CIVIL STORMWATER ENGINEERING GROUP

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Flood Impact Assessment

Project: Multi Residential Flat Development
Location: 310 Terrigal Drive, Terrigal.
Project ID: CSW2024.23
Governing Council: Central Coast LGA
Development Application #: NA
Title: 27/DP1223375
Property ID: 4023470
Total Lot Area: 4,254 sqm

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"Together WE are implementing good ideas to improve people's lives."

Revision Table				
Revision	**Date**	**Issue Description**	**Issued By**	**Signed**
01	12/04/2024	For DA	C SAAD	S HAKIM
02	17/04/2024	For DA	C SAAD	S HAKIM

The information given in this document considers the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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1. Executive Summary

Civil Stormwater Engineering Group Pty Ltd (CSEG™) has been engaged to prepare floodplain impact assessment report (FIAR) for a Development Application (DA) for the proposed Multi Residential Flat Building development proposed at 310 Terrigal Drive, Terrigal.

Central Coast Council's (CCC) has identified this site as flood prone as per the catchment-wide Coastal Lagoon Catchments Overland Flow Study (2020). As a requirement by CCC, our client has engaged CSEG™ to prepare a flood impact assessment report to accompany the development application.

This document is a flood impact assessment report outlining the results of the TUFLOW modelling conducted by CSEG™ including the purposes outlined in Section 2.1. The flood study is for an overland flow and mainstream flooding that inundates the site legally described as 27/DP1223375. Designed by CKDS Architects is a 6-story mixed used development plus mezzanine, comprising residential units, a ground floor café, and basement car parking for vehicles.

The proposed development is illustrated in Figure 1 below.

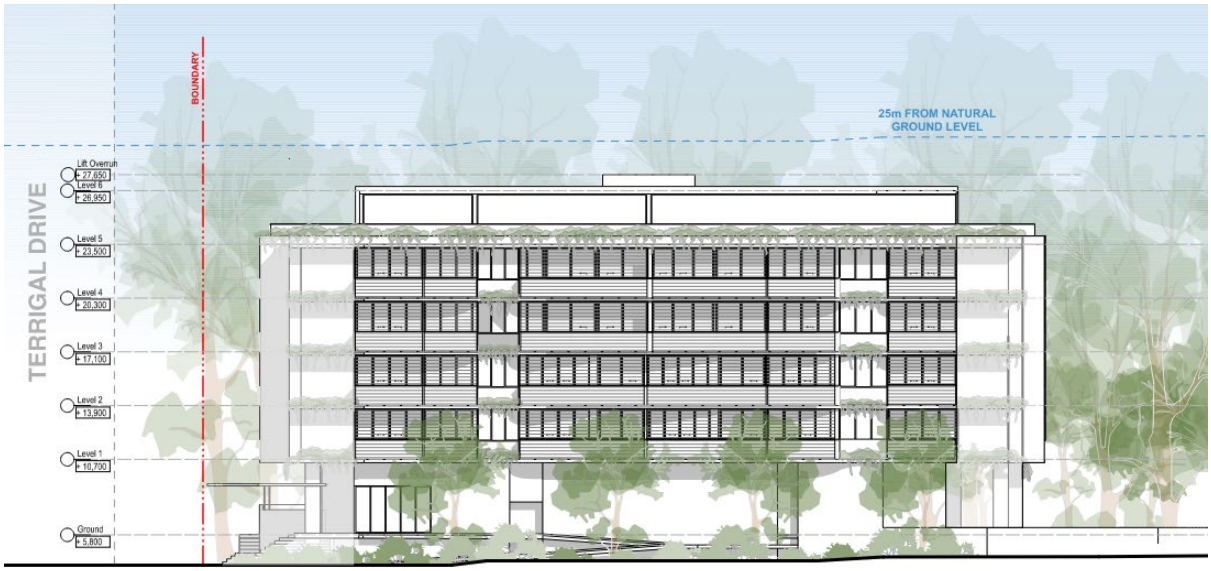

Figure 1- Architectural Design (Source: CKDS Architects)

1.1 Purpose

The flood impact assessment report (FIAR) provides:

- A flood water surface level, provisional hazard and impact assessments of the subject site based on a hydrologic and hydraulic model assessment up to 1%AEP and including PMF and 2090 climate change.

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- Addressing the requirements of Central Coast Council Development Control Plan in particular:
  - Section 9.1 Direction Clause 4.3 in relation to flooding.
  - Clause 5.21 of the Central Coast LEP (2022)
  - Part 3.1.11.6 of the Central Coast DCP 2022
  - The pre-DA notes made by CCC
- Addressing NSW floodplain development Manual (April 2005.)
- Proposal of Flood mitigation techniques and measures based on potential impacts caused by the proposed development and the associated flood hazard and risk precinct categorization.
- Proposal of flood evacuation plan & strategies based on the results of the Probable Maximum Flooding.

1.2 Introduction

CSEG™ has been engaged by LoftusLane Capital Partners to carry out a Flood Impact Assessment Report in support of the proposed Multi Residential development at 310 Terrigal Rod, Terrigal.

The following tasks were carried out:

- A site visit was undertaken on the 12th of March 2024 to ascertain site conditions and familiarize oneself with the catchment.
- Supplied documents and previous flood studies were reviewed and assessed.
- Council RFI's and comments were reviewed.
- TUFLOW 2D model was prepared to assess existing against proposed scenarios.
- Stormwater management plan applying all relevant local and national standards.
- This report was compiled.

This report has been prepared to accompany the Planning Proposal & Development Application (DA) for the development known as 310 Terrigal Road, Terrigal.

The report details the flood risk management strategies and recommendations to address the flood related controls that apply to the development.

The assessment takes into consideration the safety, engineering, environmental and social aspects of the development to effectively address the flood evacuation of people who are within the vicinity of the development site.

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1.3 Limitations

This report is intended solely for Loftuslane Capital Partner as the client of CSEG™ and no liability will be accepted for the use of the information contained in this report by other parties than this client. This report is limited to visual observations and to the information including the referenced documents made available at the time when this report was composed.

1.4 Reference

The following documents have been referenced in this report:

- Site survey plan prepared by Bannister & Hunter.
- Architectural Design prepared by CKDS Developments.
- NSW Government Floodplain Development Manual – The management of Flood Liable Land (2005).
- Engineers Australia, Australian Rainfall & Runoff (AR&R 2016).
- The Bureau of Meteorology 2019.
- Aerial Scanning Data (ALS) for the study area received from NSW department of Land & Property Information (LPI).
- Central Coast Council DCP 2022.
- Central Coast Council LEP 2022.

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2. Description

2.1 Existing Site

The site is South facing along Terrigal Drive in the suburb of Terrigal New South Wales. The site is governed by a Local Government Area of Central Coast Council and is legally known as 27/DP1223375 with a total lot area of 4,254sqm (approximately).

The site has dual frontage access and is bounded by an open channel to the east that leads to Terrigal Lagoon.

The existing site consists of a green field site. The site is of an irregular shape and is characterized by a natural slope at approximately 1.0% longitudinal grade. Figure 2 presents an areal image of the subject site.

Figure 2 - GIS Map of 310 Terrigal Drive, Terrigal. (Source: Mecone)

A detailed survey has been prepared by Bannister and Hunter in April 2022 outlining the site topography and surrounding structures to Australian Height Datum (AHD). A copy of this survey can be in Appendix B – Catchment Map of this report. Additional topographic data was obtained in the form of ALS (Airborne Laser Scan) from the NSW Government's Land & Property Information Department (LPI). This data was supplied as a 1m Digital Elevation Model (DEM) from the 2020 ALS data set.

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2.2 CCC's 2020 Flood Study

The Coastal Lagoon Catchments Overland Flood Study (2020) (CLCOFS) has been prepared for CCC in accordance with the NSW government's Floodplain Development Manual 2005. The development of CLCOFS is based on information adopted from the following flood studies:

- Wamberal Lagoon Flood Study (WMA, 2001)
- Wamberal Lagoon Floodplain Management Study (WMA, 2001)
- Wamberal Lagoon Floodplain Management Plan (WMA, 2001)
- Terrigal Lagoon Flood Study (WMA, 2001)
- Terrigal Lagoon Floodplain Management Study (WMA, 2001)
- Terrigal Lagoon Floodplain Management Plan (WMA, 2001)
- Terrigal Valley Trunk Drainage Strategy (Kinhill Engineers, 1991)
- Terrigal Valley Trunk Drainage Strategy – Grasslands Ave & Riviera Catchments (WMA, 1995)
- Avoca Lagoon Flood Study (Patterson Consultants, 2008)
- Avoca Lagoon Floodplain Management Study (Patterson Consultants, 2008)
- Avoca Lagoon Floodplain Management Plan (Patterson Consultants, 2008)
- Cockrone Lagoon Flood Study (Patterson Consultants, 2008)
- Cockrone Lagoon Floodplain Management Study (Patterson Consultants, 2008)
- Cockrone Lagoon Flood Study-Addendum One McMasters Beach Drain (Patterson Consultants, 2007)
- Cockrone Lagoon Floodplain Management Plan (Patterson Consultants, 2008)
- The Entrance Dynamics of Wamberal, Terrigal, Avoca & Cockrone Lagoons (AWACS, 1994)
- Open Coast and Broken Bay Beaches Coastal Processes and Hazard Definition Study (Worley Parsons, 2014)
- Coastal Zone Management Plan for Gosford Lagoons (BMT WBM, 2015)

The CLCOFS's report outlines the results of the hydrologic and hydraulic for the estimation of overland and mainstream flooding behavior within the catchment area. The study has been overseen and guided by the Waterways & Coastal Protection Unit of the Central Coast Council.

The CLCOFS provides a detailed flood assessment of the flood studies listed above. The study includes hydraulic model results for a full set of events from the 50% to the PMF and represents an envelope of the critical duration/pattern of a selected representative

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upstream catchment and the critical duration at the lagoon. The CLCOFS had adopted an envelope of two critical durations for the different design events. The upper catchments of the Terrigal lagoon were very flashy with short critical durations of less than 1 hour while the lower catchments had critical durations exceeding two hours as shown in Figure 3.

Table 5-3 Critical durations for each event

Lagoon	Catchment	Event	Adopted Critical Duration	Event Rainfall Depth (mm)
Wamberal	Upper	50% AEP	2 hr	40
		20% AEP	45 min	38
		10% AEP	45 min	47
		5% AEP	20 min	38
		2% AEP	20 min	47
		1% AEP	20 min	55
		1 in 200 AEP	20 min	60
		1 in 500 AEP	20 min	69
		PMF	30 min	230
	Lower	50% AEP	4.5 hr	55
		20% AEP	4.5 hr	77
		10% AEP	4.5 hr	94
		5% AEP	3 hr	95
		2% AEP	2 hr	100
		1% AEP	2 hr	116
		1 in 200 AEP	2 hr	129
		1 in 500 AEP	1.5 hr	133
		PMF	2 hr	510
Terrigal	Upper	50% AEP	45 min	26
		20% AEP	45 min	37
		10% AEP	45 min	46
		5% AEP	45 min	54
		2% AEP	45 min	67
		1% AEP	45 min	77
		1 in 200 AEP	45 min	85
		1 in 500 AEP	45 min	97
		PMF	1 hr	330
	Lower	50% AEP	9 hr	73
		20% AEP	4.5 hr	76
		10% AEP	4.5 hr	92
		5% AEP	3 hr	92
		2% AEP	3 hr	113
		1% AEP	2 hr	112
		1 in 200 AEP	2 hr	123
		1 in 500 AEP	2 hr	139
		PMF	2 hr	500

Figure 3 - Critical Durations for each event, Source Coastal Lagoons Catchments Floody Study.

The results of CLCOFS were relied upon for assessment and comparison and were not adopted for our flood study. For our site-specific study, the WBNM model showed the critical duration at 310 Terrigal Drive to be 1 Hour for the 1% AEP event. This is in line with the findings of the Coastal

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Lagoons Catchments flood study as the site sat just downstream of the steep areas comprising most of the upper catchments and therefore produced a critical duration slightly exceeding 45 minutes.

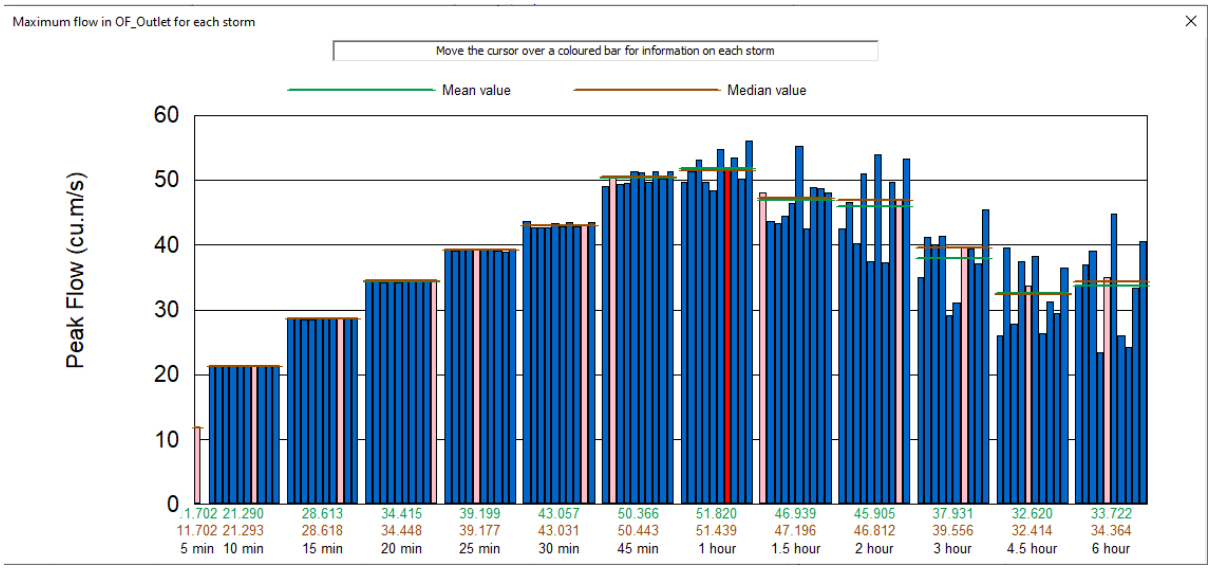

Figure 4 - Peak Flow for different storm durations.

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3. Flood Assessment

3.1 Glossary

	Abbreviation Description
AEP	Annual Exceedance Probability; The probability of a rainfall or flood event of given magnitude being equaled or exceeded in any one year.
AHD	Australian Height Datum: National reference datum for level
ALS	Air-borne Laser Scanning; aerial survey technique used for definition of ground height
ARI	Average Recurrence Interval; The expected or average interval of time between exceedances of a rainfall or flood event of given magnitude.
AR&R	Australian Rainfall and Runoff; National Code of Practice for Drainage published by Institution of Engineers, Australia, 1987.
EDS	Embedded Design Storm; synthesized design storm involving embedment of an AR&R design burst within a second design burst of much longer duration
FPDM	Floodplain Development Manual; Guidelines for Development in Floodplains published by N.S.W. State Government, 2005.
FSL	Flood Surface Level;
GIS	Geographic Information Systems: A system of software and procedures designed to support management, manipulation, analysis, and display of spatially referenced. data.
IFD	Intensity-Frequency-Duration; parameters describing rainfall at a particular location.
ISG	Integrated Survey Grid; ISG: The rectangular co-ordinate system designed for integrated surveys in New South Wales. A Transverse Mercator projection with zones 2 degrees wide (Now largely replaced by the MGA).
LEP	Local Environment Plan: plan produced by Council defining areas where different development controls apply (e.g. residential vs industrial)
LGA	Local Government Area; political boundary area under management by a given local council. Council jurisdiction broadly involves provision of services such as planning, recreational facilities, maintenance of local road infrastructure and services such as waste disposal.
MGA	Mapping Grid of Australia; This is a standard 6° Universal Transverse Mercator (UTM) projection and is now used by all states and territories across Australia.
MHI	Maximum Height Indicator: measuring equipment used to record flood levels
PMF	Probable Maximum Flood: Flood calculated to be the maximum physically possible.
PMP	Probable Maximum Precipitation: Rainfall calculated to be the maximum physically possible.
RCP	Reinforced Concrete Pipe;
km	Kilometer; (Distance = 1,000m)
m	Meter; (Basic unit of length)

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m2	**Square Meter; (Basic unit of area)**
ha	**Hectare; (Area =10,000 m2)**
m3	**Cubic Meter; (Basic unit of volume)**
m/s	**Meters/Second; (Velocity)**
m3/s	**Cubic Meter per Second; (Flowrate)**
s	**Second; (basic unit of time)**
Term	**Description**
Alluvium	Material eroded, transported, and deposited by streams.
Antecedent	Pre-existing (conditions e.g. wetness of soils).
Catchment	Area draining into a particular creek system, typically bounded by higher ground around its perimeter.
Critical Flow	Water flowing at a Froude No. of one.
Culvert	An enclosed conduit (typically pipe or box) that conveys stormwater below a road or embankment.
Discharge	The flowrate of water.
Escarpment	A cliff or steep slope, of some extent, generally separating two level or gently sloping areas.
Flood	A relatively high stream flow which overtops the stream banks.
Flood storages	Those parts of the floodplain important for the storage of floodwaters during the passage of a flood.
Floodways	Those areas where a significant volume of water flows during floods. They are often aligned with obvious naturally defined channels and areas. which, if partly blocked, would cause a significant redistribution of flow.
Flood Fringes	Those parts of the floodplain left after floodways and flood storages have been abstracted.
Froude No.	A measure of flow instability. Below a value of one, flow is tranquil and smooth, above one flow tends to be rough and undulating (as in rapids).
Geotechnical	Relating to Engineering and the materials of the earth's crust.
Gradient	Slope or rate of fall of land/pipe/stream.
Headwall	Wall constructed around inlet or outlet of a culvert.
Hydraulic	A term given to the study of water flow, as relates to the evaluation of flow depths, levels and velocities.
Hydrodynamic	The variation in water flow, depth, level and velocity with time
Hydrology	A term given to the study of the rainfall and runoff process.
Hydrograph	A graph of flood flow against time.
Hyetograph	A graph of rainfall intensity against time.
Isohyets	Lines joining points of equal rainfall on a plan.
Manning's n	A measure of channel or pipe roughness.
Orographic	Pertaining to changes in relief, mountains.
Orthophoto	Aerial photograph with contours, boundaries or grids added.
Pluviograph	An instrument which continuously records rain collected
Runoff	Water running off a catchment during a storm.
Scour	Rapid erosion of soil in the banks or bed of a creek, typically occurring in areas of high flow velocities and turbulence.
Siltation	The filling or raising up of the bed of a watercourse or channel by deposited. silt.
Stratigraphy	The sequence of deposition of soils/rocks in layers.
Surcharge	Flow unable to enter a culvert or exiting from a pit as a result of inadequate capacity or overload.
Topography	The natural surface features of a region.
Urbanization	The change in land usage from a natural to developed state.
Watercourse	A small stream or creek.

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3.2 Hydraulic Modelling

A hydraulic model converts runoff (traditionally from a hydrological model) into water levels and velocities throughout the major drainage/creek systems in the study area (known as the model 'domain', which includes the definition of both terrain and roughness). The model simulates the hydraulic behavior of the water within the study area by accounting for flow in the major channels as well as potential overland flow paths, which develop when the capacity of the channels is exceeded. It relies on boundary conditions, which include the runoff hydrographs produced by the hydrologic model and the appropriate downstream boundary.

3.2.1 Catchment Area

The catchment area upstream from the site was delineated using LiDAR data with 1m resolution has been obtained from NSW Spatial Services and found to be 244.5 Hectares. The catchment was further divided to 23 sub catchments to build the WBNM model as shown in Figure 5.

Figure 5 - Catchment Area

3.2.2 Hydrologic Model

A WBNM model has been created for this study to analyze the 20% AEP, 1% AEP, the PMF, and the 2090 climate change factor with a 20% increase in intensity. WBNM model

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parameter have been adopted from the calibrated "Coastal Lagoon Catchments" overland flood study. Shown below:

Parameter	Value	Comment
Initial loss (pervious surface)	15 mm (design events) 0-40 mm (calibration)	Determined separately for calibration and design events
Initial loss (impervious surface)	1 mm	
Continuing loss (pervious surfaces)	2.9 mm/hr	Per AR&R 2019 with modification to improve calibration
C (Lag parameter)	1.29	Adopted from previous flood study at Wamberal and Terrigal Lagoons.
Stream routing factor	1.0	Natural channel routing factor of 1.0

Figure 6 - Adopted WBNM Hydrologic Model Parameters.

Rainfall IFD's has been downloaded from the ARR Data Hub for the catchment centroid.

3.2.3 Digital Elevation Model (DEM)

A 1-meter DEM obtained from NSW Spatial Services was used to represent the existing ground surface for the hydraulic model. The detailed survey was then patched on top of the DEM. A 2m grid was then used to represent surface data across the model domain. This resolution was adopted based on AR&R Project 15 ***Table 10-2 Typical Grid/Mesh Resolutions – Urban Overland Flow.*** The 1m resolution adopted exceeds the requirement of Table 10.2.

3.2.4 Land Use

Land use throughout the site has been determined through satellite imagery and land use maps. The following land use and roughness were adopted as shown in Table 1& Figure 7.

Surface Type	Roughness Coefficient (n)
Urban	0.075
Pavement	0.02
Heavy Vegetation	0.1
Grassed	0.035
Dwellings	1.0

Table 1 - Mannings Roughness of Coefficient values 'n'

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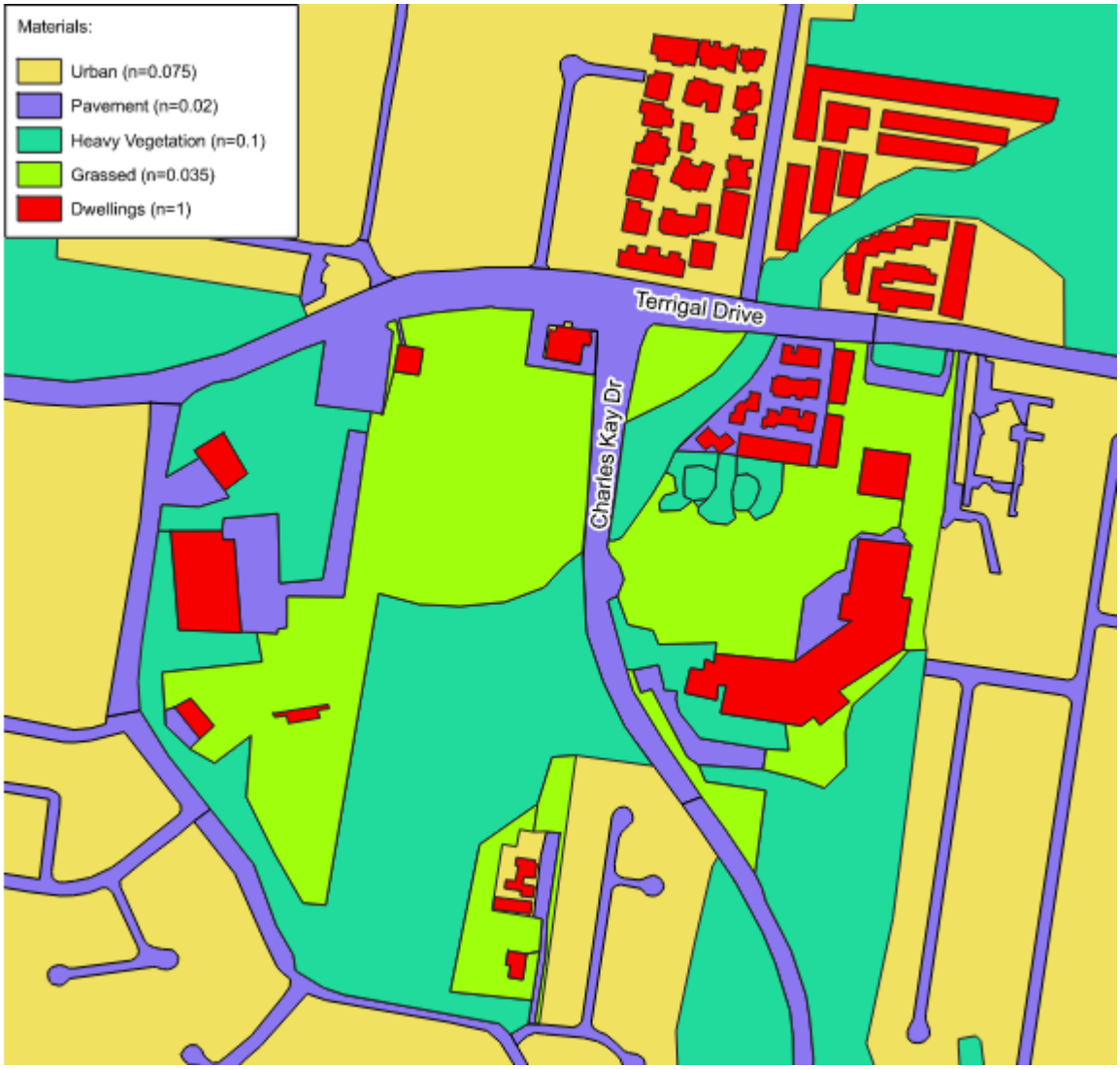

Figure 7 - Land use and Mannings Coefficient 'n'

3.2.5 Buildings

Existing building footprints adjoining our proposed site were determined from satellite imagery and have been modelled with increased manning's roughness while the proposed building footprint has been modelled as an "ineffective area" to simulate blockages.

3.2.6 Existing Stormwater Drainage Infrastructure

The following structures were included in the hydraulic model. Their details were taken from the ground survey and based on site measurements taken by the author.

- Culvert under Terrigal Drive – rectangular culvert having 4x4 meters (w) and 1.4m (h) cells (downstream of the site).
- Culvert under Charles Kay Drive – rectangular culver having 1x3.0 meters (w) x 1.85m (h) cells (upstream of the site).

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- Culvert under Terrigal Drive – Circular Culvert having 5 x 900mm (diameter) cells (west of playing fields).

Existing stormwater drainage infrastructure was modelled in TUFLOW with a blockage factor 1.0 (100%). The results from the simulation will be conservative as the full effect from the existing drainage infrastructure was reduced.

3.2.7 Upstream Boundary Conditions

Upstream inflow boundaries were extracted from the WBNM model and input into TUFLOW at 4 locations in the lower floodplain as shown in Figure 8.

Figure 8 - Grid & Boundary Condition Details

3.2.8 Downstream Boundary Condition

The downstream boundary conditions are adequately located downstream of the subject site to allow for satisfactory flood behavior results and are located well downstream of the Terrigal Drive. The downstream boundary reflects the peak water surface level in the lagoon for each event, as published in the CLCOFS. The adopted

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downstream lagoon levels are as follows:

Storm Event	Levels
20%AEP	2.1mAHD
1%AEP	2.5mAHD
PMF	4.3mAHD

Figure 9 - Downstream Lagoon Levels

3.3 TUFLOW Results

3.3.1 Existing Flood Behavior

The existing model addressed the 20%AEP, 1%AEP, PMF, and 1%AEP 2090 climate change.

The following flood planning levels (FPL) (within the property where development is proposed) were obtained for the **20%AEP**:

- Fronting Terrigal Drive western boundary = 3.58m AHD
- Fronting Terrigal Drive center boundary = 3.56m AHD
- Fronting Terrigal Drive eastern boundary = 3.47m AHD

The following flood planning levels (FPL) (within the property where development is proposed) were obtained for the **1%AEP**:

- Fronting Terrigal Drive western boundary = 3.85m AHD
- Fronting Terrigal Drive center boundary = 3.78m AHD
- Fronting Terrigal Drive eastern boundary = 3.74m AHD

The following flood planning levels (FPL) (within the property where development is proposed) were obtained for the **PMF**:

- Fronting Terrigal Drive western boundary = 5.5m AHD
- Fronting Terrigal Drive center boundary = 5.4m AHD
- Fronting Terrigal Drive eastern boundary = 5.4m AHD

The following flood planning levels (FPL) (within the property where development is proposed) were obtained for the **1%AEP 2090 climate change**:

- Fronting Terrigal Drive western boundary = 4.04m AHD
- Fronting Terrigal Drive center boundary = 3.99m AHD
- Fronting Terrigal Drive eastern boundary = 3.96m AHD

Refer to Appendix A – TUFLOW Flood Maps for further information.

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3.3.2 Proposed Scenario Flood Behavior

The proposed model addressed the 20%AEP, 1%AEP, PMF, and climate change 2090.

The following flood planning levels (FPL) (within the property where development is proposed) were obtained for the **20%AEP:**

- Fronting Terrigal Drive western boundary = 3.49m AHD
- Fronting Terrigal Drive center boundary = 3.49m AHD
- Fronting Terrigal Drive eastern boundary = 3.47m AHD

The following flood planning levels (FPL) (within the property where development is proposed) were obtained for the **1%AEP:**

- Fronting Terrigal Drive western boundary = 3.97m AHD
- Fronting Terrigal Drive center boundary = 3.76m AHD
- Fronting Terrigal Drive eastern boundary = 3.75m AHD

The following flood planning levels (FPL) (within the property where development is proposed) were obtained for the **PMF:**

- Fronting Terrigal Drive western boundary = 5.48m AHD
- Fronting Terrigal Drive center boundary = 5.47m AHD
- Fronting Terrigal Drive eastern boundary = 5.47m AHD

The following depths (within the property where development is proposed) were obtained for the **1%AEP 2090 climate change:**

- Fronting Terrigal Drive western boundary = 4.17m AHD
- Fronting Terrigal Drive center boundary = 3.97m AHD
- Fronting Terrigal Drive eastern boundary = 3.94m AHD

Refer to Appendix A – TUFLOW Flood Maps for further information.

3.3.3 1%AEP Development Impact

The proposed development resulted in minor impacts on the existing flood conditions for the 1%AEP. These impacts were mainly within the subject site's perimeter. The minor impacts outside the site's perimeter were found on the north-western boundary and did not extend past the footpath. These impacts reached a maximum level of approximately 13mm at peak time, a level greater than the council's acceptable threshold by 3mm. This increase takes place momentarily and does not have any significant effects on the road

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and adjacent properties. This minor impact can be mitigated at the design stage by introducing flood mitigation techniques.

Moreover, the proposed scenario witnessed a reduction in flood levels within Terrigal drive to the northern boundary of the site. Flood levels were reduced by 10-50mm compensating for the minor increase on the western boundary.

As per the results, it can be carefully concluded that these impacts are negligible and that the proposed development does not cause an increase in risk on adjacent and downstream properties.

3.3.4 1%AEP 2090 Climate Change Factor Development Impact – Afflux

As per the council's request, an assessment of the 1%AEP 2090 Climate change increase has been modelled and assessed. Comparing the existing 1%AEP 2090 scenario with the proposed, the results demonstrated a similar fluctuation to the 1%AEP no climate change. Refer to Appendix A – TUFLOW Flood Maps.

3.4 New Flood Planning Levels

New flood planning levels for the 1%AEP were adopted based on the TUFLOW model:

Dwelling	Required RL	Achieved RL	Event
Habitable area	4.5m (4.0 + 500mm)	5.80m	1% AEP
Non-Habitable area	4.3m (4.0 + 300mm)	5.80m	1% AEP
Evacuation	5.60m	5.80m	PMF

Table 2 - New flood planning levels for architectural design purposes.

The proposed development has been revised architecturally to incorporate the results of this flood study. The site has been designed to act as a safe refuge during flood events up to and including the PMF event. Refer to section 3.3.1, 3.3.2 and Appendix A for further details.

3.5 Flood Classification

Three Flood Classifications have been defined as follows:

1. **High Flood Risk Precinct;** This has been defined as the area of land below the 100-year flood event that is either subject to a high hydraulic hazard or where there are significant evacuation difficulties.

The high flood risk precinct is where high flood damages, the potential risk to life or evacuation. problems would be anticipated, or development would significantly and adversely affect flood behaviour. Most development should be restricted in this precinct.

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In this precinct, there would be a significant risk of flood damages without compliance with flood-related building and planning controls.

2. **Medium Flood Risk Precinct;** This has been defined as the land below the 100-year flood event that is not within a High Flood Risk Precinct. This island that is not subject to a high hydraulic hazard or where there are no significant evacuation difficulties.
In this precinct there would still be a significant risk of flood damage, but these damages can be minimised by the application of appropriate development controls.

3. **Low Flood Risk Precinct;** This has been defined as all land within the floodplain (i.e. Within the extent of the probable maximum flood) but not identified within either a High Flood Risk or a Medium Flood Risk Precinct. The Low Flood Risk Precinct is that area above the 100-year flood event.
The Low Flood Risk Precinct is where risk of damages is low for most land uses. The Low Flood Risk Precinct is that area above the 100-year flood and most land uses would be permitted within this precinct.

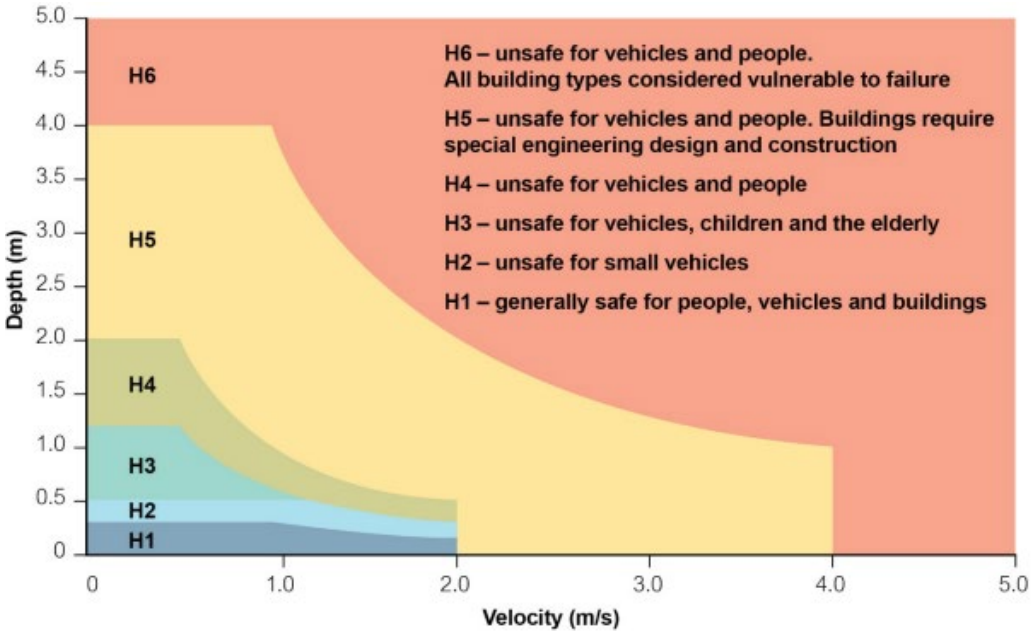

Figure 10 - Flood Hazard Classification

3.5.1 Site Hazard Classification

The site's risk level within the development zone has been categorized for each flood event as follows:

- 20%AEP Existing condition = H3
- 20%AEP Proposed condition = H3

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- 1%AEP Existing condition = H3
- 1%AEP Proposed condition = H3
- PMF Existing condition = H5
- PMF Proposed condition = H5

In accordance with Figure 10 - Flood Hazard Classification, for the 1%AEP flood event the site is predominantly categorised as H3 for both the existing and proposed scenarios. This indicates that the proposed development has negligible effects on flood hazards on the site and adjacent properties, refer to Appendix A – TUFLOW Flood Maps for further details.

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4. Governing Legislations

4.1 Requirements of Section 9.1 Direction.

The aim of a flood impact assessment is to ensure that the proposed development, which includes ancillary structures, in flood prone areas does not adversely impact on the flood regime and that the development is designed to minimise the flood impact.

In accordance with Focus area 4 'Resilience & Hazards' of the local planning directions issued by the Minister for Planning authorities under section 9.1(2) of the Environmental Planning and Assessment Act 1979, the following directions need to be met for flood prone properties:

Section 9.1 Requirements	How the Proposal Addresses the Requirement
I) A planning proposal must include provisions that give effect to and are consistent with: (a) the NSW Flood Prone Land Policy, (b) the principles of the Floodplain Development Manual 2005, (c) the Considering flooding in land use planning guideline 2021, and (d) any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.	The Planning Proposal seeks to amend the Central Coast LEP 2022 by increasing the maximum permissible height of buildings to 25m, and the maximum floor space ratio to 1.3:1
(2) A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Employment, Mixed Use, W4 Working Waterfront or Special Purpose Zones.	The planning proposal does not seek to do this.

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(3) A planning proposal must not contain provisions that apply to the flood planning area which & (4) A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which: (a) permit development in floodway areas, (b) permit development that will result in significant flood impacts to other properties, (c) permit development for the purposes of residential accommodation in high hazard areas, (d) permit a significant increase in the development and/or dwelling density of that land, (e) permit development for the purpose of centre- based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate, (f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent, (g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or (f) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	The Planning Proposal seeks to amend the Central Coast LEP 2022 by increasing the maximum permissible height of buildings to 25m, and the maximum floor space ratio to 1.3:1 Increasing the maximum permissible height of buildings (and therefore, the FSR) does not permit development that is in a floodway or high hazard area any more than the current zone facilitates such development. The Planning Proposal will not result in significant flood impacts to other properties, as quantified in the detailed modelling in this report. The proposal will result in a modest increase in density by 37 dwellings, however noting that residential flat buildings are permitted on the site and the proposal would be contained within the footprint that is permitted. Summarily, the planning proposal **does not propose:** • Development in floodway areas. • Development that will result in significant flood impacts to other properties. • A development which will result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure, or services. • Development to be carried out without development consent. • Significant increase in the development of that land. The proposed changes will lead to increased height and FSR in the air space which is well and truly above the flood levels and in a land that is already zoned for residential. Hence this planning proposal does not permit any development as per the directions that the subject land is not already approved for.

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(5) For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.	This report constitutes *a floodplain risk management plan prepared in accordance with the principles and guidelines of the Floodplain Development Manual 2005,* and the planning proposal is in accordance with it.

Table 3 - Requirements of Section 9.1 of the NSW local planning direction.

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4.2 Central Coast Council LEP section 5.21 Flood Planning

Section 5.21 of the Local Environmental Plan sets requirements applicable to flood prone that need to be adhere. Below are the list of regulations and how the proposed development adheres to these conditions:

5.21 Flood Planning Requirements	Response
(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.	This flood impact assessment report has demonstrated through hydraulic and hydrologic modelling analysis that the proposed development does not alter the functionality of the existing flooding behaviour. It is also demonstrated that despite the negligible increase in flood levels for the 1%AEP, the proposal does not increase risk levels on adjacent and downstream properties, therefore is considered satisfactory.
(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 riverbanks or watercourses.	The flood behaviour for the subject development has been assessed for the 20%AEP, 1%AEP, PMF and 1%AEP 2090 climate change. As per the results presented in this report, the proposed development does not cause adverse effects to adjacent and downstream properties. Further, the proposed development has been proposed with a ground floor at a level greater than PMF. This allows for ground floor level to be a safe refuge during all flood events up to and including the PMF. Moreover, the flood assessment presented minor increase in velocity within the site perimeters (~0.3m/s) but velocity decrease within the banks and watercourse adjacent to the subject site (~-0.05m/s). As per the Department of Primary Industries and Regional Development, the suggested maximum velocity for sand, the least resistant soil, is 0.4m/s. This suggests that the increase in flood velocity due to the proposed development is negligible.
(3) In deciding whether to grant development	In addition to the responses above, the 1%AEP

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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 because 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.	2090 climate change factor has been modelled and assessed. The results present the same outcome as the 1%AEP flood event with minor increase in flood levels within the property and negligible increases within the road reserve. The 1%AEP 2090 climate change presented flood levels slightly higher than the 1%AEP but lower than the PMF proving the building to be a safe refuge in year 2090. The results of the TUFLOW modelling for the proposed scenario have presented minor increase in flood levels and velocities but not increase in flood risk. This indicates that the proposed size of the development is consistent with the objectives of the zone. Moreover, these results also negate the requirement of modifying, relocating, or removing buildings as a result of the development. Therefore, the certifying authority can be satisfied that these matters have been successfully considered and addressed.

4.3 Objectives of CCC's Development Control Plan 2022

The purpose of this flood impact report is to ensure the development is designed and built in accordance with requirements addressed in Central Coast Council's Development Control Plan. The DCP provides the fine grain detail of the planning framework and applies in conjunction with LEP. It assists in the preparation of development applications and ensures development takes place in a quality and orderly manner. For residential development rebuild the following requirements need to be addressed and met:

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4.3.1 Flood Levels

"Habitable floor levels to be equal to or greater than the 100-year flood planning level plus freeboard." All habitable floor levels have been designed at RL 5.8m AHD. A level greater than all flood levels including PMF.

4.3.2 Building Components

"All structures to have flood compatible building components below or at 100-year flood level plus freeboard." The building structure has been proposed off flood compatible materials and in accordance with Table 4.

4.3.3 Flood Affectation

The development must not:

a) Affect the safe occupation of any flood prone land.

The proposed development has been designed to act as a safe refuge during flood events up to PMF.

b) Be sited on the land such that flood risk is increased.

The conducted hydraulic assessment of the proposed site indicated no increase in flood risk to the subject site or adjacent and downstream properties.

c) Adversely affect flood behaviour by raising predevelopment flood level by more than 10mm.

The post development hydraulic model indicated minor increase in levels and velocity within the site and immediately adjacent to the western boundary bounded by the footpath. The model witnessed depth increase by up to 13mm within the footpath. The 3mm exceedance is considered negligible as it takes place momentarily at peak flood time. Peak changes in flood characteristics do not alter the flood risk for the subject site and adjacent properties.

d) Result in an increase in the potential of flooding detrimentally affecting other development or properties.

Refer to condition c)

e) Significantly alter flow distributions and velocities to the detriment of other properties or the environment of the floodplain.

Refer to condition c)

f) Significantly and detrimentally affect the floodplain environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of any riverbank or watercourse.

The flood assessment presented minor increase in velocity within the site perimeters (~0.3m/s) but velocity decrease within the banks and watercourse adjacent to the subject site (~-0.05m/s). As per the Department of Primary Industries and Regional

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Development, the suggested maximum velocity for sand, the least resistant soil, is 0.4m/s. This suggests that the increase in flood velocity due to the proposed development is negligible.

g) Be likely to result in unsustainable social and economic costs to the flood affected community or general community as a consequence of flooding (including damage to public property and infrastructure, such as roads, stormwater, water supply, sewerage, and utilities).

The development will not result in unsustainable social and economic costs to the flood affected community or general community because of flooding, as flood damages will be minimal due to the use of flood compatible materials and the FFL and basement controls.

h) Be incompatible with the flow of floodwaters on flood prone land (considering any structures, filling, excavation, landscaping, clearing, fences, or any other works).

Refer to condition g)

i) Cause or increase any potential flood hazard (considering the number of people, their frailty, as well as emergency service and welfare personnel).

The proposed development does not change the trafficability or hazard on Terrigal Drive or cause an increase in flood hazard for other sites.

4.3.4 Evacuation and parking

a) Reliable and failsafe access for pedestrians required at or above the 100-year flood level, and not more than 0.5m below the highest floor level. This access is to be adjacent the side boundary.

The proposed development has been designed with a habitable floor level at RL5.8m AHD, a level greater than the 1%AEP plus freeboard and greater than PMF.

b) All access roads and driveways, and external parking areas to be above the 100-year ARI Flood Level (FPL less 0.5m) to provide the ability to safely receive and evacuate occupants.

The proposed parking and basement entry has been designed at RL5.8m AHD, a level greater than the 1%AEP plus freeboard and greater than PMF.

4.3.5 Management & Design

a) Fencing within a floodway will not be permissible except for security/ permeable/ open type/ safety fences of a type approved by Council. Fencing in certain areas may also be restricted by current Floodplain Risk Management Plans.

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Open style fencing to be proposed at crucial locations for pedestrian safety. Fencing to consist of vertical louvers spaced at 100mm intervals maximum.

b) Applicant to demonstrate that area is available to store goods above the 100-year flood level plus freeboard.

Habitable levels have been designed above flood planning plus freeboard. Basements have been designed with an entry above PMF level. These two areas are considered a safe area to store goods.

c) No external storage of materials below the 100-year flood level plus freeboard, which may cause pollution or be potentially hazardous during a flood.

Refer to condition b)

The table below outlines the flood compatible materials up to maximum flood level for each building component considered acceptable by standards.

BUILDING COMPONENT	FLOOD COMPATIBLE MATERIAL	BUILDING COMPONENT	FLOOD COMPATIBLE MATERIAL
Flooring and Sub-floor Structure	• Concrete slab-on-ground monolith construction • Suspension reinforced concrete slab.	**Doors**	• Solid panel with waterproof adhesives • Flush door with marine ply filled with closed cell foam. • Painted metal construction • Aluminum or Galvanised steel frame
Floor Covering	• Clay tiles • Concrete, precast or in situ • Concrete tiles • Epoxy, formed-in- place • Mastic flooring, formed-in-place • Rubber sheets or tiles with chemical- set adhesives	**Wall and Ceiling Linings**	• Fibro-cement board • Brick, face or glazed • Clay tile glazed in waterproof mortar • Concrete • Concrete block • Steel with waterproof applications • Stone, natural solid or veneer, waterproof grout

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	• Silicone floors formed-in-place • Vinyl sheets or tiles with chemical-set adhesive • Ceramic tiles, fixed with mortar or chemical-set adhesive • Asphalt tiles, fixed with water resistant adhesive		• Glass blocks • Glass • Plastic sheeting or wall with waterproof adhesive
Wall Structure	• Solid brickwork, blockwork, reinforced, concrete or mass concrete	**Insulation Windows**	• Foam (closed cell types) • Aluminum frame with stainless steel rollers or similar corrosion and water-resistant material.
Roofing Structure (for Situations Where the Relevant Flood Level is Above the Ceiling)	• **Reinforced concrete construction.** • **Galvanized metal construction**	Nails, Bolts, Hinges and Fittings	• Brass, nylon or stainless steel • Removable pin hinges • Hot dipped Galvanized steel wire nails or similar
Electrical and Mechanical Equipment **For dwellings constructed on land to which this Policy applies, the electrical and mechanical materials, equipment and installation should conform to the following requirements.**		**Heating and Air Conditioning Systems** **Heating and air conditioning systems should, to the maximum extent possible, be installed in areas and spaces of the house above the relevant flood level.** **When this is not feasible every precaution should be taken to minimize the damage caused by submersion according to the following guidelines.**	
Main power supply - Subject to the approval of the relevant authority the incoming main commercial power service equipment, including all metering equipment, shall be located above the relevant flood level. Means shall be available to easily disconnect the dwelling from the main power supply.		**Fuel -** Heating systems using gas or oil as a fuel should have a manually operated valve located in the fuel supply line to enable fuel cut-off.	

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Wiring - All wiring, power outlets, switches, etc., should, to the maximum extent possible, be located above the relevant flood level. All electrical wiring installed below the relevant flood level should be suitable for continuous submergence in water and should contain no fibrous components. Earth core linkage systems (or safety switches) are to be installed. Only submersible-type splices should be used below the relevant flood level. All conduits located below the relevant designated flood level should be so installed that they will be self-draining if subjected to flooding.	**Installation -** The heating equipment and fuel storage tanks should be mounted on and securely anchored to a foundation pad of sufficient mass to overcome buoyancy and prevent movement that could damage the fuel supply line. All storage tanks should be vented to an elevation of 500 millimeters above the relevant flood level.
Equipment - All equipment installed below or partially below the relevant flood level should be capable of disconnection by a single plug and socket assembly.	**Ducting -** All ductwork located below the relevant flood level should be provided with openings for drainage and cleaning. Self-draining may be achieved by constructing the ductwork on a suitable grade. Where ductwork must pass through a water-tight wall or floor below the relevant flood level, the ductwork should be protected by a closure assembly operated from above relevant flood level.
Reconnection - Should any electrical device and/or part of the wiring be flooded it should be thoroughly cleaned or replaced and checked by an approved electrical contractor before reconnection.	

Table 4 - Flood Compatible Materials

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4.4 In response to PRE-DA assessment notes

Request for information was made by council's assessing officer after the PRE-DA assessment meeting. These RFI's regarding flooding and stormwater and corresponding response are summarised below.

Matter Raised in CCC's Current Assessment of the Proposal	How the Matter has been integrated into this report / the proposal
The consultant has elected to undertake a new Hydrological and 2D Hydraulic Flood Study in lieu of the adopted Coastal Lagoons Overland Flood Study 2020 for the purpose of the assessment. The consultant has provided valid reasons for undertaking the new Flood Study and these reasons are understandable. The methodology and assumptions for the purpose of the study are acceptable. Does the downstream Lagoon level during a 1%AEP event influence flood levels at this location? Is it reasonable not to consider the tailwater from the model?	The tailwater level influences the extent of backwater effects within the lagoon and upstream properties. Backwater occurs when upstream flow is restricted or slowed, causing water levels to rise upstream. Considering tailwater levels as part of the assessment provides a more conservative outcome.
The consultant states that the 1%AEP impact is not considered to be adverse, significant or detrimental. The result mapping appears to show the impact on the roadway to be somewhere between 0.02 and 0.05m. It is generally accepted that a development shall have a flood impact of no more than 0.01m during the 1%AEP event. The design should be revisited to reduce the impact on the roadway to be no more than 0.01m.	CSEG™ conducted a TUFLOW model adopting the same principals adopted by RIENCO Consulting. The results presented in our model were significantly similar to RIENCO's with marginal differences. This impact has been thoroughly discussed in section 3.3.3 of this report.
The building obstruction significantly increases the velocity of water to the west of the building. The building results in a flow path with velocity of over 4m/s traveling north through the site before discharging onto Terrigal Drive. In the opinion of the consultant does this result in an increased flood risk to people or property compared to the existing. Can the design be modified to reduce the velocity impact caused by the building?	The flood model conducted by CSEG™ presented minor increase in velocity within the site perimeters (~0.3m/s) and velocity decrease within the banks and watercourse adjacent to the subject site (~-0.05m/s). These results are negligible.

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The consultant states that the basement carpark access is designed for access to be above the 1% AEP surface level. For new basement carparks Council requires that the driveway crest shall be at the PMF level to ensure that the basement will not inundate. Can this be achieved at this location?	Basement access has been designed at RL5.8m AHD a level higher than PMF by 320mm approximately.
Update the flood assessment report to include the hazard category during the post and pre-development PMF event.	An updated flood model has been prepared CSEG to address this requirement. Flood hazard category for the PMF event is found in Appendix A of this report.
Update the flood assessment report to include appropriate arrangements for shelter-in-place, and/or evacuation in a PMF event, in consideration of the Draft Shelter-in-place Guideline 2023.	Please refer to section 5.3 of this report.

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5. Site Development

5.1 Architecture

The architectural design of the multi residential development prepared by CKDS architects demonstrate the following compliances:

a) Habitable floor levels have been set to above PMF level. A level greater than the standard required level.

b) Non-Habitable floor levels have been set to above PMF level. A level greater than the standard required level.

c) Parking levels and access to parking have been set to above PMF level. A level greater than the standard required level.

d) Building has been proposed of flood compatible materials.

e) Elevated planter boxes have been proposed. Architectural plans to be amended to show non elevated planter boxes. Elevated planter boxes resulted of an increase in afflux.

f) Safe access in the form of stairs and ramps to habitable floor levels has been proposed.

g) Boundary setbacks have been maintained to allow for the passage of unobstructed overland flow.

h) The design to be amended to outline fence type and location.

5.2 Engineering

The stormwater management report was prepared by Targo Engineering Consultants, revision 04 dated September 2023. CSEG™ has assessed this report and makes the following recommendations:

a) The proposed OSD system would be beneficial in reducing flood impacts of the site and downstream properties. The OSD system is to be placed at a level higher than the 1%AEP with an unobstructed emergency overflow route. The OSD system to capture the entire impervious area if possible.

b) A 10kl rainwater tank has been proposed to meet WSUD requirements. It

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would be highly advisable to increase the rainwater tank volume for greater storage promoting greater water quantity re-use. In addition to toilet flushing and irrigation, we propose rainwater re-use car washing and for laundry. Rainwater tank to be equipped with a 3-stage filtration system to be designed by a qualified hydraulic engineer.

5.3 Shelter in place

The department of Planning and Environment has prepared guidelines to keep people safe during flood events. One of these risk management strategies is to allow for shelter within the proposed development for the PMF event, also known as vertical evacuation.

The proposed development has been designed with a finished habitable level of RL 5.80m AHD. The adopted level is set to achieve a level greater than PMF by approximately 320mm. This design approach promotes safety for residents within their own habitable area.

Moreover, the hydraulic model has presented the peak flows for the PMF to peak from 45 minutes through to approximately 2 hours. During this time frame the roads surrounding the development, Terrigal Drive & Charles Kay Drive, would be submerged. Post 2 hours to 3 hours the PMF flood levels commence descending, and the hazard levels commence to subside. At 3 hours, Charles Kay Drive becomes flood free and safe for horizontal evacuation.

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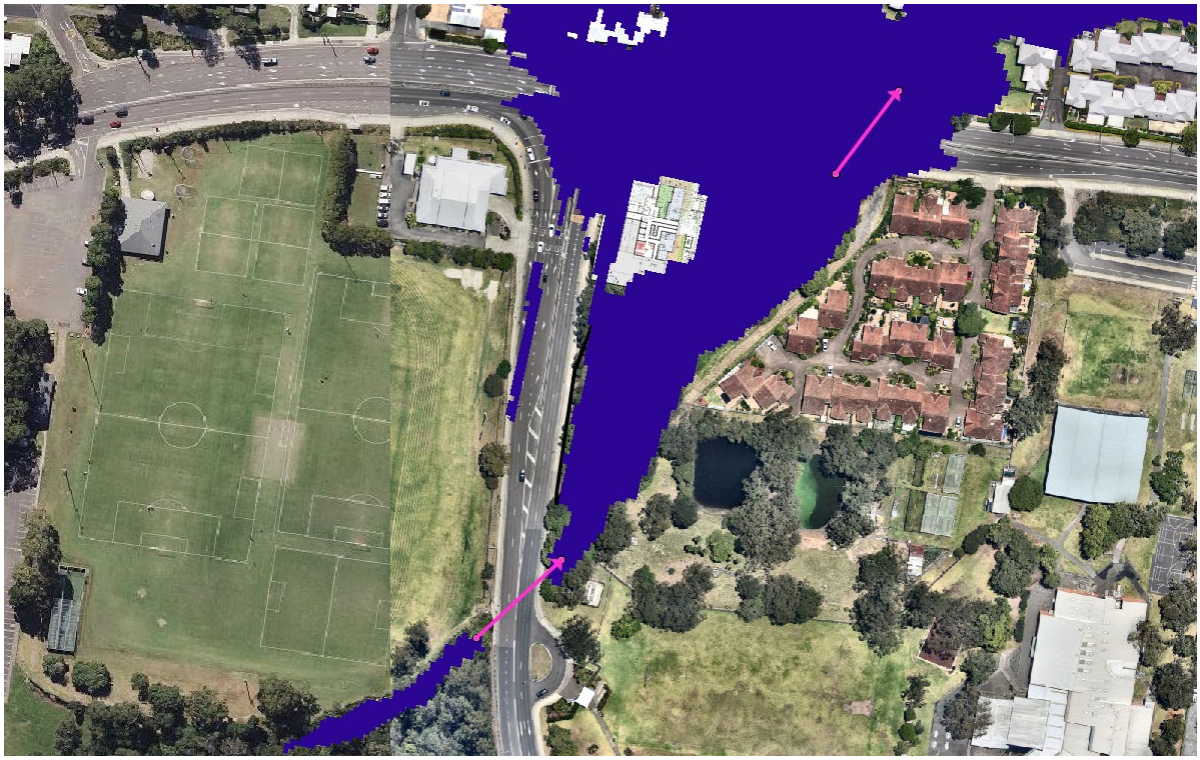

Table 5 - PMF Extent at time 0 hours.

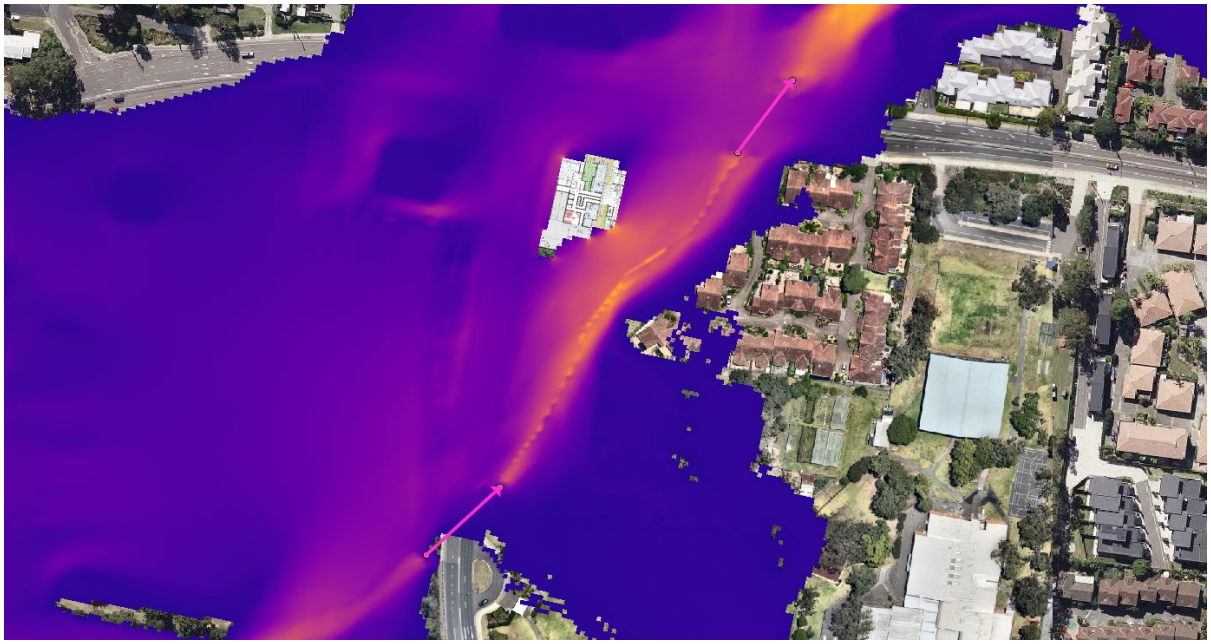

Table 6 - PMF extent at 45 minutes

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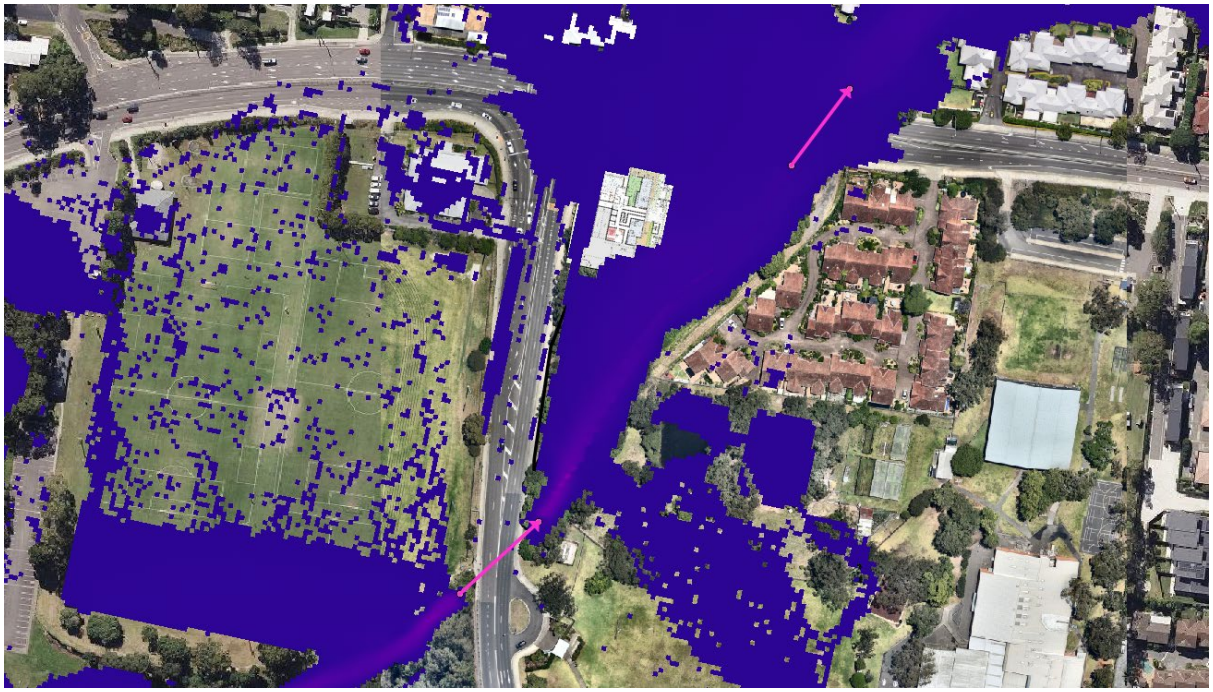

Table 7 - PMF extent at 3 hours

5.3.1 Primary Response

Evacuation is the primary response strategy for flood:

- Horizontal evacuation at street level is achieved by vehicle before any roads are cut by floodwaters.

Horizontal evacuation can be achieved post 3 hours of PMF inundation. During the initial stages of PMF flooding, the proposed development is considered a safe refuge for all residents for up to 3 hours.

- It is a risk management strategy used to reduce loss of life or lessen the effects of an emergency on a community.

No loss of life would be endured if residents remained within the building for the first 3 hours of the PMF event. Flood strategy warning signs are to be presented within the building and within each unit educating residents of risks and strategies associated with flooding.

- Evacuation requires an understanding of the full range of flood behavior up to the probable.

As described above, the hydraulic model provided a detailed understanding of the flood behavior. For the first 2 hours of the PMF event vertical evacuation is the primary approach. At post 3 hours, horizontal evacuation via Charles Kay Drive would become the primary approach.

- maximum flood (PMF), which is reflected in flood plans developed by the NSW SES and Floodplain Risk Management Studies by councils.

Flood evacuation has been assessed against the PMF event.

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5.3.2 When SIP is appropriate

- SIP is an emergency management response, especially when the flood warning time and flood duration are both less than six hours (typically called flash floods).

The hydraulic modelling results indicated the PMF exhibited a short warning time and short peak flow duration. PMF events reach peak flows within 45 minutes and subside to acceptable risk levels within approximately an hour of peak flow allowing SIP to be a suitable strategy for this site.

- These flooding events are dangerous because of the short timeframes, as well as the flood speed and depth.

Vertical evacuation is the most suitable strategy as accessible routes within the vicinity become completely submerged making horizontal evacuation unsafe for people and vehicles.

- Under such circumstances, evacuation via vehicle may not be possible. SIP is the last resort evacuation option for development in greenfield and infill areas.

Refer to the explanation within point 1 and point 2.

The proposed development has been designed with a ground floor level above PMF flood level. The proposed development constitutes of 6 levels allowing for all levels within to be a safe in place shelter. Council should deem this development acceptable for the following reasons:

1. The duration of the PMF event is less than 6 hours.
2. The development's risk level for the 1%AEP is H3 and H5 for the PMF. We note that other local facilities such as emergency response ambulance station and Terrigal High School are located within the flood zone. These facilities are deemed unsafe for a shelter in place strategy for both vertical and horizontal evacuation considering the short duration of peak flow. In comparison to the existing facilities, the proposed development exceeds the safety requirements in addressing safe shelter.
3. Continuous access to electricity, water and sewerage services would always be available. In the case of a service failure, horizontal evacuation will become a viable option post 3 hours of the PMF event.
4. The location of the SIP is proposed above the PMF.
5. SIP is proposed within each habitable unit of the proposed building complying with the minimal floor space per person.
6. The development is proposed to be constructed from flood compatible materials

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as per Table 4.

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6. Flood Evacuation

6.1 Water Entry into the building

All entrances have been set to a level above flood level plus freeboard.

6.2 Evacuation Strategy and Structural Measures

As duty of care to pedestrians and civilians, the following measures have been proposed and adopted in the design:

- Finish floor levels for are set to 500mm above the 1%AEP flood level, allowing for the site to be safe shelter location for pedestrians during a flood event.
- Side set back has been left open with no obstruction to allow for the free flow of overland flow and reduce the nuisance to adjacent properties.
- Open style fencing has been proposed within the zone of the overland flow were necessary.
- All ventilation openings are set well above the flood levels + freeboard where applicable.
- All hazardous materials are stored well above the flood levels + freeboard.
- All electrical cables are set above the flood levels + freeboard where applicable.
- Signage should be located within the site indicating the site is flood prone and warning driver attempting to exit to be careful of flooding during storm events.

Life Threatening Emergency	000	Police, Fire, Ambulance
Bureau of Meteorology (BOM)	1300 659 215 www.bom.gov.au	Weather forecast and flood warnings
State Emergency Services (SES)	132500 www.ses.nsw.gov.au	
Department of Environment, Water and Natural Resources	www.environment.nsw.gov.au	
National Relay Service NRS	1300 555 727	For the deaf/hearing/speech impaired
	www.transport.nsw.gov.au	
Poison Information centre	13 11 26	(24 hours)

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Red Cross Australia	1800 811 700	
Central Coast Council	02 4306 7900	

Table 8 - Emergency Response Contact

6.3 Before Flood Occurs

- Ask your council or State Emergency Service about local flood plans (or records) which detail problem areas and evacuation routes and centers.
- If your area is flood-prone, consider alternatives to carpets (e.g. mats and rugs). In ground level rooms, tiled walls are less likely to be damaged and are easier to clean
- Have an emergency kit on hand which should include:
- adequate supplies of canned food and bottled water
- first aid kit and instructions
- waterproof bags for clothing and valuables
- gardening gloves for clean up
- portable radio, torch and spare batteries
- Keep a list of emergency phone numbers on display

EMERGENCY PHONE NUMBERS	
State Emergency Service	**132 500**
Police	**000**
Local Council	**02 4309 7900**

6.4 When you hear a flood warning.

- Tune to your local radio for warning and advice or check the Bureau of Meteorology website www.bom.gov.au
- Prepare to move vehicles, outdoor furniture, rubbish, chemicals and poisons to higher locations
- Plan what indoor items you will raise or empty if water threatens to enter your home
- Check your emergency kit and don't forget your pets

6.5 If you need to evacuate.

- Pack spare clothes, medication, valuables, personal papers, photos and mementos into sealed plastic bags, to be taken with your emergency kit
- Lift items onto beds, tables and roof spaces. Don't forget things you have on the floor like computers, televisions and any other electrical items
- Place sandbags in the toilet bowl and over all laundry/bathroom drain holes. Put all bathplugs in with weight on top. This will prevent sewage back flow
- Turn off all power, water and gas and take your mobile phone and charger

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- Lock your home and take recommended evacuation routes for your area (please refer to the evacuation plan below)
- Don't drive into any flood waters unless you are sure it is safe.

6.6 If you stay or on your return.

- Stay tuned to local radio for updated advice and help others in your neighborhood.
- Don't allow children to play in or near flood waters.
- Don't go into flood waters and stay away from drains or culverts. Have your gas or electrical appliances which have been in flood waters safety checked.
- Don't eat food which has been in flood waters.
- Boil tap water until supplies have been declared safe.

6.7 How to draw up your emergency flood plan

- Prepare your emergency flood-storm plan with all members of the household present in advance of a flood. Prior to developing your plan learn what your flood-storm risk is.
- On the following pages are checklists which will help you to list the things you need to do prior to, during and after a flood.
- Once you have completed your plan, practice it regularly and keep it in a safe and easily accessible place for quick reference (e.g. in your emergency flood-storm kit).

6.8 Prior to flood storm

Stay informed by listening to the Bureau of Meteorology flood watches and warnings. Bureau of Meteorology website: http://www.bom.gov.au/weather/nsw/ always keep an eye on the weather. Unusually heavy rain is a good indication that flooding may occur.

- Learn your flood-storm risk.
- Prepare your home.
- Prepare your emergency flood-storm kit and plan.

6.9 Emergency Flood Evacuation Kit

- Advise Neighbors and Friends
- Locate your pets.
- Locate your emergency flood storm kit.
- Raise items to a higher level.
    - Rugs
    - Electrical appliance
    - Computers
    - Personal items
    - Light furniture

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- Sound systems.
- Chemicals

- Secure hazardous items
- Install flood proofing devices.
- Monitor Bureau of Meteorology forecasts and warnings
- Switch off the electricity at the switchboard.
- Turn off gas at the meter.
- Turn of water at the meter
- Block toilet bowls with a strong plastic bag filled with earth or sand.
- Cover drains in showers, baths, laundries, etc. with a strong plastic bag filled with earth or sand.
- Shelter in the safest part of the building

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7. Conclusion

1. A detailed investigation into the flooding behavior has been undertaken for the proposed development at 310 Terrigal Drive, Terrigal.

2. A detailed 2D hydraulic model was established. This model incorporates the upstream local catchment and has a fine 2D resolution of 1m. Hydrological modelling was undertaken utilizing a traditional hydrological modelling for catchments within the study area. A WBNM hydrologic model has been used to determine design flood estimates applicable to the site.

3. Using the established models, the study has determined the flood behavior for the 20%AEP, 1% AEP, PMF and 1%AEP 2090 climate change storm event. The primary flood characteristics reported for the design events considered include depths, levels, and velocities. The study has also defined the Provisional Flood Hazard for flood-affected areas. The study was conducted for both pre and post development conditions.

4. The study investigated the impact of the proposed development on the flood levels both upstream and downstream. Mitigation measures were proposed to ensure that the development will not have any impacts on flooding elsewhere in the floodplain and meet the requirements of Council.

5. The flood maps are included in Appendix A. The modelling results indicate that the development can be constructed in its proposed form with negligible impact on the flooding behavior in the close vicinity of the site and elsewhere in the floodplain nor having impact on upstream and downstream properties.

6. A concept flood risk management plan and flood evacuation strategy are provided in response to Council's DCP requirements, Council's LEP requirements, and the NSW government's Section 9.1 Direction.

7. The proposed development has been designed in a manner not to cause adverse reaction to adjacent and downstream properties while complying with local and state legislations.

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8. The proposed development has been designed in a manner to act as a safe refuge for residents by complying with the shelter in place requirements during flood events up to and including PMF.

This report concludes based on the information found within, that the proposed development is considered safe and does not exert any danger or risk to people, the environment and neighboring structures nor cause changes to the existing flood behavior.

Yours Faithfully,

CIVIL STORMWATER ENGINEERING GROUP
.INNOVATE.ENGINEER.TRANSFORM.

Samir C Hakim,

Principal Civil Engineer
B.E.(Civil), M.E., Adv. Dip. (Civil Design)
M.I.E. AUST #3491570
PENG No. #927492
DPR# - DEP0002224
PDPR# - PDP0000768
PRE# - PRE0001864

ENGINEERS AUSTRALIA Professional Engineers MEMBER
NSW GOVERNMENT Fair Trading DPR# DEP0002224 PDPR# PDP0000768
RPEng Registered Professional Engineer of Professionals Australia

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Appendix A – TUFLOW Flood Maps

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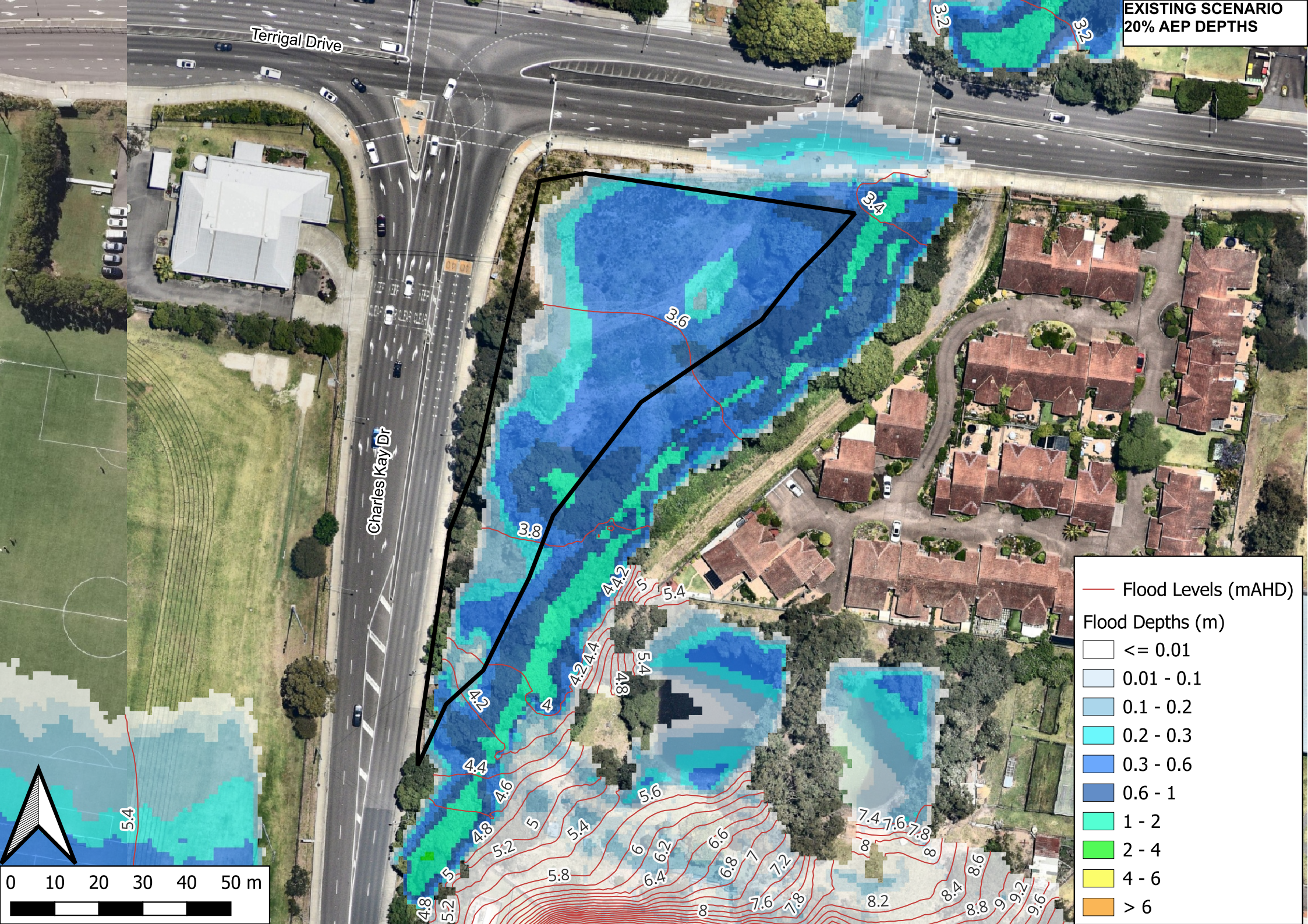
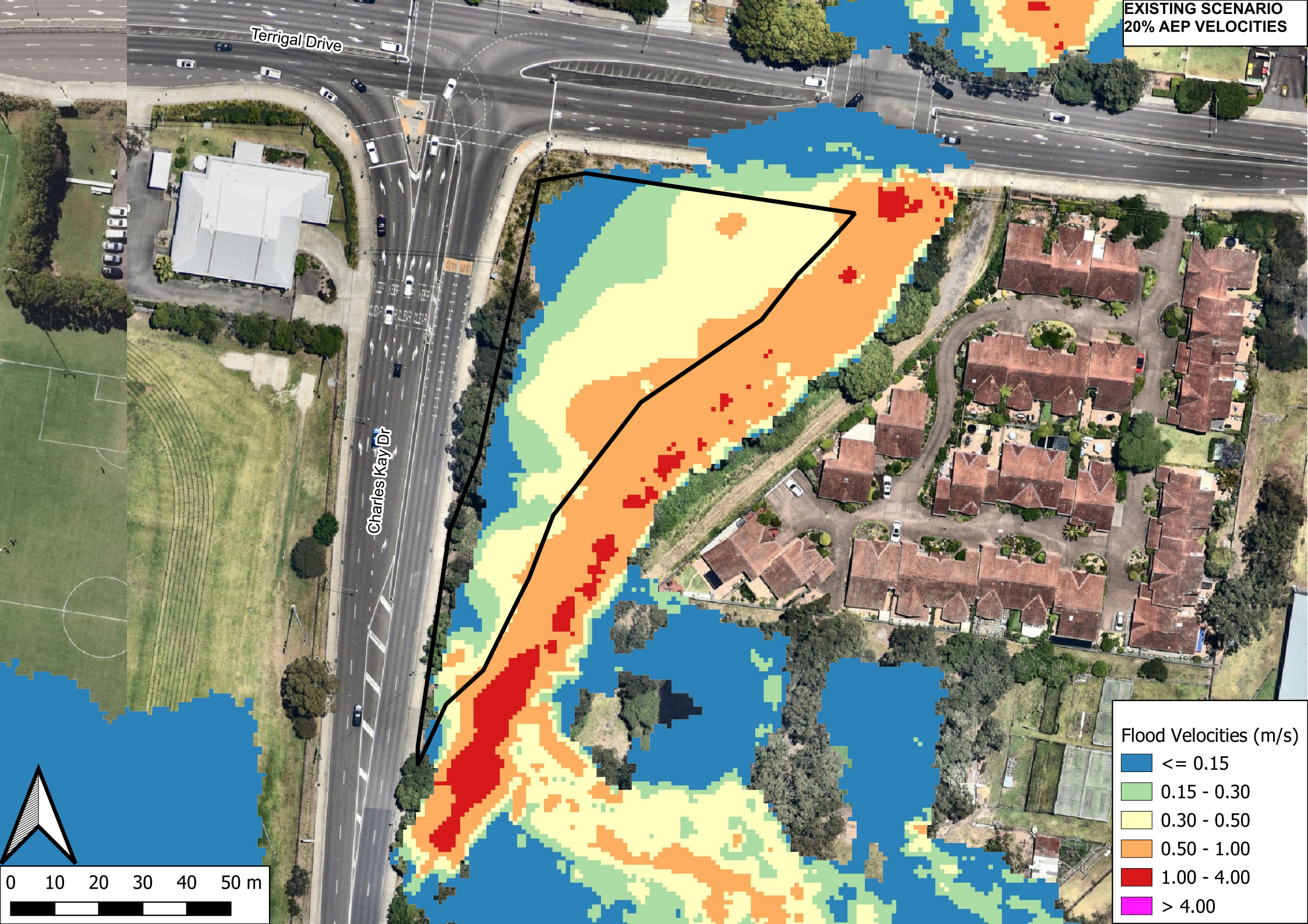
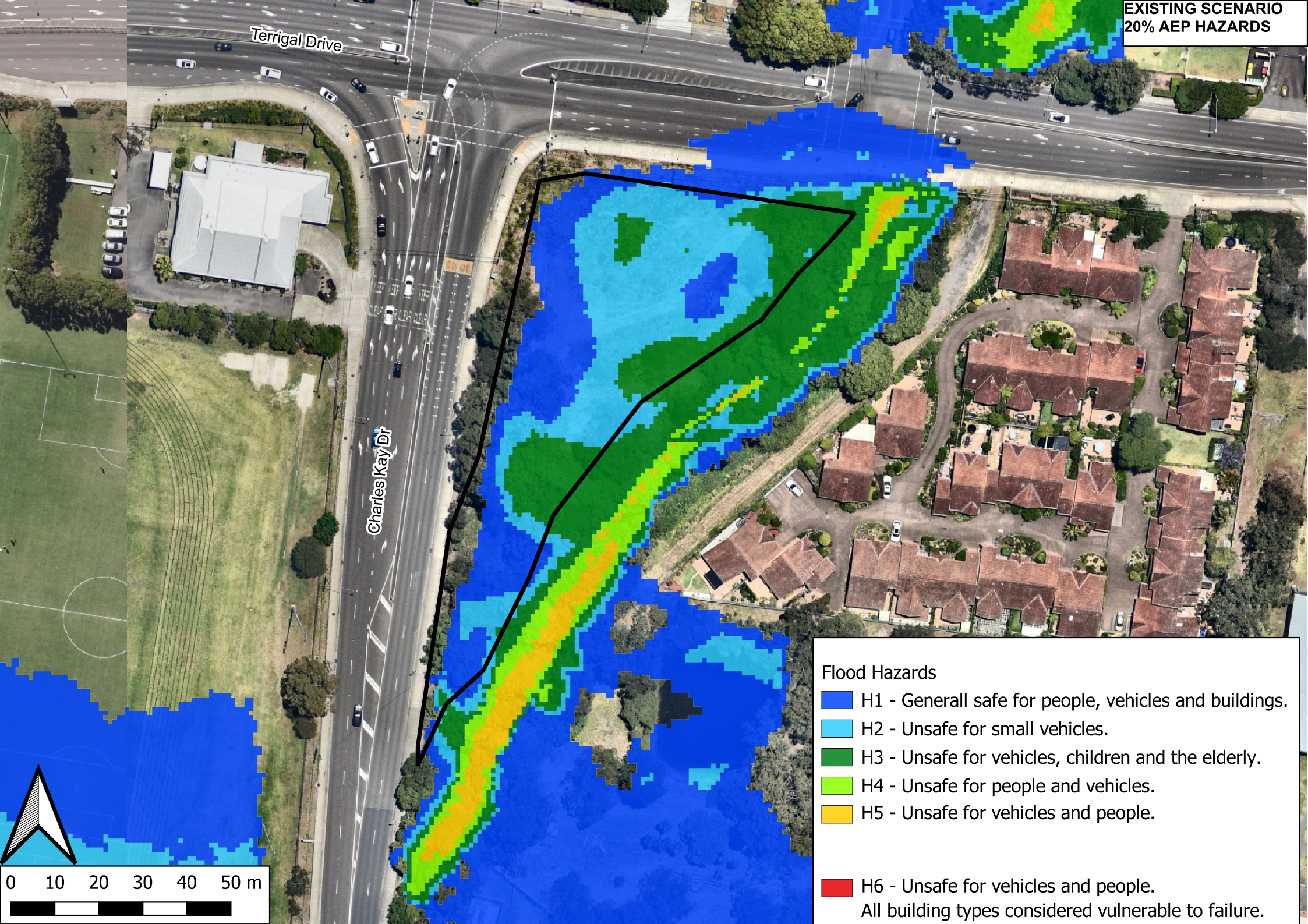
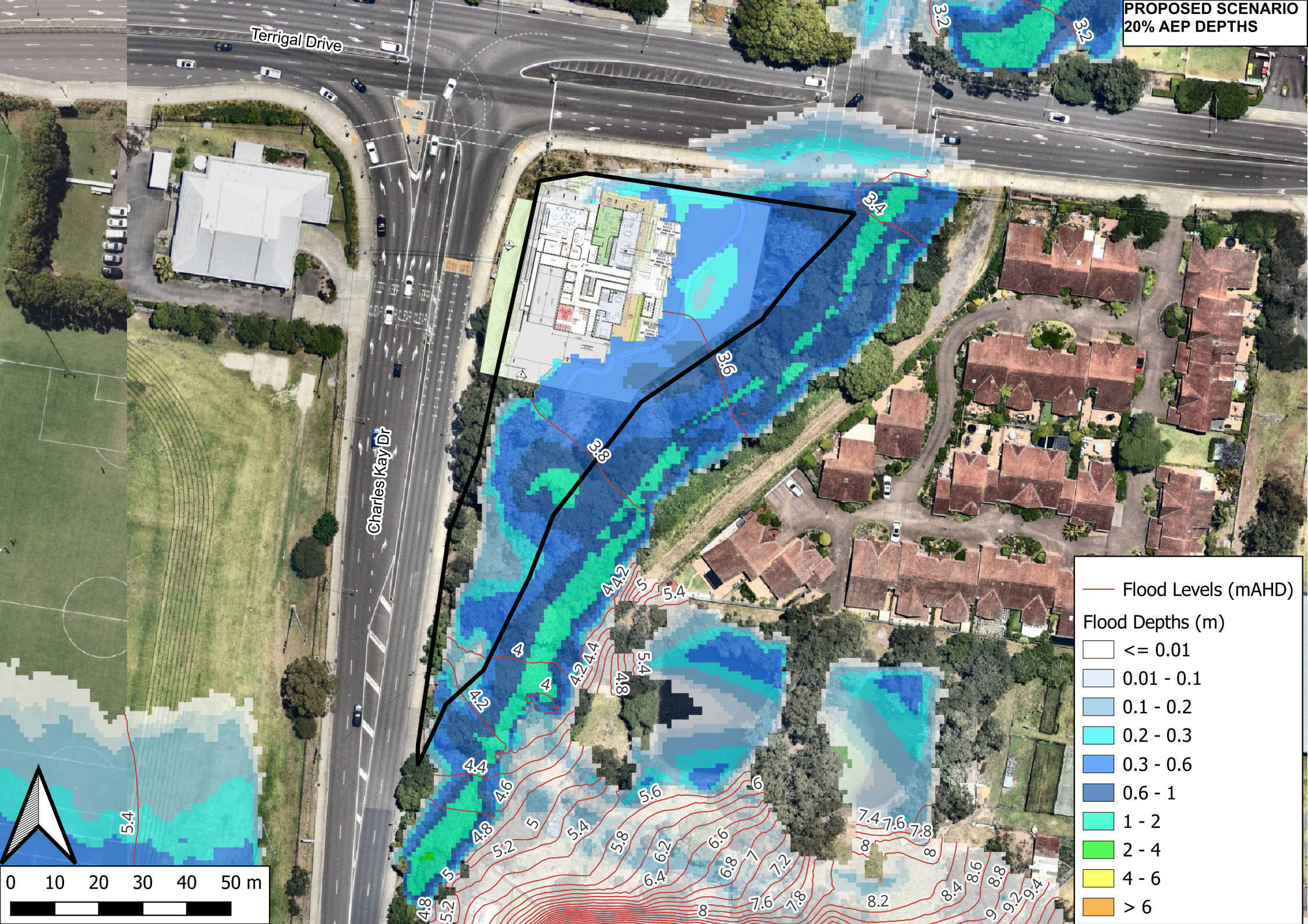
ACN 640 561 584


EXISTING SCENARIO
20% AEP DEPTHS
Terrigal Drive
Charles Kay Dr
Flood Levels (mAHD)
Flood Depths (m)
<= 0.01
0.01 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.6
0.6 - 1
1 - 2
2 - 4
4 - 6
> 6
0 10 20 30 40 50 m


EXISTING SCENARIO
20% AEP VELOCITIES
Terrigal Drive
Charles Kay Dr
Flood Velocities (m/s)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 4.00
> 4.00
0 10 20 30 40 50 m


EXISTING SCENARIO
20% AEP HAZARDS
Terrigal Drive
Charles Kay Dr
Flood Hazards
H1 - Generall safe for people, vehicles and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for vehicles, children and the elderly.
H4 - Unsafe for people and vehicles.
H5 - Unsafe for vehicles and people.
H6 - Unsafe for vehicles and people.
All building types considered vulnerable to failure.
0 10 20 30 40 50 m


PROPOSED SCENARIO
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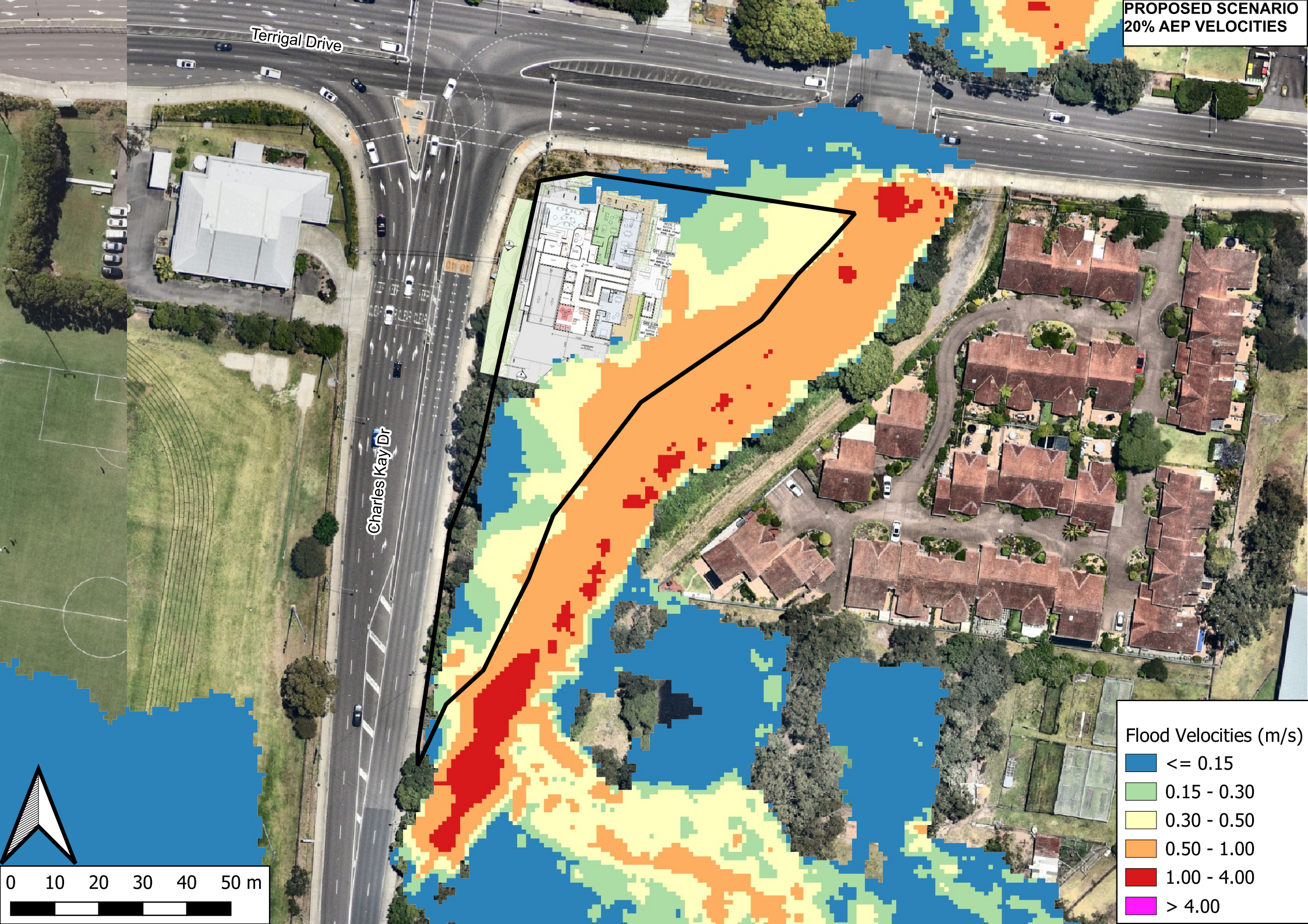
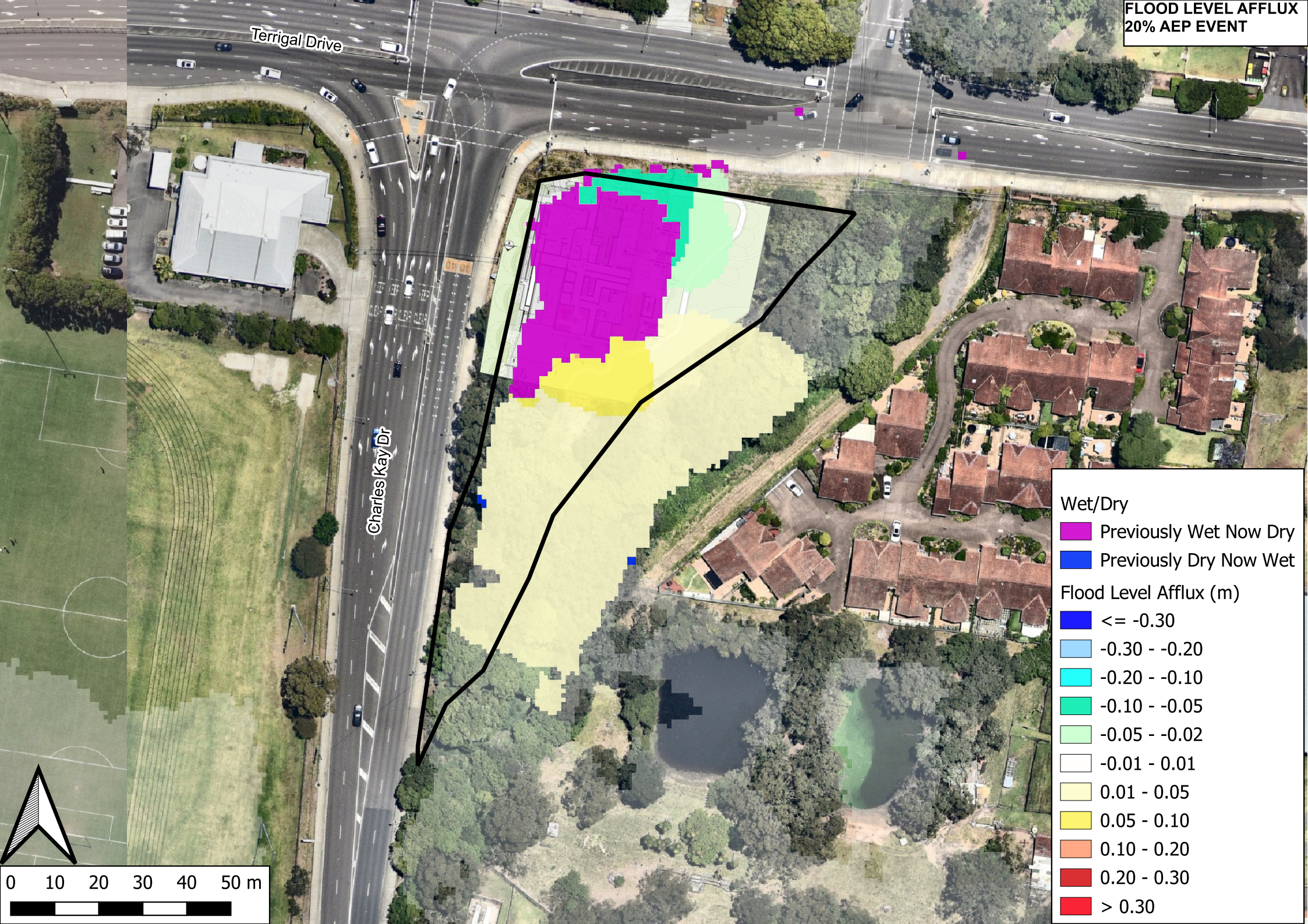
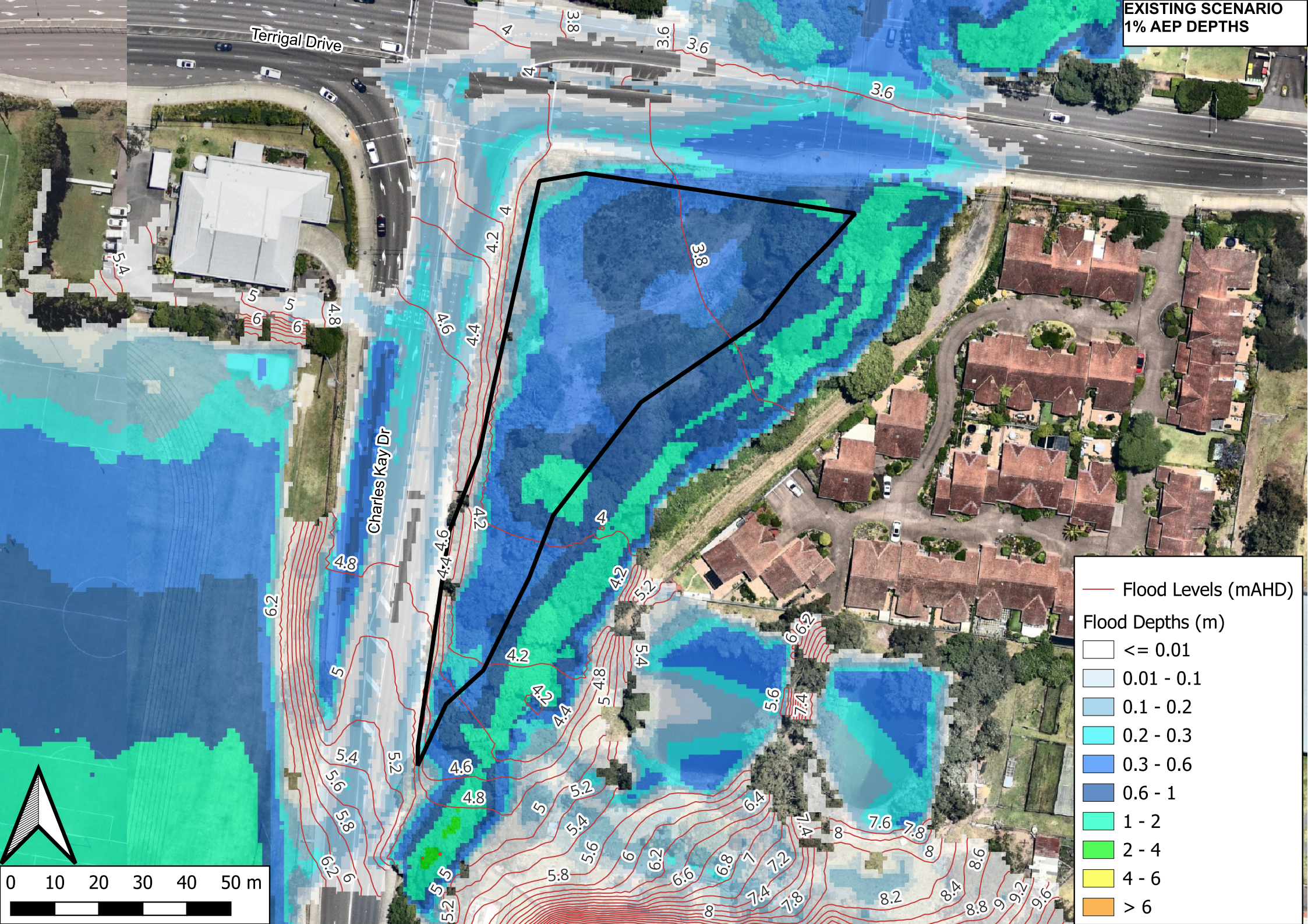
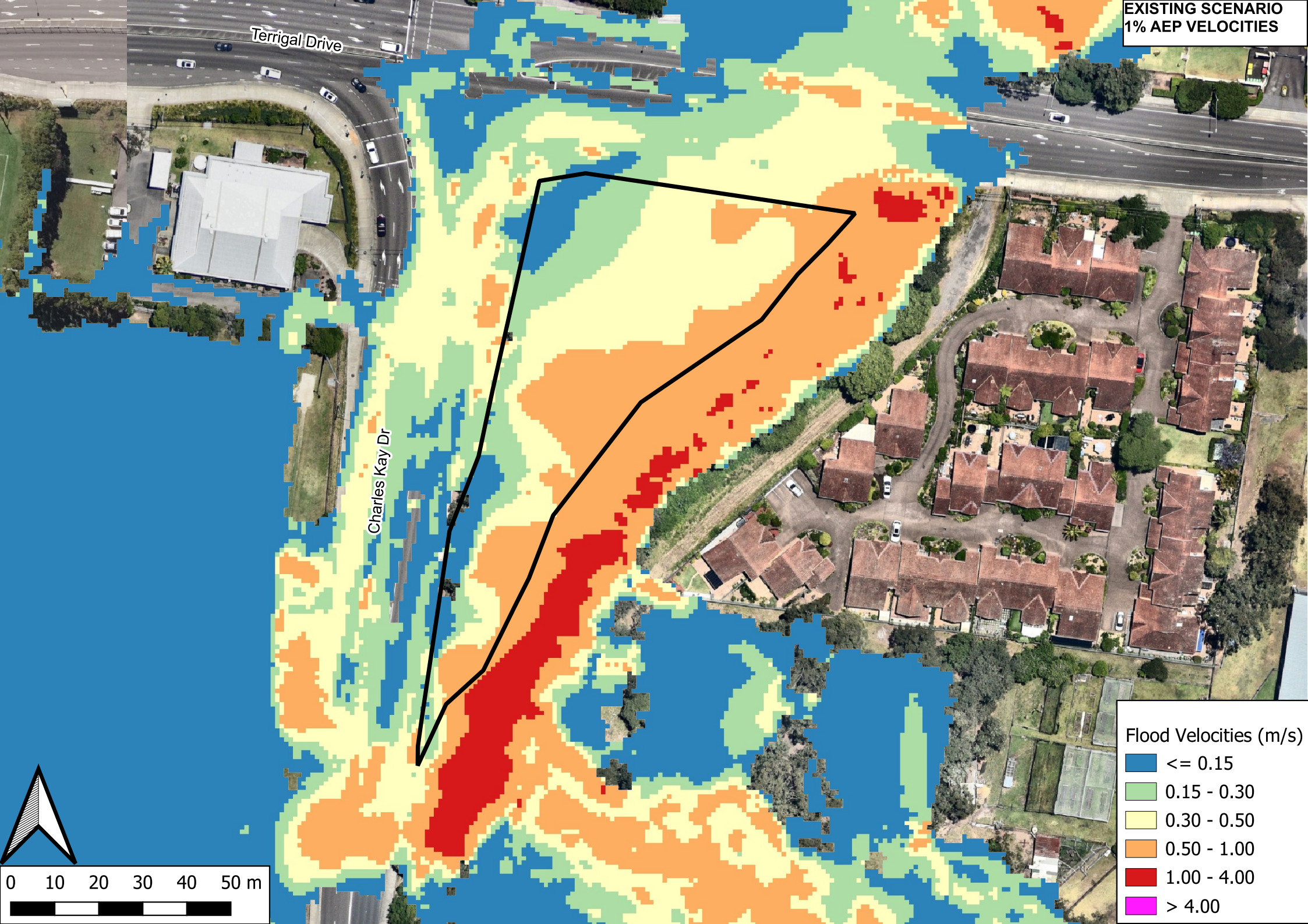
Terrigal Drive
Charles Kay Dr
Flood Levels (mAHD)
Flood Depths (m)
<= 0.01
0.01 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.6
0.6 - 1
1 - 2
2 - 4
4 - 6
> 6
0 10 20 30 40 50 m


PROPOSED SCENARIO
20% AEP VELOCITIES
Terrigal Drive
Charles Kay Dr
Flood Velocities (m/s)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 4.00
> 4.00
0 10 20 30 40 50 m


FLOOD LEVEL AFFLUX
20% AEP EVENT
Terrigal Drive
Charles Kay Dr
Wet/Dry
Previously Wet Now Dry
Previously Dry Now Wet
Flood Level Afflux (m)
<= -0.30
-0.30 - -0.20
-0.20 - -0.10
-0.10 - -0.05
-0.05 - -0.02
-0.01 - 0.01
0.01 - 0.05
0.05 - 0.10
0.10 - 0.20
0.20 - 0.30
> 0.30
0 10 20 30 40 50 m


EXISTING SCENARIO
1% AEP DEPTHS
Terrigal Drive
Charles Kay Dr
Flood Levels (mAHD)
Flood Depths (m)
<= 0.01
0.01 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.6
0.6 - 1
1 - 2
2 - 4
4 - 6
> 6
0 10 20 30 40 50 m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1% AEP VELOCITIES
Terrigal Drive
Charles Kay Dr
Flood Velocities (m/s)
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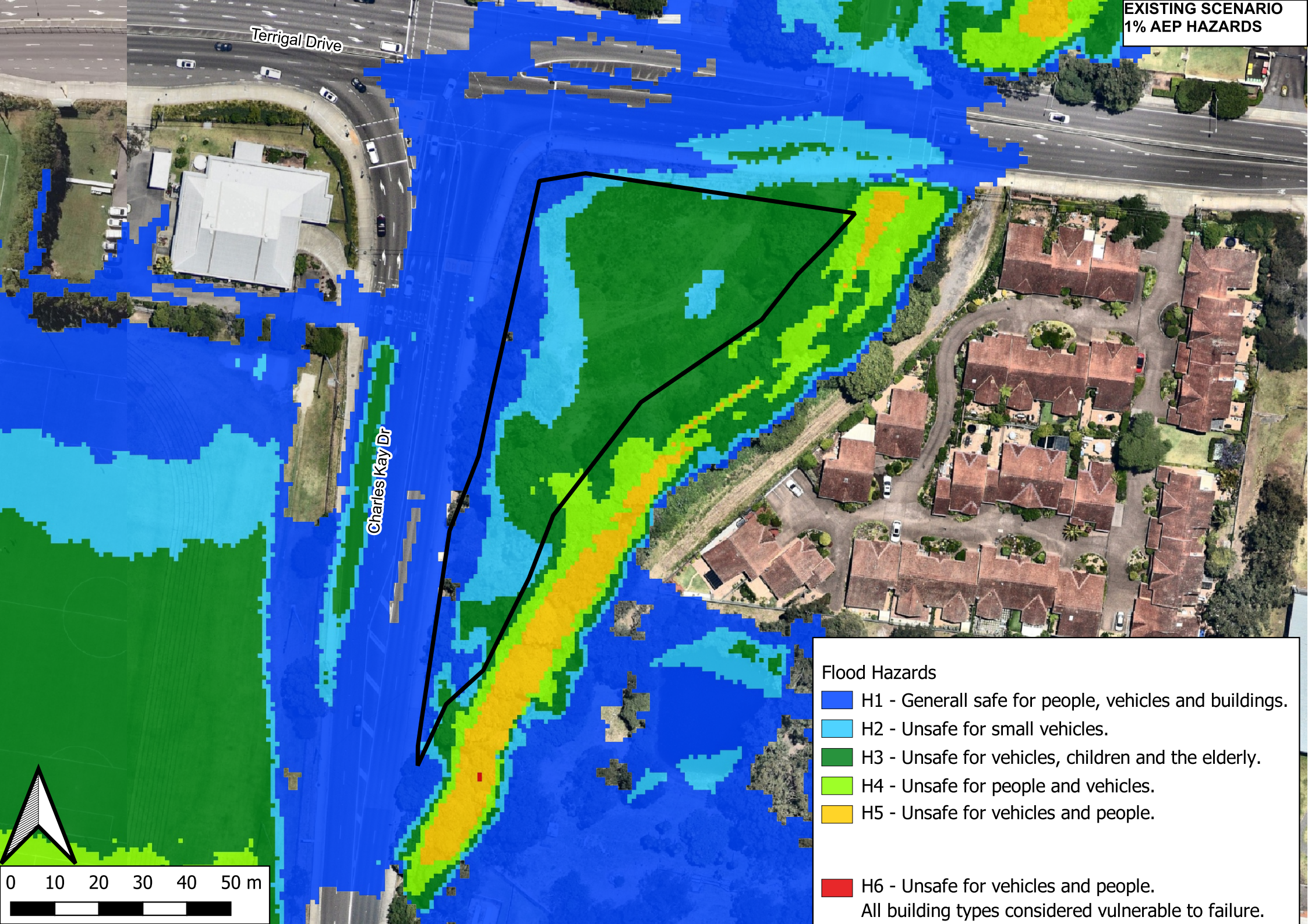
0.30 - 0.50
0.50 - 1.00
1.00 - 4.00
> 4.00
0 10 20 30 40 50 m


EXISTING SCENARIO
1% AEP HAZARDS
Terrigal Drive
Charles Kay Dr
Flood Hazards
H1 - Generall safe for people, vehicles and buildings.
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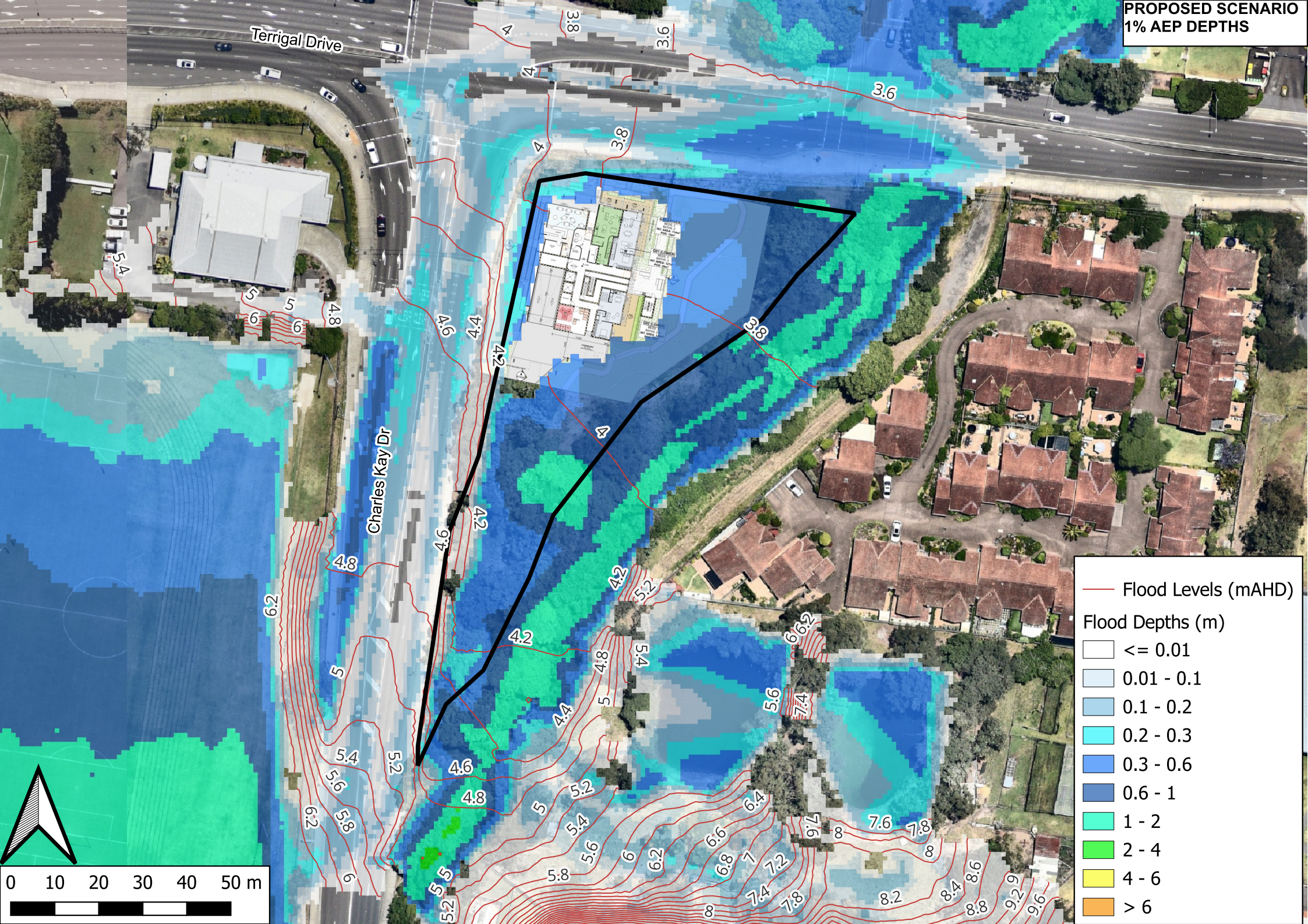
H4 - Unsafe for people and vehicles.
H5 - Unsafe for vehicles and people.
H6 - Unsafe for vehicles and people.
All building types considered vulnerable to failure.
0 10 20 30 40 50 m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1% AEP DEPTHS
Terrigal Drive
Charles Kay Dr
Flood Levels (mAHD)
Flood Depths (m)
<= 0.01
0.01 - 0.1
0.1 - 0.2
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0.6 - 1
1 - 2
2 - 4
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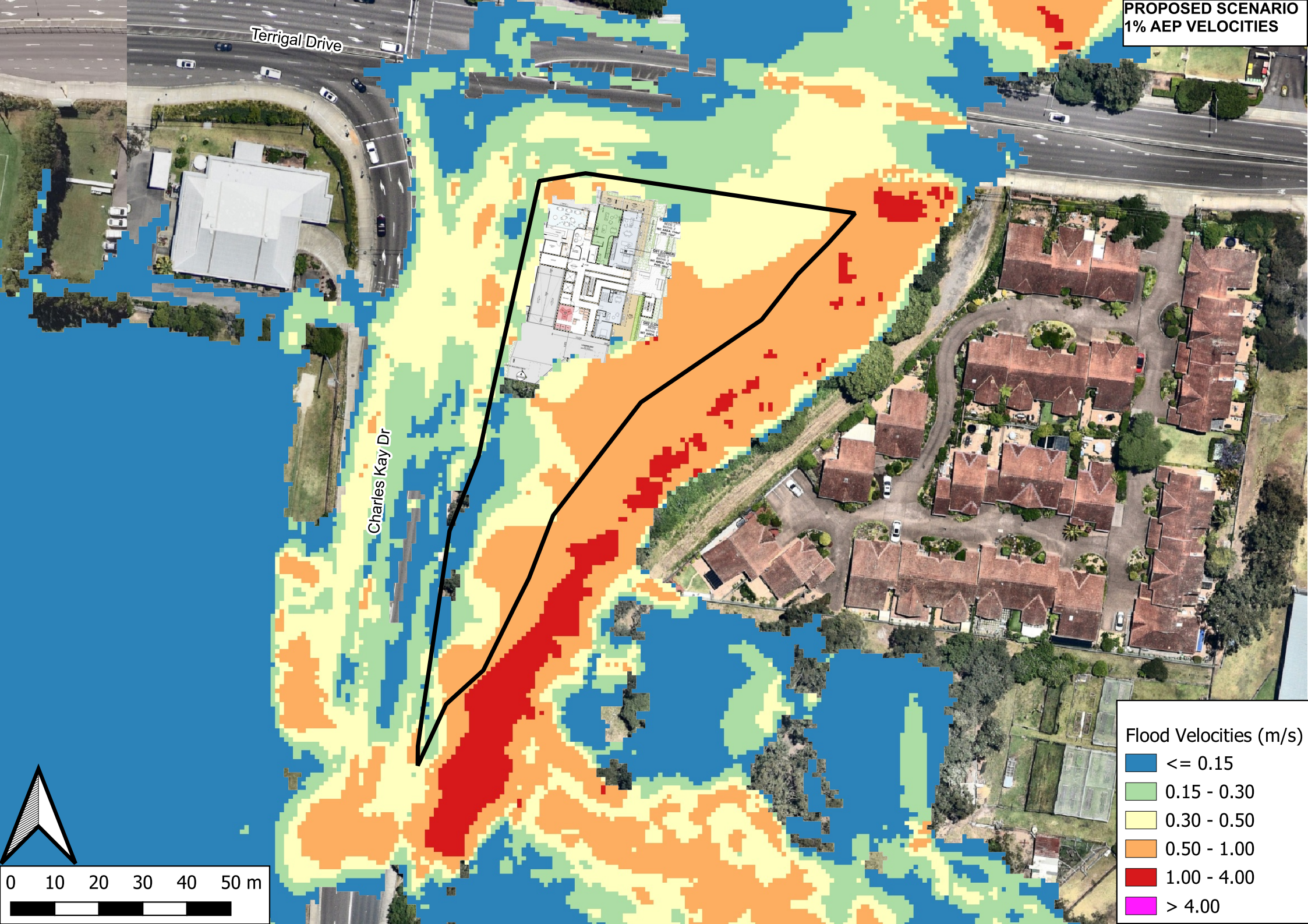
> 6
0 10 20 30 40 50 m


PROPOSED SCENARIO
1% AEP VELOCITIES
Terrigal Drive
Charles Kay Dr
Flood Velocities (m/s)
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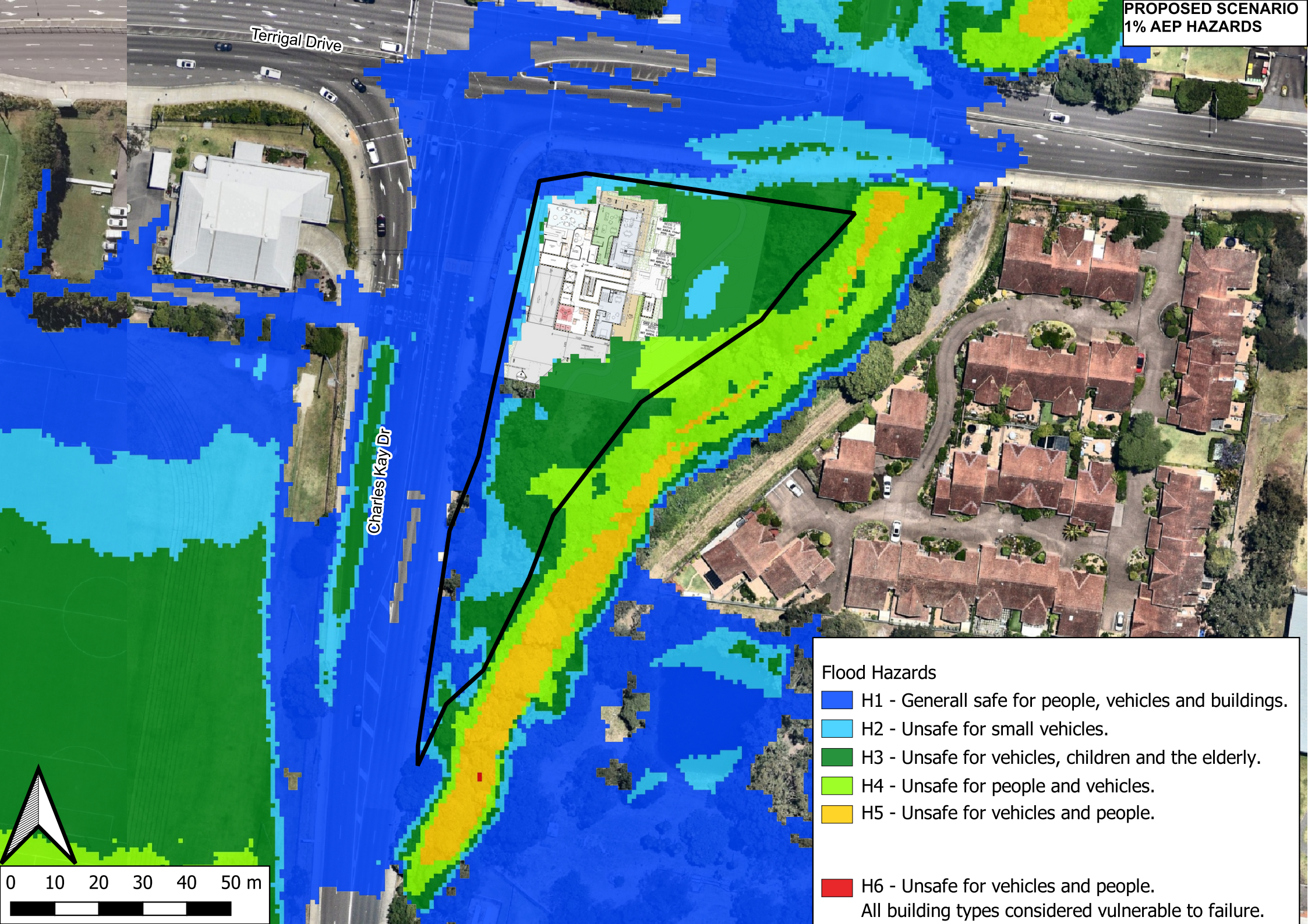
0.30 - 0.50
0.50 - 1.00
1.00 - 4.00
> 4.00
0 10 20 30 40 50 m


PROPOSED SCENARIO
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Terrigal Drive
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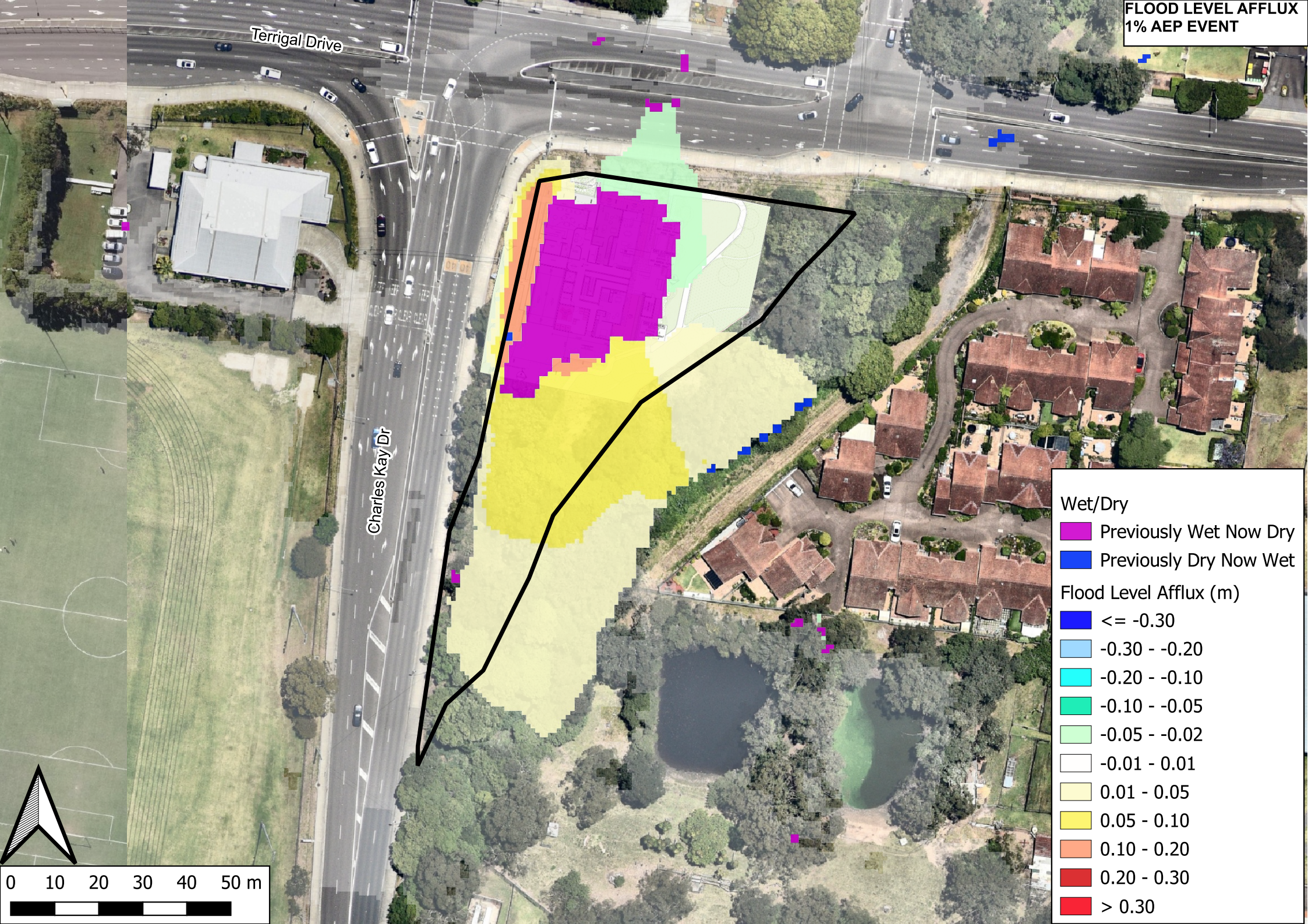
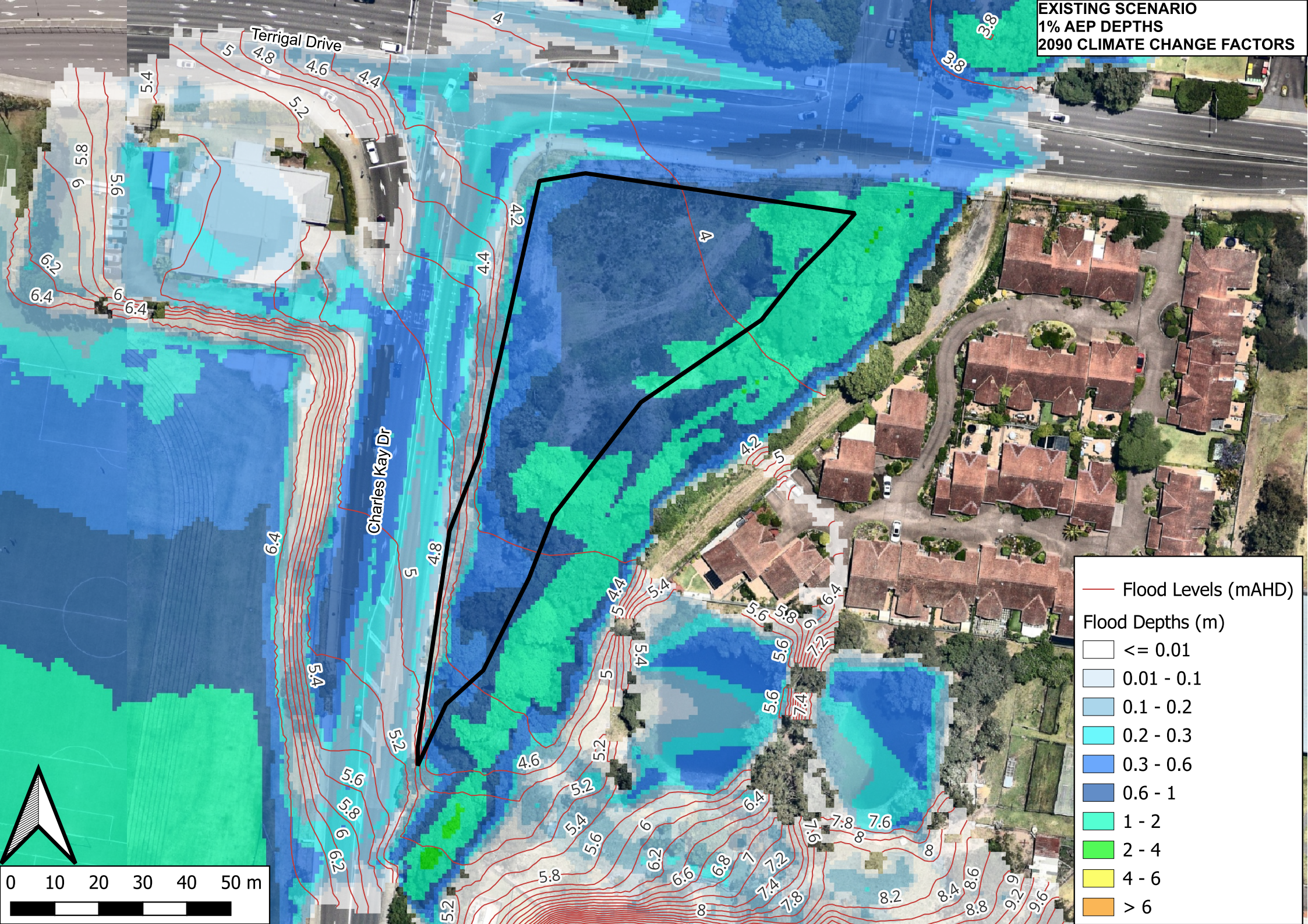
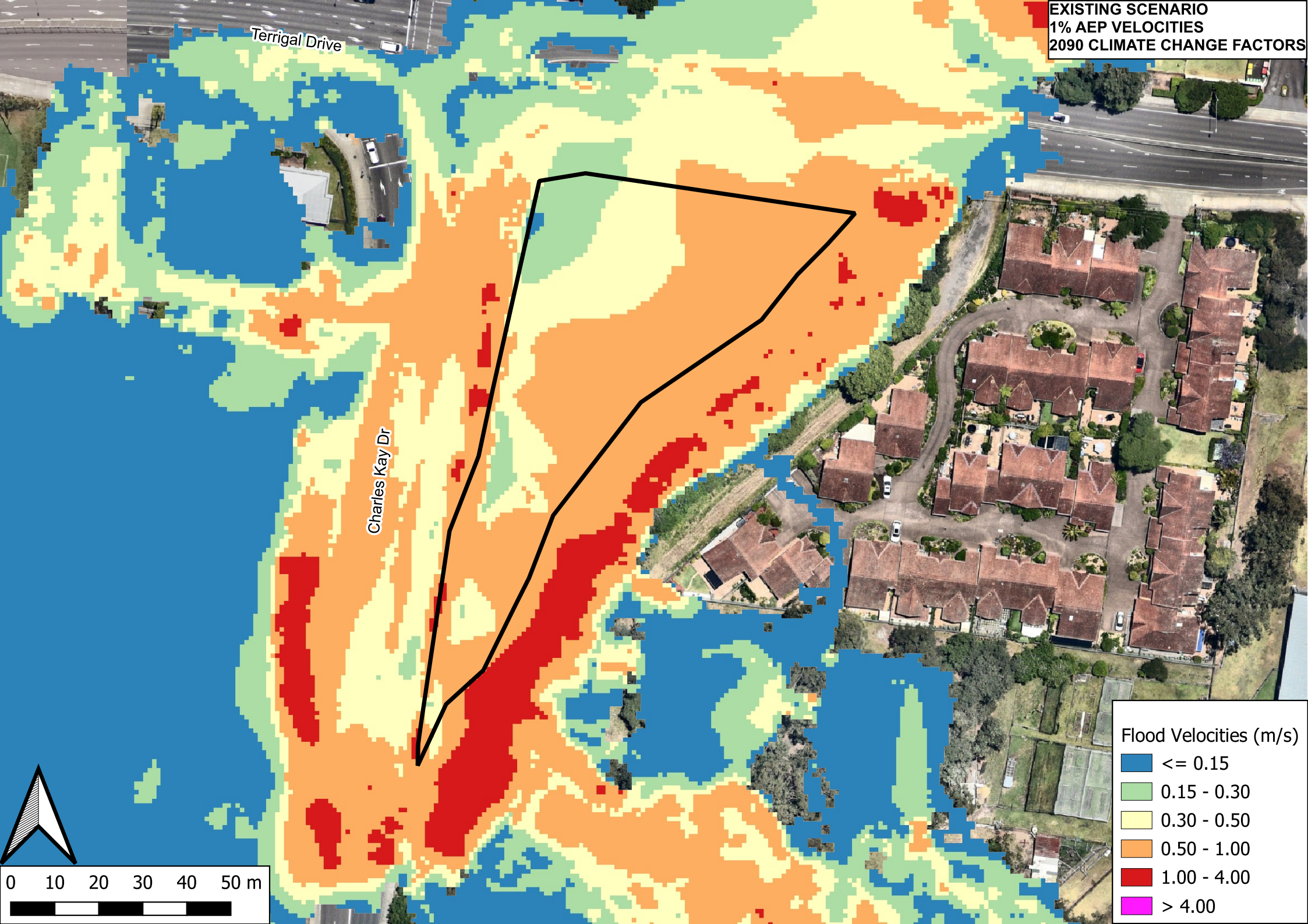

FLOOD LEVEL AFFLUX
1% AEP EVENT
Terrigal Drive
Charles Kay Dr
Wet/Dry
Previously Wet Now Dry
Previously Dry Now Wet
Flood Level Afflux (m)
<= -0.30
-0.30 - -0.20
-0.20 - -0.10
-0.10 - -0.05
-0.05 - -0.02
-0.01 - 0.01
0.01 - 0.05
0.05 - 0.10
0.10 - 0.20
0.20 - 0.30
> 0.30
0 10 20 30 40 50 m


EXISTING SCENARIO
1% AEP DEPTHS
2090 CLIMATE CHANGE FACTORS
Terrigal Drive
Charles Kay Dr
Flood Levels (mAHD)
Flood Depths (m)
<= 0.01
0.01 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.6
0.6 - 1
1 - 2
2 - 4
4 - 6
> 6
0 10 20 30 40 50 m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2090 CLIMATE CHANGE FACTORS
Terrigal Drive
Charles Kay Dr
Flood Velocities (m/s)
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0.30 - 0.50
0.50 - 1.00
1.00 - 4.00
> 4.00
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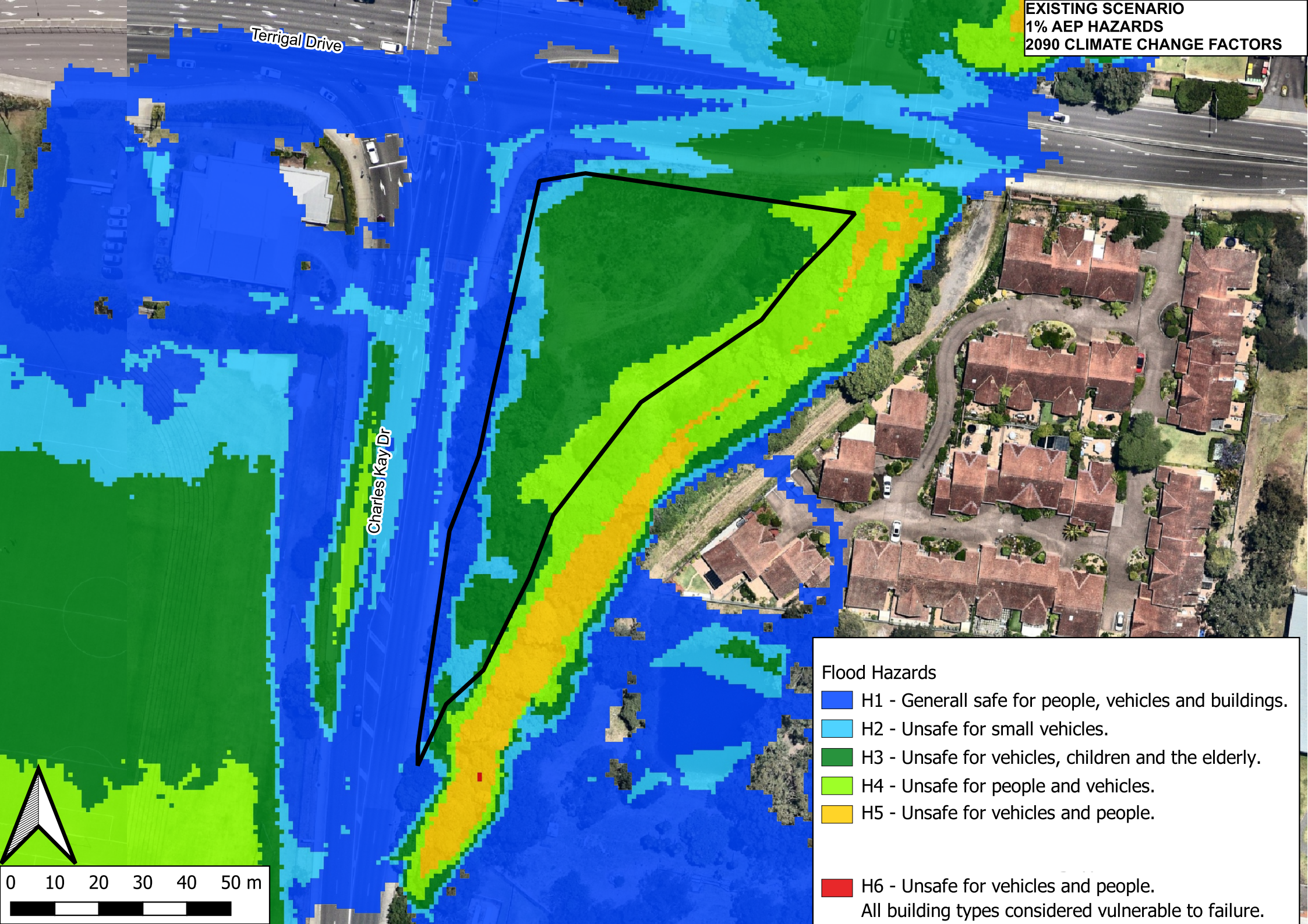
EXISTING SCENARIO
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2090 CLIMATE CHANGE FACTORS
Terrigal Drive
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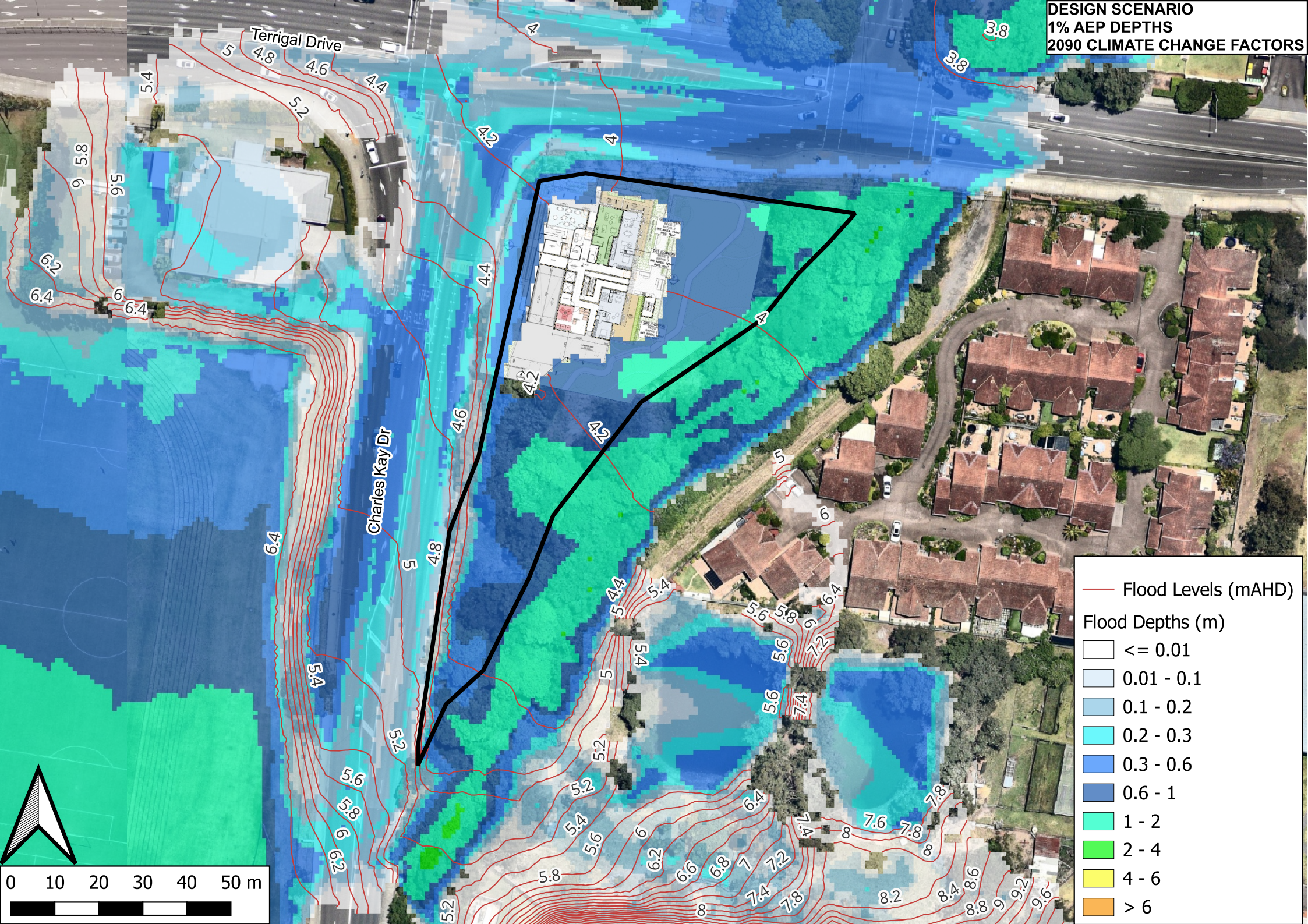
H6 - Unsafe for vehicles and people.
All building types considered vulnerable to failure.
0 10 20 30 40 50 m


DESIGN SCENARIO
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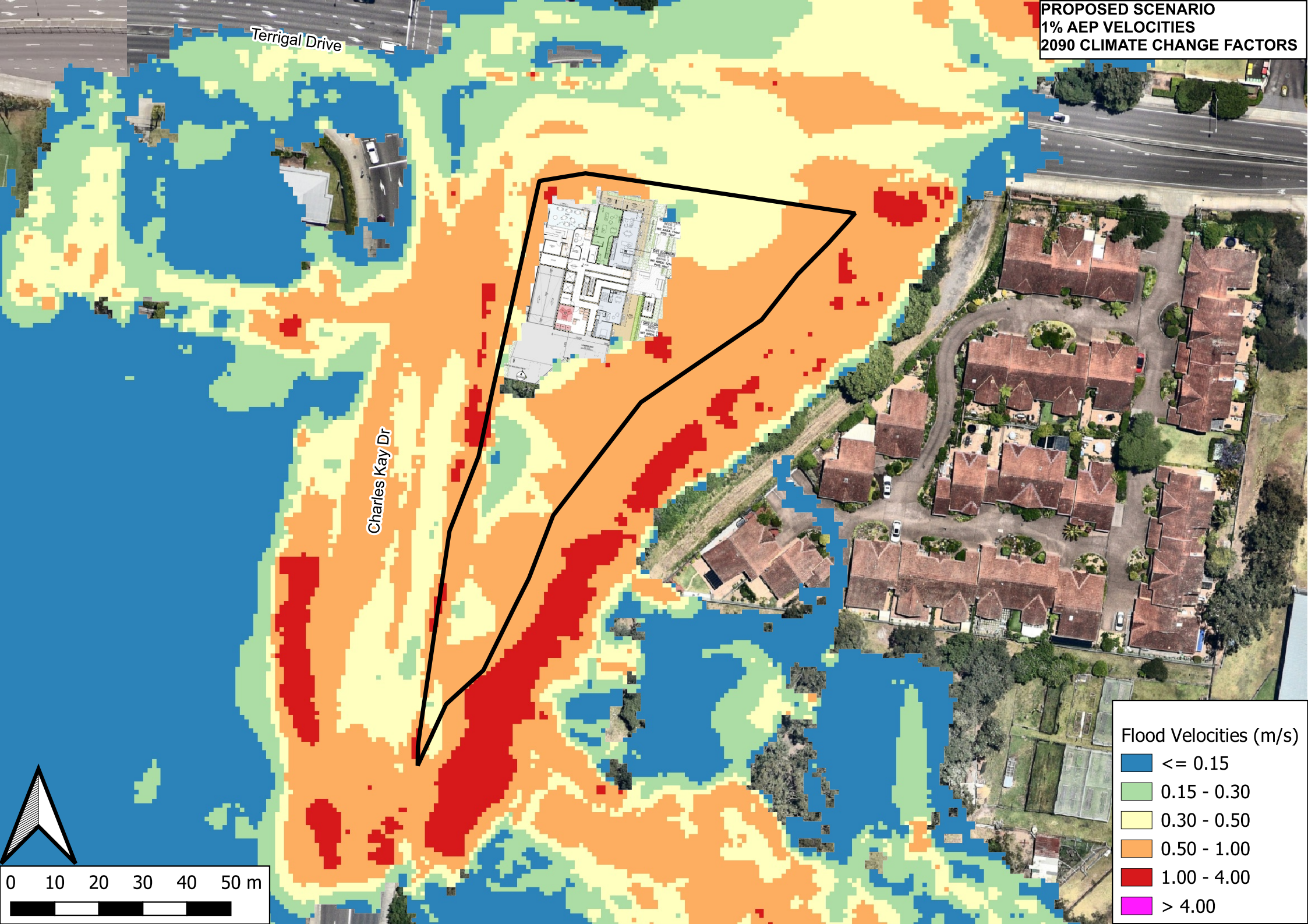
2090 CLIMATE CHANGE FACTORS
Terrigal Drive
Charles Kay Dr
Flood Levels (mAHD)
Flood Depths (m)
<= 0.01
0.01 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.6
0.6 - 1
1 - 2
2 - 4
4 - 6
> 6
0 10 20 30 40 50 m


PROPOSED SCENARIO
1% AEP VELOCITIES
2090 CLIMATE CHANGE FACTORS
Terrigal Drive
Charles Kay Dr
Flood Velocities (m/s)
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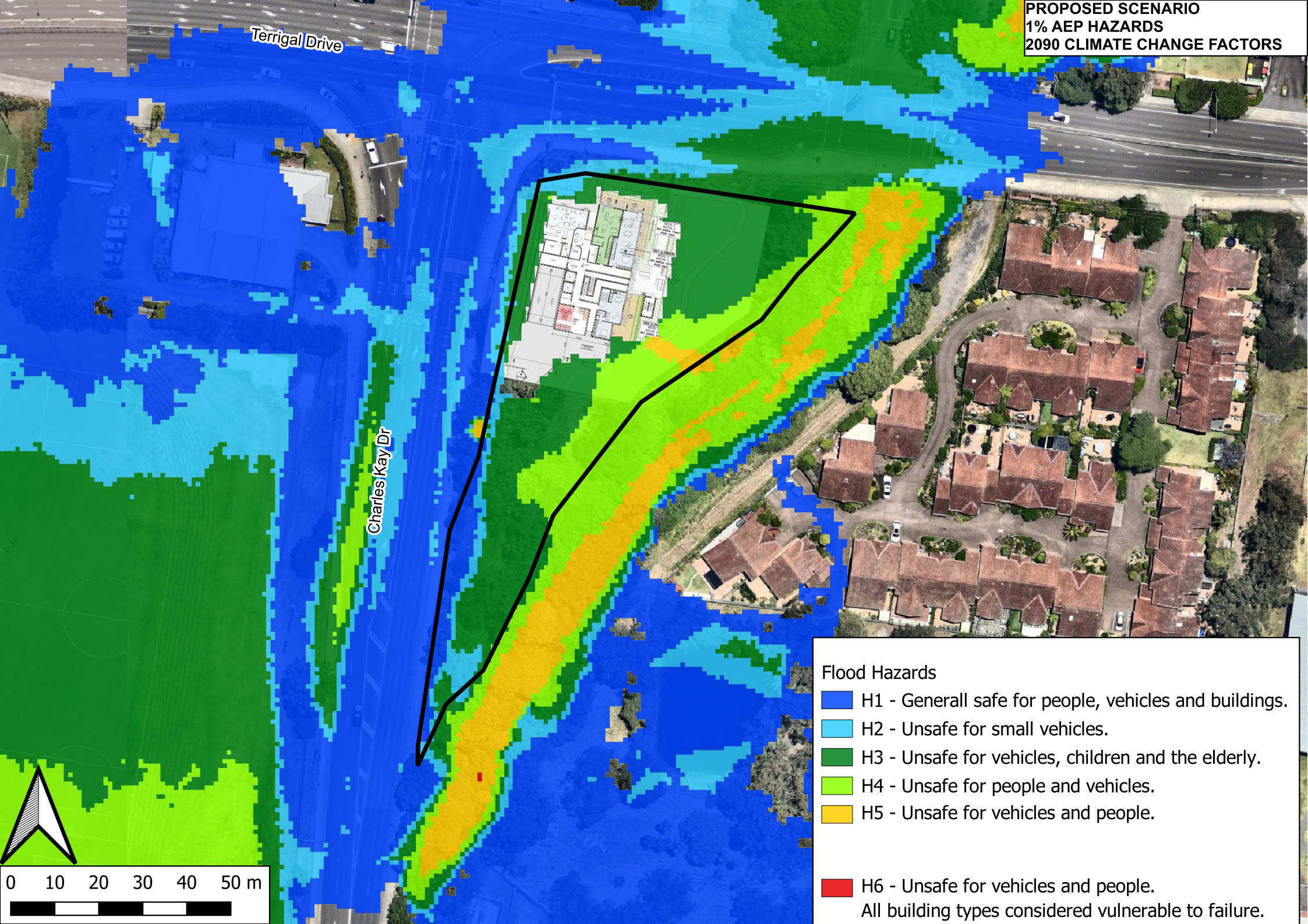
0.30 - 0.50
0.50 - 1.00
1.00 - 4.00
> 4.00
0 10 20 30 40 50 m


PROPOSED SCENARIO
1% AEP HAZARDS
2090 CLIMATE CHANGE FACTORS
Terrigal Drive
Charles Kay Dr
Flood Hazards
H1 - Generall safe for people, vehicles and buildings.
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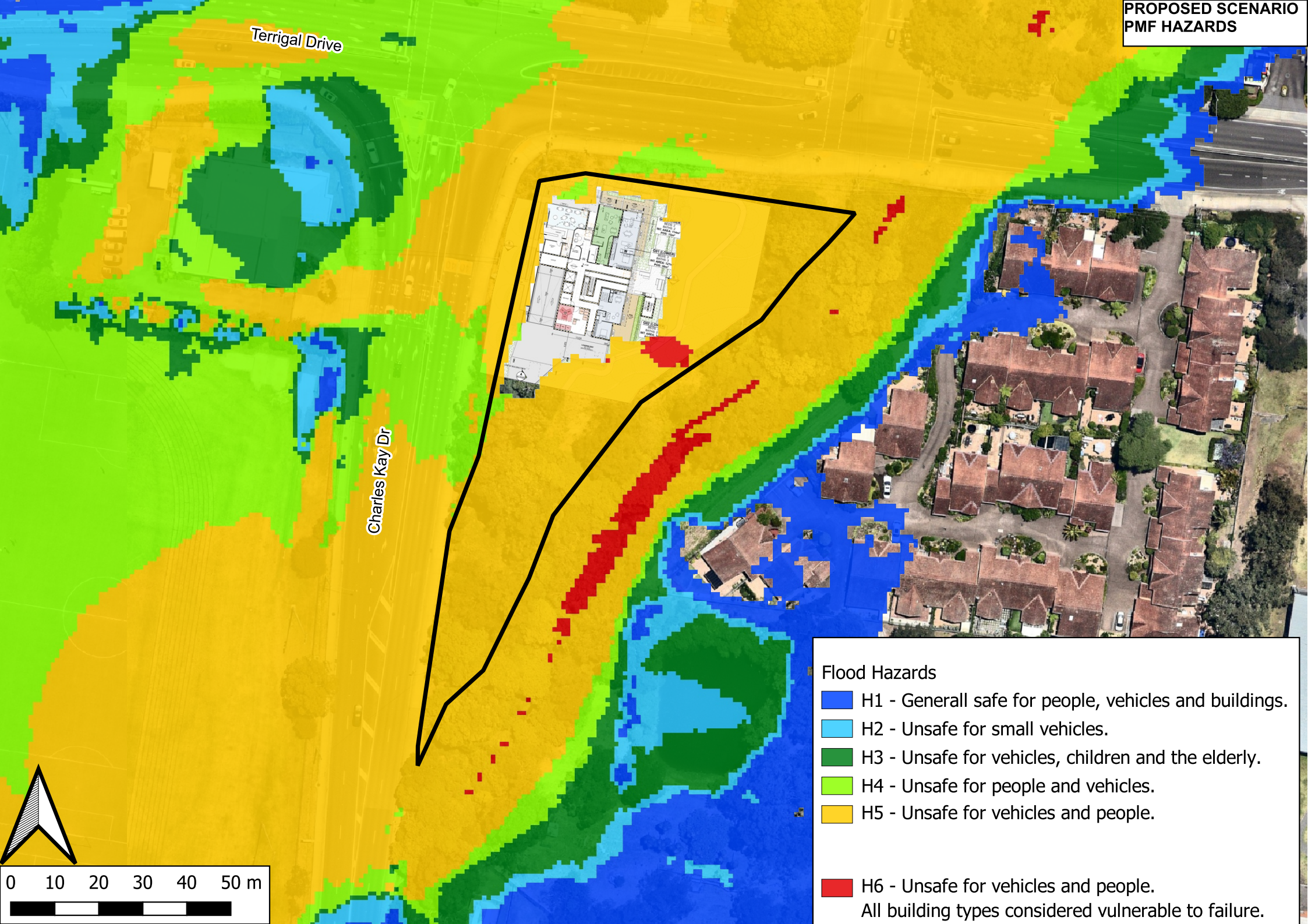
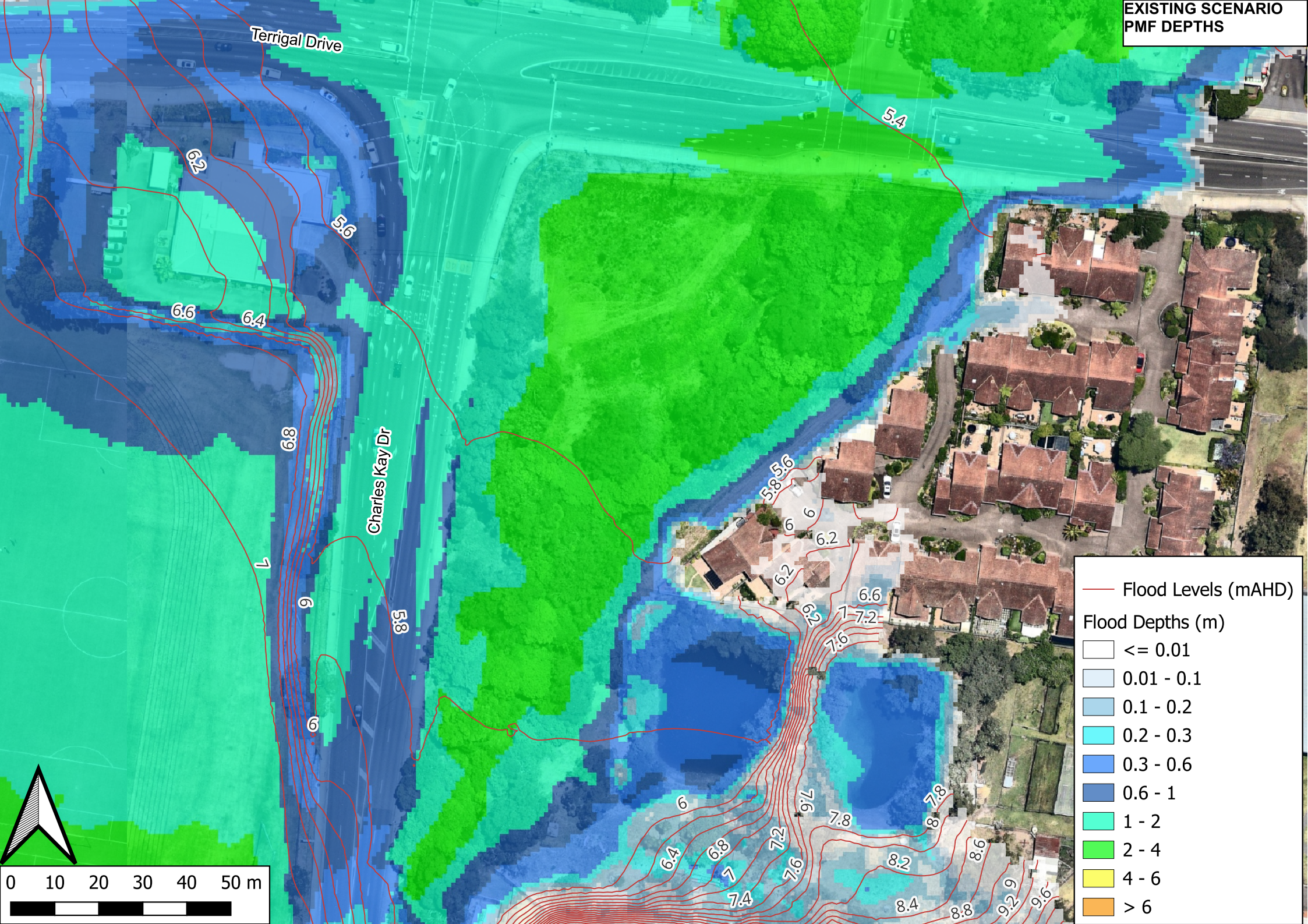
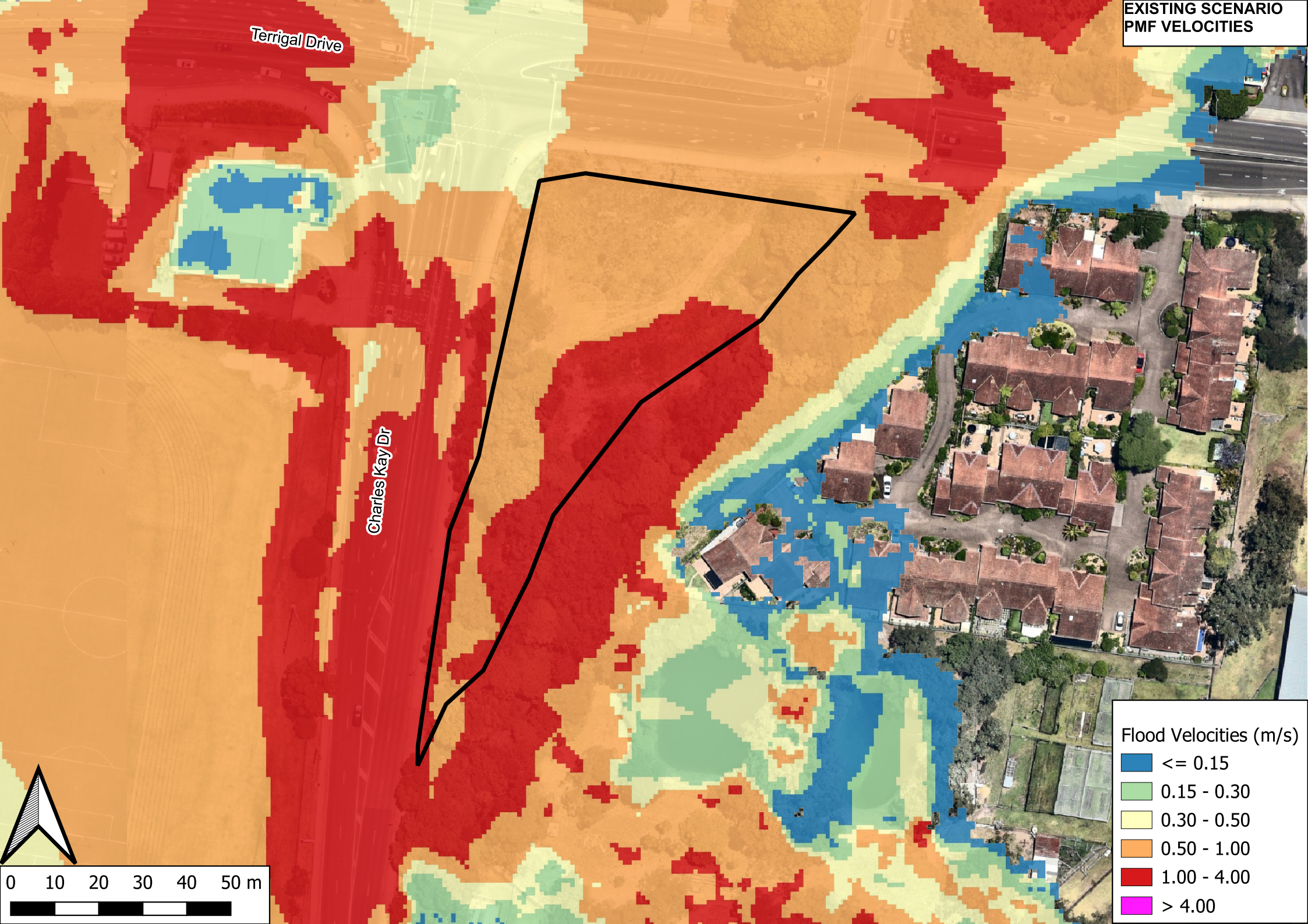
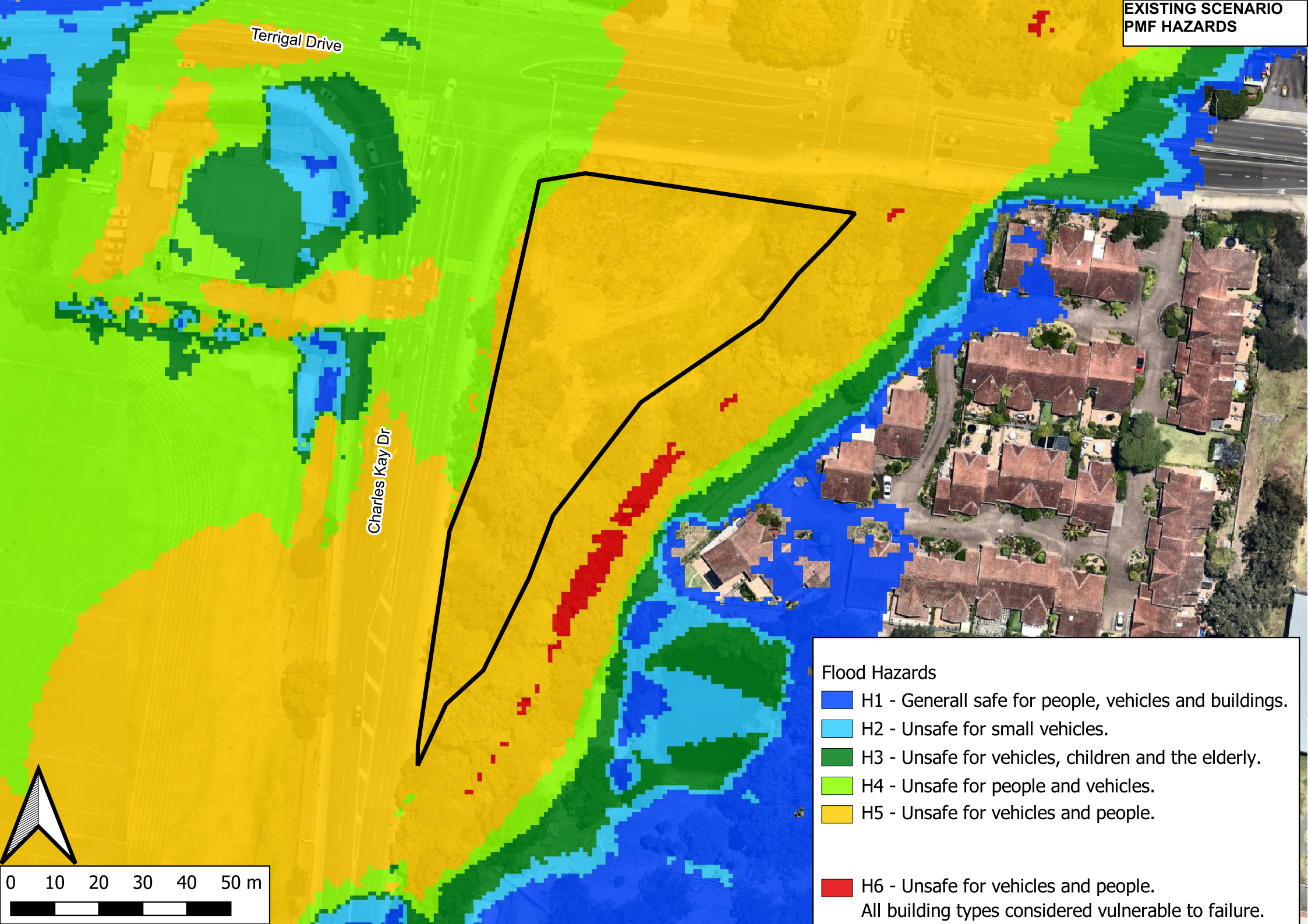
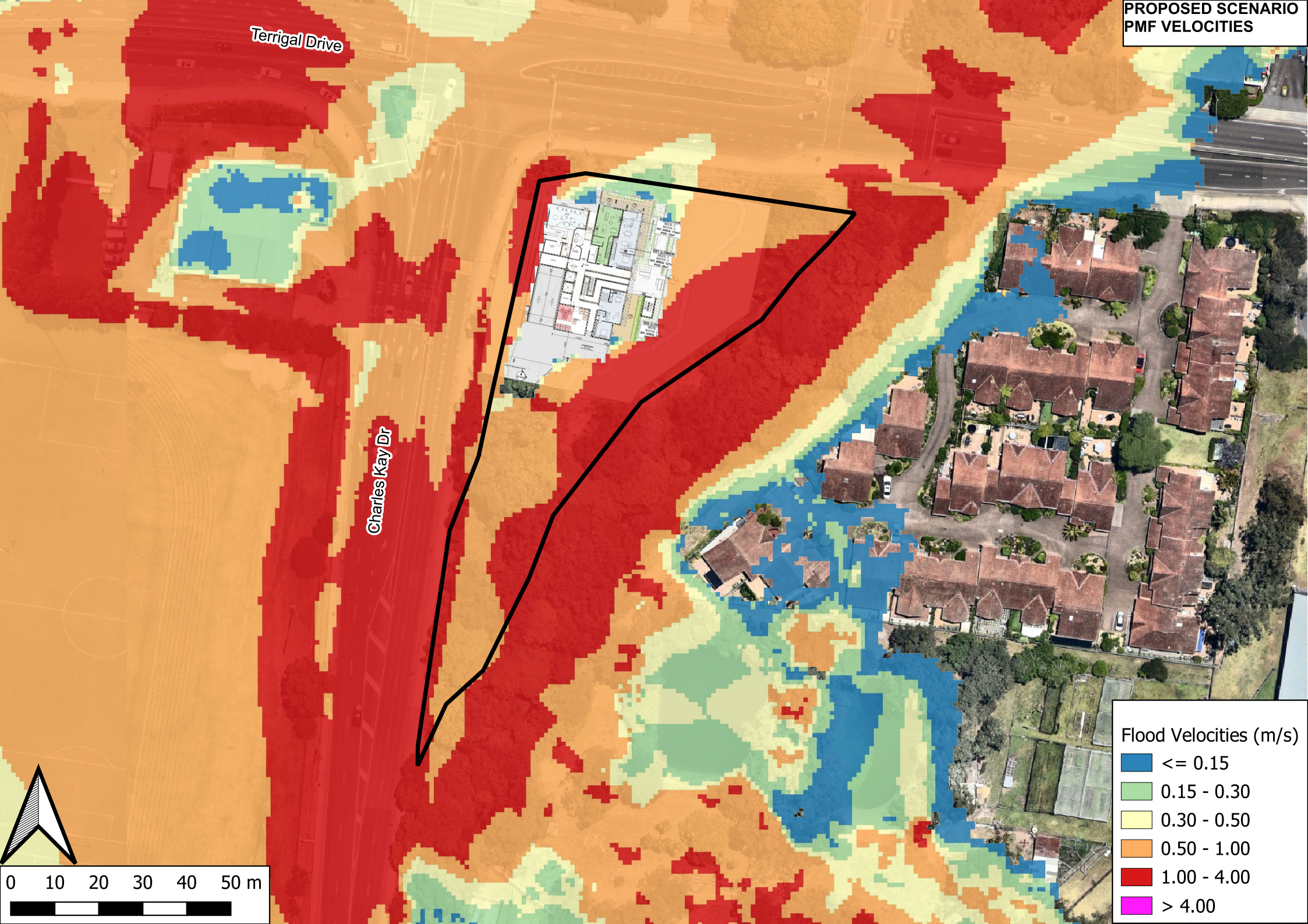

PROPOSED SCENARIO
PMF HAZARDS
Terrigal Drive
Charles Kay Dr
Flood Hazards
H1 - Generall safe for people, vehicles and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for vehicles, children and the elderly.
H4 - Unsafe for people and vehicles.
H5 - Unsafe for vehicles and people.
H6 - Unsafe for vehicles and people.
All building types considered vulnerable to failure.
0 10 20 30 40 50 m

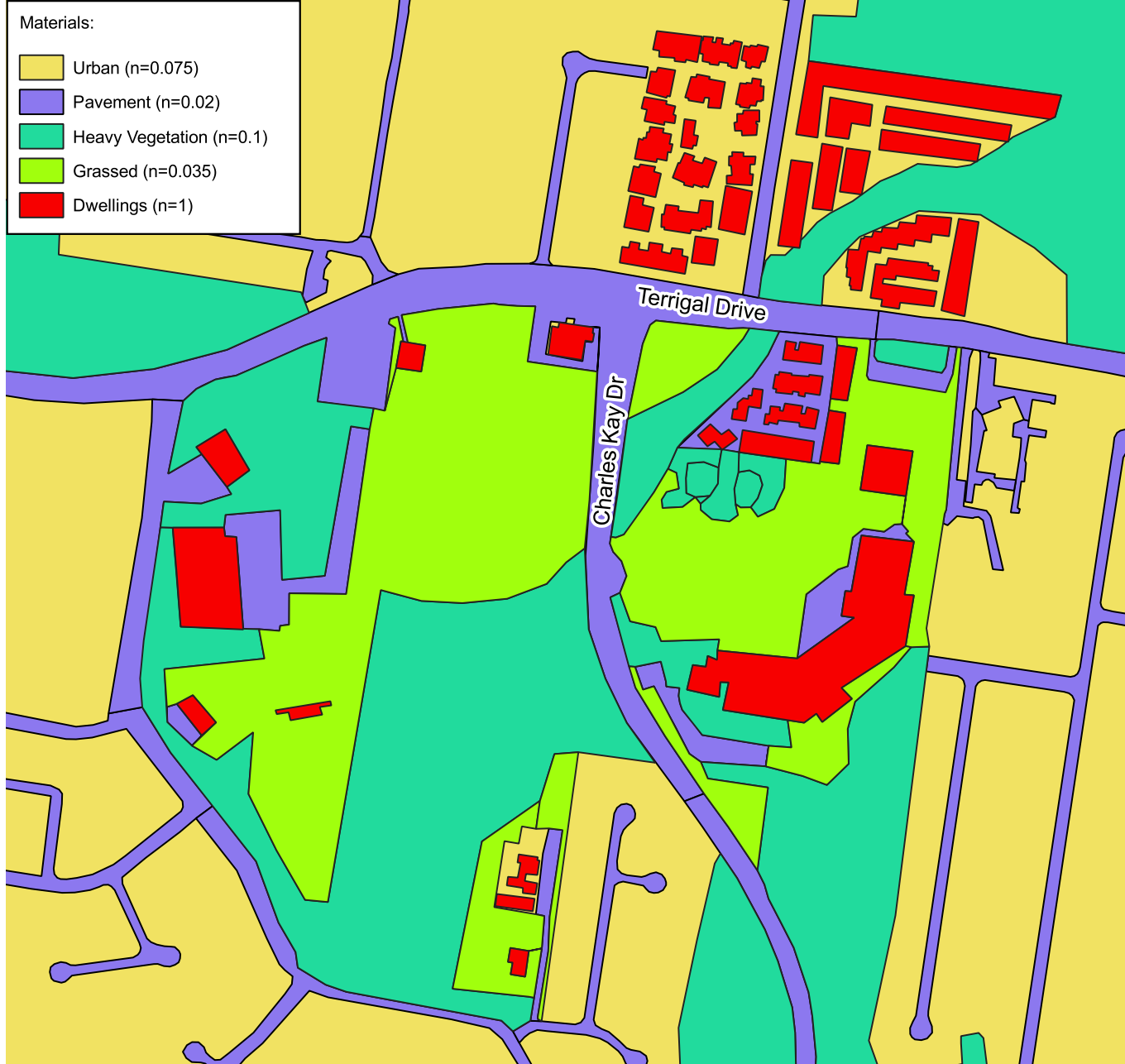

EXISTING SCENARIO
PMF DEPTHS
Terrigal Drive
Charles Kay Dr
Flood Levels (mAHD)
Flood Depths (m)
<= 0.01
0.01 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.6
0.6 - 1
1 - 2
2 - 4
4 - 6
> 6
0 10 20 30 40 50 m


EXISTING SCENARIO
PMF VELOCITIES
Terrigal Drive
Charles Kay Dr
Flood Velocities (m/s)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 4.00
> 4.00
0 10 20 30 40 50 m


EXISTING SCENARIO
PMF HAZARDS
Terrigal Drive
Charles Kay Dr
Flood Hazards
H1 - Generall safe for people, vehicles and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for vehicles, children and the elderly.
H4 - Unsafe for people and vehicles.
H5 - Unsafe for vehicles and people.
H6 - Unsafe for vehicles and people.
All building types considered vulnerable to failure.
0 10 20 30 40 50 m


PROPOSED SCENARIO
PMF VELOCITIES
Terrigal Drive
Charles Kay Dr
Flood Velocities (m/s)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 4.00
> 4.00
0
10
20
30
40
50 m


Terrigal Drive
Charles Kay Dr
Legend:
Culverts
Upstream Boundaries
Downstream Boundary
Model Domain


Materials:
Urban (n=0.075)
Pavement (n=0.02)
Heavy Vegetation (n=0.1)
Grassed (n=0.035)
Dwellings (n=1)
Terrigal Drive
Charles Kay Dr


8.7 Ha
12 Ha
20.6 Ha
6.9 Ha
4.7 Ha
8.7 Ha
5.5 Ha
3.5 Ha
6.1 Ha
18.8 Ha
12.2 Ha
1.4 Ha
2 Ha
6.6 Ha
3.4 Ha
5.1 Ha
35.3 Ha
16.9 Ha
12.2 Ha
17.3 Ha
14.5 Ha
9.6 Ha
12.2 Ha

Appendix B – Survey Plan

Civil Stormwater Engineering Group Pty Ltd
0491 719 774 www.cseggroup.com.au
Level 2, Suite 2, 10 Mallet Street Camperdown, NSW, 2050
ABN 95 640 561 584 ACN 640 561 584

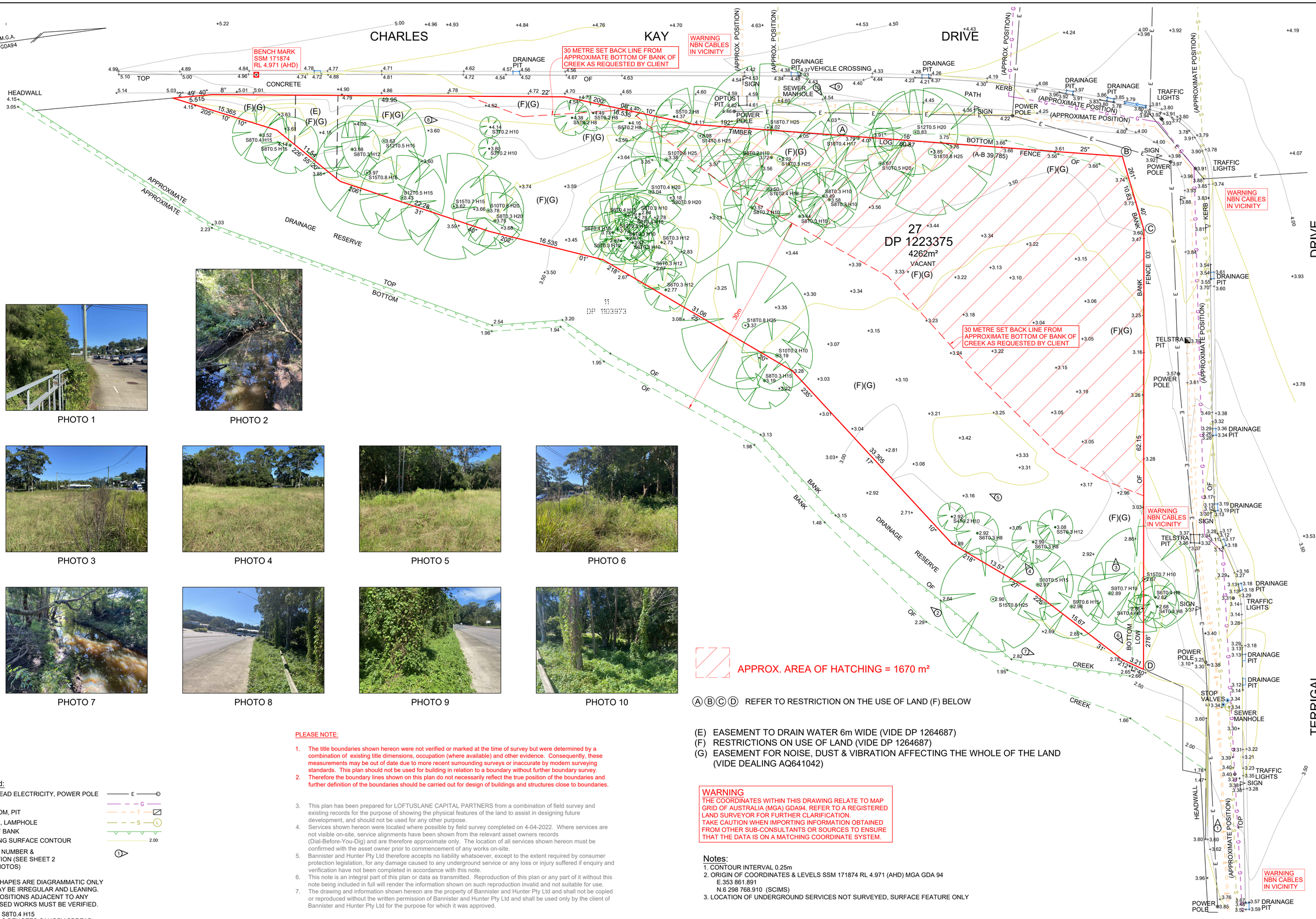


PHOTO 1

PHOTO 2

PHOTO 3

PHOTO 4

PHOTO 5

PHOTO 6

PHOTO 7

PHOTO 8

PHOTO 9

PHOTO 10

Legend:

- OVERHEAD ELECTRICITY, POWER POLE
- GAS
- TELECOM, PIT
- SEWER, LAMPHOLE
- TOP OF BANK
- EXISTING SURFACE CONTOUR
- PHOTO NUMBER & DIRECTION (SEE SHEET 2 FOR PHOTOS)

TREE SHAPES ARE DIAGRAMMATIC ONLY AND MAY BE IRREGULAR AND LEANING. TREE POSITIONS ADJACENT TO ANY PROPOSED WORKS MUST BE VERIFIED.

S8T0.4 H15
S DENOTES CANOPY SPREAD
T DENOTES TRUNK DIAMETER
H DENOTES TREE HEIGHT

5 2.5 0 5 10 15 20 25
SCALE IN METRES ON ORIGINAL DRAWING AT REDUCTION RATIO 1:250

PLEASE NOTE:

1. The title boundaries shown hereon were not verified or marked at the time of survey but were determined by a combination of existing title dimensions, occupation (where available) and other evidence. Consequently, these measurements may be out of date due to more recent surrounding surveys or inaccurate by modern surveying standards. This plan should not be used for building in relation to a boundary without further boundary survey.
2. Therefore the boundary lines shown on this plan do not necessarily reflect the true position of the boundaries and further definition of the boundaries should be carried out for design of buildings and structures close to boundaries.
3. This plan has been prepared for LOFTUSLANE CAPITAL PARTNERS from a combination of field survey and existing records for the purpose of showing the physical features of the land to assist in designing future development, and should not be used for any other purpose.
4. Services shown hereon were located where possible by field survey completed on 4-04-2022. Where services are not visible on-site, service alignments have been shown from the relevant asset owners records (Dial-Before-You-Dig) and are therefore approximate only. The location of all services shown hereon must be confirmed with the asset owner prior to commencement of any works on-site.
5. Bannister and Hunter Pty Ltd therefore accepts no liability whatsoever, except to the extent required by consumer protection legislation, for any damage caused to any underground service or any loss or injury suffered if enquiry and verification have not been completed in accordance with this note.
6. This note is an integral part of this plan or data as transmitted. Reproduction of this plan or any part of it without this note being included in full will render the information shown on such reproduction invalid and not suitable for use.
7. The drawing and information shown hereon are the property of Bannister and Hunter Pty Ltd and shall not be copied or reproduced without the written permission of Bannister and Hunter Pty Ltd and shall be used only by the client of Bannister and Hunter Pty Ltd for the purpose for which it was approved.

WARNING
THE COORDINATES WITHIN THIS DRAWING RELATE TO MAP GRID OF AUSTRALIA (MGA) GDA94, REFER TO A REGISTERED LAND SURVEYOR FOR FURTHER CLARIFICATION.
TAKE CAUTION WHEN IMPORTING INFORMATION OBTAINED FROM OTHER SUB-CONSULTANTS OR SOURCES TO ENSURE THAT THE DATA IS ON A MATCHING COORDINATE SYSTEM.

Notes:
1. CONTOUR INTERVAL 0.25m
2. ORIGIN OF COORDINATES & LEVELS SSM 171874 RL 4.971 (AHD) MGA GDA 94
   E.353 861.891
   N.6 298 768.910 (SCIMS)
3. LOCATION OF UNDERGROUND SERVICES NOT SURVEYED, SURFACE FEATURE ONLY

www.dialbeforeyoudig.com.au
DIAL 1100 BEFORE YOU DIG

CAUTION
UNDERGROUND SERVICES SHOWN ON THIS PLAN ARE APPROXIMATE ONLY AND "DIAL BEFORE YOU DIG" MUST BE CONTACTED PRIOR TO ANY WORKS BEING CONDUCTED ON THIS SITE

DATE	NO.	REVISION DESCRIPTION

SCALE 1:250
BASE DRAWING SIZE A1
SURVEYED BY: RD
DATE OF SURVEY: 4/04/2022
DRAWN BY: CA
DATE: 8/04/2022
CHECKED BY: RKB
DATE: 11/04/2022

Client: LOFTUSLANE CAPITAL PARTNERS

BANNISTER & HUNTER
39 William Street, Gosford, N.S.W. 2250
Phone: (02) 4324 2566
Web: www.bannisterhunter.com.au
Email: admin@bannisterhunter.com.au

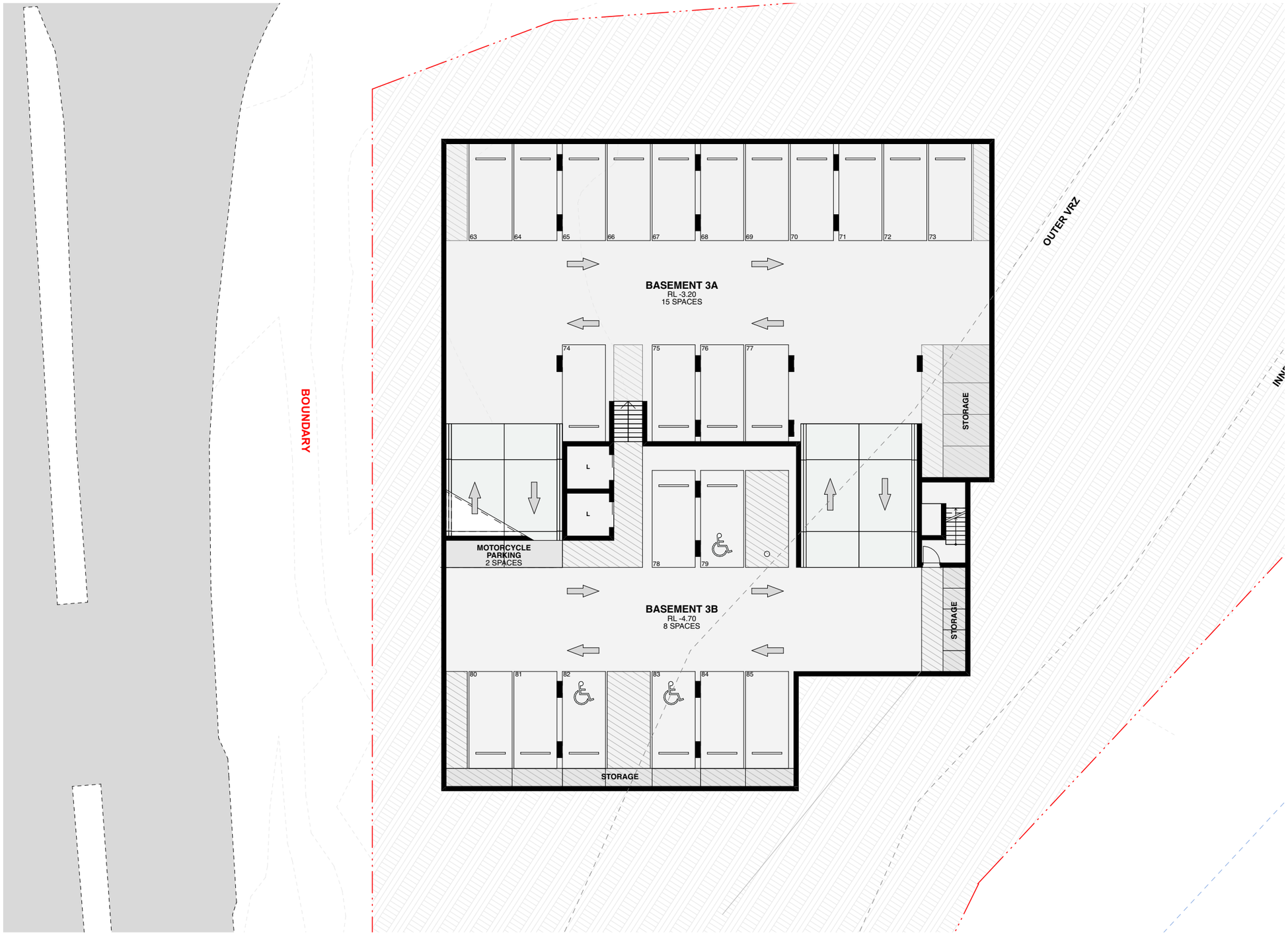
Plan of: DETAIL SURVEY OVER LOT 27 DP 1223375
No. 310 TERRIGAL DRIVE
TERRIGAL

Ref. No:	58961
Ccad Ref:	58961
Acad Ref:	58961-01c
SHEET No:	1 of 1
Date:	11th April 2022
Datum:	AHD
REVISION	-

Appendix C – Architectural Plans

Civil Stormwater Engineering Group Pty Ltd
0491 719 774
www.cseggroup.com.au
Level 2, Suite 2, 10 Mallet Street
Camperdown, NSW, 2050
ABN 95 640 561 584
ACN 640 561 584

Architecturals: Basement 03



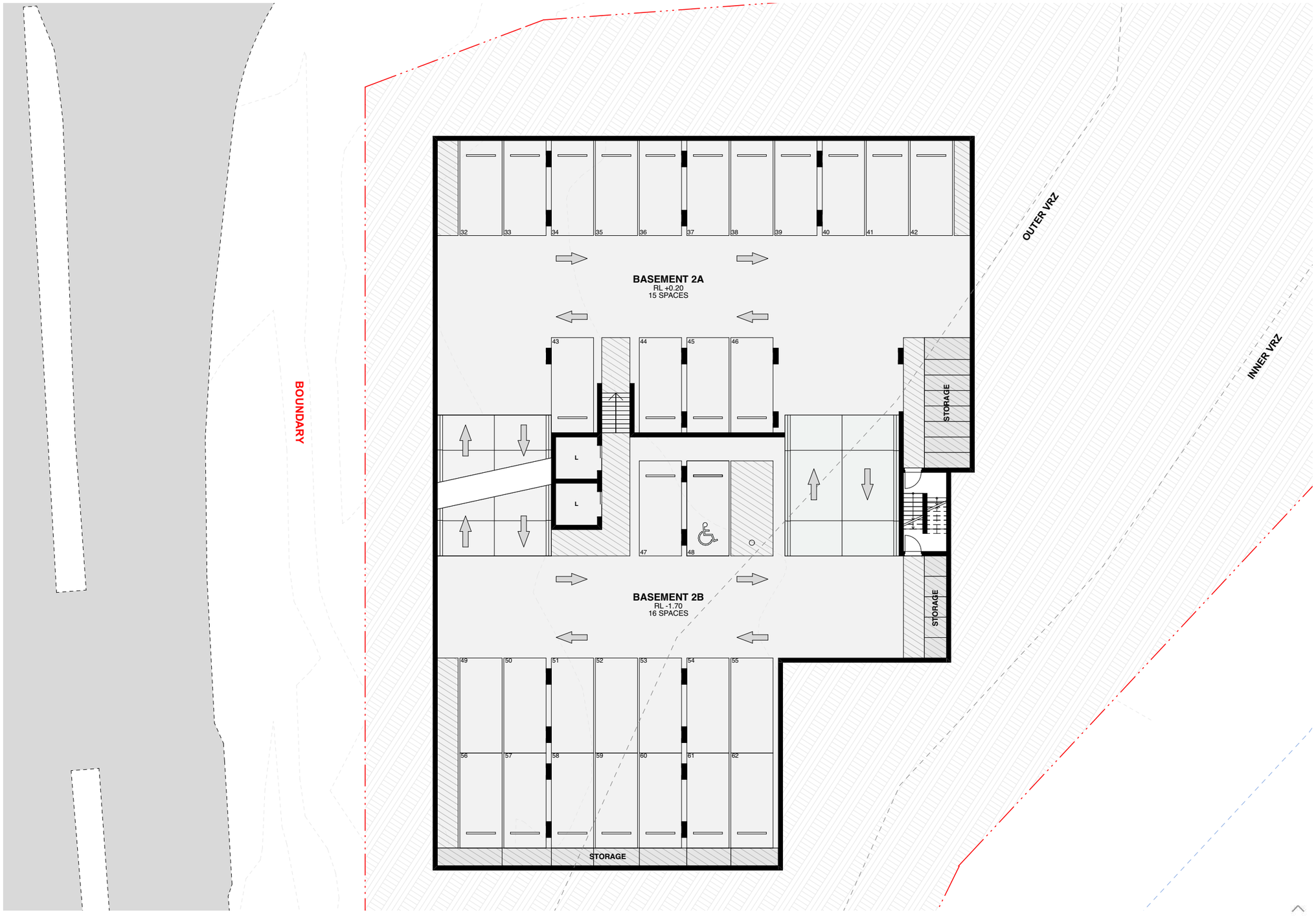
Nominated Architects: Caine King NSW ARB 7974 / Stuart Campbell NSW ARB 7545

URBAN DESIGN STUDY

310 TERRIGAL DR, TERRIGAL

CKDS
Architecture | Planning | Interiors

Architecturals: Basement 02



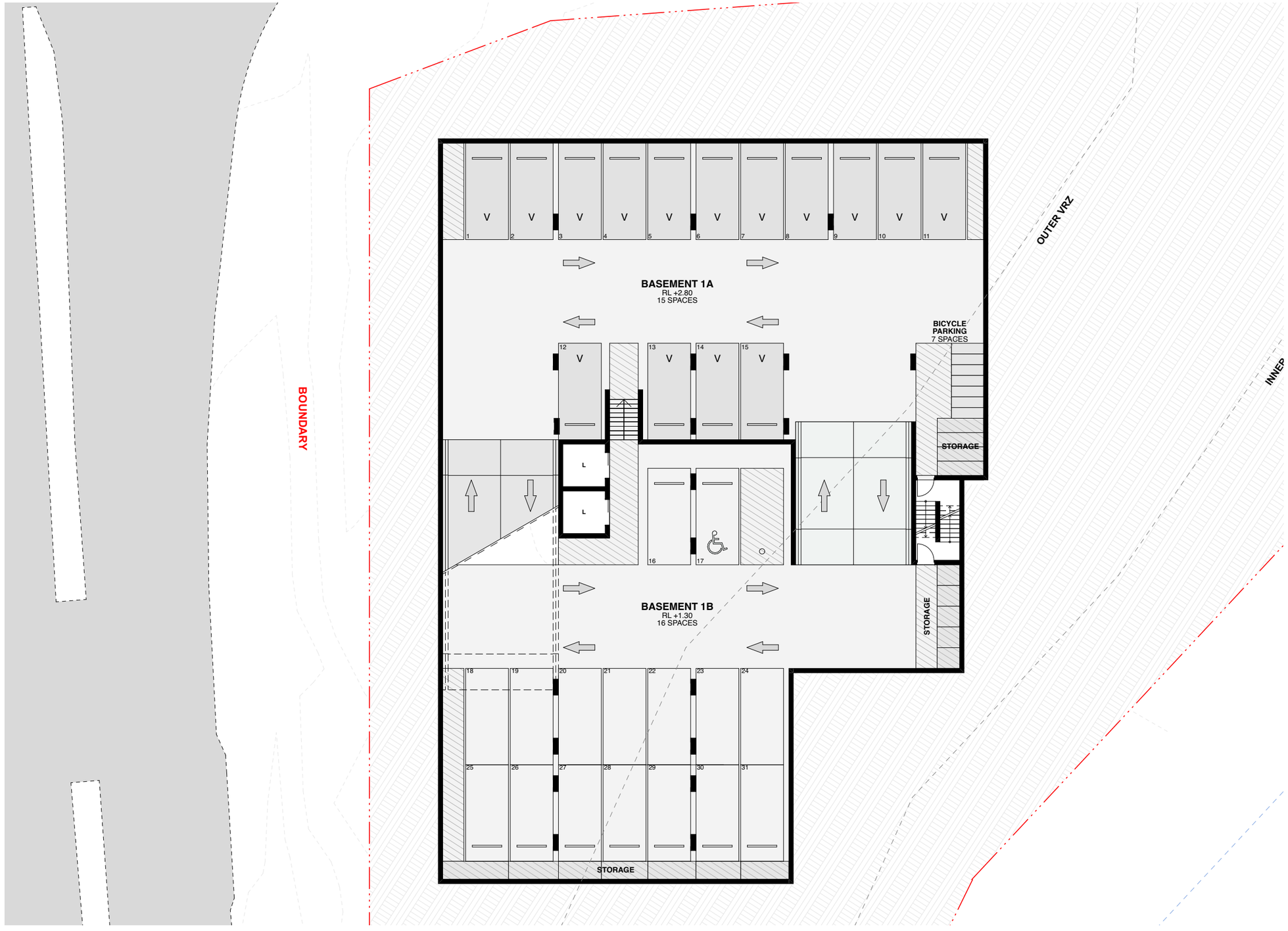
Nominated Architects: Caine King NSW ARB 7974 / Stuart Campbell NSW ARB 7545

URBAN DESIGN STUDY

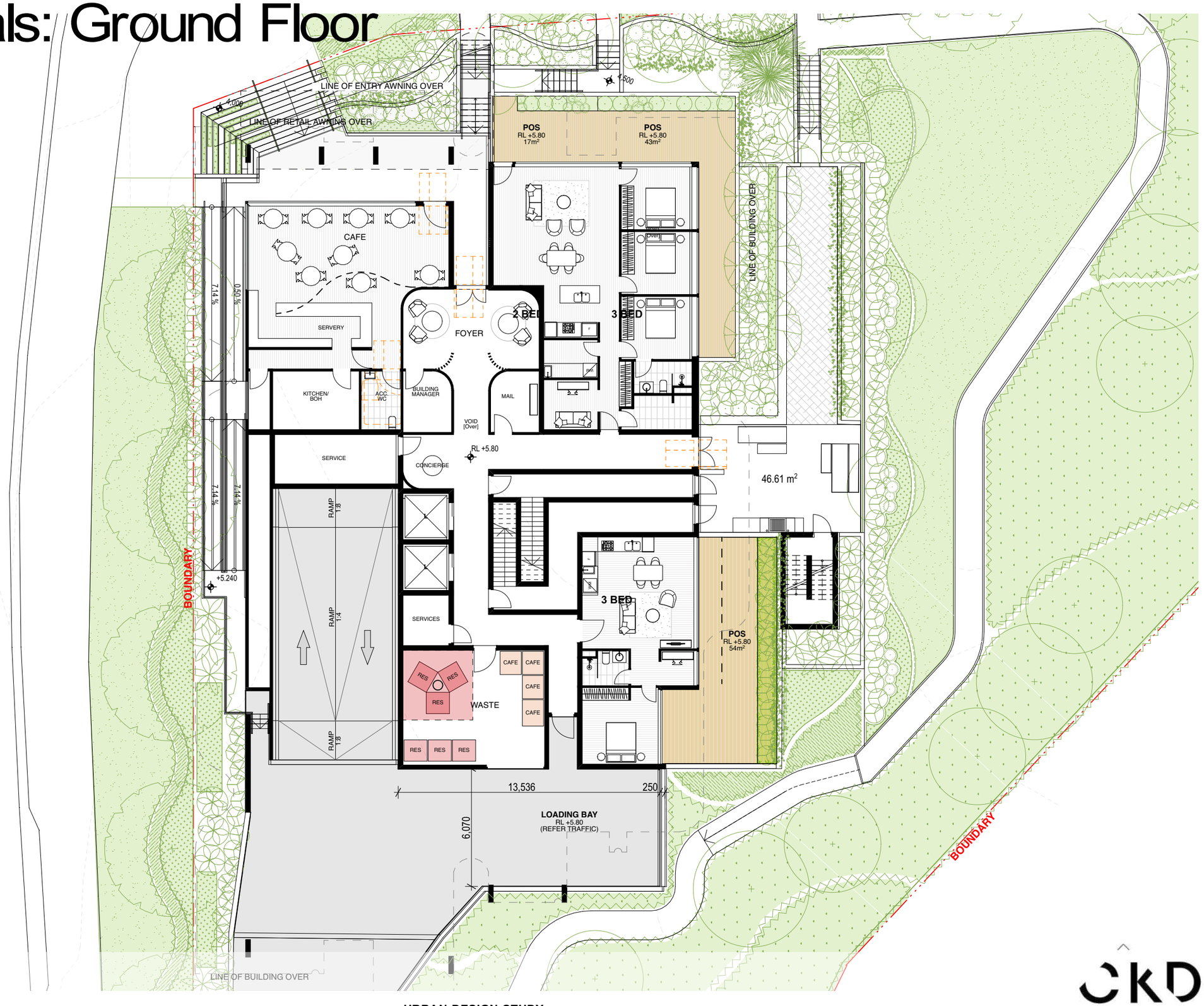
310 TERRIGAL DR, TERRIGAL

CKDS
Architecture | Planning | Interiors

Architecturals: Basement 01



Architecturals: Ground Floor



N

4 ground floor
SCALE 1:1 @ A3

Nominated Architects: Caine King NSW ARB 7974 / Stuart Campbell NSW ARB 7545

URBAN DESIGN STUDY

310 TERRIGAL DR, TERRIGAL

CKDS
Architecture | Planning | Interiors

Architecturals: Typicals Levels 1-2

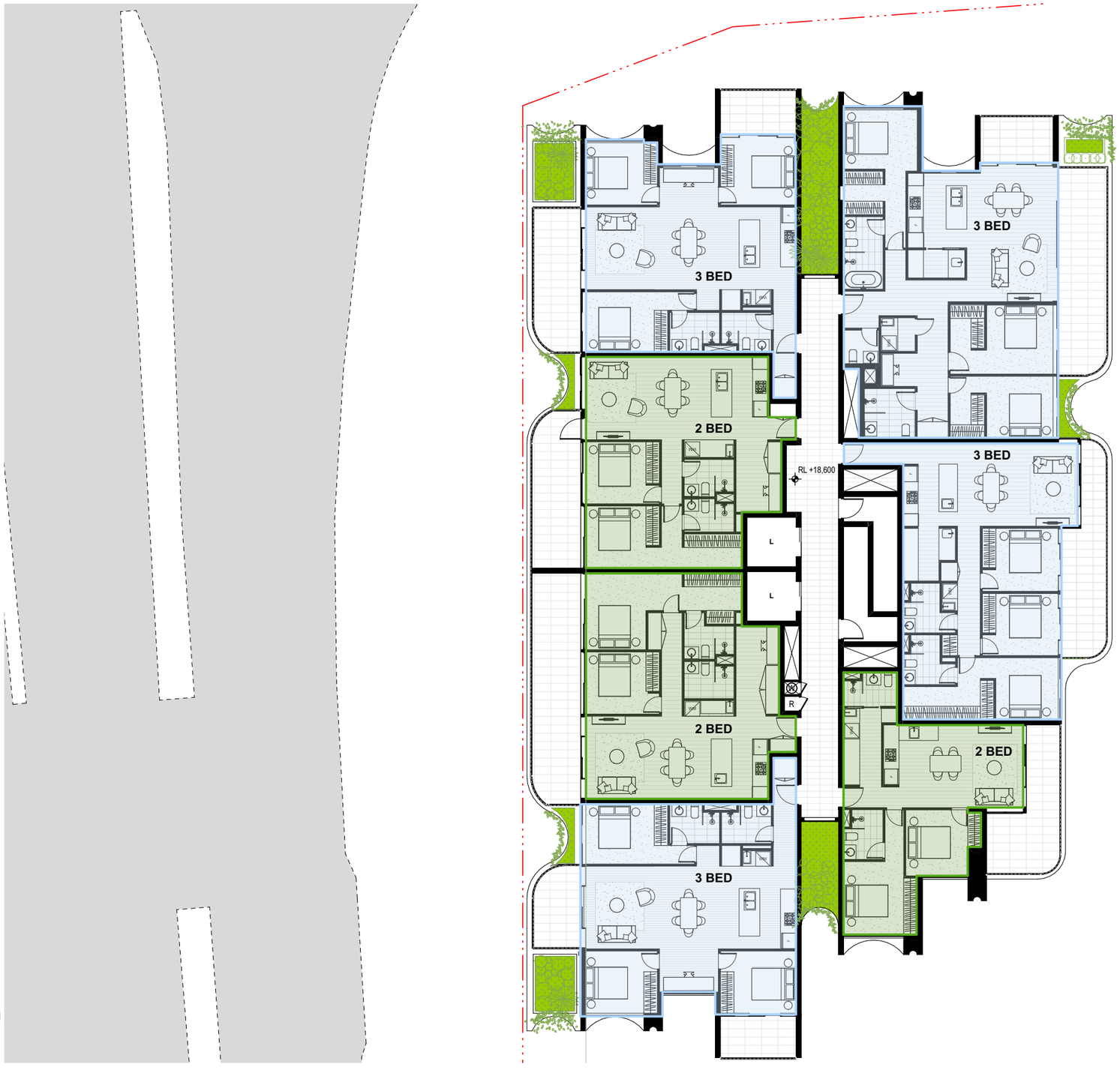
Nominated Architects: Caine King NSW ARB 7974 / Stuart Campbell NSW ARB 7545

URBAN DESIGN STUDY

310 TERRIGAL DR, TERRIGAL

CKDS
Architecture | Planning | Interiors

Architecturals: Typicals Levels 3-4



Nominated Architects: Caine King NSW ARB 7974 / Stuart Campbell NSW ARB 7545

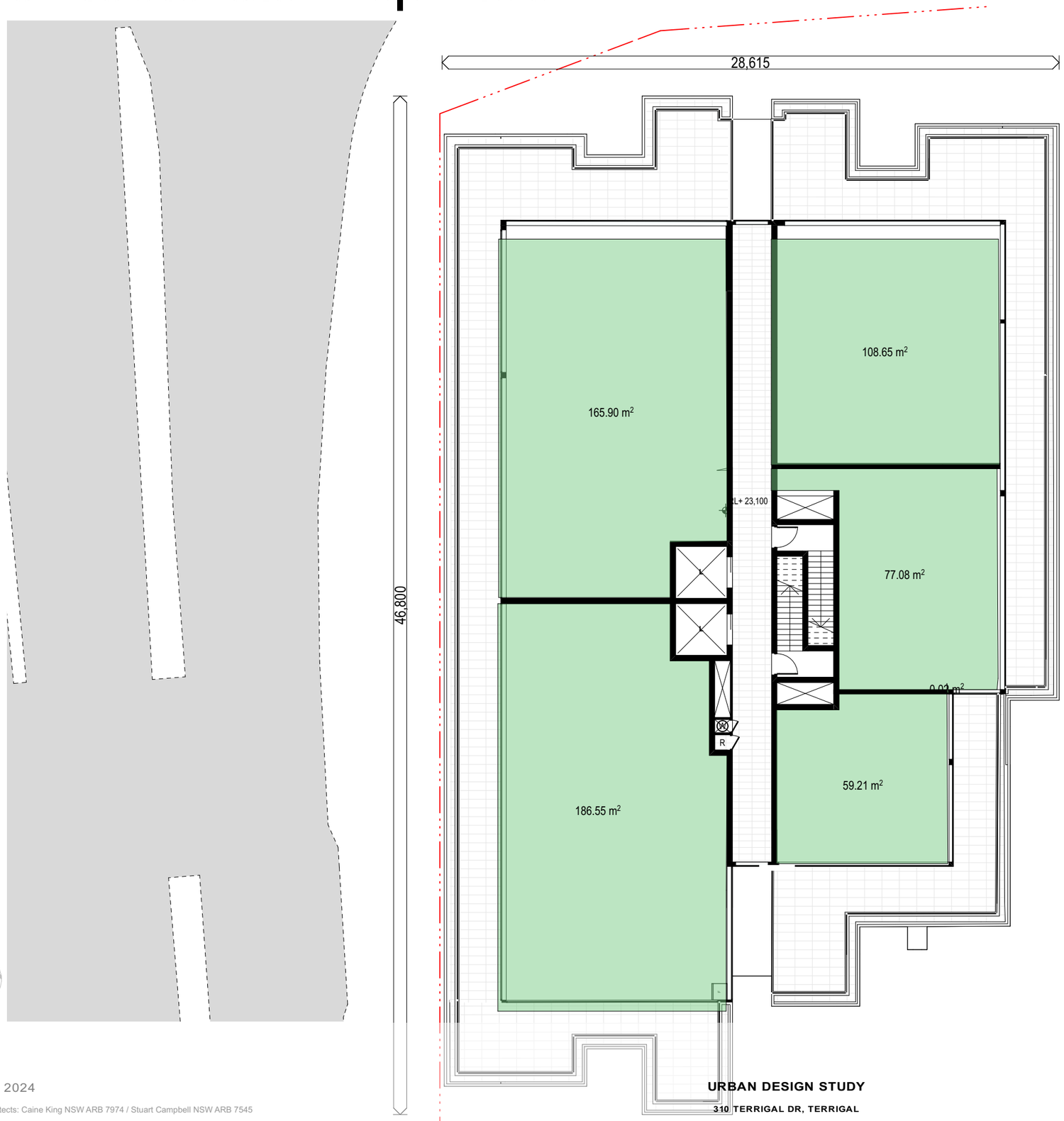
URBAN DESIGN STUDY

310 TERRIGAL DR, TERRIGAL

CKDS

Architecture | Planning | Interiors

Architecturals: Top Floor



URBAN DESIGN STUDY

310 TERRIGAL DR, TERRIGAL

Nominated Architects: Caine King NSW ARB 7974 / Stuart Campbell NSW ARB 7545

CKDS

Architecture | Planning | Interiors

CIVIL STORMWATER ENGINEERING GROUP

.INNOVATE.ENGINEER.TRANSFORM.

admin@cseggroup.com.au – www.cseggroup.com.au – 0491 179 774 – LVL 2, Suite 2, 10 mallet Street, Camperdown, NSW, 2050