Flood Study Report

4 Delmar Parade & 812 Pittwater Road, Dee Why

Issue D

Prepared For Dee Why 3 Pty Ltd & Dee Why 4 Pty Ltd

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P: 02 8883 4239
A: Suite 5.03, Level 5, 156 Pacific Highway, St Leonards NSW 2065

W: www.sgce.com.au
Postal: PO Box 7855, Baulkham Hills, NSW 2153

REVISION TABLE

Revision	Date	Issue Description	Issued by	Approved by	Signed
P1	01.11.2021	Preliminary Issue – Draft only for review	SELH	SELH	
A	09.11.2021	Development Application	SELH	SELH	
B	26.11.2021	Address Client Comments	SELH	SELH	
C	01.12.2021	Address Client Comments	SELH	SELH	
D	23.03.2023	Address Council comments	SELH	SELH	

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1 Executive Summary

This document is a flood assessment report for the proposed development located at 4 Delmar Parade & 812 Pittwater Road, Dee Why. The study is for the overland flows associated with the stormwater trunk main that enters the site from the southern boundary of the site. The site is located within the catchment of Dee Why Lagoon.

The site is a combination of multiple existing lots in Strata Plan SP32071 (4 Delmar Parade) and SP32072 (812 Pittwater Road). The site is traversed by a stormwater trunk main that drains the reserve south of the site and a small residential catchment.

The site is marked as flood control site as it is impacted by overland flows when the capacity of the trunk main is exceeded and water travels overland through the site.

The client is proposing:

1. Demolition of existing buildings, tree removal and site clearing.
2. Construction of 2x new mixed-use buildings over a shared two storey basement car park comprising:
    - i. 219 residential apartments.
    - ii. Commercial tenancies on ground floor.

The architectural concept plans prepared by Rothelowman show two levels of basement car parking, commercial tenancies at ground floor and residential levels above.

The proposed development is illustrated in Figure 1.1 below and will be subdivided into two lots.

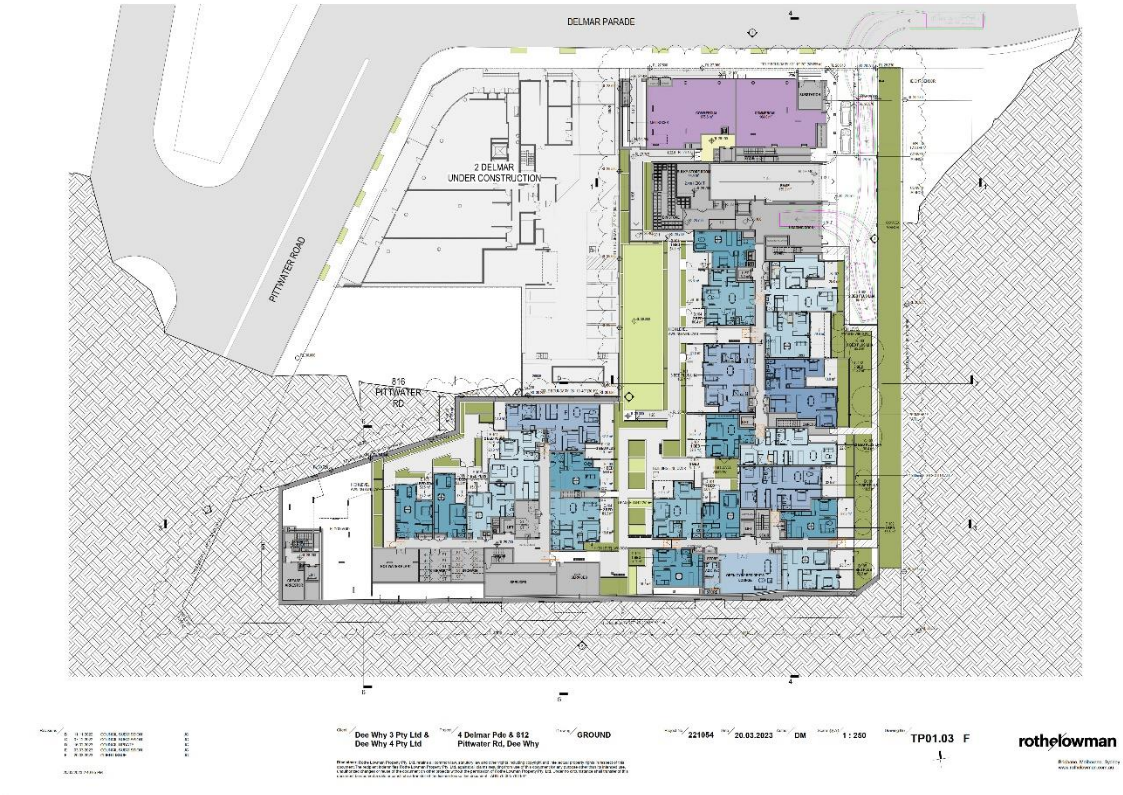

Figure 1.1 Site Plan

The flood assessment report provides:-

- An assessment of flooding from the local upstream overland flows;
- Diversion of the trunk main around the proposed development;
- Upgrade of the trunk main through the site to increase its capacity and to contain the 5% AEP flows;
- Construct a new trunk main across Delmar Pde as depicted on the stormwater design drawings;
- Provision of a dedicated 3-4m wide overland flowpath through the site to maintain the existing overland flow conditions towards Delmar Pde;
- Provision of a secondary flood conveyance void through the site in the form of a structural chamber void to cater for the PMF flood event; and
- Addressing the requirements of Northern Beaches Council and the NSW Floodplain Development Manual (2005) in relation to flood hazard and flood risk.

The proposed development has been revised to incorporate the results of this flood study. The mitigation measures have been incorporated in the stormwater plans.

The Flood Planning Level (FPL) adopted for the proposed development achieves 0.5m above the 1% AEP flood level. The FPL has been achieved using solid retaining walls to protect the buildings.

The flood impact assessment indicates that the proposed development can be constructed with nil or minimal adverse impacts on the flooding behaviour and is able to meet the requirements of Council.

2 Introduction

2.1 Brief

S&G Consultants Pty Ltd (SGC) have been engaged by Dee Why 3 Pty Ltd & Dee Why 4 Pty Ltd to carry out a flood study in support of the proposed mixed-use development at 4 Delmar Parade & 812 Pittwater Road, Dee Why.

The flood study is required to demonstrate to council how the development can be constructed without affecting the flooding elsewhere in its vicinity and how the trunk main will be diverted around the proposed building structures.

The following tasks were carried out:-

- A site visit was undertaken on the 26th of May 2020 to ascertain on-site conditions and familiarise with the catchment;
- Supplied documents and previous studies were reviewed;
- The Dee Why Lagoon XP flood model has been provided by Council at the request of SGC;
- A flood study based on the Dee Why XP flood model is carried out to determine the peak discharges and the flood levels for both the existing and the proposed site conditions;
- Flood mitigation measures are proposed and have been incorporated into the design; and
- This report has been compiled and revised following discussions with council flood engineers.

2.2 Limitations

This report is intended solely for Dee Why 3 Pty Ltd & Dee Why 4 Pty Ltd as the Client of SGC and no liability will be accepted for 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 written.

2.3 Reference Documents

The following documents have been referenced in this report:-

1. Site survey prepared by Norton Survey Partners ref. 53046 dated 11/03/2021;
2. Architectural drawings prepared by Rothelowman ref. 221054;
3. NSW Government *The Floodplain Development Manual – The management of Flood Liable Land* (2005);

4. Bureau of Meteorology (2003). *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*, June;
5. Engineers Australia, *Australian Rainfall & Runoff* (ARR 1999 & 2019); and
6. Northern Beaches “Water Management for Development Policy” (2020).

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3 Local & Regional Context

3.1 Natural & Built Environment

The site is the corner block on Pittwater Road and Delmar Parade in the suburb of Dee Why. The site falls in the Local Government Area of Northern Beaches Council.

The site has an irregular shape and is characterised by a natural gradient from South to North towards Delmar Pde.

The site is bounded by a reserve to the South, Pittwater Rd, 816 Pittwater Rd and 2 Delmar Pde to the West, Delmar Pde to the North and adjoining properties to the East. The site is currently fully developed with existing detached commercial buildings connected with an internal driveway.

The reserve along the southern boundary of the site forms part of an upstream local catchment which drains in a stormwater trunk main through the site.

Figure 3.1 shows the location of the site.

Figure 3.1 Locality Plan

4 Flood Study

4.1 Glossary

Annual Exceedance Probability (AEP)

The chance of a flood of a given or a larger size occurring in any one year, usually expressed as a percentage.

Australian Height Datum (AHD)

A common national surface level datum approximately corresponding to mean sea level.

Average Recurrence Interval (ARI)

The long-term average number of years between the occurrence of a flood as big as or larger than the selected event.

Catchment

The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.

Flood

Relatively high stream flow 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 major drainage before entering a watercourse.

Flood Liable Land or Flood Prone Land

Land susceptible to flooding by the PMF.

Flood Planning Levels (FPLs)

Are the combinations of flood levels and freeboards selected for floodplain risk management purposes.

Freeboard

Is a factor of safety typically used in relation to the setting of floor levels.

Habitable Room

In industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to damage in the event of a flood.

Peak Discharge

The maximum discharge occurring during a flood event.

Probable Maximum Flood

PMF is the largest flood that could conceivably occur at a location, usually estimated from probable maximum precipitation.

Probable Maximum Precipitation

PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year.

Runoff

The amount of rainfall which actually ends up as stream flow.

4.2 Development Description

The proposed mixed-use development comprises residential, commercial and basement car parking levels. The proposed access into the site is from Delmar Parade.

The proposal allows for a 3m wide overland flowpath at the rear of the site to collect the overland flows. The overland flowpath increases in size to 4m at the south eastern corner of the site before it widens to 4m along the eastern boundary. The overland flow path width increases to accommodate an easement over the proposed trunk main diversion.

A flood conveyance void is proposed through the site to convey the peak discharge flows in the PMF event. The flood conveyance void is in the form of a chamber that is structurally built to allow the flows in the extreme events to flow through towards the rear of 816 Pittwater Rd which mimics the existing flow situation.

Reference should be made to the architectural drawings prepared by Rothelowman and to the stormwater drawings by SGC for more details on the proposed development.

4.3 Authorities Requirements

4.3.1 Northern Beaches Council

Northern Beaches Council requirements are included in chapters 10 & 11 of the Water Management Policy.

Additional requirements are emailed by Adam Susko from Council following multiple meetings held with council staff in order to resolve the flooding constraints.

4.4 Dee Why Lagoon

The site is located within the Dee Why Lagoon catchment. The location of the site is at the top of the catchment and as such is only affected by overland flows associated with the existing stormwater infrastructure that traverses the site.

4.4.1 Previous Studies

Cardno have carried out a flood study for the Dee Why Lagoon. The study was based on a dynamically linked 1D-2D model using XP-SWMM software package.

The study determined the flooding extents and hazards across the catchment of the lagoon.

4.5 Objectives

The purpose of this flood impact study is to establish the 1% AEP flood levels for the site, which will form the basis of the controls for setting the floor levels.

The flood study will also determine how the building structures can be constructed without affecting the flood characteristics (i.e. flood level, velocity and hazard) in the floodplain and in the vicinity of the site.

The XP-SWMM model developed by Cardno has been provided by Council at the request of SGC. The model has been truncated to reduce the run times.

In summary, the objectives are as follows:-

- Use the XP-Storm model to predict the magnitude and extent of future flood events;
- Define design flood levels, velocities and depths for the catchment under existing conditions for the 1% AEP and the Probable Maximum Flood (PMF);
- Amend the model to incorporate the proposed development details and rerun the model;
- Define the extent of flooding for the 1% AEP and the Probable Maximum Flood (PMF) for the catchment;
- Determine if the proposed development has an impact on the flooding;
- Propose mitigation measures; and
- Assess the adequacy of a potential development on 816 Pittwater Road and how the flood mitigation measures can be incorporated within the future development in a PMF event.

4.6 Hydrological Modelling

A hydrologic model combines rainfall information with local catchment characteristics to estimate a runoff hydrograph. For this study, XP-STORM was used for the upstream catchment draining into the southern rear boundary of the site.

For the purpose of this flood assessment, the study area is roughly bounded by the residential properties north of Quirk Street and includes the natural reserve.

Based on Cardno's model, the critical storm duration is 90 minutes. This storm duration has been adopted in this study. The model uses Rain-On-Grid rainfall model.

4.7 Hydraulic Modelling

4.7.1 Definition

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 behaviour 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.

The Cardno 1D/2D fully dynamic hydraulic model was used for the study area. XP-STORM (1D) and XP-2D, a dynamic hydraulic modelling system developed by XP SOLUTIONS was used in this study. XP-2D is a 2-Dimensional model which uses TUFLOW as its 2D engine. TUFLOW is used world-wide and has been shown to provide reliable, robust simulation of flood behaviour in urban and rural areas through a vast number of applications.

The model allows addition of a 2-Dimensional (2D) domain (representing the study area topography) to a 1-Dimensional (1D) network (representing the channels in the study area) with the two components dynamically coupled and solved simultaneously.

An important feature of the model is the ability to model the hydraulic structures in the 1D component rather than in the 2D domain. The benefit of this approach is that structure hydraulics are modelled more precisely than the approximate representation possible in a 2D domain.

Stormwater drainage pits, pipes and channels are represented in the model as 1-Dimensional elements which are dynamically linked to the water conveyed across the elevation grid.

4.7.2 Model Schematisation

The survey data included in the model was extrapolated from Digital Terrain Model (DTM) created from the ALS (Airborne Laser Scanning) received from Council.

The pits and pipes are modelled as a 1D element. Once their capacity is exceeded, flow is able to spill into the two-dimensional (2D) overland flow grid, which overlies the 1D elements in the model. As floodwater recedes, flow is also generally able to drain from the overland areas back into the canal.

The pipes have been modelled with entry/exit coefficient losses at 0.5. This is to simulate the blockage in the pipes.

4.7.3 2D Model Set Up

Two-dimensional (2D) hydraulic modelling was carried out to determine the flood behaviour in the study area. A grid size (2m x 2m) was deemed necessary to define the extent of the flooding through the developed areas.

The Cardno model has been truncated for the purpose of this flood study to reduce the run times. The model extents downstream of the site has been capped to the area just downstream of 890 Pittwater Rd.

4.7.4 Buildings

All buildings within the study area were conservatively assumed to block the overland flow and were modelled as raised fill areas in the topographic grids. This was based on building outlines extracted from the survey drawings and orthophoto maps.

4.7.5 Hydraulic Roughness

The hydraulic roughness for the 1D cross-sections and 2D model grid was determined using the Cardno model as follows:

Table 4.1 2D Landuse

Landuse	Manning's Roughness	Initial Loss	Continuing Loss
Stone Channel	0.04	0	0
Concrete Channel	0.02	0	0
Open Space	0.06	10	1.5
Road	0.02	0	0
Roof	0.015	0	0
Business	0.075	0	0
Residential	0.045	5	1.5

4.7.6 Boundary Conditions

Downstream Boundary

A tailwater level of 17.5m AHD has been adopted as the downstream boundary condition at 890 Pittwater Road which is approximately 480m downstream of the site and 13m lower.

4.8 Design Flood Modelling Results

4.8.1 Design Flood Modelling

Design flood modelling was undertaken for the 1% AEP and the PMF design flood events. The results for the are presented in Appendix 2 of this report. The climate change scenarios have not been assessed as part of this study and we understand that council is in acceptance of this.

The simulations carried out for this study are as follows:

- Existing scenario (s0a): the existing model as provided by Cardno but truncated to reduce run times; and
- Proposed scenario (s3a): proposed 4 Delmar Pde and 812 Pittwater Rd development including mitigation measures proposed to eliminate the adverse impacts for the 1% AEP and PMF events. This scenario includes the new trunk main across Delmar Pde and the reduction in the flood void chamber to eliminate the impacts on 816 Pittwater Rd.

4.8.2 Provisional Flood Hazard

4.8.2.1 General

Flood hazard can be defined as the risk to life and limb caused by a flood. The hazard caused by a flood varies both in time and place across the floodplain. Because of the date of the Dee Why flood model received from Council, the requirements of ARR 2019 flood hazard classification is not included in this assessment.

The *Floodplain Development Manual* (NSW Government, 2005) describes various factors to be considered in determining the degree of hazard. These factors are:-

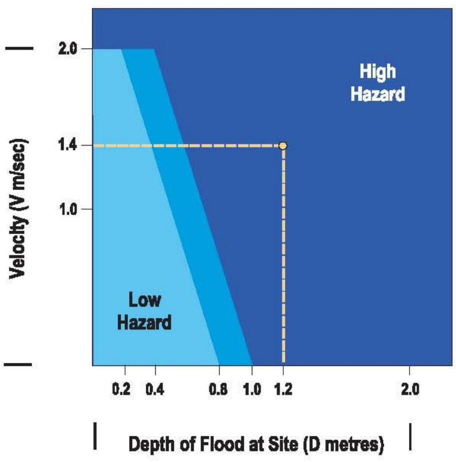
- Size of the flood;
- Depth and velocity of floodwaters;
- Effective warning time;
- Flood awareness;
- Rate of rise of floodwaters;
- Duration of flooding;
- Evacuation problems; and
- Access.

Hazard categorisation based on all the above factors is often referred to as 'true hazard'. The scope of the present study calls for determination of 'provisional' flood hazards only. The provisional flood hazard is generally considered in conjunction with the above listed factors as part of the Floodplain Risk Management Study (the next stage of the Floodplain Risk Management process after the Flood Study) to provide a comprehensive analysis of the overall flood hazard.

4.8.2.2 Provisional Flood Hazard

Provisional flood hazard is determined through a relationship developed between the depth and velocity of floodwaters (Figure L2, NSW Government, 2005). The Floodplain Development Manual (2005) defines two categories for provisional hazard - High and Low (Figure 4.1).

The provisional hazard was determined utilising the model results of flood level and velocity. Provisional flood hazard was prepared for the 1% AEP design event only.



Notes

The degree of hazard may be either -

- reduced by establishment of an effective flood evacuation procedure.
- increased if evacuation difficulties exist.

In the transition zone highlight by the median colour, the degree of hazard is dependant on site conditions and the nature of the proposed development.

Example:

If the depth of flood water is **1.2 m**
and the velocity of floodwater is **1.4 m/sec**
then the provisional hazard is **high**

FIGURE L2 - Provisional Hydraulic Hazard Categories

Figure 4.1 Provisional Hydraulic Hazard

5 Discussion

5.1 Flooding Behaviour

Overland flooding occurs along the rear of the site when the trunk drainage capacity is exceeded. When this occurs, overland flows proceed down roads and through properties until it reaches the low-lying areas.

The catchment upstream of the site is determined from the flood model received from Council and is included in the appendices below.

The open channel in the natural reserve, the pits and the pipes as received have been retained in the vicinity of the site.

The overland flows enter the site from the southern and the eastern sides at several locations as shown in the flood maps. In summary:

3. The flows are distributed between the buildings at the rear of 4 Delmar Pde and 812 Pittwater Rd;
4. The rear building of 4 Delmar Pde obstructs the flows and forces with the flows in an easterly direction;
5. The flows enter the site also at the south eastern corner of the site; and
6. The flows also enter the site at the rear of No.6 Delmar Parade.

The proposed development blocks the gap between the buildings at 4 Delmar Pde and 812 Pittwater Rd. A dedicated 3m wide overland flowpath is proposed along the southern boundary to collect the flows and divert them in an easterly direction where it turns towards the north and is upgraded to 4m width and discharge the flows in Delmar Pde. The wall that confines the flow in the dedicated flowpath is stopped 5m short from the front boundary of the site to allow the flow to spread out onto the driveway as per image below. The basement level is protected from flooding by a crest.

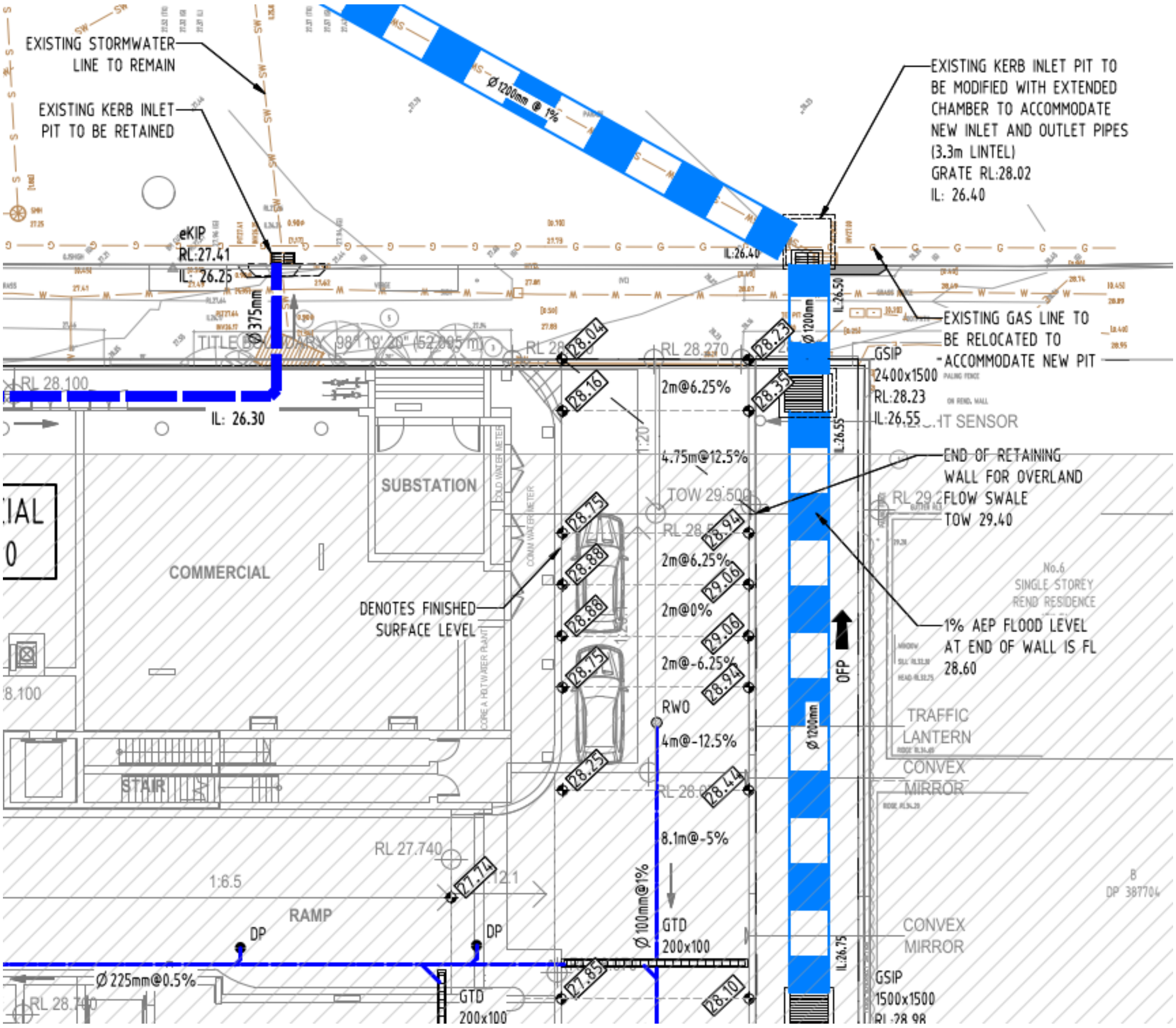


Figure 5.1 Overland Flow Design at Delmar Pde

The flows will be partially collected in a new pit and pipe network under the overland flowpath and will connect to council's trunk main which will be upgraded to increase its capacity down to Delmar Pde. A new pipe section will be constructed under Delmar Pde to connect to the other side of Delmar Pde as depicted on the Stormwater plans by SGC. These mitigations measures ensure that the 1% AEP flood is diverted without any impacts on adjoining properties.

When simulating the PMF event, it was found that these measures are not sufficient and a flood conveyance void through the building structure is needed to convey the PMF flows through the site towards Pittwater Rd. It is noted that during the 1% AEP event, some water flows through the flood void chamber in a similar manner to the existing site conditions.

The details of the flood void are included in the stormwater drawings as per extract below.

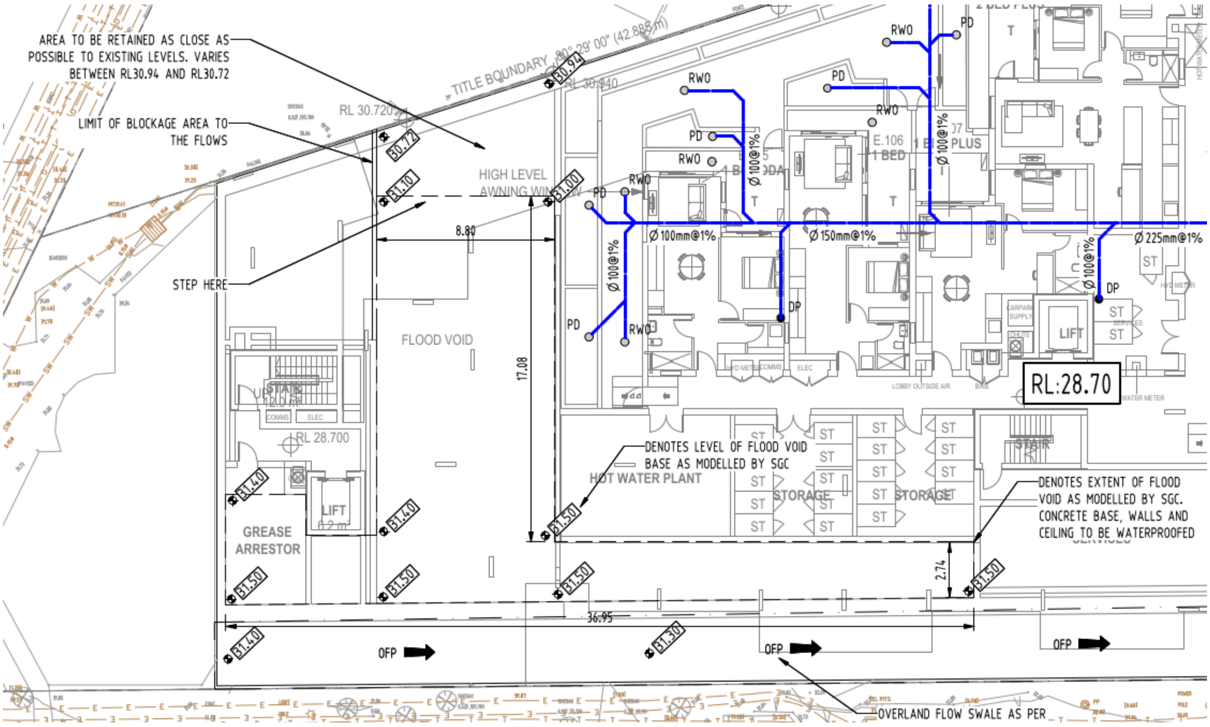


Figure 5.2 Flood Void Chamber Details

The proposed mitigation measures ensure that the proposed development does not have an impact on flooding elsewhere in the locality. This is demonstrated in the flood impact map in Appendix 2 for the 1% AEP and the PMF events.

The dedicated overland flowpath will be a High Hazard area on site and will be adequately fenced off with limited access to prevent exposing people to high flood hazards. The areas outside of the dedicated overland flowpath will be LOW or MEDIUM hazard suitable for the proposed development.

These proposed mitigation measures are considered acceptable because they alleviate the flooding at the rear of 2 Delmar Pde and the rear of 816 Pittwater Rd.

6 Conclusions

A detailed investigation on the flooding behaviour has been undertaken for the proposed development at 4 Delmar Parade and 812 Pittwater Road, Dee Why.

A detailed 1D/2D hydraulic model was established. This model incorporates the upstream catchment and has a fine 2D resolution of 2m. Hydrological modelling was undertaken utilising rain on grid.

Using the established models, the study has determined the flood behaviour for the 1% AEP and the Probable Maximum Flood (PMF). 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 looked into the impact of the proposed development on the flooding behaviour in the vicinity of the site and its impact on the flood levels both upstream and downstream. The results of the modelling indicate that the development does not have any significant impacts on the adjoining properties and the downstream floodplain.

The flood maps are included in Appendix 2**.**

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A1 Appendix 1

IFD Table

Figure A 1.1 IFD Table – Dee Why (BOM Website)

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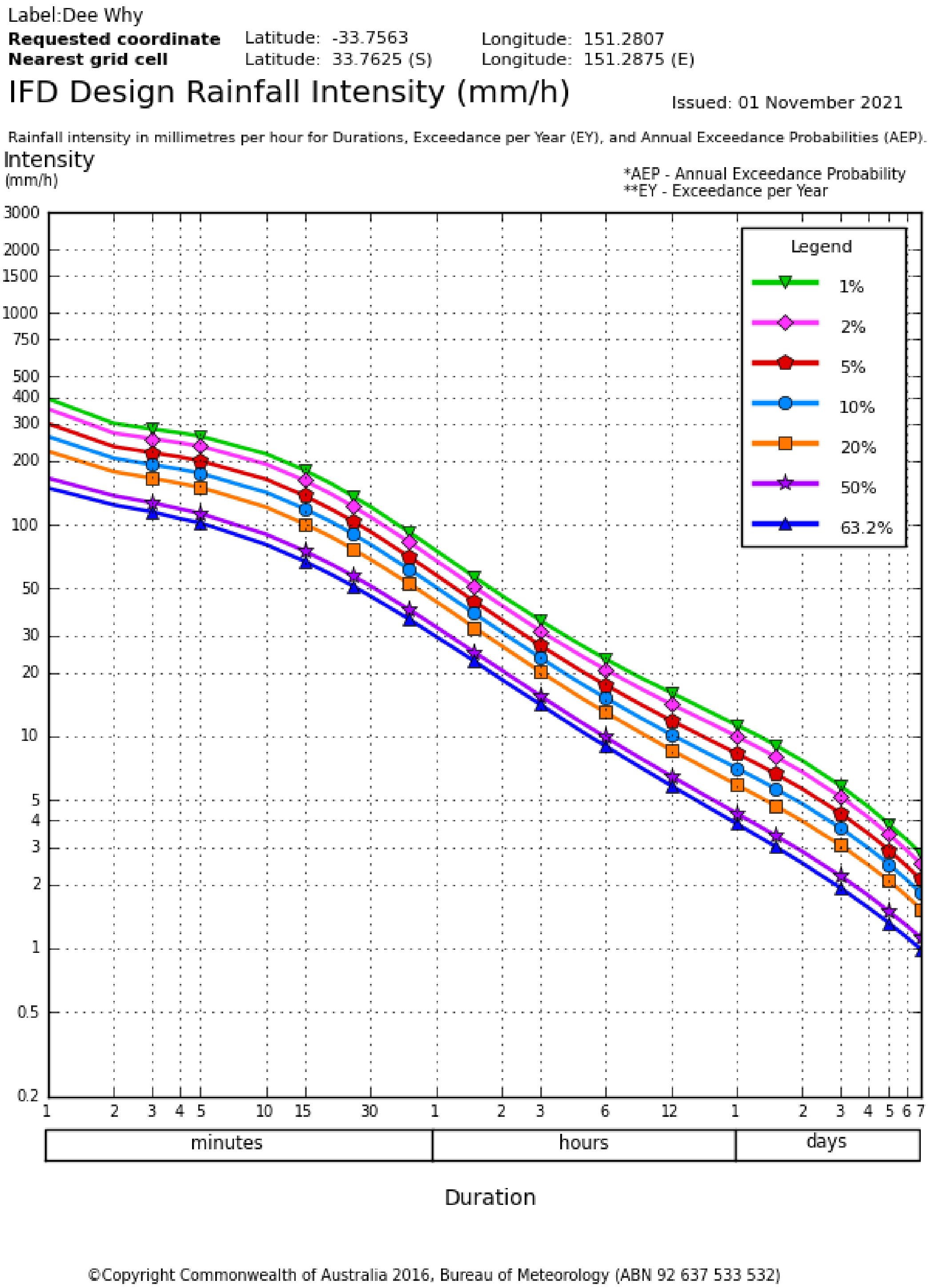

Figure A 1.1 IFD Table – Dee Why (BOM Website)

A2 Appendix 2

Flood Mapping

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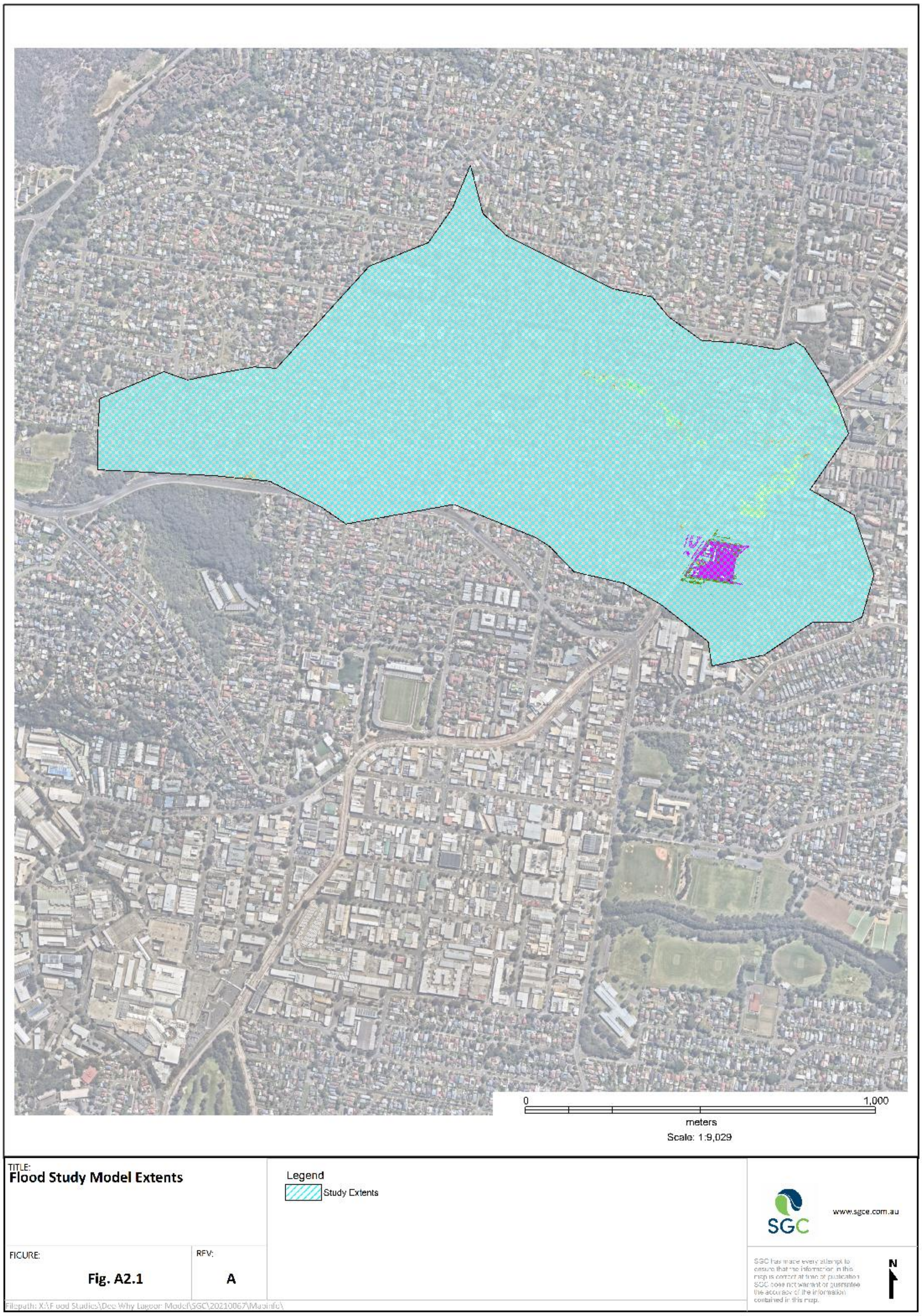

Figure A 2.1 Study Extents

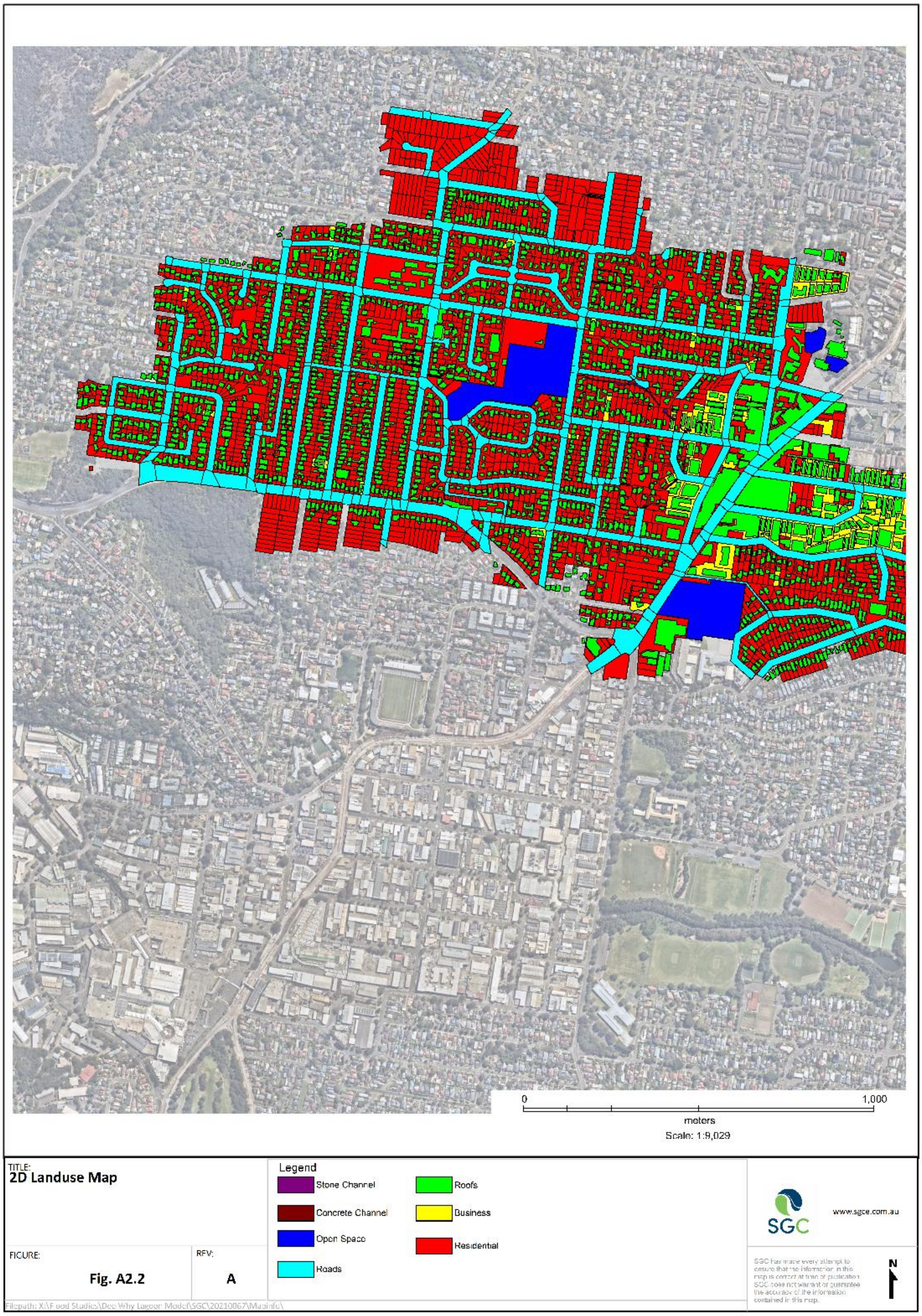

Figure A 2.2 2D Land Use

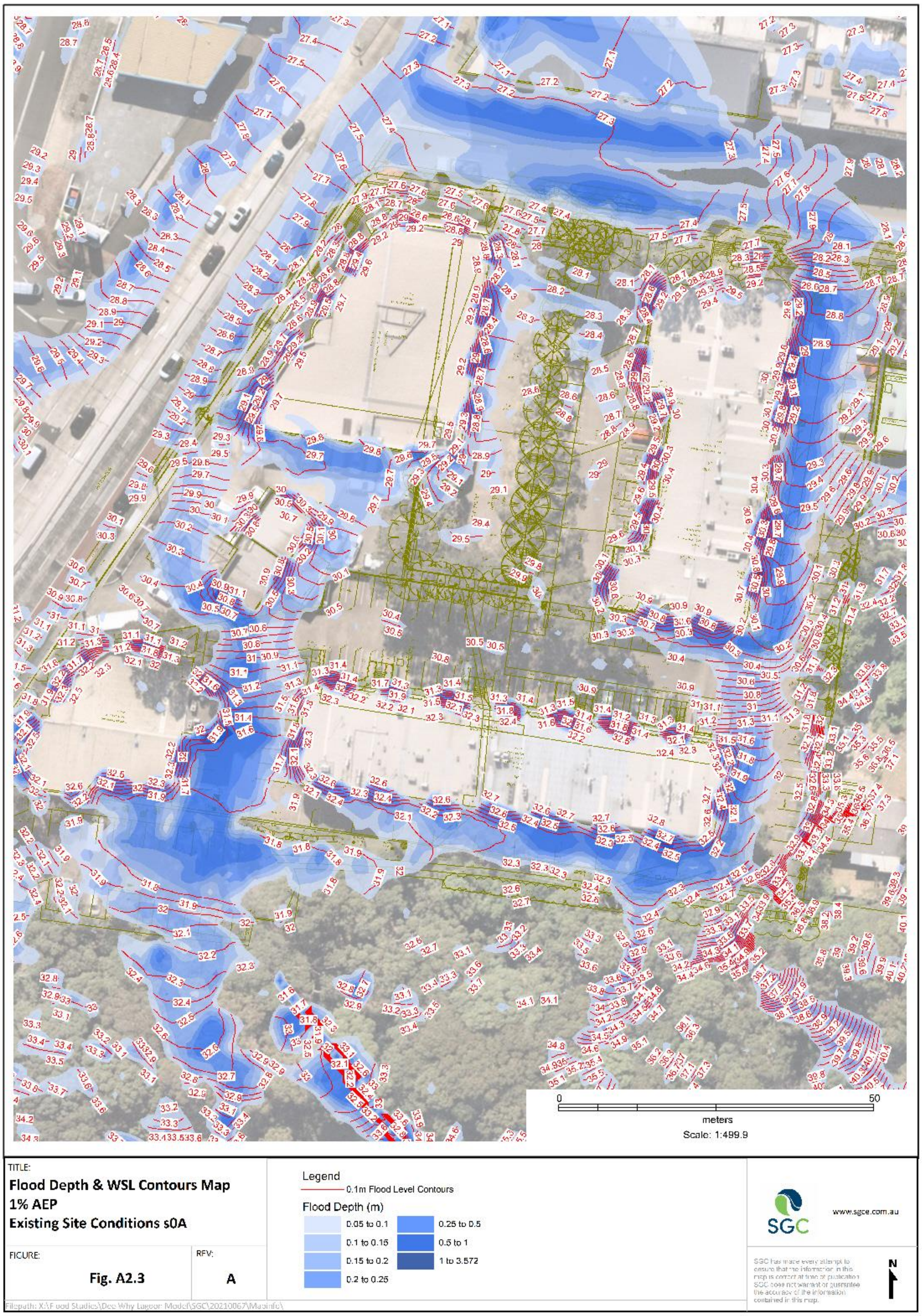

Figure A 2.3 1% AEP Flood Depth & Water Level Contours – s0a

TITLE:
Flood Hazard Map
1% AEP
Existing Site Conditions s0A

FIGURE: **Fig. A2.4**
REV: **A**

Legend
Velocity x Depth (m2/s)
- 0 to 0.1
- 0.1 to 0.3
- 0.3 to 0.4
- 0.4 to 0.6
- 0.6 to 35.9

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Figure A 2.4 1% AEP Flood Velocity x Depth – s0a

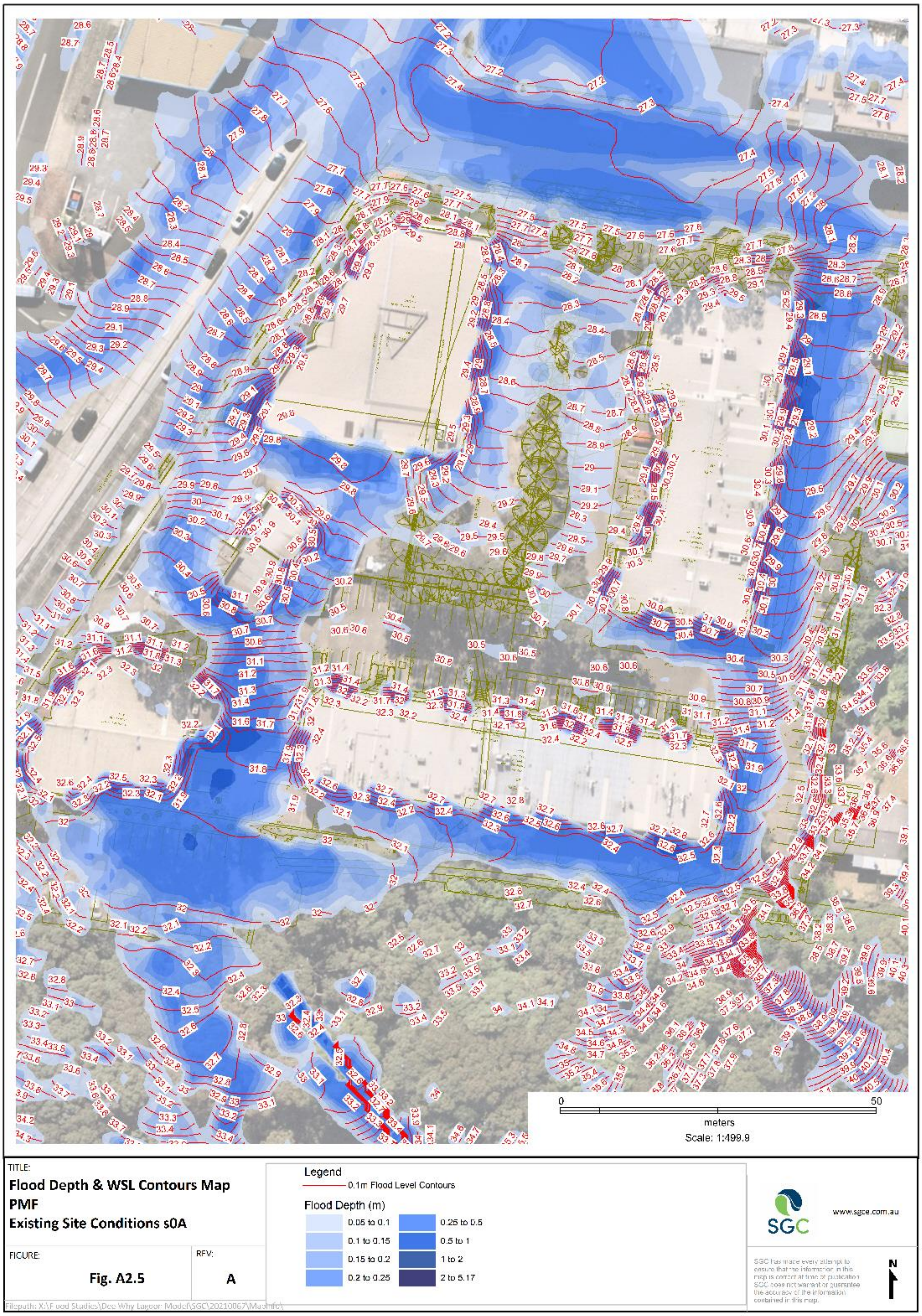


Figure A 2.5 PMF Flood Depth & Water Level Contours – s0a

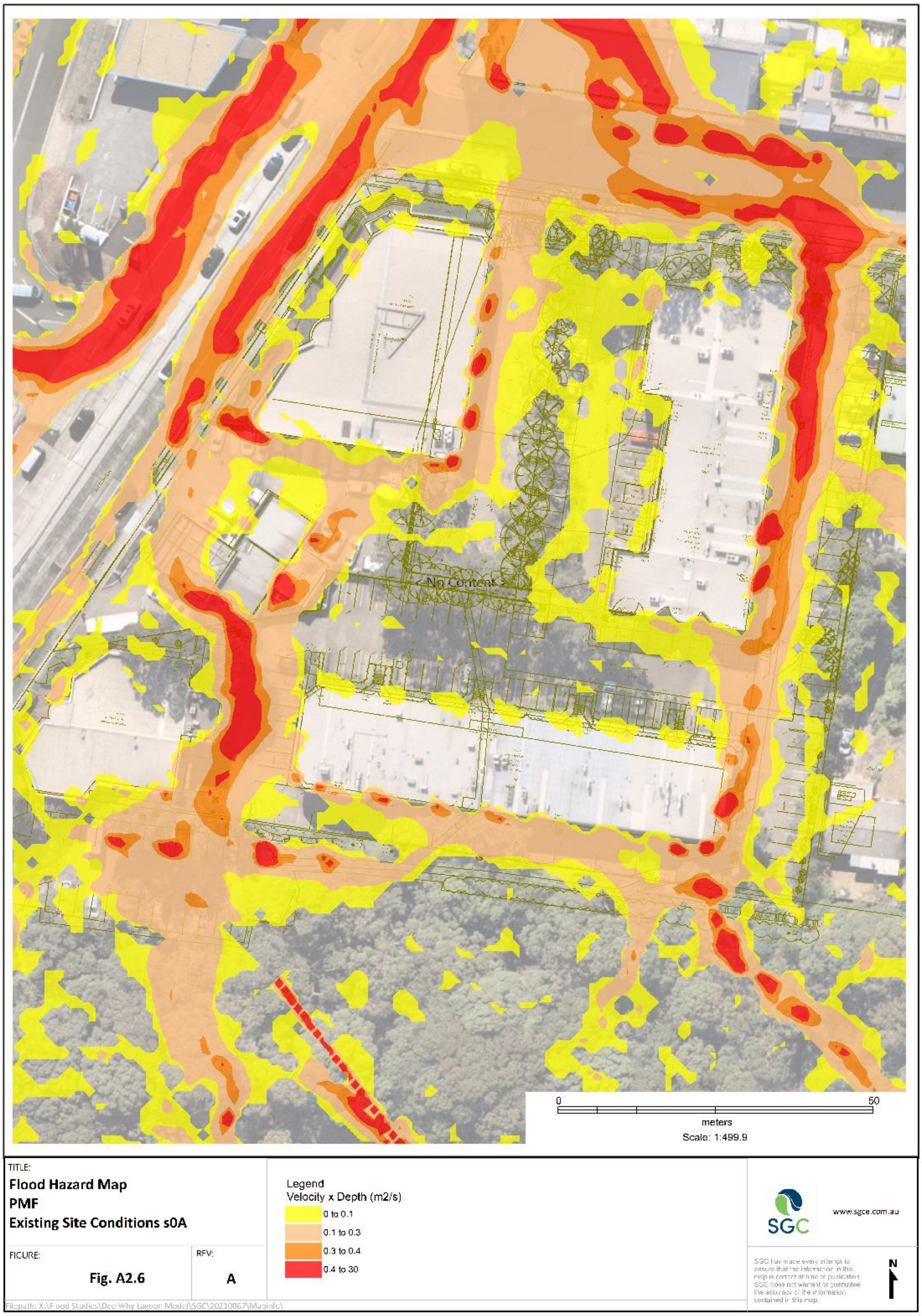


Figure A 2.6 PMF Flood Velocity x Depth – s0a

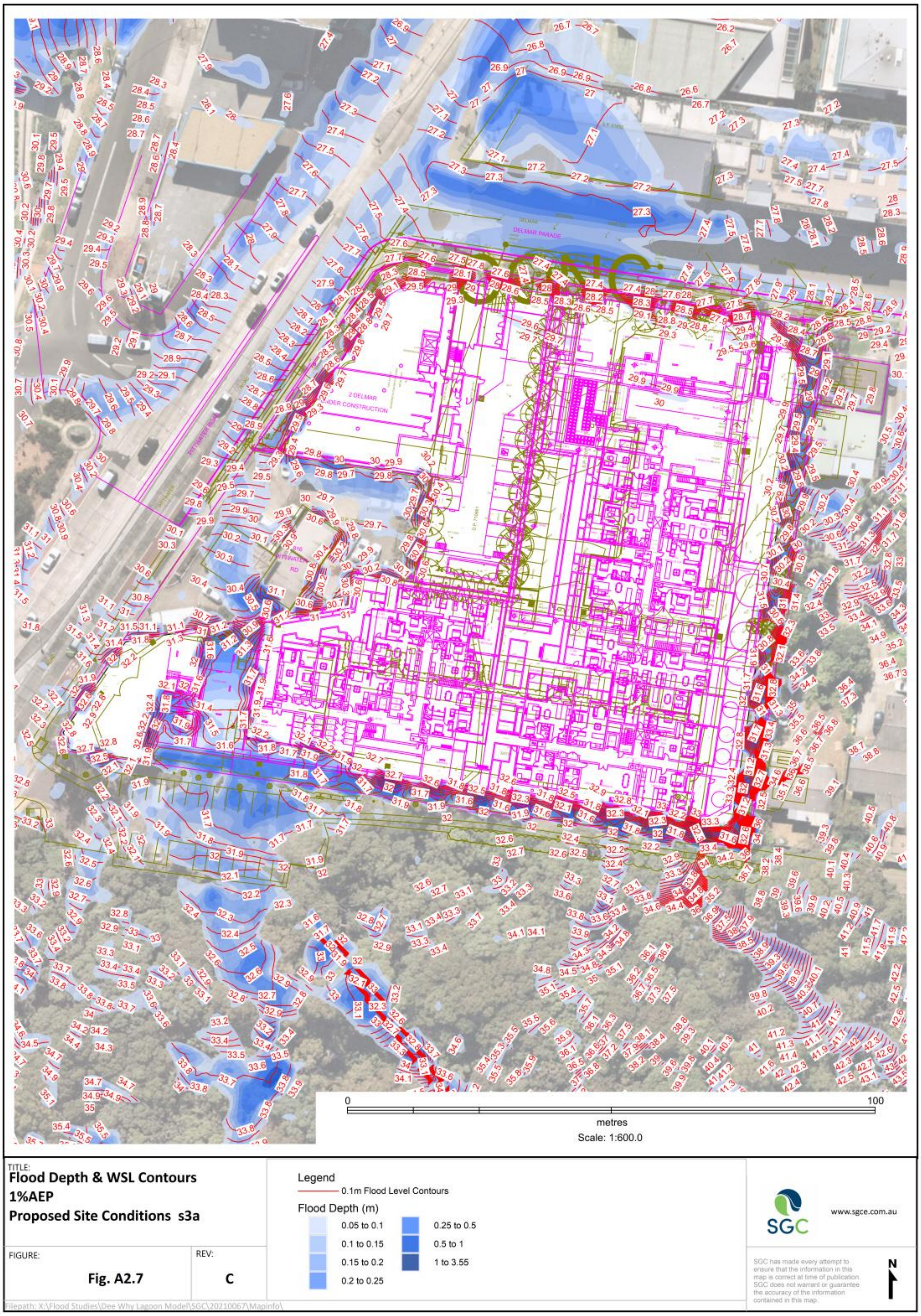


Figure A 2.7 1% AEP Flood Depth & Water Level Contours – s3a

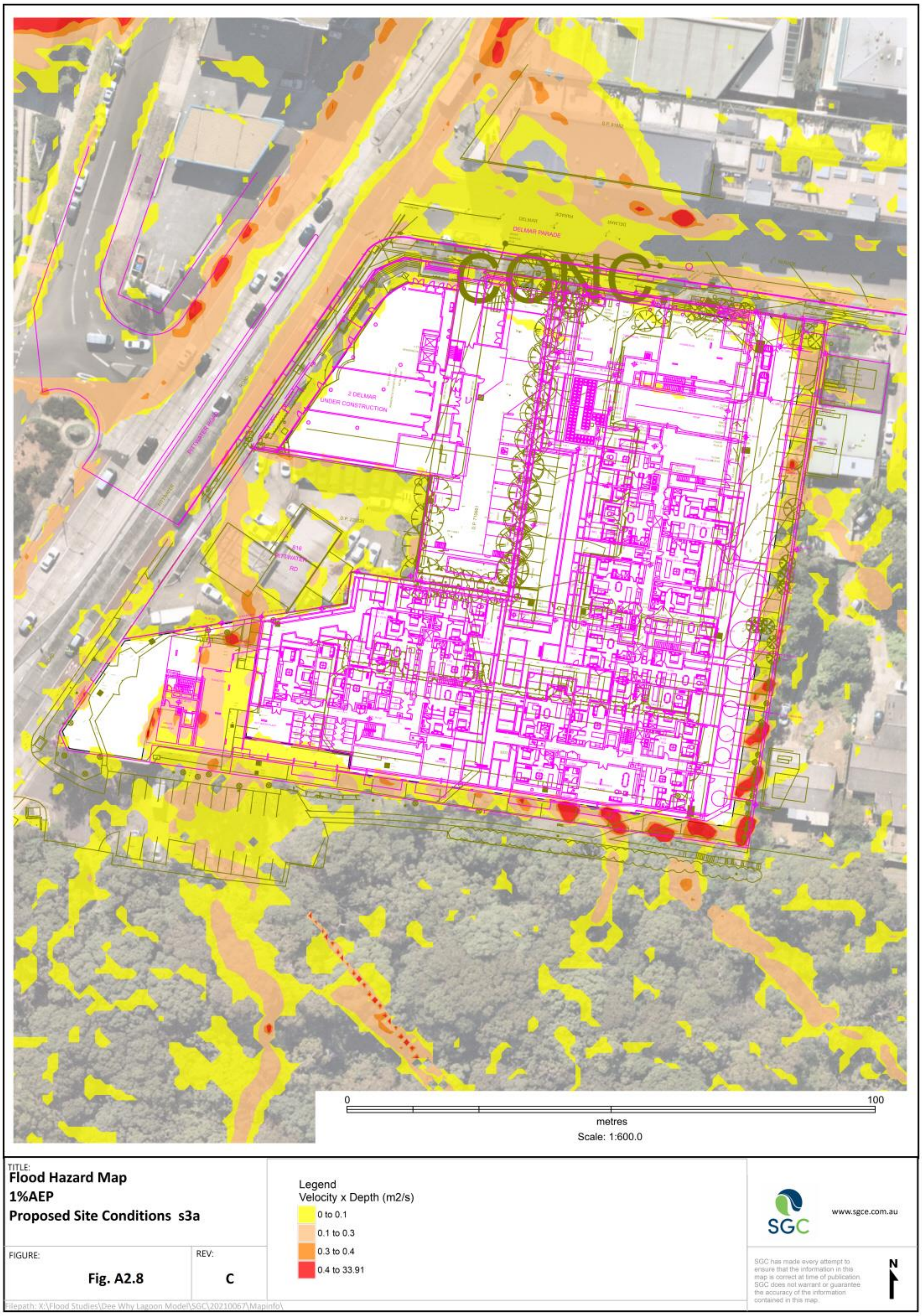
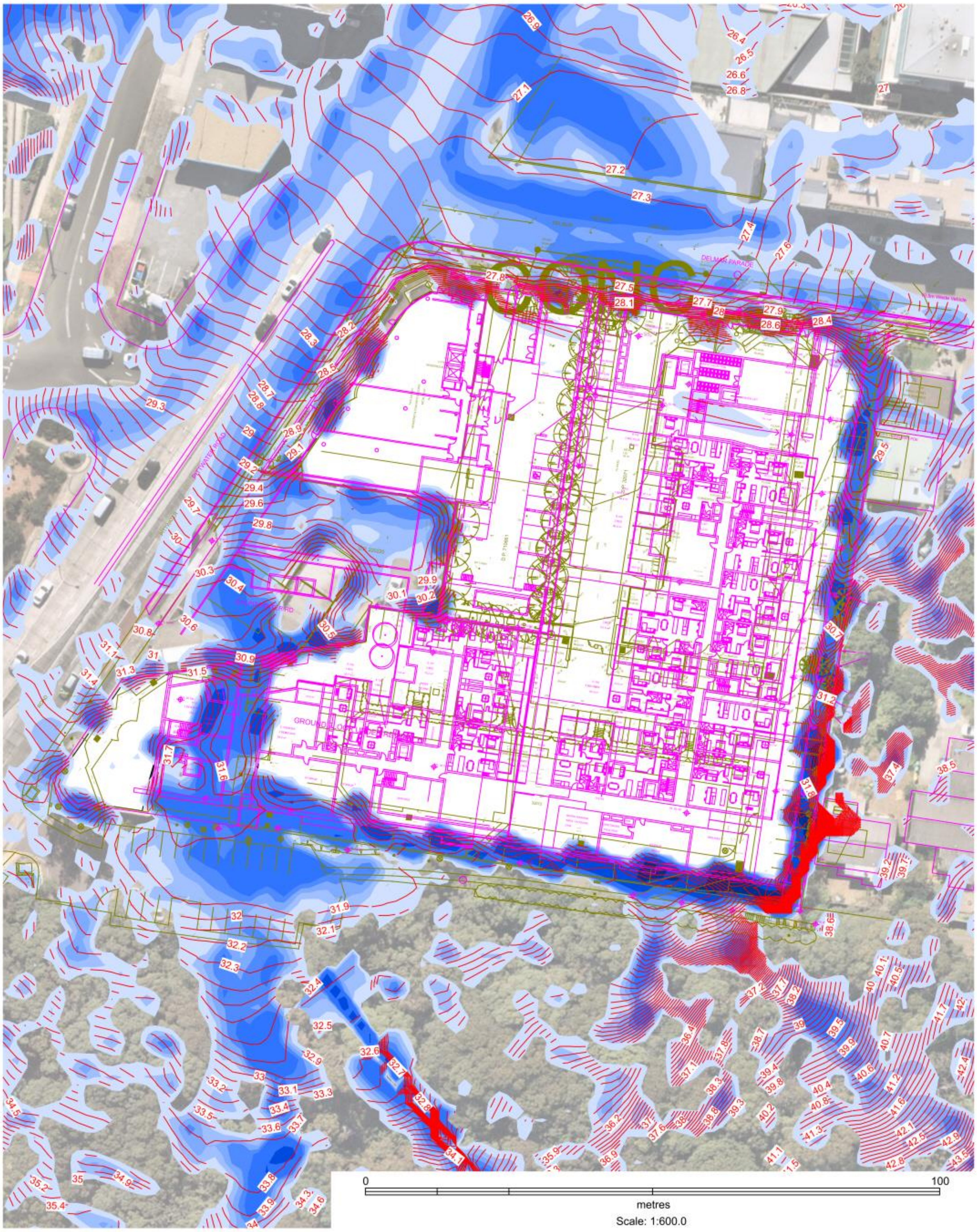


Figure A 2.8 1% AEP Flood Velocity x Depth – s3a



TITLE:
Flood Depth & WSL Contours
PMF
Proposed Site Conditions s3a

FIGURE: **Fig. A2.9**
REV: **C**

Legend
0.1m Flood Level Contours
Flood Depth (m)

0.05 to 0.1	0.25 to 0.5
0.1 to 0.15	0.5 to 1
0.15 to 0.2	1 to 4.66
0.2 to 0.25	

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Figure A 2.9 PMF Flood Depth & Water Level Contours – s3a

TITLE:
Flood Velocity x Depth
PMF
Proposed Site Conditions s3a

FIGURE: **Fig. A2.10**
REV: **C**

Legend
Velocity x Depth (m2/s)
- 0 to 0.1
- 0.1 to 0.3
- 0.3 to 0.4
- 0.4 to 37.43

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Figure A 2.10 PMF Flood Velocity x Depth – s3a

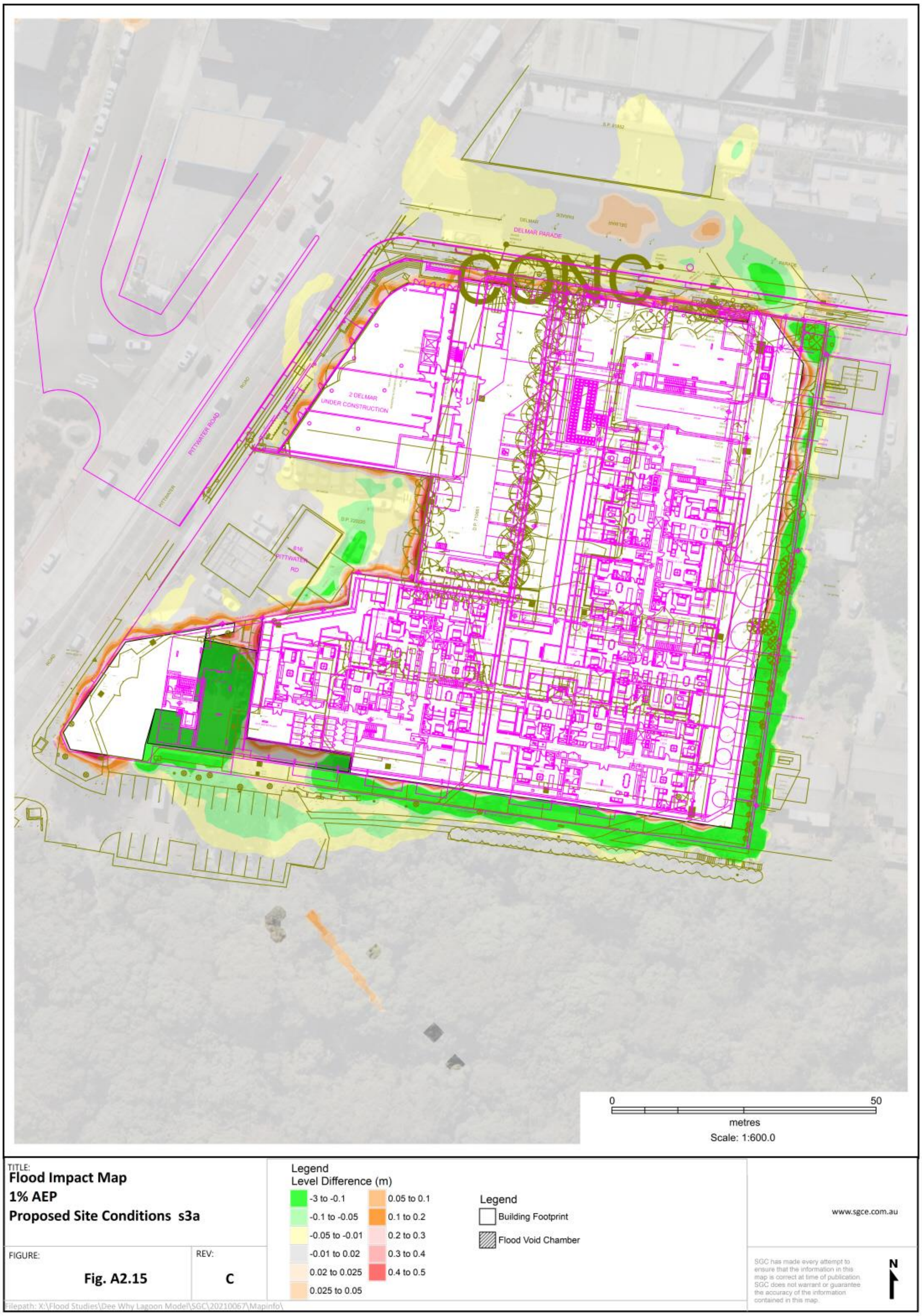

Figure A 2.11 1% AEP Flood Impact – s3a

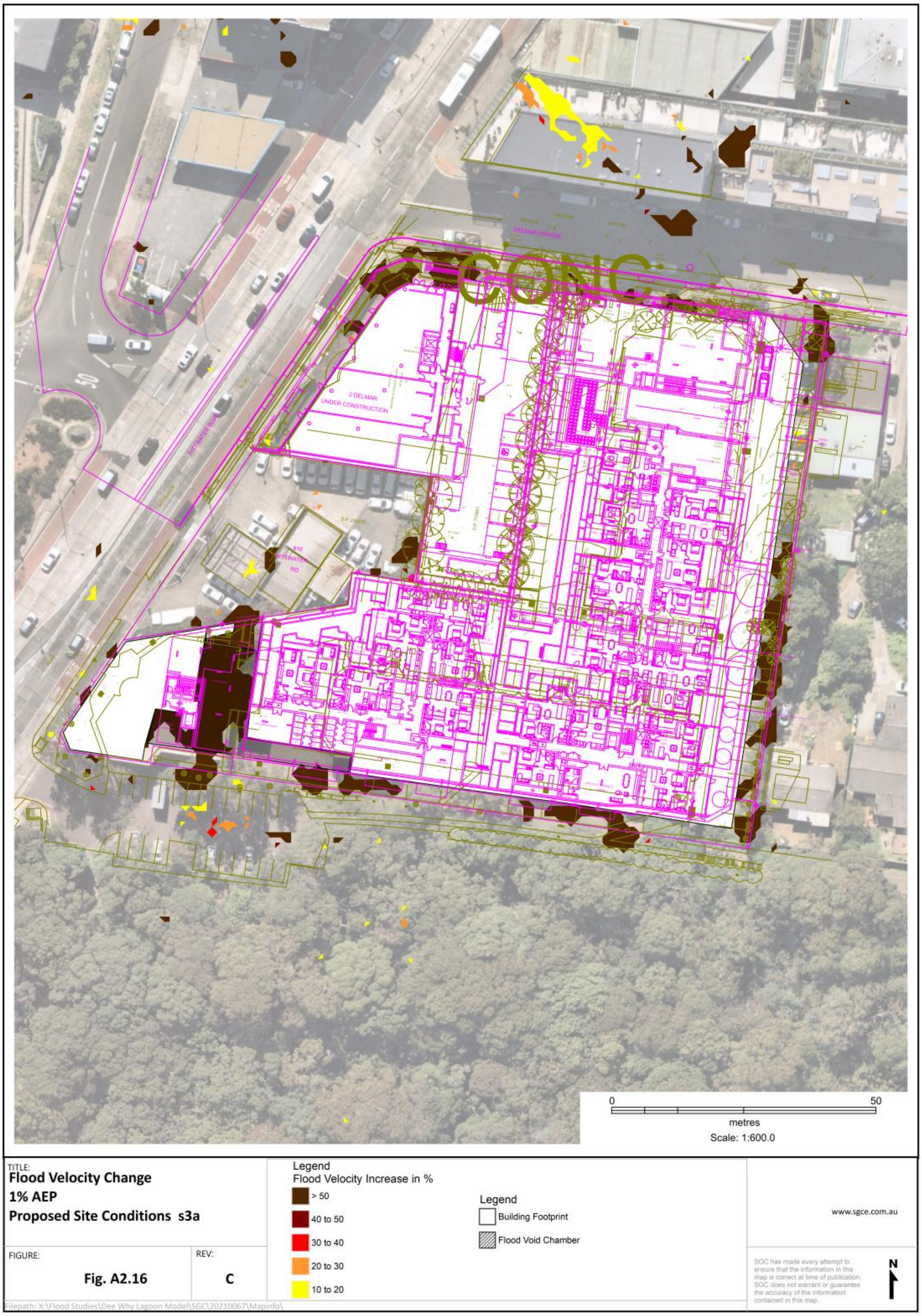

Figure A 2.12 1% AEP Flood Velocity Increase – s3a

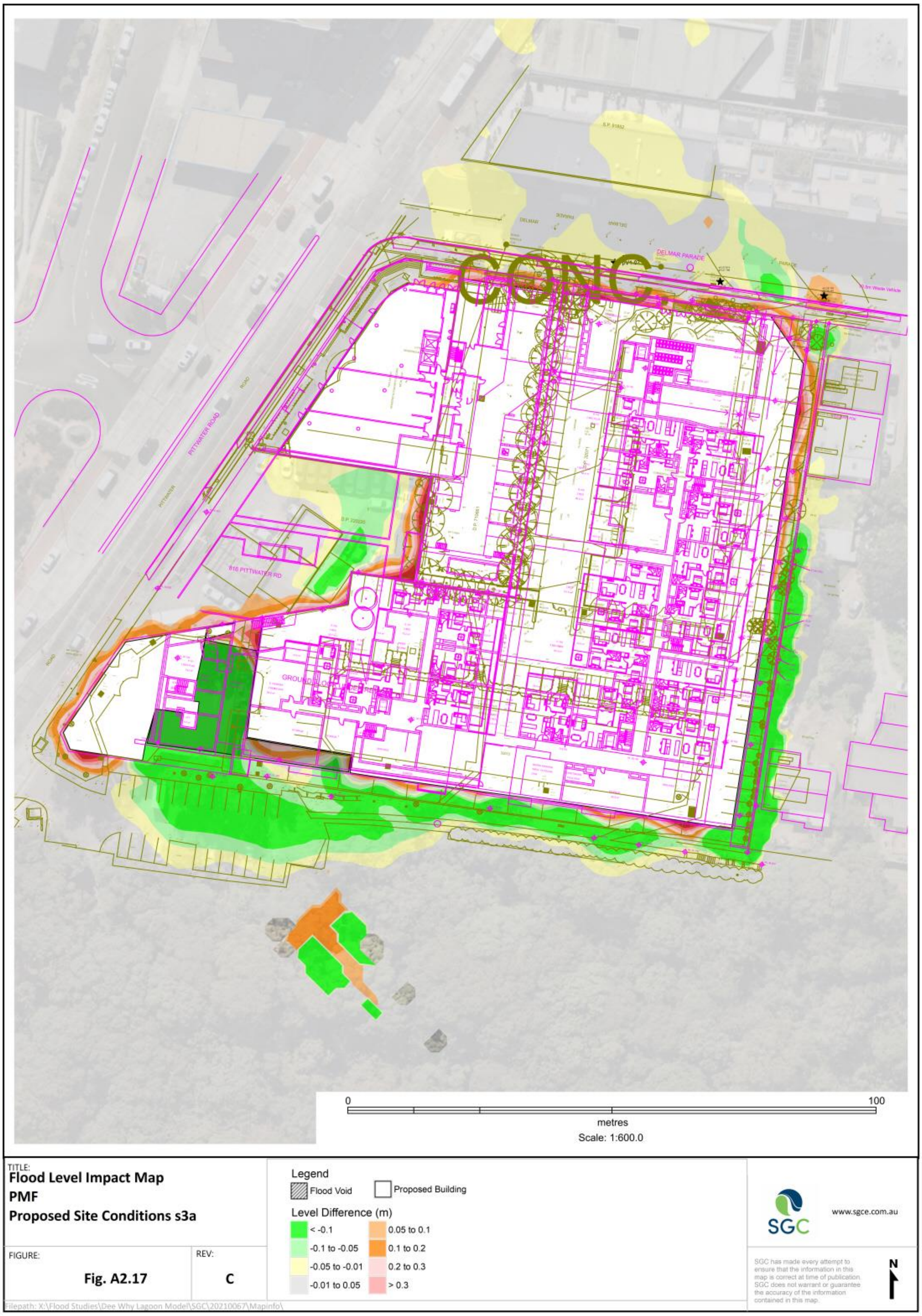

Figure A 2.13 PMF Flood Impact – s3a

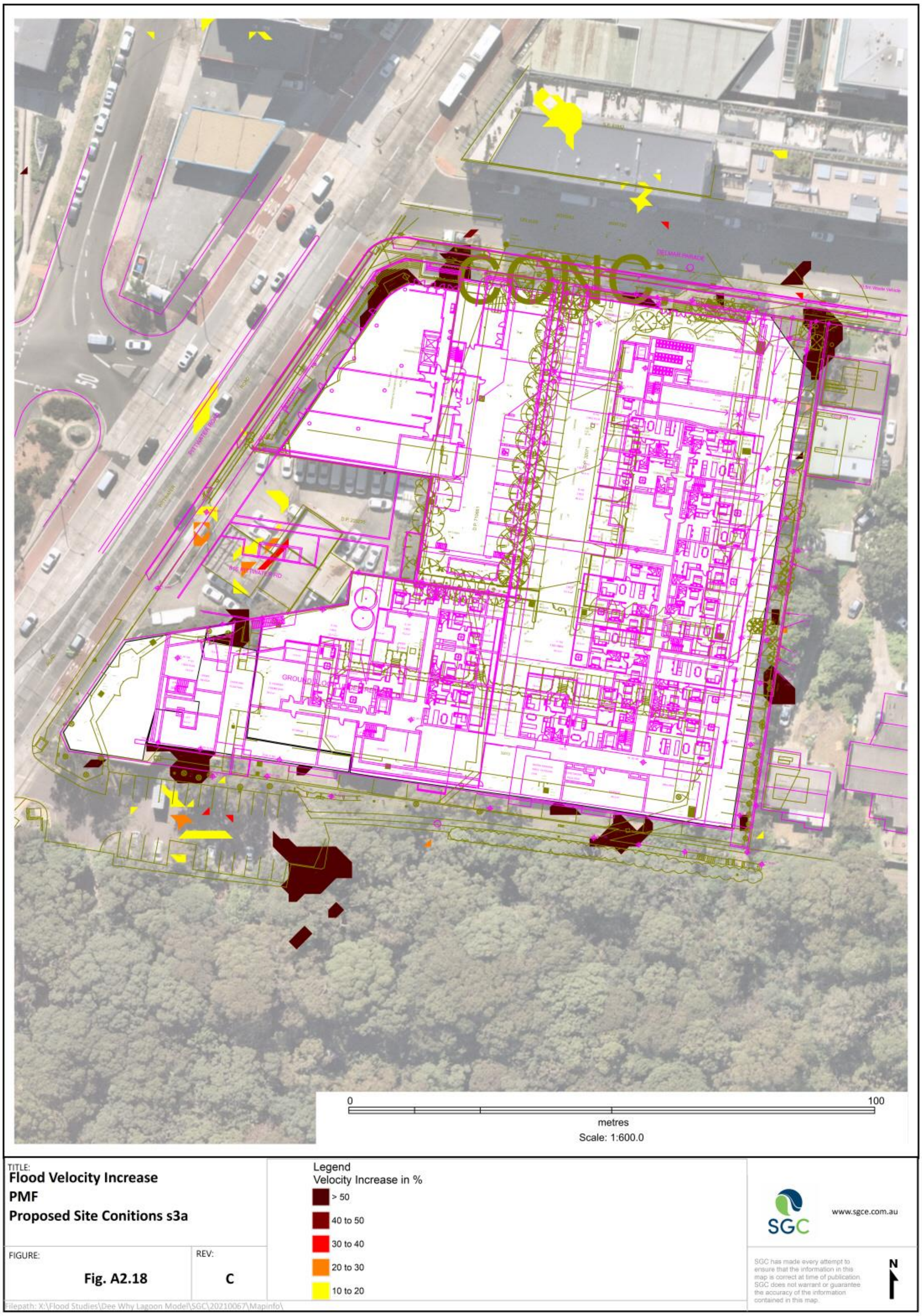

Figure A 2.14 PMF Flood Velocity Increase – s3a

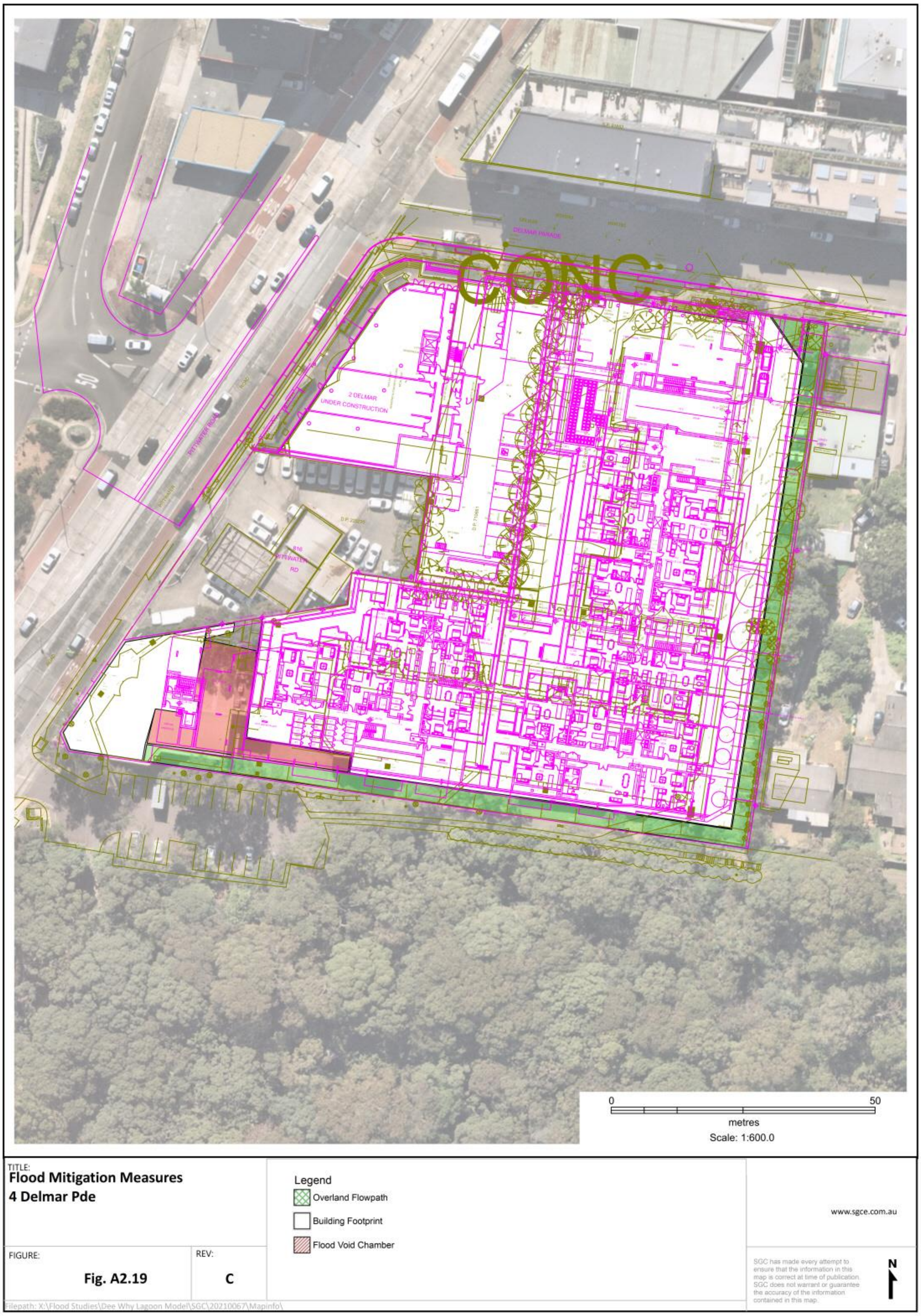

Figure A 2.15 Flood Mitigation Map – scenario s3a (4 Delmar Pde)

A3 Appendix 3

Survey

Figure A 3.1 Survey

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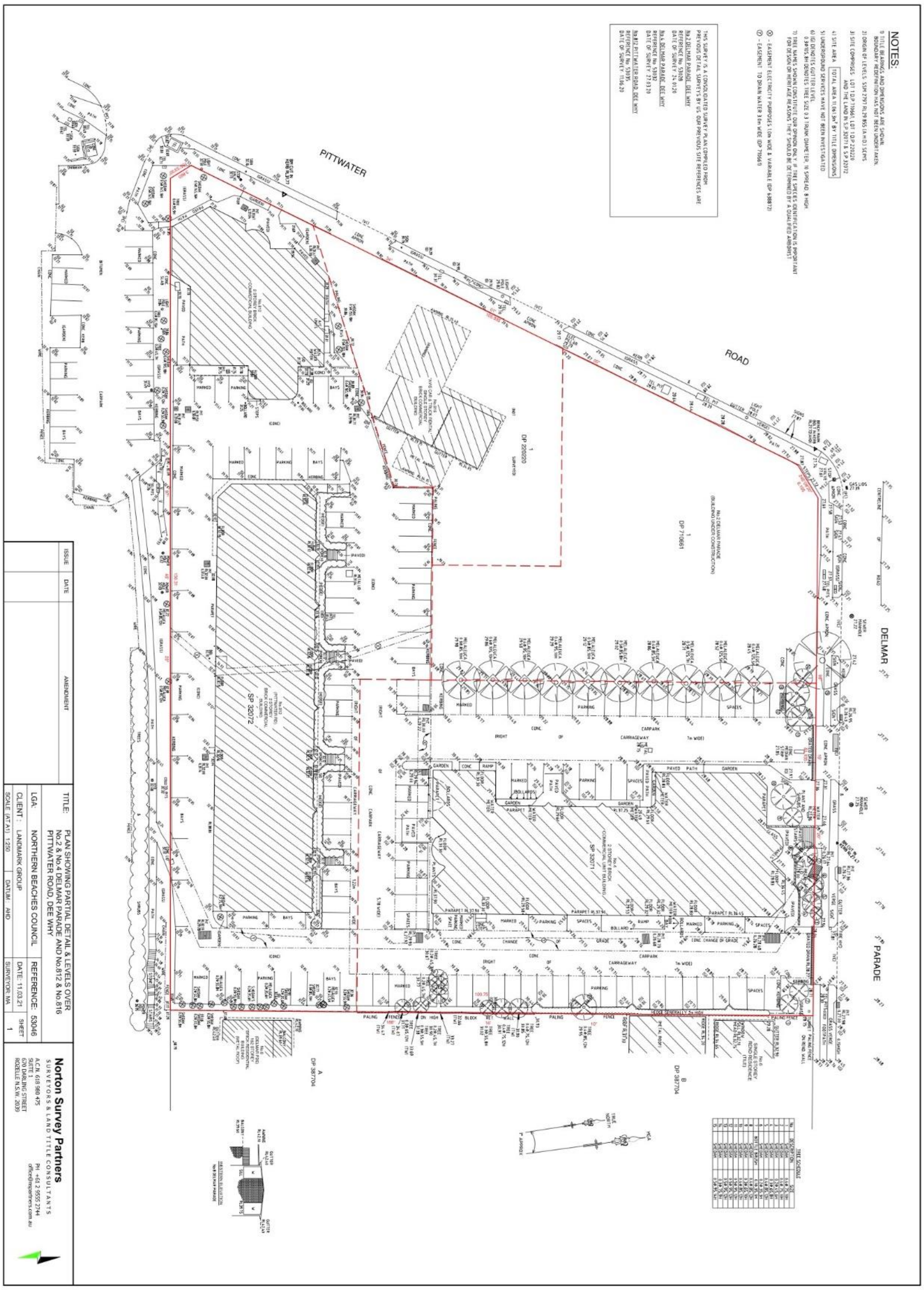

Figure A 3.1 Survey

A4 Appendix 4

Architectural Plan

Figure A 4.1 Ground Floor Plan

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Figure A 4.1 Ground Floor Plan

P: 02 8883 4239

W: www.sgce.com.au

A: Suite 5.03, Level 5,
156 Pacific Highway,
St Leonards, NSW 2065

SGC