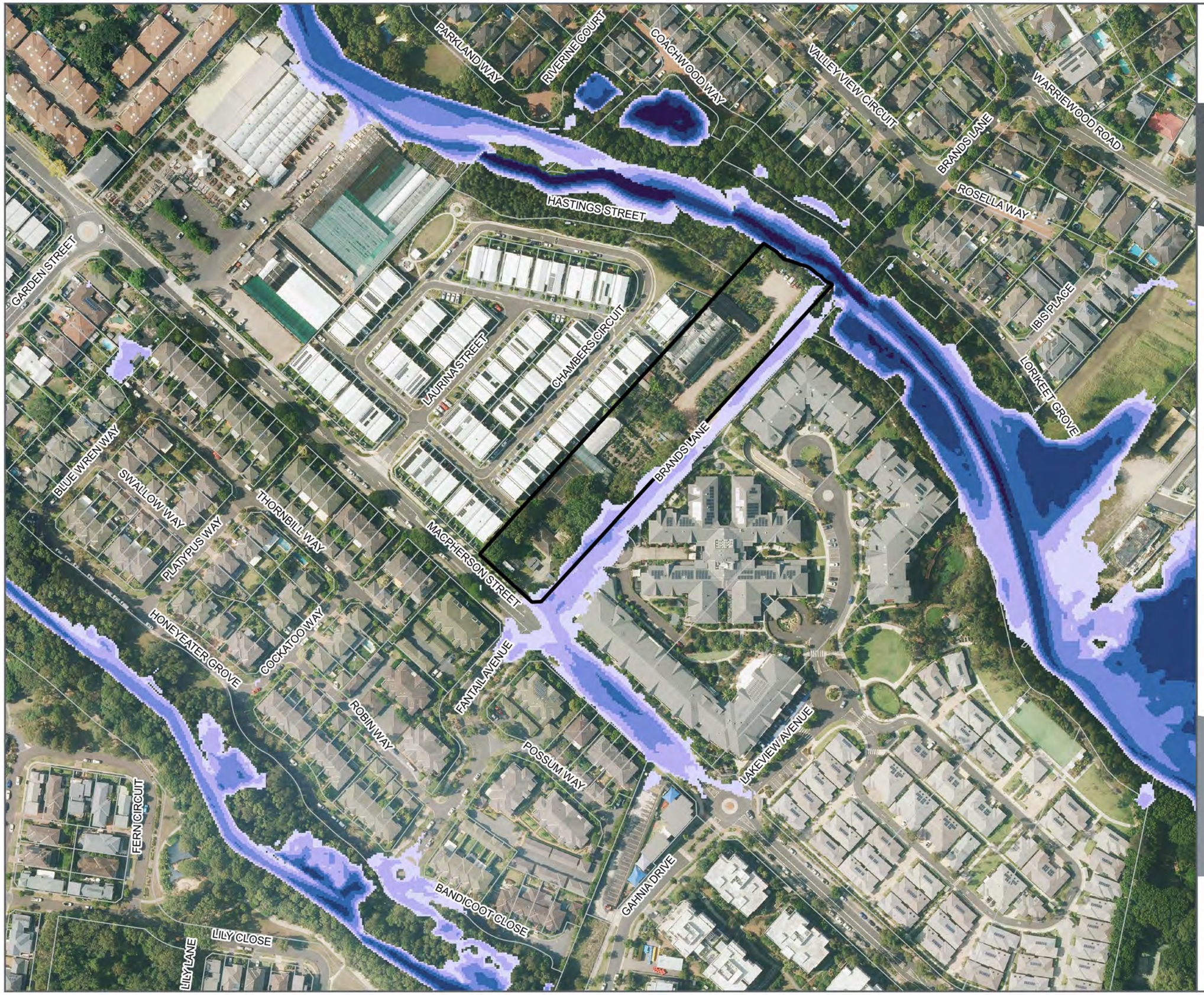

Stantec

16 Macpherson Street, Warriewood NSW

50% AEP + 30% CC Flood Depth

Legend

- Site Boundary

Flood Depth (m)

- 0.00 to 0.15
- 0.15 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50
- Cadastre

FIGURE E2

1:2,000 Scale at A3

m

0 25 50

N

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

50% AEP + 30% CC Flood Velocities

Legend

- Site Boundary
- Flood Velocity (m/s)
  - 0 - 0.1
  - 0.1 - 0.3
  - 0.3 - 0.5
  - 0.5 - 1
  - > 1
  - Cadastre

FIGURE E3

1:2,000 Scale at A3

m
0 25 50

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

50% AEP + 30% CC Flood Hazards

PARKLAND WAY
RIVERINE COURT
COACHWOOD WAY
VALLEY VIEW CIRCUIT
WARRIEWOOD ROAD
BRANDS LANE
ROSELLA WAY
HASTINGS STREET
GARDEN STREET
IBIS PLACE
LORIKEET GROVE
LAURINA STREET
CHAMBERS CIRCUIT
BLUE WREN WAY
SWALLOW WAY
PLATYPUS WAY
THORNBILL WAY
MACPHERSON STREET
HONEYEATER GROVE
COCKATOO WAY
ROBIN WAY
FANTAIL AVENUE
POSSUM WAY
LAKEVIEW AVENUE
FERN CIRCUIT
BANDICOOT CLOSE
GAHNIA DRIVE
LILY CLOSE
LILY LANE

Legend

- Site Boundary

Hazard Category

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles. children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- Cadastre

FIGURE E4

1:2,000 Scale at A3

m
0 25 50

N

Stantec

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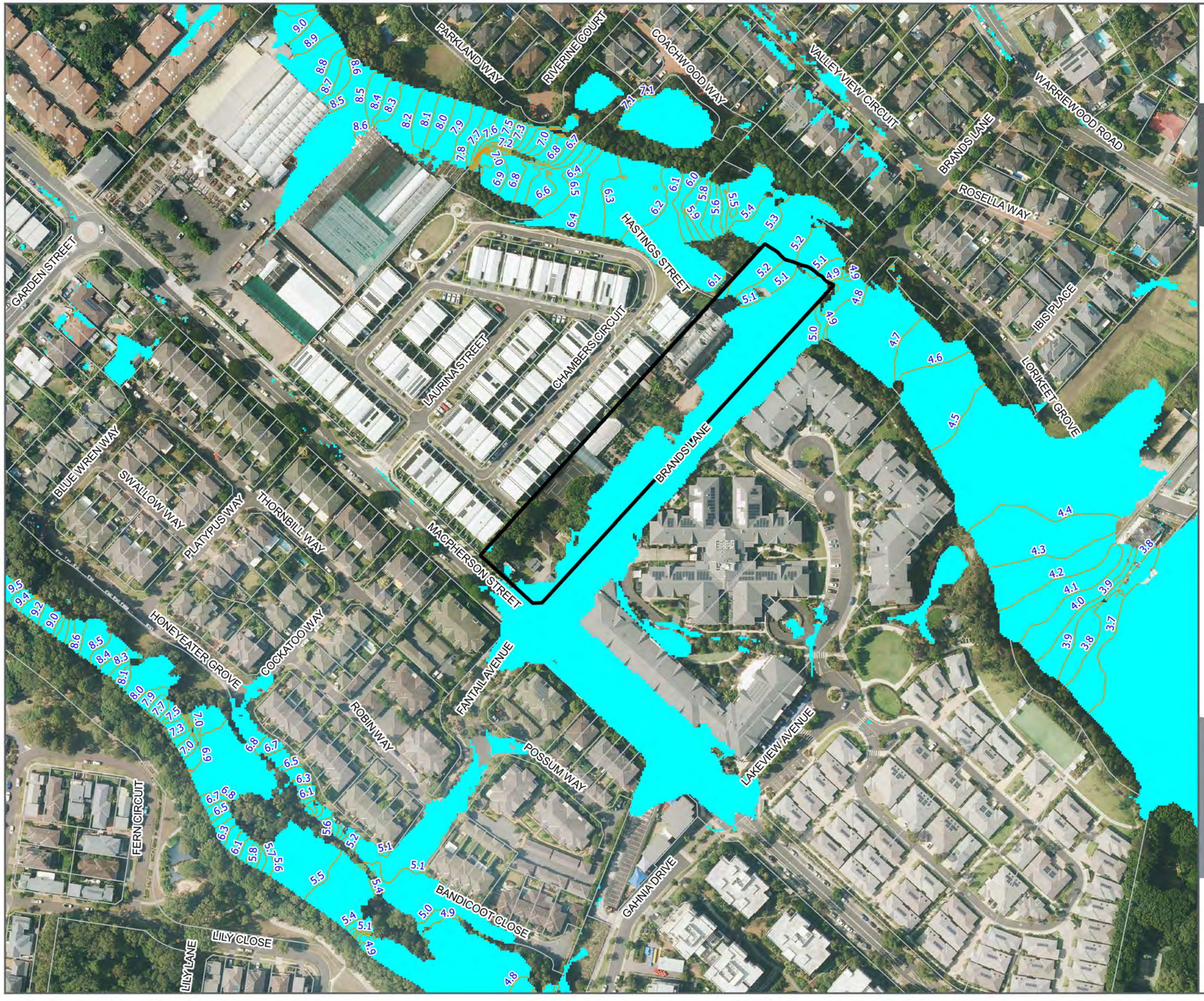

Stantec

16 Macpherson Street, Warriewood NSW

20% AEP + 30%CC Flood Levels and Extents

Legend

- Site Boundary
- 0.1m Water Level Contour
- Flood Extent
- Cadastre

FIGURE E5

1:2,000 Scale at A3

m

0 25 50

N

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

20% AEP + 30%CC Flood Depth

Legend

- Site Boundary
- Flood Depth (m)
  - 0.00 to 0.15
  - 0.15 to 0.30
  - 0.30 to 0.50
  - 0.50 to 0.70
  - 0.70 to 1.00
  - 1.00 to 1.50
  - > 1.50
  - Cadastre

PARKLAND WAY
RIVERINE COURT
COACHWOOD WAY
VALLEY VIEW CIRCUIT
WARRIEWOOD ROAD
BRANDS LANE
ROSELLA WAY
HASTINGS STREET
GARDEN STREET
IBIS PLACE
LORIKEET GROVE
LAURINA STREET
CHAMBERS CIRCUIT
BRANDS LANE
BLUE WREN WAY
SWALLOW WAY
PLATYPUS WAY
THORNBILL WAY
MACPHERSON STREET
HONEYEATER GROVE
COCKATOO WAY
ROBIN WAY
FANTAIL AVENUE
POSSUM WAY
LAKEVIEW AVENUE
FERN CIRCUIT
BANDICOOT CLOSE
GAHNIA DRIVE
LILY CLOSE
LILY LANE

FIGURE E6

1:2,000 Scale at A3

m
0 25 50

N

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

20% AEP + 30%CC Flood Velocities

Legend

- Site Boundary
- Flood Velocity (m/s)
  - < 0.1
  - 0.1 - 0.3
  - 0.3 - 0.5
  - 0.5 - 1
  - > 1
  - Cadastre

FIGURE E7

1:2,000 Scale at A3

m
0 25 50

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

20% AEP + 30%CC Flood Hazards

Legend

- Site Boundary

Hazard Category

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles. children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- Cadastre

FIGURE E8

1:2,000 Scale at A3

m

0 25 50

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

1% AEP Flood Levels and Extents

Legend

- Site Boundary
- 0.1m Water Level Contour
- Flood Extent
- Cadastre

FIGURE E9

1:2,000 Scale at A3

m

0 25 50

N

Stantec

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Map: NW30291_FA_16_Macpherson_St_E1toE24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP Flood Depth

Legend

- Site Boundary
- Flood Depth (m)
  - 0.00 to 0.15
  - 0.15 to 0.30
  - 0.30 to 0.50
  - 0.50 to 0.70
  - 0.70 to 1.00
  - 1.00 to 1.50
  - > 1.50
  - Cadastre

FIGURE E10

1:2,000 Scale at A3

m

0 25 50

N

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

1% AEP Flood Velocities

Legend

- Site Boundary
- Flood Velocity (m/s)
  - 0 - 0.1
  - 0.1 - 0.3
  - 0.3 - 0.5
  - 0.5 - 1
  - > 1
  - Cadastre

FIGURE E11

1:2,000 Scale at A3

m

0 25 50

N

Stantec

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Map: NW30291_FA_16_Macpherson_St_E1toE24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP Flood Hazards

Legend

- Site Boundary

Hazard Category

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles. children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- Cadastre

FIGURE E12

1:2,000 Scale at A3

m

0 25 50

N

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC Flood Levels and Extents

Legend

- Site Boundary
- 0.1m Water Level Contour
- Flood Extent
- Cadastre

FIGURE E13

1:2,000 Scale at A3

m

0 25 50

N

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC Flood Depth

Legend

- Site Boundary
- Flood Depth (m)
  - 0.00 to 0.15
  - 0.15 to 0.30
  - 0.30 to 0.50
  - 0.50 to 0.70
  - 0.70 to 1.00
  - 1.00 to 1.50
  - > 1.50
  - Cadastre

FIGURE E14

1:2,000 Scale at A3

m

0 25 50

N

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC Flood Velocities

Legend

- Site Boundary
- Flood Velocity (m/s)
  - 0 - 0.1
  - 0.1 - 0.3
  - 0.3 - 0.5
  - 0.5 - 1
  - > 1
  - Cadastre

FIGURE E15

1:2,000 Scale at A3

m

0 25 50

N

Stantec

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Map: NW30291_FA_16_Macpherson_St_E1toE24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC Flood Hazards

Legend

- Site Boundary

Hazard Category

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles. children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- Cadastre

FIGURE E16

1:2,000 Scale at A3

m

0 25 50

Stantec

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Stantec

16 Macpherson Street, Warriewood NSW

PMF Flood Levels and Extents

Legend

- Site Boundary
- 0.2m Water Level Contour
- Flood Extent
- Cadastre

FIGURE E17

1:2,000 Scale at A3

m

0 25 50

Stantec

Map Produced by <Division> (<BU>)
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Stantec

16 Macpherson Street, Warriewood NSW

PMF Flood Depth

Legend

- Site Boundary
- Flood Depth (m)
  - 0.00 to 0.15
  - 0.15 to 0.30
  - 0.30 to 0.50
  - 0.50 to 0.70
  - 0.70 to 1.00
  - 1.00 to 1.50
  - > 1.50
  - Cadastre

FIGURE E18

1:2,000 Scale at A3

m

0 25 50

N

Stantec

Map Produced by <Division> (<BU>)
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Map: NW30291_FA_16_Macpherson_St_E1toE24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF Flood Velocities

Legend

- Site Boundary
- Flood Velocity (m/s)
  - 0 - 0.1
  - 0.1 - 0.3
  - 0.3 - 0.5
  - 0.5 - 1
  - > 1
  - Cadastre

FIGURE E19

1:2,000 Scale at A3

m

0 25 50

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_E1toE24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF Flood Hazards

Legend

- Site Boundary

Hazard Category

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles. children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- Cadastre

FIGURE E20

1:2,000 Scale at A3

m

0 25 50

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_E1toE24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC Flood Levels and Extents

Legend

- Site Boundary
- 0.2 Water Level Contour
- Flood Extent
- Cadastre

FIGURE E21

1:2,000 Scale at A3

m

0 25 50

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_E1toE24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC Flood Depth

Legend

- Site Boundary
- Flood Depth (m)
  - 0.00 to 0.15
  - 0.15 to 0.30
  - 0.30 to 0.50
  - 0.50 to 0.70
  - 0.70 to 1.00
  - 1.00 to 1.50
  - > 1.50
  - Cadastre

PARKLAND WAY
RIVERINE COURT
COACHWOOD WAY
VALLEY VIEW CIRCUIT
WARRIEWOOD ROAD
BRANDS LANE
ROSELLA WAY
IBIS PLACE
LORIKEET GROVE
HASTINGS STREET
GARDEN STREET
LAURINA STREET
CHAMBERS CIRCUIT
BRANDS LANE
BLUE WREN WAY
SWALLOW WAY
THORNBILL WAY
PLATYPUS WAY
MACPHERSON STREET
HONEYEATER GROVE
COCKATOO WAY
ROBIN WAY
FANTAIL AVENUE
POSSUM WAY
LAKEVIEW AVENUE
FERN CIRCUIT
BANDICOOT CLOSE
GARNIA DRIVE
LILY CLOSE
LILY LANE

FIGURE E22

1:2,000 Scale at A3

m
0 25 50

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_E1toE24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC Flood Velocities

Legend

- Site Boundary
- Flood Velocity (m/s)
  - 0 - 0.1
  - 0.1 - 0.3
  - 0.3 - 0.5
  - 0.5 - 1
  - > 1
  - Cadastre

FIGURE E23

1:2,000 Scale at A3

m

0 25 50

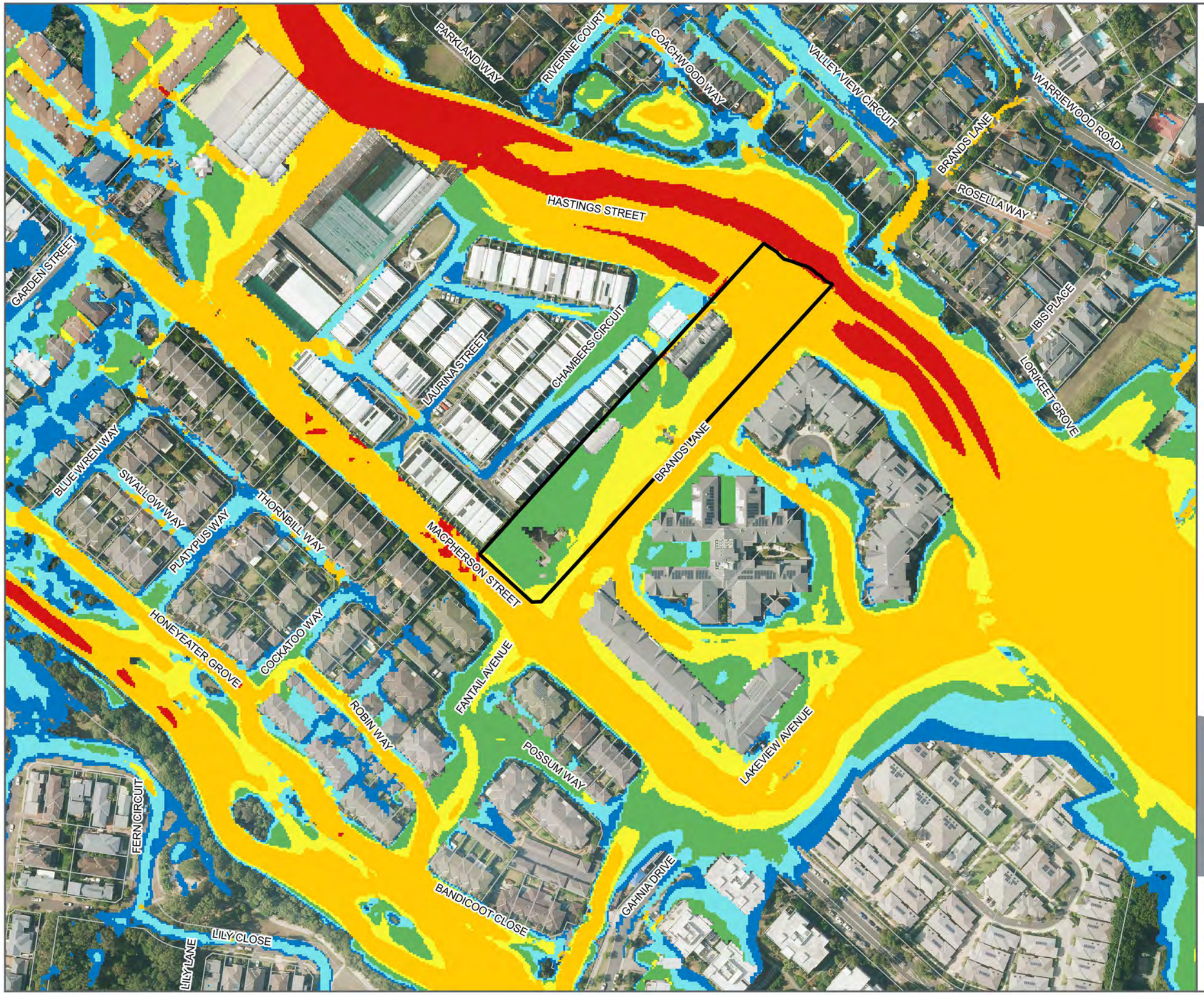
Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_E1toE24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC Flood Hazards



Legend

- Site Boundary

Hazard Category

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles. children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- Cadastre

FIGURE E24

1:2,000 Scale at A3

m

0 25 50

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_E1toE24.qgz <REV #>

16 Macpherson Street, Warriewood

APPENDIX B
FUTURE CONDITIONS

Stantec

Stantec

16 Macpherson Street, Warriewood NSW

50% AEP + 30%CC Future Flood Levels and Extents

Legend

- Site Boundary
- 0.1m Water Level Contour
- Flood Extent
- Cadastre

FIGURE F1

1:2,000 Scale at A3

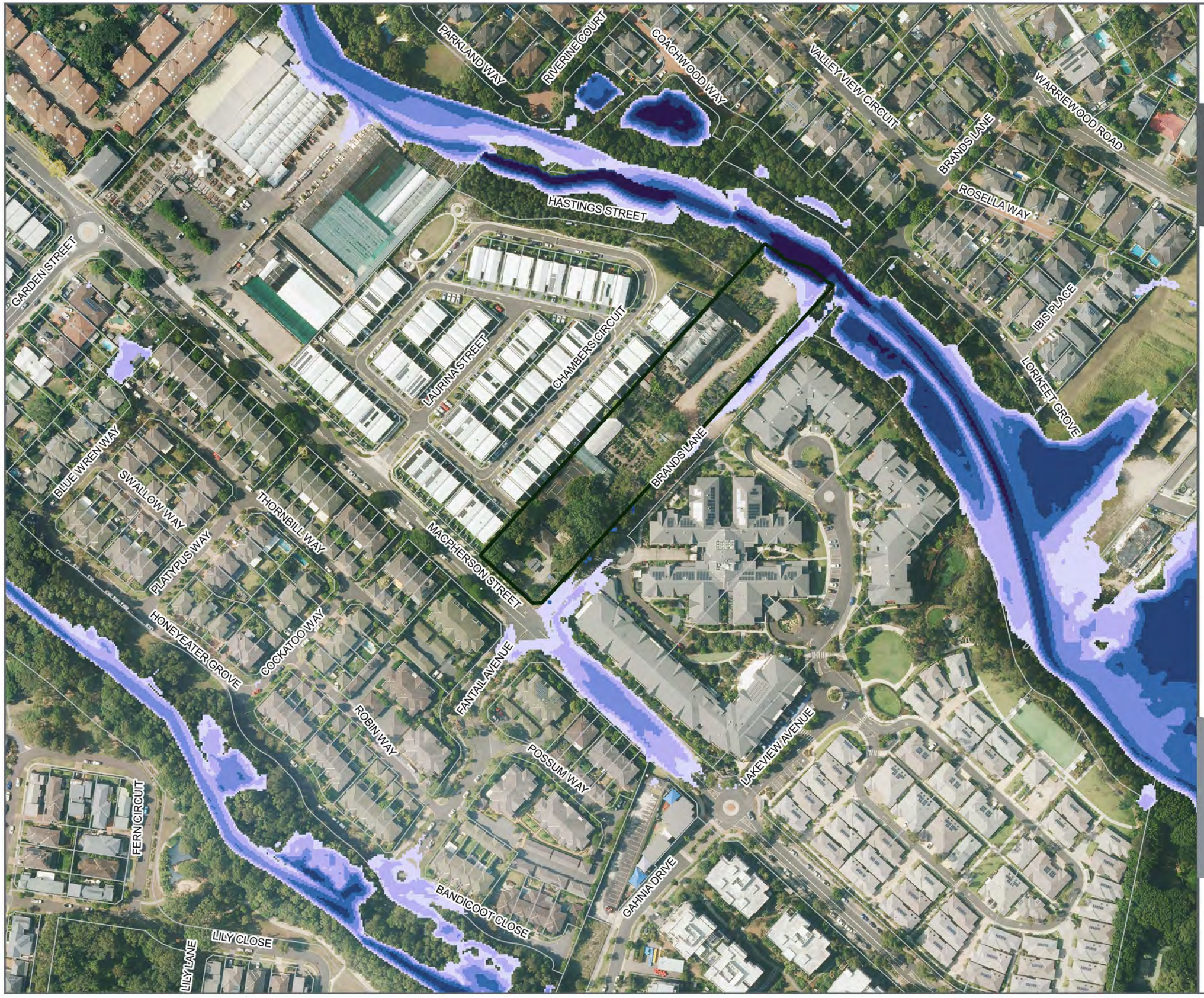
km

0 25 50 m

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>



Stantec

16 Macpherson Street, Warriewood NSW

50% AEP + 30%CC Future Flood Depth

Legend

- Site Boundary

Flood Depth (m)

- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50
- Cadastre

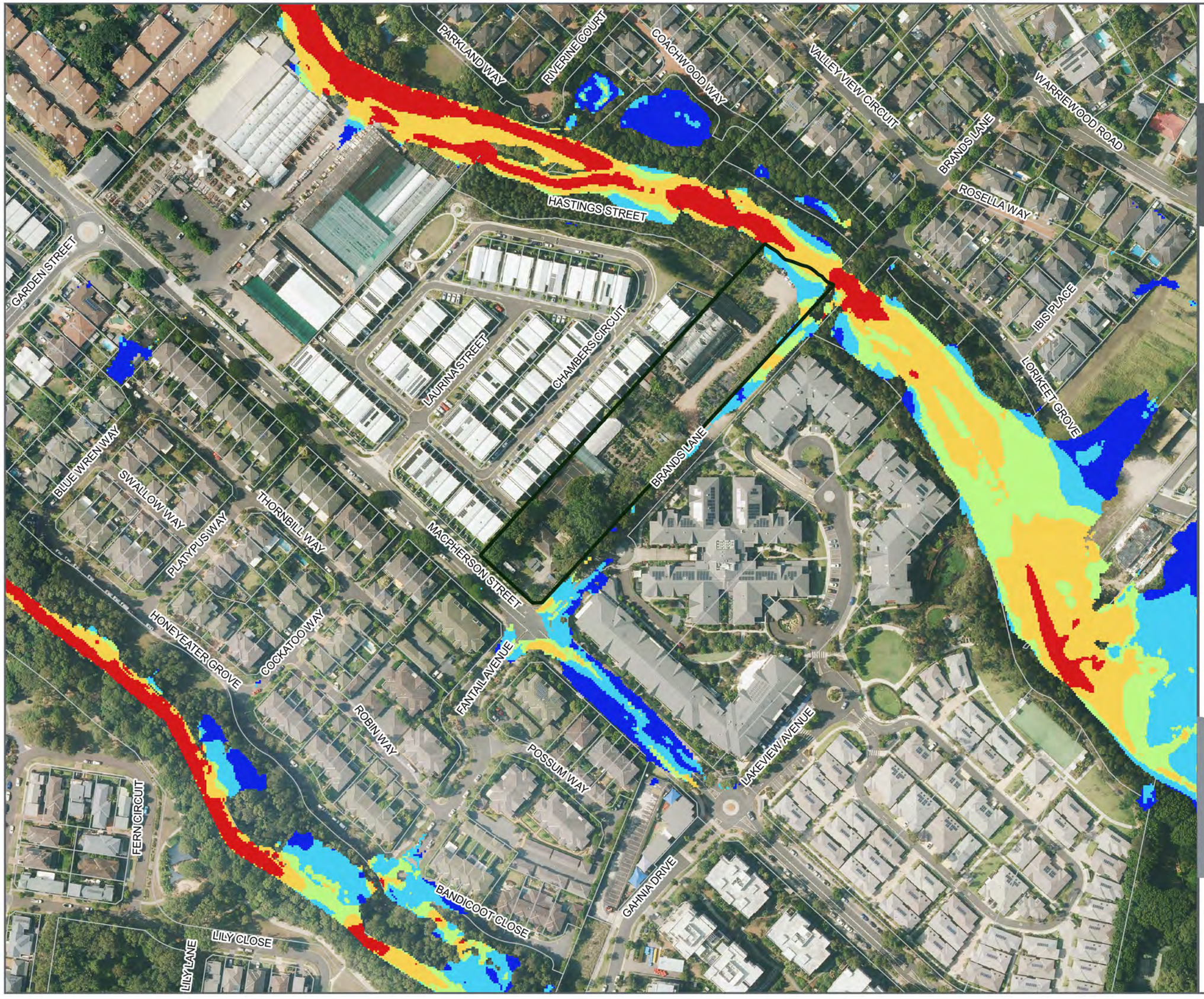
FIGURE F2

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>



Stantec

16 Macpherson Street, Warriewood NSW

50% AEP + 30%CC Future Flood Velocities

Legend

- Site Boundary

Flood Velocity (m/s)

- 0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1
- Cadastre

FIGURE F3

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

50% AEP + 30%CC Future Flood Hazards

Legend

- Site Boundary

Hazard Category

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles. children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- Cadastre

FIGURE F4

1:2,000 Scale at A3

km

0 25 50 m

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

20% AEP + 30%CC Future Flood Levels and Extents

Legend

- Site Boundary
- 0.1m Water Level Contour
- Flood Extent
- Cadastre

FIGURE F5

1:2,000 Scale at A3

km

0 25 50 m

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

20% AEP + 30%CC Future Flood Depth

Legend

- Site Boundary

Flood Depth (m)

- 0.00 to 0.15
- 0.15 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50
- Cadastre

FIGURE F6

1:2,000 Scale at A3

km

0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

20% AEP + 30%CC Future Flood Velocities

Legend

- Site Boundary

Flood Velocity (m/s)

- 0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1
- Cadastre

FIGURE F7

1:2,000 Scale at A3

km

0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

20% AEP + 30%CC Future Flood Hazards

Legend

- Site Boundary

Hazard Category

- H1 - No restrictions
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- Cadastre

FIGURE F8

1:2,000 Scale at A3

km

0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP Future
Flood Levels and Extents

Legend

- Site Boundary
- 0.1m Water Level Contour
- Flood Extent
- Cadastre

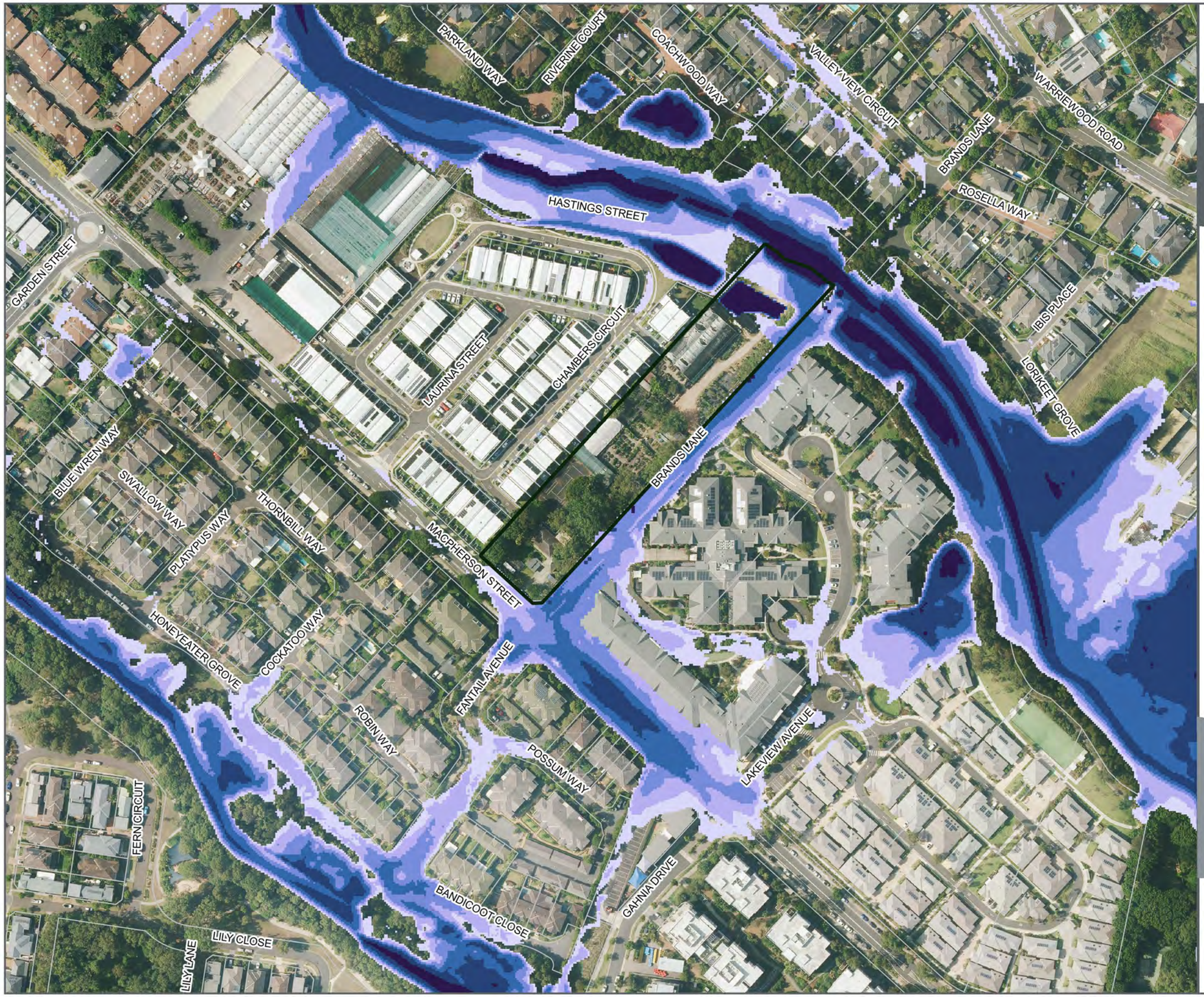
FIGURE F9

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>



Stantec

16 Macpherson Street, Warriewood NSW

1% AEP Future Flood Depth

Legend

- Site Boundary

Flood Depth (m)

- 0.00 to 0.15
- 0.15 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50
- Cadastre

FIGURE F10

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP Future
Flood Velocities

Legend

- Site Boundary

Flood Velocity (m/s)

- 0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1
- Cadastre

FIGURE F11

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP Future Flood Hazards

Legend

- Site Boundary

Hazard Category

- H1 - No restrictions
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- Cadastre

FIGURE F12

1:2,000 Scale at A3

km

0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC Future Flood Levels and Extents

Legend

- Site Boundary
- 01m Water Level Contour
- Flood Extent
- Cadastre

FIGURE F13

1:2,000 Scale at A3

km

0 25 50 m

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC Future Flood Depth

Legend

- Site Boundary

Flood Depth (m)

- 0.00 to 0.15
- 0.15 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50
- Cadastre

FIGURE F14

1:2,000 Scale at A3

km

0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC Future Flood Velocities

Legend

- Site Boundary

Flood Velocity (m/s)

- 0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1
- Cadastre

FIGURE F15

1:2,000 Scale at A3

km

0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC Future Flood Hazards

Legend

- Site Boundary

Hazard Category

- H1 - No restrictions
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
- Cadastre

FIGURE F16

1:2,000 Scale at A3

km

0 25 50 m

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF Future
Flood Levels and Extents

Legend

- Site Boundary
- Cadastre
- 0.2m Watre Level Contour
- Flood Extent

FIGURE F17

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-5-3| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF Future
Flood Depth

Legend

- Site Boundary
- Cadastre

Flood Depth (m)

- 0.00 to 0.15
- 0.15 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

FIGURE F18

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-5-3| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF Future
Flood Velocities

Legend

- Site Boundary
- Cadastre

Flood Velocity (m/s)

- 0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1

FIGURE F19

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-5-3| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF Future Flood Hazards

Legend

- Site Boundary
- Cadastre

Hazard Category

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.

FIGURE F20

1:2,000 Scale at A3

km

0 25 50 m

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-5-3| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC Future
Flood Levels and Extents

Legend

- Site Boundary
- Cadastre
- 0.2m Watre Level Contour
- Flood Extent

FIGURE F21

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-5-3| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC Future Flood Depth

Legend

- Site Boundary
- Cadastre

Flood Depth (m)

- 0.00 to 0.15
- 0.15 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

FIGURE F22

1:2,000 Scale at A3

km

0 25 50 m

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-5-3| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC Future
Flood Velocities

Legend

- Site Boundary
- Cadastre

Flood Velocity (m/s)

- 0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- > 1

FIGURE F23

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-5-3| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC Future Flood Hazards

Legend

- Site Boundary
- Cadastre

Hazard Category

- H1 - Generally safe for vehicles, people and buildings.
- H2 - Unsafe for small vehicles.
- H3 - Unsafe for vehicles, children and the elderly.
- H4 - Unsafe for vehicles and people.
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.

FIGURE F24

1:2,000 Scale at A3

km
0 25 50 m

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-5-3| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_F1toF24.qgz <REV #>

16 Macpherson Street, Warriewood

APPENDIX C
FLOOD IMPACTS

Stantec

Stantec

16 Macpherson Street, Warriewood NSW

50% AEP + 30%CC (Future – Benchmark) Level Differences

Legend

- Site Boundary

Change in Flood Extents

- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Differences (m)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50
- Cadastre

FIGURE D1

1:2,000 Scale at A3

km
0 25 50 m

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_D1toD8.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

20% AEP + 30%CC (Future – Benchmark) Level Differences

Legend

- Site Boundary

Change in Flood Extents
- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Differences (m)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50
- Cadastre

FIGURE D2

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_D1toD8.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC (Future – Benchmark) Level Differences

PARKLAND WAY
RIVERINE COURT
COACHWOOD WAY
VALLEY VIEW CIRCUIT
WARRIEWOOD ROAD
BRANDS LANE
ROSELLA WAY
HASTINGS STREET
GARDEN STREET
IBIS PLACE
LORIKEET GROVE
LAURINA STREET
CHAMBERS CIRCUIT
BRANDS LANE
BLUE WREN WAY
SWALLOW WAY
THORNBILL WAY
PLATYPUS WAY
MACPHERSON STREET
HONEYEATER GROVE
COCKATOO WAY
ROBIN WAY
FANTAIL AVENUE
POSSUM WAY
LAKEVIEW AVENUE
FERN CIRCUIT
BANDICOOT CLOSE
GAHNIA DRIVE
LILY CLOSE
LILY LANE

Legend

- Site Boundary

Change in Flood Extents
- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Differences (m)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50
- Cadastre

FIGURE D3

1:2,000 Scale at A3

km
0 25 50 m

N

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Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_D1toD8.qgz <REV #>

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16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC
(Future – Benchmark)
Velocity Differences (m/s)

PARKLAND WAY
RIVERINE COURT
COACHWOOD WAY
VALLEY VIEW CIRCUIT
WARRIEWOOD ROAD
BRANDS LANE
ROSELLA WAY
HASTINGS STREET
GARDEN STREET
IBIS PLACE
LORIKEET GROVE
LAURINA STREET
CHAMBERS CIRCUIT
BRANDS LANE
BLUE WREN WAY
SWALLOW WAY
THORNBILL WAY
PLATYPUS WAY
MACPHERSON STREET
HONEYEATER GROVE
COCKATOO WAY
ROBIN WAY
FANTAIL AVENUE
POSSUM WAY
LAKEVIEW AVENUE
FERN CIRCUIT
BANDICOOT CLOSE
GAHNIA DRIVE
LILY CLOSE
LILY LANE

Legend

- Site Boundary

Velocity Differences (m/s)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50
- Cadastre

FIGURE D4

1:2,000 Scale at A3

km
0 25 50 m

N

Stantec

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Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_D1toD8.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

1% AEP + 30%CC
(Future – Benchmark)
Velocity Differences (%)

Legend

- Site Boundary

Velocity Differences (%)

- < -10%
- -10 % - %10
- > 10%
- Cadastre

PARKLAND WAY
RIVERINE COURT
COACHWOOD WAY
VALLEY VIEW CIRCUIT
WARRIEWOOD ROAD
BRANDS LANE
ROSELLA WAY
HASTINGS STREET
GARDEN STREET
IBIS PLACE
LORIKEET GROVE
LAURINA STREET
CHAMBERS CIRCUIT
BRANDS LANE
BLUE WREN WAY
SWALLOW WAY
PLATYPUS WAY
THORNBILL WAY
MACPHERSON STREET
HONEYEATER GROVE
COCKATOO WAY
ROBIN WAY
FANTAIL AVENUE
POSSUM WAY
LAKEVIEW AVENUE
FERN CIRCUIT
BANDICOOT CLOSE
GAHNIA DRIVE
LILY CLOSE
LILY LANE

FIGURE D5

1:2,000 Scale at A3

km
0 25 50 m

N

Stantec

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Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_D1toD8.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC
(Future – Benchmark)
Level Differences

PARKLAND WAY
RIVERINE COURT
COACHWOOD WAY
VALLEY VIEW CIRCUIT
WARRIEWOOD ROAD
BRANDS LANE
ROSELLA WAY
HASTINGS STREET
GARDEN STREET
LAURINA STREET
CHAMBERS CIRCUIT
IBIS PLACE
LORIKEET GROVE
BRANDS LANE
BLUE WREN WAY
SWALLOW WAY
THORNBILL WAY
MACPHERSON STREET
PLATYPUS WAY
HONEYEATER GROVE
COCKATOO WAY
ROBIN WAY
FANTAIL AVENUE
POSSUM WAY
LAKEVIEW AVENUE
FERN CIRCUIT
BANDICOOT CLOSE
GAHNIA DRIVE
LILY CLOSE
LILY LANE

Legend

- Site Boundary

Water Level Differences (m)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

Change in Flood Extents

- Was Wet, Now Dry
- Was Dry, Now Wet
- Cadastre

FIGURE D6

1:2,000 Scale at A3

km
0 25 50 m

N

Stantec

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Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_D1toD8.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC
(Future – Benchmark)
Velocity Differences (m/s)

PARKLAND WAY
RIVERINE COURT
COACHWOOD WAY
VALLEY VIEW CIRCUIT
WARRIEWOOD ROAD
BRANDS LANE
ROSELLA WAY
HASTINGS STREET
GARDEN STREET
IBIS PLACE
LORIKEET GROVE
LAURINA STREET
CHAMBERS CIRCUIT
BRANDS LANE
BLUE WREN WAY
SWALLOW WAY
THORNBILL WAY
PLATYPUS WAY
MACPHERSON STREET
HONEYEATER GROVE
COCKATOO WAY
FANTAIL AVENUE
ROBIN WAY
POSSUM WAY
LAKEVIEW AVENUE
FERN CIRCUIT
BANDICOOT CLOSE
GAHNIA DRIVE
LILY CLOSE
LILY LANE

Legend

- Site Boundary

Velocity Differences (m/s)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50
- Cadastre

FIGURE D7

1:2,000 Scale at A3

km
0 25 50 m

N

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_D1toD8.qgz <REV #>

Stantec

16 Macpherson Street, Warriewood NSW

PMF + 30%CC
(Future – Benchmark)
Velocity Differences (%)

Legend

- Site Boundary

Velocity Differences (%)

- < -10%
- -10 % - %10
- > 10%
- Cadastre

PARKLAND WAY
RIVERINE COURT
COACHWOOD WAY
VALLEY VIEW CIRCUIT
WARRIEWOOD ROAD
BRANDS LANE
ROSELLA WAY
HASTINGS STREET
GARDEN STREET
IBIS PLACE
LORIKEET GROVE
LAURINA STREET
CHAMBERS CIRCUIT
BRANDS LANE
BLUE WREN WAY
SWALLOW WAY
PLATYPUS WAY
THORNBILL WAY
MACPHERSON STREET
HONEYEATER GROVE
COCKATOO WAY
ROBIN WAY
FANTAIL AVENUE
POSSUM WAY
LAKEVIEW AVENUE
FERN CIRCUIT
BANDICOOT CLOSE
GAHNIA DRIVE
LILY CLOSE
LILY LANE

FIGURE D8

1:2,000 Scale at A3

km
0 25 50 m

Stantec

Map Produced by <Division> (<BU>)
Date: 2023-4-24| Project: <Job #>_<Phase #>
Coordinate System: [% get_crs(@layer_name)%]
Map: NW30291_FA_16_Macpherson_St_D1toD8.qgz <REV #>

16 Macpherson Street, Warriewood

APPENDIX D
PLANNING CONSIDERATIONS

Stantec

Pittwater LEP 2014

Clause	Consideration	Stantec Comments on DA2021/1912
(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development:		
	(a) is compatible with the flood function and behaviour on the land	**Yes –** The proposed development preserves the flood function within the creek corridor and is compatible with flood function. The flood behaviour within the part of the site which will be developed is improved by reducing flooding.
	(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and	**Yes –** The flood impact assessments is described in Section 4.2. It is concluded that the proposed development has a negligible adverse impact on 50%AEP + 30%CC, 20%AEP + 30%CC, 1%AEP + 30%CC and PMF + 30%CC flood levels. While in the 1% AEP + 30%CC event the velocity increases in Brands Lane, the peak velocity remains below 1 m/s. These velocities are not of concern in relation to scour. Figure E23 discloses that velocities exceed 1m/s extensively throughout the locality, including in the creek corridor, Macpherson Street and parts of Brands Lane under Benchmark Conditions. Figure F23 discloses that the area on Brands Lane where velocities exceed 1m/s increases under Future Conditions. While the increase in velocity to parts of Brands Lane may be of possible concern in relation to scour, it is no more so than elsewhere in the locality, including the creek corridor and Macpherson Street under both Benchmark and Future Conditions and for this reason the exceedances above the DCP impact criterion are considered minor and acceptable.
	(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and	**Yes** – While within the proposed residential areas on the subject property the flood hazard categories are: • Not present in the 1% AEP + 30%CC event; • H1 and H2 in the PMF; and • H1, H2 and pockets of H3 in the PMF + 30%CC the flood hazard categories on Brands Lane, and Macpherson Street are:

		• H3 in the 1% AEP + 30%CC event; • H4 and H5 in the PMF; and • H4 and H5 in in the PMF + 30%CC Under these conditions it would be unsafe to attempt to evacuate by vehicles along Brands Lane and Macpherson Street and it will be far safer for residents to shelter in place until flooding of Brands Lane and Macpherson subsides to safe levels (H1 for small vehicles and H2 for large vehicles).
	(d) incorporates appropriate measures to manage risk to life in the event of a flood, and	**Yes -** The measures set out in this report demonstrate how the risk to life is managed in the event of a flood.
	(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	**Yes** - In the case of the 1%AEP + 30%CC the change in velocities (in m/s) are mapped in Figure D4 while the change in velocities (in %) are mapped in Figure D5. Figure D5 identifies increase that exceed 10% primarily in Brands Lane and at the intersection with Macpherson Street with scattered impacts elsewhere. Figures E15 and F15 disclose that while the velocity increases in Brands Lane, the peak velocity remains below 1 m/s. These velocity are not of concern in relation to scour. Figure E23 discloses that velocities exceed 1m/s extensively throughout the locality, including in the creek corridor, Macpherson Street and parts of Brands Lane under Benchmark Conditions. Figure F23 discloses that the area on Brands Lane where velocities exceed 1m/s increases under Future Conditions. While the increase in velocity to parts of Brands Lane may be of possible concern in relation to scour, it is no more so than elsewhere in the locality, including the creek corridor and Macpherson Street under both Benchmark and Future Conditions and for this reason the exceedances above the DCP impact criterion are considered minor and acceptable.
3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—		
	(a) the impact of the development on projected changes to flood behaviour as a result of climate change	**Yes** - Based on the guidance provided by Council (refer Section 1.3.4 and Appendix E) the following events were assessed: • 50% AEP + 30%CC • 20%AEP + 30%CC • 1% AEP • 1% AEP + 30%CC

		• PMF • PMF + 30%CC
	(b) the intended design and scale of buildings resulting from the development,	**Yes –** the intended design and scale of buildings is comparable to the development that has already occurred on 18 Macpherson Street which shares a boundary with 16 Macpherson Street.
	c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,	**Yes** – While within the proposed residential areas on the subject property the flood hazard categories are: • Not present in the 1% AEP + 30%CC event; • H1 and H2 in the PMF; and • H1, H2 and pockets of H3 in the PMF + 30%CC the flood hazard categories on Brands Lane, and Macpherson Street are: • H3 in the 1% AEP + 30%CC event; • H4 and H5 in the PMF; and • H4 and H5 in in the PMF + 30%CC Under these conditions it would be unsafe to attempt to evacuate by vehicles along Brands Lane and Macpherson Street and it will be far safer for residents to shelter in place until flooding of Brands Lane and Macpherson subsides to safe levels (H1 for small vehicles and H2 for large vehicles).
	d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.	**Yes** - the development is consistent with the form and level of development that has already occurred on 18 Macpherson Street and 6-14 Macpherson Street, Warriewood.

Warringah DCP 2011

No	Consideration	Stantec Compliance Assessment
A1	Development shall not be approved unless it can be demonstrated in a Flood Management Report that it has been designed and can be constructed so that in all events up to the 1% AEP event: (a) There are no adverse impacts on flood levels or velocities (b) There are no adverse impacts on surrounding properties; (c) It is sited to minimise exposure to flood hazard. Major developments and developments likely to have a significant impact on the PMF flood regime will need to demonstrate that there are no adverse impacts in the Probable Maximum Flood.	**Yes** – This FIRA report satisfies this requirement. Control C6.1 states that *"The filling of land will only be permitted where it can be demonstrated within the Water Management Report that:* • *there is no net decrease in the floodplain volume of the floodway or flood storage area within the property, for any flood event up to the 1% AEP flood event and the PMF event including climate change considerations for both design events; and/or* • *there is no additional adverse flood impact on the subject and surrounding properties and flooding processes for any flood event up to the PMF event including climate change impacts".* The compliance assessment has been based on the second approach and where the flood impacts are described in **Section 4.2**. Figure D1 discloses that the proposed development reduces 50% AEP + 30%CC flood levels in Brands Lane and Macpherson Street while there is a small area of local increases located within the creekline corridor adjacent to the property. Figure D2 discloses that the proposed development reduces 20% AEP + 30%CC flood levels in Brands Lane and Macpherson Street while there are areas of local increases located within the creekline corridor adjacent to the property. Figure D3 discloses that the proposed development reduces 1% AEP + 30%CC flood levels in Brands Lane and Macpherson Street and through 6-14 Macpherson Street. There are local increases located within the creekline corridor adjacent to the property as well as a zone of local increases that are slightly greater than 0.02 m located within the creek corridor downstream of Brands Lane.

		While in the 1% AEP + 30%CC event the velocity increases in Brands Lane, the peak velocity remains below 1 m/s. These velocities are not of concern in relation to scour.
A2	Development shall not be approved unless it can be demonstrated in a Flood Management Report that in all events up to the 1% AEP event there is no net loss of flood storage. Consideration may be given for exempting the volume of standard piers from flood storage calculations. If Compensatory Works are proposed to balance the loss of flood storage from the development, the Flood Management Report shall include detailed calculations to demonstrate how this is achieved.	**Not Applicable** – given the adopted approach to compliance assessment – see response to Clause A1.
B1	All buildings shall be designed and constructed with flood compatible materials in accordance with "Reducing Vulnerability of Buildings to Flood Damage: Guidance on Building in Flood Prone Areas", Hawkesbury-Nepean Floodplain Management Steering Committee (2006).	**Yes** - This requirement is noted.
B2	All new development must be designed and constructed to ensure structural integrity up to the Flood Planning Level, taking into account the forces of floodwater, wave action, flowing water with debris, buoyancy and immersion. Where shelter-in- place refuge is required, the structural integrity for the refuge is to be up to the Probable Maximum Flood level. Structural certification shall be provided confirming the above.	**Yes –** All residential development on the subject property will be constructed at a level equal to or at a level higher than the Flood Planning Level (refer Appendix F).
B3	All new electrical equipment, power points, wiring, fuel lines, sewerage systems or any other service pipes and connections must be waterproofed and/or located above the Flood Planning Level. All existing electrical equipment and power points located below the Flood Planning Level within the subject structure must have residual current devices installed that turn off all electricity supply to the property when flood waters are detected.	**Yes –** All residential development on the subject property will be constructed at a level equal to or at a level higher than the Flood Planning Level (refer Appendix F).

C1	New floor levels within the development shall be at or above the Flood Planning Level.	**Yes –** The ground floor level of all residential development on the subject property will be at a level equal to or at a level higher than the Flood Planning Level (refer Appendix F).
C3	All new development must be designed and constructed so as not to impede the floodway or flood conveyance on the site, as well as ensuring no net loss of flood storage in all events up to the 1% AEP event.	**Yes -** The proposed development preserves the flood function within the creek corridor and is compatible with flood function. The flood behaviour within the part of the site which will be developed is improved by reducing flooding
C4	A one-off addition or alteration below the Flood Planning Level of less than 30 square metres (in total, including walls) may be considered only where: (d) it is an extension to an existing room; and (e) the Flood Planning Level is incompatible with the floor levels of the existing room; and (f) out of the 30 square metres, not more than 10 square metres is below the 1% AEP flood level. This control will not be permitted if this provision has previously been utilised since the making of this Plan. The structure must be floodproofed to the Flood Planning Level, and the Flood Management Report must demonstrate that there is no net loss of flood storage in all events up to the 1% AEP event.	**Not Applicable**
C6	Consideration may be given to the retention of an existing floor level below the Flood Planning Level when undertaking a first floor addition.	**Not Applicable**
D1	Open carpark areas and carports shall not be located within a floodway.	**Yes –** Carpark areas are located outside Council's mapped 1% AEP floodway and at a level equal to or at a level higher than the Flood Planning Level (refer Appendix F).
D2	The lowest floor level of open carparks and carports shall be constructed no lower than the natural ground levels, unless it can be shown that the carpark or carport is free draining with a grade greater than 1% and that flood depths are not increased.	**Not Applicable**

D3	Carports must be of open design, with at least 2 sides completely open such that flow is not obstructed up to the 1% AEP flood level. Otherwise it will be considered to be enclosed. When undertaking a like-for-like replacement and the existing garage/carport is located on the street boundary and ramping is infeasible, consideration may be given for dry floodproofing up to the 1% AEP flood level.	**Not Applicable**
D4	Where there is more than 300mm depth of flooding in a car park or carport during a 1% AEP flood event, vehicle barriers or restraints are to be provided to prevent floating vehicles leaving the site. Protection must be provided for all events up to the 1% AEP flood event.	**Not Applicable**
D5	Enclosed Garages must be located at or above the 1% AEP level	**Yes –** Garages are located outside Council's mapped 1% AEP floodway and at a level equal to or at a level higher than the Flood Planning Level (refer Appendix F).
D6	All enclosed car parks (including basement carparks) must be protected from inundation up to the Flood Planning Level. All access, ventilation, driveway crests and any other potential water entry points to any enclosed car parking shall be above the Flood Planning Level. Where a driveway is required to be raised it must be demonstrated that there is no net loss to available flood storage in any event up to the 1% AEP flood event and no impact on flood conveyance through the site. Council will not accept any options that rely on electrical, mechanical or manual exclusion of the floodwaters from entering the enclosed carpark	**Yes –** Enclosed car parks are located at a level equal to or at a level higher than the Flood Planning Level (refer Appendix F).
E1	If the property is affected by a Flood Life Hazard Category of H3 or higher, then Control E1 applies and a Flood Emergency Assessment must be included in the Flood Management Report. If the property is affected by a Flood Life Hazard Category of H6, then development is not permitted unless it can be demonstrated to the satisfaction of the consent authority that the risk level on the property is or can be reduced to a level below H6 or its equivalent. If the property is flood affected but the Flood Life Hazard Category has not been mapped by Council, then calculations for its determination must be shown in the Flood Management Report, in accordance with the "Technical Flood Risk Management Guideline: Flood Hazard", Australian Institute for	**Yes -** While within the proposed residential areas on the subject property the flood hazard categories are: • Not present in the 1% AEP + 30%CC event; • H1 and H2 in the PMF; and • H1, H2 and pockets of H3 in the PMF + 30%CC the flood hazard categories on Brands Lane, and Macpherson Street are: • H3 in the 1% AEP + 30%CC event;

	Disaster Resilience (2012). Where flood-free evacuation above the Probable Maximum Flood level is not possible, new development must provide a shelter-in-place refuge where: a) The floor level is at or above the Probable Maximum Flood; b) The floor space provides at least 2m^2 per person where the flood duration is long (6 or more hours) in the Probable Maximum Flood event) or 1 m2 per person for less than 6 hours; c) It is intrinsically accessible to all people on the site, plainly evident, and self-directing, with sufficient capacity of access routes for all occupants without reliance on an elevator; and d) It must contain as a minimum: sufficient clean water for all occupants; portable radio with spare batteries; torch with spare batteries; and a first aid kit Class 10 classified buildings and structures (as defined in the Building Codes of Australia) are excluded from this control. In the case of change of use or internal alterations to an existing building, a variation to this control may be considered if justified appropriately by a suitably qualified professional. Note that in the event of a flood, occupants would be required to evacuate if ordered by Emergency Services personnel regardless of the availability of a shelter-in-place refuge.	• H4 and H5 in the PMF; and • H4 and H5 in in the PMF + 30%CC Under these conditions it would be unsafe to attempt to evacuate by vehicles along Brands Lane and Macpherson Street and it will be far safer for residents to shelter in place until flooding of Brands Lane and Macpherson subsides to safe levels (H1 for small vehicles and H2 for large vehicles). The two storey dwellings offer a suitable refuge for all residents.
F1	Fencing, (including pool fencing, boundary fencing, balcony balustrades and accessway balustrades) shall be designed so as not to impede the flow of flood waters and not to increase flood affectation on surrounding land. At least 50% of the fence must be of an open design from the natural ground level up to the 1% AEP flood level. Less than 50% of the perimeter fence would be permitted to be solid. Openings should be a minimum of 75 mm x 75mm.	**Yes** - This requirement is noted and would inform any fencing that may be proposed noting that fencing would be located on ground higher than the 1% AEP flood level.
G1	Hazardous or potentially polluting materials shall not be stored below the Flood Planning Level unless adequately protected from floodwaters in accordance with industry standards.	**Yes –** This requirement is noted and would inform any storage of hazardous or polluting materials noting that proposed development is located on ground at or higher than the Flood Planning Level.
H1	Pools located within the 1% AEP flood extent are to be in-ground, with coping flush with natural ground level. Where it is not possible to have	**Not Applicable**

	pool coping flush with natural ground level, it must be demonstrated that the development will result in no net loss of flood storage and no impact on flood conveyance on or from the site. All electrical equipment associated with the pool (including pool pumps) is to be waterproofed and/or located at or above the Flood Planning Level. All chemicals associated with the pool are to be stored at or above the Flood Planning Level.	

16 Macpherson Street, Warriewood

APPENDIX E
NBC FLOODING INFORMATION

Stantec

Attachment E1

northern beaches council

FLOOD INFORMATION REPORT – COMPREHENSIVE

Property: 16 Macpherson Street WARRIEWOOD NSW 2102
Lot DP: Lot 4 DP 553816
Issue Date: 10/03/2022
Flood Study Reference: Ingleside, Elanora and Warriewood Overland Flow Flood Study 2019, WMAwater

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Flood Information for lot [1]:

Flood Risk Precinct – See Map A

Flood Planning Area – See Map A

Maximum Flood Planning Level (FPL) [2, 3, 4]: 6.28 m AHD

1% AEP Flood – See Flood Map B

1% AEP Maximum Water Level [2, 3]: 5.78 mAHD

1% AEP Maximum Depth from natural ground level[3]: 1.25 m

1% AEP Maximum Velocity: 1.69 m/s

1% AEP Hydraulic Categorisation: N/A **See Flood Map D**

Probable Maximum Flood (PMF) – See Flood Map C

PMF Maximum Water Level [4]: 6.20 m AHD

PMF Maximum Depth from natural ground level: 1.99 m

PMF Maximum Velocity: 3.03 m/s

PMF Hydraulic Categorisation: N/A **See Flood Map E**

Flooding with Climate Change (See Flood Map F)

The following is for the 30% Rainfall intensity increase and 0.9m Sea Level Rise Scenario:

1% AEP Maximum Water Level with Climate change [3]: 5.98 m AHD

1% AEP Maximum Depth with Climate Change[3]: 1.45 m

1% AEP Maximum Velocity with Climate Change[3]: NA

Flood Life Hazard Category – See Map G

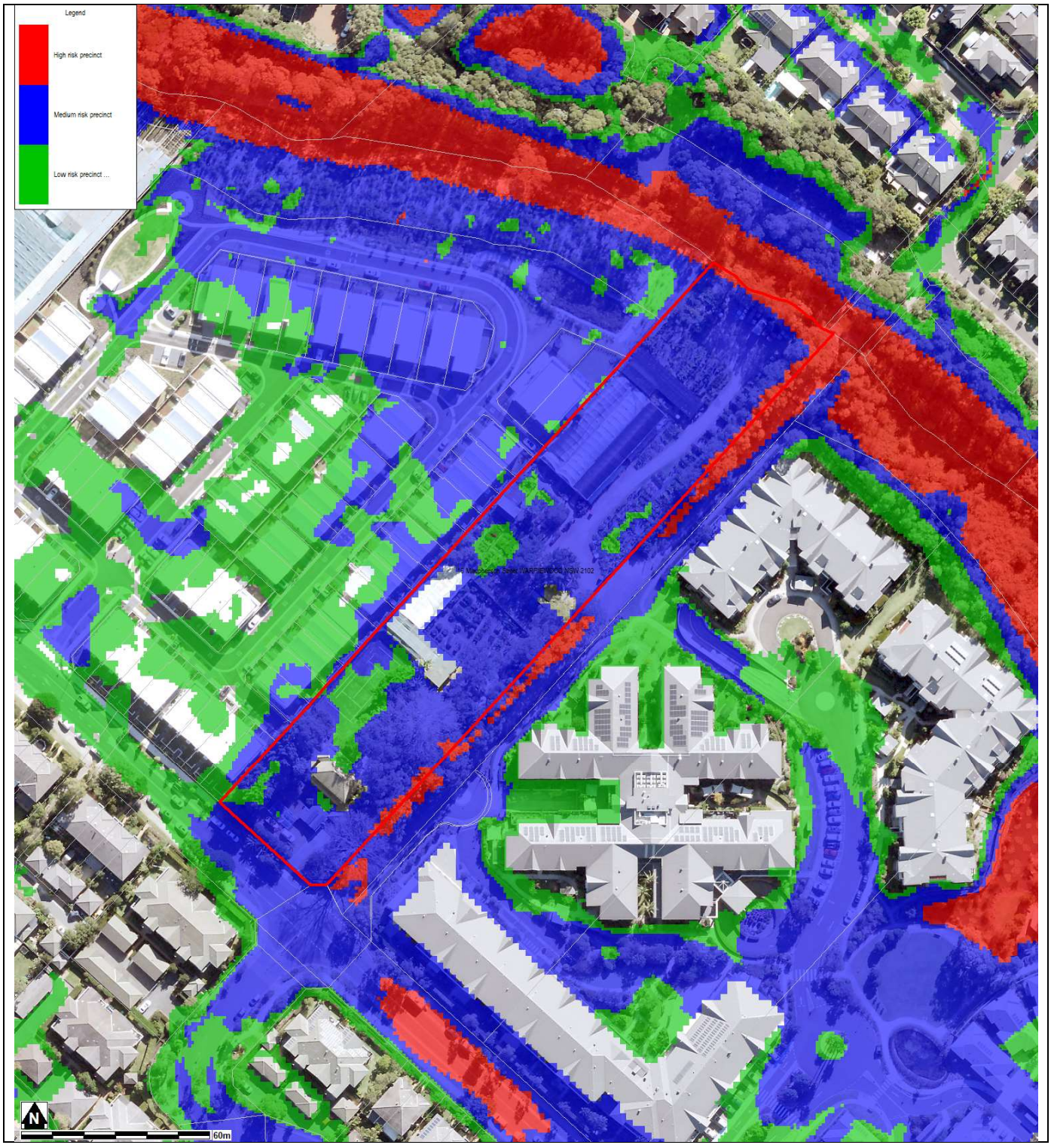
Indicative Ground Surface Spot Heights – See Map H

[1] The flood information does not take into account any local overland flow issues nor private stormwater drainage systems.
[2] Overland flow/mainstream water levels may vary across a sloping site, resulting in variable minimum floor/ flood planning levels across the site. The maximum Flood Planning Level may be in a different location to the maximum 1% AEP flood level.
[3] Intensification of development in the former Pittwater LGA requires the consideration of climate change impacts which may result in higher minimum floor levels.
[4] Vulnerable/critical developments require higher minimum floor levels using the higher of the PMF or FPL.

General Notes:

- All levels are based on Australian Height Datum (AHD) unless otherwise noted.
- This is currently the best available information on flooding; it may be subject to change in the future.
- Council recommends that you obtain a detailed survey of the above property and surrounds to AHD by a registered surveyor to determine any features that may influence the predicted extent or frequency of flooding. It is recommended you compare the flood level to the ground and floor levels to determine the level of risk the property may experience should flooding occur.
- Development approval is dependent on a range of issues, including compliance with all relevant provisions of Northern Beaches Council's Local Environmental Plans and Development Control Plans.
- Please note that the information contained within this letter is general advice only as a detail survey of the property as well as other information is not available. Council recommends that you engage a suitably experienced consultant to provide site specific flooding advice prior to making any decisions relating to the purchase or development of this property.
- The Flood Studies on which Council's flood information is based are available on Council's website.

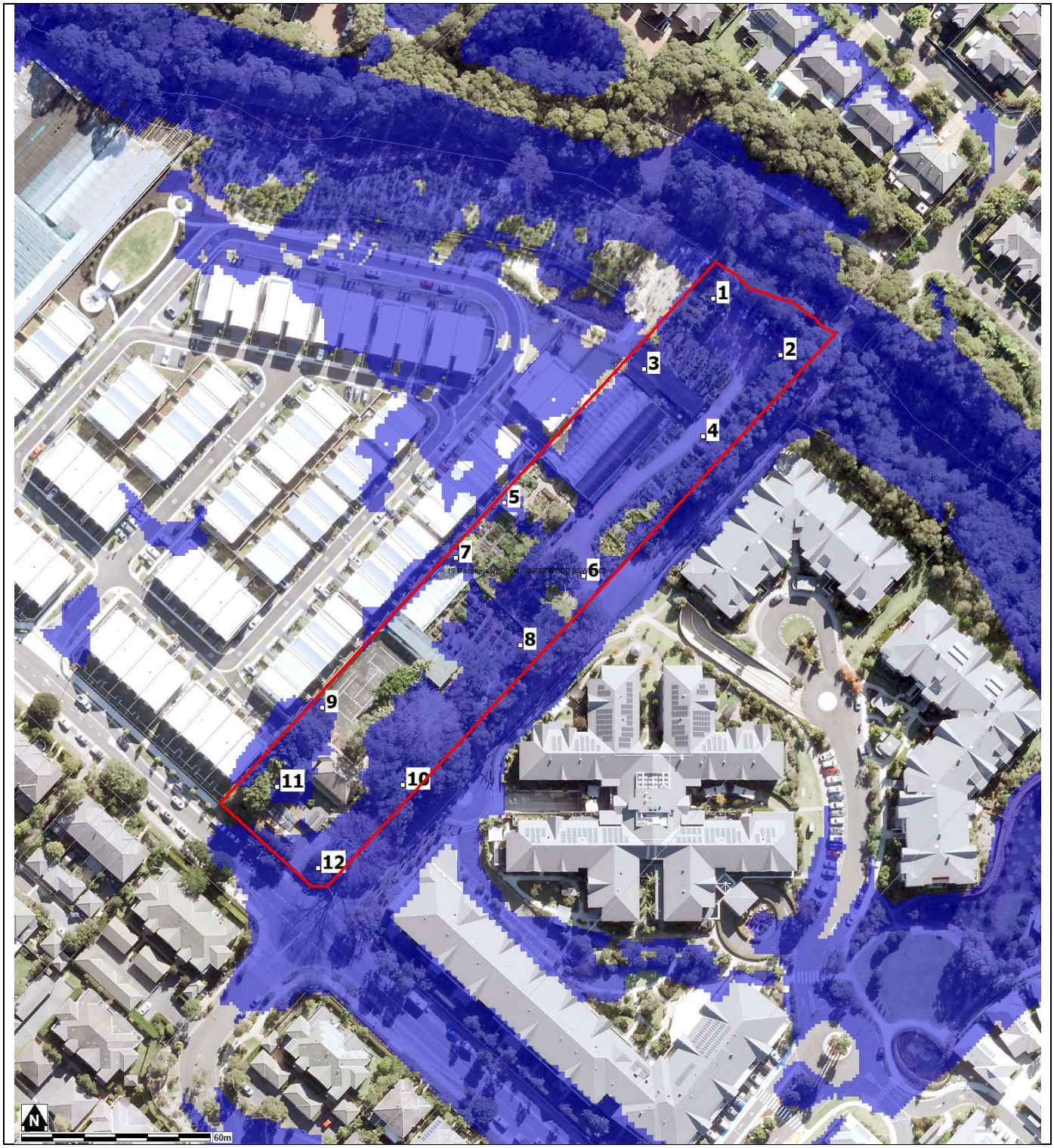
FLOOD MAP A: FLOOD RISK PRECINCT MAP



Notes:

- **Low Flood Risk precinct** means all flood prone land not identified within the High or Medium flood risk precincts.
- **Medium Flood Risk precinct** means all flood prone land that is (a) within the 1% AEP Flood Planning Area; and (b) is not within the high flood risk precinct.
- **High Flood Risk precinct** means all flood prone land (a) within the 1% AEP Flood Planning Area; and (b) is either subject to a high hydraulic hazard, within the floodway or subject to significant evacuation difficulties (H5 or H6 Life Hazard Classification).
- The **Flood Planning Area** extent is equivalent to the Medium Flood Risk Precinct extent, and includes the High Flood Risk Precinct within it. The mapped extent represents the 1% annual Exceedance Probability (AEP) flood event + freeboard.
- None of these mapped extents include climate change.

FLOOD LEVEL POINTS



Note: Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Ingleside, Elanora and Warriewood Overland Flow Flood Study 2019, WMAwater) and aerial photography (Source: NearMap 2014) are indicative only.

Flood Levels

ID	5% AEP Max WL (m AHD)	5% AEP Max Depth (m)	1% AEP Max WL (m AHD)	1% AEP Max Depth (m)	1% AEP Max Velocity (m/s)	Flood Planning Level (m)	PMF Max WL (m AHD)	PMF Max Depth (m)	PMF Max Velocity (m/s)
1	4.99	0.16	5.29	0.49	0.75	5.79	6.01	1.21	1.21
2	4.58	0.06	5.17	0.55	0.89	5.67	5.91	1.29	1.33
3	5.20	0.20	5.30	0.30	1.02	5.80	6.02	1.02	1.18
4	4.62	0.04	5.25	0.63	0.44	5.75	6.01	1.39	0.65
5	N/A	N/A	5.78	0.18	0.91	6.28	6.05	0.50	1.52
6	5.12	0.27	5.26	0.41	0.40	5.76	5.99	1.14	0.68
7	5.55	0.21	5.63	0.28	0.47	6.13	6.11	0.76	1.18
8	5.13	0.43	5.27	0.57	0.13	5.77	5.97	1.28	0.52
9	5.39	0.23	5.41	0.25	0.21	5.91	5.97	0.80	0.72
10	5.13	0.69	5.27	0.82	0.10	5.77	5.92	1.48	0.63
11	N/A	N/A	N/A	N/A	N/A	5.88	5.91	0.68	0.69
12	5.13	0.32	5.27	0.46	0.15	5.77	5.90	1.09	0.35

WL – Water Level
PMF – Probable Maximum Flood
N/A = no peak water level/depth/velocity available in flood event

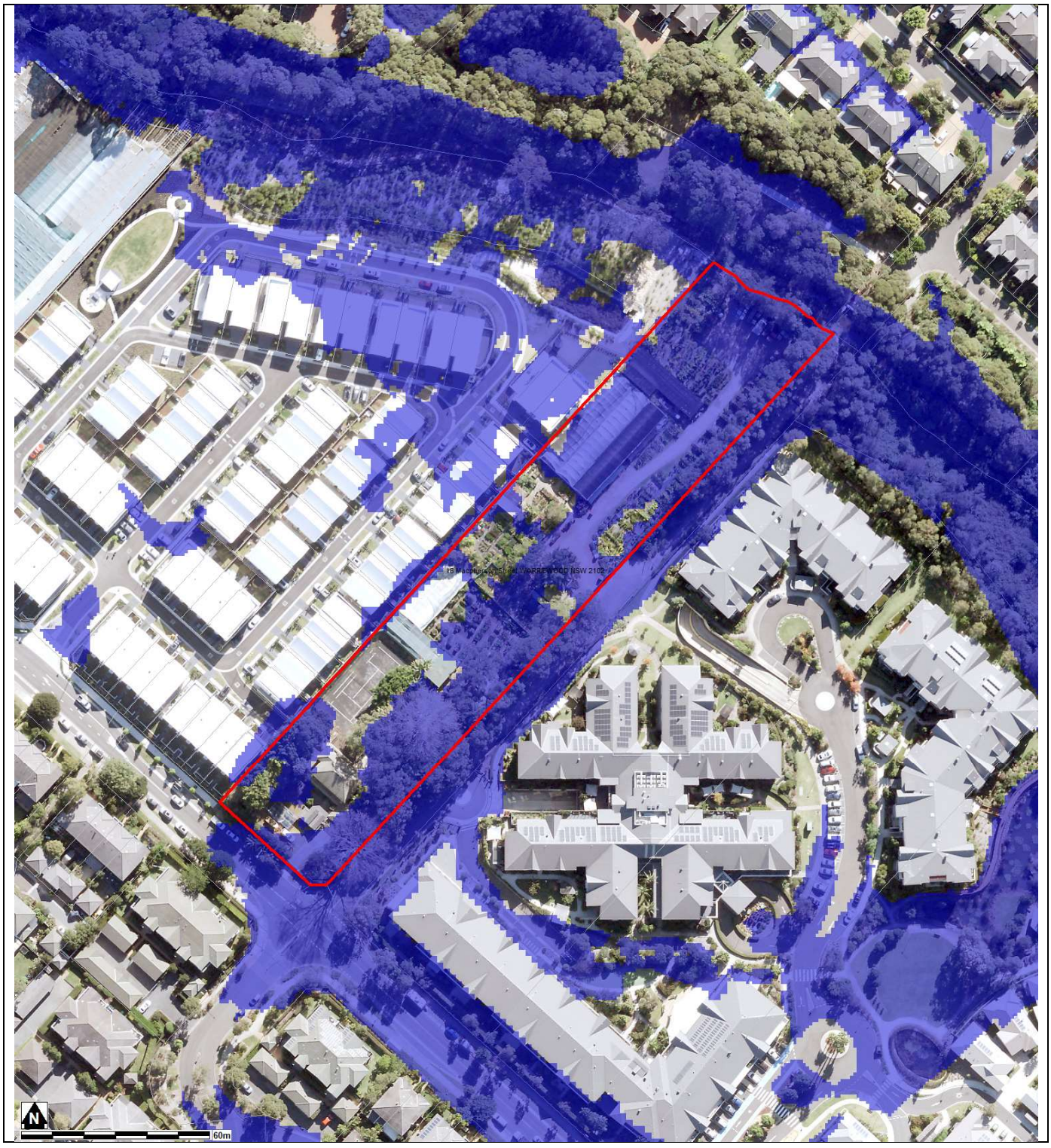
Climate Change Flood Levels (30% Rainfall intensity and 0.9m Sea Level Rise)

ID	CC 1% AEP Max WL (m AHD)	CC1 % AEP Max Depth (m)
1	5.49	0.69
2	5.37	0.75
3	5.5	0.5
4	5.45	0.83
5	5.98	0.38
6	5.46	0.61
7	5.83	0.48
8	5.47	0.77
9	5.61	0.45
10	5.47	1.02
11	5.44	0.2
12	5.47	0.66

WL – Water Level
PMF – Probable Maximum Flood
N/A = no peak water level/depth/velocity available in flood event.

A variable Flood Planning Level might apply. Freeboard is generally 0.5m above the maximum 1% AEP water level. However for overland flow with a depth less than 0.3m and a VelocityxDepth product less than 0.3m^2/s, a freeboard of 0.3m may be able to be justified.

FLOOD MAP B: FLOODING - 1% AEP EXTENT



Notes:

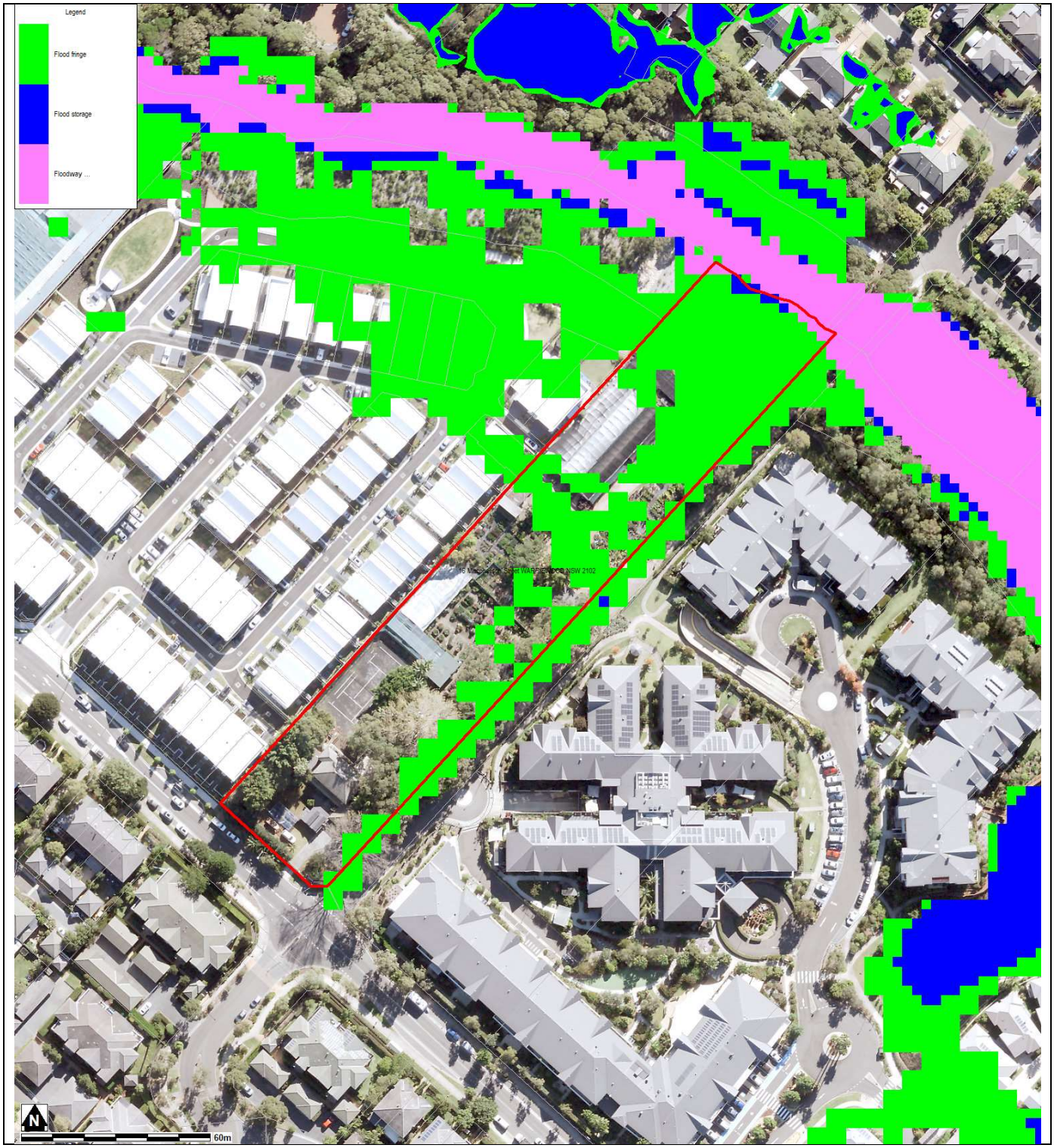
- Extent represents the 1% annual Exceedance Probability (AEP) flood event.
- Flood events exceeding the 1% AEP can occur on this site.
- Extent does not include climate change.
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Ingleside, Elanora and Warriewood Overland Flow Flood Study 2019, WMAwater) and aerial photography (Source Near Map 2014) are indicative only.

FLOOD MAP C: PMF EXTENT MAP

Notes:

- Extent represents the Probable Maximum Flood (PMF) flood event
- Extent does not include climate change
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Ingleside, Elanora and Warriewood Overland Flow Flood Study 2019, WMAwater) and aerial photography (Source: NearMap 2014) are indicative only

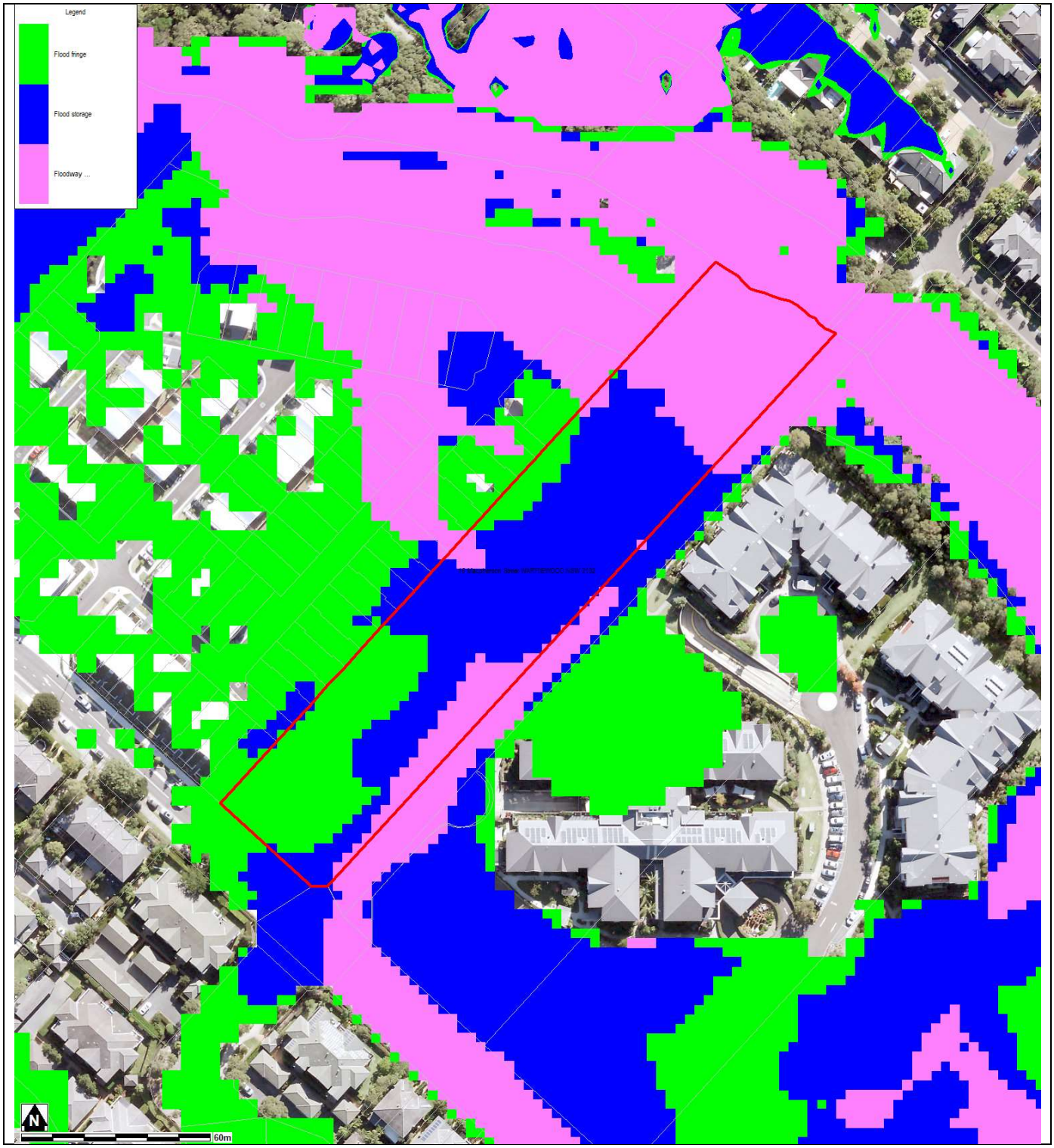
FLOOD MAP D: 1% AEP FLOOD HYDRAULIC CATEGORY EXTENT MAP



Notes:

- Extent represents the 1% annual Exceedance Probability (AEP) flood event
- Extent does not include climate change
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Ingleside, Elanora and Warriewood Overland Flow Flood Study 2019, WMAwater) and aerial photography (Source: NearMap 2014) are indicative only

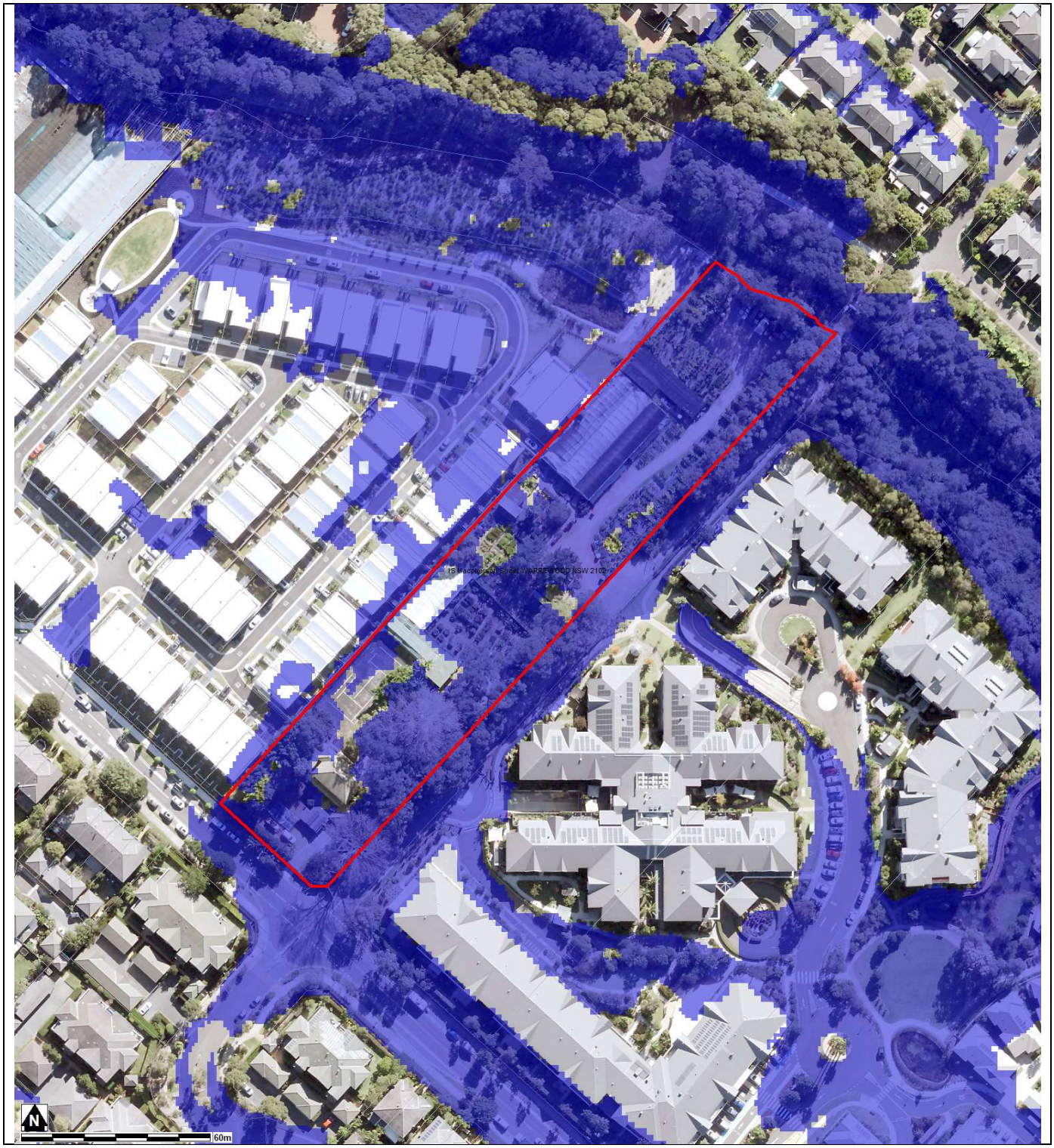
FLOOD MAP E: PMF FLOOD HYDRAULIC CATEGORY EXTENT MAP



Notes:

- Extent represents the Probable Maximum Flood (PMF) event
- Extent does not include climate change
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Ingleside, Elanora and Warriewood Overland Flow Flood Study 2019, WMAwater) and aerial photography (Source: NearMap 2014) are indicative only

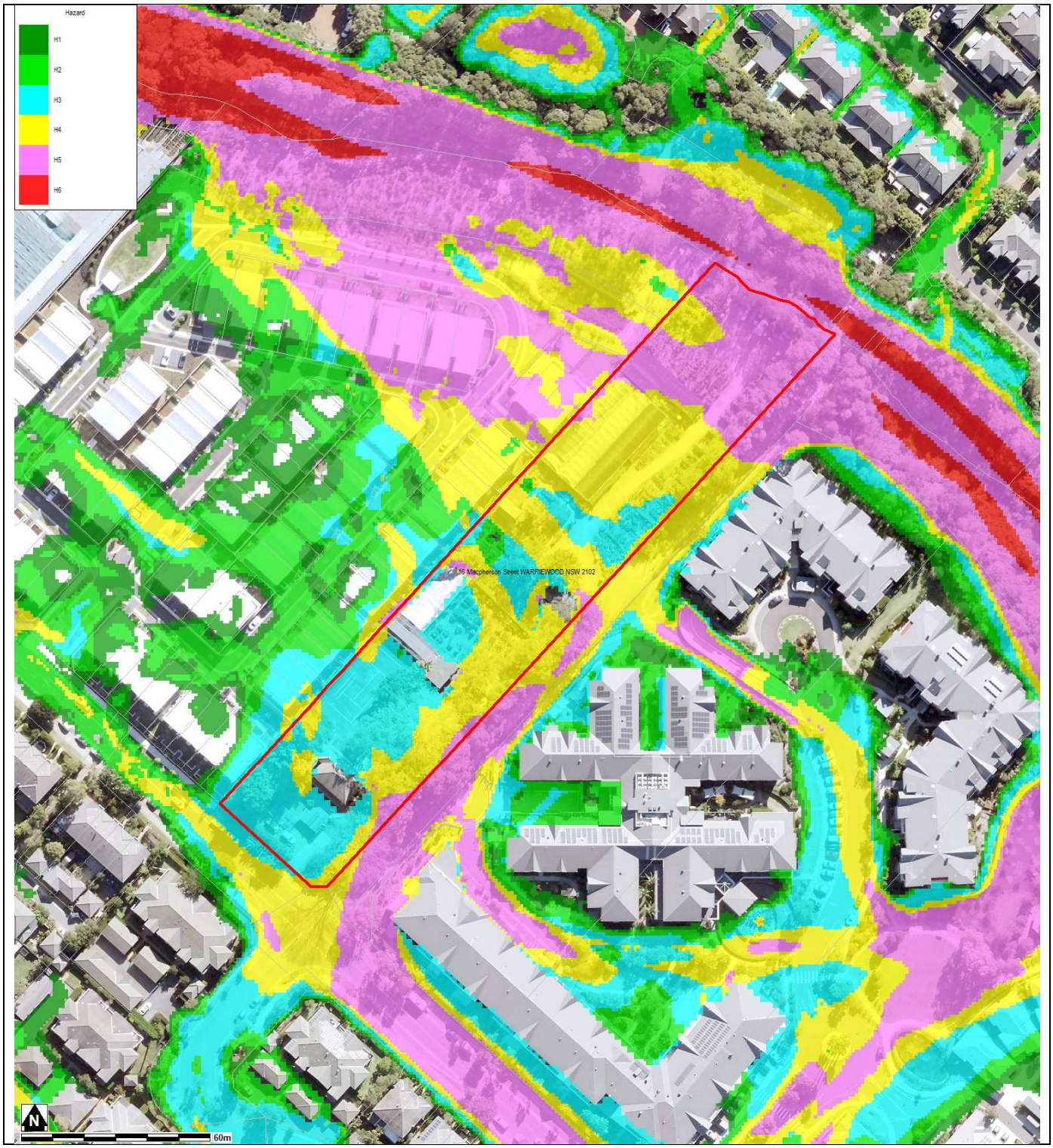
FLOOD MAP F: FLOODING – 1% AEP EXTENT PLUS CLIMATE CHANGE



Note:

- Extent represents the 1% annual Exceedance Probability (AEP) flood event including 30% rainfall intensity and 0.9m Sea Level Rise climate change scenario
- Flood events exceeding the 1% AEP can occur on this site.
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Ingleside, Elanora and Warriewood Overland Flow Flood Study 2019, WMAwater) and aerial photography (Source: NearMap 2014) are indicative only

FLOOD MAP G: FLOOD LIFE HAZARD CATEGORY



Notes:

- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Ingleside, Elanora and Warriewood Overland Flow Flood Study 2019, WMAwater) and aerial photography (Source Near Map 2014) are indicative only.

MAP H: INDICATIVE GROUND SURFACE SPOT HEIGHTS


24
23
22


18
17
16
15
14

Notes:

- The surface spot heights shown on this map were derived from Airborne Laser Survey and are indicative only.
- Accuracy is generally within ± 0.2m vertically and ± 0.15m horizontally, and Northern Beaches Council does not warrant that the data does not contain errors.
- If accuracy is required, then survey should be undertaken by a registered surveyor.

Preparation of a Flood Management Report

Introduction

These guidelines are intended to provide advice to applicants on how to determine what rules apply on flood prone land, and how to prepare a Flood Management Report. The purpose of a Flood Management Report is to demonstrate how a proposed development will comply with flood related planning requirements.

Planning Requirements for Flood Prone Land

Development must comply with the requirements for developing flood prone land set out in the relevant Local Environment Plan (LEP) and Development Control Plan (DCP). There are separate LEPs and DCPs for each of the former Local Government Areas (LGAs), although preparation of a LGA-wide LEP and DCP is currently under way.

The clauses specific to flooding in the LEPs and DCPs are as follows:

LEP Clauses	DCP Clauses
Manly LEP (2013) – 6.3 Flood Planning	Manly DCP (2013) – 5.4.3 Flood Prone Land
Warringah LEP (2011) – 6.3 Flood Planning Warringah LEP (2000) – 47 Flood Affected Land *	Warringah DCP (2011) – E11 Flood Prone Land
Pittwater LEP (2014) – 7.3 Flood Planning Pittwater LEP (2014) – 7.4 Flood Risk Management	Pittwater 21 DCP (2014) – B3.11 Flood Prone Land Pittwater 21 DCP (2014) – B3.12 Climate Change

* The Warringah LEP (2000) is relevant only for the “deferred lands” which affects only a very small number of properties, mostly in the Oxford Falls area.

Development on flood prone land must also comply with Council’s Water Management for Development Policy, and if it is in the Warriewood Release Area, with the Warriewood Valley Water Management Specification. Guidelines for Flood Emergency Response Planning are available for addressing emergency response requirements in the DCP. These documents can be found on Council’s website on the Flooding page.

Note that if the property is affected by estuarine flooding or other coastal issues, these need to be addressed separately under the relevant DCP clauses.

When is a Flood Management Report required?

A Flood Management Report must be submitted with any Development Application on flood prone land (with exceptions noted below), for Council to consider the potential flood impacts and applicable controls. For Residential or Commercial development, it is required for development on land identified within the Medium or High Flood Risk Precinct. For Vulnerable or Critical development, it is required if it is within any Flood Risk Precinct.

There are some circumstances where a formal Flood Management Report undertaken by a professional engineer may not be required. However the relevant parts of the DCP and LEP would still need to be addressed, so as to demonstrate compliance. Examples where this may apply include:

- If all proposed works are located outside the relevant Flood Risk Precinct extent
- First floor addition only, where the floor level is above the Probable Maximum Flood level
- Internal works only, where habitable floor areas below the FPL are not being increased

Note that development on flood prone land will still be assessed for compliance with the relevant DCP and LEP, and may still be subject to flood related development controls.

What is the purpose of a Flood Management Report?

The purpose of a Flood Management Report is to demonstrate how a proposed development will comply with flood planning requirements, particularly the development controls outlined in the relevant LEP and DCP clauses. The report must detail the design, measures and controls needed to achieve compliance, following the steps outlined below.

A Flood Management Report should reflect the size, type and location of the development, proportionate to the scope of the works proposed, and considering its relationship to surrounding development. The report should also assess the flood risk to life and property.

Preparation of a Flood Management Report

The technical requirements for a Flood Management Report include (where relevant):

1. Description of development
   - Outline of the proposed development, with plans if necessary for clarity
   - Use of the building, hours of operation, proposed traffic usage or movement
   - Type of use, eg vulnerable, critical, residential, business, industrial, subdivision, etc

2. Flood analysis
   - 1% AEP flood level
   - Flood Planning Level (FPL)
   - Probable Maximum Flood (PMF) level
   - Flood Risk Precinct, ie High, Medium or Low
   - Flood Life Hazard Category
   - Mapping of relevant extents
   - Flood characteristics for the site, eg depth, velocity, hazard and hydraulic category, and the relevance to the proposed development

   If the property is affected by an Estuarine Planning Level (EPL) which is higher than the FPL, then the EPL should be used as the FPL. If the FPL is higher than the PMF level, then the FPL should still be used as the FPL, as it includes freeboard which the PMF does not.

3. Assessment of impacts
- Summary of compliance for each category of the DCP, as per the table below.

	Compliance		
	N/A	Yes	No
A) Flood effects caused by Development			
B) Building Components & Structural Soundness			
C) Floor Levels			
D) Car parking			
E) Emergency Response			
F) Fencing			
G) Storage of Goods			
H) Pools			

- Demonstration of how the development complies with any relevant flood planning requirements from the DCP, LEP, Water Management for Development Policy, and if it is in the Warriewood Valley Urban Land Release Area, with the Warriewood Valley Water Management Specification (2001)
- For any non-compliance, a justification for why the development should still be considered.
- Calculations of available flood storage if compensatory flood storage is proposed
- Plan of the proposed development site showing the predicted 1% AEP and PMF flood extents, as well as any high hazard or floodway affectation
- Development recommendations and construction methodologies
- Qualifications of author - Council requires that the Flood Management Report be prepared by a suitably qualified Engineer with experience in flood design / management who has, or is eligible for, membership to the Institution of Engineers Australia
- Any flood advice provided by Council
- Any other details which may be relevant

Further information and guidelines for development are available on Council's website at:

https://www.northernbeaches.nsw.gov.au/planning-and-development/building-and-renovations/development-applications/guidelines-development-flood-prone-land

Council's Flood Team may be contacted on 1300 434 434 or at floodplain@northernbeaches.nsw.gov.au .

Attachment E2

From: Flood plain
To: Brett Phillips
Cc: William Allen; Chris Webster; Matthew Zollinger; Ghazal Hosseini; Flood plain
Subject: RE: NW30291 Flood Information Report 16 Macpherson Street WARRIEWOOD
Date: Friday, 18 March 2022 11:04:38 AM
Attachments: image012.png
image013.png
image014.png
image015.png
image016.png
image017.png
image018.png
image003.png
Additional Points 16 Macpherson Street Warriewood.pdf
Flood Information Report 16 Macpherson Street Warriewood Rev2.pdf

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Dear Brett,

Please find attached the updated Comprehensive Flood Information Report for 16 Macpherson Street, Warriewood and answers to your questions below.

Sorry about the confusion with the climate change results. The results have not been enveloped at the peak level. To get the 1% AEP climate change levels please add 200mm to the 1% AEP levels.

This table provides the Flood Planning Levels.

ID	FPL = (CC 1% AEP WL+ freeboard)
1	5.99
2	5.87
3	6
4	5.95
5	6.28
6	5.96
7	6.13
8	5.97
9	5.91
10	5.97
11	5.74
12	5.97

Please also see attached extra levels around ID 5 if it helps.

Kind regards,
Christina

Christina Femia
Senior Water Cycle Officer

Stormwater, Floodplain Engineering
t 02 8495 6656 **m** 0407921040
christina.femia@northernbeaches.nsw.gov.au
northernbeaches.nsw.gov.au

northern beaches council

From: Brett Phillips <Brett.Phillips@cardno.com.au>
Sent: Monday, 14 March 2022 11:17 AM
To: Ghazal Hosseini <Ghazal.Hosseini@northernbeaches.nsw.gov.au>
Cc: Flood plain <floodplain@northernbeaches.nsw.gov.au>; William Allen <wallen@ipmproperty.com.au>; Chris Webster <cwebster@ipmproperty.com.au>; Matthew Zollinger <matthew.zollinger@cardno.com.au>
Subject: NW30291 Flood Information Report 16 Macpherson Street WARRIEWOOD

Ghazal,

Thanks for issuing the attached Comprehensive Flood Information Report for 16 Macpherson Street Warriewood.

We have summarised the flood levels provided in Council's report as follows:

ID	Inferred Ground Level (m AHD)	1% AEP Max WL (m AHD)	Freeboard (m)	CC 1% AEP Max WL (m AHD)	Impact of CC in a 1% AEP Flood (m)	PMF Max WL (m AHD)	FPL = 1% AEP FL + Freeboard + CC (m AHD)	PMF-FPL (m)
1	4.80	5.29	0.50	5.05	-0.24	6.01	5.55	0.46
2	4.62	5.17	0.50	4.63	-0.54	5.91	5.13	0.78
3	5.00	5.30	0.50	5.48	0.18	6.02	5.98	0.04
4	4.62	5.25	0.50	4.68	-0.57	6.01	5.18	0.83
5	5.60	5.78	0.30	5.86	0.08	6.05	6.16	-0.11
6	4.85	5.26	0.50	5.45	0.19	5.99	5.95	0.04
7	5.35	5.63	0.30	5.76	0.13	6.11	6.06	0.05
8	4.70	5.27	0.50	5.44	0.17	5.97	5.94	0.03
9	5.16	5.41	0.30	5.47	0.06	5.97	5.77	0.20
10	4.45	5.27	0.50	5.43	0.16	5.92	5.93	-0.01
11	5.23	N/A	0.3	5.44	0.21	5.91	5.74	0.17
12	4.81	5.27	0.50	5.42	0.15	5.90	5.92	-0.02

A variable Flood Planning Level might apply. Freeboard is generally 0.5m above the maximum 1% AEP water level. However for overland flow with a depth less than 0.3m and a VelocityxDepth product less than 0.3m2/s, a freeboard of 0.3m may be able to be justified.

Our queries regarding Council's flood information and its application are as follows:

(i) Can Council please explain why a 30% increase in the 1% AEP rainfall intensity reduces the 1% AEP flood level at a three locations by up to 0.57 m? Sorry about the confusion. The results are due to a modelling issue with the enveloping of the peak climate change results. Please add 200mm to the 1% AEP levels to get the 1% AEP climate change levels.

(ii) Council has advised a Maximum FPL = 6.28 m AHD. Given the summary above can Council please explain how it calculated this Flood Planning Level and at which location? Close to Point 5 with a freeboard of 500mm.

(iii) While Council noted in part: *Vulnerable/critical developments require higher minimum floor levels using the higher of the PMF or FPL* in the case of Residential development (ie. not vulnerable nor critical) if the FPL is higher than the PMF is it acceptable to set the floor level at the PMF. No the minimum floor levels should be set at the FPL.

Cheers
Brett

Dr Brett C Phillips
DISCIPLINE LEADER - WATER
SENIOR PRINCIPAL - HYDROLOGY
CARDNO now STANTEC

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Postal PO Box 19, St Leonards NSW 1590
Email brett.phillips@cardno.com.au Web www.cardno.com
CONNECT WITH CARDNO

Cardno acknowledges the Traditional Owners of the land upon which we live and work and pay our respects to their Elders past, present and emerging - learn more.

From: Ghazal Hosseini <Ghazal.Hosseini@northernbeaches.nsw.gov.au>
Sent: Monday, 14 March 2022 9:49 AM
To: Brett Phillips <Brett.Phillips@cardno.com.au>
Cc: Flood plain <floodplain@northernbeaches.nsw.gov.au>
Subject: Flood Information Report 16 Macpherson Street WARRIEWOOD

Hi Brett,

Please find attached the flood information certificate for 16 Macpherson Street WARRIEWOOD.

If you have any question please call 1300 434 434 and ask for flood officer or email floodplain@northernbeaches.nsw.gov.au.

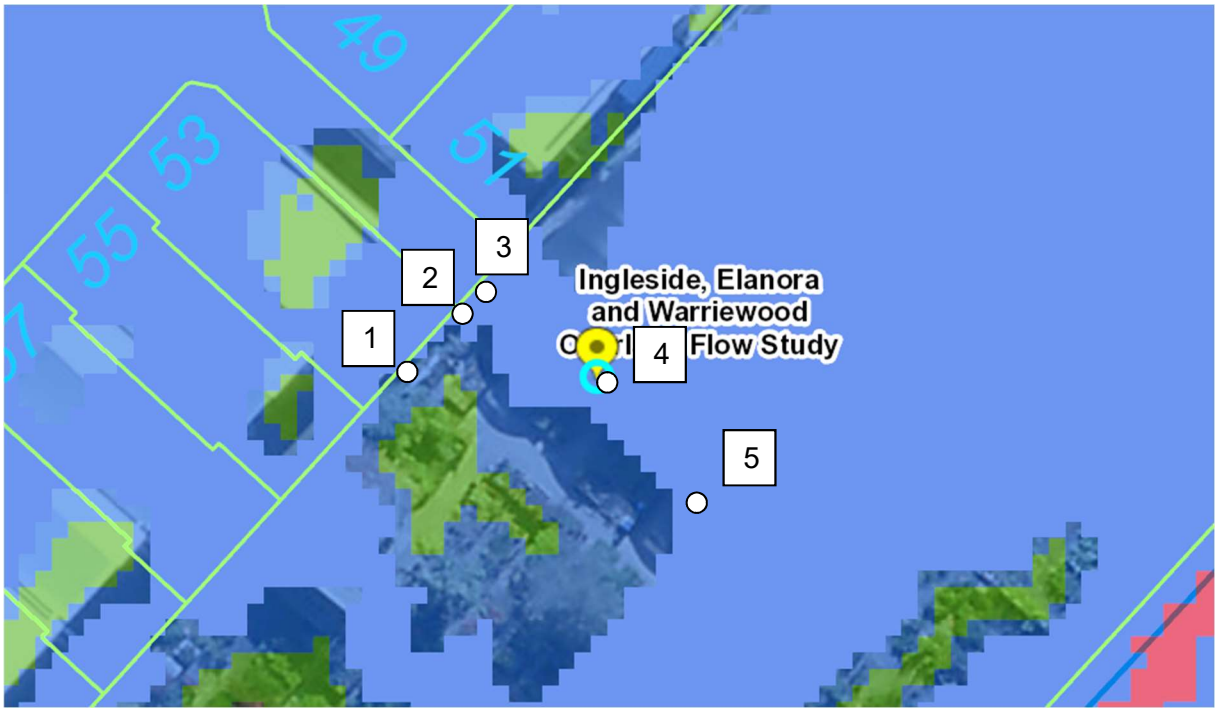
Kind regards,

Ghazal Hosseini
Contractor - Project Engineer

Stormwater, Floodplain Engineering
t
ghazal.hosseini@northernbeaches.nsw.gov.au
northernbeaches.nsw.gov.au

northern beaches council

Attachment E3



	1% AEP levels (m AHD)
1	5.72
2	5.64
3	5.64
4	5.37
5	5.28

Attachment E4

From: Valerie Tulk
To: Brett Phillips
Cc: Anne-Marie Young; Chris Webster; William Allen; Venus Jofreh; Leo Zhou; Adrian Miller; Andrew Hilly; Robert Barbuto; David Hellot
Subject: RE: NW30291 Flood Information for 16 Macpherson Street WARRIEWOOD
Date: Thursday, 2 February 2023 5:51:49 PM
Attachments: image003.png
image008.png
image010.png
image018.png

Hi Brett,
We recognise that there are discrepancies between the documents, which makes it complex to work out what is required for a DA.
As far as flooding is concerned, please address Control C6.1 (in conjunction with Control B3.12) of the Pittwater DCP first, which require that climate change (CC) should be included in all flood assessment.
Consideration of climate change only needs to include a 30% increase in rainfall intensity, as this property is considered to be upstream of the impact of Narrabeen Lagoon even in the PMF. Sea level rise and tailwater levels do not need to be considered.

Controls C6.1 and B3.12 of the Pittwater DCP:
Adverse impacts on flood levels: 50% AEP, 20% AEP, 1% AEP, PMF - all including CC
Adverse impacts on flood velocities: 1% AEP, PMF - both including CC

Flood Category: for 1% +CC
Flood Hazard Category: for PMF +CC

Floor levels: FPL +CC
Building platform: FPL +CC

Control C6.1 states that "The filling of land will only be permitted where it can be demonstrated within the Water Management Report that:

- there is no net decrease in the floodplain volume of the floodway or flood storage area within the property, for any flood event up to the 1% AEP flood event and the PMF event including climate change considerations for both design events; and/or
- there is no additional adverse flood impact on the subject and surrounding properties and flooding processes for any flood event up to the PMF event including climate change impacts".

In this statement, please note the "and/or" – I'd suggest that the second bullet point would be the more appropriate method of demonstration for this development.

Adverse impacts are defined in Section A1.9 of the DCP and require that "the proposed development:
Will result in less than 0.02m increase in the 1% AEP
Will result in less than a 0.05m increase in the PMF
Will result less than a 10% increase in PMF peak velocity
Will have no loss in flood storage or flood way in the 1% AEP".

For this property, where adverse impacts need to be assessed for a broader range of design floods, assessment should show that the proposed development:
Will result in less than 0.02m increase in the 1% AEP, 20% AEP and 50% AEP – all including CC
Will result in less than a 0.05m increase in the PMF – including CC
Will result in less than a 10% increase in the PMF and 1% AEP peak velocities – including CC
Will have no loss in flood storage or flood way in the 1% AEP – including CC.

As per the comment above, if the second method of demonstration is selected then there does not have to be zero loss of flood storage or floodway in the 1% AEP event.
Impact mapping is required for each aspect of the impact assessment.

Warriewood Valley Urban Land Release Water Management Specification:
The Warriewood Valley Urban Land Release Water Management Specification was prepared in 2001. It contains no mention of climate change, as it was prepared before Council had any requirements for inclusion of climate change in flood modelling.
Climate change does not need to be included (but can be if you think it appropriate or simpler) for the design level requirements listed in Table 4.3 except where climate change needs to be considered as identified above, ie for the

FPL, floor levels, and flood hazard in the PMF. The Specification calls for mapping of the 1% AEP and PMF flood extents – please map both with and without CC. If the post-development flood hazard is H3 or larger, shelter in place refuge is required above the PMF+CC level.

The Flood Information Report previously supplied to you by Council was based on the best information and mapping that we have available to us in our system. It does not include information for all of the events listed above, and modelling will be required as part of the assessment.

If any of this information conflicts with information provided for the previous Pre-lodgement Meeting PLM2022/0211, this information takes precedence.
I hope this provides clarification on what is required. Please feel free to contact me if you would like to discuss.

Kind regards,
Valerie

Valerie Tulk
Senior Engineer - Floodplain Management and Strategic Projects

Stormwater, Floodplain Engineering
t 02 8495 6646 **m** 0412 987 728
valerie.tulk@northernbeaches.nsw.gov.au
northernbeaches.nsw.gov.au

northern beaches council

From: Brett Phillips <Brett.Phillips@cardno.com.au>
Sent: Monday, 23 January 2023 5:29 PM
To: Valerie Tulk <Valerie.Tulk@northernbeaches.nsw.gov.au>
Cc: Anne-Marie Young <Anne-Marie.Young@northernbeaches.nsw.gov.au>; Chris Webster <cwebster@ipmproperty.com.au>; William Allen <wallen@ipmproperty.com.au>; Venus Jofreh <venus.jofreh@cardno.com.au>; Leo Zhou <lzhou@crhodes.com.au>; Adrian Miller <amiller@crhodes.com.au>; Andrew Hilly <ahilly@crhodes.com.au>
Subject: NW30291 Flood Information Report with updated hydraulic categories - 16 Macpherson Street WARRIEWOOD

Valerie,

We have summarised the design floods assessed in the 2019 Ingleside, Elanora and Warriewood Overland Flow Flood Study and identified in

- 2001 Warriewood Valley Urban Land Release Water Management Specification Table 4.3 Flood Planning Levels
- Section C Development Control Types, C6 Design Criteria for Warriewood Valley Release Area

as follows:

NW30291 Summary of Warriewood OFFS Design Floods

	A			B	C
AEP	0% CC	10%CC	30%CC	0%CC	30%CC
50%					
20%					
10%					
5%					
2%					
1%					
0.2%					
0.1%					
PMF					

A Ingleside, Elanora and Warriewood Overland Flow Flood Study (WMA Water, 2019)
B 2001 Warriewood Valley Urban Land Release Water Management Specification Table 4.3 Flood Planning Levels
C Section C Development Control Types, C6 Design Criteria for Warriewood Valley Release Area

Noting that Council has not run any 50% AEP events nor the 20% AEP +30%CC event, can Council please identify the events that need to be included in a Flood Impact Assessment for 16 Macpherson Street, Warriewood.

Cheers
Brett

Dr Brett C Phillips
Senior Principal - Water Resources
Senior Principal - Hydrology

Phone: +61 2 9496 7777
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Stantec Australia
Level 9, The Forum, 203 Pacific Highway St Leonards New South Wales 2065 Australia
PO Box 19, St Leonards NSW 1590

From: Valerie Tulk <Valerie.Tulk@northernbeaches.nsw.gov.au>
Sent: Friday, 2 December 2022 6:21 PM
To: Brett Phillips <Brett.Phillips@cardno.com.au>
Cc: Anne-Marie Young <Anne-Marie.Young@northernbeaches.nsw.gov.au>
Subject: Flood Information Report with updated hydraulic categories - 16 Macpherson Street WARRIEWOOD

Hi Brett,
Please find attached the Flood Information Report for 16 Macpherson St, updated with the correct hydraulic category mapping, as discussed at the Pre-lodgement Meeting yesterday.
Apologies that the original report contained the incorrect hydraulic categories – these were based on the Narrabeen Lagoon FS which was not so accurate in this area as the Ingleside, Elanora and Warriewood OFFS.
I expect you probably noticed yourself that the previously supplied 1% AEP and PMF hydraulic category extents did not match very well with the 1% AEP and PMF extents in the rest of the Flood Information Report.

Kind regards,
Valerie

Valerie Tulk
Acting Team Leader, Floodplain Planning & Response

Stormwater, Floodplain Engineering
t 02 8495 6646 **m** 0412 987 728
valerie.tulk@northernbeaches.nsw.gov.au
northernbeaches.nsw.gov.au

From: Ghazal Hosseini
Sent: Monday, 14 March 2022 9:49 AM
To: brett.phillips@cardno.com.au
Cc: Flood plain <floodplain@northernbeaches.nsw.gov.au>
Subject: Flood Information Report 16 Macpherson Street WARRIEWOOD

Hi Brett,

Please find attached the flood information certificate for 16 Macpherson Street WARRIEWOOD.

If you have any question please call 1300 434 434 and ask for flood officer or email floodplain@northernbeaches.nsw.gov.au.

Kind regards,

Ghazal Hosseini
Contractor - Project Engineer

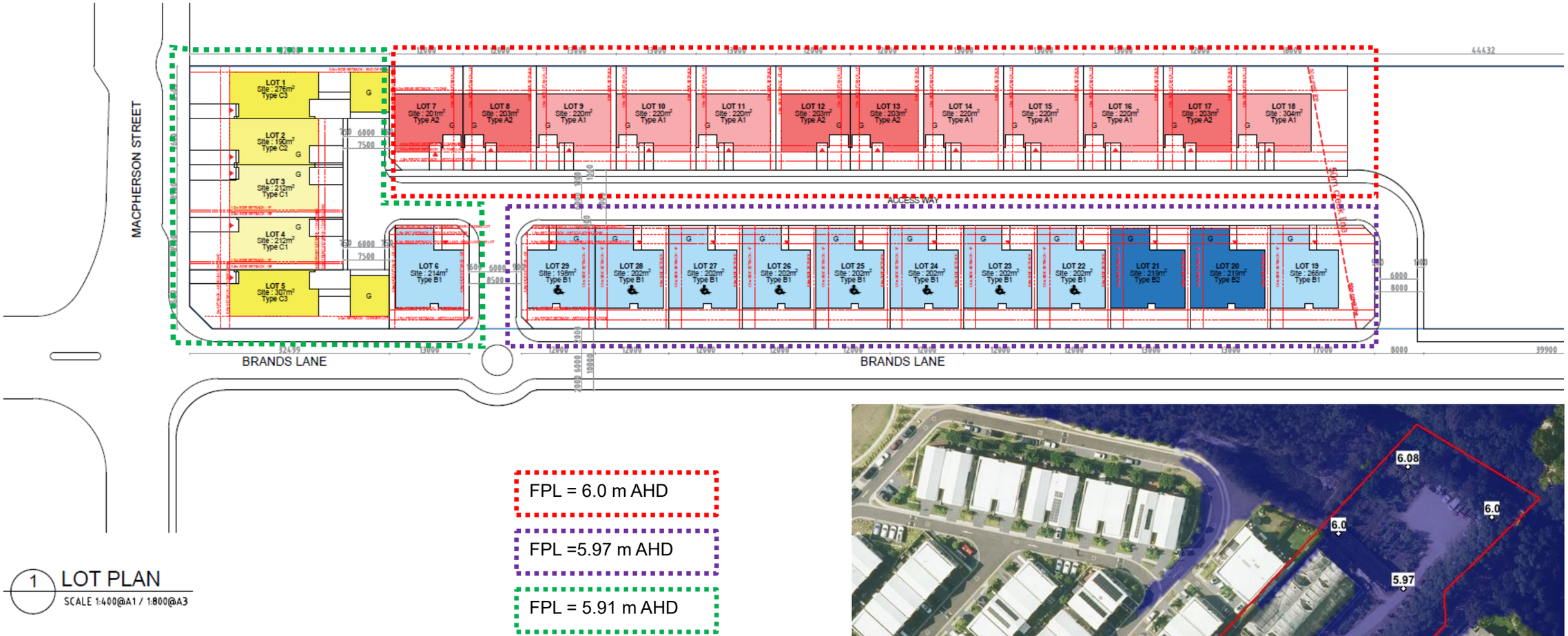
Stormwater, Floodplain Engineering
t
ghazal.hosseini@northernbeaches.nsw.gov.au
northernbeaches.nsw.gov.au

16 Macpherson Street, Warriewood

APPENDIX F
FLOOD PLANNING LEVELS

Stantec

NW30291 Proposed Flood Planning Levels for Lots



1 LOT PLAN
SCALE 1:400@A1 / 1:800@A3

FPL = 6.0 m AHD

FPL =5.97 m AHD

FPL = 5.91 m AHD

16 Macpherson Street, Warriewood

APPENDIX G
SELECTED DEVELOPMENT PLANS

Stantec

A1

D.A. _ _ _ _ _ _

PROPOSED SUBDIVISION of
LOT 4 D.P. 553816
16 MACPHERSON STREET, WARRIEWOOD

CIVIL WORKS
DEVELOPMENT APPLICATION

(SOURCE: NEARMAP MARCH 2023)

LOCALITY PLAN

NOT TO SCALE

DRAWING No.	DRAWING TITLE	REV.
048-22C-DA-0001	COVER SHEET, LOCALITY PLAN & INDEX	B
048-22C-DA-0002	GERNERAL NOTES	B
048-22C-DA-0003	GENERAL LEGEND	B
048-22C-DA-0004	KEY PLAN	B
048-22C-DA-0021	DEMOLISHION PLAN	B
048-22C-DA-0051	BULK EARTHWORKS PLAN & CALUCATIONS	B
048-22C-DA-0061	BULK EARTHWORKS SITE SECTIONS SHEET 1 of 2	B
048-22C-DA-0062	BULK EARTHWORKS SITE SECTIONS SHEET 2 of 2	B
048-22C-DA-0101	ROAD & DRAINAGE PLAN SHEET 1 of 2	B
048-22C-DA-0102	ROAD & DRAINAGE PLAN SHEET 1 of 2	B
048-22C-DA-0151	TYPICAL ROAD CROSS SECTIONS	B
048-22C-DA-0201	ROAD LONGITUDINAL SECTIONS MacPHERSON STREET & ROAD No. 01	B
048-22C-DA-0202	ROAD LONGITUDINAL SECTIONS BARNDS LANE ROAD No. 02 & ROAD No. 03	B
048-22C-DA-0501	PAVEMENT PLAN	B
048-22C-DA-0701	CATCHMENT PLAN	B
048-22C-DA-0711	STORMWATER DRAINAGE LONGITUDINAL SECTIONS	B
048-22C-DA-0712	STORMWATER DRAINAGE LONGITUDINAL SECTIONS	B
048-22C-DA-0751	WSUD BASIN & OSD TANK PLAN AND CALCULATIONS	B
048-22C-DA-0752	WSUD BASIN & OSD TANK DETAILS	B
048-22C-DA-0753	DRAINAGE DETAILS	B
048-22C-DA-0801	RETAINING WALL PLAN (INDICATIVE HEIGHTS)	B
048-22C-DA-0901	SEDIMENT & EROSION CONTROL PLAN	B
048-22C-DA-0902	SEDIMENT & EROSION CONTROL DETAILS	B

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

APPROVED COMPANY ISO 45001 Occupational Health & Safety Management Systems — QMS Certification Services
APPROVED COMPANY ISO 14001 Environmental Management Systems — QMS Certification Services
APPROVED COMPANY ISO 9001 Quality Management Systems — QMS Certification Services
DIAL 1100 BEFORE YOU DIG

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES

L.G.A. NORTHERN BEACHES COUNCIL

Scale: AS SHOWN

Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

CRAIG& RHODES
TAKE THE LEAD

ABN 77 050 209 991 ACN 050 209 991
Suite 7.01, Level 7, 3 Rider Boulevard,
Rhodes, NSW, 2138
PO Box 3220, Rhodes NSW 2138
Tel. (02) 9869-1855
reception@crhodes.com.au
www.craigandrhodes.com.au

Drawing Title: COVER SHEET, LOCALITY PLAN & INDEX

C&R Ref. 048-22

Drawing Ref. 048-22C-DA-0001

Revision B

A1

LEGEND - CIVIL

DESCRIPTION	PROPOSED	EXISTING
LIMIT OF CONSTRUCTION		
CIVIL WORKS BOUNDARY		
SITE WORKS BOUNDARY		
DESIGN CONTOUR - MAJOR	49.0	49.0
DESIGN CONTOUR - MINOR		
MASONRY RETAINING WALL		
ROCK RETAINING WALL		
FENCE		
LOCKABLE GATE		
GUIDE POST		
SITE FENCE		
GUARD RAIL		
BATTER (EARTHWORKS) (TOP BATTER / BATTER TICK / BTM. BATTER)		
CENTRELINE / CHAINAGE	CH 0.00	
KERB LINE		
KERB LINE (FUTURE)		
KERB RETURN LABEL	KR-01	
SURFACE LEVEL	RL:90.00	RL:90.00
VEHICULAR CROSSING	VC	
DRIVEWAY		

LEGEND - PAVEMENT

DESCRIPTION	PROPOSED	EXISTING
ROAD		
TEMPORARY		
FOOTPATH		

LEGEND - SURVEY

DESCRIPTION	PROPOSED	EXISTING
TREES		
EXISTING TREES TO BE REMOVED (MUST BE CONCORDANT WITH ARBORIST REPORT)		

LEGEND - DRAINAGE

DESCRIPTION	PROPOSED	EXISTING	FUTURE	TEMPORARY
SUBSOIL DRAINAGE LINE	SS	SS		
SUBSOIL DRAINAGE FLUSHING POINT	FP			
STORMWATER DRAINAGE LINE				
RCBC CULVERT LINE				
FLOW DIRECTION AND PIPE SIZE	Ø375	Ø375	Ø375	Ø375
STUB, CAP AND BURY FOR FUTURE CONNECTION				
TEMPORARILY BLOCK PIPE				
STRUCTURAL STORMWATER PIT (LINTEL/GRATE VARIABLE)				
STORMWATER PIT - ONGRADE				
STORMWATER PIT - SAG				
STORMWATER PIT - SURFACE INLET				
STORMWATER PIT - JUNCTION PIT				
STORMWATER PIT LABEL (DRAINAGE LINE No. \ DRAINAGE PIT No.)	00\00	00\00	00\00	00\00
CONCRETE HEADWALL WITH RIPRAP SCOUR PROTECTION				
STACKED ROCK HEADWALL WITH RIPRAP SCOUR PROTECTION				
OVERLAND FLOW PATH				
CATCHMENT DIRECTION				
EARTHBANK (LOW FLOW)				
SWALE				
ROOF WATER OUTLET TO KERB				
ROOF WATER CONNECTION TO REAR OF LINTEL				
BASIN FENCE				
BASIN BIO FILTER				

LEGEND - SERVICES

DESCRIPTION	PROPOSED	EXISTING	FUTURE
O/H ELECTRICAL LINE	E	E	E
ELECTRICAL LINE	E	E	E
ELECTRICAL PILLAR			
STREET LIGHT			
POWER POLE	PP	PP	
ELECTRICAL SUBSTATION			
WATER LINE	W	W	W
WATER HYDRANT			
WATER STOP VALVE	X	X	
RECYCLE WATER	RW	RW	RW
COMMUNICATION LINE	C	C	C
GAS LINE	G	G	G
SEWER LINE	S	S	S
SEWER RISING MAIN	RM	RM	RM
SEWER LINE CONCRETE ENCASED	S		
SEWER MAINTENANCE HOLE			
SEWER MS/TMS			
NBN LINE	NBN	NBN	NBN
TELECOMS LINE	TEL	TEL	TEL
FIBRE OPTIC LINE	F	F	F
COMBINED SERVICES TRENCH			

ABBREVIATIONS

RKG	ROLL KERB AND GUTTER
K&G	KERB AND GUTTER
KO	KERB ONLY
ES	EDGE STRIP
DD	DISH DRAIN
PR	PRAM RAMP
VC	VEHICULAR CROSSING
RW	RETAINING WALL
S.G.G.P.	STANDARD GRATED GULLY PIT
G.S.I.P.	GRATED SURFACE INLET PIT
JP	JUNCTION PIT
HW	HEADWALL
GPT	GROSS POLLUTANT TRAP
TOW	TOP OF WALL
BOW	BOTTOM OF WALL
TFSL	TOP FINISHED SURFACE LEVEL
BFSL	BOTTOM FINISHED SURFACE LEVEL
RCP	STEEL REINFORCED CONCRETE PIPE
RRJ	RUBBER RING JOINT
C1 or C2	PIPE CLASS
MH	MAINTENANCE HOLE
MS	MAINTENANCE SHAFT
TMS	TERMINAL MAINTENANCE SHAFT
RP	RODDING POINT
HYD	HYDRANT
SV	STOP VALVE
SAG	LOW POINT
CREST	HIGH POINT
PP	POWER POLE

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES

L.G.A. NORTHERN BEACHES COUNCIL

Scale: AS SHOWN

Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

CRAIG & RHODES TAKE THE LEAD

ABN 77 050 209 991 ACN 050 209 991
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Tel. (02) 9869-1855
reception@crhodes.com.au
www.craigandrhodes.com.au

Drawing Title: GENERAL LEGEND

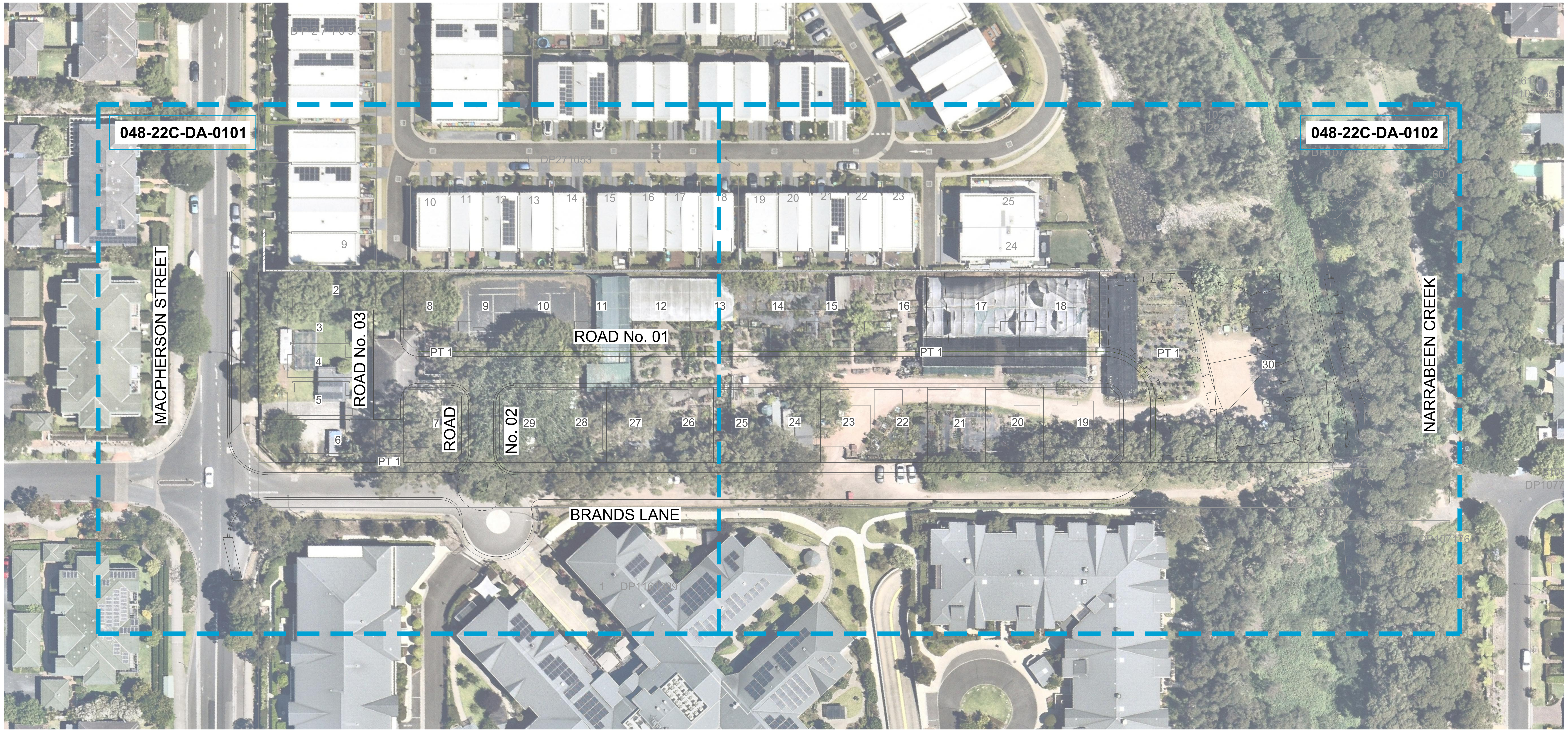
C&R Ref: 048-22

Drawing Ref: 048-22C-DA-0003

Revision: B

LEGEND

PLAN OUTLINE



PLAN

SCALE 1:500

0 5 10 15 20 30 40 50m

1:500 @A1

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
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A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES

L.G.A. NORTHERN BEACHES COUNCIL

Scale: AS SHOWN

Datum: AHD

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www.craigandrhodes.com.au

Drawing Title: KEY PLAN

C&R Ref.: 048-22

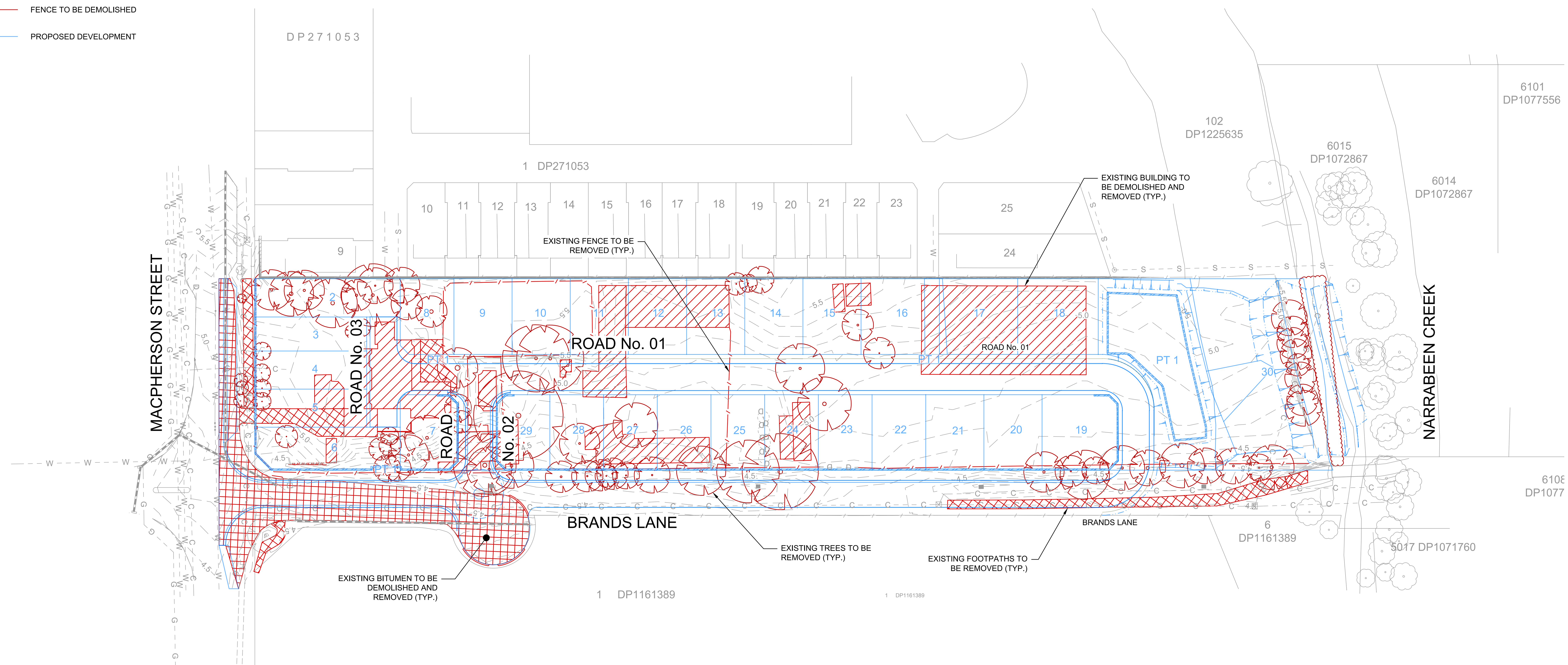
Drawing Ref.: 048-22C-DA-0004

Revision: B

LEGEND

- BUILDING STRUCTURES TO BE DEMOLISHED
- IMPERVIOUS SURFACES TO BE DEMOLISHED
- FENCE TO BE DEMOLISHED
- PROPOSED DEVELOPMENT

ALL EXISTING BUILDINGS, PAVEMENT & SERVICES WITHIN THE SITE BOUNDARIES ARE TO BE DEMOLISHED AND MATERIAL IS TO BE STOCKPILED AND REMOVED OFFSITE. UNLESS NOTED OTHERWISE.



PLAN

SCALE 1:500

0 5 10 15 20 30 40 50m
1:500 @A1

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
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A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES

L.G.A.: NORTHERN BEACHES COUNCIL

Scale: AS SHOWN

Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

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Tel. (02) 9869-1855
reception@crhodes.com.au
www.craigandrhodes.com.au

Drawing Title: DEMOLISHION PLAN

C&R Ref: 048-22

Drawing Ref: 048-22C-DA-0021

Revision: B

LEGEND

- MODELLED DESIGN SURFACE
- MODELLED BULK EARTHWORKS SURFACE

PLAN
SCALE 1:500

CUT FILL DEPTH LEGEND

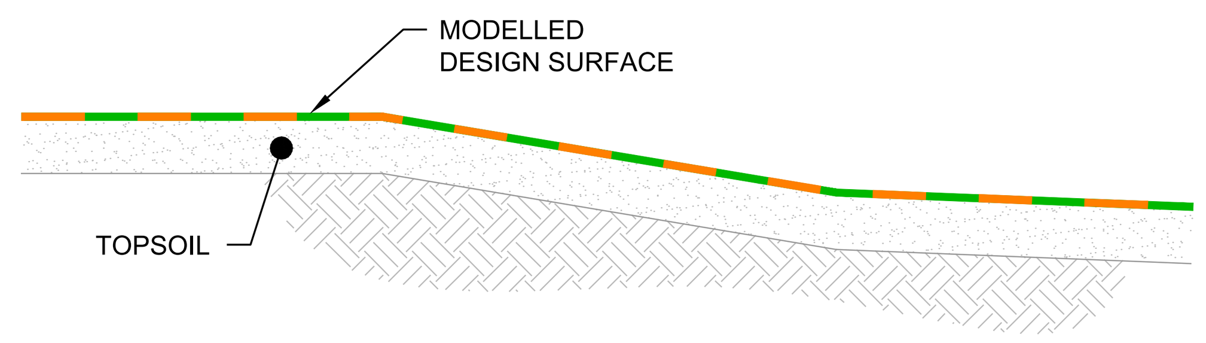
LOWER VALUE (m)	UPPER VALUE (m)	COLOUR
-3.5	-4	
-3	-3.5	
-2.5	-3	
-2	-2.5	
-1.5	-2	
-1	-1.5	
-0.5	-1	
0	-0.5	
0	0.5	
0.5	1	
1	1.5	
1.5	2	
2	2.5	
2.5	3	
3	3.5	
3.5	4	

CUT FILL VOLUMES (APPROX.):

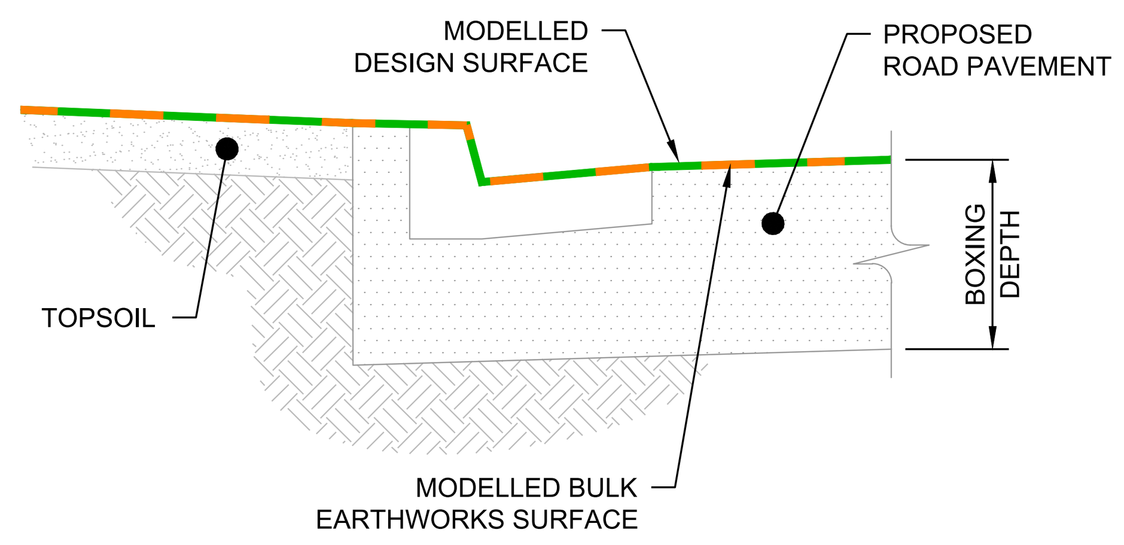
CUT = -1,212m^3
FILL = 7,858m^3
BALANCE = 6,646m^3 (IMPORTED FILL)

ALLOWANCES USED IN CALCULATIONS:

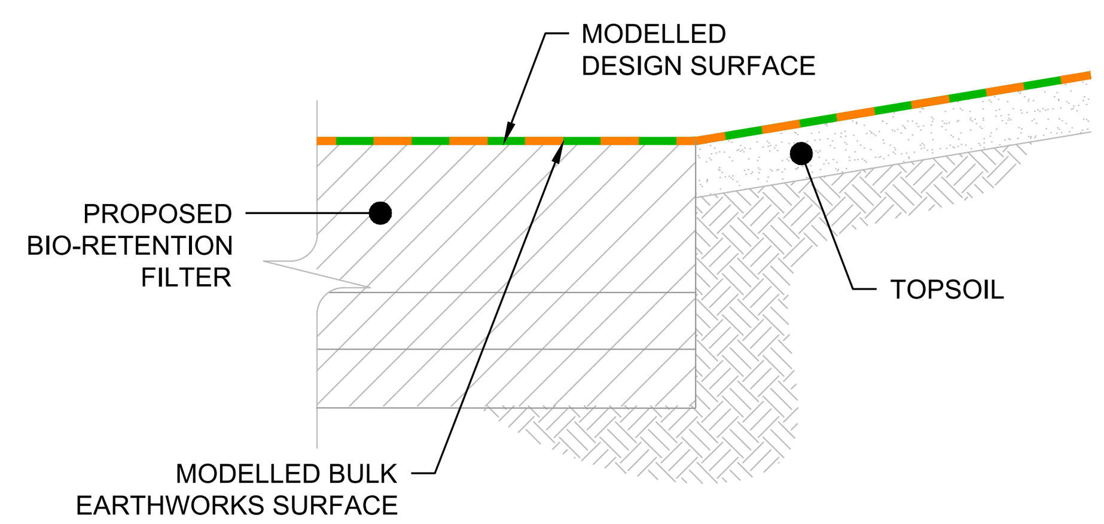
1. DOES NOT ALLOW BOXING DEPTH FOR ALL ROADS.
2. DOES NOT ALLOW FOR STRIPPING & REPLACEMENT OF TOPSOIL.
3. DOES NOT ALLOW FOR EXCAVATION OF DRAINAGE TRENCHES.
4. DOES NOT ALLOW FOR ANY UNSUITABLE MATERIAL FOUND ANYWHERE ON SITE.
5. DESIGN CONTOURS AND CUT FILL HATCH SHOWN IN THIS PLAN ARE THE FINAL SURFACE.



SECTION THROUGH LOTS
DETAIL 1 / -
NTS



SECTION THROUGH ROAD
DETAIL 2 / -
NTS



SECTION THROUGH BASIN
DETAIL 3 / -
NTS

0 5 10 15 20 30 40 50m
1:500 @A1

DEVELOPMENT APPLICATION

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L.G.A.: NORTHERN BEACHES COUNCIL
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Datum: AHD

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www.craigandrhodes.com.au

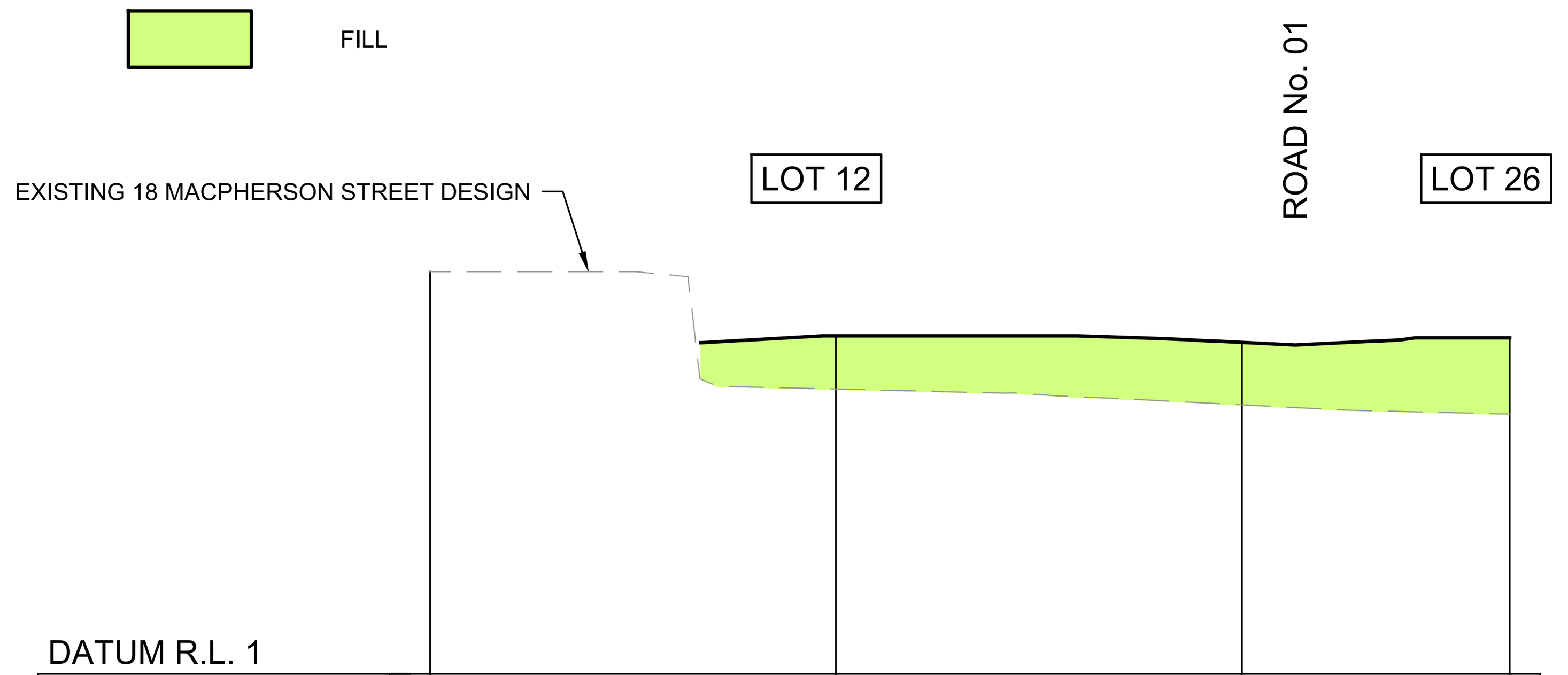
Drawing Title: BULK EARTHWORKS PLAN & CALUCATIONS

C&R Ref: 048-22
Drawing Ref: 048-22C-DA-0051
Revision: B

A1

LEGEND

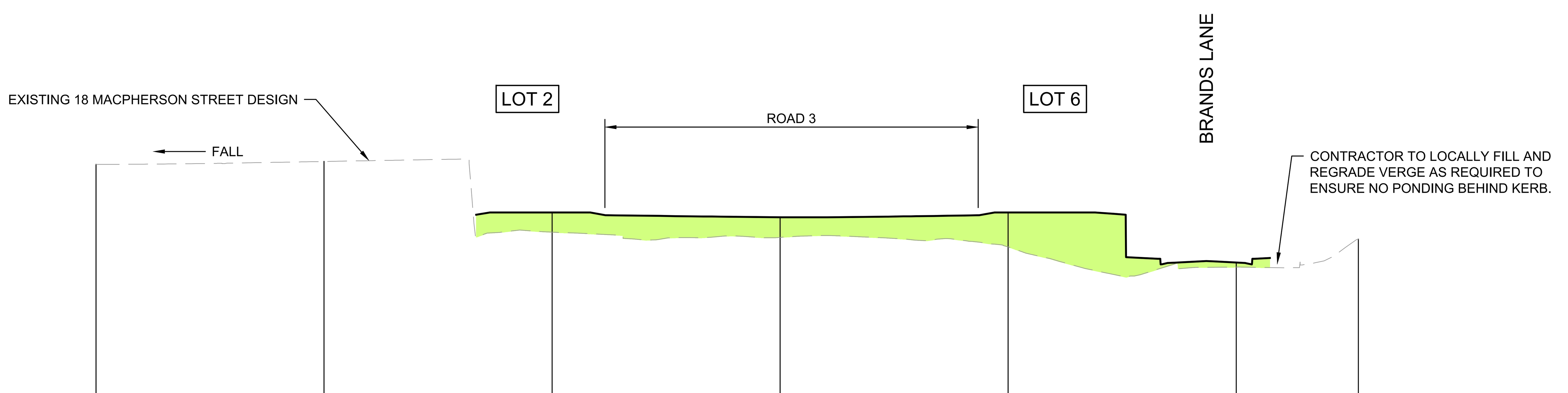
DESIGN SURFACE
FUTURE SURFACE
EXISTING SURFACE
CUT
FILL



DATUM R.L. 1

WAE				
DESIGN LEVEL		6.00	5.90	5.97
EXISTING LEVEL	6.95	5.21	4.98	4.84
CHAINAGE	0	15	30	39.9

B (0051) LONGITUDINAL SECTION
HORIZONTAL SCALE - 1:250
VERTICAL SCALE - 1:100



DATUM R.L. 1

WAE							
DESIGN LEVEL			5.91	5.78	5.91	4.59	
EXISTING LEVEL	7.17	7.25	5.39	5.25	5.00	4.47	5.21
CHAINAGE	0	15	30	45	60	75	83.04

A (0051) LONGITUDINAL SECTION
HORIZONTAL SCALE - 1:250
VERTICAL SCALE - 1:100

0 1 2 3 4 6 8 10m
1:100 @A1
0 2.5 5 7.5 10 15 20 25m
1:250 @A1

DEVELOPMENT APPLICATION

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A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

DIAL 1100 BEFORE YOU DIG

Authorised for issue by:
Signature:

Principal: IPM PROPERTIES
L.G.A. NORTHERN BEACHES COUNCIL
Scale: AS SHOWN
Datum: AHD

Project:
PROPOSED SUBDIVISION OF
LOT 4 D.P. 553816
16 MACPHERSON STREET, WARRIEWOOD

CRAIG & RHODES
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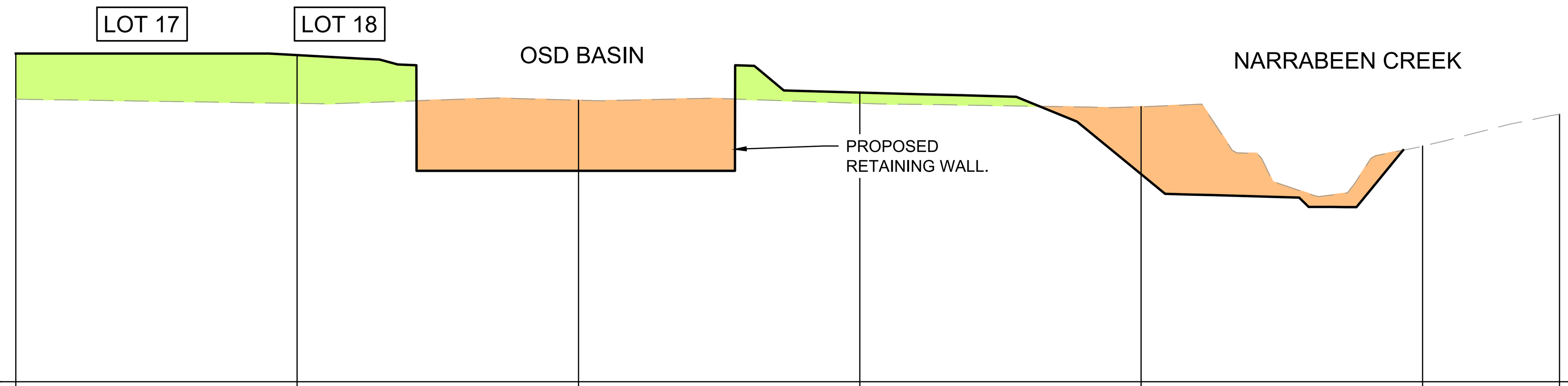
reception@crhodes.com.au
www.craigandrhodes.com.au

Drawing Title: BULK EARTHWORKS SITE SECTIONS SHEET 1 of 2
C&R Ref.: 048-22
Drawing Ref.: 048-22C-DA-0061
Revision: B

A1

LEGEND

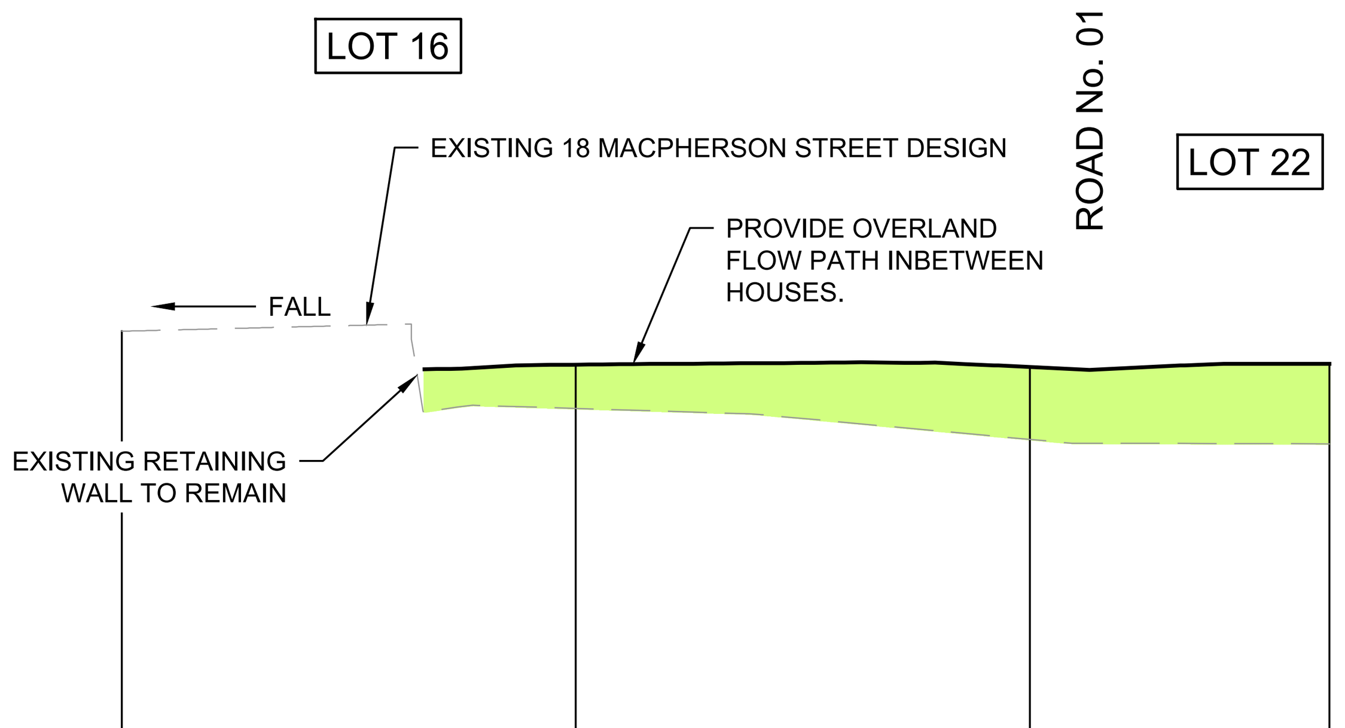
- DESIGN SURFACE
- FUTURE SURFACE
- EXISTING SURFACE
- CUT
- FILL



DATUM R.L. -1

WAE							
DESIGN LEVEL	6.00	5.97	3.50	5.17	3.43		
EXISTING LEVEL	5.03	4.94	5.00	4.94	4.87	4.02	4.71
CHAINAGE	0	15	30	45	60	75	82.3

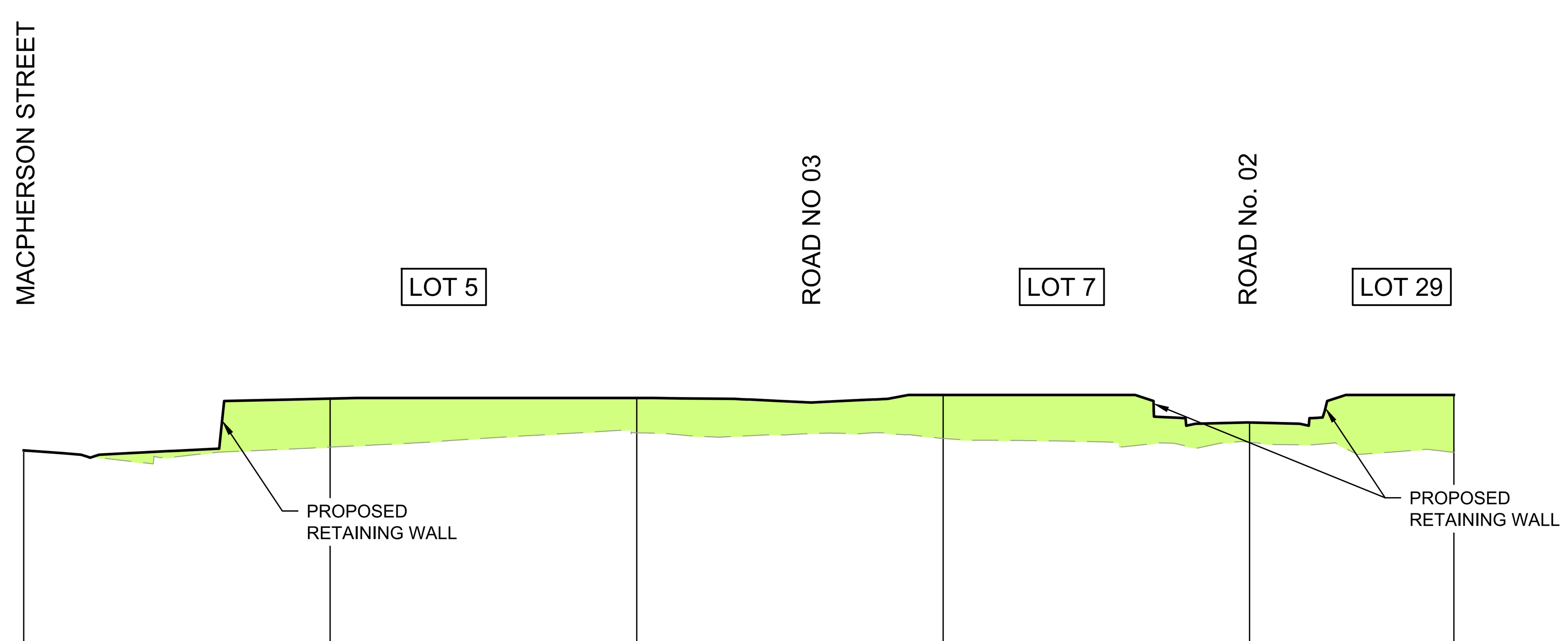
D 0051 LONGITUDINAL SECTION
HORIZONTAL SCALE - 1:250
VERTICAL SCALE - 1:100



DATUM R.L. 1

WAE				
DESIGN LEVEL		5.96	5.93	5.97
EXISTING LEVEL	6.40	5.38	4.97	4.91
CHAINAGE	0	15	30	39.9

C 0051 LONGITUDINAL SECTION
HORIZONTAL SCALE - 1:250
VERTICAL SCALE - 1:100



DATUM R.L. 1

WAE						
DESIGN LEVEL	4.89	5.90	5.91	5.97	5.43	5.97
EXISTING LEVEL	4.86	4.95	5.23	5.12	5.05	4.85
CHAINAGE	0	15	30	45	60	70

E 0051 LONGITUDINAL SECTION
HORIZONTAL SCALE - 1:250
VERTICAL SCALE - 1:100

0 1 2 3 4 6 8 10m
1:100 @A1
0 2.5 5 7.5 10 15 20 25m
1:250 @A1

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
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APPROVED COMPANY ISO 45001 · APPROVED COMPANY ISO 14001 · APPROVED COMPANY ISO 9001 · DIAL 1100 BEFORE YOU DIG

Authorised for issue by:
Signature:

Principal: IPM PROPERTIES
L.G.A. NORTHERN BEACHES COUNCIL
Scale: AS SHOWN
Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816
16 MACPHERSON STREET, WARRIEWOOD

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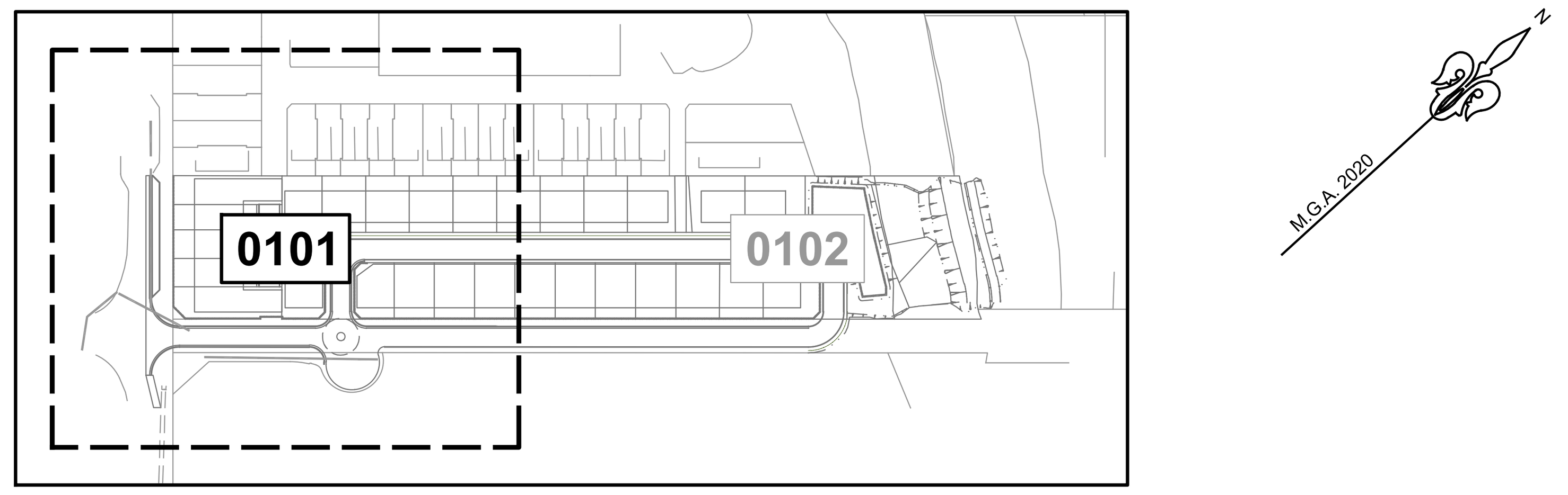
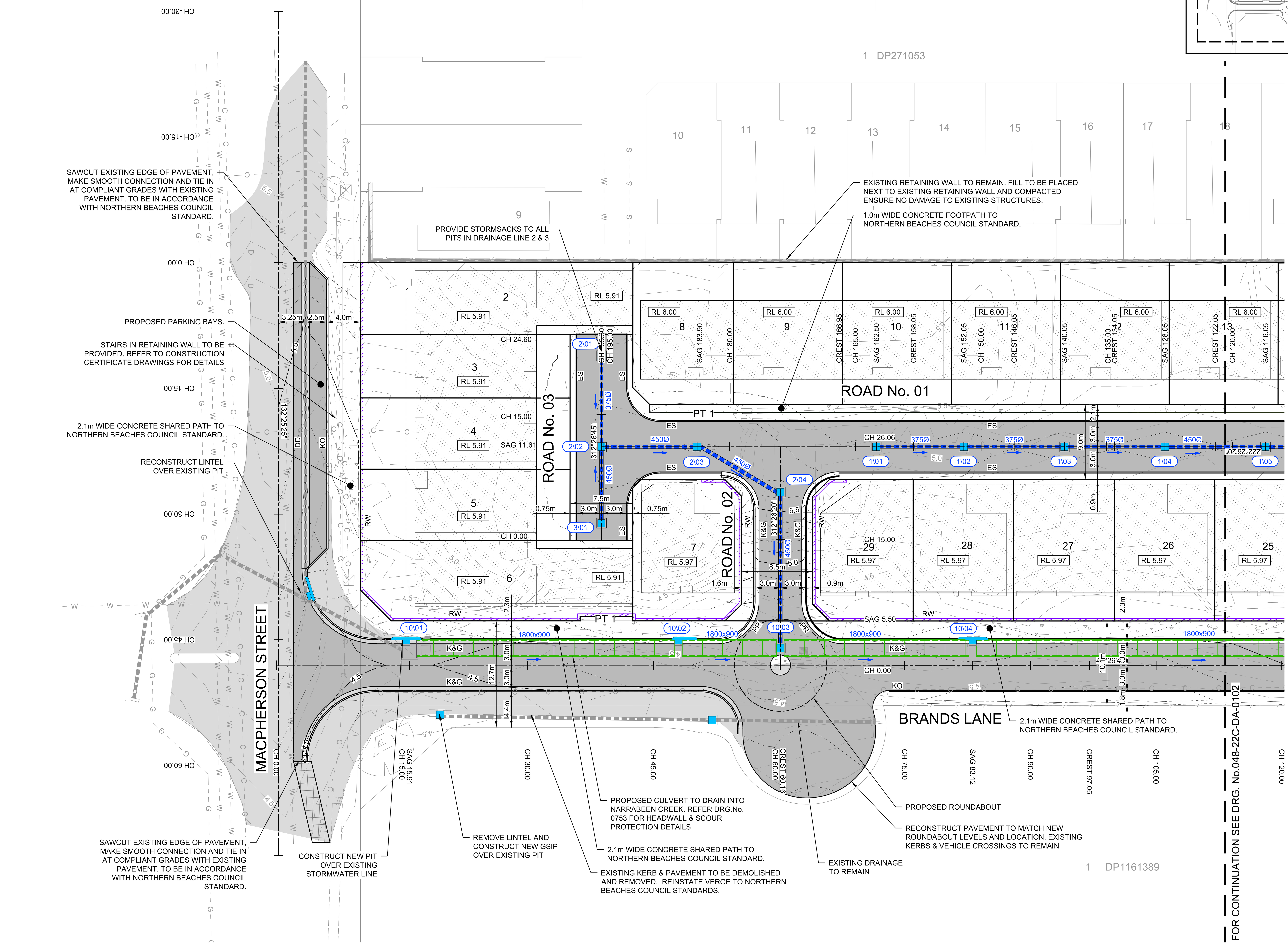
Tel. (02) 9869-1855
reception@crhodes.com.au
www.craigandrhodes.com.au

Drawing Title: BULK EARTHWORKS SITE SECTIONS
SHEET 2 of 2

C&R Ref: 048-22
Drawing Ref: 048-22C-DA-0062
Revision: B



KEY PLAN



SAWCUT EXISTING EDGE OF PAVEMENT, MAKE SMOOTH CONNECTION AND TIE IN AT COMPLIANT GRADES WITH EXISTING PAVEMENT. TO BE IN ACCORDANCE WITH NORTHERN BEACHES COUNCIL STANDARD.
PROPOSED PARKING BAYS.
STAIRS IN RETAINING WALL TO BE PROVIDED. REFER TO CONSTRUCTION CERTIFICATE DRAWINGS FOR DETAILS
2.1m WIDE CONCRETE SHARED PATH TO NORTHERN BEACHES COUNCIL STANDARD.
RECONSTRUCT LINTEL OVER EXISTING PIT
PROVIDE STORMSACKS TO ALL PITS IN DRAINAGE LINE 2 & 3
EXISTING RETAINING WALL TO REMAIN. FILL TO BE PLACED NEXT TO EXISTING RETAINING WALL AND COMPACTED ENSURE NO DAMAGE TO EXISTING STRUCTURES.
1.0m WIDE CONCRETE FOOTPATH TO NORTHERN BEACHES COUNCIL STANDARD.
1 DP271053
MACPHERSON STREET
ROAD No. 01
ROAD No. 02
ROAD No. 03
BRANDS LANE
2.1m WIDE CONCRETE SHARED PATH TO NORTHERN BEACHES COUNCIL STANDARD.
PROPOSED CULVERT TO DRAIN INTO NARRABEEN CREEK. REFER DRG.No. 0753 FOR HEADWALL & SCOUR PROTECTION DETAILS
REMOVE LINTEL AND CONSTRUCT NEW GSIP OVER EXISTING PIT
2.1m WIDE CONCRETE SHARED PATH TO NORTHERN BEACHES COUNCIL STANDARD.
EXISTING KERB & PAVEMENT TO BE DEMOLISHED AND REMOVED. REINSTATE VERGE TO NORTHERN BEACHES COUNCIL STANDARDS.
EXISTING DRAINAGE TO REMAIN
PROPOSED ROUNDABOUT
RECONSTRUCT PAVEMENT TO MATCH NEW ROUNDABOUT LEVELS AND LOCATION. EXISTING KERBS & VEHICLE CROSSINGS TO REMAIN
SAWCUT EXISTING EDGE OF PAVEMENT, MAKE SMOOTH CONNECTION AND TIE IN AT COMPLIANT GRADES WITH EXISTING PAVEMENT. TO BE IN ACCORDANCE WITH NORTHERN BEACHES COUNCIL STANDARD.
CONSTRUCT NEW PIT OVER EXISTING STORMWATER LINE
1 DP1161389
FOR CONTINUATION SEE DRG. No.048-22C-DA-0102

PLAN

SCALE 1:250

NOTES:

1. REFER TO DRG. No. 0003 FOR LEGEND & ABBREVIATIONS
2. REFER TO NORTHERN BEACHES COUNCIL FOR STANDARD DETAILS & DRAWINGS.
3. REFER TO ARCHITECTURAL DRAWINGS FOR INTERNAL DRIVEWAY & BUILDING DETAILS.
4. STORMWATER DRAINAGE EASEMENT SIZES:

   "A" = 1.5m WIDE STORMWATER DRAINAGE EASEMENT

   "B" = 2.0m WIDE TEMPORARY STORMWATER DRAINAGE EASEMENT
5. PROPOSED SEWER, WATER AND ELECTRIC SUBSTATION SHOWN ARE INDICATIVE ONLY. REFER TO APPROVED PLANS PRIOR TO CONSTRUCTION.

0 2.5 5 7.5 10 15 20 25m
1:250 @A1

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES

L.G.A.: NORTHERN BEACHES COUNCIL

Scale: AS SHOWN

Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

CRAIG & RHODES
TAKE THE LEAD

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www.craigandrhodes.com.au

Drawing Title: ROAD & DRAINAGE PLAN SHEET 1 of 2

C&R Ref: 048-22

Drawing Ref: 048-22C-DA-0101

Revision: B

KEY PLAN
0101
0102
M.G.A. 2020
102 DP1225635
6014 DP1072867
PROVIDE OVERLAND FLOW PATH INBETWEEN HOUSES.
EXISTING RETAINING WALL TO REMAIN. FILL TO BE PLACED NEXT TO EXISTING RETAINING WALL AND COMPACTED ENSURE NO DAMAGE TO EXISTING STRUCTURES.
1.0m WIDE CONCRETE FOOTPATH TO NORTHERN BEACHES COUNCIL STANDARD.
PROPOSED GPT
PROPOSED BIO-RETENTION BASIN. REFER DRG. No. 0751 FOR DETAILS
FOR NARRABEEN CREEK CENTRELINE PROFILE, CROSS SECTIONS & DETAILS REFER 048-22C-CK DRAWING SET.
EXISTING CREEK ALIGNMENT
REFER TO 048-22C-CK PLANS FOR CREEK DETAILS.
ROAD No. 01
NARRABEEN CREEK
BRANDS LANE
RECONSTRUCT FOOTPATH TO EXISTING FOOT BRIDGE. MAX GRADE TO BE 5%.
EXISTING FOOT BRIDGE OVER NARRABEEN CREEK TO REMAIN
PROVIDE SMOOTH TRANSITION WITH EXISTING FOOTPATH.
PROPOSED HOUSE PAD. FINISHED HOUSE LEVELS SHOWN.
2.1m WIDE CONCRETE SHARED PATH TO NORTHERN BEACHES COUNCIL STANDARD.
EXISTING COMMS PIT TO BE RAISED TO MATCH NEW ROAD LEVELS.
PROVIDE REMOVABLE BOLLARDS AROUND CORNER
EXISTING COMMS PIT TO BE RAISED TO MATCH NEW ROAD LEVELS.
EXISTING COMMS TO BE ACCURATELY LOCATED PRIOR TO COMMENCEMENT OF ANY WORKS.
PROPOSED CULVERT TO DRAIN INTO NARRABEEN CREEK. REFER DRG.No. 0753 FOR HEADWALL & SCOUR PROTECTION DETAILS
6 DP1161389
5017 DP1071760
1 DP1161389
FOR CONTINUATION SEE DRG. No.048-22C-DA-0101
DEVELOPMENT APPLICATION

PLAN

SCALE 1:250

NOTES:

1. REFER TO DRG. No. 0101 FOR NOTES.

1:250 @A1

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES

L.G.A. NORTHERN BEACHES COUNCIL

Scale: AS SHOWN

Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

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Drawing Title: ROAD & DRAINAGE PLAN SHEET 1 of 2

C&R Ref: 048-22

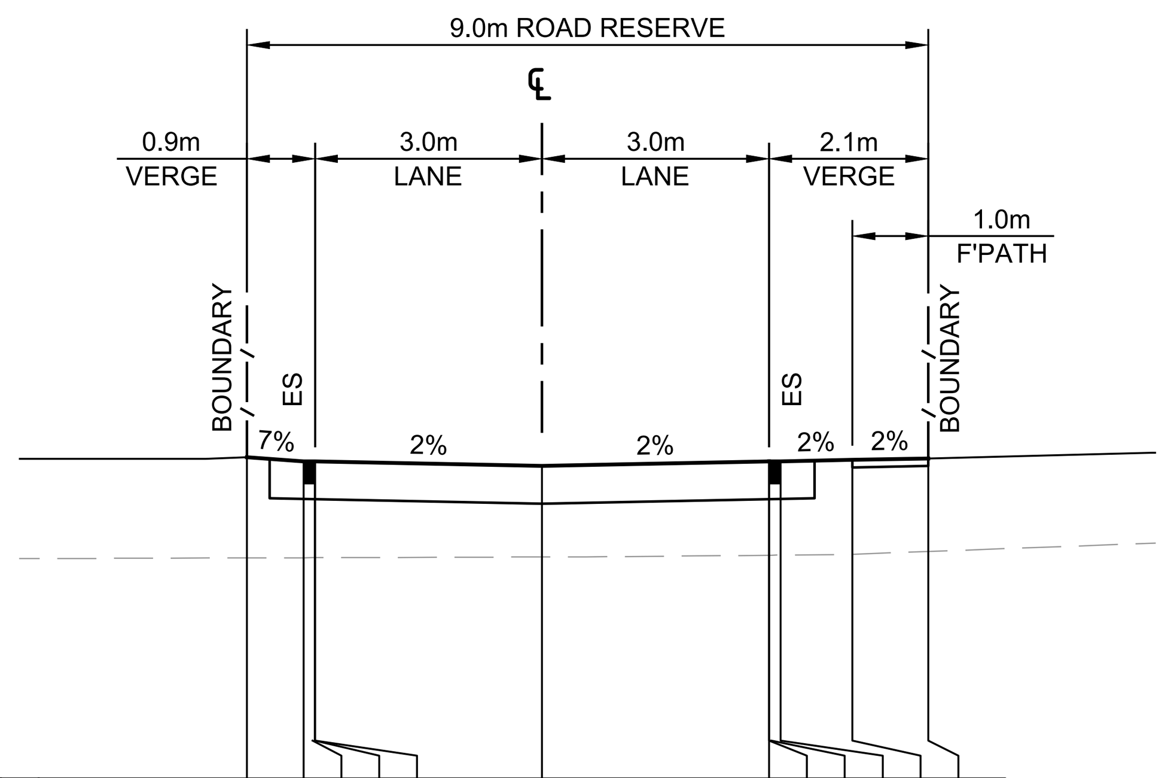
Drawing Ref: 048-22C-DA-0102

Revision: B

A1

LEGEND

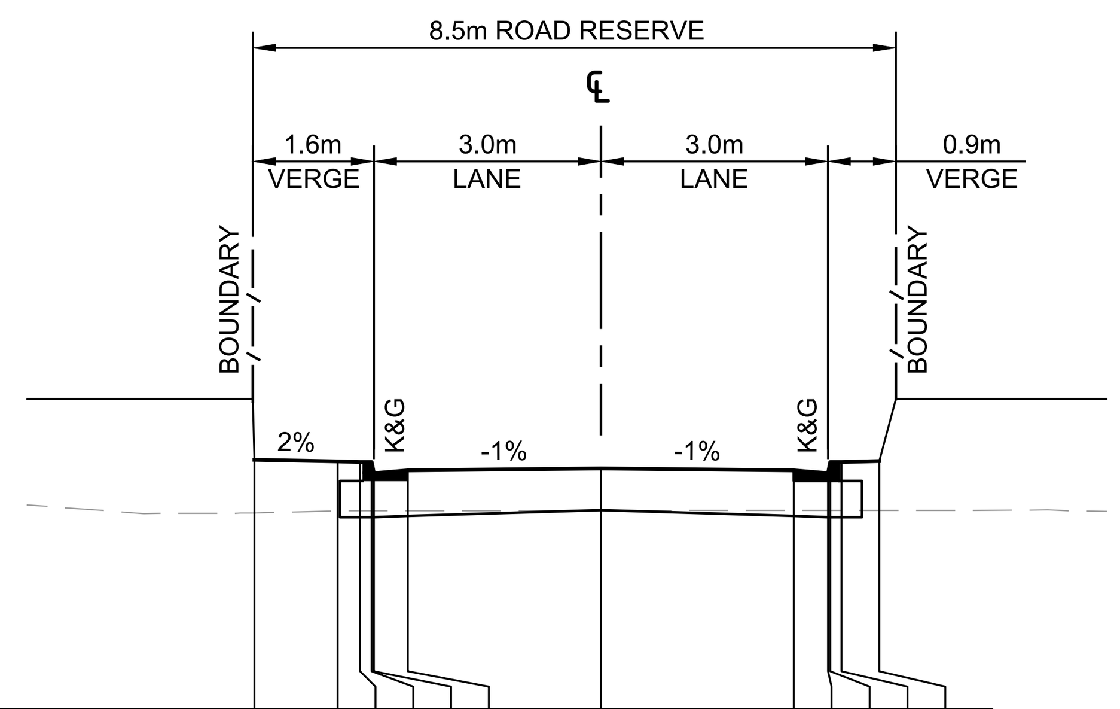
- DESIGN SURFACE (solid line)
- FUTURE DESIGN (dashed line)
- EXISTING SURFACE (light dashed line)



RELATIVE DIFFERENCE	0.11	0.06	0.06	0.06	0.06	0.00	0.06	0.06	0.06	0.06	0.07	0.09
OFFSET	-3.90	-3.15	-3.03	-3.00	-3.00	0.00	3.00	3.00	3.03	3.15	4.10	5.10

ROAD No. 01 - TYPICAL CROSS

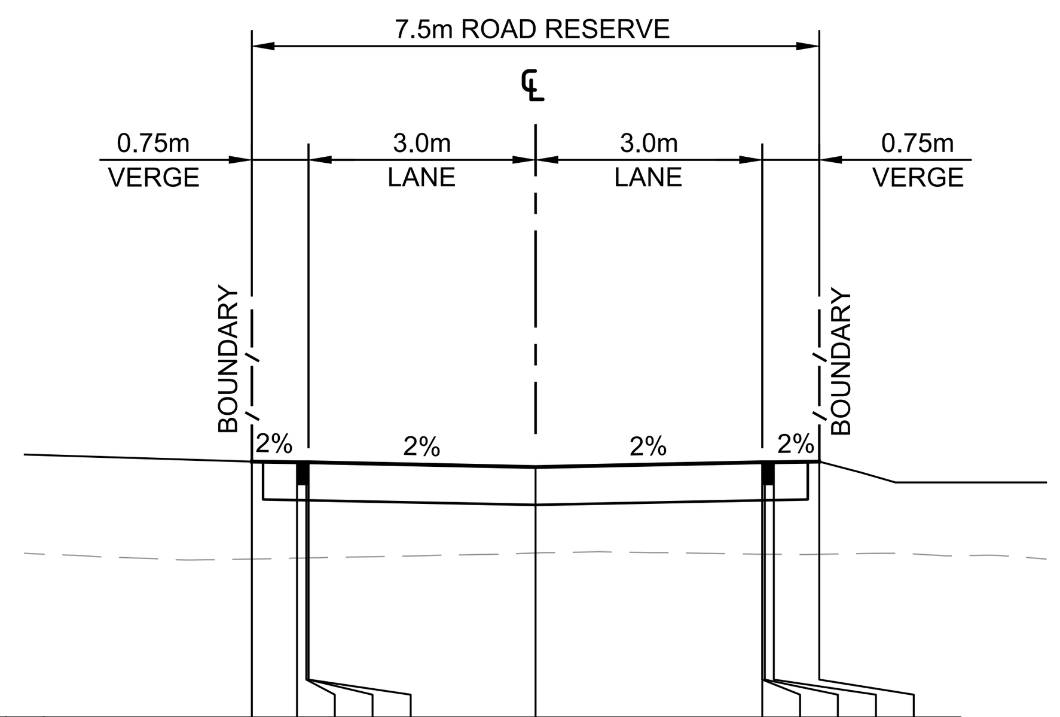
HORIZONTAL SCALE - 1:100
VERTICAL SCALE - 1:100



RELATIVE DIFFERENCE	0.11	0.09	0.09	0.09	-0.06	-0.02	0.00	-0.02	-0.06	0.09	0.09	0.10
OFFSET	-4.58	-3.48	-3.18	-3.03	-3.00	-2.55	0.00	2.55	3.00	3.03	3.18	3.68

ROAD No. 02 - TYPICAL CROSS

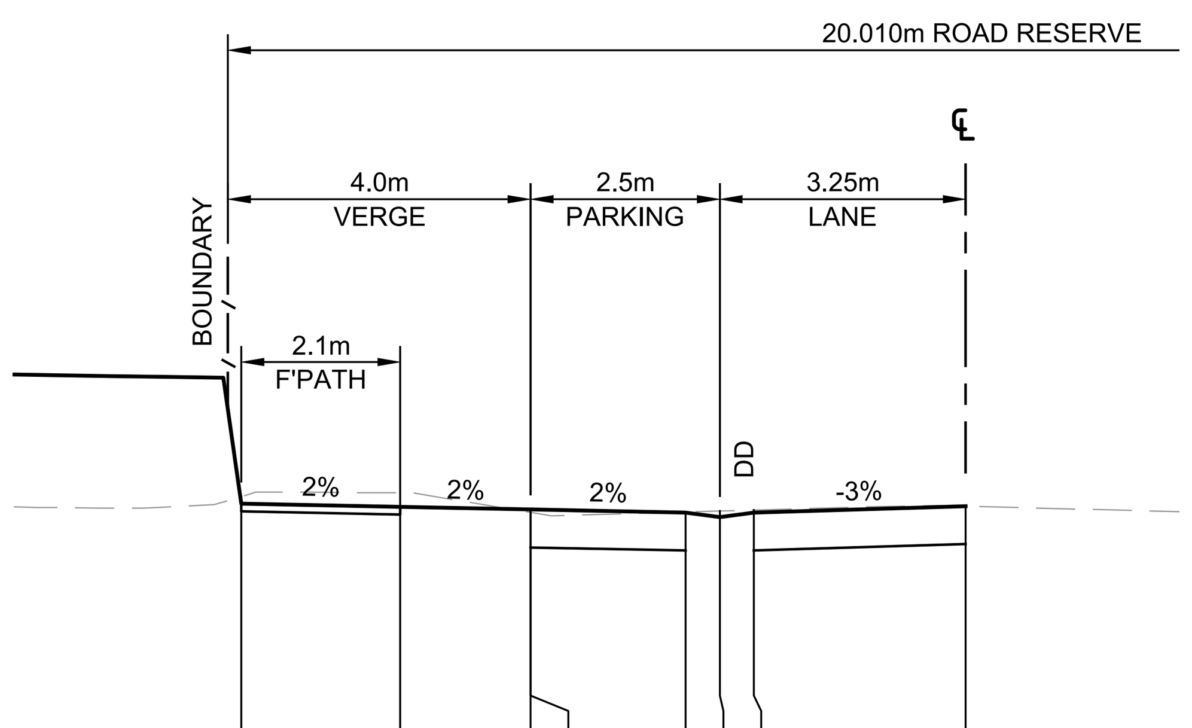
HORIZONTAL SCALE - 1:100
VERTICAL SCALE - 1:100



RELATIVE DIFFERENCE	0.07	0.06	0.06	0.06	0.06	0.00	0.06	0.06	0.06	0.06	0.07
OFFSET	-3.75	-3.15	-3.03	-3.00	-3.00	0.00	3.00	3.00	3.03	3.15	3.75

ROAD No. 03 - TYPICAL CROSS

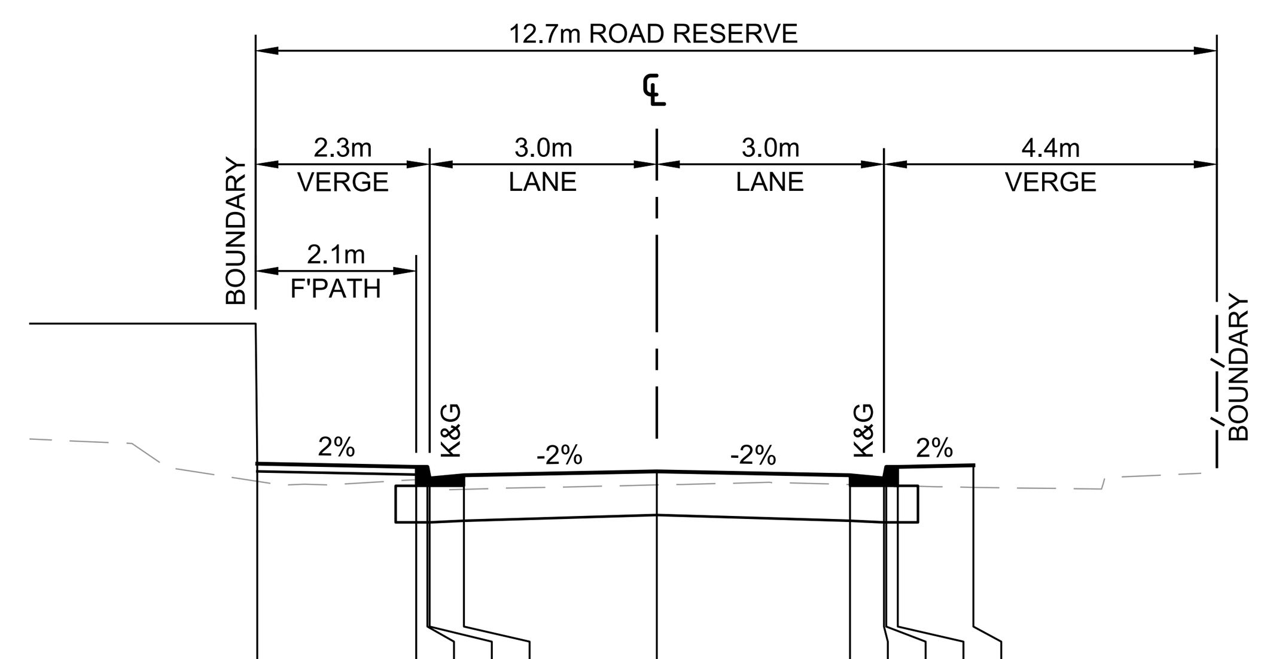
HORIZONTAL SCALE - 1:100
VERTICAL SCALE - 1:100



RELATIVE DIFFERENCE	0.04	-0.01	-0.04	-0.04	-0.08	-0.14	-0.08	0.00
OFFSET	-9.57	-7.47	-5.75	-5.75	-3.70	-3.25	-2.80	0.00

MACPHERSON STREET - TYPICAL CROSS

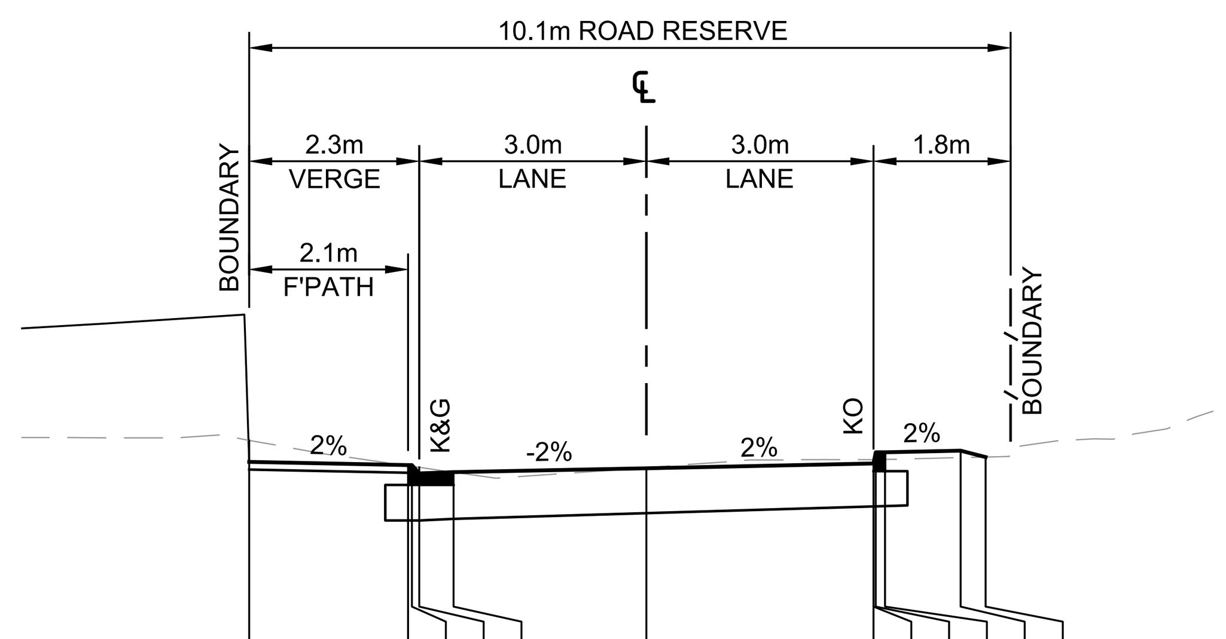
HORIZONTAL SCALE - 1:100
VERTICAL SCALE - 1:100



RELATIVE DIFFERENCE	0.10	0.06	0.06	-0.09	-0.05	0.00	-0.05	-0.09	0.06	0.06	0.08
OFFSET	-5.28	-3.18	-3.03	-3.00	-2.55	0.00	2.55	3.00	3.03	3.18	4.18

BRANDS LANE - TYPICAL CROSS

HORIZONTAL SCALE - 1:100
VERTICAL SCALE - 1:100



RELATIVE DIFFERENCE	0.08	0.04	0.04	-0.07	-0.05	0.00	0.06	0.06	0.21	0.21	0.23	0.15
OFFSET	-5.25	-3.15	-3.10	-3.00	-2.55	0.00	3.00	3.00	3.03	3.15	4.15	4.48

BRANDS LANE - TYPICAL CROSS

HORIZONTAL SCALE - 1:100
VERTICAL SCALE - 1:100

DEVELOPMENT APPLICATION

1:100 @A1

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

Authorised for issue by:
Signature:

Principal: IPM PROPERTIES
L.G.A.: NORTHERN BEACHES COUNCIL
Scale: AS SHOWN
Datum: AHD

Project: PROPOSED SUBDIVISION OF
LOT 4 D.P. 553816
16 MACPHERSON STREET, WARRIEWOOD

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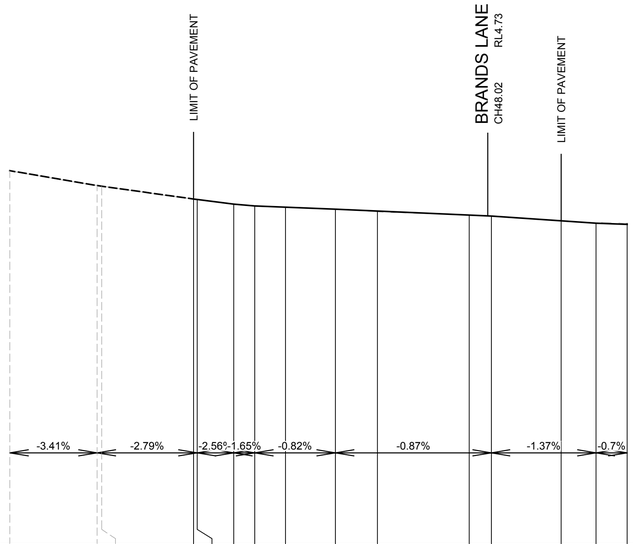
Drawing Title: TYPICAL ROAD CROSS SECTIONS
C&R Ref.: 048-22
Drawing Ref.: 048-22C-DA-0151
Revision: B



A1

LEGEND

————	DESIGN SURFACE
- - - - - -	FUTURE DESIGN
— — —	EXISTING SURFACE

NOTES:

1. SERVICES SHOWN INDICATIVE ONLY.
2. FOR STORM WATER DRAINAGE SETOUT REFER TO COUNCIL STANDARDS & SPECIFICATIONS

WAE															
DESIGN LEVEL	6.21	5.72	5.70	5.28	5.27	5.12	5.06	5.02	4.95	4.89	4.76	4.73	4.57	4.49	4.46
EXISTING LEVEL	6.20	5.73	5.71	5.29	5.27	5.12	5.06	5.02	4.95	4.87	4.76	4.73	4.57	4.50	4.49
CHAINAGE	-30	-15.75	-15	0	0.59	6.54	9.97	15	23.15	30	45	48.6	60	65.7	70.77

MACPHERSON STREET - LONGITUDINAL SECTION

HORIZONTAL SCALE - 1:500
VERTICAL SCALE - 1:100

WAE													
DESIGN LEVEL	4.43	4.43	4.43	4.63	4.67	4.78	5.02	5.14	5.48	5.60	5.70	5.79	5.87
EXISTING LEVEL	4.34	4.34	4.34	4.46	4.52	4.63	4.75	4.77	4.82	4.83	4.82	4.81	4.83
CHAINAGE	0	0	0.59	10.59	11.79	15	20.59	22.87	30	32.27	34.65	37.27	42.27

WAE													
DESIGN LEVEL	5.88	5.90	5.86	5.89	5.90	5.86	5.90	5.89	5.87	5.89	5.88	5.87	5.89
EXISTING LEVEL	4.85	4.86	4.90	4.93	4.93	4.92	4.92	4.92	4.95	5.00	5.02	5.04	5.04
CHAINAGE	45	48.05	54.55	60	61.05	67.55	74.05	75	80.05	86.05	90	92.05	98.05

WAE													
DESIGN LEVEL	5.87	5.87	5.89	5.87	5.88	5.89	5.87	5.89	5.89	5.87	5.89	5.88	5.86
EXISTING LEVEL	5.00	4.99	4.95	4.94	4.94	4.93	4.94	4.96	4.97	4.95	5.03	4.98	5.03
CHAINAGE	104.05	105	110.05	116.05	120	122.05	128.05	134.05	135	140.05	146.05	150	152.05

WAE													
DESIGN LEVEL	5.89	5.87	5.89	5.89	5.79	5.75	5.71	5.70	5.69	5.70	5.73	5.78	5.78
EXISTING LEVEL	5.00	5.06	5.08	5.09	5.14	4.99	5.37	5.14	5.26	5.37	5.37	5.30	5.29
CHAINAGE	158.05	162.5	165	166.95	173.95	176.29	180	181.29	183.9	186.29	192.75	195	195.3

ROAD No. 01 - LONGITUDINAL SECTION

HORIZONTAL SCALE - 1:500
VERTICAL SCALE - 1:100

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

APPROVED COMPANY ISO 45001 Occupational Health & Safety Management Systems QMS Certification Services
APPROVED COMPANY ISO 14001 Environmental Management Systems QMS Certification Services
APPROVED COMPANY ISO 9001 Quality Management Systems QMS Certification Services
DIAL 1100 BEFORE YOU DIG

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES
L.G.A. NORTHERN BEACHES COUNCIL
Scale: AS SHOWN
Datum: AHD

Project:
PROPOSED SUBDIVISION OF
LOT 4 D.P. 553816
16 MACPHERSON STREET, WARRIEWOOD

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Drawing Title
ROAD LONGITUDINAL SECTIONS
MacPHERSON STREET
& ROAD No. 01

C&R Ref. 048-22
Drawing Ref. 048-22C-DA-0201
Revision B

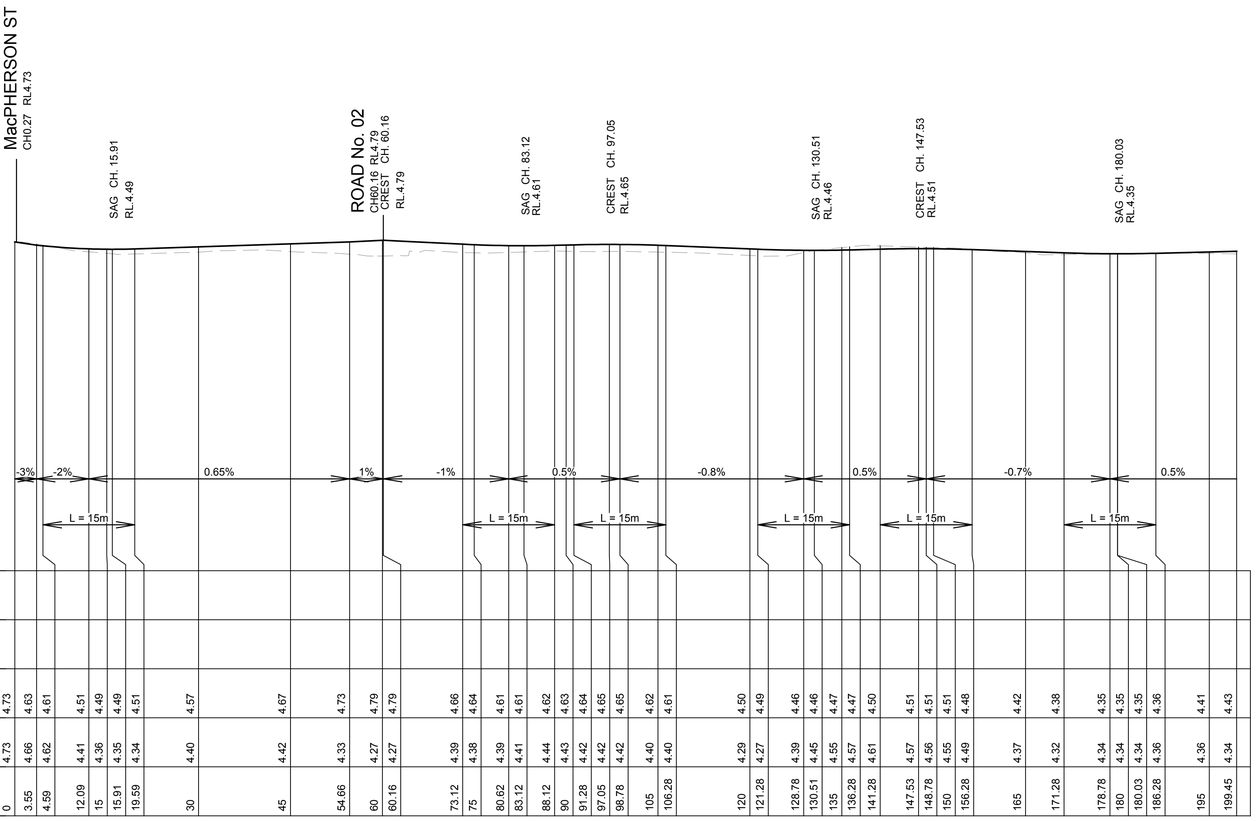
A1

LEGEND

- DESIGN SURFACE
- FUTURE DESIGN
- EXISTING SURFACE

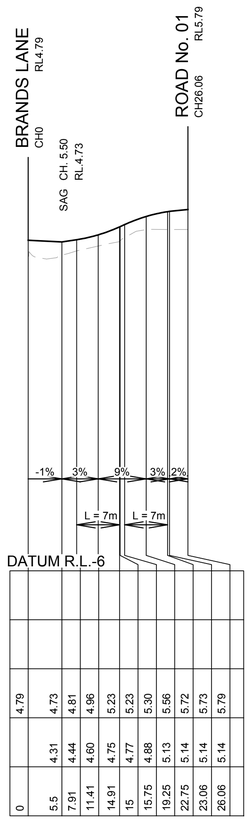
NOTES:

1. SERVICES SHOWN INDICATIVE ONLY.
2. FOR STORM WATER DRAINAGE SETOUT REFER TO COUNCIL STANDARDS & SPECIFICATIONS



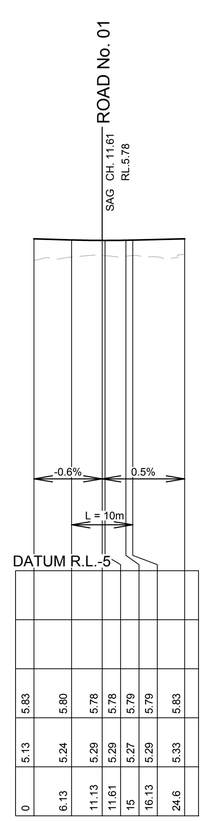
BRANDS LANE - LONGITUDINAL SECTION

HORIZONTAL SCALE - 1:500
VERTICAL SCALE - 1:100



ROAD No. 02 LONGITUDINAL SECTION

HORIZONTAL SCALE - 1:500
VERTICAL SCALE - 1:100



ROAD No. 03 LONGITUDINAL SECTION

HORIZONTAL SCALE - 1:500
VERTICAL SCALE - 1:100

0 1 2 3 4 6 8 10m
1:100 @A1
0 5 10 15 20 30 40 50m
1:500 @A1

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

APPROVED COMPANY ISO 45001 Occupational Health and Safety Management System Certification Services
APPROVED COMPANY ISO 14001 Environmental Management System Certification Services
APPROVED COMPANY ISO 9001 Quality Management System Certification Services
DIAL 1100 BEFORE YOU DIG

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES
L.G.A. NORTHERN BEACHES COUNCIL
Scale: AS SHOWN
Datum: AHD

Project:
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16 MACPHERSON STREET, WARRIEWOOD

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Drawing Title
ROAD LONGITUDINAL SECTIONS
BARNDS LANE
ROAD No. 02 & ROAD No. 03

C&R Ref.	Drawing Ref.	Revision
048-22	048-22C-DA-0202	B

A1

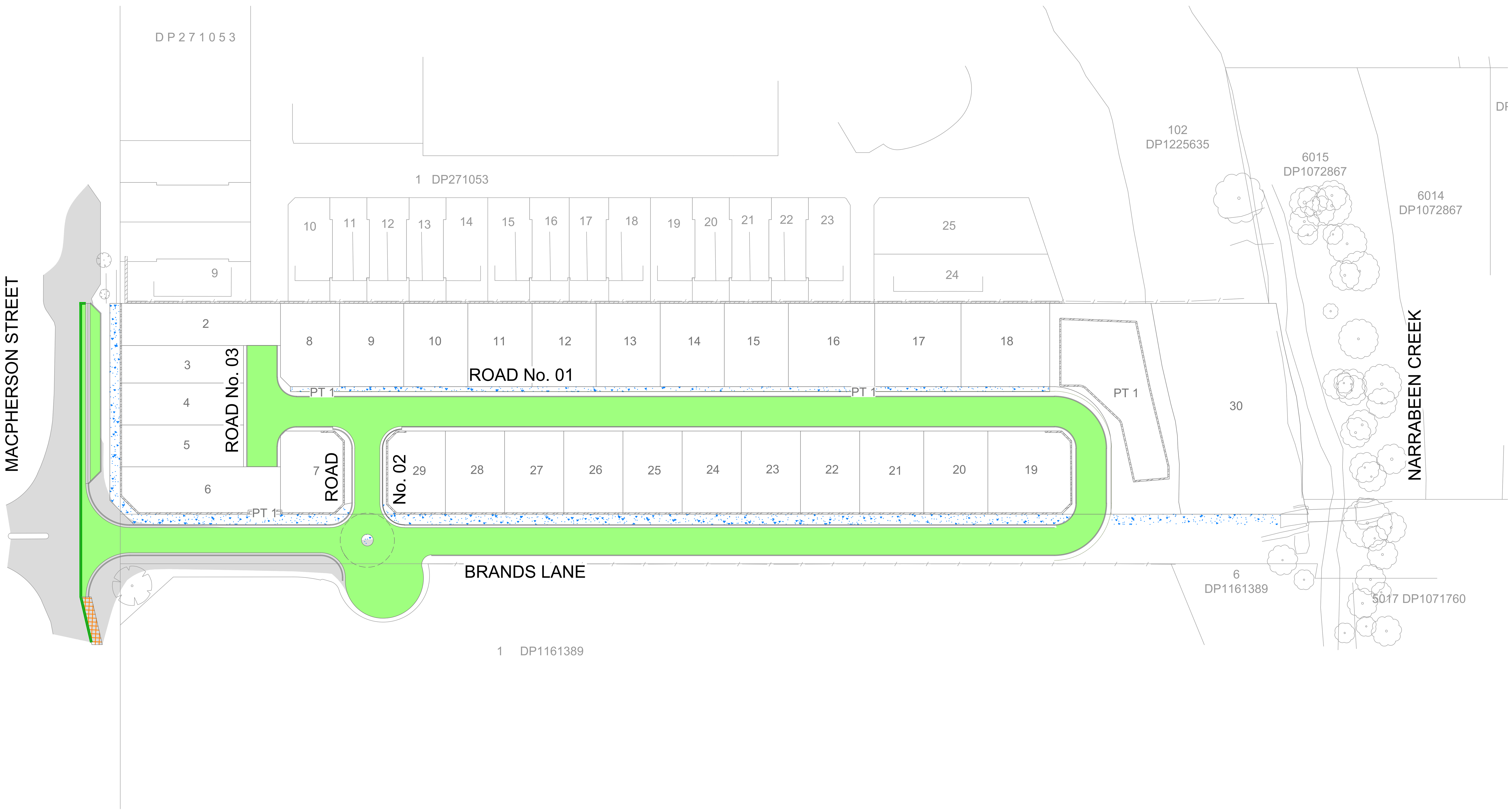
LEGEND

- EXISTING PAVEMENT
- LOCAL ROAD PAVEMENT
- PROPOSED CONCRETE FOOTPATH
- EXISTING CONCRETE FOOTPATH
- TEMPORARY TRANSITIONAL PAVEMENT
- PAVEMENT SAWCUT JOINT

NOTE:

1. PAVEMENT DESIGN REPORT SUBJECT TO FINAL PAVEMENT REPORT PRIOR TO CONSTRUCTION.
2. CONTRACTOR TO CONFIRM CBR PRIOR TO CONSTRUCTION.
3. CONCRETE FOOTPATHS TO BE CONSTRUCTED IN ACCORDANCE WITH COUNCIL CONSTRUCTION SPECIFICATIONS.

PAVEMENT DESIGN SHOWN ON THIS DRAWING IS INDICATIVE ONLY & IS SUBJECT TO FINAL GEOTECHNICAL REPORT TO BE UNDERTAKEN PRIOR TO CONSTRUCTION.



PLAN
SCALE 1:500

0 5 10 15 20 30 40 50m
1:500 @A1

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

DIAL 1100 BEFORE YOU DIG

Authorised for issue by:
Signature:

Principal: IPM PROPERTIES
L.G.A. NORTHERN BEACHES COUNCIL
Scale: AS SHOWN
Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

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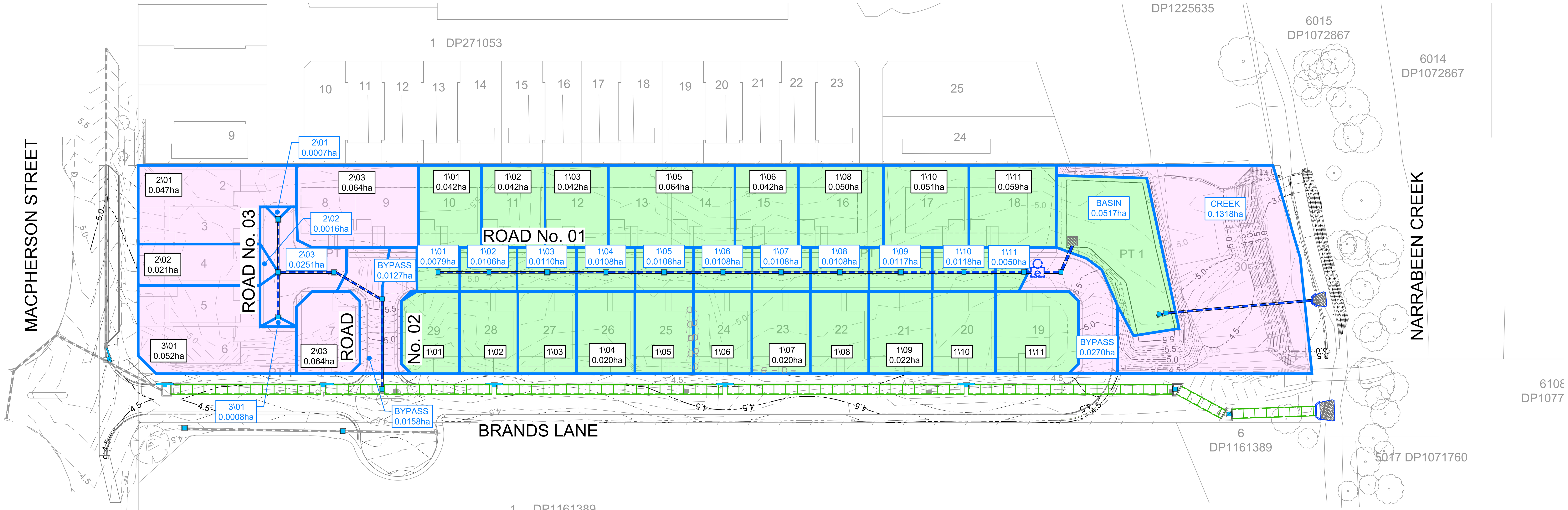
Drawing Title: PAVEMENT PLAN
C&R Ref. 048-22
Drawing Ref. 048-22C-DA-0501
Revision B

A1

LEGEND

- STORMWATER DRAINAGE CATCHMENT BOUNDARY
- CATCHMENT DIRECTION
- INTERNAL CATCHMENT - DRAINS TO OSD BASIN
- INTERNAL CATCHMENT - BYPASSES OSD BASIN



PLAN

SCALE 1:500

0 5 10 15 20 30 40 50m
1:500 @A1

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES

L.G.A.: NORTHERN BEACHES COUNCIL

Scale: AS SHOWN

Datum: AHD

Project:
PROPOSED SUBDIVISION OF
LOT 4 D.P. 553816
16 MACPHERSON STREET, WARRIEWOOD

CRAIG & RHODES
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www.craigandrhodes.com.au

Drawing Title: CATCHMENT PLAN

C&R Ref: 048-22

Drawing Ref: 048-22C-DA-0701

Revision: B

A1

LEGEND

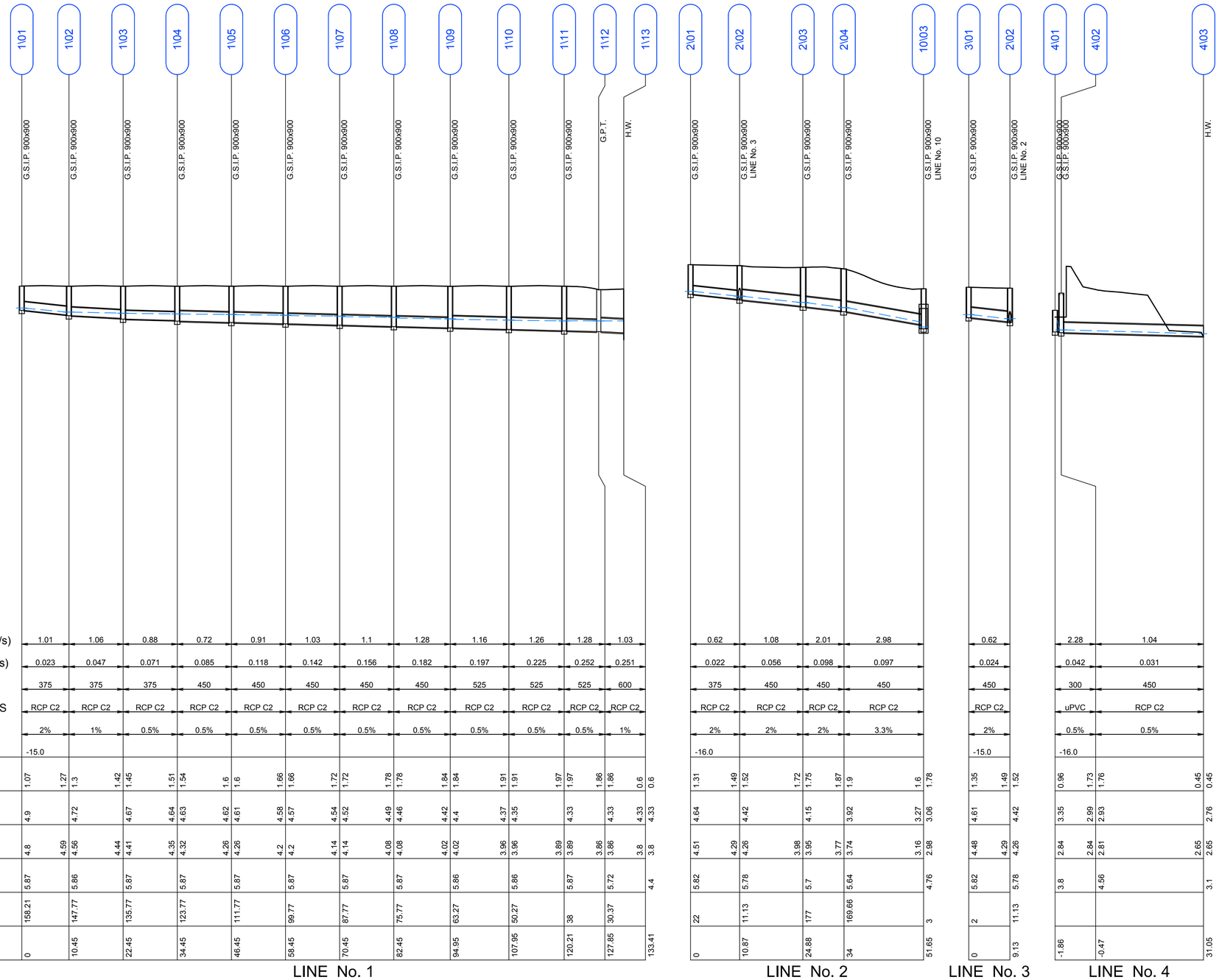
- DESIGN SURFACE
- FUTURE SURFACE
- H.G.L. 5% AEP
- W PROPOSED WATER
- S PROPOSED SEWER

00\00 PROPOSED STORMWATER PITS
00\00 EXISTING STORMWATER PITS
00\00 FUTURE STORMWATER PITS
00\00 TEMPORARY STORMWATER PITS

NOTES:

1. ALL DRAINAGE RESULTS SHOWN ARE 5% AEP U.N.O.

ALL RCP PIPES TO BE STEEL REINFORCED CONCRETE PIPE (RCP) & RUBBER RING JOINT (RRJ) UNLESS NOTED OTHERWISE.



PIPE VELOCITY (m/s)	1.01	1.06	0.88	0.72	0.91	1.03	1.1	1.28	1.16	1.26	1.28	1.03	0.62	1.08	2.01	2.98	0.62	2.28	1.04					
DISCHARGE (cu.m/s)	0.023	0.047	0.071	0.085	0.118	0.142	0.156	0.182	0.197	0.225	0.252	0.251	0.022	0.056	0.098	0.097	0.024	0.042	0.031					
PIPE SIZE	375	375	375	450	450	450	450	450	525	525	525	600	375	450	450	450	450	300	450					
PIPE TYPE & CLASS	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	RCP C2	uPVC	RCP C2					
DESIGN GRADE	2%	1%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	1%	2%	2%	2%	3.3%	2%	0.5%	0.5%					
DATUM R.L	-15.0												-16.0				-15.0	-16.0						
DEPTH TO INVERT	1.07	1.27	1.3	1.42	1.45	1.51	1.54	1.6	1.6	1.66	1.66	1.72	1.72	1.78	1.78	1.84	1.84	1.91	1.91	1.97	1.97	1.86	1.86	0.6	0.6	1.31	1.49	1.52	1.72	1.75	1.87	1.9	1.6	1.78	1.35	1.49	1.52	0.96	1.73	1.76	0.45	0.45
H.G.L. LEVEL 5%	4.9		4.72		4.67	4.64	4.63	4.62	4.61	4.58	4.57	4.54	4.52	4.49	4.46	4.42	4.4	4.37	4.35		4.33		4.33	4.33	4.64		4.42		4.15	3.92		3.27	3.06	4.61		4.42	3.35	2.99	2.93			2.76
INVERT LEVEL	4.8	4.59	4.56	4.44	4.41	4.35	4.32	4.26	4.26	4.2	4.2	4.14	4.14	4.08	4.08	4.02	4.02	3.96	3.96	3.89	3.89	3.86	3.86	3.8	3.8	4.51	4.29	4.26	3.98	3.95	3.77	3.74	3.16	2.98	4.48	4.29	4.26	2.84	2.84	2.81	2.65	2.65
SURFACE LEVEL	5.87		5.86		5.87		5.87		5.87		5.87		5.87		5.87		5.86		5.86		5.87		5.72	4.4	5.82		5.78		5.7	5.64		4.76		5.82		5.78	3.8		4.56			3.1
ROAD CHAINAGE	158.21		147.77		135.77		123.77		111.77		99.77		87.77		75.77		63.27		50.27		38		30.37		22		11.13		177	169.66		3		2		11.13						
PIPE CHAINAGE	0		10.45		22.45		34.45		46.45		58.45		70.45		82.45		94.95		107.95		120.21		127.85	133.41	0		10.87		24.88	34		51.65		0		9.13	-1.86		-0.47			31.05

LINE No. 1 LINE No. 2 LINE No. 3 LINE No. 4

DEVELOPMENT APPLICATION

1:100 @A1 (0 1 2 3 4 6 8 10m)
1:500 @A1 (0 5 10 15 20 30 40 50m)

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

Authorised for issue by:
Signature:

Principal: IPM PROPERTIES
L.G.A. NORTHERN BEACHES COUNCIL
Scale: AS SHOWN
Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

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reception@crhodes.com.au
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Drawing Title: STORMWATER DRAINAGE LONGITUDINAL SECTIONS
C&R Ref. 048-22
Drawing Ref. 048-22C-DA-0711
Revision B

A1

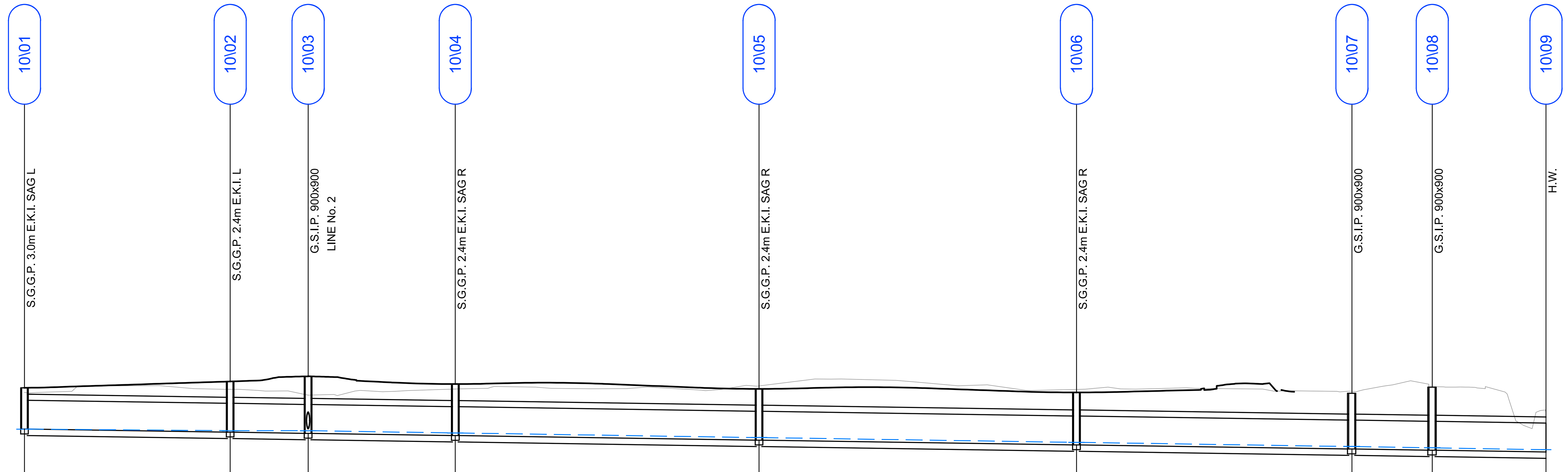
LEGEND

- DESIGN SURFACE
- FUTURE SURFACE
- H.G.L. 5% AEP
- W PROPOSED WATER
- S PROPOSED SEWER
- 00\00 PROPOSED STORMWATER PITS
- 00\00 EXISTING STORMWATER PITS
- 00\00 FUTURE STORMWATER PITS
- 00\00 TEMPORARY STORMWATER PITS

NOTES:

1. ALL DRAINAGE RESULTS SHOWN ARE 5% AEP U.N.O.

ALL RCP PIPES TO BE STEEL REINFORCED CONCRETE PIPE (RCP) & RUBBER RING JOINT (RRJ) UNLESS NOTED OTHERWISE.



	10\01–10\02	10\02–10\03	10\03–10\04	10\04–10\05	10\05–10\06	10\06–10\07	10\07–10\08	10\08–10\09
PIPE VELOCITY (m/s)	0	0.11	0.64	0.72	0.71	0.68	0.75	0.81
DISCHARGE (cu.m/s)	0	0.009	0.093	0.103	0.1	0.095	0.1	0.099
PIPE SIZE	1800x900	1800x900	1800x900	1800x900	1800x900	1800x900	1800x900	1800x900
PIPE TYPE & CLASS	RCBC	RCBC	RCBC	RCBC	RCBC	RCBC	RCBC	RCBC
DESIGN GRADE	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%

DATUM R.L -17.0

	10\01	10\02	10\03	10\04	10\05	10\06	10\07	10\08	10\09
DEPTH TO INVERT	1.29	1.58 / 1.58	1.78 / 1.78	1.61 / 1.61	1.6 / 1.6	1.64 / 1.64	1.74 / 1.74	1.97 / 1.97	0.9 / 0.9
H.G.L. LEVEL 5 YEAR ARI	3.11	3.06	3.06	2.99	2.85	2.7	2.57	2.53	2.47
INVERT LEVEL	3.11	3.02 / 3.02	2.98 / 2.98	2.91 / 2.91	2.77 / 2.77	2.62 / 2.62	2.49 / 2.49	2.45 / 2.45	2.4 / 2.4
SURFACE LEVEL	4.4	4.6	4.76	4.52	4.37	4.26	4.23	4.42	3.3
ROAD CHAINAGE	15.91	48	3	83.12	130.51	180.03	199.45	199.45	199.45
PIPE CHAINAGE	-6.11	25.98	38.14	61.1	108.49	158.01	200.98	213.52	231.26

LINE No. 10

0 1 2 3 4 6 8 10m 1:100 @A1
0 5 10 15 20 30 40 50m 1:500 @A1

DEVELOPMENT APPLICATION

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A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

DIAL 1100 BEFORE YOU DIG

Authorised for issue by: .... Signature:

Principal: IPM PROPERTIES

L.G.A. NORTHERN BEACHES COUNCIL

Scale: AS SHOWN   Datum: AHD

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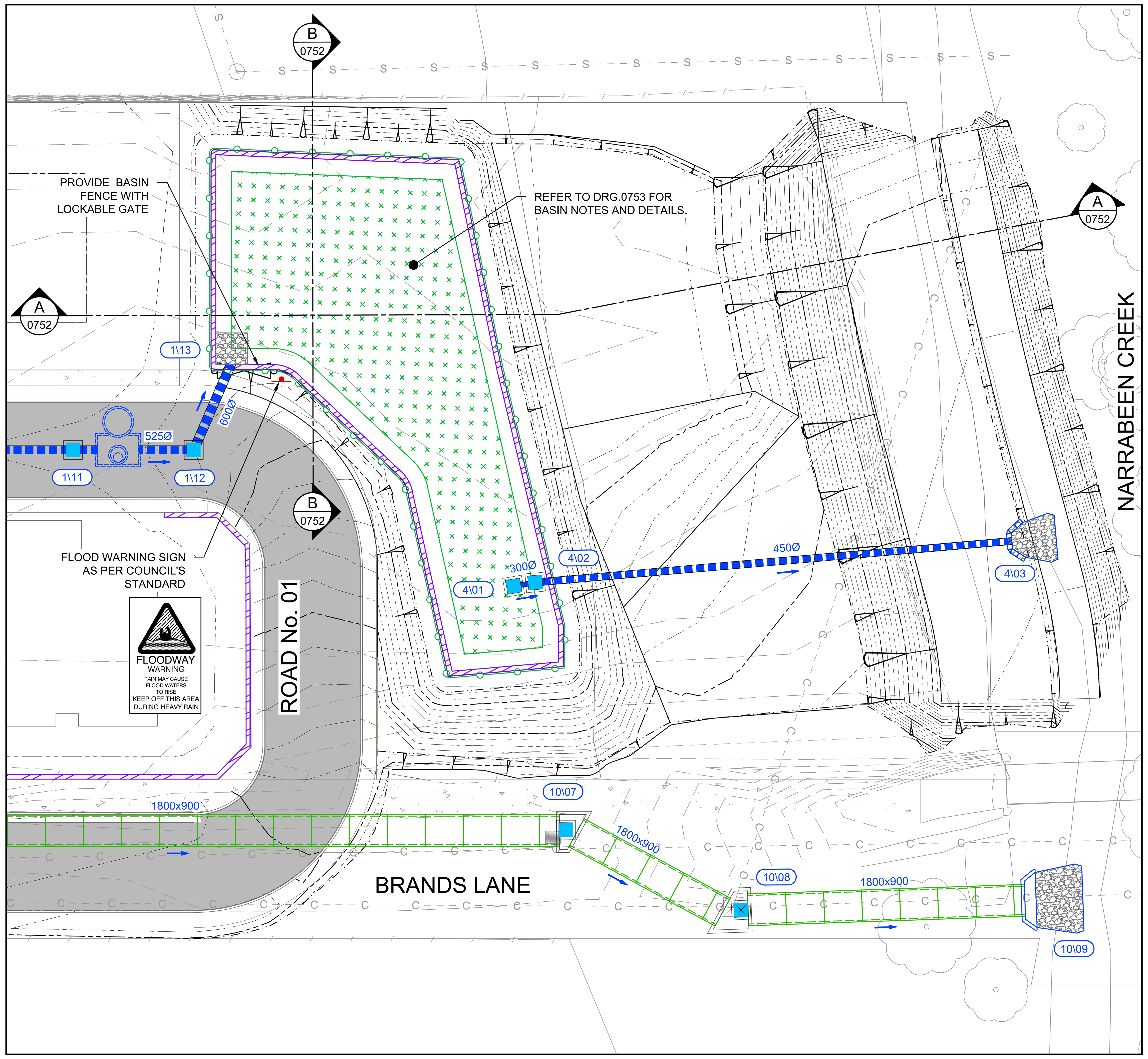
Drawing Title: STORMWATER DRAINAGE LONGITUDINAL SECTIONS

C&R Ref. 048-22 | Drawing Ref. 048-22C-DA-0712 | Revision B



PLAN

SCALE 1:200

SITE DISCHARGE			
AEP	PRE DEVELOPMENT FLOW	POST DEVELOPMENT FLOW	BASIN TOP WATER LEVEL
	(m3/s)	(m3/s)	TWL (m AHD)
50%	0.14	0.11	4.00
20%	0.24	0.14	4.14
10%	0.30	0.17	4.23
5%	0.36	0.20	4.33
2%	0.44	0.30	4.40
1%	0.70	0.57	4.48

BASIN DETAILS		
Developed Catchment Area To OSD	1.017	ha
Developed Catchment Area Bypassing OSD	0.397	ha
Top of Berm Level	5.75	mRL
Emergency Weir Level	5.65	mRL
Extended Detention Level (ED)	3.80	mRL
Top of Filter Level	3.50	mRL
Total Basin Volume Provided (to emergency weir)	725	m³
Filter Media Area (min)	277	m2

0 2 4 6 8 12 16 20m
1:200 @A1

DEVELOPMENT APPLICATION

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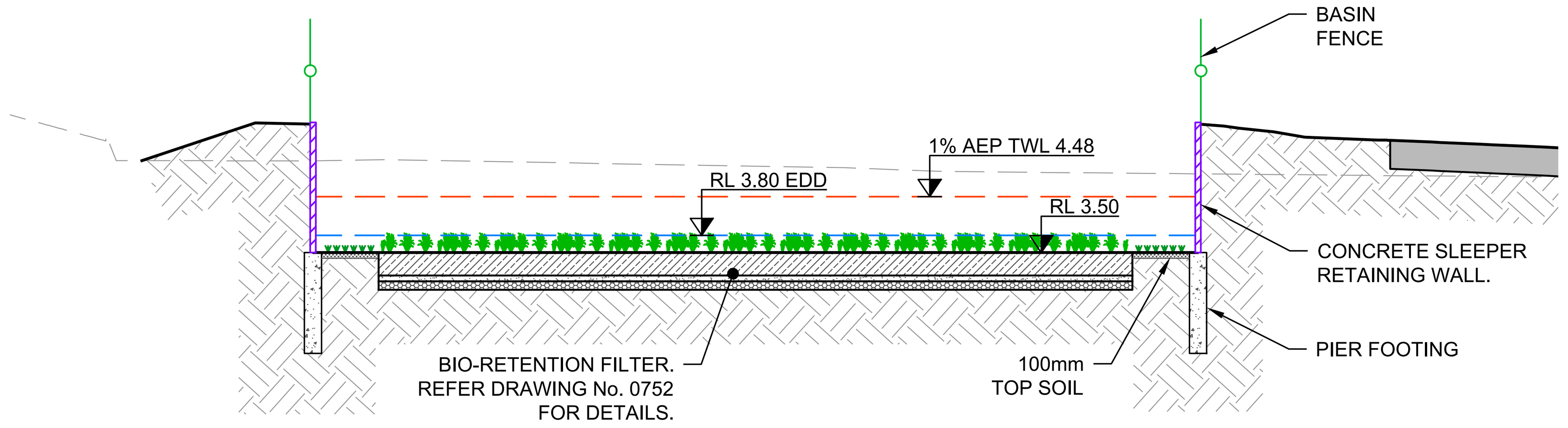
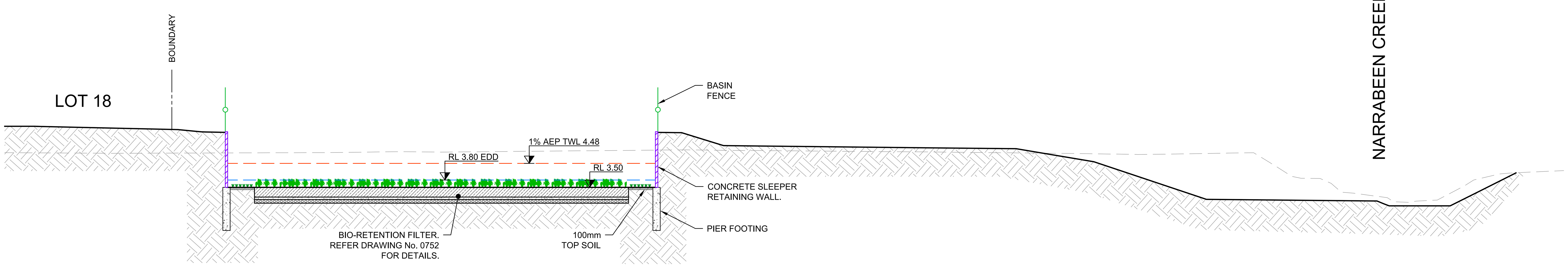
Drawing Title: WSUD BASIN & OSD TANK PLAN AND CALCULATIONS

C&R Ref. 048-22 | Drawing Ref. 048-22C-DA-0751 | Revision B

A1



B SECTION
0751 SCALE 1:100



A SECTION
0751 SCALE 1:100

DEVELOPMENT APPLICATION

0 1 2 3 4 6 8 10m
1:100 @A1

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

Authorised for issue by:
Signature:

Principal: IPM PROPERTIES
L.G.A. NORTHERN BEACHES COUNCIL
Scale: AS SHOWN
Datum: AHD

Project:
PROPOSED SUBDIVISION OF
LOT 4 D.P. 553816
16 MACPHERSON STREET, WARRIEWOOD

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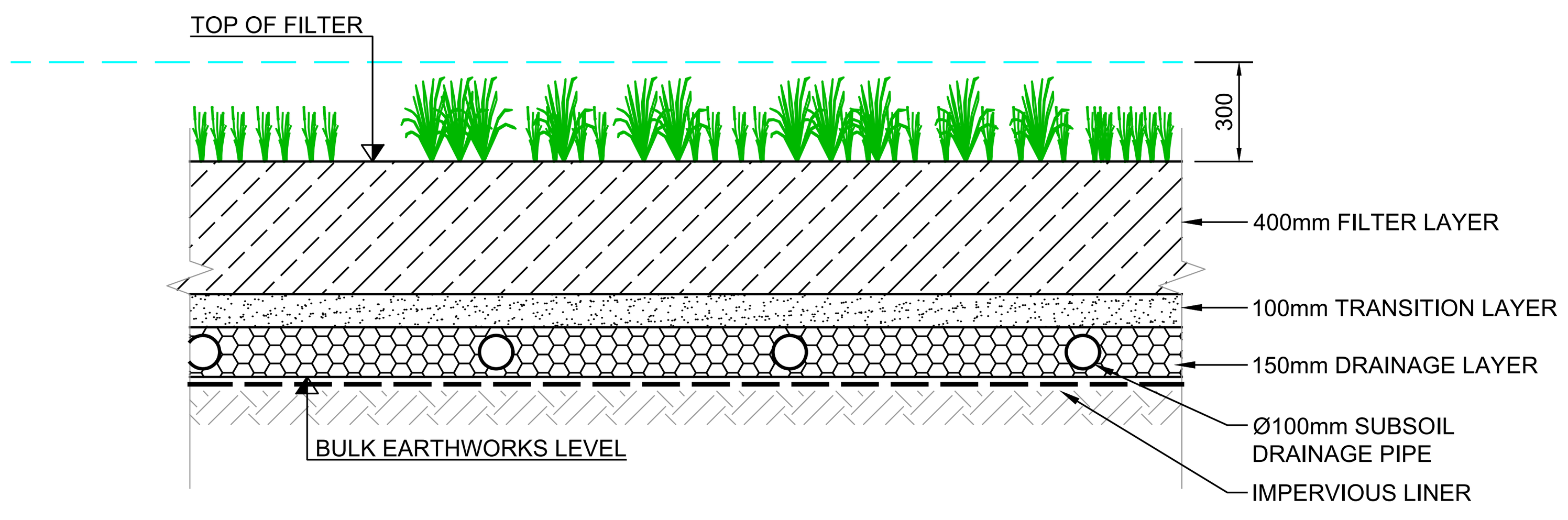
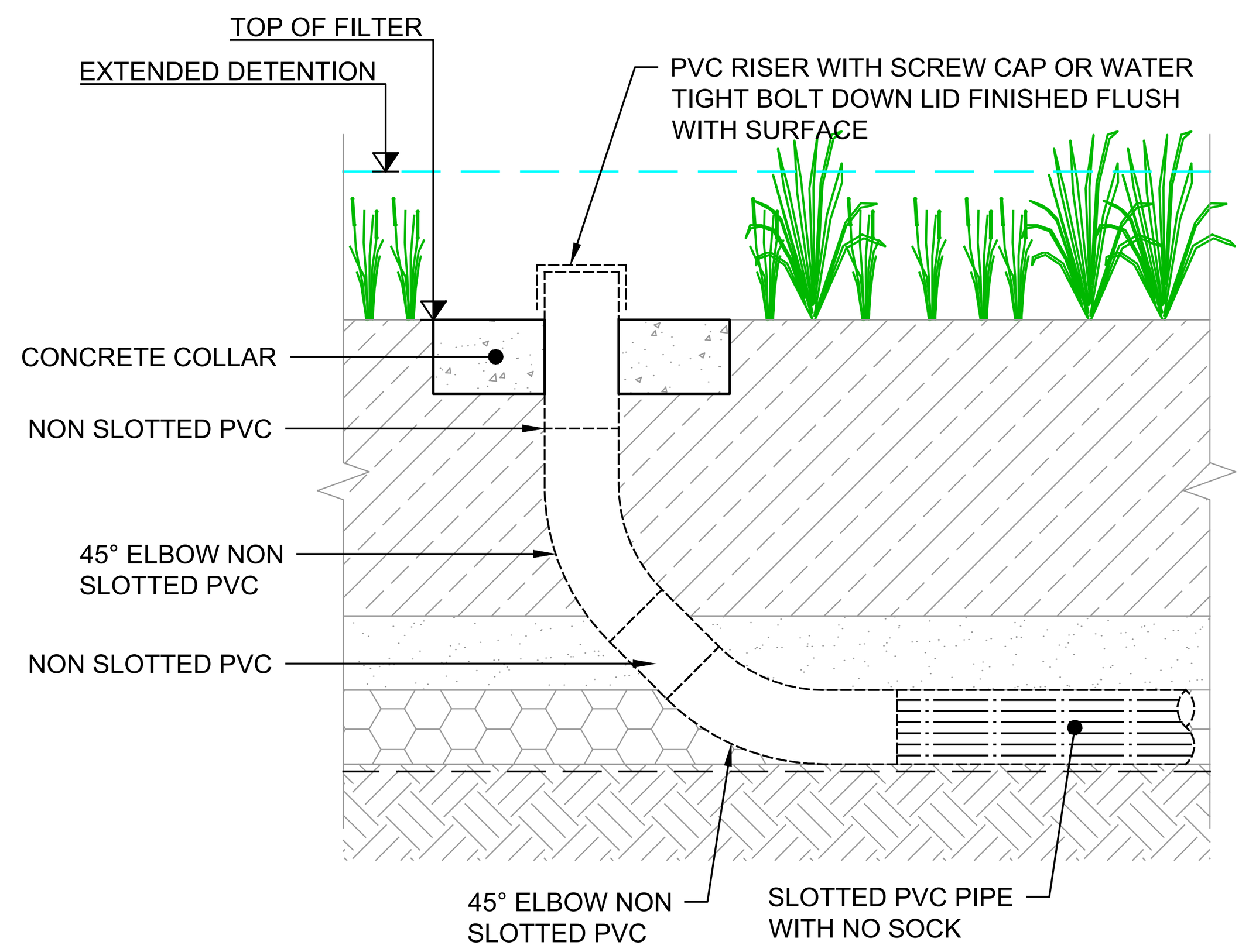
Drawing Title: WSUD BASIN & OSD TANK DETAILS
C&R Ref. 048-22
Drawing Ref. 048-22C-DA-0752
Revision B



BIO-RETENTION FILTER PROFILE

SCALE NTS



FLUSHING POINT DETAIL

SCALE NTS

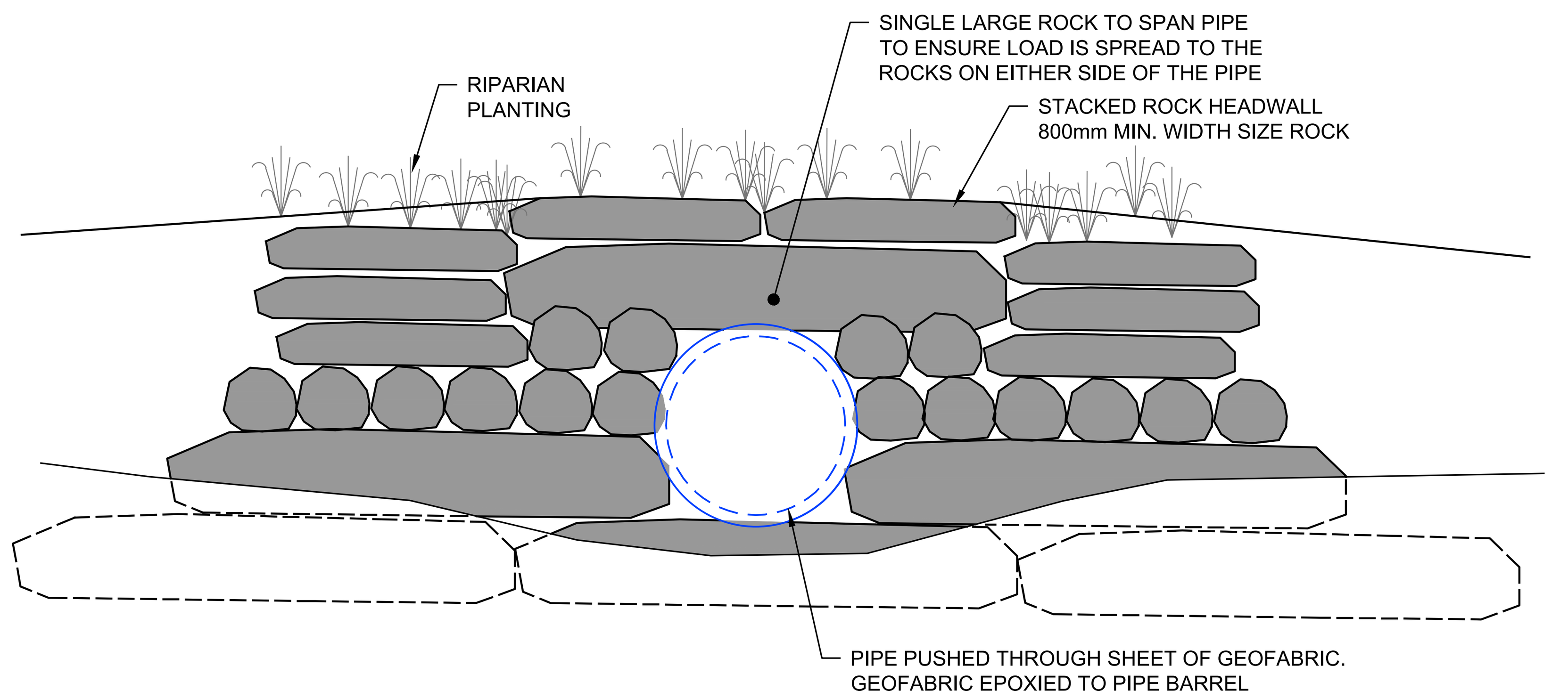
BIORETENTION NOTES

1. A 100mm THICK COARSE SAND TRANSITION LAYER IS TO BE INSTALLED OVER THE GRAVEL DRAINAGE LAYER TO COMPLY WITH THE FOLLOWING PARTICLE SIZE DISTRIBUTION:

   1-4mm - 100% PASSING
   1.0mm - 80% PASSING
   0.7mm - 44% PASSING
   0.5mm 8.5% PASSING

2. FILTER MEDIA IS TO BE FREE OF RUBBISH AND DELETERIOUS MATERIAL AND LIGHTLY COMPACTED ONLY (TO 90% STANDARD COMPACTION)
3. FILTER MEDIA SATURATED HYDRAULIC CONDUCTIVITY TO BE 180mm/hr. PERMEABILITY IS TO BE TESTED USING THE A.S.4419 (LATEST EDITION) (SOILS FOR LANDSCAPING AND GARDEN USE) METHODS (APPENDIX H)
4. FILTER MEDIA PARTICLE SIZE DISTRIBUTION IS TO BE AS FOLLOWS:
   - CLAY 2-4% (<0.002 mm)
   - SILT 4-8% (0.002-0.05mm)
   - VERY FINE SAND 5-10% (0.05-0.1mm)
   - FINE SAND 10-30% (0.1-0.5mm)
   - MEDIUM SAND 40-70% (0.5-1.0mm)
   - COARSE SAND 7-10% (1.0-2.0mm)
   - FINE GRAVEL <3% (2.0-3.4mm)

   THE COMBINED PERCENTAGE OF CLAY & SILT MAY NOT EXCEED 12% UNDER ANY CIRCUMSTANCES.
5. FILTER MEDIA IS TO COMPLY WITH A.S.4419 (LATEST EDITION), INCLUDING TESTING REQUIREMENTS AND THE FOLLOWING:
   a. BULK DENSITY - AS SPECIFIED FOR 'NATURAL SOILS AND SOIL BLENDS' > 0.7 kg/L
   b. ORGANIC MATTER CONTENT - BETWEEN 3 AND 10%
   c. WETTABILITY - AS SPECIFIED FOR 'NATURAL SOILS AND SOIL BLENDS' > 5 mm/min.
   d. pH - 5.5 - 7.5 (pH 1:5 IN WATER)
   e. ELECTRICAL CONDUCTIVITY (EC) AS SPECIFIED FOR 'NATURAL SOILS AND SOIL BLENDS' < 1.20 ds/m
   f. PHOSPHOROUS - < 5 mg/kg
   g. NITROGEN DRAWDOWN (NDI) AS SPECIFIED FOR 'NATURAL SOILS AND SOIL BLENDS' > 0.5 NDI 150
   h. TOXICITY - AS SPECIFIED FOR 'NATURAL SOILS AND SOIL BLENDS'
   i. DISPERSIBILITY - AS SPECIFIED FOR 'NATURAL SOILS AND SOIL BLENDS' CATEGORY 1 OR 2
   j. PERMEABILITY - SATURATED HYDRAULIC CONDUCTIVITY 80mm/hr ±20% AT 90% STANDARD COMPACTION
   k. TEXTURE - SANDY LOAM
   l. LARGE PARTICLES - AS SPECIFIED FOR 'NATURAL SOILS AND SOIL BLENDS'
6. ESTABLISHMENT OF BIO-RETENTION SYSTEM IN ACCORDANCE WITH CONSTRUCTION & ESTABLISHMENT GUIDELINES: SWALES, BIO-RETENTION SYSTEMS & WETLANDS (WATER BY DESIGN 2010).
7. BASIN/FILTER MEDIA TO BE CONSTRUCTED WHEN 80% OF DWELLINGS ARE CONSTRUCTED.

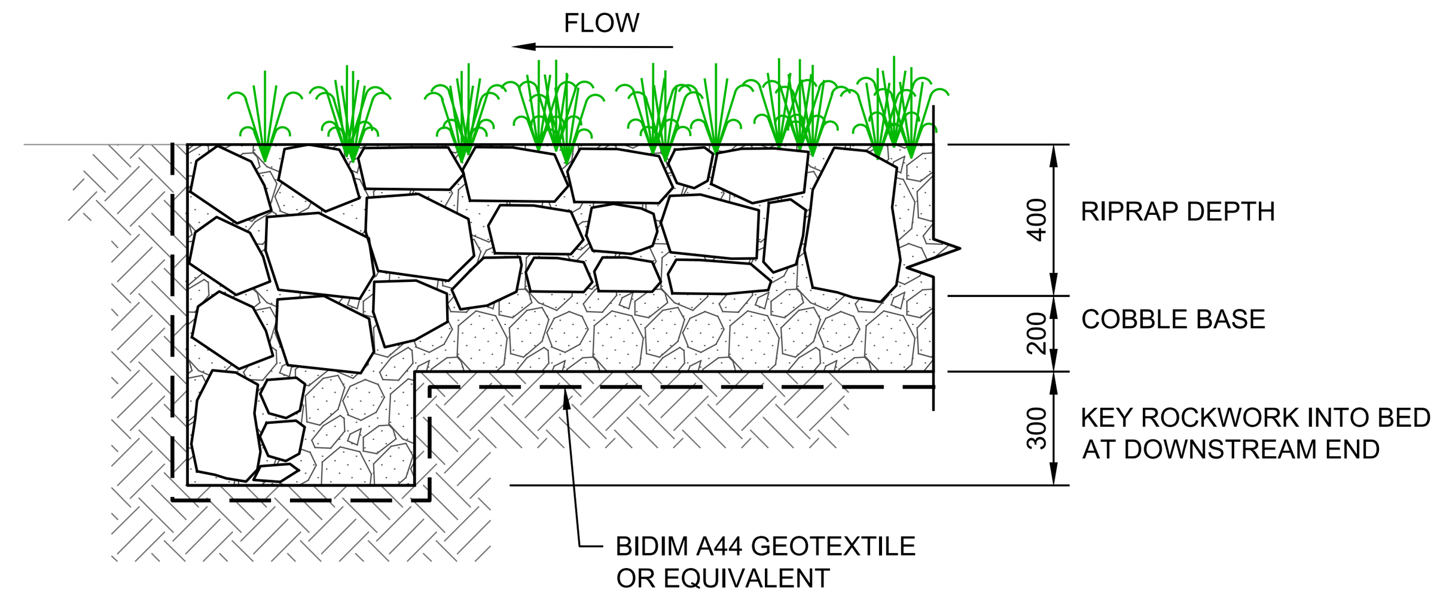


STACKED ROCK HEADWALL ELEVATION

SCALE NTS

ROCK RIP RAP SPECIFICATIONS

1. ALL RIPRAP MUST CONSIST OF ANGULAR RUN-OF-QUARRY DURABLE ROCK PLACED OVER A 200mm LAYER OF ANGULAR COBBLES D_{50}=250mm MIXED WITH GRAVEL D_{50}=10mm.
2. ALL ROCK IS TO BE A HARD DURABLE ROCK WITH A POINT INDEX LOAD Is50 GREATER THAN 1.0MPa AS DETERMINED IN ACCORDANCE WITH AS4133.4.1 -2007
3. RIPRAP IS TO BE PLACED BY HAND AND CROW-BARRED INTO PLACE TO ENSURE FIT WITH MINIMUM VOIDS.
4. ALL ROCK AND COBBLES TO BE PACKED WITH TOPSOIL. GAPS IN RIPRAP TO BE PLANTED.
   M50 - 60kg (NOM 300MD)
   M15 - 25kg
   100 - 120kg
5. BASE OF RIPRAP TO BE LINED WITH GEOTEXTILE FABRIC (BIDIM A44)
6. ROCK SIZE D_{50} = 250mm. Dmax = 400mm UNLESS NOTED OTHERWISE



RIP RAP DETAIL

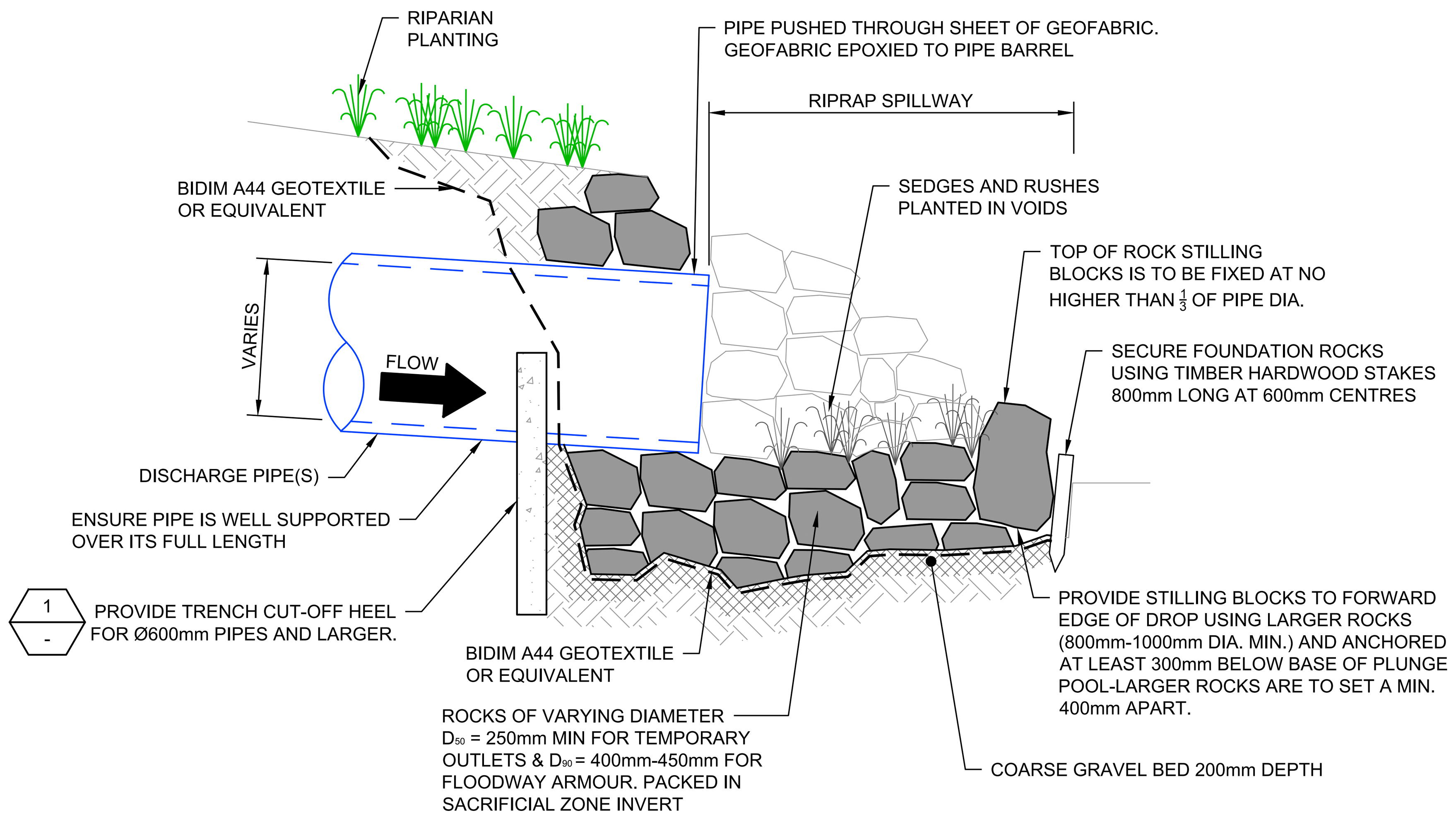
SCALE NTS

STACKED ROCK HEADWALLS

1. BACKFILL IS TO BE GRANULAR, FREE DRAINING AND COMPACTED TO 95% MAXIMUM DRY DENSITY.
2. FOUNDATION TO BE APPROVED FOR 200 kPa BEARING CAPACITY.
3. ROCK IS TO BE SOUND DURABLE BASALT OR OTHER MATERIAL APPROVED BY COUNCIL ENGINEER.
4. ROCKS SHALL BE PLACED IN SUCH A MANNER THAT THEY ARE STABLE AND INTERLOCKING AND LAID ROUGHLY COURSED AND BEDDED ON THEIR BROADEST BASE.
5. EACH ROCK SHALL BE:
   - ELONGATED TO ALLOW STACKING ON THE LONGEST AXIS.
   - ANGULAR IN SHAPE (PROMOTES INTERLOCKING)
   - FREE FROM OVERBURDEN, SPOIL, SHALE AND ORGANIC MATERIAL.
6. WALL CONSTRUCTION TO BE SUPERVISED BY A SUITABLY QUALIFIED PERSON.
7. AIR VOIDS SHALL NOT EXCEED 30% VOLUME.
8. THE TOP COURSE OF ROCKS ON EMBANKMENT AND ADJACENT TO PIPE SHALL BE MORTARED INTO POSITION.

EARTHWORKS - BASINS

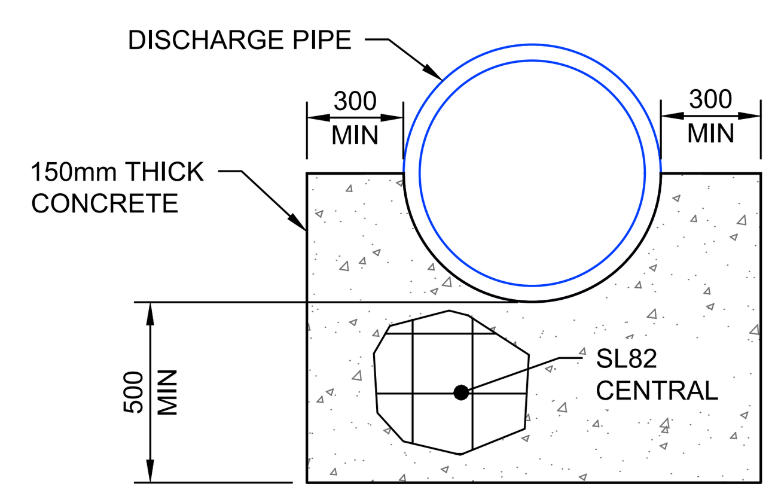
1. THE CONTRACTOR SHALL PROVIDE PROPER FENCING, GUARDING & LIGHTING AND OBSERVATION OF ALL EARTHWORKS, TEMPORARY ROADWAYS, FOOTWAYS, GUARDS & FENCES AS MAY BE RENDERED NECESSARY FOR THE ACCOMMODATION AND PROTECTION OF PEDESTRIANS, VEHICLES, ANIMALS & THE PUBLIC
2. ALL EARTHWORKS SHALL BE CARRIED OUT IN THE LOCATIONS SHOWN AND TO THE LEVELS, WIDTHS AND BATTER SLOPES INDICATED ON THE DRAWINGS
3. EXCAVATED MATERIAL NOT MEETING THE SPECIFICATIONS FOR FILL MATERIAL SHALL BE DISPOSED OFF SITE IN AN APPROPRIATE MANNER
4. WHERE EARTHWORKS ARE REQUIRED IN THE VICINITY OF EXISTING SERVICES, THE CONTRACTOR SHALL SUPPORT ALL SERVICES DURING THE WORKS
5. THE CONTRACTOR SHALL, AT ITS OWN EXPENSE, DO ALL THINGS NECESSARY TO DIVERT ANY WATER INTERFERING WITH THE PROCESS OF WORKS, KEEP THE EXCAVATIONS AND TRENCHES FREE FROM WATER WHILE THE WORKS ARE IN PROGRESS AND PREVENT ANY DAMAGE TO THE WORKS BY WATER DUE TO FLOODS OR OTHER CAUSES. THE CONTRACTOR SHALL HAVE PUMPING EQUIPMENT FOR KEEPING THE EXCAVATION OR TRENCHES CONSTANTLY DEWATERED DURING THE TIMES THE WORKS ARE IN PROGRESS. ANY WORK OR MATERIAL DAMAGED BY WATER SHALL BE MADE GOOD BY THE CONTRACTOR.
6. WHERE DIRECTED BY THE SUPERINTENDENT THE BOTTOM OF TRENCHES OR EXCAVATIONS SHALL BE COMPACTED PRIOR TO THE PLACING OF ANY BEDDING OR CONCRETE MATERIALS. SHOULD, IN THE OPINION OF THE SUPERINTENDENT, THE FOUNDATION MATERIAL BE INCAPABLE OF EFFECTIVE COMPACTION, THE MATERIAL SHALL BE REMOVED AND REPLACED WITH APPROPRIATE MATERIAL
7. MATERIAL SHALL BE INSPECTED & APPROVED BY THE SUPERINTENDENT PRIOR TO USE. RELEVANT MATERIAL SPECIFICATION SHEETS ARE TO BE PROVIDED BY THE CONTRACTOR.
8. SUBSOIL DRAINAGE PIPES WITHIN THE BIORETENTION SYSTEM ARE TO BE SLOTTED 100mm uPVC CONSISTENT WITH AS/NZS 1254. JOINTS ARE TO BE SOLVENT CEMENT GLUED AND BENDS ARE TO BE 45° TO MINIMISE BLOCKAGE.



STACKED ROCK HEADWALL & RIP RAP SPILLWAY

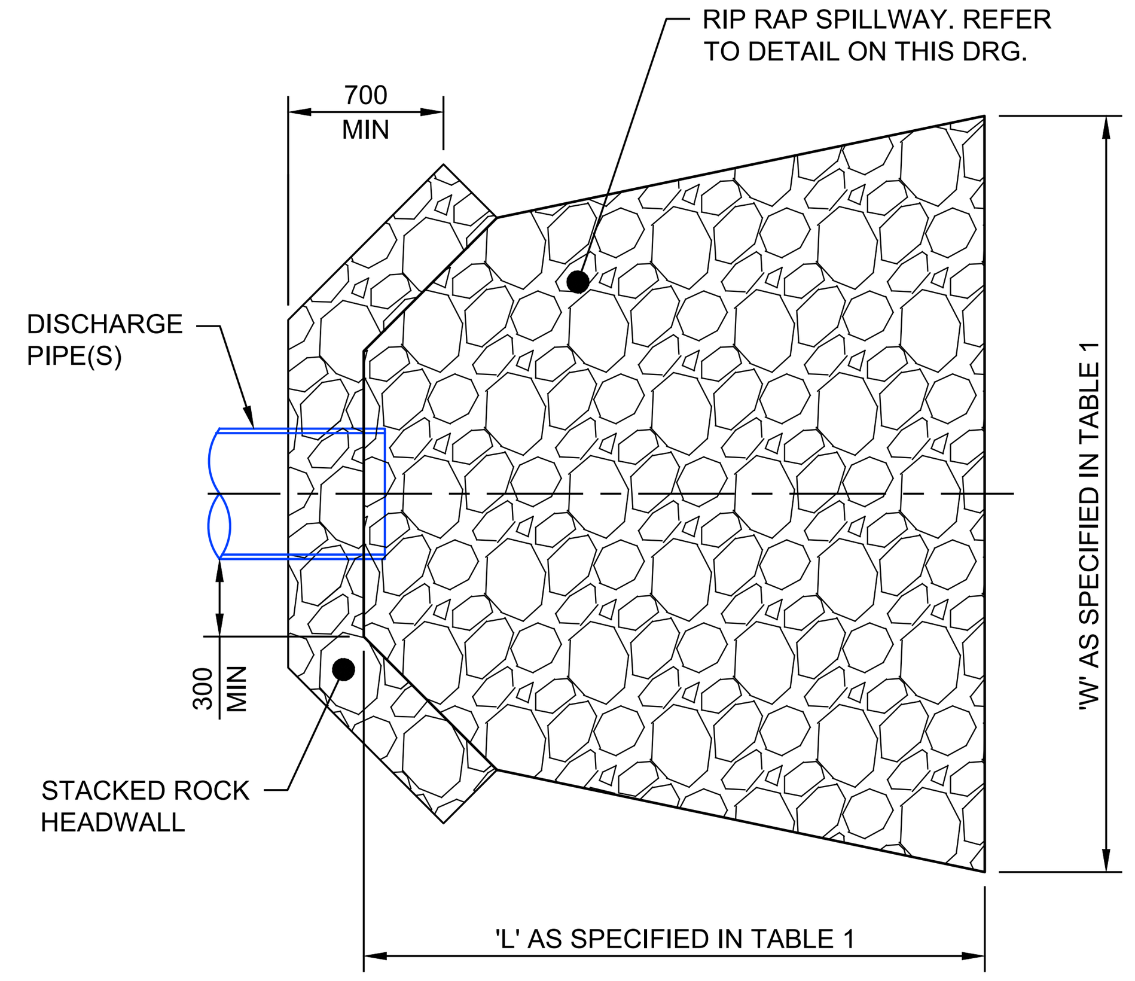
A - SECTION

SCALE NTS



DETAIL 1 -

SCALE N.T.S.



PLAN VIEW

TYPICAL HEADWALL TREATMENT

SCALE NTS

TABLE 1

PIT	PIPE SIZE (Ø)	1% AEP + CC	L (m)	W (m)	D_{50} (mm)
1\13	600	1.610	2.40	2.20	250
4\03	450	NA	2.00	CHANNEL	250
10\09	1800x900	NA	5.00	CHANNEL	250

EXCAVATIONS - BASINS

1. ALL TOPSOIL TO BE STRIPPED AND STOCKPILED FOR FUTURE USE. STRIPPED SURFACES ARE TO BE ROLLED AND INSPECTED BY A GEOTECHNICAL ENGINEER PRIOR TO CONTINUING WORKS. DEPTH OF TOPSOIL STRIPPING TO BE BETWEEN 125mm AND 200mm (TO BE CONFIRMED BY THE SUPERINTENDENT PRIOR TO CONSTRUCTION)
2. WHERE ROCK IS EXPOSED DURING EXCAVATION, THE CONTRACTOR SHALL CEASE EXCAVATION AT THIS LOCATION AND CONTACT THE SUPERINTENDENT WHO WILL THEN ADVISE ON THE LEVEL TO WHICH THE EXCAVATION IS TAKEN.

DEVELOPMENT APPLICATION

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B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
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Drawing Title: DRAINAGE DETAILS

C&R Ref: 048-22

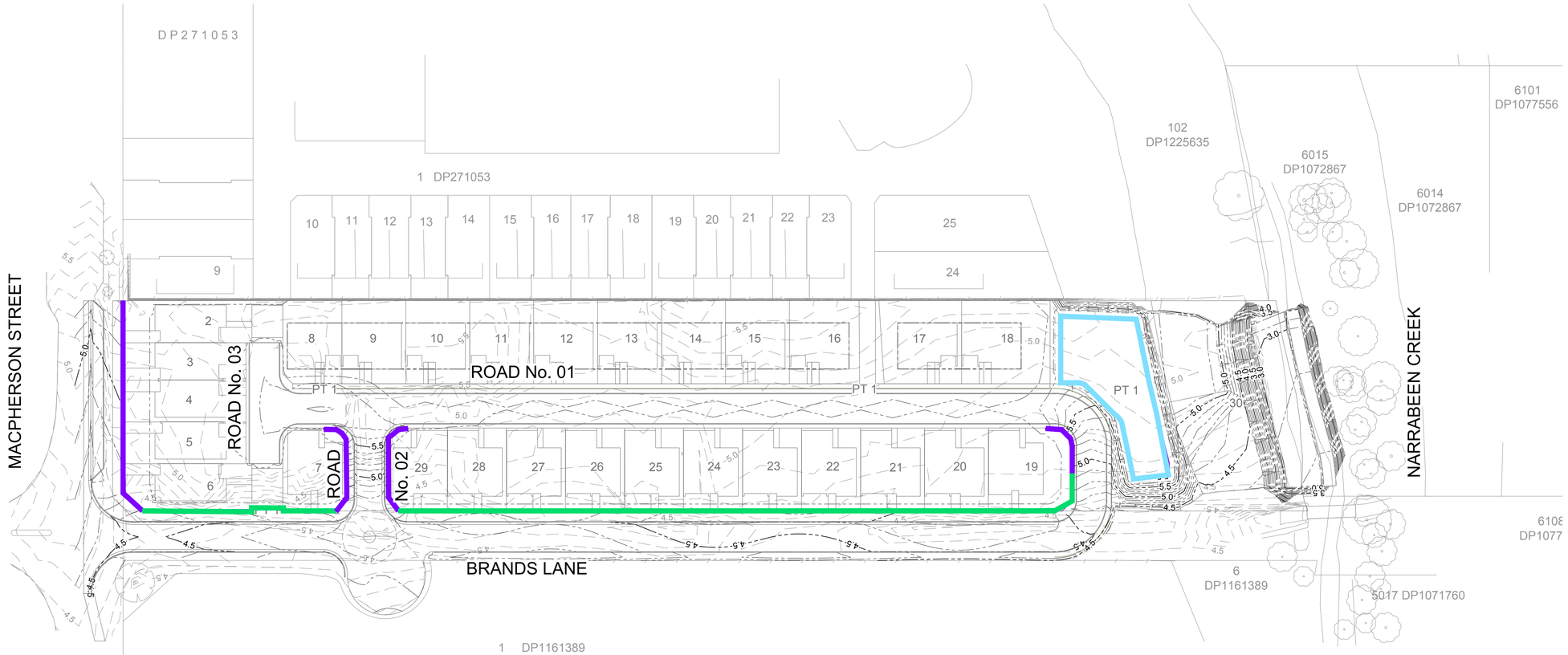
Drawing Ref: 048-22C-DA-0753

Revision: B

A1

LEGEND

- WALL HEIGHT 0.0m - 1.0m
- WALL HEIGHT 1.0m - 2.0m
- WALL HEIGHT 2.0m - 3.0m



PLAN

SCALE 1:500

0 5 10 15 20 30 40 50m
1:500 @A1

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES

L.G.A. NORTHERN BEACHES COUNCIL

Scale: AS SHOWN

Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

CRAIG & RHODES TAKE THE LEAD

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Drawing Title: RETAINING WALL PLAN (INDICATIVE HEIGHTS)

C&R Ref. 048-22 | Drawing Ref. 048-22C-DA-0801 | Revision B

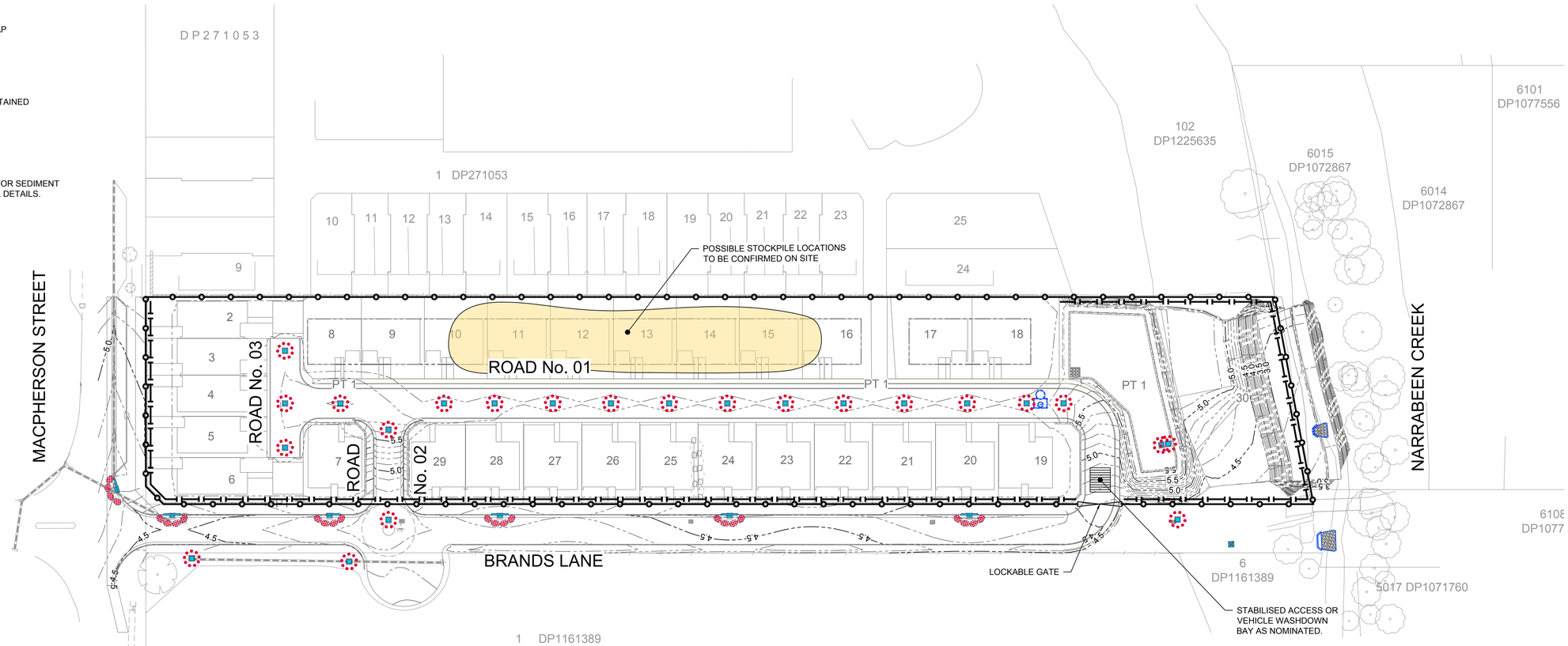
A1

LEGEND

- SEDIMENT FENCE
- SITE FENCE
- GEOTEXTILE INLET FILTER
- KERB INLET SEDIMENT TRAP
- STRAW BALE FILTERS
- EXISTING TREES TO BE RETAINED

NOTE:

1. REFER TO DRG. No.902 FOR SEDIMENT AND EROSION CONTROL DETAILS.



PLAN

SCALE 1:500

DEVELOPMENT APPLICATION

0 5 10 15 20 30 40 50m
1:500 @A1

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Drawing Title: SEDIMENT & EROSION CONTROL PLAN

C&R Ref.	Drawing Ref.	Revision
048-22	048-22C-DA-0901	B

A1

STABILISED SITE ACCESS

1. COVER THE EXISTING SANDSTONE SUBGRADE AREA WITH NEEDLE-PUNCHED GEOTEXTILE.
2. CONSTRUCT A 200mm THICK PAD OVER THE GEOTEXTILE USING ROAD BASE OR 30mm AGGREGATE.
3. ENSURE THE STRUCTURE IS AT LEAST 15 METERS LONG OR TO BUILDING ALIGNMENT AND AT LEAST 3 METERS WIDE.
4. WHERE A SEDIMENT FENCE JOINS ONTO THE STABILISED ACCESS, CONSTRUCT A HUMP IN THE STABILISED ACCESS TO DIVERT WATER TO THE SEDIMENT

SEDIMENT FENCE

1. CONSTRUCT SEDIMENT FENCES AS CLOSE AS POSSIBLE TO BE PARALLEL TO THE CONTOURS OF THE SITE, BUT WITH SMALL RETURNS AS SHOWN IN THE DRAWING, TO LIMIT THE CATCHMENT AREA OF ANY ONE SECTION. THE CATCHMENT AREA SHOULD BE SMALL ENOUGH TO LIMIT WATER FLOW IF CONCENTRATED AT ONE POINT TO 50 LITRES/SEC IN THE DESIGN STORM EVENT, USUALLY THE 10 YEAR EVENT.
2. CUT A 150mm DEEP TRENCH ALONG THE UPSLOPE LINE OF THE FENCE FOR THE BOTTOM OF THE FABRIC TO BE ENTRENCHED.
3. DRIVE 1.5 METER LONG STAR PICKETS INTO GROUND AT 2.5 METER INTERVALS (MAX.) AT THE DOWNSLOPE EDGE OF THE TRENCH. ENSURE ANY STAR PICKETS ARE FITTED WITH SAFETY CAPS.
4. FIX SELF-SUPPORTING GEOTEXTILE TO THE UPSLOPE SIDE OF THE POSTS, ENSURING IT GOES TO THE BASE OF THE TRENCH. FIX THE GEOTEXTILE WITH WIRE TIES, OR AS RECOMMENDED BY THE MANUFACTURER. ONLY USE GEOTEXTILE SPECIFICALLY PRODUCED FOR SEDIMENT FENCING. THE USE OF SHADE CLOTH FOR THIS PURPOSE IS NOT SATISFACTORY.
5. JOIN SECTIONS OF FABRIC AT A SUPPORT POST WITH A 150mm OVERLAP.
6. BACKFILL THE TRENCH OVER THE BASE OF THE FABRIC AND COMPACT IT THOROUGHLY OVER THE GEOTEXTILE.

KERB INLET SEDIMENT FILTER

1. REFER TO APPROVED PLANS FOR LOCATION AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION,DIMENSIONS, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.
2. ENSURE THAT THE INSTALLATION OF THE SEDIMENT TRAP WILL NOT CAUSE UNDESIRABLE SAFETY OR FLOODING ISSUES.
3. INSTALL SEDIMENT TRAP IN ACCORDANCE WITH STANDARD DRAWING SUPPLIED WITH THE APPROVED PLAN, OR AS DIRECTED BY THE SITE SUPERVISOR.
4. ENSURE THE SEDIMENT TRAP IS CONSTRUCTED UP-SLOPE OF AN ON-GRADE KERB INLET. THE SEDIMENT TRAP MUST NOT SURROUND THE KERB INLET UNLESS SPECIFICALLY DIRECTED BY THE SITE SUPERVISOR.
5. ENSURE THE SEDIMENT TRAP FULLY ENCLOSES THE KERB INLET. USE APPROPRIATE SPACERS TO ENSURE THE SEDIMENT TRAP DOES NOT BLOCK THE SIDE-ENTRY INLET.
6. TAKE ALL NECESSARY MEASURE TO MINIMISE THE SAFETY RISK CAUSED BY THE STRUCTURE

DROP INLET FILTERS

1. FABRICATE A SEDIMENT BARRIER MADE FROM GEOTEXTILE OF STRAW BALES.
2. FOLLOW STANDARD DRAWINGS OF STRAW BALE FILTERS AND SEDIMENT FENCES FOR INSTALLATION PROCEDURES FOR THE STRAW BALES OR GEOFABRIC. REDUCE THE PICKET SPACING TO 1m CENTRES.
3. IN WATERWAYS, ARTIFICIAL SAG POINTS CAN BE CREATED WITH SANDBAGS OR EARTH BANKS AS SHOWN IN THE DRAWING.
4. DO NOT COVER THE INLET WITH GEOTEXTILE UNLESS THE DESIGN IS ADEQUATE TO ALLOW FOR ALL WATERS TO BYPASS IT.

EARTHBANK (LOW FLOW)

1. BUILD WITH GRADIENTS BETWEEN 1% AND 5%.
2. AVOID REMOVING TREES AND SHRUBS IF POSSIBLE - WORK AROUND THEM.
3. ENSURE THE STRUCTURES ARE FREE OF PROJECTIONS OR OTHER IRREGULARITIES THAT COULD IMPEDE WATER FLOW.
4. BUILD THE DRAINS WITH CIRCULAR, PARABOLIC OR TRAPEZOIDAL CROSS SECTIONS, NOT V SHAPED.
5. ENSURE BANKS ARE PROPERLY COMPACTED TO PREVENT FAILURE.
6. COMPLETE PERMANENT OR TEMPORARY STABILISATION WITHIN 10 DAYS OF CONSTRUCTION.

STRAW BALE FILTERS

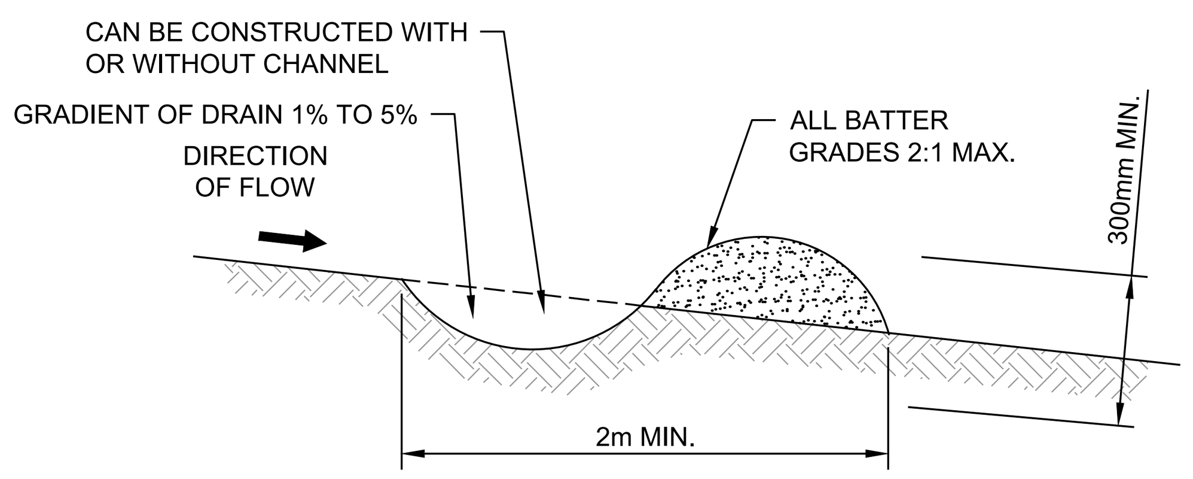
1. CONSTRUCT THE STRAW BALE FILTER AS CLOSE AS POSSIBLE TO BEING PARALLEL TO THE CONTOURS OF THE SITE, BUT WITH SMALL RETURNS AS SHOWN IN THE DIAGRAM TO LIMIT THE CATCHMENT AREA OF ANY ONE SECTION.
2. PLACE BALES LENGTHWISE IN A ROW WITH ENDS TIGHTLY ABUTTING. USE STRAW TO FILL ANY GAPS BETWEEN THE BALES. THE STRAWS IN EACH BALE ATE TO BE ALIGNED PARALLEL TO THE GROUND.
3. ENSURE THAT THE MAXIMUM HEIGHT OF THE FILTER IS ONE BALE.
4. EMBED EACH BALE IN THE GROUND 75mm TO 100mm AND ANCHOR WITH 1.2m STAR PICKETS OR STAKES. ANGLE THE FIRST STAR PICKET OR STAKE IN EACH BALE TOWARDS THE PREVIOUSLY LAID BALE. DRIVE THEM 600mm INTO THE GROUND AND, IF POSSIBLE, FLUSH WITH THE TOP OF THE BALES. WHERE STAR PICKETS ARE USED AND THEY PROTRUDE ABOVE THE BALES, ENSURE THEY ARE FITTED WITH SAFETY CAPS.
5. WHERE A STRAW BALE FILTER IS CONSTRUCTED DOWNSLOPE FROM A DISTURBED BATTER, ENSURE BALES ARE PLACED 1M TO 2m DOWNSLOPE FROM THE TOE.
6. ESTABLISH A MAINTENANCE PROGRAM THE ENSURES THE INTEGRITY OF THE BALES IS RETAINED - THEY COULD REQUIRE REPLACEMENT EACH TWO TO FOUR MONTHS.

STOCKPILE

1. MAINTAIN THE TRENCH FREE OF WATER AND RECOMPACT THE MATERIALS WITH EQUIPMENT AS SPECIFIED IN THE SWMP TO 95% STANDARD PROCTOR DENSITY.
2. SELECT FILL FOLLOWING THE SWMP THAT IS FREE OF ROOTS, WOOD, ROCK LARGE STONE OR FOREIGN MATERIAL.
3. SPREAD THE FILL IN 100mm TO 150mm LAYERS AND COMPACT IT AT OPTIMUM MOISTURE CONTENT FOLLOWING THE SWMP.

KERBSIDE TURF STRIP

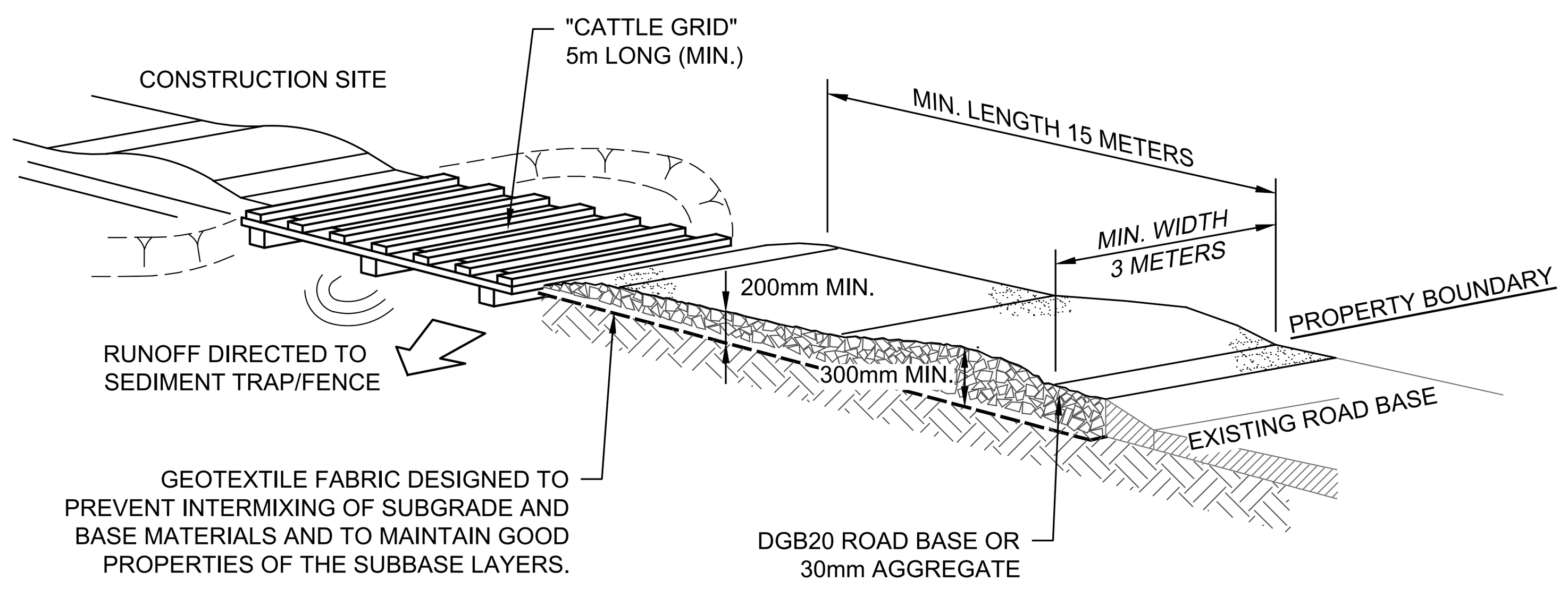
1. INSTALL A 400mm MINIMUM WIDE ROLL OF TURF ON THE FOOTPATH NEXT TO THE KERB AND AT THE SAME LEVEL AS THE TOP OF THE KERB.
2. LAY 1.4m LONG TURF STRIPS NORMAL TO THE KERB EVERY 10m.
3. REHABILITATE DISTURBED SOIL BEHIND THE TURF STRIP FOLLOWING THE ESCP/SWMP.



NOTE: ONLY TO BE USED AS TEMPORARY BANK WHERE MAXIMUM UPSLOPE LENGTH IS 80 METRES

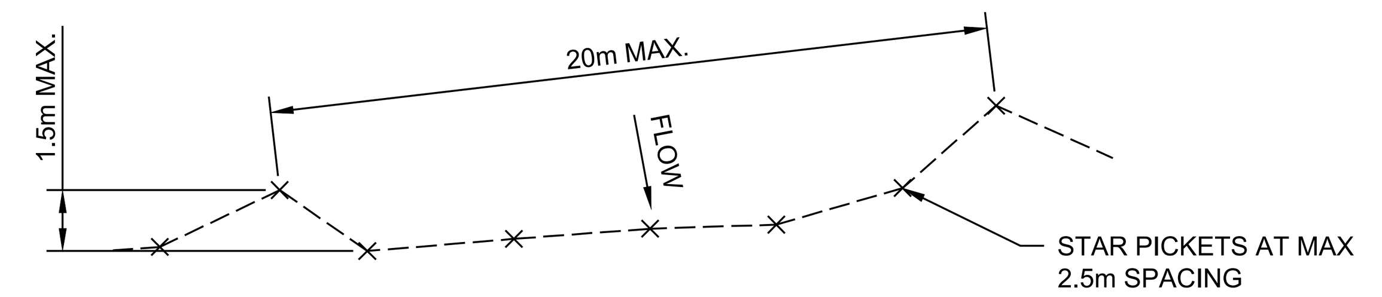
EARTHBANK

NTS



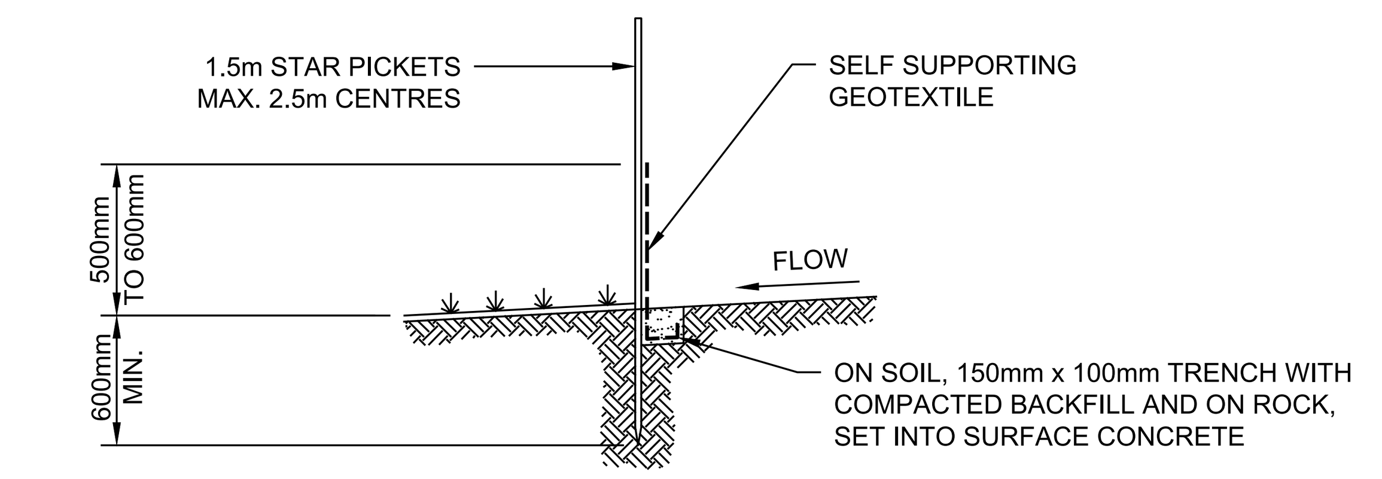
STABILISED SITE ACCESS DETAIL

NTS



SEDIMENT FENCE - PLAN

NTS



SEDIMENT FENCE - SECTION

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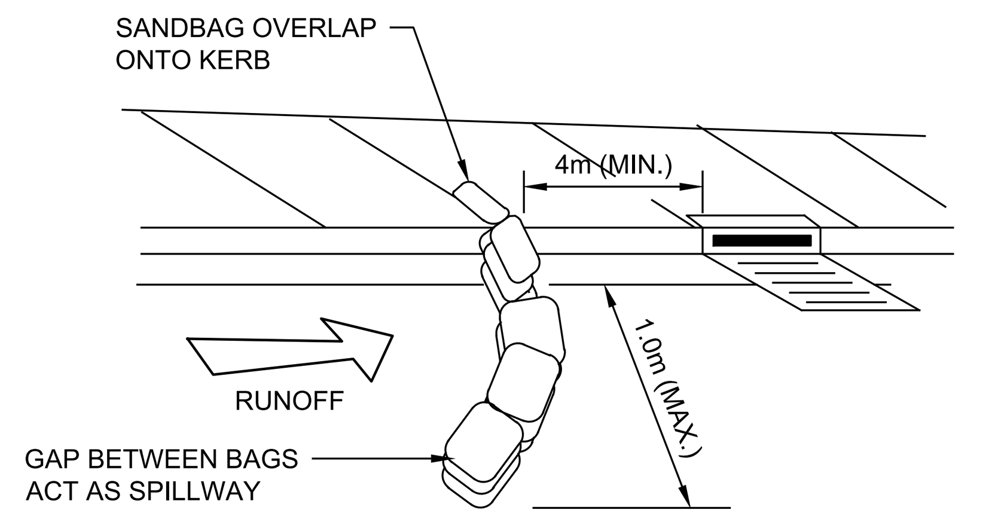
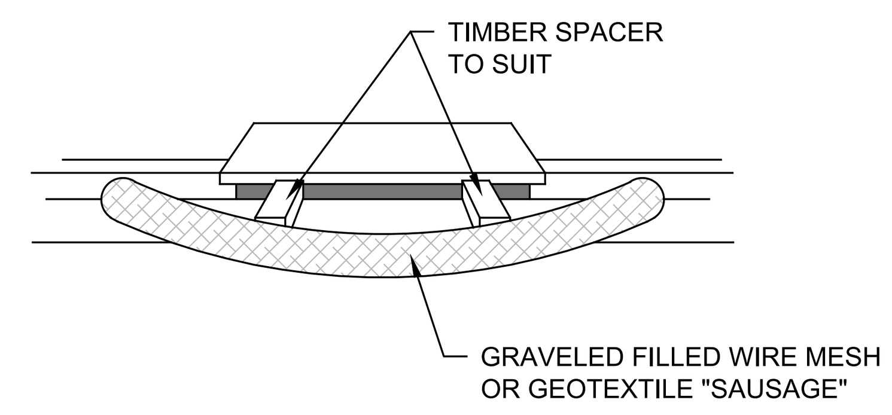


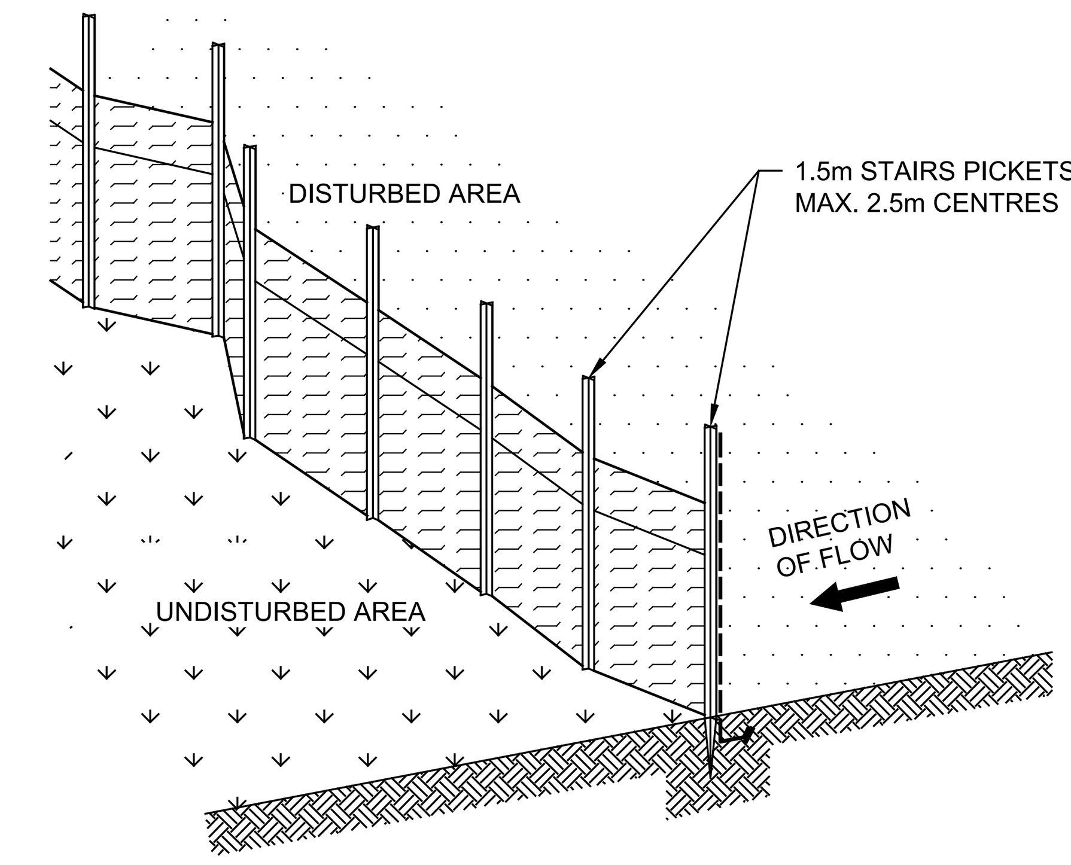
KERB INLET SEDIMENT FILTER (ON GRADE)

NTS



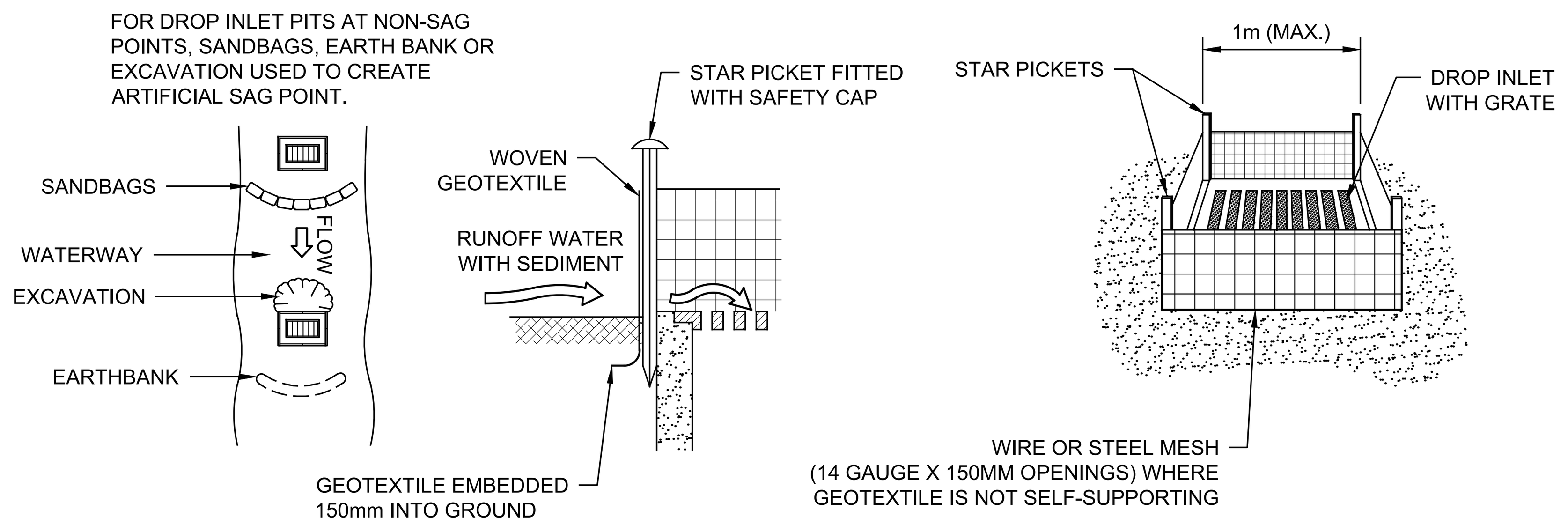
KERB INLET SEDIMENT FILTER (SAG)

NTS



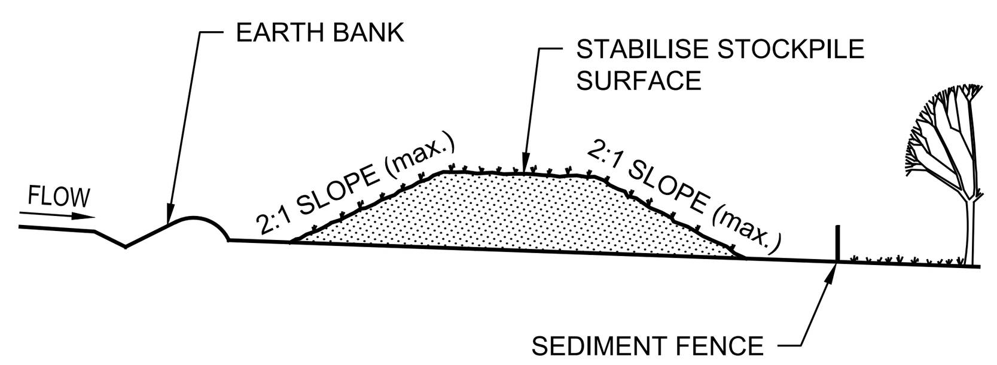
SEDIMENT FENCE - DETAIL

NTS



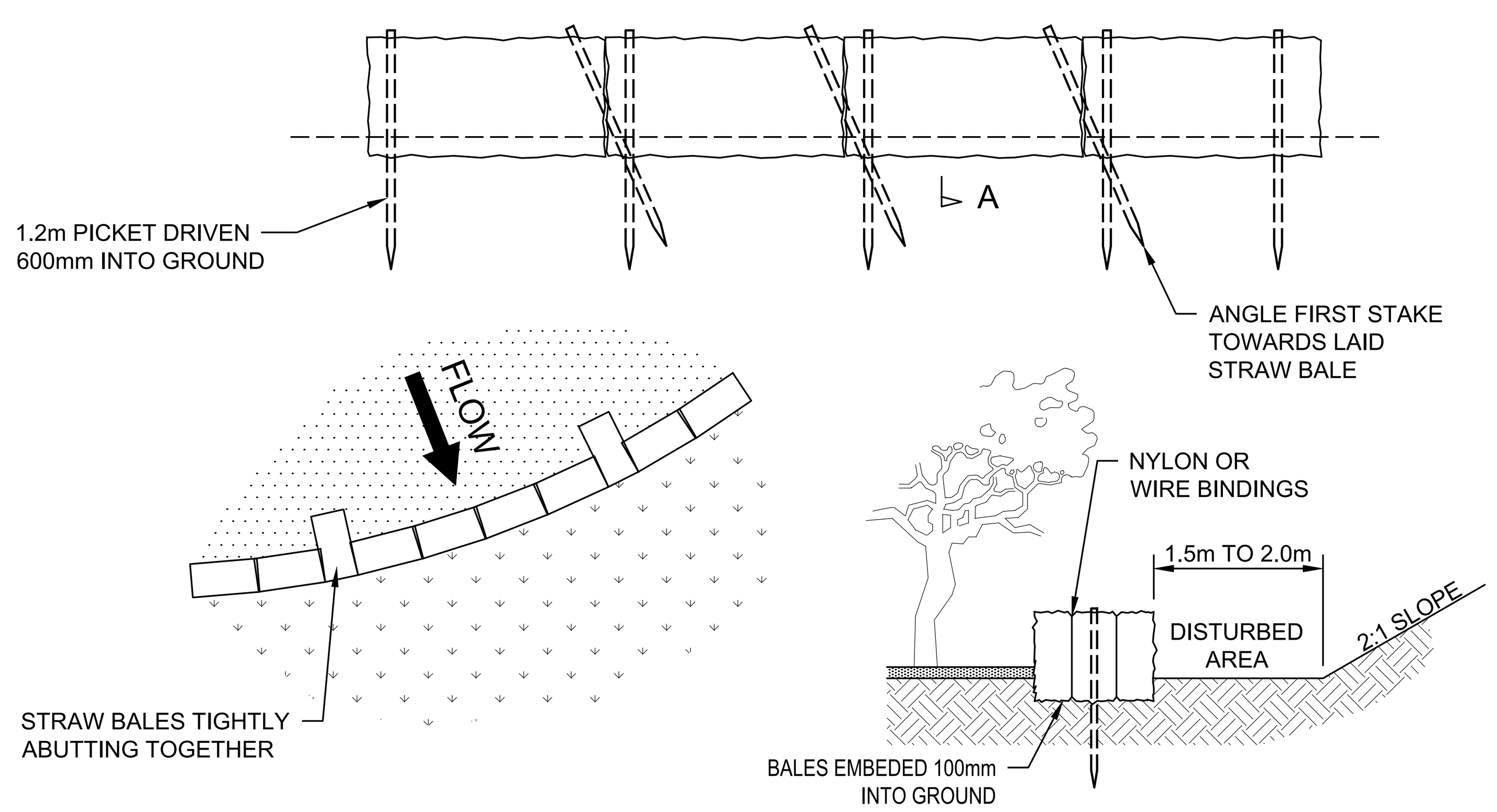
DROP INLET FILTER

NTS



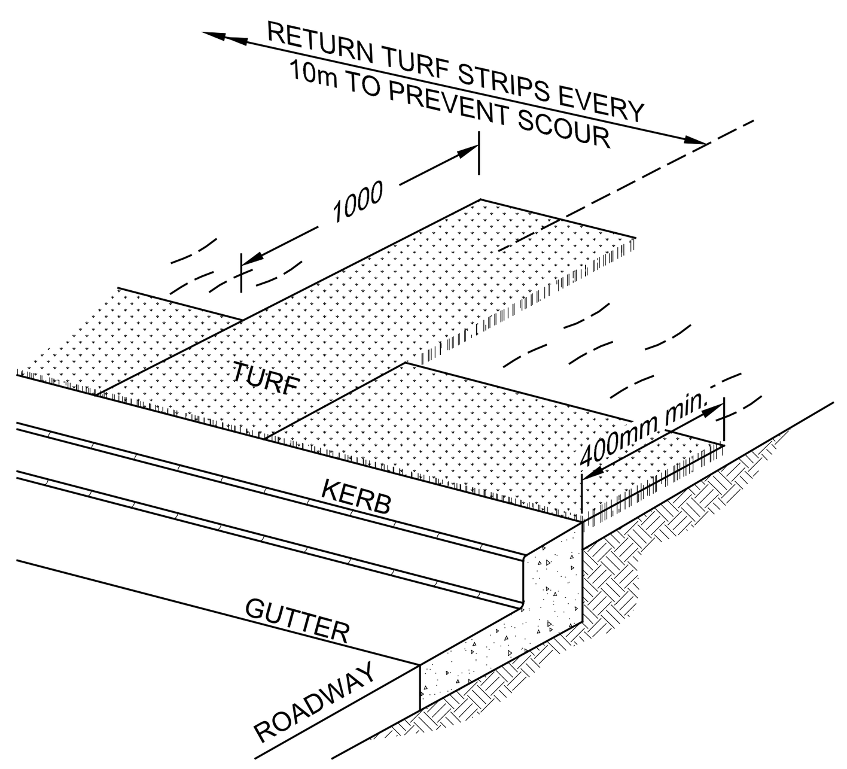
STOCKPILE A

NTS



STRAW BALE FILTERS

NTS



KERBSIDE TURF STRIP

NTS

DEVELOPMENT APPLICATION

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Drawing Title: SEDIMENT & EROSION CONTROL DETAILS

C&R Ref.: 048-22

Drawing Ref.: 048-22C-DA-0902

Revision: B

A1

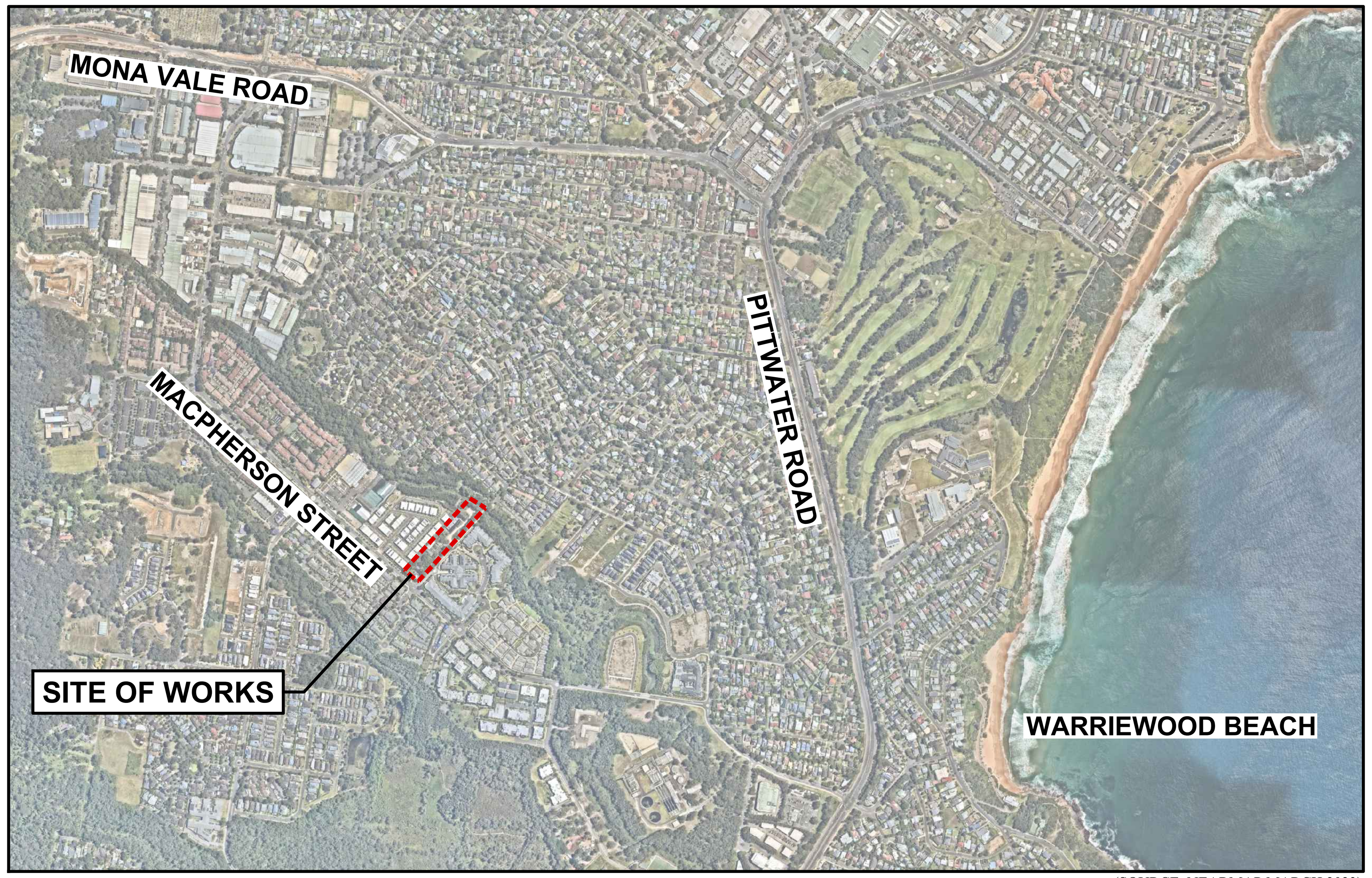
D.A. _ _ _ _ _ _

PROPOSED SUBDIVISION of LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

NARRABEEN CREEK REHABILITATION WORKS DEVELOPMENT APPLICATION

N

M.G.A. 2020



(SOURCE: NEARMAP MARCH 2023)

LOCALITY PLAN

NOT TO SCALE

DRAWING No.	DRAWING TITLE	REV.
048-22C-CK-0001	COVER SHEET, LOCALITY PLAN & INDEX	B
048-22C-CK-0003	GENERAL LEGEND	B
048-22C-CK-0101	NARRABEEN CREEK PLAN, LONGITUDINAL SECTION & TYPICAL CROSS SECTION	B
048-22C-CK-0741	NARRABEEN CREEK CROSS SECTIONS	B
048-22C-CK-0771	DRAINAGE DETAILS	B
048-22C-CK-0901	SEDIMENT & EROSION CONTROL PLAN	B
048-22C-CK-0902	SEDIMENT & EROSION CONTROL DETAILS	B

CREEK WORK NOTES:

ROCK SCOUR PROTECTION

1. ROCK USED IN THE SCOUR PROTECTION SHALL CONSIST OF MATERIAL WHICH COMPLIES WITH THESE NOTES AND THE DRAWINGS. THESE REQUIREMENTS APPLY TO BOTH IMPORTED ROCK AND IN-SITU ROCK WHICH IS REUSED.

2. INDIVIDUAL ROCKS SHALL BE FREE FROM CRACKS, CLEAVAGE PLANES, SEAMS AND DEFECTS WHICH WOULD RESULT IN THE BREAKDOWN OF ROCK IN SERVICE

3. ROCK UNITS SHALL BE EITHER SEDIMENTARY ROCK ONLY OR IGNEOUS ROCK ONLY AND, AS A MINIMUM, SHALL SATISFY THE FOLLOWING CRITERIA:
   - ROCK SHALL BE BOTH ROUGH AND ANGULAR
   - ROCK SHALL HAVE A MINIMUM DRY DENSITY OF 2200 kg/m^3
   - IGNEOUS ROCK SHALL NOT HAVE MORE THAN 10% (BY VOLUME) OLIVINE MATERIAL AND SHALL EXHIBIT NO ZONES OF SECONDARY ALTERATION SUCH AS CHLORITISTAION.
   - SEDIMENTARY ROCK SHALL HAVE A SODIUM SULPHATE SOUNDNESS WEIGHT LOSS NOT EXCEEDING 25%

4. ROCK SHALL HAVE A SATURATED POINT LOAD STRENGTH INDEX (15SO) NO LESS THAN 5.0MPa FOR IGNEOUS ROCK AND 1.5MPa FOR SEDIMENTARY ROCK

5. THE RATIO OF THE MAXIMUM DIMENSION TO THE MINIMUM DIMENSION, MEASURED AT RIGHT ANGLES TO THE MAXIMUM DIMENSION, SHALL NOT EXCEED 2.5x

6. THE ROCK UNITS SHALL BE PLACED SUCH THAT THE SPECIFIED REQUIREMENTS FOR SIZE, FINISHED SURFACE SIDE SLOPES, TOP AND TOE LEVELS AND DENSITY REQUIREMENTS ARE SATISFIED. IN ADDITION, ROCKS SHALL BE WEDGED AND LOCKED TOGETHER SUCH THAT THEY ARE NOT FREE TO MOVE. ROCK UNITS SHALL NOT BE ROLLED OF DROPPED IN TO POSITION, THEY SHALL BE PLACED.

7. THE METHOD OF ROCK PLACEMENT SHALL BE SUCH AS TO MINIMISE ITS BREAKDOWN ON HANDLING AND THE PRODUCTION OF FINES.

8. A NON-WOVEN SHALL BE PLACED UNDERNEATH AND BEHIND ALL ROCK ARMOUR AND EXTEND 0.5m ABOVE THE EXTENT OF THE WORKS, OR AS OTHERWISE SHOWN ON THE DRAWINGS. THE GEOTEXTILE IS TO BE LAID ON A HEAVILY TRIMMED BATTER THAT IS FREE OF HOLLOWS OR SHARP OBJECTS

9. GEOTEXTILE LAYERS SHALL EITHER OVERLAP ONE ANOTHER BY 1000mm OR BE SEWN TOGETHER (WITH A NON-BIODEGRADABLE THREAD) WITH AN OVERLAP OF 100mm

10. ROCK AND SUB-ARMOUR SHALL BE PLACED UPON THE GEOTEXTILE IN A LAYER NO LESS THAN 150mm THICK U.N.O. ON DRAWINGS

11. ROCK ARMOUR SHALL BE SELECTIVELY HAND PLACED UPON THE SUB-ARMOUR TO ENSURE A SNUG FIT SUCH THAT INDIVIDUAL ROCKS ARE NOT FREE TO MOVE. THE PLACING OF ANY ARMOUR ROCK SHALL BE COMPLETED IN SUCH A MANNER AS TO MINIMISE THE DISTURBANCE OR DISLODGEMENT OF THE SUB-ARMOUR.

12. THE ARMOUR ROCK AND SUB-ARMOUR ROCK SHALL BE PLACED TO THE CONSTRUCTION TOLERANCES SHOWN ON THE DRAWINGS

13. AT LEAST FOURTEEN (14) DAYS PRIOR TO THE SUPPLY OF ANY ROCK, THE CONTRACTOR SHALL PROVIDE DOCUMENTATION TO DEMONSTRATE THAT THE ROCK TO BE SUPPLIED COMPLIES WITH THE REQUIREMENTS OF THIS SPECIFICATION

EARTH WORKS

1. THE CONTRACTOR SHALL PROVIDE PROPER FENCING, GUARDING & LIGHTING AND OBSERVATION OF ALL EARTHWORKS, TEMPORARY ROADWAYS, FOOTWAYS, GUARDS & FENCES AS MAY BE RENDERED NECESSARY FOR THE ACCOMMODATION AND PROTECTION OF PEDESTRIANS, VEHICLES, ANIMALS & THE PUBLIC

2. ALL EARTHWORKS SHALL BE CARRIED OUT IN THE LOCATIONS SHOWN AND TO THE LEVELS, WIDTHS AND BATTER SLOPES INDICATED ON THE DRAWINGS

3. EXCAVATED MATERIAL NOT MEETING THE SPECIFICATIONS FOR FILL MATERIAL SHALL BE DISPOSED OFF SITE IN AN APPROPRIATE MANNER

4. WHERE EARTHWORKS ARE REQUIRED IN THE VICINITY OF EXISTING SERVICES, THE CONTRACTOR SHALL SUPPORT ALL SERVICES DURING THE WORKS

5. THE CONTRACTOR SHALL, AT ITS OWN EXPENSE, DO ALL THINGS NECESSARY TO DIVERT ANY WATER INTERFERING WITH THE PROCESS OF WORKS, KEEP THE EXCAVATIONS AND TRENCHES FREE FROM WATER WHILE THE WORKS ARE IN PROGRESS AND PREVENT ANY DAMAGE TO THE WORKS BY WATER DUE TO FLOODS OR OTHER CAUSES. THE CONTRACTOR SHALL HAVE PUMPING EQUIPMENT FOR KEEPING THE EXCAVATION OR TRENCHES CONSTANTLY DEWATERED DURING THE TIMES THE WORKS ARE IN PROGRESS. ANY WORK OR MATERIAL DAMAGED BY WATER SHALL BE MADE GOOD BY THE CONTRACTOR.

6. WHERE DIRECTED BY THE SUPERINTENDENT THE BOTTOM OF TRENCHES OR EXCAVATIONS SHALL BE COMPACTED PRIOR TO THE PLACING OF ANY BEDDING OR CONCRETE MATERIALS. SHOULD, IN THE OPINION OF THE SUPERINTENDENT, THE FOUNDATION MATERIAL BE INCAPABLE OF EFFECTIVE COMPACTION, THE MATERIAL SHALL BE REMOVED AND REPLACED WITH APPROPRIATE MATERIAL

EXCAVATIONS

1. ALL TOPSOIL TO BE STRIPPED AND STOCKPILED FOR FUTURE USE. STRIPPED SURFACES ARE TO BE ROLLED AND INSPECTED BY A GEOTECHNICAL ENGINEER PRIOR TO CONTINUING WORKS. DEPTH OF TOPSOIL STRIPPING TO BE BETWEEN 125mm AND 200mm (TO BE CONFIRMED BY THE SUPERINTENDENT PRIOR TO CONSTRUCTION)

2. WHERE ROCK IS EXPOSED DURING EXCAVATION, THE CONTRACTOR SHALL CEASE EXCAVATION AT THIS LOCATION AND CONTACT THE SUPERINTENDENT WHO WILL THEN ADVISE ON THE LEVEL TO WHICH THE EXCAVATION IS TAKEN

FILL

1. FOUNDATION MATERIAL DEEMED BY THE SUPERINTENDENT AS UNSUITABLE TO BE REMOVED AS DIRECTED BY THE SUPERINTENDENT AND REPLACED WITH APPROVED MATERIAL SATISFYING THE REQUIREMENTS LIST BELOW

2. UNLESS OTHERWISE APPROVED OR SPECIFIED, ALL FILL MATERIAL SHALL BE FROM A SOURCE APPROVED BY THE SUPERINTENDENT AND SHALL COMPLY WITH THE FOLLOWING:-
   - FREE FROM ORGANIC & PERISHABLE MATTER
   - MAXIMUM PARTICLE SIZE 75mm
   - PLASTICITY INDEX BETWEEN 2% AND 20%
   - CBR > 10

3. SELECT FILL MATERIAL SHALL BE PLACED IN MAXIMUM 200MM LOOSE THICK LAYERS AND COMPACTED AT OPTIMUM MOISTURE CONTENT (±2%) TO ACHIEVE A DRY DENSITY DETERMINED IN ACCORDANCE WITH AS1289E3.1 (LATEST EDITION) OF NOT LESS THAN THE STANDARD DRY DENSITY ON ACCORDANCE WITH AS1289E3.1 (LATEST EDITION) SHOWN ON THE DRAWING

4. COMPACTION CONTROL TESTING SHALL BE CARRIED OUT BY & AT THE COST OF THE CONTRACTOR TO CONFORM WITH LEVEL 1 AS DEFINED IN AS3798 (LATEST EDITION)

5. REPLACEMENT SUBGRADE MATERIAL MAY COMPRISE GRANULAR FILL MATERIAL & SHOULD HAVE A CBR OF AT LEAST 10% REPLACEMENT. SUBGRADE SHALL BE PLACED ON PROOF ROLLED SUBGRADE IN HORIZONTAL LAYERS OF 200mm TO 250mm MAXIMUM LOOSE THICKNESS DEPENDING ON THE SIZE OF EQUIPMENT) AND COMPACTED TO A MINIMUM DRY DENSITY OF (MIDDR) OF 98% STANDARD, AT MOISTURE CONTENT WITHIN 2% OF OPTIMUM MOISTURE CONTENT

6. WHERE EXCAVATED MATERIAL IS TO BE USED FOR FILLING, THE MATERIAL SHALL BE INSPECTED & APPROVED BY THE SUPERINTENDENT PRIOR TO USE.

TIE IN WORKS

1. ALL CREEK WORKS TO TIE INTO EXISTING LOW FLOW CHANNEL AT BOTH UPSTREAM AND DOWNSTREAM LIMIT OF WORKS. TRANSITION TIE IN OVER 5m.

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APPROVED COMPANY ISO 45001 Occupational Health & Safety Management Systems — QMS Certification Services

APPROVED COMPANY ISO 14001 Environmental Management Systems — QMS Certification Services

APPROVED COMPANY ISO 9001 Quality Management Systems — QMS Certification Services

DIAL 1100 BEFORE YOU DIG

Authorised for issue by:

.... Signature:

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L.G.A.: NORTHERN BEACHES COUNCIL

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Drawing Title: COVER SHEET, LOCALITY PLAN & INDEX

C&R Ref. 048-22

Drawing Ref. 048-22C-CK-0001

Revision B

CAD REF.: Z:\048-22P MACPHERSON ST\ENGINEERING\DRAWINGS\...

A1

LEGEND - CIVIL

DESCRIPTION	PROPOSED	EXISTING
LIMIT OF CONSTRUCTION		
CIVIL WORKS BOUNDARY		
SITE WORKS BOUNDARY		
DESIGN CONTOUR - MAJOR	49.0	49.0
DESIGN CONTOUR - MINOR		
MASONRY RETAINING WALL		
ROCK RETAINING WALL		
FENCE		
LOCKABLE GATE		
GUIDE POST		
SITE FENCE		
GUARD RAIL		
BATTER (EARTHWORKS) TOP BATTER / BATTER TICK / BTM. BATTER		
CENTRELINE / CHAINAGE	CH 0.00	
KERB LINE		
KERB LINE (FUTURE)		
KERB RETURN LABEL	KR-01	
SURFACE LEVEL	RL:90.00	RL:90.00
VEHICULAR CROSSING	VC	
DRIVEWAY		

LEGEND - PAVEMENT

DESCRIPTION	PROPOSED	EXISTING
ROAD		
TEMPORARY		
FOOTPATH		

LEGEND - SURVEY

DESCRIPTION	PROPOSED	EXISTING
TREES		
EXISTING TREES TO BE REMOVED (MUST BE CONCORDANT WITH ARBORIST REPORT)		

LEGEND - DRAINAGE

DESCRIPTION	PROPOSED	EXISTING	FUTURE	TEMPORARY
SUBSOIL DRAINAGE LINE	SS	SS		
SUBSOIL DRAINAGE FLUSHING POINT	FP			
STORMWATER DRAINAGE LINE				
RCBC CULVERT LINE				
FLOW DIRECTION AND PIPE SIZE	Ø375	Ø375	Ø375	Ø375
STUB, CAP AND BURY FOR FUTURE CONNECTION				
TEMPORARILY BLOCK PIPE				
STRUCTURAL STORMWATER PIT (LINTEL/GRATE VARIABLE)				
STORMWATER PIT - ONGRADE				
STORMWATER PIT - SAG				
STORMWATER PIT - SURFACE INLET				
STORMWATER PIT - JUNCTION PIT				
STORMWATER PIT LABEL (DRAINAGE LINE No. \ DRAINAGE PIT No.)	00\00	00\00	00\00	00\00
CONCRETE HEADWALL WITH RIPRAP SCOUR PROTECTION				
STACKED ROCK HEADWALL WITH RIPRAP SCOUR PROTECTION				
OVERLAND FLOW PATH				
CATCHMENT DIRECTION				
EARTHBANK (LOW FLOW)				
SWALE				
ROOF WATER OUTLET TO KERB				
ROOF WATER CONNECTION TO REAR OF LINTEL				
BASIN FENCE				
BASIN BIO FILTER				

LEGEND - SERVICES

DESCRIPTION	PROPOSED	EXISTING	FUTURE
O/H ELECTRICAL LINE	E	E	E
ELECTRICAL LINE	E E	E E	E E
ELECTRICAL PILLAR			
STREET LIGHT			
POWER POLE	PP	PP	
ELECTRICAL SUBSTATION			
WATER LINE	W W	W W	W W
WATER HYDRANT			
WATER STOP VALVE	X	X	
RECYCLE WATER	RW	RW	RW
COMMUNICATION LINE	C C	C C	C C
GAS LINE	G G	G G	G G
SEWER LINE	S S	S S	S S
SEWER RISING MAIN	RM	RM	RM
SEWER LINE CONCRETE ENCASED	S S		
SEWER MAINTENANCE HOLE			
SEWER MS/TMS			
NBN LINE	NBN	NBN	NBN
TELECOMS LINE	TEL	TEL	TEL
FIBRE OPTIC LINE	F F	F F	F F
COMBINED SERVICES TRENCH			

ABBREVIATIONS

RKG	ROLL KERB AND GUTTER
K&G	KERB AND GUTTER
KO	KERB ONLY
ES	EDGE STRIP
DD	DISH DRAIN
PR	PRAM RAMP
VC	VEHICULAR CROSSING
RW	RETAINING WALL
S.G.G.P.	STANDARD GRATED GULLY PIT
G.S.I.P.	GRATED SURFACE INLET PIT
JP	JUNCTION PIT
HW	HEADWALL
GPT	GROSS POLLUTANT TRAP
TOW	TOP OF WALL
BOW	BOTTOM OF WALL
TFSL	TOP FINISHED SURFACE LEVEL
BFSL	BOTTOM FINISHED SURFACE LEVEL
RCP	STEEL REINFORCED CONCRETE PIPE
RRJ	RUBBER RING JOINT
C1 or C2	PIPE CLASS
MH	MAINTENANCE HOLE
MS	MAINTENANCE SHAFT
TMS	TERMINAL MAINTENANCE SHAFT
RP	RODDING POINT
HYD	HYDRANT
SV	STOP VALVE
SAG	LOW POINT
CREST	HIGH POINT
PP	POWER POLE

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	L.Mc.

DIAL 1100 BEFORE YOU DIG

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES

L.G.A. NORTHERN BEACHES COUNCIL

Scale: AS SHOWN

Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

CRAIG & RHODES TAKE THE LEAD

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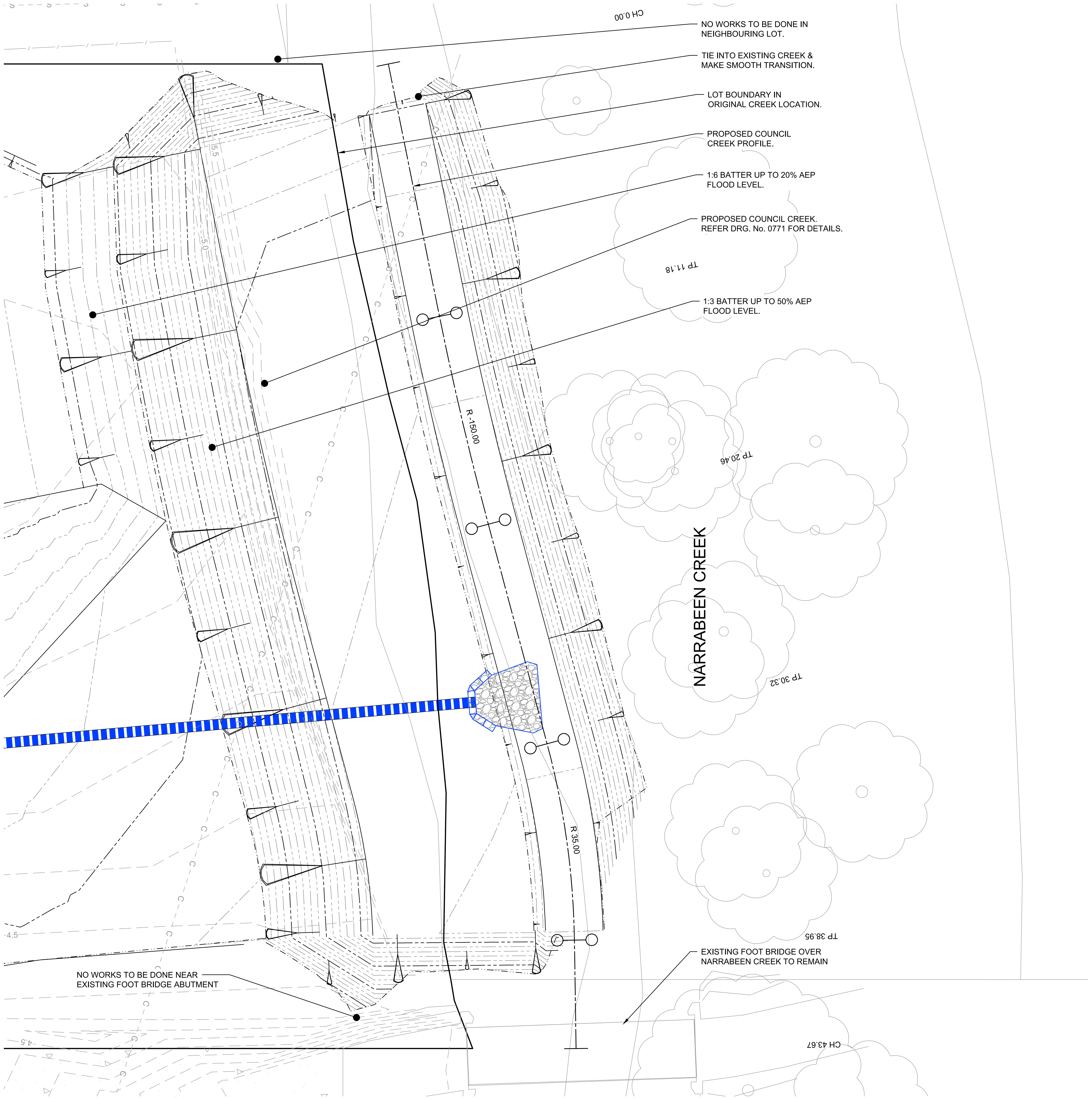
Drawing Title: GENERAL LEGEND

C&R Ref. 048-22

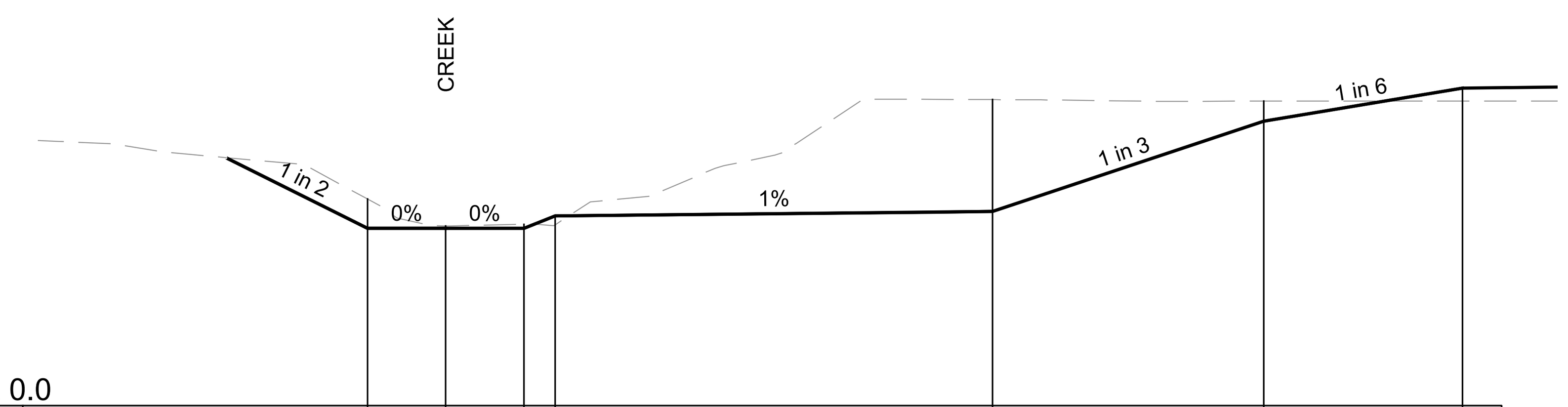
Drawing Ref. 048-22C-CK-0003

Revision B



PLAN

SCALE 1:100

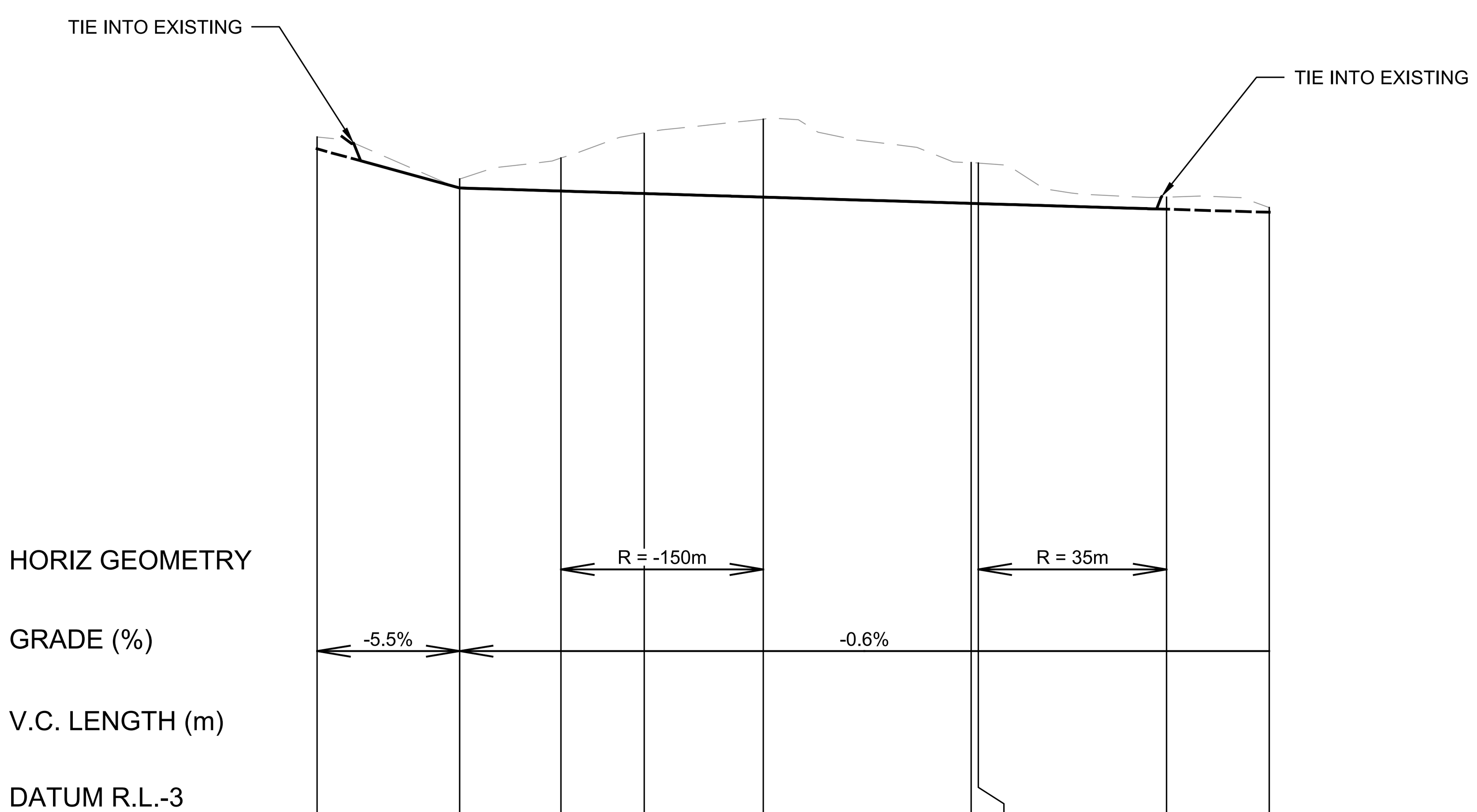


DATUM RL 0.0

DESIGN	0.00	0.00	0.00	0.20	0.27	1.72	2.25
OFFSET	-1.25	0.00	1.25	1.75	8.75	13.09	16.27

NARRABEEN CREEK - TYPICAL CROSS SECTION

SCALE - 1:100



HORIZ GEOMETRY: R = -150m; R = 35m

GRADE (%): -5.5%; -0.6%

V.C. LENGTH (m)

DATUM R.L.-3

WAE									
DESIGN LEVEL	3.11	2.75	2.72	2.70	2.67	2.61	2.61	2.56	2.53
EXISTING LEVEL	3.22	2.83	3.03	3.25	3.38	2.98	2.98	2.67	2.57
CHAINAGE	0	6.54	11.18	15	20.46	30	30.32	38.95	43.67

NARRABEEN CREEK - LONGITUDINAL SECTION

HORIZONTAL SCALE - 1:250
VERTICAL SCALE - 1:50

NOTES:

1. REFER TO DRG. No. 0003 FOR LEGEND & ABBREVIATIONS
2. REFER TO NORTHERN BEACHES COUNCIL FOR STANDARD DETAILS & DRAWINGS.

0 2.5 5 7.5 10 15 20 25m — 1:250 @A1
0 1 2 3 4 6 8 10m — 1:100 @A1
0 0.5 1 1.5 2 3 4 5m — 1:50 @A1

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	L.Mc.

Authorised for issue by: .... Signature:

Principal: IPM PROPERTIES
L.G.A. NORTHERN BEACHES COUNCIL
Scale: AS SHOWN Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816, 16 MACPHERSON STREET, WARRIEWOOD

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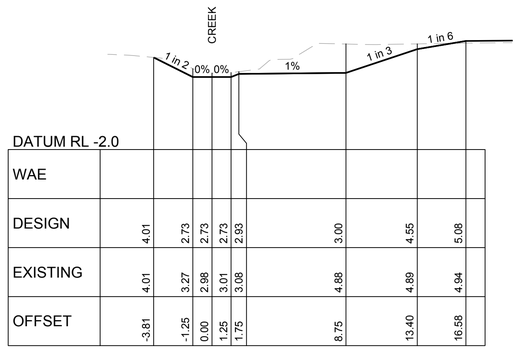
Drawing Title: NARRABEEN CREEK PLAN, LONGITUDINAL SECTION & TYPICAL CROSS SECTION

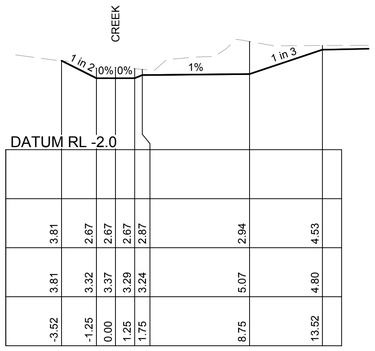
C&R Ref: 048-22 Drawing Ref: 048-22C-CK-0101 Revision: B



DATUM RL -2.0

WAE								
DESIGN	4.01	2.73	2.73	2.73	2.93	3.00	4.55	5.08
EXISTING	4.01	3.27	2.98	3.01	3.08	4.88	4.89	4.94
OFFSET	-3.81	-1.25	0.00	1.25	1.75	8.75	13.40	16.58

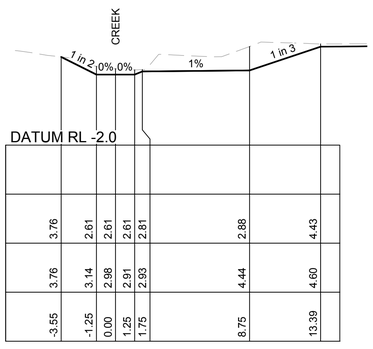
CHAINAGE 10.00



DATUM RL -2.0

WAE							
DESIGN	3.81	2.67	2.67	2.67	2.87	2.94	4.53
EXISTING	3.81	3.32	3.37	3.29	3.24	5.07	4.80
OFFSET	-3.52	-1.25	0.00	1.25	1.75	8.75	13.52

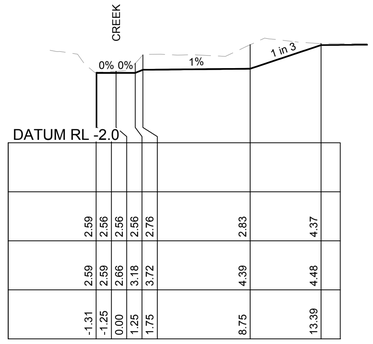
CHAINAGE 20.00



DATUM RL -2.0

WAE							
DESIGN	3.76	2.61	2.61	2.61	2.81	2.88	4.43
EXISTING	3.76	3.14	2.98	2.91	2.93	4.44	4.60
OFFSET	-3.55	-1.25	0.00	1.25	1.75	8.75	13.39

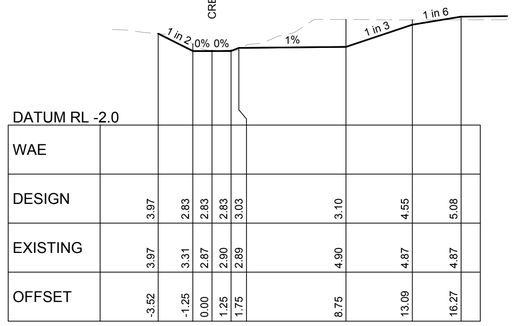
CHAINAGE 30.00



DATUM RL -2.0

WAE							
DESIGN	2.59	2.56	2.56	2.56	2.76	2.83	4.37
EXISTING	2.59	2.59	2.66	3.18	3.72	4.39	4.48
OFFSET	-1.31	-1.25	0.00	1.25	1.75	8.75	13.39

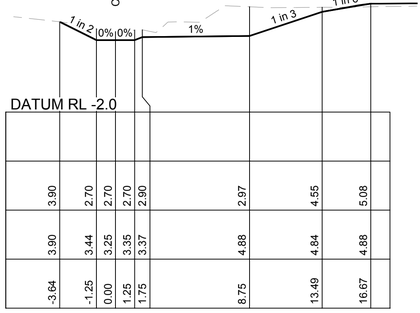
CHAINAGE 38.50



DATUM RL -2.0

WAE								
DESIGN	3.97	2.83	2.83	2.83	3.03	3.10	4.55	5.08
EXISTING	3.97	3.31	2.87	2.90	2.89	4.90	4.87	4.87
OFFSET	-3.52	-1.25	0.00	1.25	1.75	8.75	13.09	16.27

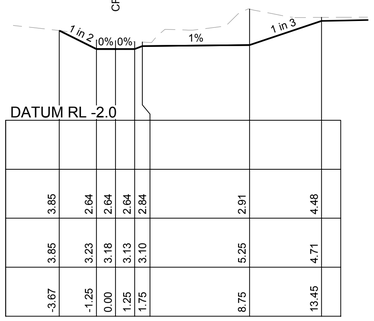
CHAINAGE 5.00



DATUM RL -2.0

WAE								
DESIGN	3.90	2.70	2.70	2.70	2.90	2.97	4.55	5.08
EXISTING	3.90	3.44	3.25	3.35	3.37	4.88	4.84	4.88
OFFSET	-3.64	-1.25	0.00	1.25	1.75	8.75	13.49	16.67

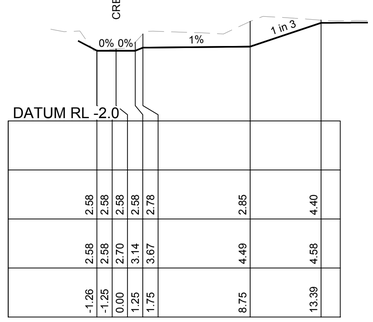
CHAINAGE 15.00



DATUM RL -2.0

WAE							
DESIGN	3.85	2.64	2.64	2.64	2.84	2.91	4.48
EXISTING	3.85	3.23	3.18	3.13	3.10	5.25	4.71
OFFSET	-3.67	-1.25	0.00	1.25	1.75	8.75	13.45

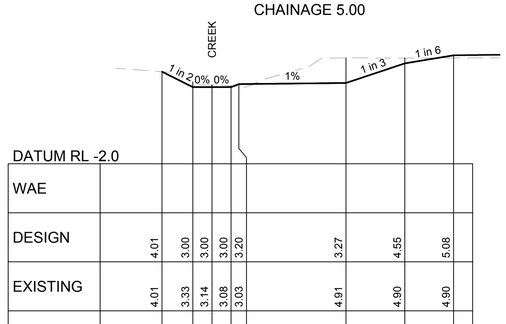
CHAINAGE 25.00



DATUM RL -2.0

WAE							
DESIGN	2.58	2.58	2.58	2.58	2.78	2.85	4.40
EXISTING	2.58	2.58	2.70	3.14	3.67	4.49	4.58
OFFSET	-1.26	-1.25	0.00	1.25	1.75	8.75	13.39

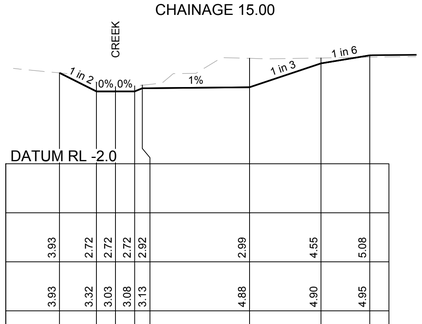
CHAINAGE 35.00



DATUM RL -2.0

WAE								
DESIGN	4.01	3.00	3.00	3.00	3.20	3.27	4.55	5.08
EXISTING	4.01	3.33	3.14	3.08	3.03	4.91	4.90	4.90
OFFSET	-3.26	-1.25	0.00	1.25	1.75	8.75	12.59	15.77

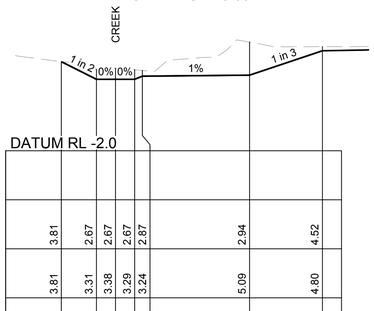
CHAINAGE 2.00



DATUM RL -2.0

WAE								
DESIGN	3.93	2.72	2.72	2.72	2.92	2.99	4.55	5.08
EXISTING	3.93	3.32	3.03	3.08	3.13	4.88	4.90	4.95
OFFSET	-3.66	-1.25	0.00	1.25	1.75	8.75	13.42	16.60

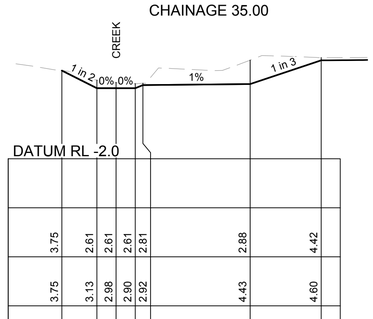
CHAINAGE 11.18



DATUM RL -2.0

WAE							
DESIGN	3.81	2.67	2.67	2.67	2.87	2.94	4.52
EXISTING	3.81	3.31	3.38	3.29	3.24	5.09	4.80
OFFSET	-3.54	-1.25	0.00	1.25	1.75	8.75	13.51

CHAINAGE 20.46



DATUM RL -2.0

WAE							
DESIGN	3.75	2.61	2.61	2.61	2.81	2.88	4.42
EXISTING	3.75	3.13	2.98	2.90	2.92	4.43	4.60
OFFSET	-3.54	-1.25	0.00	1.25	1.75	8.75	13.39

CHAINAGE 30.32

DEVELOPMENT APPLICATION

0 2 4 6 8 12 16 20m
1:200 @A1

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	L.Mc.

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES

L.G.A. NORTHERN BEACHES COUNCIL

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Drawing Title: NARRABEEN CREEK CROSS SECTIONS

C&R Ref: 048-22

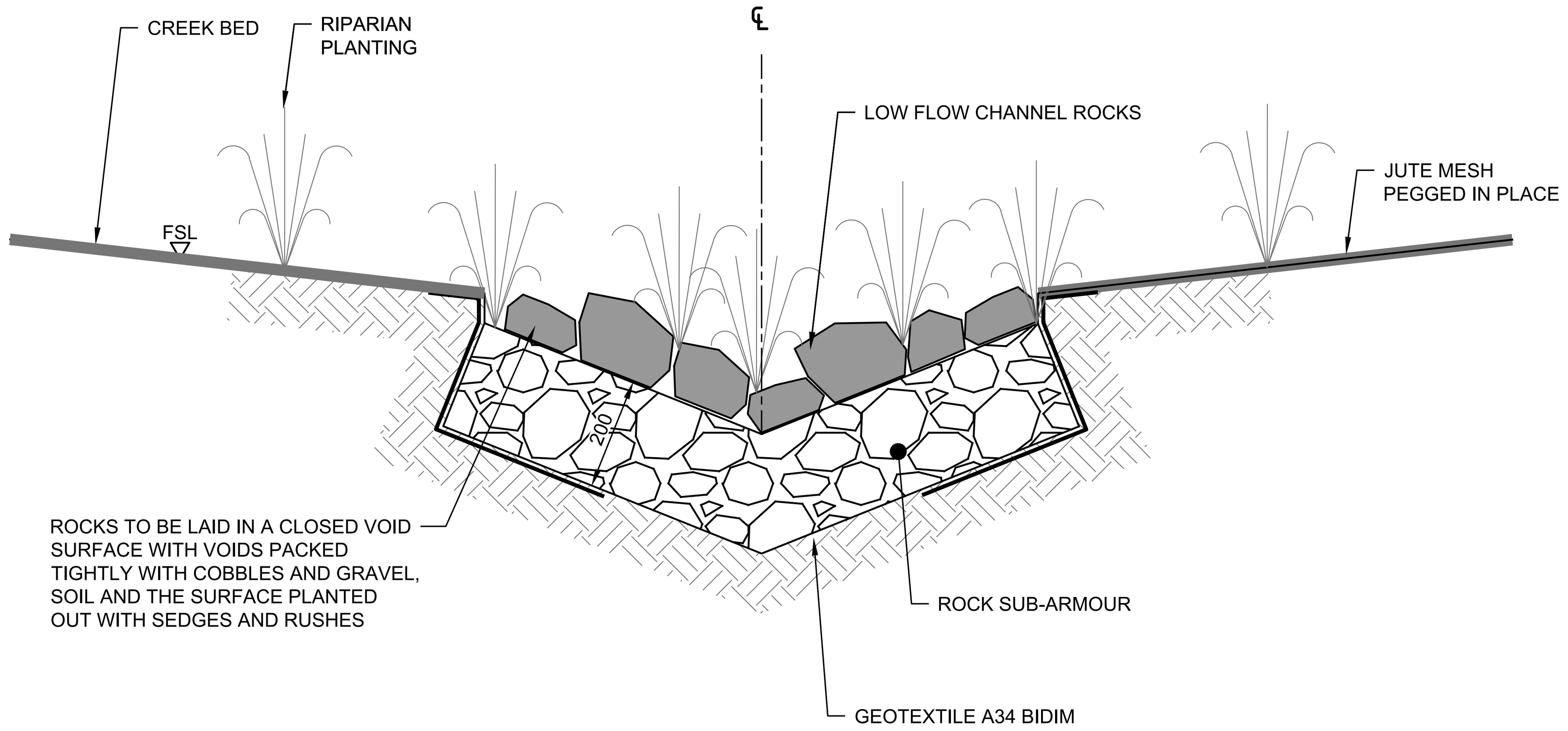
Drawing Ref: 048-22C-CK-0741

Revision: B

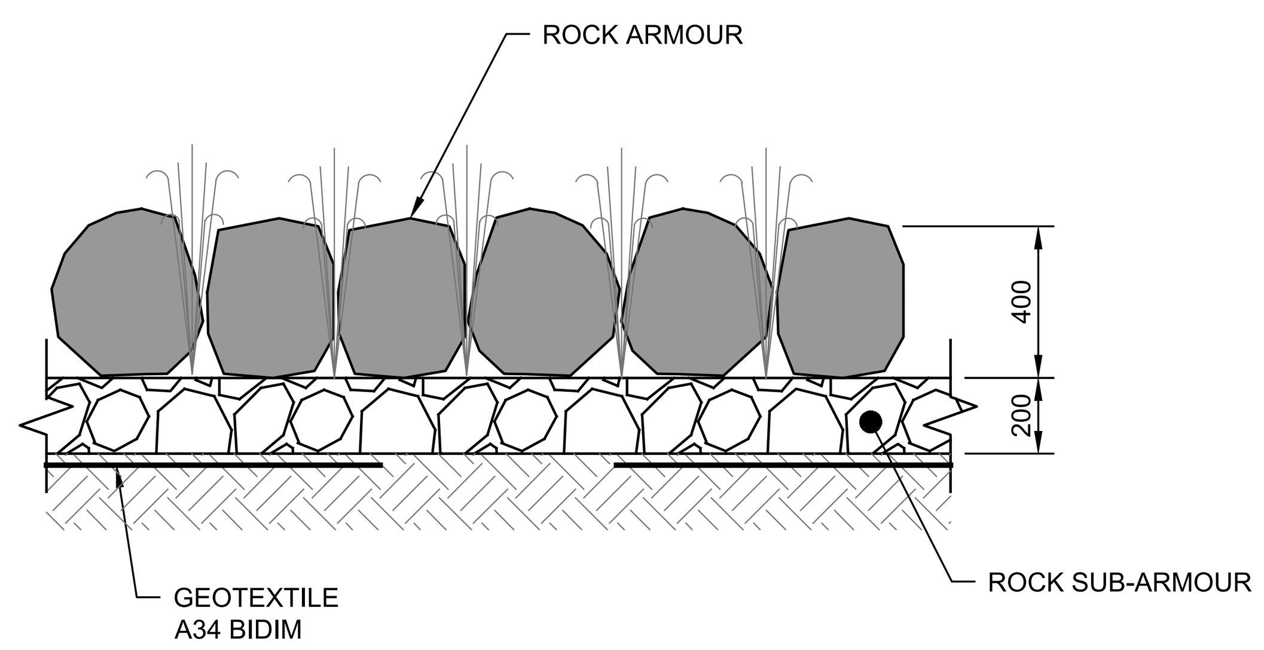
A1

NOTE
STORMWATER OUTLETS TO BE ORIENTATED IN THE DIRECTION OF NATURAL FLOW OF THE RECEIVING WATER COURSE AND NOT OBSTRUCTING FLOW FROM UPSTREAM. OUTLETS TO BE INSTALLED IN ACCORDANCE WITH NSW OFFICE OF WATER REQUIREMENTS

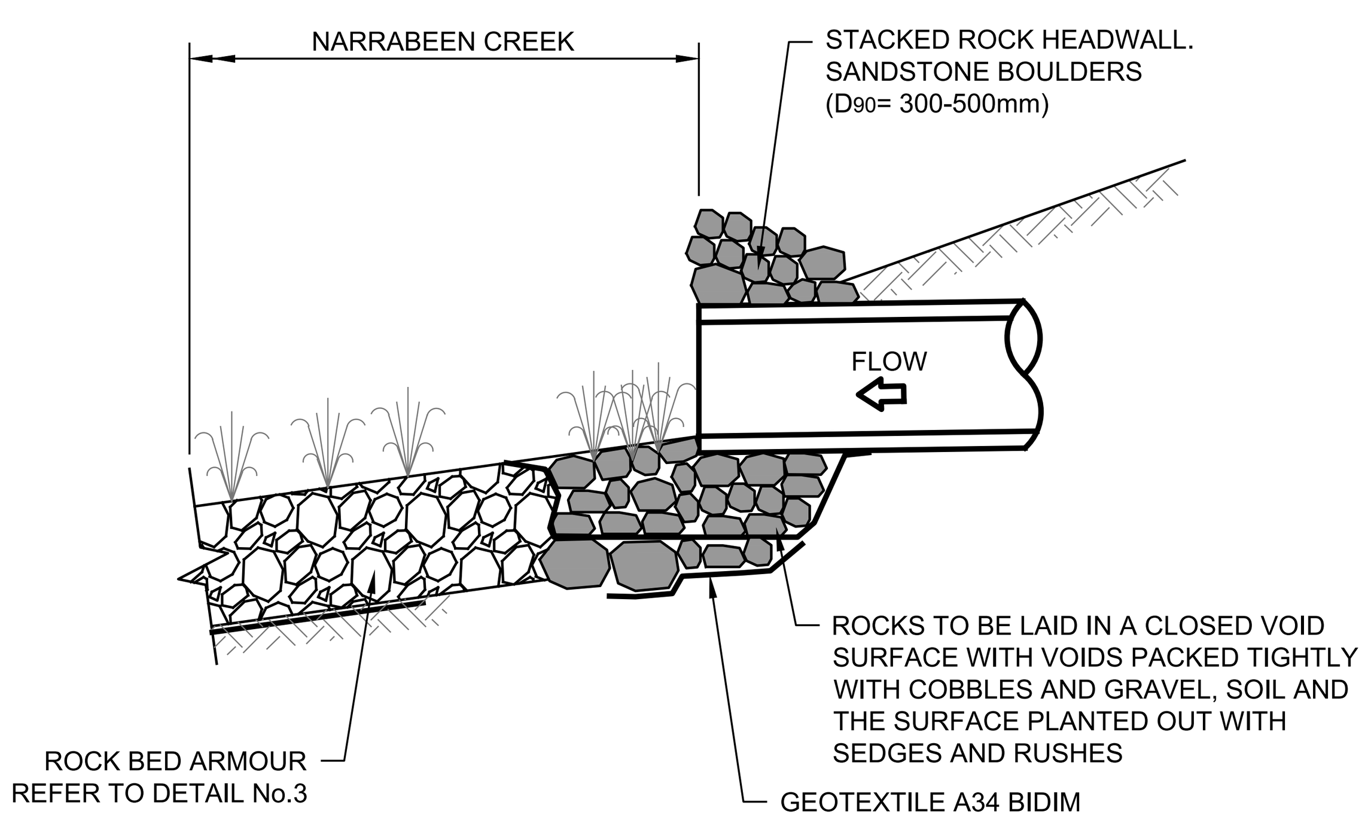
NOTE
ROCK SIZES AND DEPTH ARE SHOWN AS INDICATIVE ONLY.TO BE CONFIRMED IN DESIGNED DURING DETAIL DESIGN.



LOW FLOW CHANNEL
DETAIL A / -
NTS



STANDARD ARMOUR
DETAIL C / -
NTS



STORMWATER OUTLET
DETAIL B / -
NTS

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	L.Mc.

Authorised for issue by:
Signature:

Principal: IPM PROPERTIES
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Project:
PROPOSED SUBDIVISION OF
LOT 4 D.P. 553816
16 MACPHERSON STREET, WARRIEWOOD

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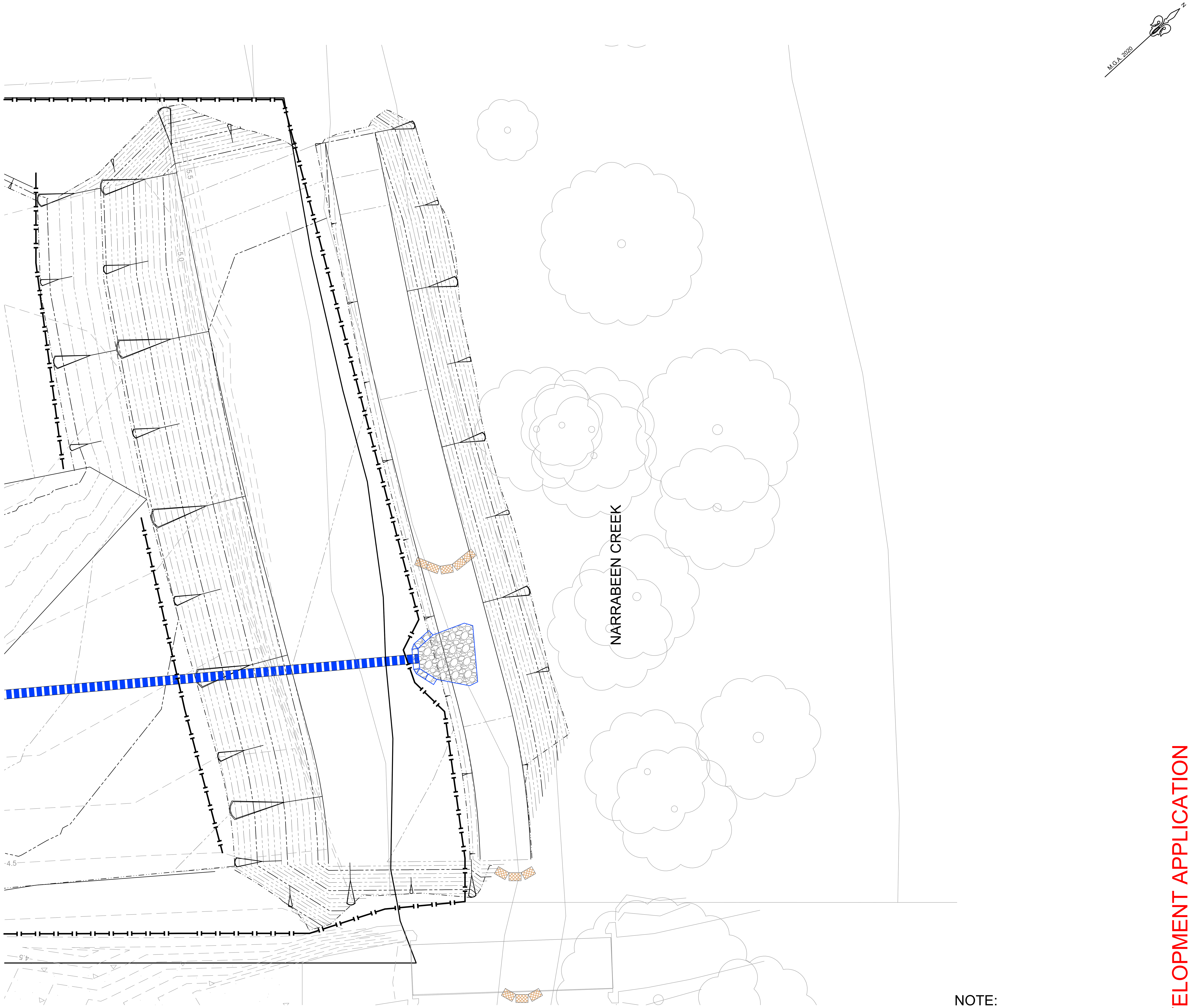
Drawing Title: DRAINAGE DETAILS
C&R Ref: 048-22
Drawing Ref: 048-22C-CK-0771
Revision: B

A1

LEGEND

- SEDIMENT FENCE
- SITE FENCE
- GEOTEXTILE INLET FILTER
- KERB INLET SEDIMENT TRAP
- STRAW BALE FILTERS
- EXISTING TREES TO BE RETAINED



PLAN

SCALE 1:100

NOTE:

1. REFER TO DRG. No. 0902 FOR DETAILS.

0 1 2 3 4 6 8 10m
1:100 @A1

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	L.Mc.

Authorised for issue by:

Signature:

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Drawing Title: SEDIMENT & EROSION CONTROL PLAN

C&R Ref. 048-22

Drawing Ref. 048-22C-CK-0901

Revision B

A1

STABILISED SITE ACCESS

1. COVER THE EXISTING SANDSTONE SUBGRADE AREA WITH NEEDLE-PUNCHED GEOTEXTILE.
2. CONSTRUCT A 200mm THICK PAD OVER THE GEOTEXTILE USING ROAD BASE OR 30mm AGGREGATE.
3. ENSURE THE STRUCTURE IS AT LEAST 15 METERS LONG OR TO BUILDING ALIGNMENT AND AT LEAST 3 METERS WIDE.
4. WHERE A SEDIMENT FENCE JOINS ONTO THE STABILISED ACCESS, CONSTRUCT A HUMP IN THE STABILISED ACCESS TO DIVERT WATER TO THE SEDIMENT

SEDIMENT FENCE

1. CONSTRUCT SEDIMENT FENCES AS CLOSE AS POSSIBLE TO BE PARALLEL TO THE CONTOURS OF THE SITE, BUT WITH SMALL RETURNS AS SHOWN IN THE DRAWING, TO LIMIT THE CATCHMENT AREA OF ANY ONE SECTION. THE CATCHMENT AREA SHOULD BE SMALL ENOUGH TO LIMIT WATER FLOW IF CONCENTRATED AT ONE POINT TO 50 LITRES/SEC IN THE DESIGN STORM EVENT, USUALLY THE 10 YEAR EVENT.
2. CUT A 150mm DEEP TRENCH ALONG THE UPSLOPE LINE OF THE FENCE FOR THE BOTTOM OF THE FABRIC TO BE ENTRENCHED.
3. DRIVE 1.5 METER LONG STAR PICKETS INTO GROUND AT 2.5 METER INTERVALS (MAX.) AT THE DOWNSLOPE EDGE OF THE TRENCH. ENSURE ANY STAR PICKETS ARE FITTED WITH SAFETY CAPS.
4. FIX SELF-SUPPORTING GEOTEXTILE TO THE UPSLOPE SIDE OF THE POSTS, ENSURING IT GOES TO THE BASE OF THE TRENCH. FIX THE GEOTEXTILE WITH WIRE TIES, OR AS RECOMMENDED BY THE MANUFACTURER. ONLY USE GEOTEXTILE SPECIFICALLY PRODUCED FOR SEDIMENT FENCING. THE USE OF SHADE CLOTH FOR THIS PURPOSE IS NOT SATISFACTORY.
5. JOIN SECTIONS OF FABRIC AT A SUPPORT POST WITH A 150mm OVERLAP.
6. BACKFILL THE TRENCH OVER THE BASE OF THE FABRIC AND COMPACT IT THOROUGHLY OVER THE GEOTEXTILE.

KERB INLET SEDIMENT FILTER

1. REFER TO APPROVED PLANS FOR LOCATION AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION,DIMENSIONS, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.
2. ENSURE THAT THE INSTALLATION OF THE SEDIMENT TRAP WILL NOT CAUSE UNDESIRABLE SAFETY OR FLOODING ISSUES.
3. INSTALL SEDIMENT TRAP IN ACCORDANCE WITH STANDARD DRAWING SUPPLIED WITH THE APPROVED PLAN, OR AS DIRECTED BY THE SITE SUPERVISOR.
4. ENSURE THE SEDIMENT TRAP IS CONSTRUCTED UP-SLOPE OF AN ON-GRADE KERB INLET. THE SEDIMENT TRAP MUST NOT SURROUND THE KERB INLET UNLESS SPECIFICALLY DIRECTED BY THE SITE SUPERVISOR.
5. ENSURE THE SEDIMENT TRAP FULLY ENCLOSES THE KERB INLET. USE APPROPRIATE SPACERS TO ENSURE THE SEDIMENT TRAP DOES NOT BLOCK THE SIDE-ENTRY INLET.
6. TAKE ALL NECESSARY MEASURE TO MINIMISE THE SAFETY RISK CAUSED BY THE STRUCTURE

DROP INLET FILTERS

1. FABRICATE A SEDIMENT BARRIER MADE FROM GEOTEXTILE OF STRAW BALES.
2. FOLLOW STANDARD DRAWINGS OF STRAW BALE FILTERS AND SEDIMENT FENCES FOR INSTALLATION PROCEDURES FOR THE STRAW BALES OR GEOFABRIC. REDUCE THE PICKET SPACING TO 1m CENTRES.
3. IN WATERWAYS, ARTIFICIAL SAG POINTS CAN BE CREATED WITH SANDBAGS OR EARTH BANKS AS SHOWN IN THE DRAWING.
4. DO NOT COVER THE INLET WITH GEOTEXTILE UNLESS THE DESIGN IS ADEQUATE TO ALLOW FOR ALL WATERS TO BYPASS IT.

EARTHBANK (LOW FLOW)

1. BUILD WITH GRADIENTS BETWEEN 1% AND 5%.
2. AVOID REMOVING TREES AND SHRUBS IF POSSIBLE - WORK AROUND THEM.
3. ENSURE THE STRUCTURES ARE FREE OF PROJECTIONS OR OTHER IRREGULARITIES THAT COULD IMPEDE WATER FLOW.
4. BUILD THE DRAINS WITH CIRCULAR, PARABOLIC OR TRAPEZOIDAL CROSS SECTIONS, NOT V SHAPED.
5. ENSURE BANKS ARE PROPERLY COMPACTED TO PREVENT FAILURE.
6. COMPLETE PERMANENT OR TEMPORARY STABILISATION WITHIN 10 DAYS OF CONSTRUCTION.

STRAW BALE FILTERS

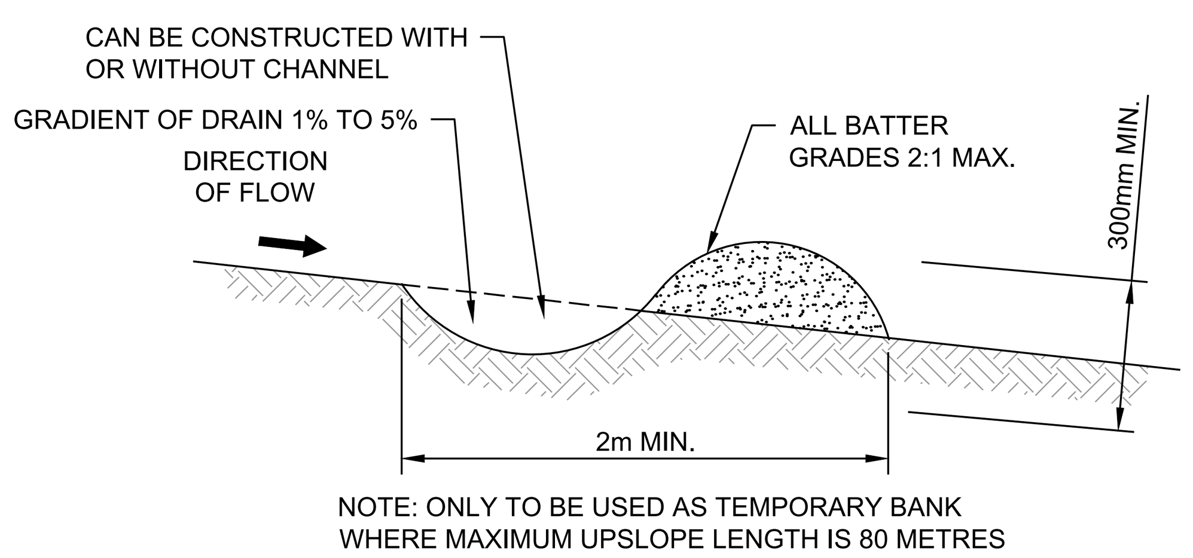
1. CONSTRUCT THE STRAW BALE FILTER AS CLOSE AS POSSIBLE TO BEING PARALLEL TO THE CONTOURS OF THE SITE, BUT WITH SMALL RETURNS AS SHOWN IN THE DIAGRAM TO LIMIT THE CATCHMENT AREA OF ANY ONE SECTION.
2. PLACE BALES LENGTHWISE IN A ROW WITH ENDS TIGHTLY ABUTTING. USE STRAW TO FILL ANY GAPS BETWEEN THE BALES. THE STRAWS IN EACH BALE ATE TO BE ALIGNED PARALLEL TO THE GROUND.
3. ENSURE THAT THE MAXIMUM HEIGHT OF THE FILTER IS ONE BALE.
4. EMBED EACH BALE IN THE GROUND 75mm TO 100mm AND ANCHOR WITH 1.2m STAR PICKETS OR STAKES. ANGLE THE FIRST STAR PICKET OR STAKE IN EACH BALE TOWARDS THE PREVIOUSLY LAID BALE. DRIVE THEM 600mm INTO THE GROUND AND, IF POSSIBLE, FLUSH WITH THE TOP OF THE BALES. WHERE STAR PICKETS ARE USED AND THEY PROTRUDE ABOVE THE BALES, ENSURE THEY ARE FITTED WITH SAFETY CAPS.
5. WHERE A STRAW BALE FILTER IS CONSTRUCTED DOWNSLOPE FROM A DISTURBED BATTER, ENSURE BALES ARE PLACED 1M TO 2m DOWNSLOPE FROM THE TOE.
6. ESTABLISH A MAINTENANCE PROGRAM THE ENSURES THE INTEGRITY OF THE BALES IS RETAINED - THEY COULD REQUIRE REPLACEMENT EACH TWO TO FOUR MONTHS.

STOCKPILE

1. MAINTAIN THE TRENCH FREE OF WATER AND RECOMPACT THE MATERIALS WITH EQUIPMENT AS SPECIFIED IN THE SWMP TO 95% STANDARD PROCTOR DENSITY.
2. SELECT FILL FOLLOWING THE SWMP THAT IS FREE OF ROOTS, WOOD, ROCK LARGE STONE OR FOREIGN MATERIAL.
3. SPREAD THE FILL IN 100mm TO 150mm LAYERS AND COMPACT IT AT OPTIMUM MOISTURE CONTENT FOLLOWING THE SWMP.

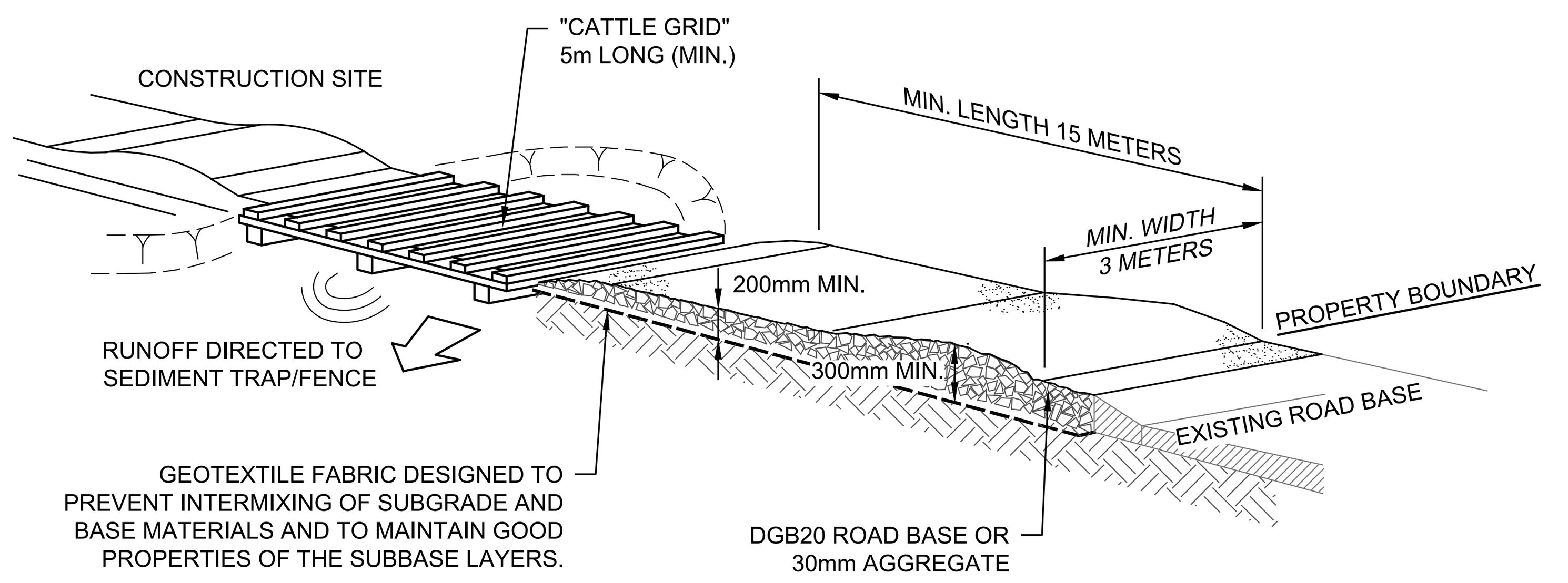
KERBSIDE TURF STRIP

1. INSTALL A 400mm MINIMUM WIDE ROLL OF TURF ON THE FOOTPATH NEXT TO THE KERB AND AT THE SAME LEVEL AS THE TOP OF THE KERB.
2. LAY 1.4m LONG TURF STRIPS NORMAL TO THE KERB EVERY 10m.
3. REHABILITATE DISTURBED SOIL BEHIND THE TURF STRIP FOLLOWING THE ESCP/SWMP.

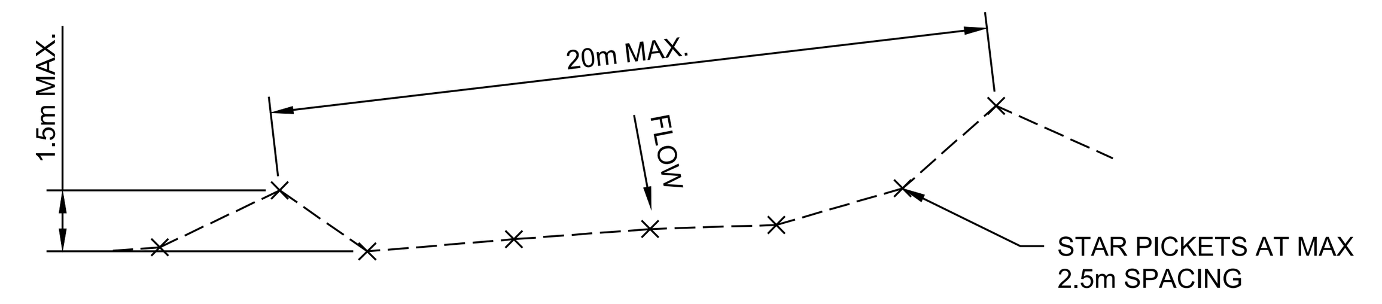


NOTE: ONLY TO BE USED AS TEMPORARY BANK WHERE MAXIMUM UPSLOPE LENGTH IS 80 METRES

EARTHBANK
NTS



STABILISED SITE ACCESS DETAIL
NTS



SEDIMENT FENCE - PLAN
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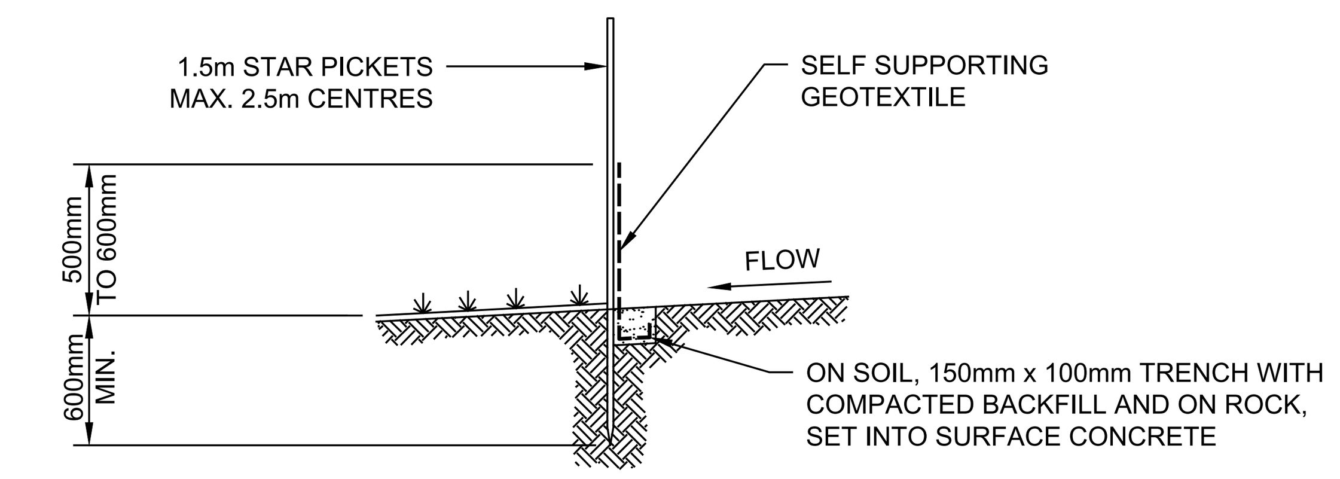

SEDIMENT FENCE - SECTION
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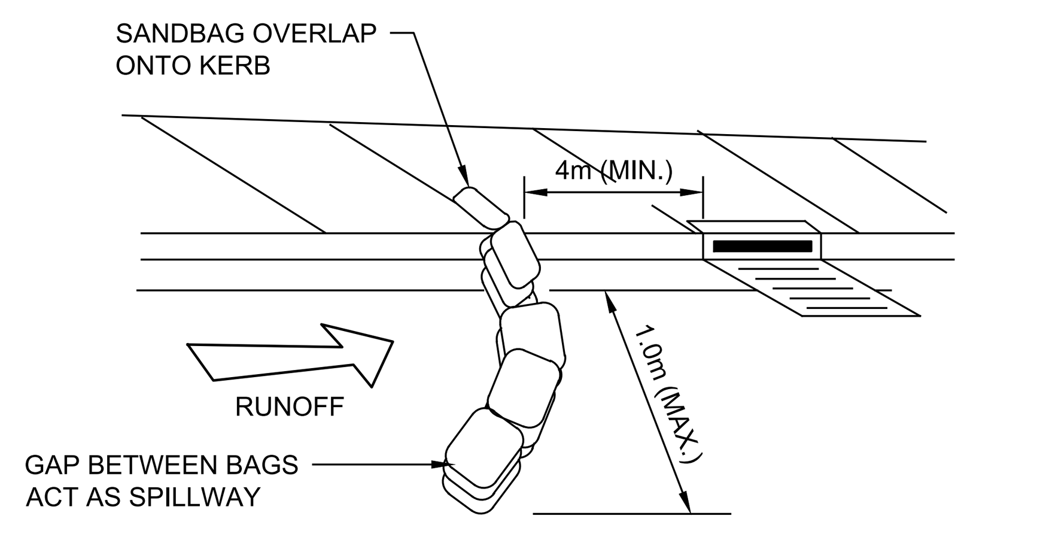

KERB INLET SEDIMENT FILTER (ON GRADE)
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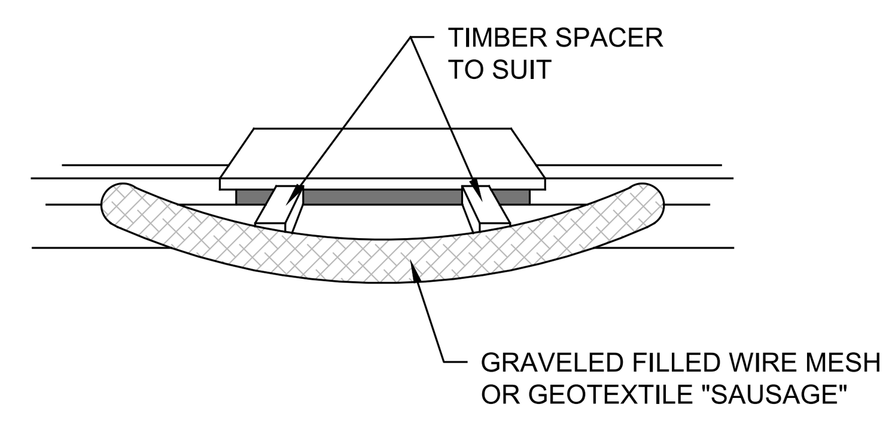

KERB INLET SEDIMENT FILTER (SAG)
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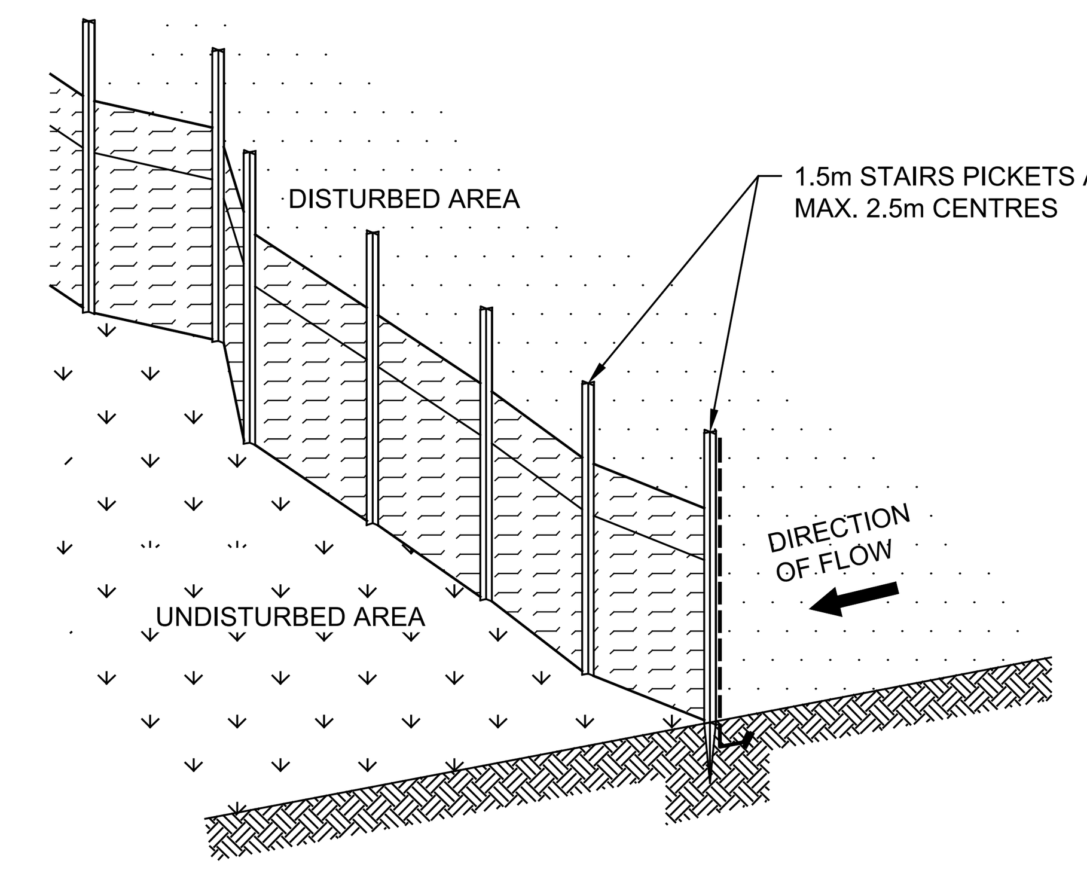

SEDIMENT FENCE - DETAIL
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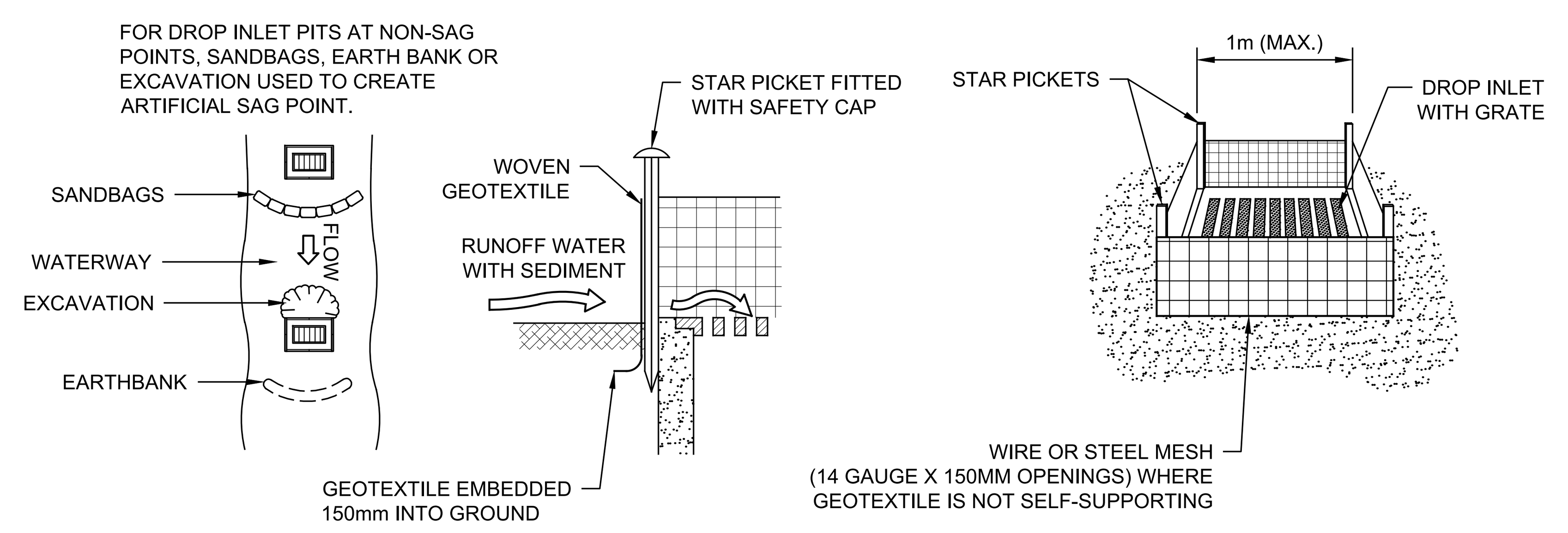

DROP INLET FILTER
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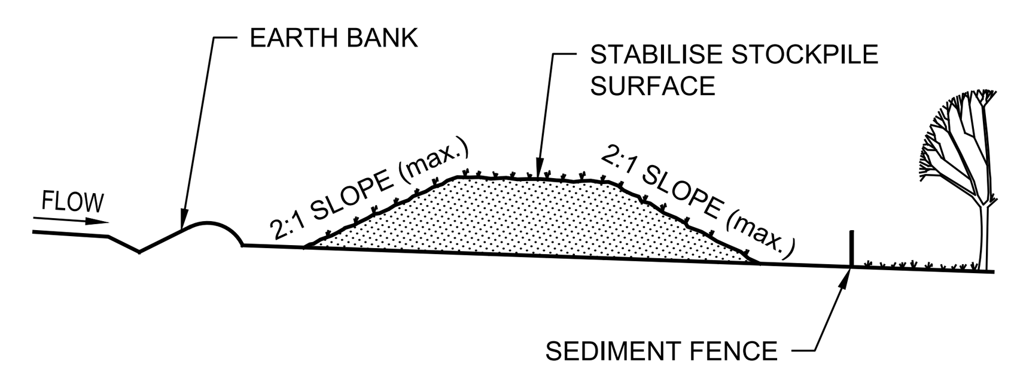

STOCKPILE
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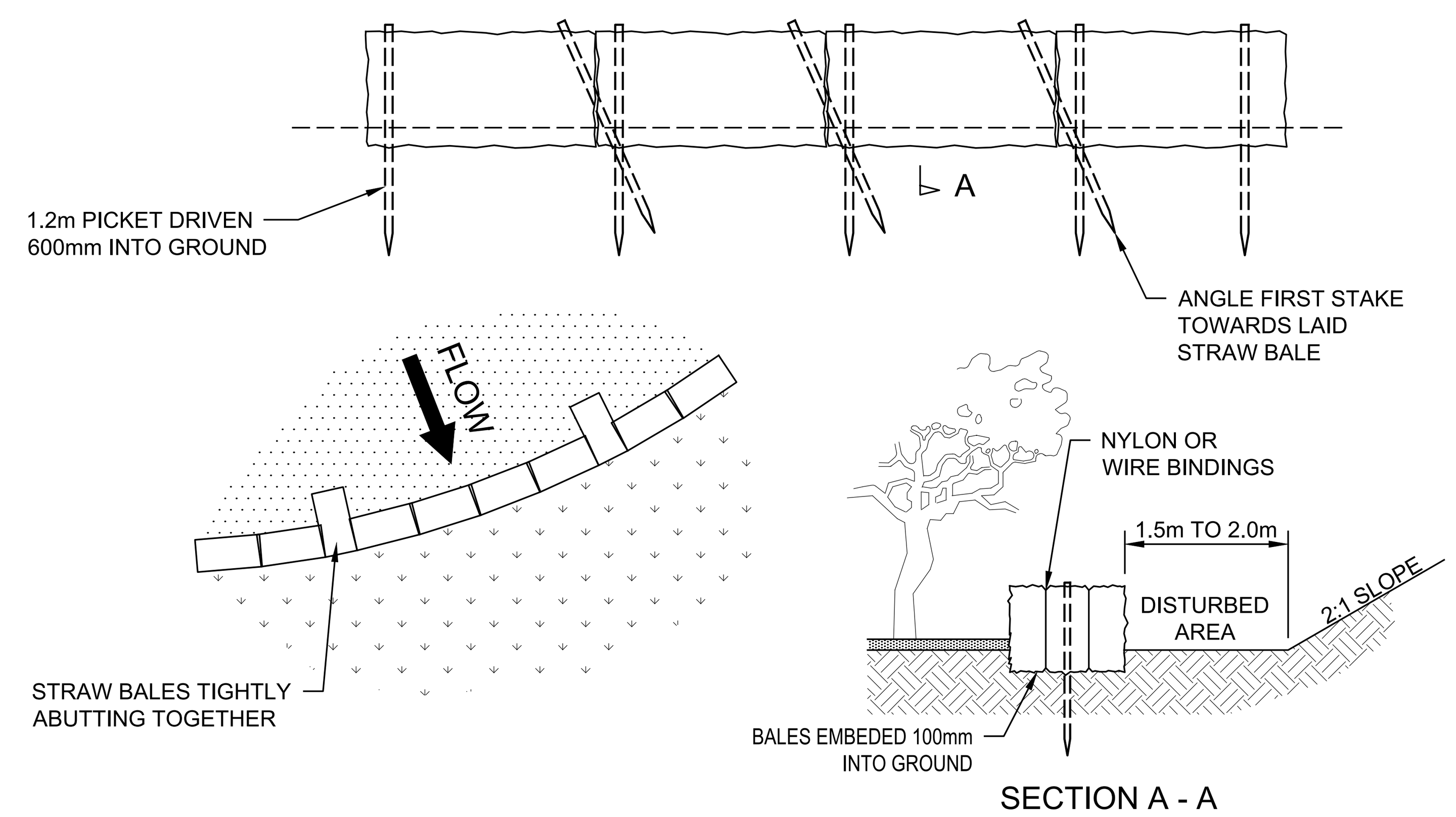

STRAW BALE FILTERS
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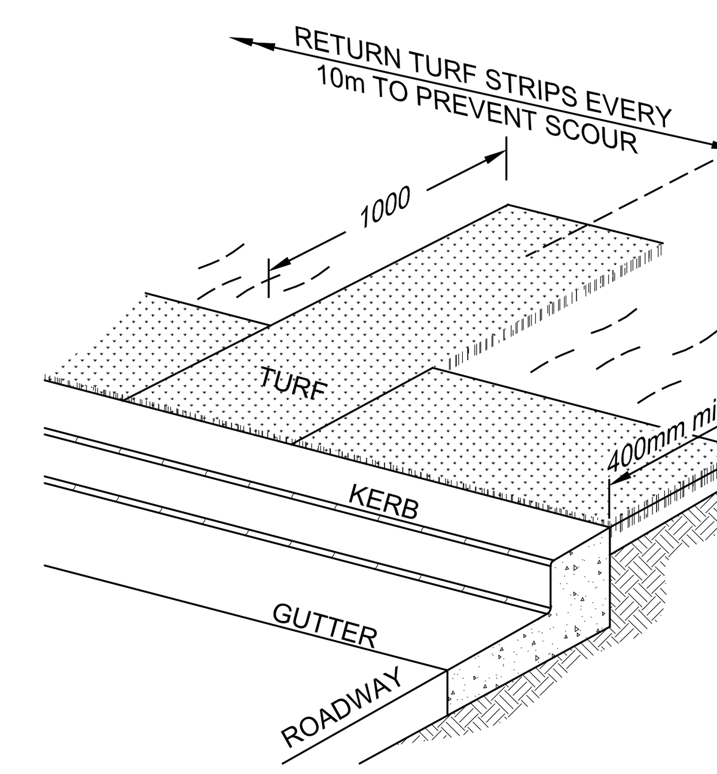

KERBSIDE TURF STRIP
NTS

DEVELOPMENT APPLICATION

REV.	DATE	AMENDMENT DESCRIPTION	DES.	DRN.
B	04.05.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	N.M.
A	14.04.23	ISSUED FOR DEVELOPMENT APPLICATION	L.Mc.	L.Mc.

DIAL 1100 BEFORE YOU DIG

Authorised for issue by:

Signature:

Principal: IPM PROPERTIES
L.G.A.: NORTHERN BEACHES COUNCIL
Scale: AS SHOWN
Datum: AHD

Project: PROPOSED SUBDIVISION OF LOT 4 D.P. 553816 16 MACPHERSON STREET, WARRIEWOOD

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Drawing Title: SEDIMENT & EROSION CONTROL DETAILS

C&R Ref: 048-22
Drawing Ref: 048-22C-CK-0902
Revision: B