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Flood Investigation Report

For a Proposed Mixed-Use Development

Prepared for: **Waldron Hills Projects Pty Ltd**

Project address: **No.'s 913 – 925 Punchbowl Road and No. 21 Canterbury Road, Punchbowl**

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VERSION HISTORY

Version	Date	Purpose	Prepared By	Approved By
1.0	25/05/22	Preliminary Report	Nathan Broadbent	
2.0	2/06/22	Revised Preliminary Report	Amanda Newman & Nathan Broadbent	

Review Panel	
Division/Office	**Name**
Central Coast	Bruce Kenny

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1 Introduction

ACOR Consultants (CC) Pty Ltd has been commissioned to prepare a Flood Investigation Report in accordance with the requirements of Bankstown Development Control Plan 2015 Part B12. The Flood Investigation Report is supported by a flood study which investigates flood behaviour throughout the catchment impacting the subject site. This includes the analysis of:

- Surface runoff across the catchment.
- Flooding towards the lower part of the catchment.
- Backwater flooding impact on the subject site.

A two-dimensional computer model of the catchment was established to analyse mainstream and overland flood behaviour under existing and proposed catchment conditions. The model provides information on the extent of flood inundation, flood depths and flood velocities throughout the catchment for the 1% AEP flood event. Results from this study will form the technical basis for the subsequent flood risk management plan, if required, which will identify problem areas and investigate options to reduce the risk of flooding.

1.1 Objective

The objective of the study is to define flooding in accordance with the Floodplain Development Manual (NSW DIPNR 2005) and assess if the proposal is consistent with Ministerial Direction 4.1 relating to Section 9.1(2) of the *Environmental Planning and Assessment Act 1979*. It involved the following steps:

- Attend the site to assess the anticipated extent and nature of flooding and identify hydraulic controls likely to impact on flooding behaviour.
- Develop hydraulic model to determine 1% AEP flood levels, velocities and provisional hazard categories.
- Review flooding behaviour and provide recommendations to ensure that future redevelopment of the site will meet flood compatibility standards.

1.2 Site description

The subject site is located at the intersection of Canterbury Road and Punchbowl Road in Punchbowl, being on the northern side of Canterbury Road and the western side of Punchbowl Road. The subject site consists of the sites known as:

- Lot A DP 378634, Lot D DP 382627, Lot 6 DP 5245, Lot 14 DP 132440, Lot 15 DP 132440 and Lot 1 DP 236825, collectively known as (No. 21) Canterbury Road, Punchbowl.
- Lot B DP 378634 (No. 913) Punchbowl Road, Punchbowl.
- Lot 2 DP 21524 (No. 915) Punchbowl Road, Punchbowl.
- Lot 3 DP 21524 (No. 917) Punchbowl Road, Punchbowl.
- Lot 4 DP 21524 (No. 919) Punchbowl Road, Punchbowl.

The site is a developed site of total area 1.9 ha. Current development of the site consists of four residential dwellings located on the parts of the site known as No.'s 913 to 919 Punchbowl Road, a commercial building operating as Club Punchbowl located on the parts of the site known as Lots 14 and 15 DP 132440, and open paved car parking area.

The site is zoned partly R2 Low Density Residential and partly B1 Neighbourhood Centre under the provisions of Bankstown Local Environmental Plan 2015. The parts of the site zoned B1 Neighbourhood Centre are contained within Lots 14 and 15 DP 132440.

A concrete open channel is located within the site, adjacent to the western site boundary. The site falls toward the open channel. Ground levels within the remainder of the site are generally within the range 6.1 m AHD to 8.2 m AHD.

The site owner proposes the demolition of existing structures on site and the erection of four residential apartment blocks and a mixed-use building housing a club and retail space on the ground floor level with residential apartments above. Associated with the proposed building works is the proposed rezoning of the site to be entirely B1 Neighbourhood centre.

1.3 Flood characteristics

The subject site is impacted by mainstream floodwaters from Salt Pan Creek, a tributary of Georges River. Flooding within the Salt Pan Creek catchment is characterised as flash flooding, whereby floodwaters rise rapidly in response to rainfall, with little to no warning time prior to flooding occurring (Bewsher Consulting & BMT WBM 2011; Bewsher Consulting 2013).

The site is impacted by floodwaters during flood events as frequent as the 5% AEP flood event. In addition to flows traversing the site from north to south in the stormwater channel, flows also enter the site from Punchbowl Road in the east.

Site specific 1% AEP flood information is provided in a Stormwater System Report issued by Canterbury Bankstown Council, dated 18 August 2016 (copy enclosed under Annexure A). The 1% AEP floodwaters impact the site at elevations within the range 7.2 m AHD to 7.5 m AHD, inundating the site to depths locally in excess of 2 m. The majority of the site is impacted by flood depths less than 0.6 m. Away from the stormwater channel, floodwater velocities are generally less than 0.5 m/s. The 1% AEP floodwaters pose low hazard conditions over much of the site.

The PMF floodwaters impact the site at approximately 8 m AHD (Bewsher Consulting & BMT WBM 2011), inundating the majority of the site to depths in excess of 2 m. Away from the stormwater channel, PMF floodwater velocities are generally less than 1 m/s. The PMF floodwaters create high hazard conditions in the vicinity of the stormwater channel and north of the existing club building. The PMF floodwaters in the vicinity of the existing residential dwellings create low hazard conditions.

2 Available Data

This flood study used topographic and flood related data obtained from a number of sources. The origin and types of information underpinning the assumptions used in this study are presented below.

2.1 Published flood model

The flood study has been undertaken using a TUFLOW model for the Salt Pan Creek catchment provided under data share agreement with Canterbury Bankstown Council. We understand the TUFLOW model provided to ACOR was used to prepare ‘Salt Pan Creek Stormwater Catchment Study’ (Bewsher Consulting & BMT WBM 2011) and support the preparation of ‘Salt Pan Creek Catchments Floodplain Risk Management Study and Plan’ (Bewsher Consulting 2013). This section provides a brief description of the provided model and commentary as to its fitness for purpose for the current study.

2.1.1 TUFLOW executable version

Based on the information provided under data share agreement, results held by Council were likely to have been generated using the 2009-07-AD version of TUFLOW. It is noted that there have been numerous changes and significant improvements to the TUFLOW model software since this release. It is advisable to undertake the impact assessment using the latest version, which at the time of preparation of this report is 2020-10-AD. It is noted that this may result in some difference in predicted flood levels, velocities and flowrates than presently held by Council.

2.1.2 Model control files

Model control files were provided for the 2 hour duration storm for the 20 Year ARI, 50 Year ARI, 100 Year ARI and PMF events. The control files allow the hydraulic structures within the catchment to be modelled as unblocked, or with inlets and hydraulic structures partially blocked.

2.1.3 Issues with the TUFLOW model as supplied

The following issues were encountered during review of the TUFLOW model supplied to ACOR.

- Commands require adjusting prior to running the model.

  In order to run the TUFLOW model, it was necessary to set the command “Check MI Save Date” to issue a warning. This indicates there is a possibility that some GIS layers were modified prior to the model being received by ACOR.

- Inconsistencies between initial water levels and boundary conditions.

  Initial water levels were assigned to parts of the model which did not match the corresponding water levels in the boundary condition time series. These inconsistencies affect both the 1D and 2D model domains and have the greatest impact on the outlet of the eastern portion of the model, near the subject site. Such inconsistencies can adversely impact on model stability. ACOR attempted to address this issue as described in Section 4.5.

- Sub-optimal configuration and application of external flows in the eastern part of the model domain.

  It was observed that the 2D model domain only covered parts of the subject site and does not cover the intersection of Punchbowl Road and Canterbury Road.

  Flows from the catchment east of Punchbowl Road assumed to enter the study area at the culvert passing under Punchbowl Road. Flows exceeding the capacity of the culvert under Punchbowl Road were transferred to the 2D model domain near the kerb and gutter on the western side of Punchbowl Road, with the crown of Punchbowl Road represented as a 1D weir.

  This arrangement of 2D model domain and handling of flows from east of Punchbowl Road is sub-optimal as a portion of the flows applied to the culvert under Punchbowl Road would be conveyed as overland flow down Canterbury Road and never enters Punchbowl Road; while if overtopping of Punchbowl Road is significant, some flows will spill south to Canterbury Road rather than flowing west through the site. This behaviour is evident during the modelling of the PMF and reduces confidence in the reliability of the estimated PMF flood levels at the site and the impact of the proposed development on flood behaviour during extreme flood events.

2.1.4 Fitness for purpose

The existing TUFLOW model is deemed fit for purpose for assessing flood levels and impacts of the proposed development during the 1% AEP flood event.

ACOR has concerns regarding suitability of the existing model for assessing PMF conditions at the site due to the configuration of the 2D domain boundary at the site. It is our view that the existing model is not suitable for use when assessing PMF flood behaviour at the level required for the current planning proposal.

2.2 Additional survey data

The existing TUFLOW model was updated with recent survey information collated from the following sources:

- Site survey prepared by STRUCterre Surveying, sheets 1 to 6, reference 1595/302158, no date.
- Aerial imagery provided by NearMap, dated 17 May 2022.
- GIS layers of cadastre provided by NSW Spatial Services.

Recent infill development was observed to potentially effect flow paths near the site due to the erection of additional buildings and adjustments to existing building footprints. As noted in Section 4.3, the model was updated to reflect these changes near the site.

3 Hydrologic Modelling

Hydrologic modelling was not updated as part of the current study. The reader is referred to 'Salt Pan Creek Stormwater Catchment Study' (Bewsher Consulting & BMT WBM 2011) for a detailed description of hydrologic modelling of the catchment.

We note that the hydrologic modelling was undertaken prior to the release of the updated Australian Rainfall Runoff (ARR) guide. In this regard, the hydrologic modelling uses ARR87 rainfall depths and temporal patterns. We refer to Section 2.4.1 of Flood Risk Management Guide LU01 (NSW DPIE 2022a), which states that a historic version of ARR may be used for flood impact assessments where Council has adopted a flood study based on a previous version of ARR to ensure "the impacts assessed, and the controls used, are consistent with council studies and practices and flood behaviour derived from models that were calibrated and validated against historic floods". We note that Flood Risk Management Guide LU01 is written to support the implementation of the NSW Flood Prone Land Policy as described in Flood Risk Management Manual (NSW DPIE 2022b); based on the foregoing, we are of the view that utilising the existing hydrologic model is consistent with Ministerial Direction 4.1 relating to Section 9.1(2) of the *Environmental Planning and Assessment Act 1979*.

4 Hydraulic Modelling

A TUFLOW 1D/2D was used to hydraulically route flows through the catchment and to derive flow depths, velocities and hazards for the 1% AEP flood event. This section summarises the hydraulic modelling approach and hydraulic model development. For further details regarding the original TUFLOW model, the reader is directed to Bewsher Consulting and BMT WBM (2011).

4.1 Choice of hydraulic model

Different hydraulic modelling approaches can be applied according to the floodplain's hydraulic characteristics and the objectives of the study. The simpler methods lump the left and right overbank floodplain areas and the main channel into a one-dimensional (1D) representation. This approach is relatively simple and computationally fast, and is generally appropriate for modelling flows through pipe networks and straight sections of formed open channel. The main limitation of such 1D modelling approaches is that flow is assumed to occur in a linear direction, and the water levels across the floodplain are assumed to be at the same level as the main channel.

A more detailed two-dimensional (2D) approach is recommended in areas where significant differences can occur between the channel flood level and the floodplain flood levels. This approach is also preferable where separate flow paths and flow around catchment obstructions occur, as is the case in this study. This is a more complex analysis, which requires greater data requirements and computational resources.

The TUFLOW 1D/2D modelling system used in this study dynamically couples the one-dimensional and two-dimensional flow paths in the floodplain.

4.2 TUFLOW 1D model domain

Open channels, culverts, bridges and the pit and pipe network were represented in the TUFLOW model as 1D elements. The original 1D model was trimmed to only include those elements which interacted with the reduced 2D model domain described in section 4.3. The location and extents of the 1D model domain are depicted in 'TUFLOW model plan' (refer CC210530/F1/C, copy enclosed under Annexure B).

Two hydraulic structure blockage scenarios were considered during hydraulic modelling: a 50% blocked scenario, and a no blockage scenario. Refer Section 5.7 for further details of the blockage analysis.

4.3 TUFLOW 2D model domain

The 2D hydraulic model domain covers the area indicated as '2D model domain' in 'TUFLOW model plan' (refer CC210530/F1/C, copy enclosed under Annexure B). In order to reduce model run times, the 2D model extents were reduced from the original 2D model extent.

A square grid was utilised for this study, with a grid size of 5 m. Each grid element contains information on ground topography (see Section 4.3.1), surface resistance to flow (see Section 4.3.3) and initial water level (see Section 4.5). The grid cell size of 5 m was retained from the original TUFLOW model developed by BMT WBM and is considered to be sufficiently fine to appropriately represent the variations in floodplain topography and land use within the study area. It should be noted that TUFLOW samples elevation points at the cell centres, mid-sides and corners, as a consequence a 5 m square cell size results in surface elevations being sampled every 2.5 m.

Linear features that potentially influence flow behaviour, such as gullies and levees were incorporated into the topography using 3D 'breaklines' to ensure that these were accurately represented in the model. It is noted that although brick walls and fences could also significantly affect local overland flow paths, these have not been explicitly incorporated into the model in urban areas unless deemed critical to the study, and were instead considered in the setting of appropriate Manning's 'n' values for these areas.

4.3.1 Topography

The topography in the study area is based upon the topography of the TUFLOW model developed for Council by BMT WBM. During examination of the model, it was noted that several GIS layers defining model topography were read into the model in such a manner that elevations were assigned based on model grid co-ordinates, rather than real word co-ordinates. This approach meant that it was necessary to regenerate an approximation to the terrain model to allow the TUFLOW 2D model domain to be reduced. This was achieved by exporting the cell corner, centre and mid-side elevations at an appropriate point during terrain construction in the BMT WBM model and creating a 1 m grid Digital Elevation Model (DEM) from triangulation of these point elevations.

This 1 m grid DEM was then used to assign base ground elevations throughout the catchment. Terrain was then adjusted in accordance with the original BMT WBM model.

In the post-development model, ground levels within the site were left at pre-development levels.

4.3.2 Building footprint

The footprints of buildings within the subject site and buildings on nearby sites which had the potential to effect flow paths within the site were digitised and raised 0.5 m above adjoining ground levels to prevent stormwater flows entering the buildings. Buildings far away from the subject site or far from critical flow paths were modelled at ground level. Building outlines were determined from site survey and aerial photographs.

All buildings were modelled as having a varying Manning's 'n' hydraulic roughness value (see Section 4.3.3) to account for rapid runoff from rooves when the building footprint is not flooded, while allowing a greater degree of obstruction to flow when the building footprint is impacted by floodwaters.

4.3.3 Hydraulic roughness

Hydraulic roughness in TUFLOW is modelled using the Manning's 'n' roughness co-efficient. Land use categories were assigned to areas of the catchment based on the BMT WBM TUFLOW model, with building footprints adjusted as required. Table 1 lists the Manning's n values for each land use adopted in the BMT WBM TUFLOW model.

Table 1: Adopted roughness parameters.

Land use	Manning's n
Grass	0.100 when depth < 0.03 m; 0.030 when depth > 0.10 m Interpolated otherwise
Parkland	0.100 when depth < 0.03 m; 0.040 when depth > 0.10 m Interpolated otherwise
Open concrete and road	0.020
Dense vegetation	0.100 when depth < 0.03 m; 0.090 when depth > 0.10 m Interpolated otherwise
Building	0.015 when depth < 0.03 m; 1.000 when depth > 0.10 m Interpolated otherwise
Urban block	0.100 when depth < 0.03 m; 0.070 when depth > 0.10 m Interpolated otherwise
Railway corridor	0.100 when depth < 0.03 m; 0.080 when depth > 0.10 m Interpolated otherwise

4.4 Boundary conditions

This section describes the boundary conditions imposed upon the hydraulic model, excluding the majority of boundary conditions associated with the linkage of the 1D and 2D domains. Typical model boundary conditions include flows entering the model domain from upstream, backwater effects from hydraulic controls such as chokes and streams downstream, and the flow predicted through the model domain by a separate hydrologic model.

4.4.1 Direct rainfall boundary

A direct rainfall boundary condition was applied to the entire 2D model domain depicted in 'TUFLOW model plan' (refer CC210530/F1/C, copy enclosed under Annexure B). This boundary condition is consistent with the boundary condition imposed on the original model developed by BMT WBM.

In this regard, rainfall is applied directly to the 2D terrain covered by the direct rainfall ("rainfall on the grid") boundary condition, and the hydraulic model automatically routes the flow as determined by the elevation and roughness grids and any included 1D pipeline network.

Direct rainfall modelling is a relatively new feature of hydraulic modelling and it is still being tested on a number of catchments to ensure it is reliably representing the flood behaviour of a given catchment. Runoff is generated over the entire catchment, rather than the more traditional approach of calculating an inflow hydrograph and lumping this in at an assumed location(s). This 'direct rainfall' approach means the whole catchment will be 'wet' and the hydraulic modelling results need to be filtered to show only those cells that genuinely represent areas of catchment flooding. This was achieved by only mapping inundation at cells with a flood depth greater than 0.05 m.

4.4.2 Stage-discharge boundary

A stage-discharge (water level versus flowrate) curve was adopted as the downstream boundary condition at the location marked '2D downstream boundary' in 'TUFLOW model plan' (refer CC210530/F1/C, copy enclosed under Annexure B). This stage-discharge relationship was generated by TUFLOW by specifying a water surface slope, extracted from the peak 1% AEP water surface profile generated when running the TUFLOW model developed by BMT WBM.

4.4.3 Inflow hydrograph

Upstream catchment flows are applied directly to the 1D network at the location marked as 'Inflow' in 'TUFLOW model plan' (refer CC210530/F1/C, copy enclosed under Annexure B). The inflow hydrograph was derived by BMT WBM as part of their hydrologic analysis of the Salt Pan Creek Catchment, refer Bewsher Consulting and BMT WBM (2011) for further details.

Upstream catchment flows in excess of the capacity of the culvert under Punchbowl Road were automatically transferred from the 1D domain to the 2D domain by TUFLOW as part of the 1D/2D coupling at the location marked '2D inflow boundary' in 'TUFLOW model plan' (refer CC210530/F1/C, copy enclosed under Annexure B).

4.4.4 Tailwater boundary

Tailwater levels were applied to the 1D model domain at the location marked as 'Water level' in 'TUFLOW model plan' (refer CC210530/F1/C, copy enclosed under Annexure B). The tailwater boundary for the 1% AEP event was a constant water level of 4.01 m AHD. This tailwater level was derived by BMT WBM as part of their hydrologic analysis of the Salt Pan Creek Catchment, refer Bewsher Consulting and BMT WBM (2011) for further details.

4.5 Initial conditions

This section describes the initial conditions applied to the TUFLOW model.

4.5.1 1D domain initial conditions

During modelling of the 1% AEP flood event, the water level in the 1D domain was initialised to 4.01 m AHD in order to match the level of the 1D tailwater boundary level.

4.5.2 2D domain initial conditions

During modelling of the 1% AEP flood event, the water level in the 2D domain was initialised to 4.01 m AHD to match the initial water level in the 1D network.

4.5.3 Adjustment of initial conditions by ACOR

We note that the original model developed by BMT WBM initialised the water level within the entire 1D and 2D model domains to 4.59 m AHD. The level of 4.59 m AHD corresponds to the tailwater boundary level applied by BMT WBM to the 2D and 1D model domain outlets located at Canterbury Road near Gow Street.

ACOR adopted reduced 1D and 2D model extents such that the ACOR model terminates at Canterbury Road near Moxon Road. BMT WBM applied an initial water level of 4.59 m AHD to this portion of 1D network, yet set a 1D tailwater boundary condition of 4.01 m AHD here.

Inconsistency between tailwater boundary levels and initial conditions can cause model instability. To reduce the risk of model instability, ACOR adjusted the initial water levels for the 1D and 2D domains to match the tailwater boundary level set by BMT WBM for this branch of 1D network.

5 Flood Model Results

This section summarises the results of the hydraulic modelling of 1% AEP flood depth, velocity and hydraulic hazard within the catchment. Note that discussion of the results focuses primarily on the 50% blockage scenario, with reporting of flood behaviour for the unblocked scenario and a discussion of the impact of blockage of the underground network contained within Section 5.9.

Firstly, the flood model is validated against Council's flood information for the 1% AEP flood event. After validation of the flood model in Section 5.1, peak flowrates in the vicinity of the site are presented in Section 5.2. A summary of flood behaviour is provided in Section 5.3, with a more detailed discussion of flood hazard presented in 5.4, and commentary on floodways provided in Section 5.5. Flood Planning Levels (FPLs) are presented in Section 5.6 and the availability of evacuation routes is discussed in Section 5.7. The impact of the proposed development on 1% AEP flood behaviour is presented in Section 5.8.

5.1 Flood model validation

The pre-development 1% AEP flood behaviour predicted by the TUFLOW model developed by ACOR may be validated against the description of 1% AEP flood behaviour produced by Council's adopted model developed by BMT WBM. Validation is undertaken by comparing the 1% AEP flood behaviour in the vicinity of the site predicted by the TUFLOW model developed by ACOR for the pre-development 50% blockage scenario against the description of flooding provided in the Stormwater System Report. Firstly, the 1% AEP flood extents are considered, followed by peak 1% AEP flood levels, 1% AEP flood hazard, and finally peak flowrates.

The 1% AEP flood extents predicted by the ACOR model in the vicinity of the main flow path closely match, with the ACOR flood extents of flooding falling between Council's mapped absolute extents and the extent of flooding greater than 0.1 m. As the ACOR flood mapping uses a 0.05 m map cut-off depth, we are of the view that flood extents in the vicinity of the main flow path are appropriately replicated.

We note that the ACOR model tends to slightly underestimate flood extents on the steeper slopes on the north-western side of the channel; however, this discrepancy is not considered to be problematic for the purposes of this planning proposal.

A comparison of the peak 1% AEP flood level contours supplied by Council (refer page 4 of Stormwater System Report, copy enclosed under Annexure A) and peak 1% AEP flood level contours presented in 'Pre-development 1% AEP flood depth and level plan – 50% blockage' (refer CC210530/F13/C, copy enclosed under Annexure D) indicates that peak flood level contours are generally located less than 2.5 m from each other. Considering the effects of distortion from georeferencing images from Council's of Stormwater System Report, the grid size of 5 m and the changes in nearby building footprints, it is ACOR's view that the 1% AEP flood levels are satisfactorily reproduced.

A comparison of the 'High Risk Area' defined by Council (refer page 4 of Stormwater System Report, copy enclosed under Annexure A) and 1% AEP provisional flood hazard presented in 'Pre-development 1% AEP provisional flood hazard plan – 50% blockage' (refer CC210530/F15/C, copy enclosed under Annexure D) shows good agreement between Council's mapped High Risk Area and the mapped area of High Provisional Hazard prepared by ACOR. It is noted that the ACOR High Hazard area is slightly larger than Council's mapped High Risk Area, but this increase in area is within the tolerance of what is expected based on model grid size. In this regard, it is ACOR's view that the flood hazard is being satisfactorily recreated.

Overland flow hydrographs were provided at a number of locations near the subject site by Canterbury Bankstown Council, refer pages 10 to 15 of Stormwater System Report (copy enclosed under Annexure A). Peak overland flowrates were extracted at these locations from the TUFLOW model developed by ACOR for the pre-development 50% blocked scenario. Peak overland flows predicted by the ACOR model are benchmarked against Council's peak overland flowrates in Table 2, adopting the location numbering presented in the Stormwater System Report.

Table 2: Peak overland flowrate (m^3/s) comparison.

Location	Council	ACOR *	Difference
376	3.634	3.274	-0.360 (-9.9%)
377	5.684	5.703	+0.019 (+0.3%)
378	6.075	6.018	-0.057 (-0.9%)
379	1.085	1.223	+0.138 (+12.7%)
380	15.855	15.901	+0.046 (+0.3%)

Note: * Reported flowrate is the peak instantaneous flowrate.

It is observed that peak flowrates predicted by the ACOR model are generally in good agreement with peak flowrates predicted by Council's model in the vicinity of the site. The discrepancies in predicted peak overland flowrate are not unexpected and are not considered problematic. In additional to the factors presented at the end of this section, discrepancies in reported peak overland flowrate may be partly explained by the manner in which reported peak flowrates were extracted. Council's peak overland flowrate presented above was extracted from hydrographs reporting the flowrate at 15 second intervals; while ACOR has reported the peak instantaneous flowrate, which is tracked at every computational timestep (every second). The peak instantaneous flowrate did not occur at one of the computational timesteps reported by Council. However, it is noted that the peak instantaneous flowrate is not more than 0.011 m^3/s above the maximum flowrate from hydrographs using a 15 second reporting interval and thus the difference is not entirely due to reporting method.

The TUFLOW model developed by ACOR has been shown to satisfactorily reproduce the 1% AEP flood extents, levels, hazard and flowrates. Discrepancies in predicted flood behaviour may be due to one or more of the following factors:

- Changes in the TUFLOW software package since the 2009-07-AD release.
- Differences in topography resulting from the use of an approximation to the base DEM in the ACOR model (refer Section 4.3.1).
- Updated building footprints in the vicinity of the site.
- Adjustment of the 2D model domain may have resulted in small changes in contributing catchment area.

Based on the foregoing, we are of the view that the TUFLOW model adjustments undertaken by ACOR have resulted in a model which is fit for purpose for assessing 1% AEP flood behaviour and the impact of the planning proposal on 1% AEP flood behaviour. As noted in Section 2.1.4, ACOR is of the view that the existing model is not fit for purpose to assess PMF flood behaviour at the site. ACOR has not undertaken sufficient adjustments to overcome the identified shortcomings of the model when used to predict PMF flood behaviour.

5.2 Design flowrates

Peak 1% AEP flowrates for overland flows and flows through the underground network are presented in Table 3. Flowrate locations are as identified on page 10 of Stormwater System Report (copy enclosed under Annexure A). Peak flows from the north and west impact the site approximately 50 minutes after the commencement of the storm burst, while peak flows entering the site from Punchbowl Road arrive later at approximately 1.5 hours after the commencement of the storm burst.

Table 3: Peak 1% AEP flowrates (m^3/s).

Location	Overland & open channel flow	Pipe flow
376	28.709	N/A
377	5.703	4.624
378	31.118	N/A
379	1.223	0.607
380	15.901	20.377

5.3 Design flood characteristics

The water level, depth, velocity and hazard of the 1% AEP floodwaters in the vicinity of the subject site were mapped for both pre- and post-development scenarios. The following maps are enclosed under Annexure D :

- Pre-development 1% AEP flood depth and level plan – 50% blockage (refer CC210530/F13/C)
- Pre-development 1% AEP flood velocity plan – 50% blockage (refer CC210530/F14/C)
- Pre-development 1% AEP provisional flood hazard plan – 50% blockage (refer CC210530/F15/C)
- Pre-development 1% AEP flood hazard vulnerability plan – 50% blockage (refer CC210530/F16/C)
- Post-development 1% AEP flood depth and level plan – 50% blockage (refer CC210530/F17/C)
- Post-development 1% AEP flood velocity plan – 50% blockage (refer CC210530/F18/C)
- Post-development 1% AEP provisional flood hazard plan – 50% blockage (refer CC210530/F19/C)
- Post-development 1% AEP flood hazard vulnerability plan – 50% blockage (refer CC210530/F20/C)

Localised stormwater flows pond to depths up to 0.3 m at the parts of the site known as No.'s 913, to 919 Punchbowl Road, Punchbowl. We note that these flows are considered stormwater flows in line with Council's Stormwater System Report.

Flows in the vicinity of the existing open channel follow the channel alignment, generally traversing the site from north to south. Some floodwaters the site from the east, where flows from the catchment to the east enter a culvert under Punchbowl Road, flowing generally west overland to the existing open channel.

The parts of the site known as Lot 6 DP5245 and Lot D DP 382627 are significantly flood affected, with notable flooding also occurring on Lot 15 DP 132440 to the north and west of the existing club building. The remainder of the subject site experiences limited to no inundation during the 1% AEP flood event.

The 1% AEP floodwaters impact the site at elevations within the range 7.2 m AHD to 7.5 m AHD, partially inundating the site to depths in excess of 2 m. As expected, flood depths are deepest near the existing open channel located near the western boundary of the site. Away from the existing open channel, flood depths are generally less than 0.75 m deep.

Flow velocities within the open channel are high, exceeding 4 m/s during the 1% AEP flood event. Away from the open channel, 1% AEP flood velocities are typically less than 2 m/s, with much of the site impacted by flow velocities less than 1 m/s.

1% AEP floodwaters create High Hazard (H4-H6) conditions within and adjacent to the open channel. Flows entering the site from Punchbowl Road generally create Low Hazard (H1-H3) conditions within the site. In the pre-development scenario, localised High Hazard (H3-H4) floodwaters occur near the north-western corner of the existing club building. In the post-development scenario, High Hazard (H3-H5) floodwaters impact the proposed road layout near the indicative turning head and near the intersection of the two internal roads.

5.4 Flood hazard

The degree of provisional hazard attributed to flooding at the subject site is a function of hydraulic hazard (relating to the depth and velocity of floodwaters). The true hazard attributed to flood behaviour is based on provisional hazard ratings which have been adjusted to account for the following factors:

- Size of flood;
- Effective warning time;
- Flood awareness;
- Rate of rise of floodwater;
- Duration of flooding;
- Evacuation problems;
- Effective flood access; and
- Type of development.

Provisional flood hazard has been determined using the provisional hydraulic categories described in the Appendix L of Floodplain Development Manual (NSW DIPNR 2005), refer Section 5.4.1, and the hazard vulnerability classification system described in Australian Disaster Resilience Guideline 7-3: Flood Hazard (AIDR 2017), refer Section 5.4.2.

5.4.1 NSW Floodplain Development Manual

The NSW Floodplain Development Manual assigns provisional hazard categories of low, intermediate or high to floodwaters based on the velocity and depth of flows. The relationship between depth, velocity and hazard is presented in Figure L.2 of NSW DIPNR (2005) which is reproduced in Figure 1.

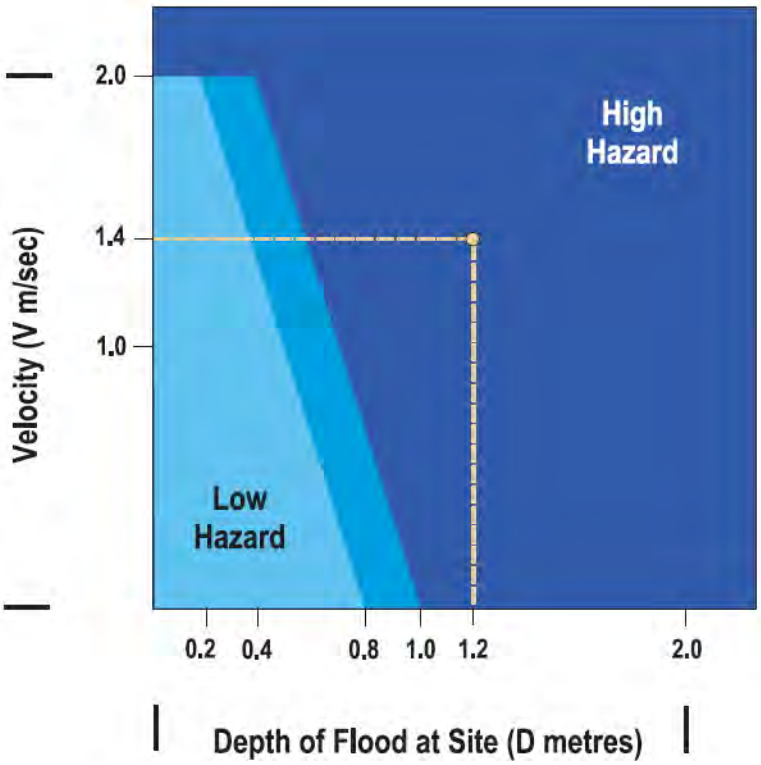

Figure 1: Provisional flood hazard (NSW DIPNR 2005).

Areas of the site located near the existing open channel are impacted by high hazard floodwaters. The remainder of the site is impacted by low hazard floodwaters.

The proposed buildings, with the exception of the building located immediately south-east of the proposed turning head, are impacted by low hazard floodwaters during the 1% AEP flood event. The building located immediately south-east of the proposed turning head is impacted by high hazard floodwaters at the north-west corner, with the remainder of the building impacted by low hazard floodwaters.

Indicative driveway access to the two buildings adjoining the proposed turning head is impacted by intermediate to high hazard floodwaters. We note that alternative potential vehicle access points to these buildings are available which are located within the low hazard area, and furthermore road design during DA stage will be required to provide trafficable levels and vehicle access to the proposed buildings. We are of the view that this matter can be satisfactorily resolved at DA stage.

Low hazard or flood free pedestrian access and egress is available to all buildings during the 1% AEP flood event.

5.4.2 AIDR Guideline 7-3

'Australian Disaster Resilience Guideline 7-3: Flood Hazard' (AIDR 2017) assigns hazard vulnerability classifications based on the depth and velocity of floodwaters, accounting for the vulnerability of the community and community assets to damage or danger when interacting with floodwaters. The relationship between depth, velocity and hazard vulnerability classification is depicted in Figure 6 of AIDR (2017), reproduced in Figure 2 and summarised in Table 4.

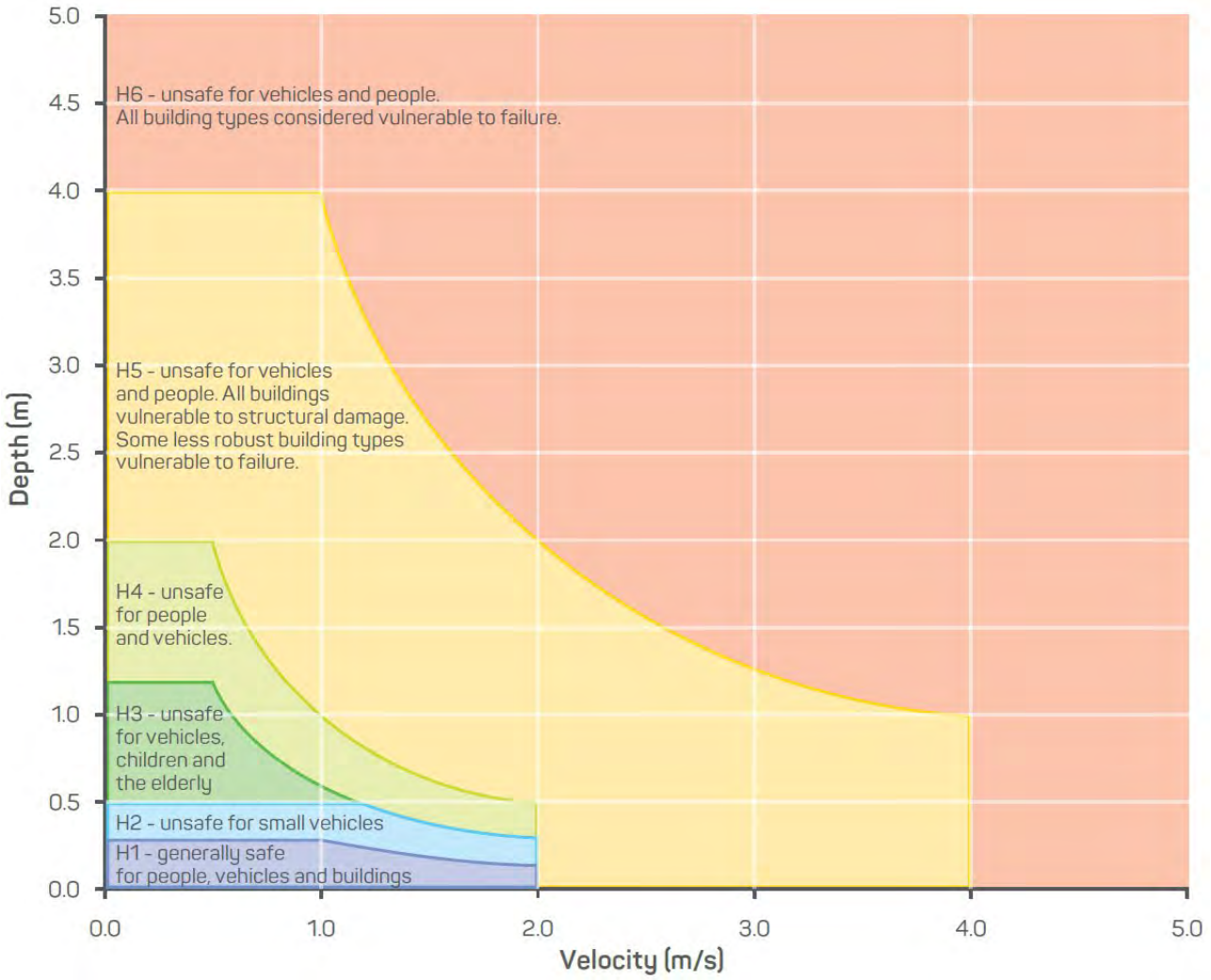

Figure 2: Hazard vulnerability classification (AIDR 2017).

Table 4: Description of hazard vulnerability classifications (AIDR 2017).

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

Areas of the site located near the existing open channel are impacted by H4 to H6 classification floodwaters. The remainder if the site is impacted by H1 to H3 classification floodwaters.

The proposed buildings are impacted by H1 to H3 classification floodwaters during the 1% AEP flood event.

Indicative driveway access to the two buildings adjoining the proposed turning head is impacted by H3 classification floodwaters. We note that alternative potential vehicle access points to these buildings are available which are located within trafficable areas, and furthermore road design during DA stage will be required to provide trafficable levels and vehicle access to the proposed buildings. We are of the view that this matter can be satisfactorily resolved at DA stage.

Flood free or H1 to H2 classification impacted pedestrian access and egress is available to all buildings during the 1% AEP flood event.

5.5 Delineation of floodways and flood storage areas

Delineation of floodways and flood storage areas was not undertaken as part of this study.

We refer to 'Salt Pan Creek Catchments Floodplain Risk Management Study and Plan' and note that floodways were not formally defined during preparation of Council's adopted Floodplain Risk Management Study and Plan. It was noted by Bewsher Consulting (2013) that the use of an indicator technique, which derived floodways as areas where velocity-depth product exceeded 1 m^2/s, resulted in all areas identified as potential floodways falling within previously mapped high hazard areas, but that not all high hazard areas were classified as floodways. We note that the mapped areas of high hazard in the vicinity of the existing and proposed development are primarily high hazard due to depth, and do not have a velocity-depth product approaching 1 m^2/s. In this regard, no part of the proposed development is located within a floodway as defined by Bewsher Consulting (2013).

We refer to the definition of a floodway provided in 'Floodplain Development Manual' (NSW DIPNR 2005): "*Floodways are areas conveying a significant proportion of the flood flow and where partial blocking will adversely affect flood behaviour to a significant and unacceptable extent.*", and guidance which indicates that a impact suitable threshold for assigning hydraulic classifications is a flood level increase if 0.1 m or an increase in peak flowrate of 10%. It is demonstrated in Section 5.8 that the proposed development does not cause flood level increases of 0.1 m and the increase in peak discharge is less than 3%. In this regard, the impact of the proposed development does not meet the criteria for defining a floodway or flood storage area under 'Floodplain Development Manual' (NSW DIPNR 2005).

Based on the foregoing. We are of the view that the proposed buildings are not located within a floodway or flood storage area.

5.6 Flood Planning Levels

In accordance with Schedule 5 of Bankstown Development Control Plan 2015 Part B12, a freeboard of 0.5 m is to be applied to the 1% AEP flood levels to determine the Flood Planning Level for the proposed development.

In this regard, the Flood Planning Level applicable to buildings in the north of the site and fronting Punchbowl Road is 8.0 m AHD, while the Flood Planning Level applicable to the proposed club building and the two residential buildings adjoining the proposed turning head is 7.8 m AHD.

The proposed development is located partly within the Medium Flood Risk Precinct and partly within the Low Flood Risk Precinct as defined by Bankstown Development Control Plan 2015 Part B12.

5.7 Availability of evacuation routes

During the 1% AEP flood event, Low Hazard (H1-H2) pedestrian access and egress is available from the existing and proposed structures on site.

The south-western part of the current indicative road layout is impacted by Intermediate to High Hazard (H3-H4) floodwaters, potentially preventing vehicle egress from two of the proposed residential buildings during the 1% AEP flood event. We note that alternative vehicle entry points to these buildings can be designed at DA stage which would provide vehicle access and egress which is either trafficable or flood free during the 1% AEP flood event. Furthermore, we note that detailed design of the proposed internal road layout at DA stage will be required to provide effective pedestrian and vehicular access and egress during the 1% AEP flood event.

5.8 Impact of the proposed development

The impact of the proposed development on 1% AEP flood levels is depicted in the following figures enclosed under Annexure D :

- Post-development 1% AEP flood level difference plan – 50% blockage (refer CC210530/F21/C)
- Post-development 1% AEP flood velocity difference plan – 50% blockage (refer CC210530/F22/C)
- Post-development 1% AEP flood hazard vulnerability difference plan – 50% blockage (refer CC210530/F23/C)

The 1% AEP flood levels within the site increase in the vicinity of the proposed buildings. Flood level increases are largely less than 0.05 m and do not exceed 0.1 m. The impact of the proposed development is greatest at the proposed southern entrance to the site, where flows from the east enter the site. Floodwater velocities are altered along the length of the proposed southern access road due to realignment of the flow path through the site. There is an increase in flood hazard along the proposed southern access road. We note that reliable pedestrian evacuation routes are available from all proposed buildings, and it is our view that appropriate measures to address the change in flood behaviour along the proposed southern access road can be addressed at DA stage.

The proposed development causes minor increases in inundation extents at the site known as Lot 12 DP 1027748 (No. 23) Canterbury Road, Punchbowl. This site also experiences a minor localised increase in 1% AEP flood level within the range 0.01 m to 0.02 m, minor localised changes in floodwater velocity within the range 0.05 m/s to 0.10 m/s, and minor localised increases in hazard vulnerability classification which are not located near any existing structures. It is our view that the increase in inundation extent at this site is negligible as it is the result of a +0.005 m increase in flood level. It is our view that the modelled small pockets of flood hazard vulnerability classification shifting up by one classification level should not be considered significant as they are due to very small changes in flood level and velocity, many of which are too small to show as changes on the velocity and level difference maps. Based on the foregoing, the impact of the proposed development on No. 23 Canterbury Road is negligible.

The proposed development results in minor decreases in 1% AEP flood levels on the site known as Lot 53 DP 15551 (No. 911) Punchbowl Road, Punchbowl. Associated with this decrease in flood level is a slight reduction in inundation extents and no change in flood hazard. In this regard, the proposed development has a neutral or beneficial impact on the flood affectation of the site known as No. 911 Punchbowl Road.

The proposed development results in increased flood levels within Punchbowl Road immediately adjoining the site. The increase in 1% AEP flood level is generally within the range +0.01 m to +0.02 m, with a couple of instances of flood level increases of up to +0.05 m. Associated with the modelled water level increase is the occurrence of localised pockets of H1 floodwaters being increased to H2 classification floodwaters. It is our view that this increase in flood level and hazard does not represent a significant impact as reliable pedestrian and vehicular egress is still available from the site and the evacuation of other sites is not affected.

The proposed development does not have a significant impact on peak overland flow rates in the vicinity of the site, with post-development scenario peak overland flowrates being within 3% of pre-development peak flowrates, refer Table 5.

Table 5: Impact of the proposed development on peak overland flowrates (m^3/s).

Location	Pre-development	Post-development	Impact
376	3.274	3.275	+0.001 (+0.0%)
377	5.703	5.629	-0.075 (-1.3%)
378	6.018	6.187	+0.168 (+2.8%)
379	1.223	1.223	+0.000 (+0.0%)
380	15.901	16.231	+0.330 (+2.1%)

Based on the foregoing, we are of the view that the planning proposal does not result in significant flood impacts on other properties and will not result in a significantly increased requirement for government spending on emergency management services, flood mitigation or emergency response measures.

5.9 Blockage sensitivity analysis

A sensitivity analysis was undertaken to determine the effect of blockage of the 1D network on flood behaviour. The following blockage scenarios were considered:

- "0% blockage": no blockage of bridges, culverts or inlets.
- "50% blockage": described in supplied model control files as 50% blockage applied to bridges and culverts with a diagonal width of less than 6 m, 50% blockage of grates and 20% blockage of lintels.

Flood behaviour for pre- and post-development site conditions under the 0% blockage scenario is enclosed under Annexure C . Under the 0% blockage scenario, 1% AEP flood levels within the open channel in the west of the site are within the range 6.4 m AHD to 7.1 m AHD, while flows entering the site from Punchbowl Road impact the site at elevations within the range 6.4 m AHD to 7.4 m AHD. Away from the open channel, the 1% AEP floodwaters partially inundate the site to depths up to 0.75 m with the majority of flows shallower than 0.25 m. Flows impacting the proposed development create H1 to H2 hazard vulnerability conditions, posing low risk to occupants of the site and allowing effective evacuation of the site.

Flood mapping for the 50% blockage scenario is enclosed under Annexure D . Flood behaviour for the 50% blockage scenario is described in detail in Section 5.

The impact of blockage of hydraulic structures within the study area on 1% AEP post-development flood levels is depicted in the following maps enclosed under Annexure E :

- 1% AEP flood level blockage sensitivity plan – post-development (refer CC210530/F24/C)
- 1% AEP flood velocity blockage sensitivity plan – post-development (refer CC210530/F25/C)
- 1% AEP flood hazard vulnerability blockage sensitivity plan – post-development (refer CC210530/F26/C)

The partial blockage of hydraulic structures and the underground drainage system causes a significant rise in flood levels and associated increase in inundation extents at several locations within the 2D model domain, but most notably in the vicinity of the site. Flood levels within the site are increased by 0.15 m to 0.90 m.

Partial blockage of the underground network causes the peak flowrate of overland flows entering the site from Punchbowl Road to more than double. Associated with this significant increase in peak flowrate is an increase in floodwater velocity and hazard vulnerability classification.

6 Formal response to Ministerial Direction

This section presents a formal response outlining the level of compliance of the planning proposal with Direction 4.1 issued by the Minister for Planning to relevant planning authorities under section 9.1(2) of the *Environmental Planning and Assessment Act 1979*.

Direction:

"(1) 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."

Response:

The planning proposal includes provisions which do not have significant impacts on the flood affectation of other properties. The planning proposal maintains the current flood planning area. The planning proposal allows for safe and effective evacuation of the development during the 1% AEP flood event. The planning proposal seeks to manage risks to life and property posed by flooding of the site. In this regard, we are of the view that the planning proposal is consistent with Clause (1) of the Ministerial Direction.

Direction:

"(2) A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Business, Industrial or Special Purpose Zones."

Response:

The site is zoned partly R2 Low Density Residential and partly B1 Neighbourhood Centre. The planning proposal seeks to rezone the site to B1 Neighbourhood Centre. In this regard, the planning proposal is consistent with the requirements of Clause (2) of the Ministerial Direction.

Direction:

"(3) A planning proposal must not contain provisions that apply to the flood planning area 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

(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event."

Response:

Floodways were not defined in the adopted Floodplain Risk Management Study and Plan covering the site, and were not formally derived as part of this report. Based on the impacts of the proposal, we are of the view that the planning proposal does not permit development within floodway areas. In this regard, the planning proposal is consistent with Clause (3)(a) of the Ministerial Direction.

The planning proposal does not cause significant flood impacts to other properties. In this regard, the planning proposal is consistent with Clause (3)(b) of the Ministerial Direction.

The planning proposal does not seek to locate residential accommodation within high hazard areas. In this regard, the planning proposal is consistent with Clause (3)(c) of the Ministerial Direction.

While the planning proposal increases the development of the land, we note that several of the lots are presently vacant.

The planning proposal does not seek to create childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres or seniors housing. Additionally, we note that occupants of the site can effectively evacuate. In this regard, the planning proposal is consistent with Clause (3)(e) of the Ministerial Direction.

The planning proposal does not seek to permit development to be carried out without development consent except for the purposes of exempt development or agriculture. In this regard, the planning proposal is consistent with Clause (3)(f) of the Ministerial Direction.

The proposed development is not likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation or emergency response measures. In this regard, the planning proposal is consistent with Clause (3)(g) of the Ministerial Direction.

The planning proposal does not seek to permit hazardous industries or hazardous storage establishments. In this regard, the planning proposal is consistent with Clause (3)(h) of the Ministerial Direction.

Direction:

"(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 a significant increase in the dwelling density of that land,

(d) permit the development 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,

(e) are likely to affect the safe occupation of and efficient evacuation of the lot, or

(f) are likely to result in a significantly increased requirement for government spending on emergency management services, and flood mitigation and emergency response measures, which can include but not limited to road infrastructure, flood mitigation infrastructure and utilities."

Response:

Bankstown Local Environmental Plan 2015 has not adopted the Special Flood Considerations standard clause. In this regard, Clause (4) of the Ministerial Direction does not apply to the planning proposal.

Direction:

"(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."

Response:

The planning proposal does not seek to vary the existing freeboard requirement of 0.5 m and does not propose to vary the defined flood event from the existing defined flood event of 1% AEP. Based on the foregoing, the proposal incorporates a flood planning area which is consistent with the adopted Floodplain Risk Management Study and Plan and is consistent with the principles of the Floodplain Development Manual. In this regard, the planning proposal is consistent with the requirements of Clause (5) of the Ministerial Direction.

7 Conclusion

A planning proposal seeks to rezone land located at the sites known as No. 21 Canterbury Road and No.'s 913 to 919 Punchbowl Road, Punchbowl. It is proposed to rezone the land from partly R2 Low Density Residential and partly B1 Neighbourhood Centre to B1 Neighbourhood Centre. Associated with the rezoning of the site is the development of the site to support a mixed-use building and several residential apartment buildings.

The site is located within the Salt Pan Creek catchment. A TUFLOW 1D/2D model was developed to determine design flood behaviour at the site and evaluate the impact of the planning proposal on flood behaviour. The hydrologic and hydraulic modelling of the catchment is described in Sections 3 and 4 respectively. The results of the flood modelling are presented in Section 5.

The site is impacted by flows from a stormwater channel located along the western boundary of the site, and flows overtopping the culvert passing under Punchbowl Road to the east of the site. A blockage sensitivity analysis, undertaken in Section 5.9 has demonstrated that the blockage factors applied to the underground drainage network have a significant effect on flood behaviour at the site.

For the purposes of the flood impact assessment, a 50% blockage scenario was adopted for design flood modelling. This is consistent with Council's adopted flood study covering the site. The TUFLOW model developed for this report produces a description of 1% AEP flood behaviour which is in good agreement with Council's flood information, refer Section 5.1. As noted in Section 2.1.4, we are of the view that the model is not suitable for assessing PMF flood behaviour.

The parts of the site located near the existing stormwater channel are impacted by high hazard floodwaters. The proposed development is located within low hazard floodwaters. It is our view that the proposed development is not located within a defined floodway. Reliable pedestrian and vehicular egress are achievable from the proposed development.

The Flood Planning Level, providing 0.5 m freeboard to the 1% AEP floodwaters, varies from 8.0 m at Punchbowl Road to 7.8 m AHD at the western edge of the proposed building footprints.

The proposed development does not result in significant flood impacts on other property, refer Section 5.8.

A formal response outlining the level of compliance of the planning proposal with Direction 4.1 issued by the Minister for Planning to relevant planning authorities under section 9.1(2) of the *Environmental Planning and Assessment Act 1979* is provided in Section 6. It is our view that the planning proposal is generally consistent with the Ministerial Direction.

Yours faithfully,
ACOR Consultants (CC) Pty Ltd

"[Click here to add author]"
"[Click here to add qualifications & post-nominals]"

8 References

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9 Glossary

Terminology in this Glossary has been derived or adapted from the Floodplain Development Manual (NSW DIPNR 2005), where appropriate.

Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, 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.
Design flood	A flood event to be considered in the design process.
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, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood hazard	A measure of the floodwaters potential to cause harm or loss. Full definitions of hazard categories are provided in Appendix L of the Floodplain Development Manual (NSW Government, 2005). In summary: ▪ High: conditions that pose a possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty wading to safety; potential for significant structural damage to buildings. ▪ Low: conditions such that people and their possessions could be evacuated by trucks; able-bodied adults would have little difficulty wading to safety.
Flood planning area	The area of land below the FPL and thus subject to flood related development controls.
Flood planning levels (FPLs)	Combinations of flood levels (derived from significant historical flood events or floods of specific ARIs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans.
Floodplain, flood-prone land	Land susceptible to inundation by the probable maximum flood (PMF) event, i.e. the maximum extent of flood liable land.
Floodplain risk management options	The measures that might be feasible for the management of a particular area of the floodplain.
Freeboard	Provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc.
Geographical information systems (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.
Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.

Hydraulic category	A classification of floodwater hydraulic behaviour. The categories are: ▪ Floodway: those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels. ▪ Flood storage: those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. ▪ Flood fringe: remaining area of flood-prone land after floodway and flood storage areas have been defined.
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
Local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Peak discharge	The maximum discharge occurring during a flood event.
Probable maximum flood (PMF)	The PMF is the largest flood that could conceivably occur at a particular location.
Probable Maximum Precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location.
Probability	A statistical measure of the expected frequency or occurrence of flooding.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. For this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.

Annexure A Stormwater System Report issued 18 August 2016 by Canterbury Bankstown Council, reference WP-SIA/978/2016

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BANKSTOWN CITY COUNCIL

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STORMWATER SYSTEM REPORT
921, 921A, 921B, 923, 925 Punchbowl Road & 21 Canterbury Road, PUNCHBOWL NSW 2196

Date: 18-Aug-2016
Ref: WP-SIA/978/2016
Development type: **Residential Flat Buildings**

YES — FLOOD/OVERLAND FLOW STUDY & FLOOD IMPACT STATEMENT REQUIRED

The site is affected by the following Council & Sydney Water stormwater system components:

- An open channel & culvert (according to Council records) and associated variable width easements located within the site.

- Overland flowpath [floodway] for excess stormwater runoff from the upstream catchment and associated with these drainage systems.

The site will be subject to stormwater inundation from this overland flowpath during large storm events. Refer to the attached **"100 Year ARI Flood Extent Maps from Salt Pan Creek Catchment Study"** showing the flood contours to mAHD**. Provision should be made on site, and at boundary fences, for this stormwater runoff to pass unobstructed over the site. Stormwater flowing naturally onto the site must not be impeded or diverted.

For the proposed development, it will be necessary to carry out a flood/overland flow study to determine the following:

- **The post development 100 year ARI* water surface levels, and extent of flooding, at the site.**

- **The impact of the development on the 100 year ARI* inundation levels and on adjoining properties.**

- **The required floodway width for conveyance of the 100 year ARI* overland flow through the site (based on a maximum velocity-depth product of 0.4m²/s). The floodway calculations need to incorporate any requirements of the Department of Water and Energy (DWE) for a riparian corridor along the open creek.**

- **The hydraulic grade line of the proposed drainage system from the site to the point of connection to Council's system, for the 10 year ARI* storm.**

- **Boundary fencing treatments necessary to pass the design floodway flows.**

The necessary flood/overland flow study shall be prepared by a qualified Civil Engineer competent in the field of drainage analysis. Flood/overland flow study requirements are detailed in Bankstown Council's *Development Engineering Standards** . The Flood Study & Flood Impact Statement shall be subject to Sydney Water's approval.**

The completed flood/ overland flow study and drainage concept plan are to be submitted with your Development Application. The concept drainage plan is to show all necessary floodways and minimum floor levels as determined by the flood / overland flow study.

The Development Application submission shall be based on an AHD datum for levels where sites are affected by overland flow / flooding. Refer Bankstown Council's *Development Engineering Standards**.**

The proposed development including floor levels, shall comply with the development controls specified in Part B12 Schedule 5, of Bankstown's Development Control Plan 2015 - Catchments Affected by Stormwater Flooding.

Habitable floor levels are to be at least 500mm above the 100 year ARI* flood level at the site adjacent to the proposed buildings.

Garage floor levels are to be no lower than the determined 100 year ARI* flood level.

Runoff from the site is to be collected and piped by gravity to open channel & culverts at the site. **The connection is subject to Sydney Water's approval**.

Runoff on the site, and naturally draining to it is to be collected and disposed of to Council's requirements detailed in Bankstown Council's *Development Engineering Standards****.

All structures and buildings must be located clear of open channel, culvert, easements. Proposed structures may require special footings due to their proximity to stormwater easements and pipelines. Refer to Bankstown Council's *Development Engineering Standards****.

This report is based on site plans prepared by CMT Architects dated 20/07/2016 no site survey. Council may choose to vary some report requirements following evaluation of detailed plans when they are submitted.

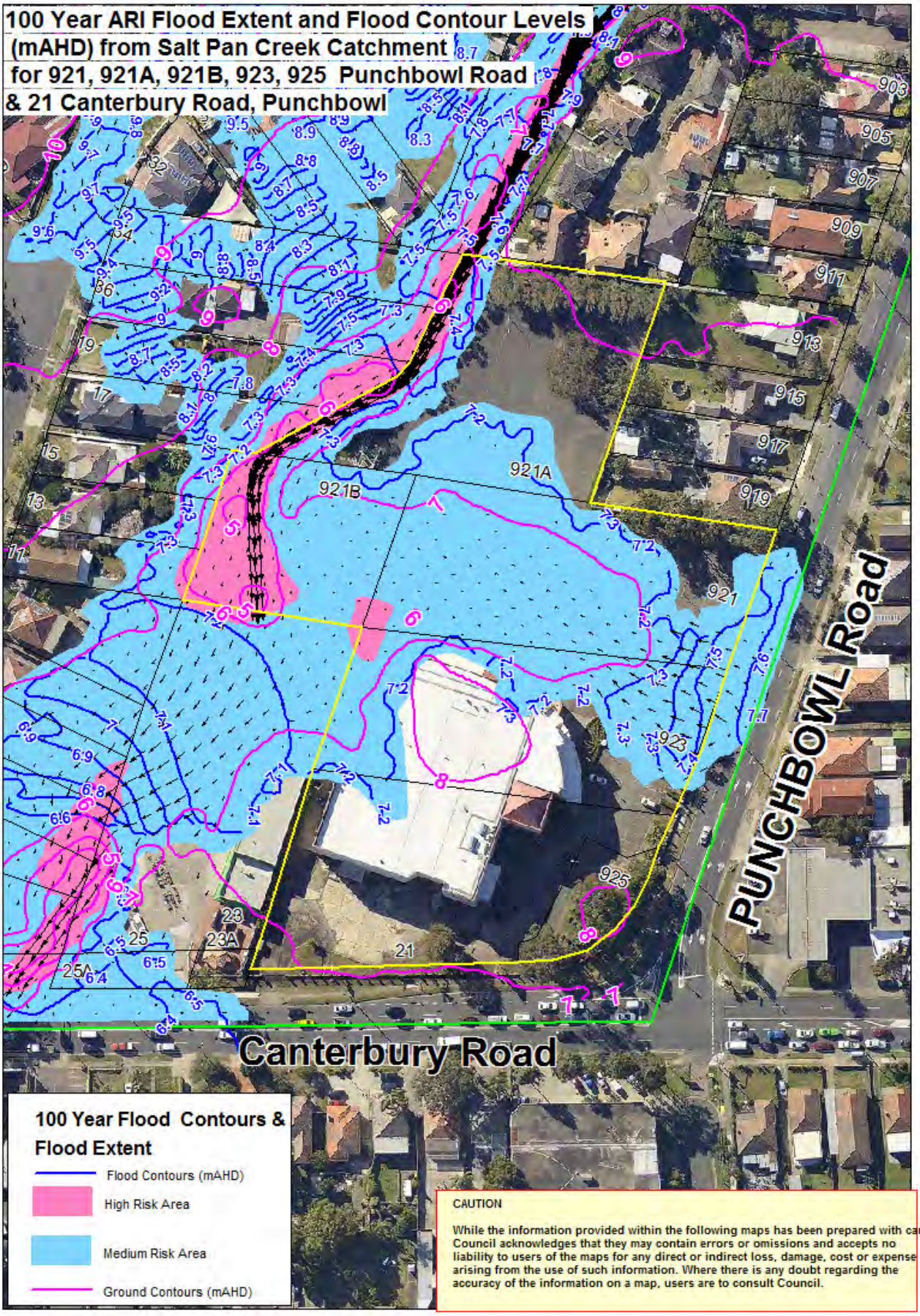
This report relates to the exposure of the subject site to Council's & Sydney Water's &stormwater system, both underground and overland. It does not assess the suitability or otherwise of this site for the proposed development.

* Average Recurrence Interval

** Australian Height Datum

*** Bankstown Council's *Development Engineering Standards* and *Bankstown's Development Control Plan 2015* is available from Council's Customer Service Centre, and from http://www.bankstown.nsw.gov.au/planb/guidelines/dcp.cfm

Pushpa Goonetilleke
ENGINEER



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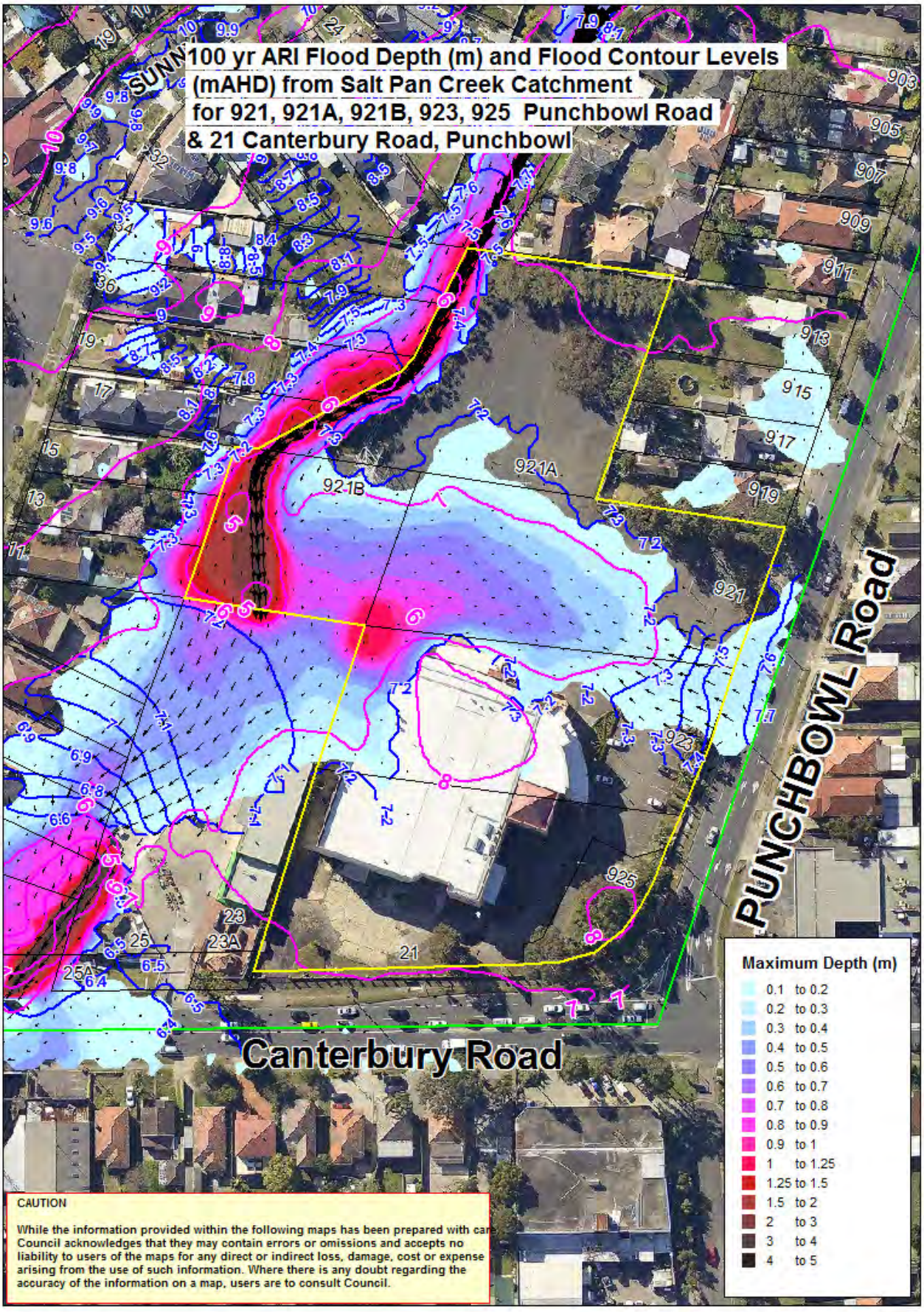
100 yr ARI Flood Depth (m) and Flood Contour Levels (mAHD) from Salt Pan Creek Catchment for 921, 921A, 921B, 923, 925 Punchbowl Road & 21 Canterbury Road, Punchbowl
PUNCHBOWL Road
Canterbury Road
921
921A
921B
923
925
21
23
23A
25
25A
Maximum Depth (m)
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
0.7 to 0.8
0.8 to 0.9
0.9 to 1
1 to 1.25
1.25 to 1.5
1.5 to 2
2 to 3
3 to 4
4 to 5
CAUTION
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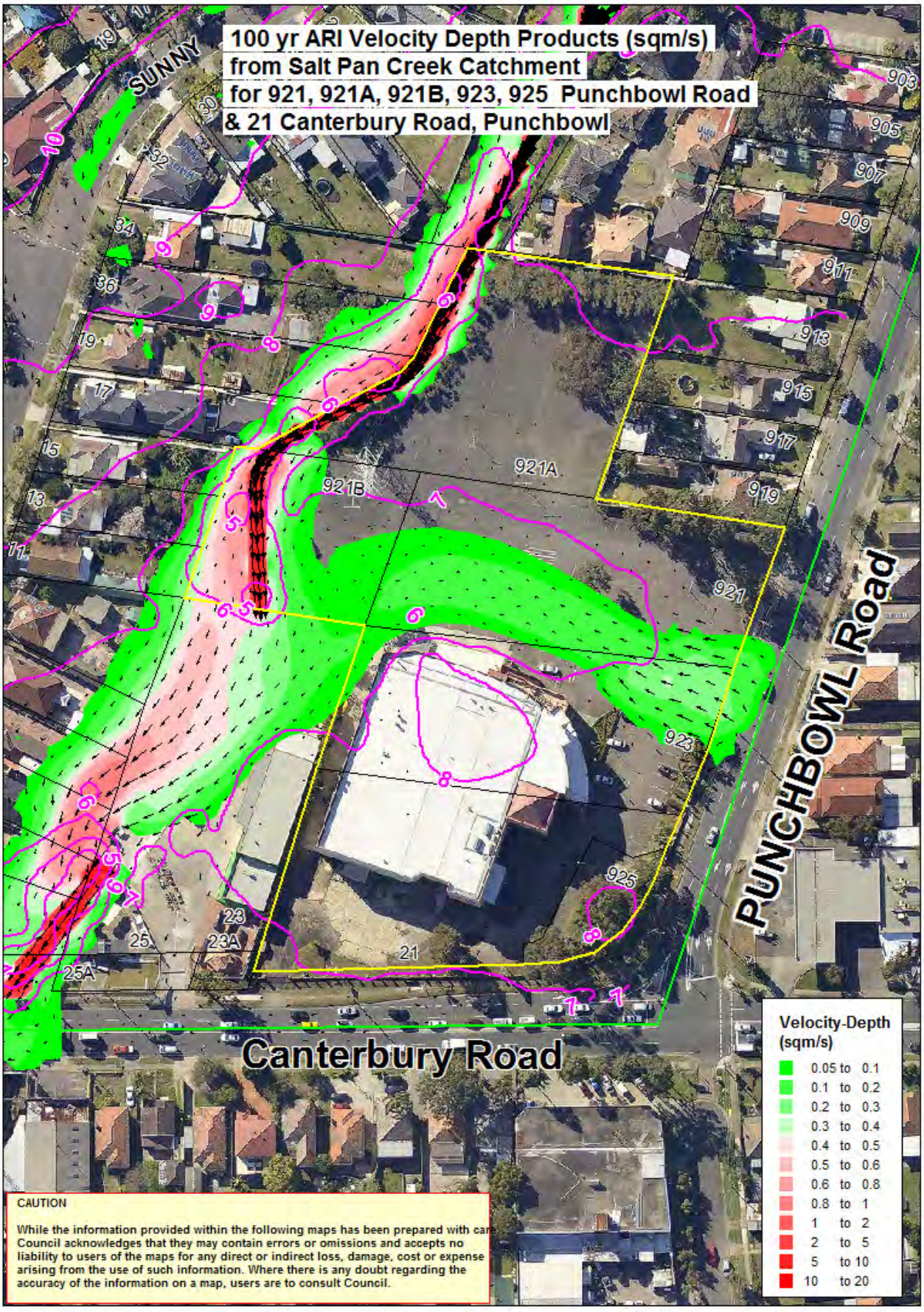
100 yr ARI Velocity Depth Products (sqm/s)
from Salt Pan Creek Catchment
for 921, 921A, 921B, 923, 925 Punchbowl Road
& 21 Canterbury Road, Punchbowl
SUNNY
PUNCHBOWL Road
Canterbury Road
921A
921B
921
923
925
21
23
23A
25
25A
903
905
907
909
911
913
915
917
919
Velocity-Depth (sqm/s)
0.05 to 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.8
0.8 to 1
1 to 2
2 to 5
5 to 10
10 to 20
CAUTION
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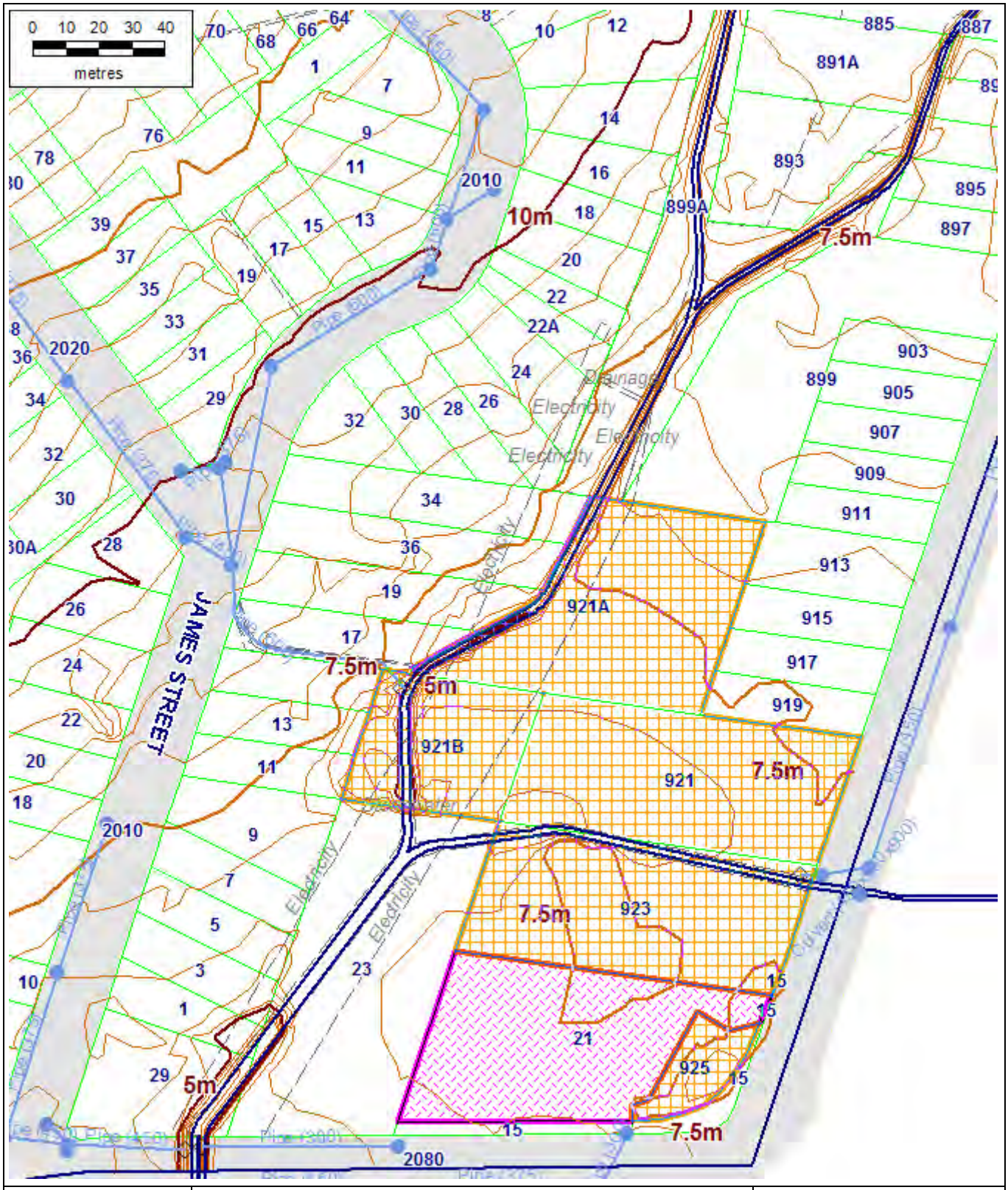

1:1,677
22 August 2016

921 Punchbowl Road, Punchbowl

GIS Map

DISCLAIMER: COUNCIL EXPRESSLY DISCLAIMS ALL LIABILITY FOR ERRORS OR OMISSIONS.
THIS PLAN HAS NO LEGAL STANDING

The NEW City of CANTERBURY BANKSTOWN

1:1,677
22 August 2016

921 Punchbowl Road, Punchbowl

Aerial Map

DISCLAIMER: COUNCIL EXPRESSLY DISCLAIMS ALL LIABILITY FOR ERRORS OR OMISSIONS.
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The NEW City of CANTERBURY BANKSTOWN

Legend

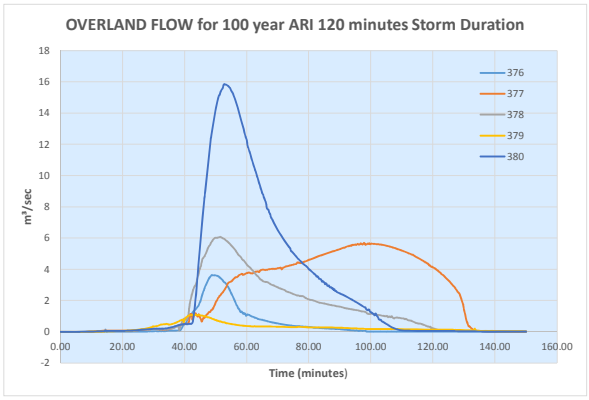
- Suburb
- Drainage Conduits
- Drainage Devices
- Sydney Water
- Contour Major 5m
- Contour Intermediate 2.5m
- Contour Minor 0.5m
- Parcel
- Parcel Associate
- Parcel Vinculum
- Jetty
- Easements
- Road Boundaries
- Aerial Photo August 2013
- Road Names
- Road Sections
- Airport Internal Road
- Water Boundary
- Railway
- Airport Taxiway

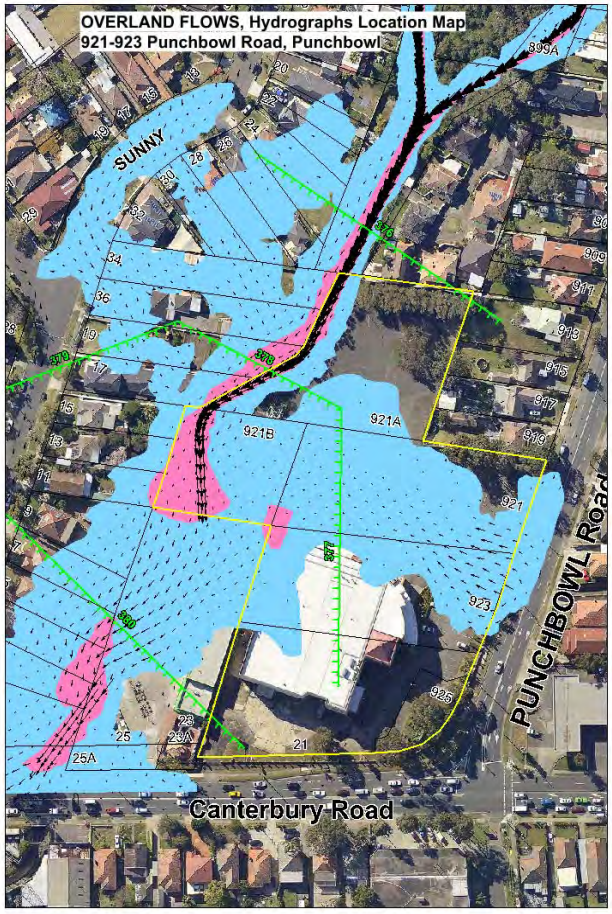
Stormwater Data from Salt Pan Creek Catchment study

Property address:- 921A, 921B, 921 923 Punhbowl Road, & 21 Canterbury Road

Location →→→		376	377	378	379	380 →→→
Time(hours)	Minutes	m³/sec	m³/sec	m³/sec	m³/sec	m³/sec
0	0.00	0	0	0	0	0
0.004167	0.25	0	0	0	0	0
0.008333	0.50	0	0	0	0	0
0.0125	0.75	0	0	0	0	0
0.016667	1.00	0	0	0	0	0
0.020833	1.25	0	0	0	0	0
0.025	1.50	0	0	0	0	0
0.029167	1.75	0	0	0	0	0
0.033333	2.00	0	0	0	0	0
0.0375	2.25	0	0	0	0	0
0.041667	2.50	0	0	0	0	0
0.045833	2.75	0	0	0	0	0
0.05	3.00	0	0	0	0	0
0.054167	3.25	0	0	0	0	0
0.058333	3.50	0	0	0	0	0
0.0625	3.75	0	0	0	0	0
0.066667	4.00	0	-0.002	0	0	0.001
0.070833	4.25	0	0	0	0	0
0.075	4.50	0	0	0	0	0
0.079167	4.75	0	0	0	0	0
0.083333	5.00	0	0	0	0	0
0.0875	5.25	0	0	0	0	0
0.091667	5.50	0	0	0	0	0
0.095833	5.75	0	0	0	0.001	0.001
0.1	6.00	0	0.001	0	0.001	0.002
0.104167	6.25	0	0.002	0	0.001	0.002
0.108333	6.50	0	0.002	0	0.001	0.003
0.1125	6.75	0	0.002	0	0.002	0.003
0.116667	7.00	0	0.003	0.001	0.002	0.004
0.120833	7.25	0	0.003	0.001	0.003	0.004
0.125	7.50	0	0.003	0.001	0.003	0.005
0.129167	7.75	0	0.003	0.001	0.003	0.006
0.133333	8.00	0.001	0.004	0.001	0.004	0.007
0.1375	8.25	0.001	0.004	0.001	0.004	0.008
0.141667	8.50	0.001	0.005	0.001	0.004	0.009
0.145833	8.75	0.001	0.005	0.001	0.005	0.01
0.15	9.00	0.001	0.006	0.001	0.005	0.01
0.154167	9.25	0.001	0.007	0.001	0.006	0.013
0.158333	9.50	0.001	0.008	0.001	0.006	0.014
0.1625	9.75	0.001	0.01	0.002	0.007	0.015
0.166667	10.00	0.001	0.013	0.003	0.007	0.016
0.170833	10.25	0.001	0.016	0.004	0.008	0.018
0.175	10.50	0.001	0.02	0.006	0.008	0.02
0.179167	10.75	0.001	0.024	0.007	0.009	0.022
0.183333	11.00	0.001	0.03	0.01	0.01	0.023
0.1875	11.25	0.001	0.034	0.01	0.011	0.025
0.191667	11.50	0.001	0.038	0.011	0.012	0.025
0.195833	11.75	0.001	0.042	0.013	0.013	0.029
0.2	12.00	0.001	0.044	0.014	0.014	0.03
0.204167	12.25	0.002	0.047	0.015	0.014	0.027
0.208333	12.50	0.002	0.051	0.016	0.015	0.032
0.2125	12.75	0.002	0.052	0.017	0.016	0.034
0.216667	13.00	0.002	0.054	0.019	0.018	0.034
0.220833	13.25	0.002	0.06	0.02	0.019	0.038
0.225	13.50	0.003	0.066	0.021	0.02	0.04
0.229167	13.75	0.006	0.071	0.022	0.021	0.043
0.233333	14.00	0.002	0.076	0.023	0.022	0.044
0.2375	14.25	0.002	0.079	0.023	0.024	0.047
0.241667	14.50	0.144	0.081	0.024	0.024	0.047
0.245833	14.75	0.002	0.083	0.025	0.025	0.049
0.25	15.00	0.002	0.085	0.025	0.028	0.048
0.254167	15.25	0.003	0.086	0.025	0.03	0.05
0.258333	15.50	0.004	0.087	0.025	0.032	0.051
0.2625	15.75	0.004	0.087	0.025	0.033	0.052
0.266667	16.00	0.004	0.087	0.025	0.034	0.051
0.270833	16.25	0.004	0.087	0.025	0.035	0.051
0.275	16.50	0.004	0.087	0.025	0.038	0.051
0.279167	16.75	0.004	0.086	0.025	0.039	0.052
0.283333	17.00	0.004	0.086	0.025	0.041	0.05
0.2875	17.25	0.004	0.085	0.025	0.042	0.052
0.291667	17.50	0.004	0.084	0.024	0.043	0.052
0.295833	17.75	0.004	0.083	0.024	0.045	0.052
0.3	18.00	0.005	0.082	0.024	0.046	0.052
0.304167	18.25	0.005	0.081	0.023	0.048	0.05
0.308333	18.50	0.005	0.08	0.023	0.05	0.053
0.3125	18.75	0.005	0.079	0.023	0.051	0.054
0.316667	19.00	0.004	0.078	0.023	0.053	0.053
0.320833	19.25	0.006	0.077	0.023	0.055	0.052
0.325	19.50	0.007	0.077	0.023	0.057	0.055
0.329167	19.75	0.008	0.077	0.023	0.059	0.058
0.333333	20.00	0.009	0.076	0.023	0.061	0.057
0.3375	20.25	0.009	0.076	0.024	0.063	0.058
0.341667	20.50	0.01	0.076	0.024	0.065	0.062
0.345833	20.75	0.01	0.076	0.024	0.067	0.061
0.35	21.00	0.01	0.077	0.025	0.069	0.065
0.354167	21.25	0.011	0.077	0.026	0.072	0.066
0.358333	21.50	0.011	0.078	0.026	0.075	0.067
0.3625	21.75	0.011	0.079	0.023	0.077	0.071
0.366667	22.00	0.011	0.079	0.025	0.08	0.071
0.370833	22.25	0.011	0.08	0.027	0.083	0.076
0.375	22.50	0.011	0.081	0.028	0.086	0.077
0.379167	22.75	0.011	0.083	0.031	0.089	0.079
0.383333	23.00	0.011	0.084	0.06	0.093	0.081
0.3875	23.25	0.011	0.086	0.054	0.096	0.084
0.391667	23.50	0.011	0.088	0.057	0.1	0.085

Refer the Hydrogrphs Location Map





0.395833	23.75	0.011	0.09	0.062	0.104	0.09
0.4	24.00	0.011	0.092	0.068	0.108	0.094
0.404167	24.25	0.011	0.094	0.077	0.113	0.098
0.408333	24.50	0.011	0.097	0.09	0.118	0.102
0.4125	24.75	0.01	0.1	0.099	0.123	0.106
0.416667	25.00	0.011	0.103	0.108	0.128	0.11
0.420833	25.25	0.011	0.107	0.117	0.134	0.114
0.425	25.50	0.012	0.111	0.126	0.141	0.119
0.429167	25.75	0.012	0.115	0.133	0.148	0.124
0.433333	26.00	0.013	0.118	0.14	0.155	0.128
0.4375	26.25	0.014	0.123	0.146	0.162	0.132
0.441667	26.50	0.015	0.127	0.151	0.17	0.136
0.445833	26.75	0.016	0.131	0.155	0.179	0.14
0.45	27.00	0.017	0.135	0.158	0.186	0.143
0.454167	27.25	0.019	0.139	0.161	0.195	0.146
0.458333	27.50	0.021	0.144	0.163	0.207	0.149
0.4625	27.75	0.016	0.147	0.167	0.218	0.153
0.466667	28.00	0.021	0.153	0.169	0.229	0.158
0.470833	28.25	0.026	0.157	0.174	0.24	0.163
0.475	28.50	0.031	0.158	0.18	0.251	0.168
0.479167	28.75	0.04	0.163	0.184	0.264	0.173
0.483333	29.00	0.034	0.166	0.188	0.276	0.177
0.4875	29.25	0.039	0.167	0.187	0.29	0.182
0.491667	29.50	0.04	0.171	0.199	0.304	0.186
0.495833	29.75	0.033	0.168	0.195	0.345	0.188
0.5	30.00	0.037	0.172	0.191	0.339	0.191
0.504167	30.25	0.041	0.169	0.172	0.345	0.192
0.508333	30.50	0.044	0.168	0.152	0.354	0.194
0.5125	30.75	0.044	0.166	0.19	0.358	0.196
0.516667	31.00	0.042	0.163	0.194	0.36	0.198
0.520833	31.25	0.036	0.163	0.182	0.376	0.2
0.525	31.50	0.035	0.159	0.135	0.397	0.202
0.529167	31.75	0.042	0.158	0.187	0.418	0.203
0.533333	32.00	0.053	0.152	0.189	0.439	0.203
0.5375	32.25	0.043	0.152	0.141	0.459	0.203
0.541667	32.50	0.039	0.147	0.178	0.466	0.204
0.545833	32.75	0.046	0.148	0.193	0.47	0.204
0.55	33.00	0.044	0.143	0.194	0.476	0.204
0.554167	33.25	0.037	0.143	0.189	0.481	0.206
0.558333	33.50	0.041	0.143	0.163	0.488	0.208
0.5625	33.75	0.058	0.144	0.136	0.493	0.212
0.566667	34.00	0.046	0.146	0.185	0.499	0.217
0.570833	34.25	0.048	0.147	0.173	0.503	0.223
0.575	34.50	0.077	0.156	0.149	0.493	0.23
0.579167	34.75	0.067	0.161	0.206	0.47	0.248
0.583333	35.00	0.074	0.175	0.185	0.461	0.262
0.5875	35.25	0.064	0.187	0.201	0.465	0.269
0.591667	35.50	0.067	0.198	0.224	0.474	0.274
0.595833	35.75	0.065	0.21	0.194	0.485	0.289
0.6	36.00	0.07	0.228	0.229	0.5	0.3
0.604167	36.25	0.074	0.246	0.233	0.517	0.313
0.608333	36.50	0.078	0.263	0.253	0.534	0.329
0.6125	36.75	0.079	0.29	0.264	0.55	0.346
0.616667	37.00	0.076	0.329	0.293	0.566	0.361
0.620833	37.25	0.079	0.352	0.315	0.588	0.375
0.625	37.50	0.086	0.374	0.332	0.611	0.391
0.629167	37.75	0.085	0.39	0.346	0.633	0.406
0.633333	38.00	0.089	0.41	0.363	0.659	0.422
0.6375	38.25	0.099	0.431	0.115	0.68	0.433
0.641667	38.50	0.097	0.448	0.252	0.711	0.445
0.645833	38.75	0.128	0.465	0.389	0.744	0.458
0.65	39.00	0.215	0.483	0.497	0.755	0.461
0.654167	39.25	0.284	0.486	0.735	0.769	0.474
0.658333	39.50	0.416	0.488	0.74	0.777	0.487
0.6625	39.75	0.435	0.497	0.818	0.615	0.497
0.666667	40.00	0.521	0.502	0.847	0.815	0.509
0.670833	40.25	0.544	0.506	0.843	0.878	0.509
0.675	40.50	0.581	0.508	0.746	0.921	0.493
0.679167	40.75	0.708	0.513	0.799	0.959	0.488
0.683333	41.00	0.799	0.521	1	1.002	0.493
0.6875	41.25	0.873	0.561	1.133	1.027	0.507
0.691667	41.50	0.914	0.778	1.587	1.055	0.503
0.695833	41.75	0.995	1.127	1.904	1.065	0.499
0.7	42.00	1.073	1.151	2.089	1.07	0.503
0.704167	42.25	1.138	1.118	2.343	1.073	0.518
0.708333	42.50	1.217	0.775	2.511	1.074	0.584
0.7125	42.75	1.294	0.919	2.695	1.085	0.757
0.716667	43.00	1.349	1.039	2.822	1.079	1.181
0.720833	43.25	1.389	1.109	2.902	1.077	1.599
0.725	43.50	1.444	1.188	2.996	1.074	2.073
0.729167	43.75	1.486	1.116	3.106	1.077	2.529
0.733333	44.00	1.556	1.029	3.333	1.071	3.209
0.7375	44.25	1.625	0.966	3.53	1.078	3.843
0.741667	44.50	1.687	1.114	3.724	1.074	4.437
0.745833	44.75	1.817	1.064	3.947	1.062	4.996
0.75	45.00	1.918	0.892	4.098	1.054	5.576
0.754167	45.25	2.058	0.799	4.221	1.044	6.105
0.758333	45.50	2.258	0.657	4.474	1.035	6.752
0.7625	45.75	2.417	0.753	4.656	1.033	7.277
0.766667	46.00	2.57	0.879	4.726	1.02	7.805
0.770833	46.25	2.679	0.879	4.795	1.004	8.339
0.775	46.50	2.837	0.921	4.871	1.006	8.767
0.779167	46.75	2.955	1.001	4.997	0.987	9.27
0.783333	47.00	3.065	1.077	5.099	0.961	9.751
0.7875	47.25	3.179	1.128	5.21	0.944	10.21
0.791667	47.50	3.279	1.159	5.354	0.938	10.62
0.795833	47.75	3.371	1.255	5.452	0.922	11.014
0.8	48.00	3.458	1.265	5.52	0.916	11.453
0.804167	48.25	3.532	1.279	5.584	0.891	12.115
0.808333	48.50	3.591	1.376	5.704	0.875	12.444
0.8125	48.75	3.634	1.396	5.765	0.851	12.771
0.816667	49.00	3.619	1.439	5.837	0.825	13.04
0.820833	49.25	3.611	1.536	5.919	0.808	13.396
0.825	49.50	3.617	1.643	5.971	0.792	13.674
0.829167	49.75	3.626	1.737	6.012	0.766	13.967

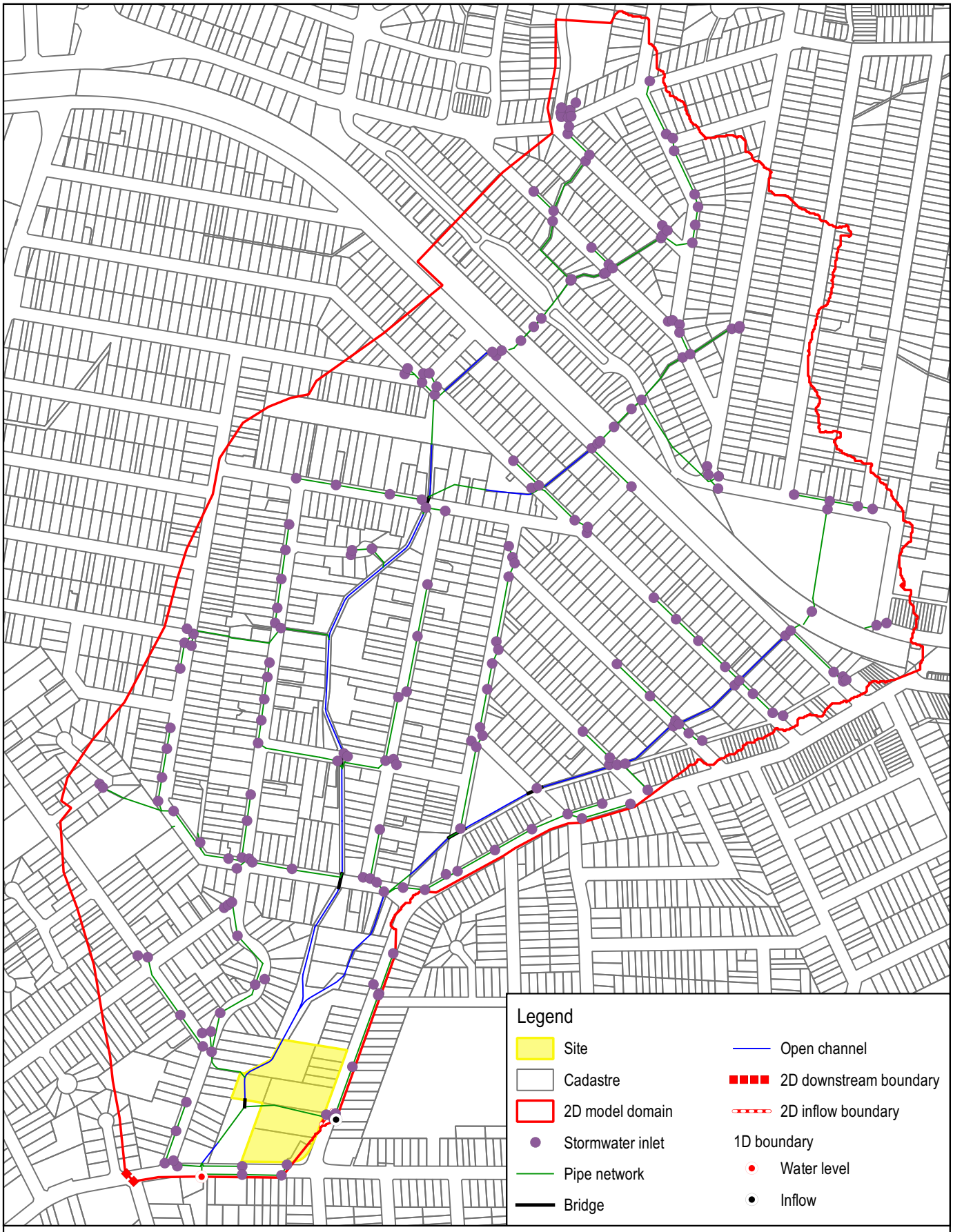
0.833333	50.00	3.613	1.887	6.029	0.747	14.226
0.8375	50.25	3.594	1.962	6.011	0.744	14.487
0.841667	50.50	3.585	2.057	6.01	0.707	14.737
0.845833	50.75	3.573	2.149	6.038	0.705	14.929
0.85	51.00	3.535	2.22	6.05	0.679	15.099
0.854167	51.25	3.489	2.295	6.061	0.677	15.157
0.858333	51.50	3.449	2.335	6.075	0.667	15.313
0.8625	51.75	3.409	2.412	6.047	0.651	15.433
0.866667	52.00	3.353	2.474	6.022	0.63	15.526
0.870833	52.25	3.293	2.519	6	0.612	15.59
0.875	52.50	3.227	2.586	5.974	0.609	15.777
0.879167	52.75	3.17	2.655	5.944	0.601	15.855
0.883333	53.00	3.148	2.729	5.91	0.588	15.839
0.8875	53.25	3.095	2.815	5.862	0.567	15.826
0.891667	53.50	3.04	2.924	5.824	0.549	15.812
0.895833	53.75	2.962	3.024	5.788	0.542	15.773
0.9	54.00	2.875	3.115	5.746	0.536	15.737
0.904167	54.25	2.784	3.155	5.69	0.527	15.697
0.908333	54.50	2.685	3.177	5.643	0.517	15.634
0.9125	54.75	2.578	3.196	5.591	0.507	15.551
0.916667	55.00	2.465	3.217	5.535	0.498	15.456
0.920833	55.25	2.367	3.257	5.48	0.484	15.349
0.925	55.50	2.275	3.317	5.425	0.479	15.292
0.929167	55.75	2.167	3.371	5.368	0.474	15.146
0.933333	56.00	2.053	3.424	5.313	0.467	15.008
0.9375	56.25	1.932	3.463	5.248	0.458	14.875
0.941667	56.50	1.816	3.502	5.178	0.45	14.739
0.945833	56.75	1.698	3.49	5.102	0.438	14.585
0.95	57.00	1.622	3.52	5.025	0.433	14.417
0.954167	57.25	1.509	3.569	4.957	0.426	14.24
0.958333	57.50	1.457	3.615	4.9	0.419	14.057
0.9625	57.75	1.384	3.65	4.854	0.413	13.875
0.966667	58.00	1.258	3.677	4.805	0.407	13.698
0.970833	58.25	1.295	3.696	4.736	0.401	13.524
0.975	58.50	1.281	3.713	4.652	0.396	13.346
0.979167	58.75	1.167	3.645	4.597	0.391	13.164
0.983333	59.00	1.211	3.668	4.574	0.386	12.978
0.9875	59.25	1.127	3.675	4.518	0.381	12.775
0.991667	59.50	1.163	3.712	4.45	0.377	12.59
0.995833	59.75	1.029	3.733	4.377	0.374	12.414
1	60.00	1.061	3.76	4.307	0.37	12.272
1.004167	60.25	1.112	3.767	4.254	0.365	11.93
1.008333	60.50	1.092	3.786	4.204	0.361	11.774
1.0125	60.75	1.08	3.799	4.172	0.358	11.622
1.016667	61.00	1.06	3.777	4.133	0.356	11.478
1.020833	61.25	1.018	3.745	4.076	0.354	11.303
1.025	61.50	0.998	3.737	4.014	0.352	11.132
1.029167	61.75	0.973	3.746	3.95	0.35	10.961
1.033333	62.00	0.962	3.746	3.912	0.348	10.814
1.0375	62.25	0.94	3.774	3.853	0.348	10.657
1.041667	62.50	0.919	3.823	3.777	0.355	10.487
1.045833	62.75	0.9	3.853	3.716	0.348	10.323
1.05	63.00	0.88	3.848	3.658	0.344	10.193
1.054167	63.25	0.86	3.859	3.609	0.341	10.009
1.058333	63.50	0.836	3.876	3.568	0.341	9.846
1.0625	63.75	0.815	3.849	3.521	0.339	9.689
1.066667	64.00	0.802	3.824	3.454	0.338	9.53
1.070833	64.25	0.795	3.898	3.389	0.338	9.372
1.075	64.50	0.784	3.946	3.352	0.337	9.199
1.079167	64.75	0.771	3.958	3.316	0.336	9.043
1.083333	65.00	0.768	3.975	3.28	0.335	8.875
1.0875	65.25	0.751	3.982	3.239	0.334	8.794
1.091667	65.50	0.734	3.981	3.218	0.334	8.621
1.095833	65.75	0.732	3.96	3.2	0.333	8.488
1.1	66.00	0.715	3.954	3.189	0.333	8.369
1.104167	66.25	0.699	3.965	3.194	0.333	8.209
1.108333	66.50	0.69	3.971	3.184	0.333	7.9
1.1125	66.75	0.671	3.977	3.174	0.333	7.853
1.116667	67.00	0.659	3.997	3.143	0.333	7.806
1.120833	67.25	0.643	4.012	3.108	0.333	7.644
1.125	67.50	0.635	4.016	3.071	0.333	7.549
1.129167	67.75	0.623	4.02	3.039	0.333	7.373
1.133333	68.00	0.612	4.023	3.014	0.333	7.256
1.1375	68.25	0.602	4.028	2.997	0.332	7.185
1.141667	68.50	0.594	4.024	2.982	0.332	7.098
1.145833	68.75	0.582	4.032	2.965	0.332	6.975
1.15	69.00	0.572	4.038	2.941	0.332	6.886
1.154167	69.25	0.561	4.034	2.918	0.331	6.769
1.158333	69.50	0.552	4.036	2.891	0.33	6.686
1.1625	69.75	0.543	4.059	2.863	0.33	6.599
1.166667	70.00	0.534	4.069	2.84	0.328	6.512
1.170833	70.25	0.525	4.081	2.819	0.327	6.425
1.175	70.50	0.517	4.087	2.797	0.325	6.343
1.179167	70.75	0.509	4.097	2.779	0.324	6.263
1.183333	71.00	0.5	4.103	2.758	0.323	6.185
1.1875	71.25	0.494	3.999	2.742	0.321	6.109
1.191667	71.50	0.486	4.049	2.722	0.319	6.037
1.195833	71.75	0.475	4.109	2.708	0.317	5.963
1.2	72.00	0.465	4.122	2.691	0.316	5.894
1.204167	72.25	0.455	4.144	2.664	0.314	5.802
1.208333	72.50	0.447	4.18	2.629	0.312	5.733
1.2125	72.75	0.438	4.198	2.593	0.31	5.672
1.216667	73.00	0.431	4.199	2.567	0.308	5.613
1.220833	73.25	0.424	4.205	2.551	0.306	5.547
1.225	73.50	0.417	4.227	2.537	0.303	5.472
1.229167	73.75	0.409	4.242	2.524	0.301	5.405
1.233333	74.00	0.403	4.253	2.509	0.3	5.337
1.2375	74.25	0.398	4.259	2.486	0.297	5.176
1.241667	74.50	0.396	4.273	2.465	0.296	5.147
1.245833	74.75	0.384	4.286	2.447	0.295	5.102
1.25	75.00	0.376	4.302	2.416	0.293	5.04
1.254167	75.25	0.375	4.32	2.4	0.292	4.98
1.258333	75.50	0.371	4.328	2.379	0.293	4.921
1.2625	75.75	0.366	4.33	2.355	0.291	4.864
1.266667	76.00	0.363	4.355	2.337	0.293	4.808

1.270833	76.25	0.362	4.425	2.333	0.303	4.741
1.275	76.50	0.355	4.445	2.334	0.314	4.691
1.279167	76.75	0.354	4.421	2.317	0.316	4.64
1.283333	77.00	0.356	4.429	2.293	0.315	4.586
1.2875	77.25	0.349	4.401	2.285	0.314	4.539
1.291667	77.50	0.353	4.4	2.292	0.311	4.492
1.295833	77.75	0.343	4.431	2.29	0.309	4.441
1.3	78.00	0.343	4.447	2.281	0.306	4.387
1.304167	78.25	0.328	4.465	2.268	0.303	4.344
1.308333	78.50	0.333	4.48	2.23	0.301	4.306
1.3125	78.75	0.326	4.502	2.192	0.3	4.262
1.316667	79.00	0.314	4.516	2.165	0.298	4.229
1.320833	79.25	0.321	4.534	2.134	0.297	4.184
1.325	79.50	0.303	4.562	2.117	0.294	4.137
1.329167	79.75	0.309	4.585	2.09	0.291	4.087
1.333333	80.00	0.307	4.604	2.074	0.288	4.002
1.3375	80.25	0.304	4.621	2.064	0.286	3.978
1.341667	80.50	0.298	4.636	2.047	0.285	3.934
1.345833	80.75	0.293	4.652	2.039	0.284	3.891
1.35	81.00	0.291	4.672	2.03	0.283	3.844
1.354167	81.25	0.286	4.689	2.017	0.282	3.8
1.358333	81.50	0.272	4.708	1.999	0.282	3.755
1.3625	81.75	0.258	4.725	1.989	0.281	3.713
1.366667	82.00	0.267	4.746	1.968	0.28	3.67
1.370833	82.25	0.267	4.768	1.949	0.279	3.623
1.375	82.50	0.25	4.789	1.924	0.28	3.532
1.379167	82.75	0.25	4.809	1.907	0.28	3.558
1.383333	83.00	0.253	4.827	1.891	0.28	3.51
1.3875	83.25	0.254	4.848	1.879	0.28	3.406
1.391667	83.50	0.237	4.868	1.861	0.28	3.394
1.395833	83.75	0.239	4.884	1.855	0.28	3.378
1.4	84.00	0.24	4.897	1.847	0.28	3.333
1.404167	84.25	0.241	4.914	1.838	0.279	3.21
1.408333	84.50	0.227	4.932	1.829	0.279	3.245
1.4125	84.75	0.232	4.949	1.823	0.278	3.211
1.416667	85.00	0.227	4.966	1.815	0.278	3.152
1.420833	85.25	0.219	4.981	1.797	0.278	3.045
1.425	85.50	0.223	4.995	1.787	0.278	3.106
1.429167	85.75	0.222	5.014	1.778	0.279	3.047
1.433333	86.00	0.208	5.033	1.762	0.278	2.947
1.4375	86.25	0.213	5.052	1.752	0.276	2.934
1.441667	86.50	0.218	5.069	1.742	0.277	2.962
1.445833	86.75	0.198	5.087	1.726	0.276	2.85
1.45	87.00	0.2	5.104	1.718	0.275	2.85
1.454167	87.25	0.205	5.122	1.715	0.274	2.848
1.458333	87.50	0.197	5.139	1.7	0.273	2.768
1.4625	87.75	0.187	5.156	1.687	0.272	2.781
1.466667	88.00	0.193	5.163	1.683	0.271	2.675
1.470833	88.25	0.198	5.18	1.673	0.269	2.72
1.475	88.50	0.182	5.189	1.667	0.267	2.609
1.479167	88.75	0.18	5.211	1.647	0.266	2.614
1.483333	89.00	0.182	5.233	1.636	0.264	2.554
1.4875	89.25	0.19	5.246	1.629	0.263	2.53
1.491667	89.50	0.169	5.256	1.62	0.261	2.507
1.495833	89.75	0.17	5.274	1.617	0.259	2.486
1.5	90.00	0.171	5.295	1.612	0.258	2.454
1.504167	90.25	0.17	5.305	1.602	0.257	2.432
1.508333	90.50	0.152	5.33	1.588	0.255	2.406
1.5125	90.75	0.153	5.351	1.574	0.254	2.387
1.516667	91.00	0.16	5.374	1.563	0.252	2.367
1.520833	91.25	0.142	5.387	1.545	0.249	2.345
1.525	91.50	0.133	5.381	1.527	0.247	2.317
1.529167	91.75	0.134	5.413	1.512	0.246	2.293
1.533333	92.00	0.137	5.439	1.503	0.243	2.268
1.5375	92.25	0.13	5.459	1.498	0.24	2.238
1.541667	92.50	0.115	5.473	1.49	0.237	2.207
1.545833	92.75	0.112	5.483	1.476	0.236	2.179
1.55	93.00	0.12	5.484	1.473	0.233	2.154
1.554167	93.25	0.114	5.508	1.459	0.229	2.127
1.558333	93.50	0.098	5.535	1.453	0.229	2.099
1.5625	93.75	0.097	5.512	1.441	0.226	2.069
1.566667	94.00	0.099	5.564	1.427	0.222	2.042
1.570833	94.25	0.103	5.576	1.424	0.222	2.016
1.575	94.50	0.095	5.556	1.413	0.219	1.989
1.579167	94.75	0.083	5.573	1.405	0.216	1.959
1.583333	95.00	0.082	5.591	1.396	0.213	1.931
1.5875	95.25	0.088	5.561	1.389	0.212	1.906
1.591667	95.50	0.087	5.586	1.383	0.211	1.877
1.595833	95.75	0.065	5.629	1.376	0.208	1.845
1.6	96.00	0.063	5.591	1.367	0.206	1.815
1.604167	96.25	0.06	5.579	1.351	0.201	1.783
1.608333	96.50	0.075	5.608	1.338	0.199	1.754
1.6125	96.75	0.078	5.663	1.325	0.197	1.725
1.616667	97.00	0.065	5.615	1.312	0.195	1.689
1.620833	97.25	0.058	5.591	1.307	0.193	1.66
1.625	97.50	0.066	5.619	1.297	0.191	1.625
1.629167	97.75	0.066	5.684	1.294	0.191	1.591
1.633333	98.00	0.065	5.669	1.283	0.188	1.562
1.6375	98.25	0.06	5.573	1.271	0.186	1.557
1.641667	98.50	0.024	5.598	1.235	0.185	1.447
1.645833	98.75	0.009	5.614	1.18	0.185	1.407
1.65	99.00	0.019	5.643	1.157	0.184	1.381
1.654167	99.25	0.019	5.626	1.134	0.183	1.424
1.658333	99.50	0.019	5.67	1.13	0.182	1.409
1.6625	99.75	0.019	5.606	1.142	0.18	1.286
1.666667	100.00	0.012	5.637	1.159	0.177	1.25
1.670833	100.25	0.016	5.642	1.167	0.18	1.223
1.675	100.50	0.022	5.64	1.161	0.179	1.188
1.679167	100.75	0.022	5.634	1.148	0.178	1.153
1.683333	101.00	0.015	5.627	1.132	0.177	1.094
1.6875	101.25	0.015	5.623	1.119	0.177	1.056
1.691667	101.50	0.009	5.619	1.107	0.176	1.172
1.695833	101.75	0.008	5.615	1.097	0.176	1.091
1.7	102.00	0.014	5.611	1.089	0.176	1.001
1.704167	102.25	0.019	5.605	1.078	0.177	0.946

1.708333	102.50	0.021	5.601	1.073	0.178	0.828
1.7125	102.75	0.02	5.595	1.068	0.178	0.769
1.716667	103.00	0.013	5.589	1.06	0.179	0.77
1.720833	103.25	0.014	5.582	1.051	0.18	0.761
1.725	103.50	0.02	5.574	1.04	0.182	0.671
1.729167	103.75	0.019	5.566	1.028	0.183	0.658
1.733333	104.00	0.019	5.557	1.015	0.183	0.619
1.7375	104.25	0.015	5.547	1.01	0.183	0.596
1.741667	104.50	0.013	5.536	0.999	0.183	0.562
1.745833	104.75	0.015	5.525	0.996	0.183	0.529
1.75	105.00	0.022	5.514	1.007	0.184	0.498
1.754167	105.25	0.017	5.502	1.01	0.184	0.468
1.758333	105.50	0.009	5.49	0.941	0.182	0.443
1.7625	105.75	0.016	5.476	0.972	0.184	0.409
1.766667	106.00	0.018	5.466	0.982	0.182	0.377
1.770833	106.25	0.016	5.447	0.938	0.181	0.345
1.775	106.50	0.016	5.433	0.97	0.18	0.314
1.779167	106.75	0.012	5.422	0.99	0.18	0.287
1.783333	107.00	0.017	5.403	0.913	0.179	0.264
1.7875	107.25	0.019	5.386	0.878	0.178	0.244
1.791667	107.50	0.016	5.371	0.856	0.177	0.225
1.795833	107.75	0.01	5.359	0.892	0.175	0.206
1.8	108.00	0.01	5.343	0.909	0.177	0.19
1.804167	108.25	0.016	5.321	0.919	0.176	0.171
1.808333	108.50	0.015	5.301	0.911	0.174	0.154
1.8125	108.75	0.012	5.285	0.902	0.174	0.143
1.816667	109.00	0.009	5.272	0.89	0.173	0.129
1.820833	109.25	0.016	5.255	0.893	0.169	0.116
1.825	109.50	0.015	5.237	0.886	0.17	0.107
1.829167	109.75	0.014	5.216	0.865	0.167	0.099
1.833333	110.00	0.008	5.199	0.862	0.168	0.092
1.8375	110.25	0.013	5.187	0.865	0.165	0.087
1.841667	110.50	0.014	5.16	0.86	0.166	0.082
1.845833	110.75	0.012	5.144	0.829	0.164	0.079
1.85	111.00	0.01	5.125	0.804	0.164	0.076
1.854167	111.25	0.013	5.101	0.828	0.163	0.074
1.858333	111.50	0.012	5.083	0.812	0.162	0.072
1.8625	111.75	0.014	5.062	0.766	0.161	0.071
1.866667	112.00	0.012	5.04	0.742	0.16	0.069
1.870833	112.25	0.013	5.018	0.732	0.16	0.068
1.875	112.50	0.01	5.002	0.724	0.159	0.067
1.879167	112.75	0.012	4.983	0.715	0.158	0.066
1.883333	113.00	0.012	4.957	0.703	0.157	0.065
1.8875	113.25	0.012	4.939	0.686	0.157	0.064
1.891667	113.50	0.012	4.932	0.663	0.156	0.064
1.895833	113.75	0.012	4.902	0.64	0.155	0.063
1.9	114.00	0.012	4.864	0.616	0.154	0.063
1.904167	114.25	0.012	4.832	0.59	0.154	0.062
1.908333	114.50	0.011	4.803	0.573	0.153	0.062
1.9125	114.75	0.011	4.776	0.557	0.152	0.061
1.916667	115.00	0.011	4.75	0.543	0.152	0.061
1.920833	115.25	0.011	4.723	0.532	0.15	0.06
1.925	115.50	0.011	4.696	0.529	0.151	0.06
1.929167	115.75	0.011	4.668	0.526	0.148	0.06
1.933333	116.00	0.011	4.64	0.519	0.15	0.059
1.9375	116.25	0.01	4.61	0.502	0.147	0.059
1.941667	116.50	0.011	4.582	0.487	0.149	0.059
1.945833	116.75	0.01	4.549	0.465	0.148	0.058
1.95	117.00	0.01	4.528	0.45	0.148	0.059
1.954167	117.25	0.01	4.481	0.433	0.147	0.058
1.958333	117.50	0.01	4.466	0.414	0.146	0.058
1.9625	117.75	0.01	4.426	0.38	0.146	0.059
1.966667	118.00	0.01	4.414	0.367	0.143	0.058
1.970833	118.25	0.01	4.358	0.339	0.145	0.057
1.975	118.50	0.01	4.344	0.342	0.144	0.058
1.979167	118.75	0.01	4.259	0.332	0.144	0.057
1.983333	119.00	0.01	4.258	0.307	0.143	0.057
1.9875	119.25	0.01	4.194	0.317	0.143	0.057
1.991667	119.50	0.01	4.158	0.193	0.143	0.057
1.995833	119.75	0.01	4.167	0.222	0.139	0.056
2	120.00	0.01	4.12	0.232	0.142	0.057
2.004167	120.25	0.01	4.106	0.166	0.143	0.057
2.008333	120.50	0.01	4.082	0.199	0.141	0.057
2.0125	120.75	0.01	4.04	0.168	0.141	0.056
2.016667	121.00	0.01	3.999	0.155	0.138	0.056
2.020833	121.25	0.01	3.963	0.135	0.14	0.056
2.025	121.50	0.01	3.92	0.117	0.139	0.056
2.029167	121.75	0.01	3.894	0.104	0.139	0.056
2.033333	122.00	0.01	3.839	0.105	0.139	0.056
2.0375	122.25	0.01	3.809	0.096	0.138	0.056
2.041667	122.50	0.01	3.758	0.1	0.138	0.056
2.045833	122.75	0.01	3.694	0.096	0.136	0.056
2.05	123.00	0.01	3.664	0.051	0.138	0.054
2.054167	123.25	0.01	3.626	0.069	0.137	0.055
2.058333	123.50	0.009	3.592	0.064	0.136	0.055
2.0625	123.75	0.01	3.534	0.064	0.136	0.055
2.066667	124.00	0.01	3.481	0.064	0.135	0.054
2.070833	124.25	0.009	3.43	0.063	0.135	0.054
2.075	124.50	0.01	3.388	0.063	0.134	0.053
2.079167	124.75	0.009	3.34	0.063	0.133	0.053
2.083333	125.00	0.009	3.288	0.063	0.133	0.054
2.0875	125.25	0.009	3.24	0.062	0.132	0.054
2.091667	125.50	0.009	3.184	0.062	0.131	0.051
2.095833	125.75	0.008	3.132	0.061	0.13	0.051
2.1	126.00	0.008	3.065	0.061	0.129	0.052
2.104167	126.25	0.008	3.004	0.061	0.128	0.049
2.108333	126.50	0.008	2.957	0.06	0.128	0.048
2.1125	126.75	0.008	2.905	0.06	0.126	0.048
2.116667	127.00	0.007	2.852	0.059	0.125	0.048
2.120833	127.25	0.007	2.784	0.059	0.12	0.045
2.125	127.50	0.007	2.698	0.058	0.123	0.044
2.129167	127.75	0.006	2.627	0.058	0.121	0.044
2.133333	128.00	0.006	2.556	0.057	0.12	0.043
2.1375	128.25	0.006	2.488	0.057	0.115	0.041
2.141667	128.50	0.006	2.459	0.056	0.117	0.04

2.145833	128.75	0.005	2.326	0.055	0.115	0.04
2.15	129.00	0.005	2.199	0.055	0.113	0.038
2.154167	129.25	0.005	2.017	0.054	0.112	0.037
2.158333	129.50	0.005	1.887	0.054	0.111	0.037
2.1625	129.75	0.005	1.737	0.053	0.109	0.036
2.166667	130.00	0.005	1.427	0.053	0.107	0.035
2.170833	130.25	0.005	1.222	0.052	0.106	0.035
2.175	130.50	0.004	0.991	0.052	0.102	0.033
2.179167	130.75	0.004	0.755	0.051	0.104	0.034
2.183333	131.00	0.004	0.618	0.051	0.102	0.032
2.1875	131.25	0.004	0.469	0.05	0.1	0.031
2.191667	131.50	0.004	0.359	0.049	0.099	0.031
2.195833	131.75	0.004	0.354	0.049	0.097	0.03
2.2	132.00	0.004	0.299	0.048	0.091	0.03
2.204167	132.25	0.004	0.245	0.048	0.094	0.029
2.208333	132.50	0.004	0.21	0.047	0.092	0.028
2.2125	132.75	0.004	0.168	0.047	0.09	0.028
2.216667	133.00	0.004	0.108	0.046	0.088	0.027
2.220833	133.25	0.004	0.107	0.046	0.089	0.027
2.225	133.50	0.004	0.097	0.045	0.203	0.026
2.229167	133.75	0.003	0.086	0.045	0.07	0.026
2.233333	134.00	0.003	0.072	0.045	0.068	0.025
2.2375	134.25	0.003	0.065	0.044	0.068	0.025
2.241667	134.50	0.003	0.06	0.044	0.067	0.024
2.245833	134.75	0.003	0.057	0.044	0.067	0.024
2.25	135.00	0.003	0.053	0.044	0.064	0.024
2.254167	135.25	0.003	0.051	0.044	0.063	0.023
2.258333	135.50	0.003	0.048	0.044	0.062	0.023
2.2625	135.75	0.003	0.046	0.044	0.06	0.022
2.266667	136.00	0.003	0.045	0.044	0.059	0.022
2.270833	136.25	0.003	0.043	0.045	0.058	0.021
2.275	136.50	0.003	0.041	0.045	0.057	0.021
2.279167	136.75	0.003	0.04	0.045	0.056	0.021
2.283333	137.00	0.002	0.039	0.045	0.054	0.02
2.2875	137.25	0.002	0.038	0.045	0.054	0.02
2.291667	137.50	0.002	0.037	0.045	0.052	0.019
2.295833	137.75	0.002	0.036	0.044	0.052	0.019
2.3	138.00	0.002	0.041	0.045	0.051	0.019
2.304167	138.25	0.002	0.042	0.044	0.05	0.018
2.308333	138.50	0.002	0.04	0.044	0.05	0.018
2.3125	138.75	0.002	0.038	0.043	0.049	0.018
2.316667	139.00	0.002	0.036	0.043	0.048	0.018
2.320833	139.25	0.002	0.029	0.043	0.048	0.017
2.325	139.50	0.002	0.028	0.042	0.047	0.017
2.329167	139.75	0.002	0.03	0.041	0.046	0.017
2.333333	140.00	0.002	0.03	0.039	0.046	0.017
2.3375	140.25	0.002	0.029	0.039	0.045	0.016
2.341667	140.50	0.002	0.029	0.039	0.044	0.016
2.345833	140.75	0.002	0.03	0.039	0.043	0.016
2.35	141.00	0.002	0.029	0.039	0.043	0.016
2.354167	141.25	0.002	0.028	0.038	0.042	0.015
2.358333	141.50	0.002	0.028	0.038	0.042	0.015
2.3625	141.75	0.002	0.028	0.038	0.041	0.015
2.366667	142.00	0.002	0.027	0.038	0.041	0.015
2.370833	142.25	0.002	0.027	0.037	0.04	0.015
2.375	142.50	0.002	0.026	0.037	0.039	0.014
2.379167	142.75	0.001	0.026	0.037	0.039	0.014
2.383333	143.00	0.002	0.026	0.036	0.038	0.014
2.3875	143.25	0.002	0.025	0.036	0.038	0.014
2.391667	143.50	0.002	0.025	0.036	0.037	0.014
2.395833	143.75	0.002	0.024	0.035	0.037	0.014
2.4	144.00	0.002	0.024	0.035	0.036	0.013
2.404167	144.25	0.002	0.024	0.035	0.035	0.013
2.408333	144.50	0.001	0.024	0.034	0.035	0.013
2.4125	144.75	0.001	0.023	0.034	0.034	0.013
2.416667	145.00	0.002	0.023	0.034	0.034	0.013
2.420833	145.25	0.001	0.023	0.033	0.033	0.013
2.425	145.50	0.001	0.022	0.033	0.033	0.012
2.429167	145.75	0.002	0.022	0.033	0.032	0.012
2.433333	146.00	0.001	0.022	0.033	0.032	0.012
2.4375	146.25	0.001	0.022	0.032	0.031	0.012
2.441667	146.50	0.002	0.022	0.032	0.03	0.012
2.445833	146.75	0.001	0.021	0.032	0.03	0.012
2.45	147.00	0.002	0.021	0.031	0.029	0.012
2.454167	147.25	0.001	0.021	0.031	0.029	0.012
2.458333	147.50	0.001	0.021	0.031	0.028	0.011
2.4625	147.75	0.002	0.021	0.031	0.028	0.011
2.466667	148.00	0.001	0.02	0.03	0.027	0.011
2.470833	148.25	0.001	0.02	0.03	0.027	0.011
2.475	148.50	0.002	0.02	0.03	0.027	0.011
2.479167	148.75	0.001	0.02	0.029	0.026	0.011
2.483333	149.00	0.002	0.019	0.029	0.026	0.011
2.4875	149.25	0.001	0.02	0.029	0.025	0.011
2.491667	149.50	0.001	0.019	0.029	0.025	0.011
2.495833	149.75	0.001	0.019	0.029	0.024	0.011
2.5	150.00	0.001	0.019	0.028	0.024	0.01

Annexure B TUFLOW model layout



Title: TUFLOW MODEL PLAN

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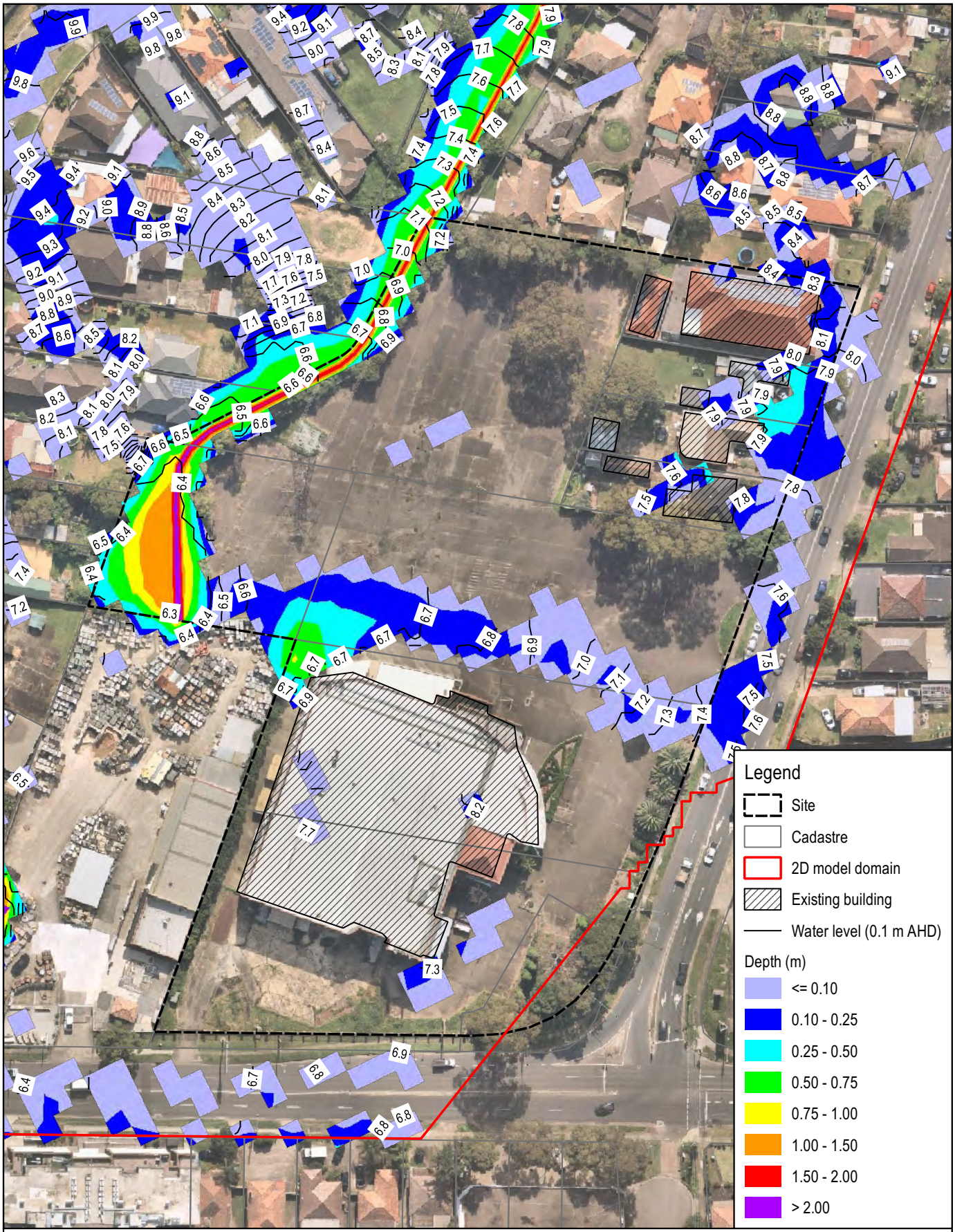
CC210530	F1	C	31.05.2022	BK	AN	1:8,000

Annexure C 1% AEP flood mapping for 0% blockage scenario



Title: PRE-DEVELOPMENT 1% AEP FLOOD DEPTH & LEVEL PLAN - 0% BLOCKAGE

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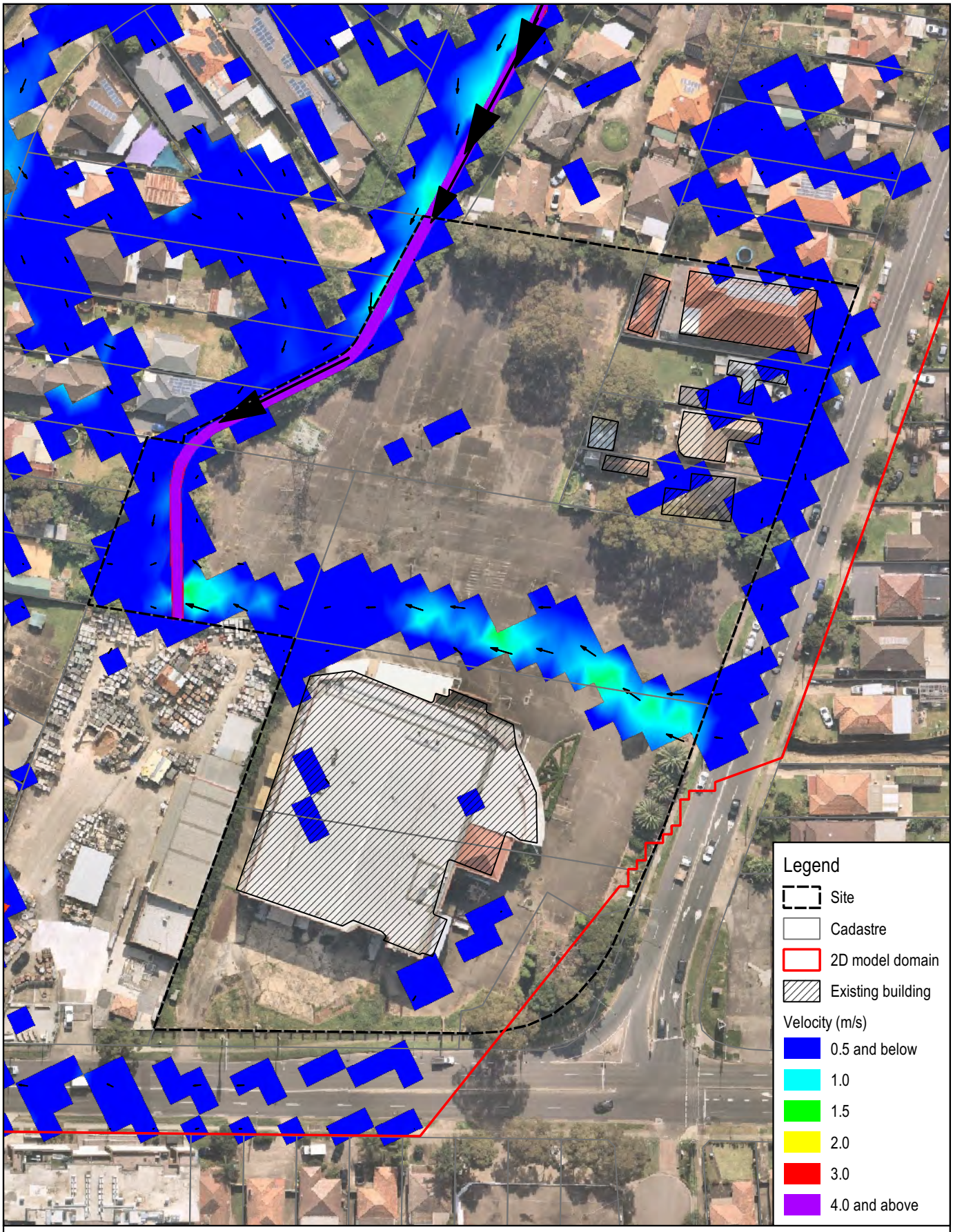

Title: PRE-DEVELOPMENT 1% AEP FLOOD VELOCITY PLAN - 0% BLOCKAGE

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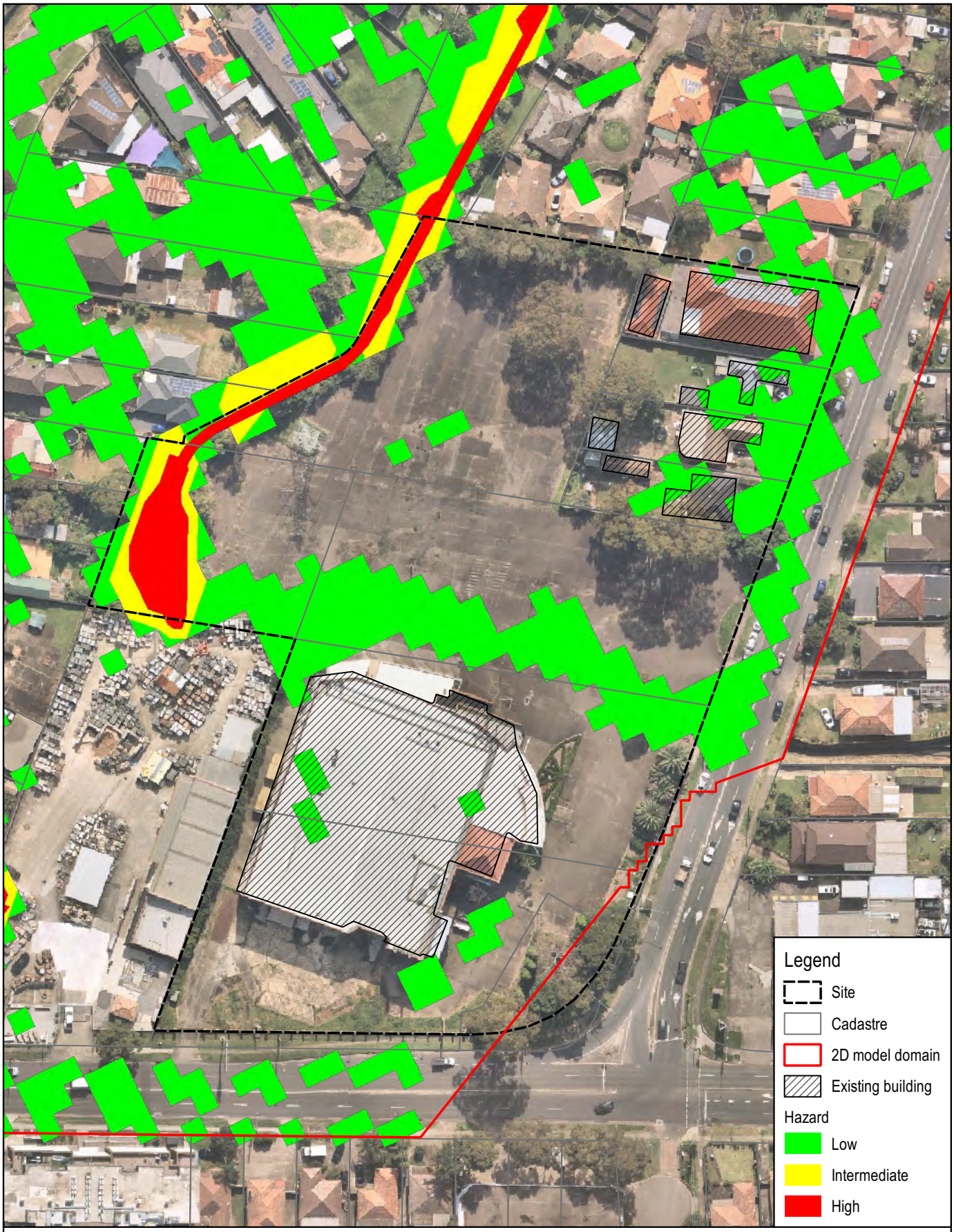

Title: PRE-DEVELOPMENT 1% AEP PROVISIONAL FLOOD HAZARD PLAN - 0% BLOCKAGE

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North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
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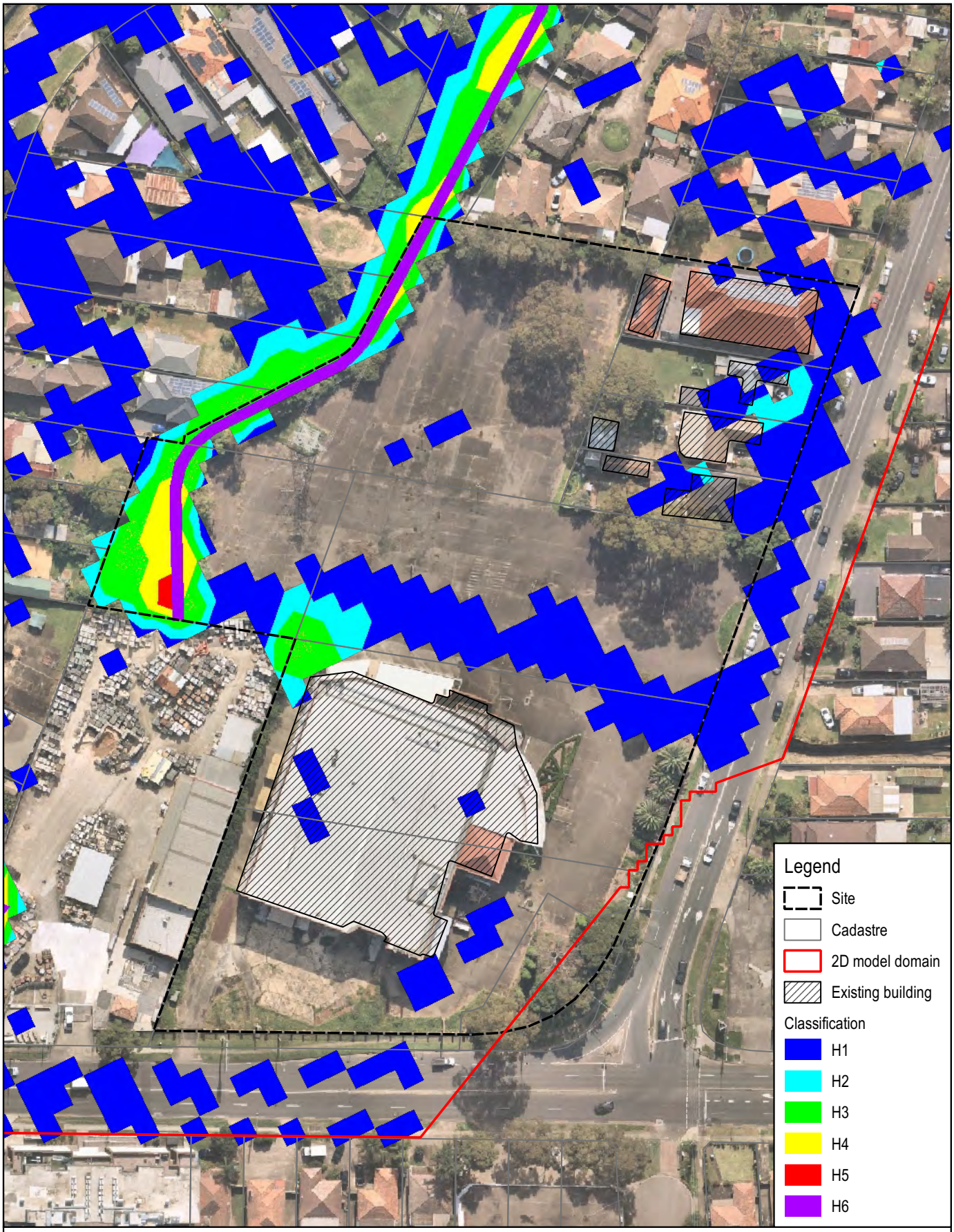

Title: PRE-DEVELOPMENT 1% AEP FLOOD HAZARD VULNERABILITY PLAN - 0% BLOCKAGE

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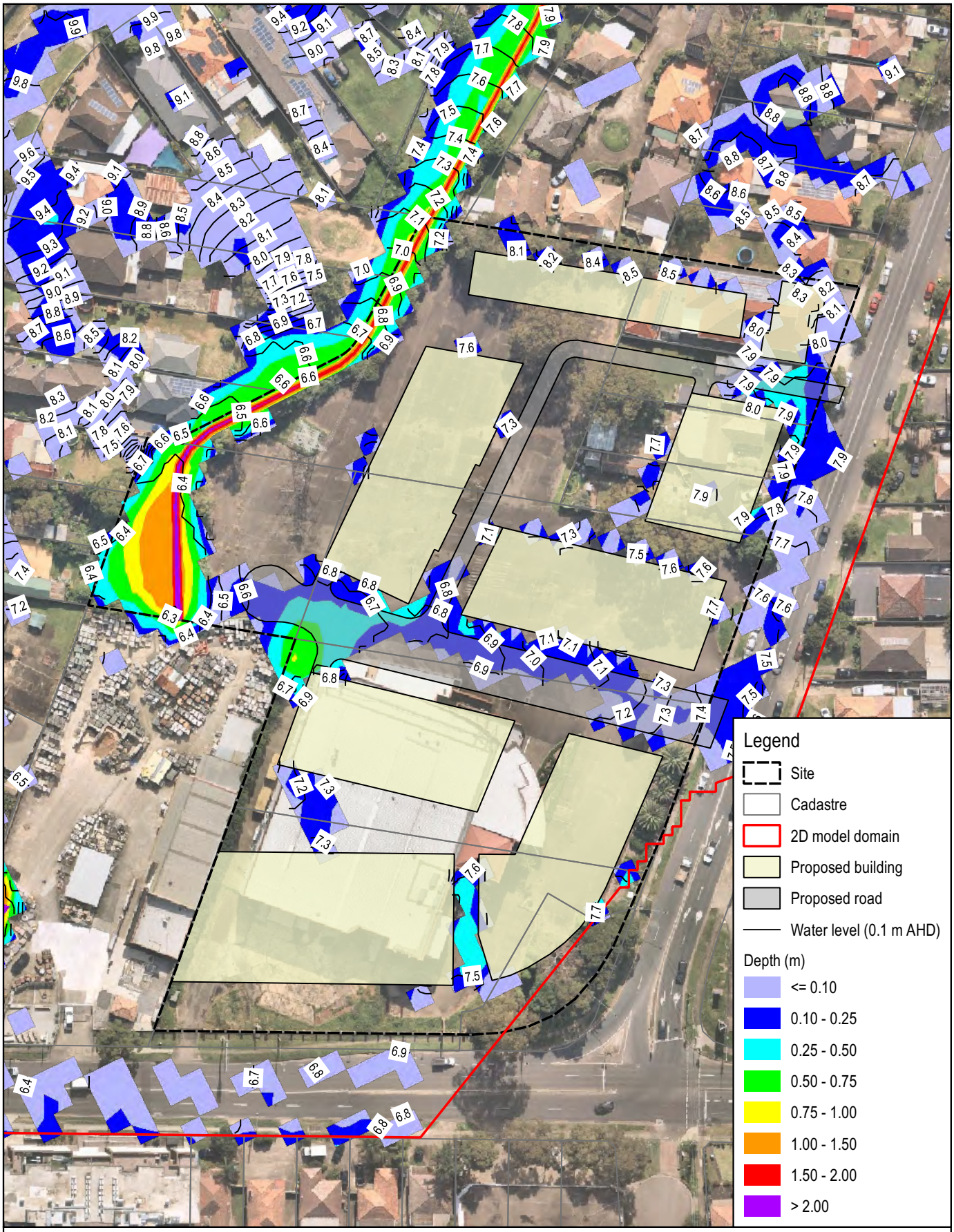

Title: POST-DEVELOPMENT 1% AEP FLOOD DEPTH & LEVEL PLAN - 0% BLOCKAGE

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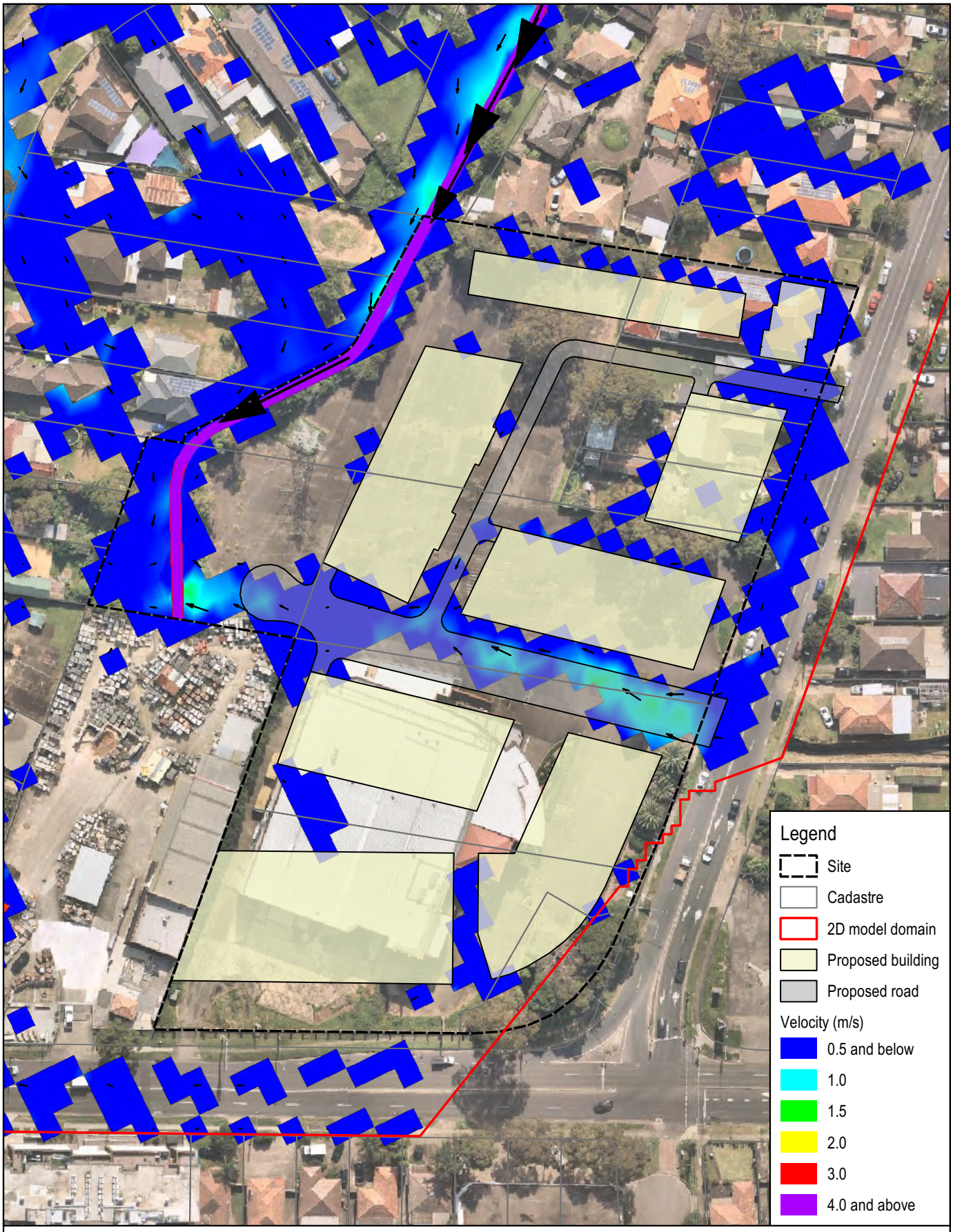

Title: POST-DEVELOPMENT 1% AEP FLOOD VELOCITY PLAN - 0% BLOCKAGE

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Client: CMT ARCHITECTS

North:

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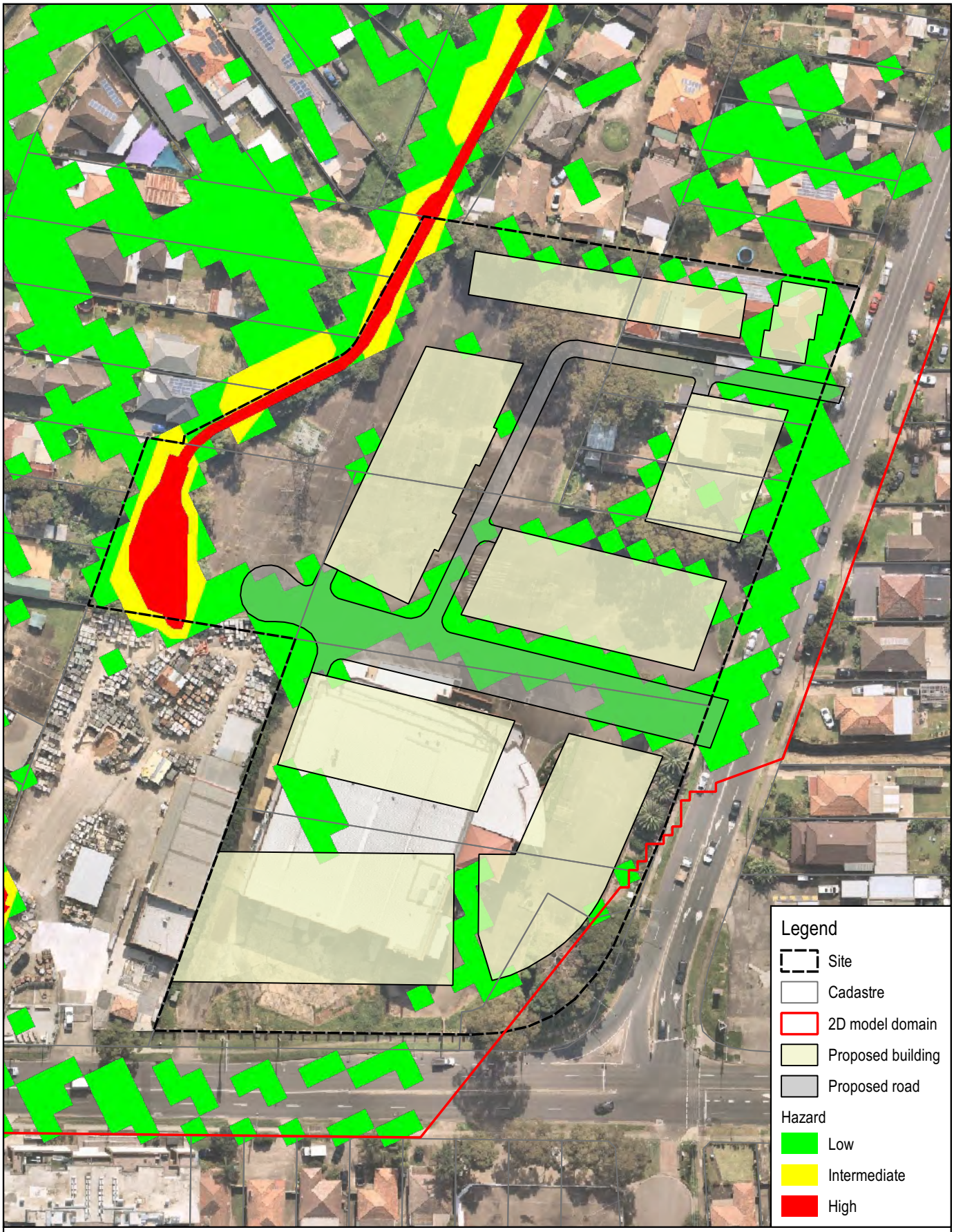

Title: POST-DEVELOPMENT 1% AEP PROVISIONAL FLOOD HAZARD PLAN - 0% BLOCKAGE

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Client: CMT ARCHITECTS

North:

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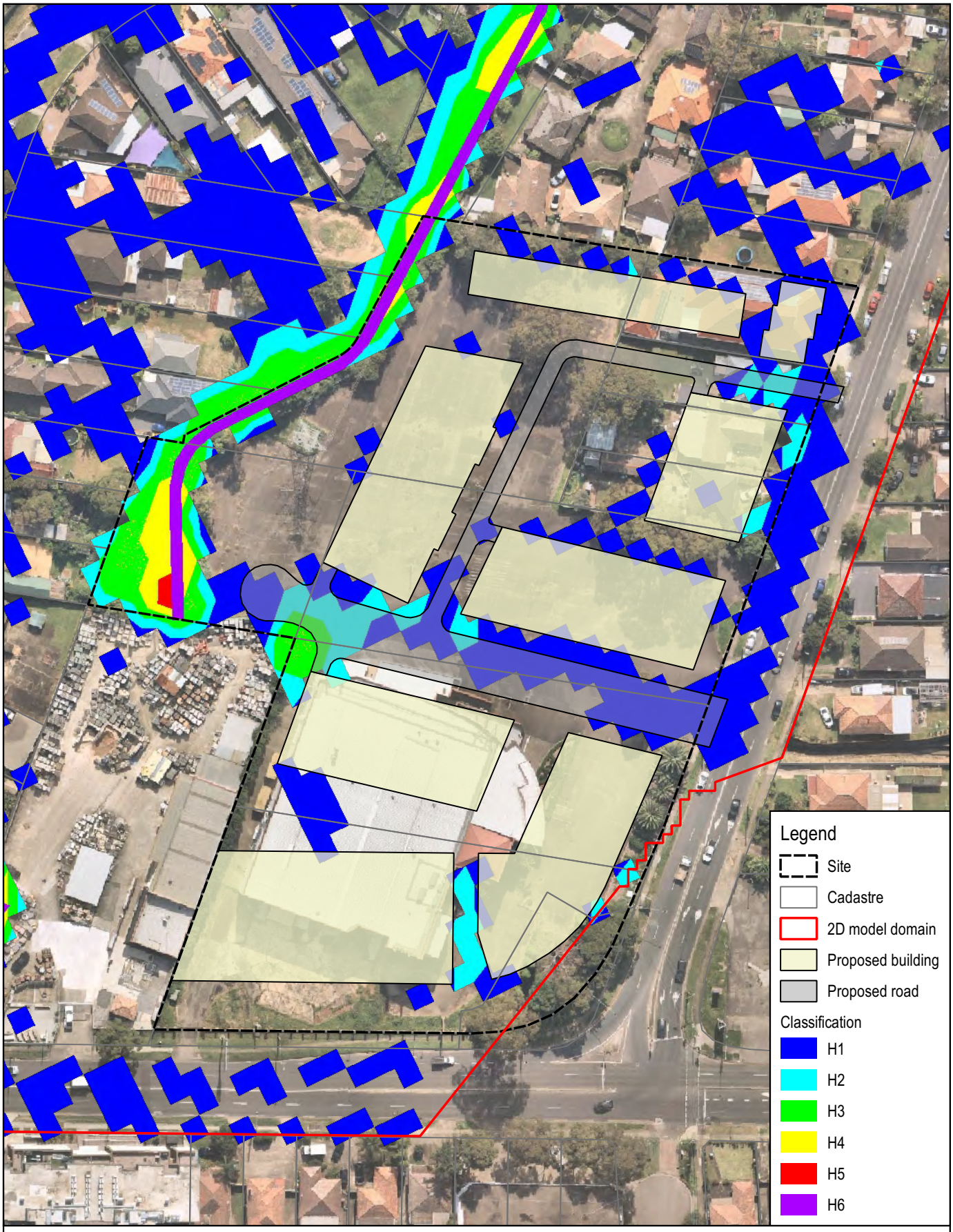

Title: POST-DEVELOPMENT 1% AEP FLOOD HAZARD VULNERABILITY PLAN - 0% BLOCKAGE

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Client: CMT ARCHITECTS

North:

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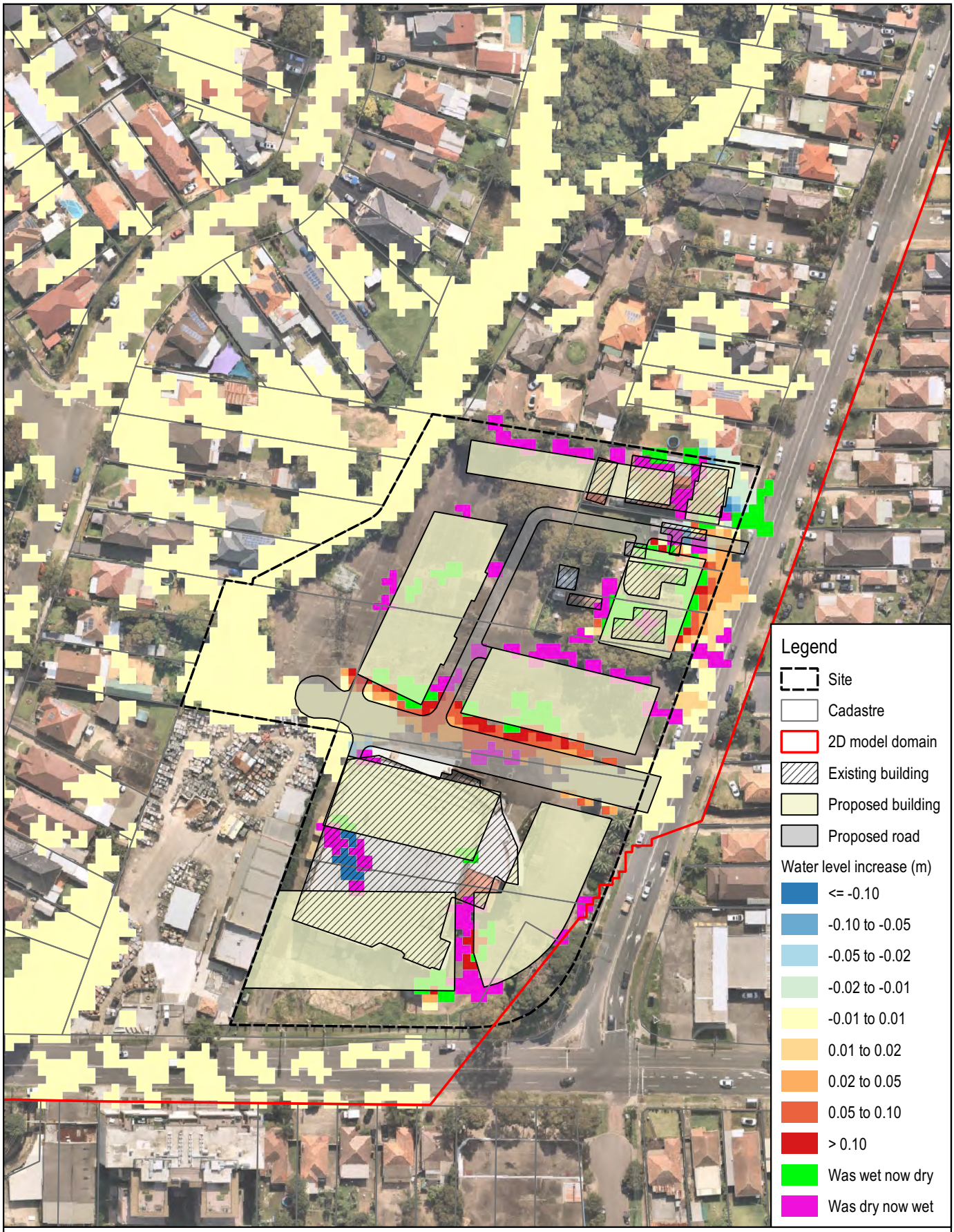

Title: POST-DEVELOPMENT 1% AEP FLOOD LEVEL DIFFERENCE PLAN - 0% BLOCKAGE

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Project: PROPOSED RESIDENTIAL DEVELOPMENT
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Client: CMT ARCHITECTS

North:

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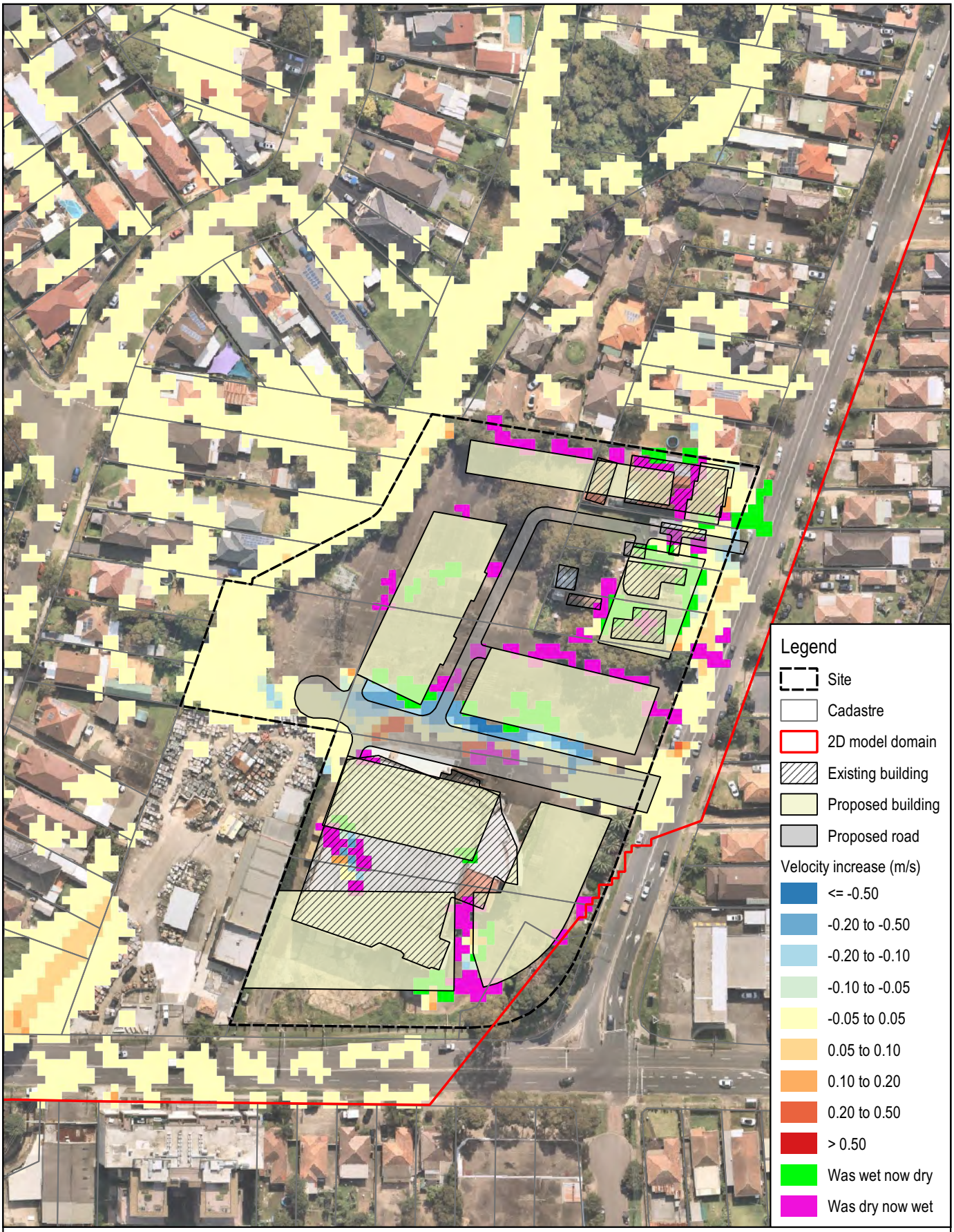

Title: POST-DEVELOPMENT 1% AEP FLOOD VELOCITY DIFFERENCE PLAN - 0% BLOCKAGE

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Project: PROPOSED RESIDENTIAL DEVELOPMENT
NO.'S 913 - 925 PUNCHBOWL ROAD & NO. 21 CANTERBURY ROAD PUNCHBOWL

Client: CMT ARCHITECTS

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
CC210530	F11	C	31.05.2022	BK	AN	1:1,600

Title: POST-DEVELOPMENT 1% AEP FLOOD HAZARD VULNERABILITY DIFFERENCE PLAN - 0% BLOCKAGE

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NO.'S 913 - 925 PUNCHBOWL ROAD & NO. 21 CANTERBURY ROAD PUNCHBOWL

Client: CMT ARCHITECTS

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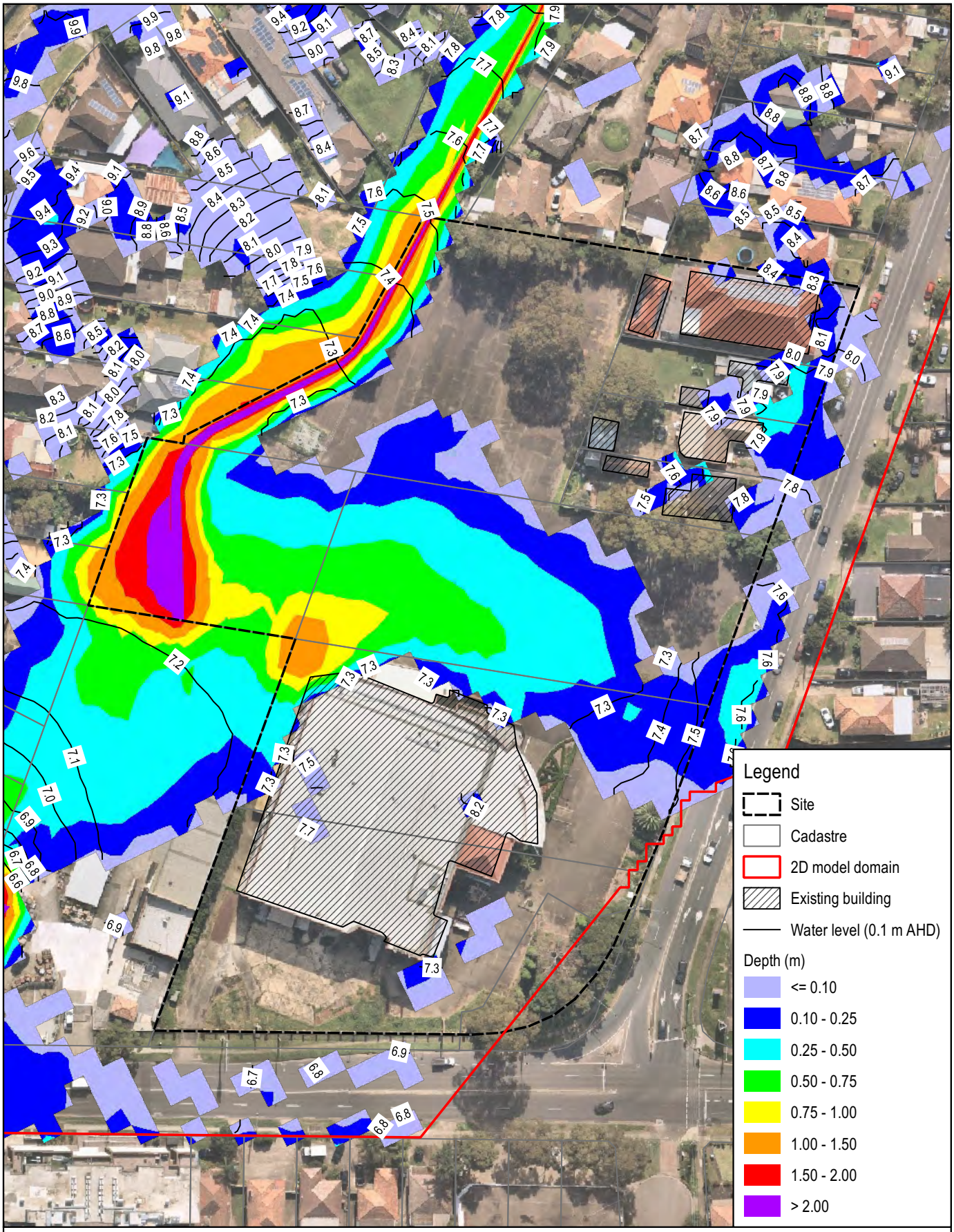
CC210530	F12	C	31.05.2022	BK	AN	1:1,600

Annexure D 1% AEP flood mapping for 50% blockage scenario



Title: PRE-DEVELOPMENT 1% AEP FLOOD DEPTH & LEVEL PLAN - 50% BLOCKAGE

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NO.'S 913 - 925 PUNCHBOWL ROAD & NO. 21 CANTERBURY ROAD PUNCHBOWL

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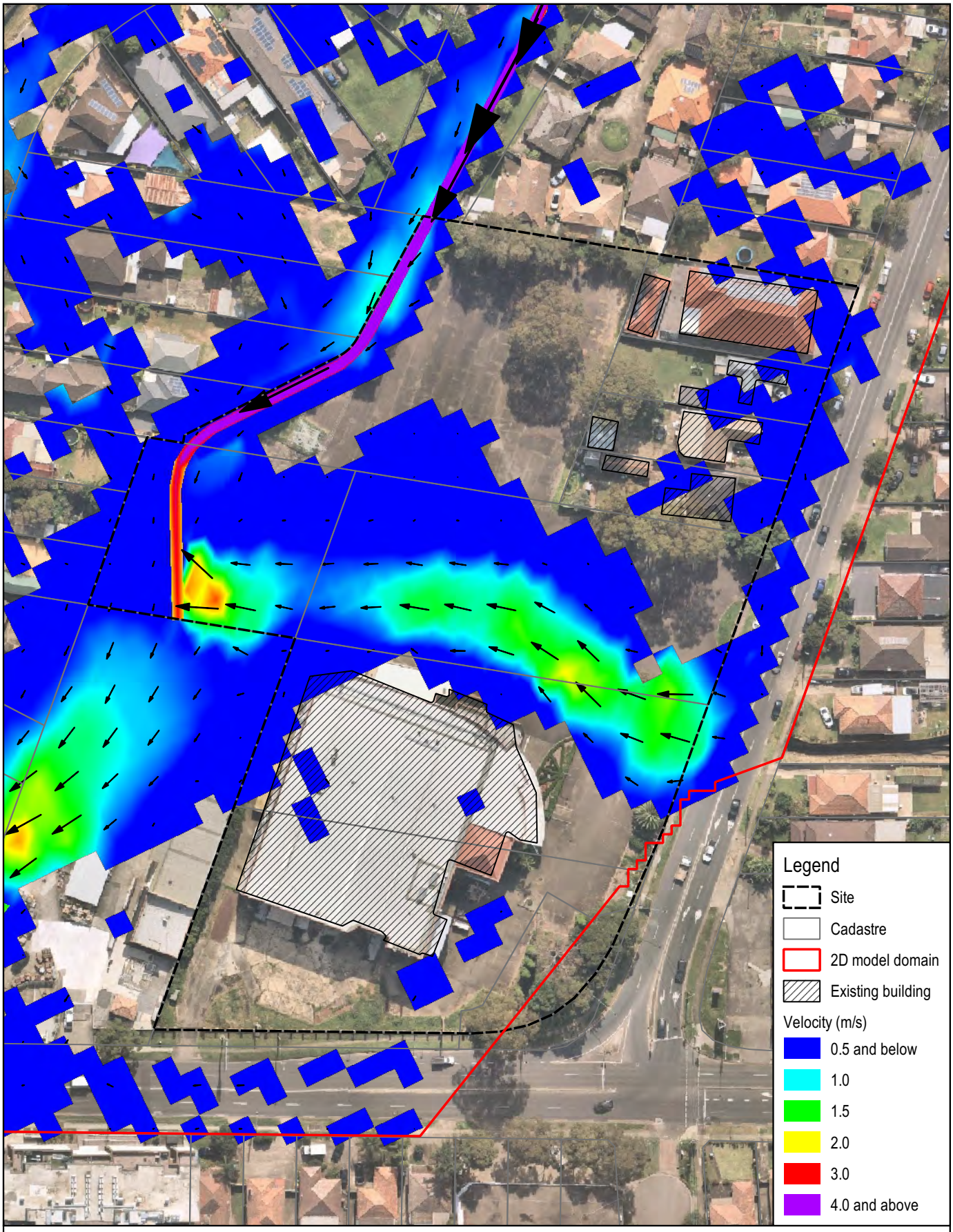

Title: PRE-DEVELOPMENT 1% AEP FLOOD VELOCITY PLAN - 50% BLOCKAGE

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Client: CMT ARCHITECTS

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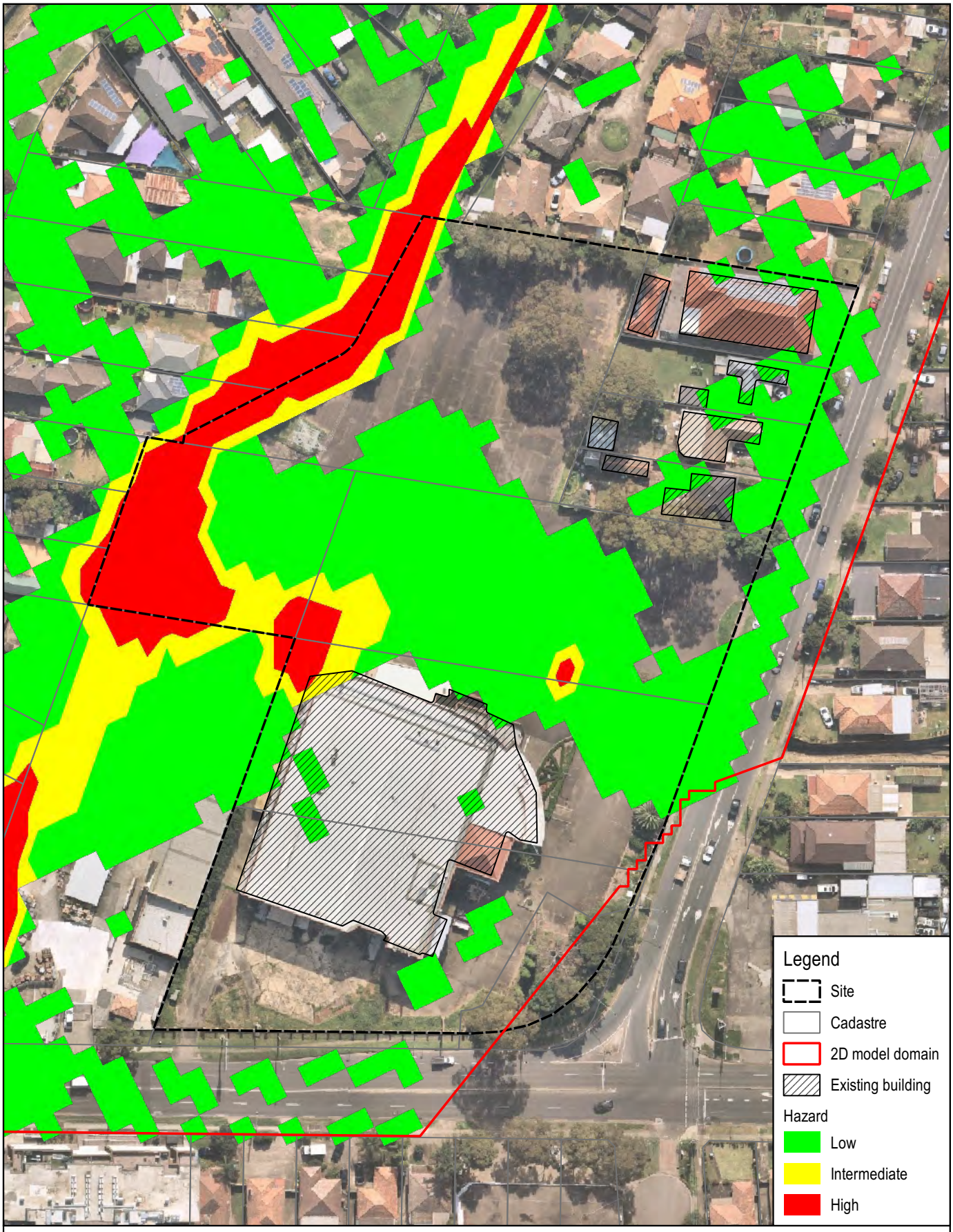

Title: PRE-DEVELOPMENT 1% AEP PROVISIONAL FLOOD HAZARD PLAN - 50% BLOCKAGE

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Client: CMT ARCHITECTS

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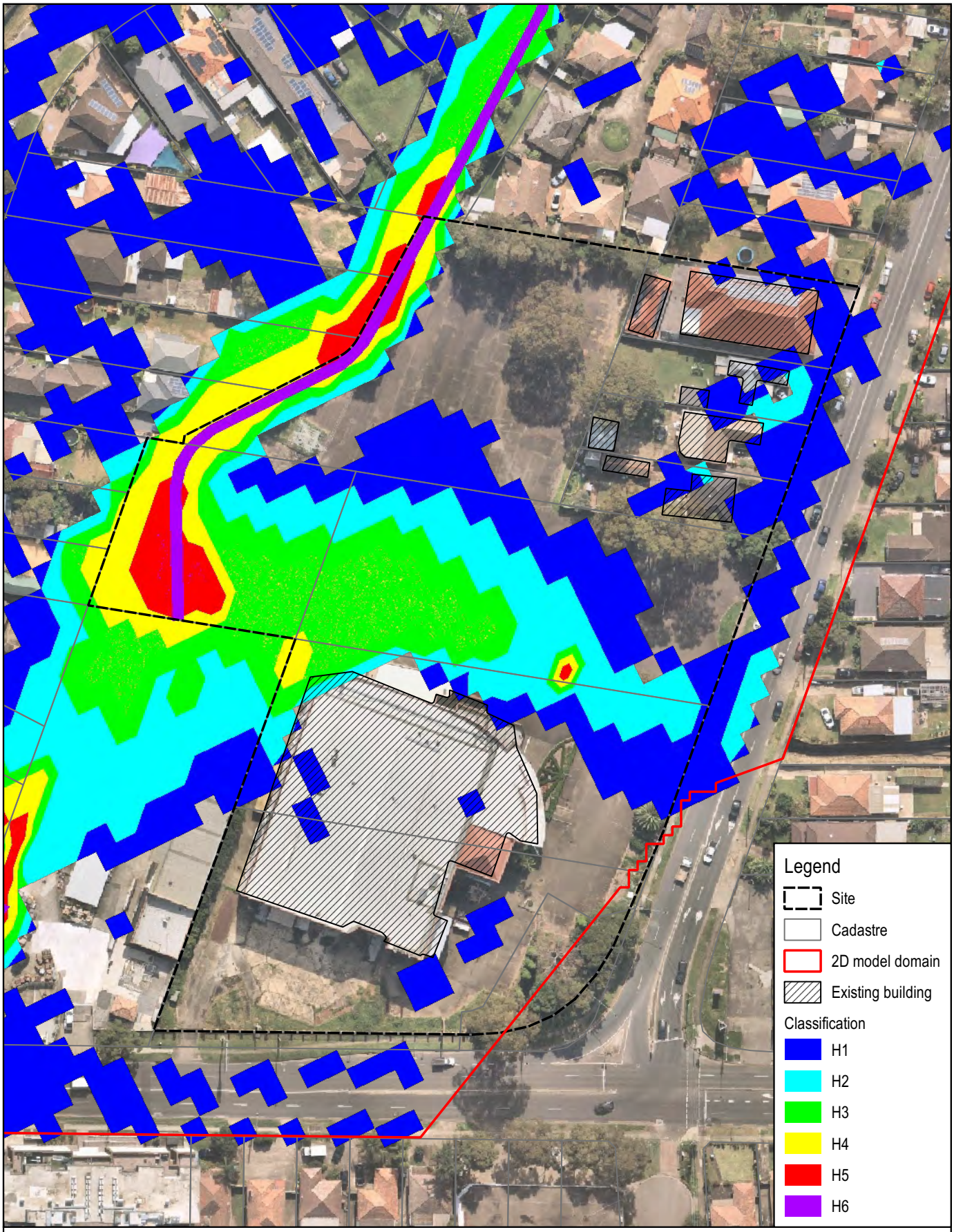

Title: PRE-DEVELOPMENT 1% AEP FLOOD HAZARD VULNERABILITY PLAN - 50% BLOCKAGE

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NO.'S 913 - 925 PUNCHBOWL ROAD & NO. 21 CANTERBURY ROAD PUNCHBOWL

Client: CMT ARCHITECTS

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Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
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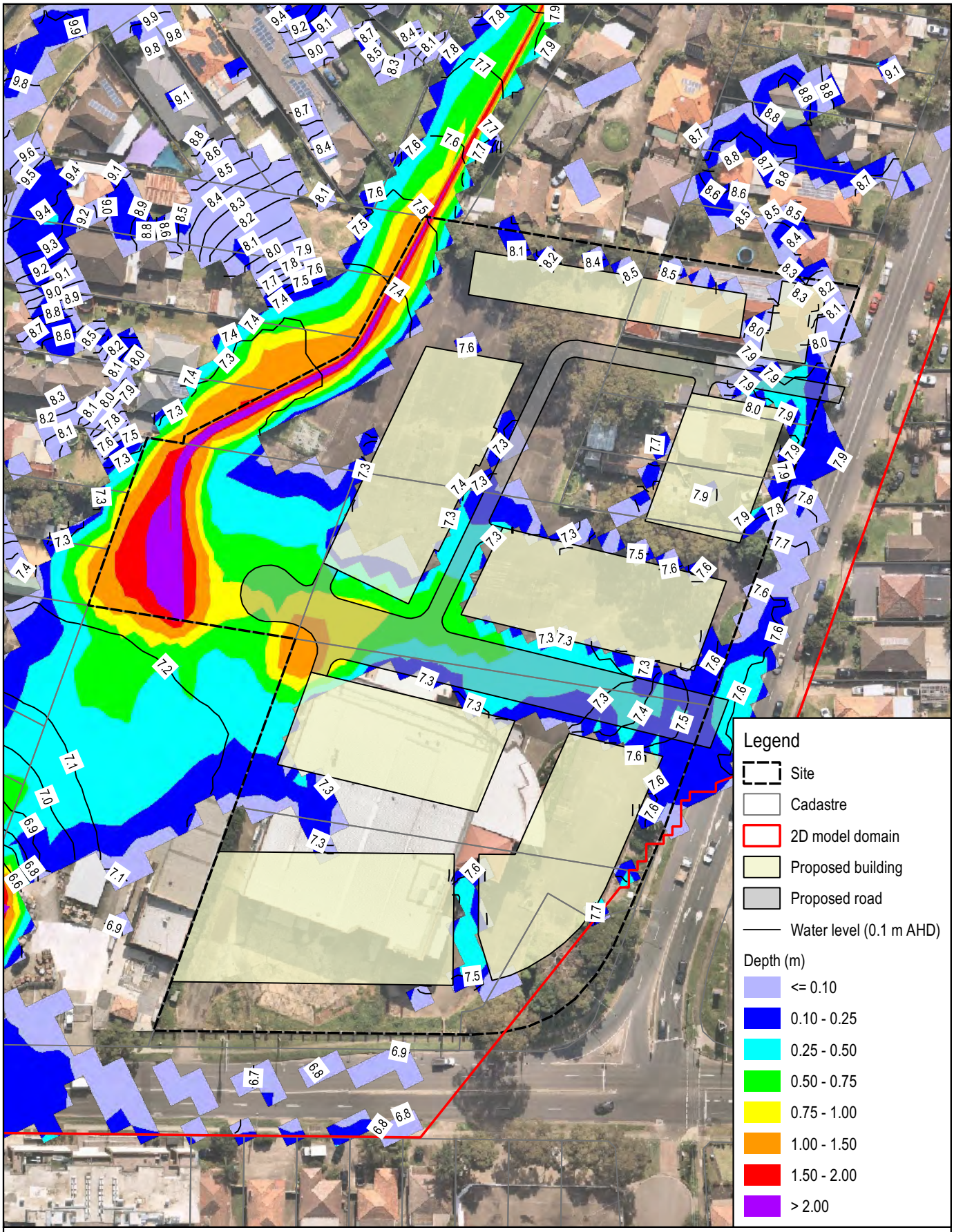

Title: POST-DEVELOPMENT 1% AEP FLOOD DEPTH & LEVEL PLAN - 50% BLOCKAGE

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NO.'S 913 - 925 PUNCHBOWL ROAD & NO. 21 CANTERBURY ROAD PUNCHBOWL

Client: CMT ARCHITECTS

North:

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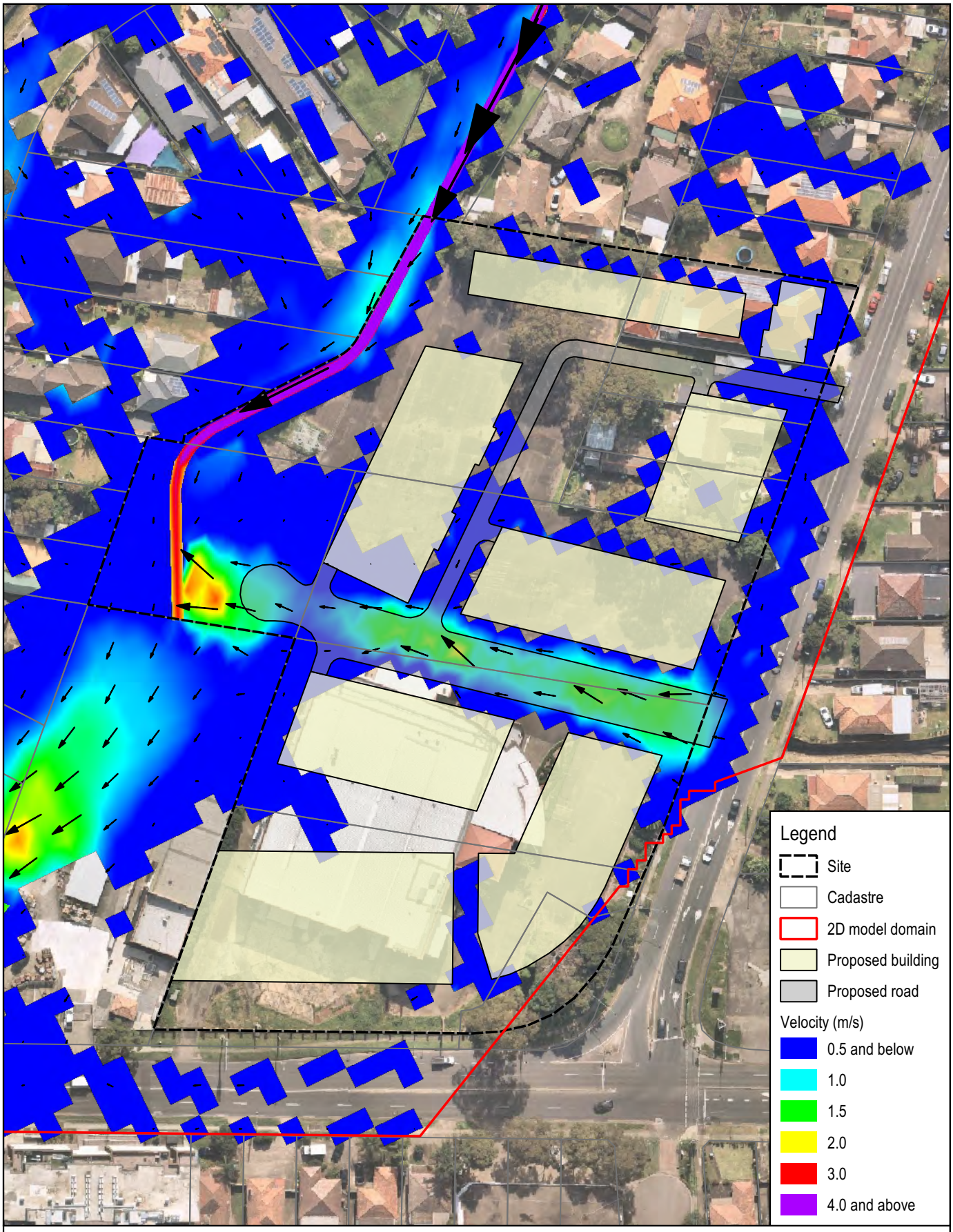

Title: POST-DEVELOPMENT 1% AEP FLOOD VELOCITY PLAN - 50% BLOCKAGE

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NO.'S 913 - 925 PUNCHBOWL ROAD & NO. 21 CANTERBURY ROAD PUNCHBOWL

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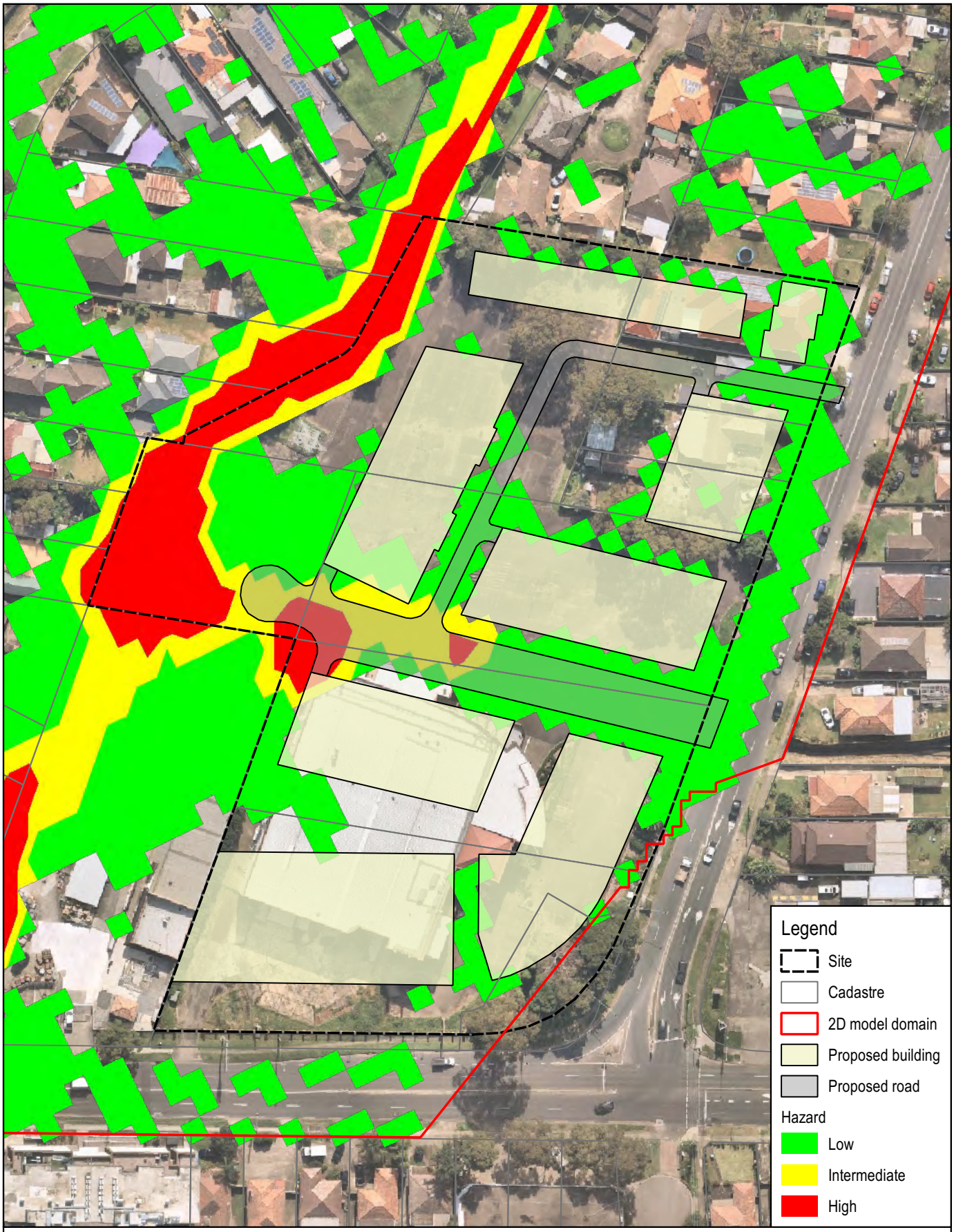

Title: POST-DEVELOPMENT 1% AEP PROVISIONAL FLOOD HAZARD PLAN - 50% BLOCKAGE

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NO.'S 913 - 925 PUNCHBOWL ROAD & NO. 21 CANTERBURY ROAD PUNCHBOWL

Client: CMT ARCHITECTS

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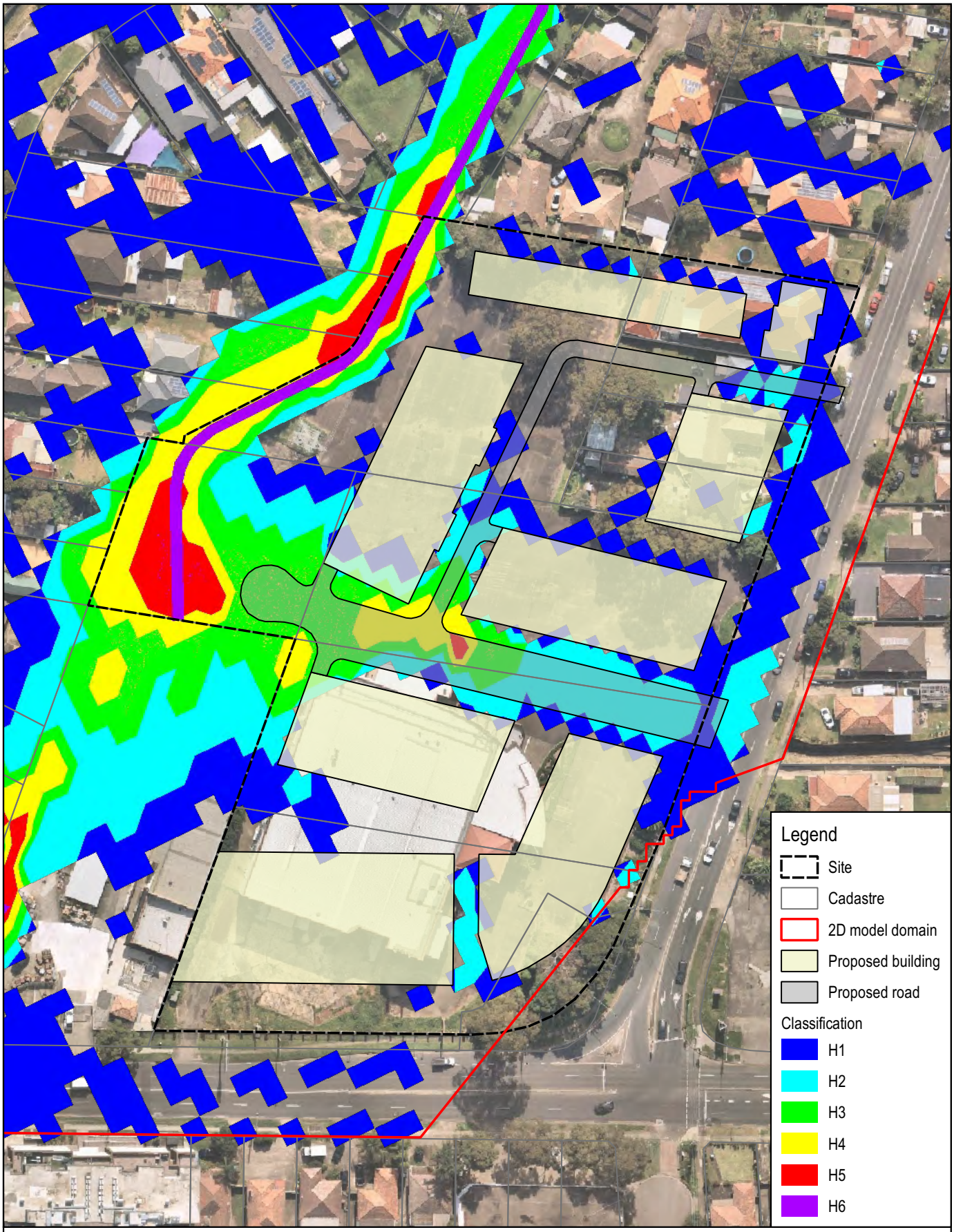

Title: POST-DEVELOPMENT 1% AEP FLOOD HAZARD VULNERABILITY PLAN - 50% BLOCKAGE

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Client: CMT ARCHITECTS

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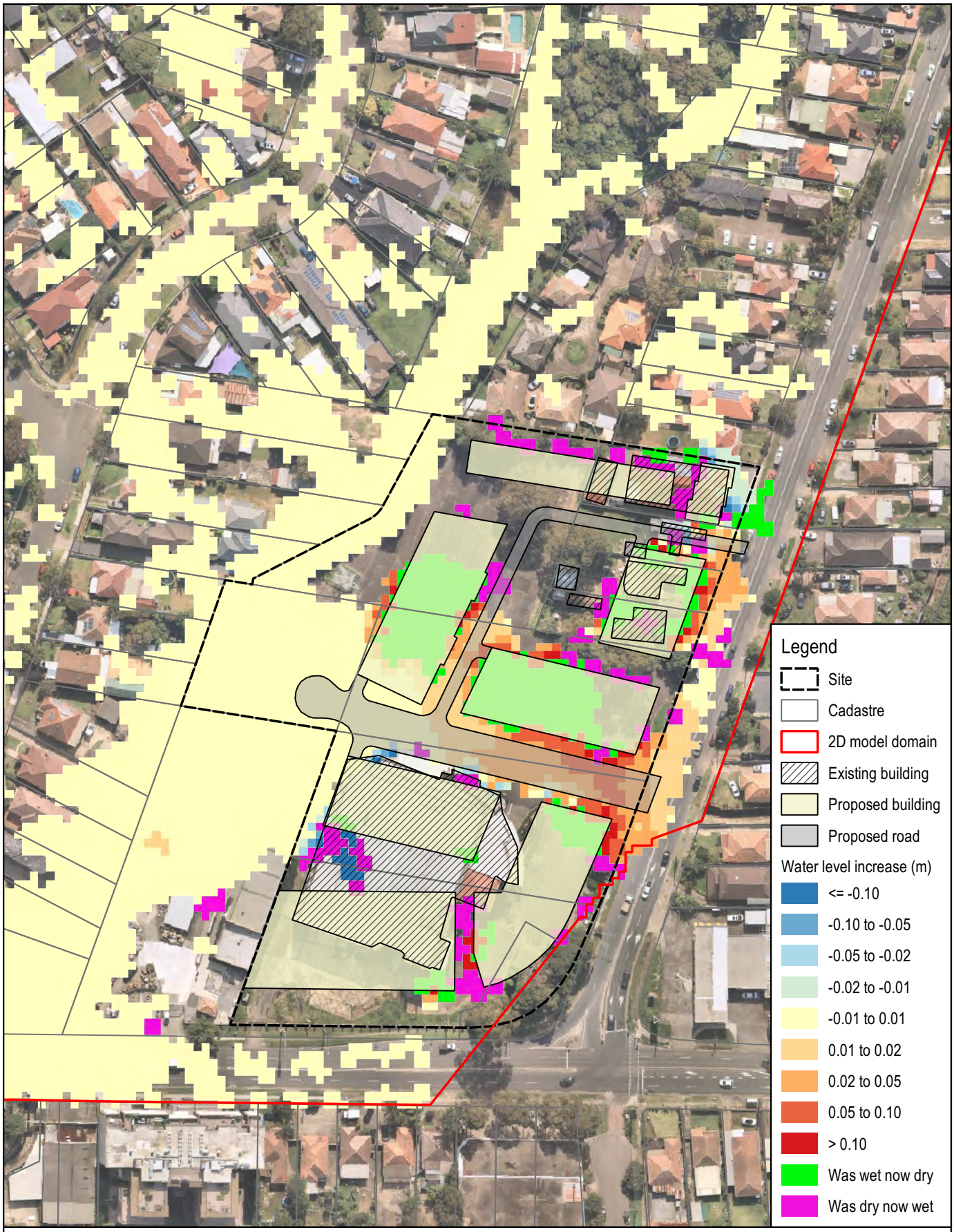

Title: POST-DEVELOPMENT 1% AEP FLOOD LEVEL DIFFERENCE PLAN - 50% BLOCKAGE

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Client: CMT ARCHITECTS

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CC210530	F21	C	31.05.2022	BK	AN	1:1,600

Title: POST-DEVELOPMENT 1% AEP FLOOD VELOCITY DIFFERENCE PLAN - 50% BLOCKAGE

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Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
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Title: POST-DEVELOPMENT 1% AEP FLOOD HAZARD VULNERABILITY DIFFERENCE PLAN - 50% BLOCKAGE

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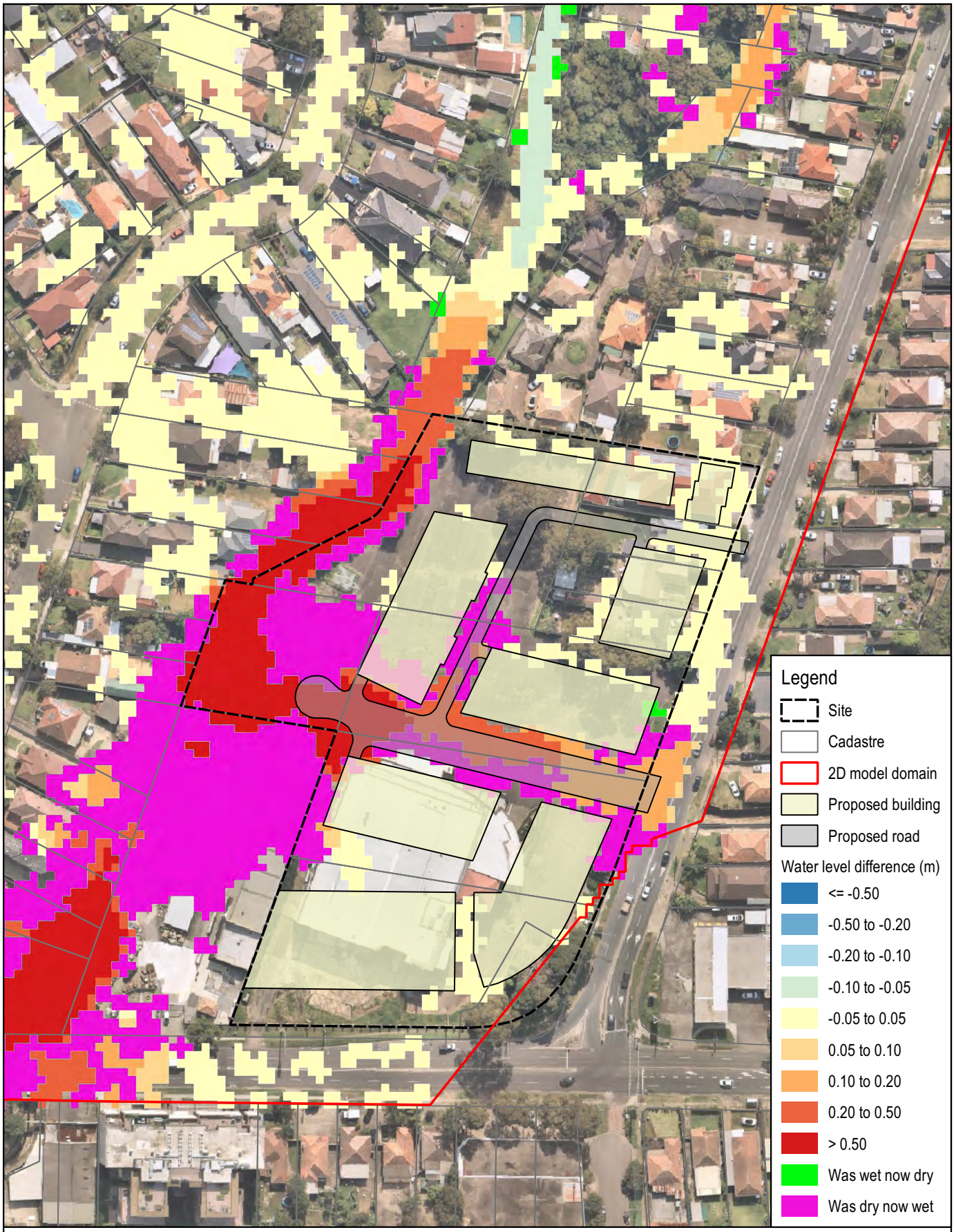
CC210530	F23	C	31.05.2022	BK	AN	1:1,600

Annexure E Blockage sensitivity analysis



Title: 1% AEP FLOOD LEVEL BLOCKAGE SENSITIVITY PLAN - POST-DEVELOPMENT

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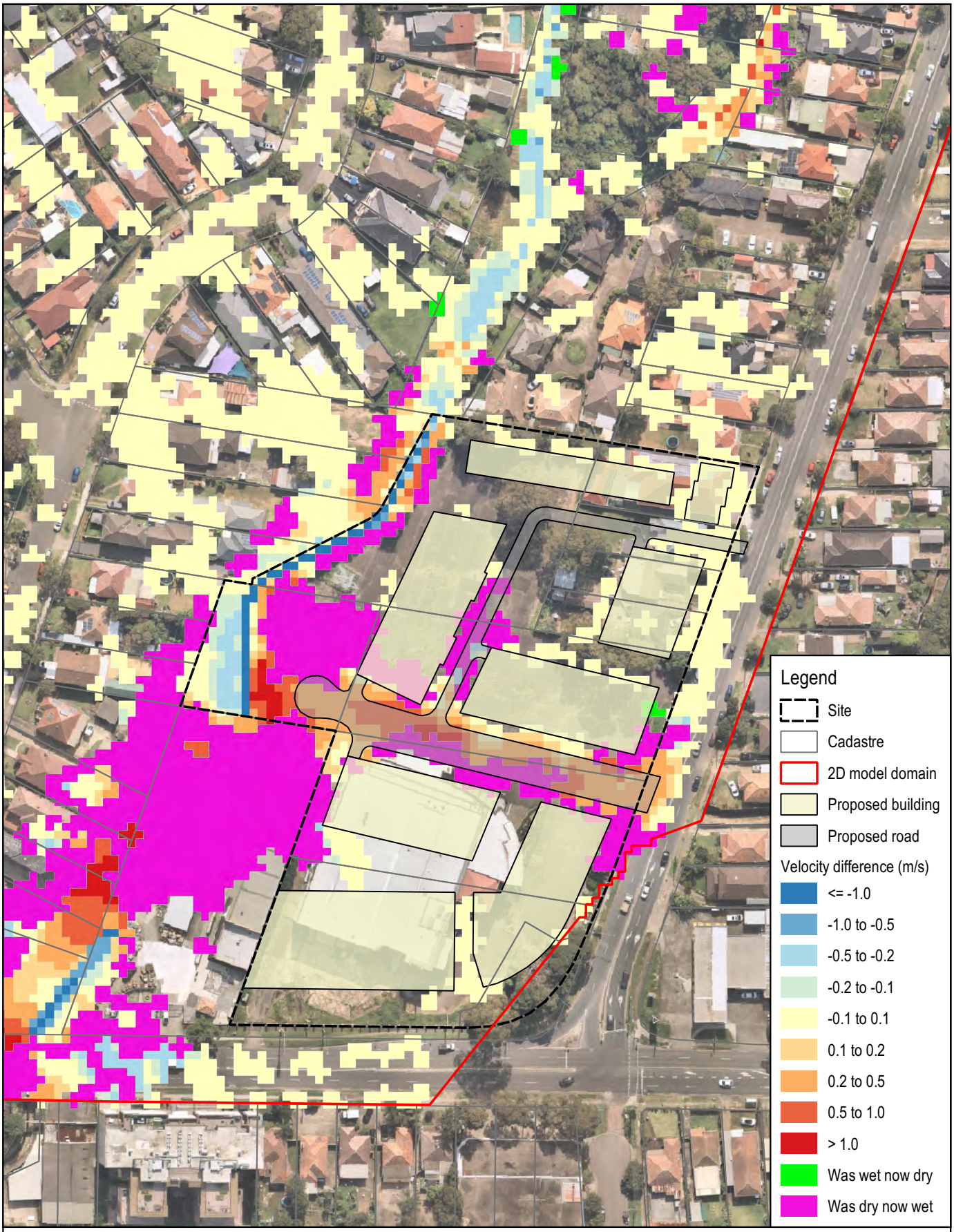

Title: 1% AEP FLOOD VELOCITY BLOCKAGE SENSITIVITY PLAN - POST-DEVELOPMENT

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Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
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Title: 1% AEP FLOOD HAZARD VULNERABILITY BLOCKAGE SENSITIVITY PLAN - POST-DEVELOPMENT

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