Flood Risk and Impact Assessment

for

242-244 Beecroft Road, Epping

for Dasco Australia Pty Ltd

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Contents

Acronyms

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ALS	Airborne Laser Survey (LiDAR)
ARI	Average Recurrence Interval
ARR2019	Australian Rainfall and Runoff 2019
BoM	Bureau of Meteorology
CoPC	City of Parramatta Council
DCP	Development Control Plan
DRAINS	A 1D hydrologic and hydraulic modelling software
DTM	Digital Terrain Model
FPL	Flood Planning Level
Ha	Hectares – Measure of Area
HSC	Hornsby Shire Council
IFD	Intensity-Frequency-Duration Rainfall Chart
LGA	Local Government Area
LiDAR	Light Detection and Ranging Terrain Data (also see ALS)
m	Measure of length / height / distance (metres)
m AHD	Meters above Australian High Datum
m/s	Measure of velocity (metres per second)
m^3/s	Measure of flow rate (cubic metres per second)
NSW OEH	New South Wales Office of Environment and Heritage
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
SW	Sydney Water
TUFLOW	A 1D and 2D hydraulic modelling software
WaC	Works as Constructed Drawings

Introduction

Northrop Consulting Engineers have been engaged by Dasco Australia Pty Ltd to prepare a Flood Impact and Risk Assessment for the proposed development at 242-244 Beecroft Road, Epping, herein referred to as the subject site or the site. The subject site locality is presented in **Figure 1** overleaf.

The proposed development was approved in September of 2023 (SSD-31576972) however, the proponent is seeking to amend the previous approval for the site with the submission of an amending Concept Development Application (Ref: SSD 68939460) and an amending Detailed Design Development application (Ref: SSD 68708456).

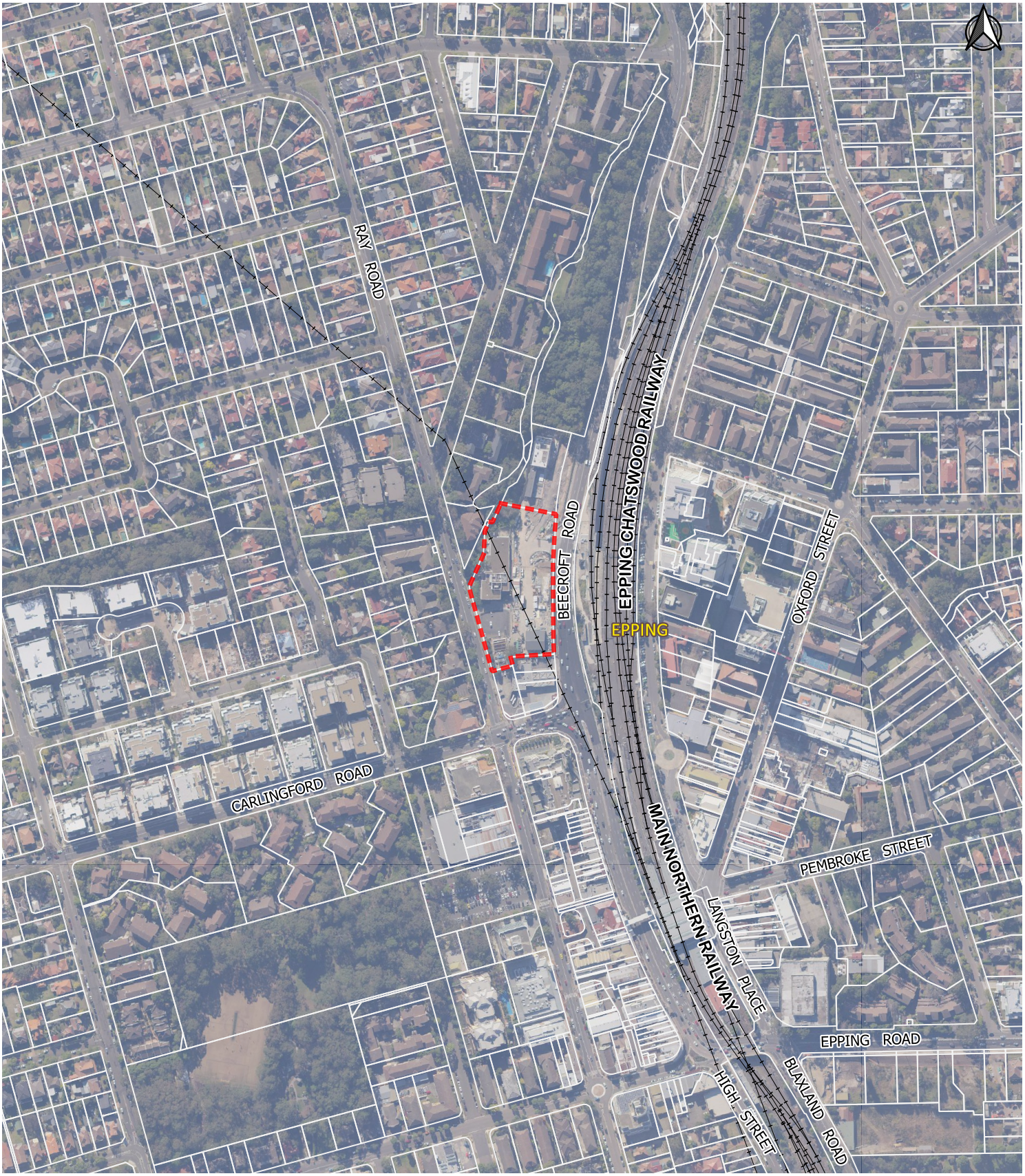
The amending applications are intended to permit an additional 5 levels (i.e. an additional 4 levels above ground and 1 additional basement level). The modelling and report prepared as part of the original submission (SSD-31576972) has been updated herein to reflect the latest changes to the layout and civil design.

The revised Secretary's Environmental Assessment Requirements (SEARS) (SSD-68939460 & 68708456) have been considered herein. This report specifically relates to Issue and Assessment Requirements identified as Item 15 – *Flooding Risk* of the SEARS related for the development which pertains to:

- Identify any flood risk on-site having regard to adopted flood studies, the potential effects of climate change, and any relevant provisions of the NSW Flood Risk Management Manual.
- Where the development could alter flood behaviour, affect flood risk to the existing community or expose its users to flood risk, provide a flood impact and risk assessment (FIRA) prepared in accordance with the Flood Impact and Risk Assessment – Flood Risk Management Guide LU01.
- Detail design solutions and operational procedures to mitigate flood risk where required.

This assessment has been prepared with the consideration of the following guidelines and documents:

- NSW Department of Planning and Environment (DPIE) - Secretary's Environmental Assessment Requirements (SEARS).
- City of Parramatta Council Development Control Plan 2011.
- City of Parramatta Council Development Engineering Design Guidelines 2018.
- Australian Rainfall and Runoff 2019 Guidelines (AR&R 2019).
- Australian Rainfall and Runoff Project 15: Two-Dimensional Modelling in Urban and Rural Floodplains (2012).
- NSW Floodplain Development Manual (NSW Government 2005).
- NSW Flood Risk Management Manual (NSW Government 2023).
- The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method" (BoM, 2003).



Legend

Site Boundary

0 100 200 300 Metres

1:5,000

Figure 1

Subject Site Locality

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - NSW Imagery, Cadastre - NSW LPI 2020

30/5/2022 X:\PROJECTS\SYDNEY\2021 Jobs\SY212798 242-244 Beecroft Road, Epping\O - Drawings\MAP\Figures\220530_Report\Figure_1.qgzFigure_1.qgz

Methodology

This flood impact assessment has been undertaken generally using the following procedure:

- Desktop review of available previous investigations and information including design plans, LiDAR and survey data, stormwater infrastructure information and land use classifications.
- Preparation of a one-dimensional DRAINS hydrological model to quantify peak flows approaching the subject site.
- Preparation of an Existing Case one-dimensional and two-dimensional TUFLOW hydraulic model to quantify the existing flood behaviour across the subject site and vicinity.
- Modification of the Existing Case TUFLOW hydraulic model to include the proposed development layout and terrain, creating the Developed Case scenario.
- Comparison of the existing and developed case results to review the impact the proposed development has on the existing flood behaviour on-site and in adjacent properties.

The one-dimensional DRAINS model has been prepared to generate inflows and to assist with the determination of the critical durations to be passed onto the two-dimensional model thus, reducing the time it takes for design run iterations.

This study has been prepared with consideration to the following plans and reports:

- Architectural Drawings prepared by Turner Architects and dated 31st of May 2024.
- Civil Drawings and Report prepared by Northrop Consulting Engineers and dated July 2024.

This report has been prepared for State Significant Development Application (SSDA) submission to the NSW Department of Planning and Environment.

Subject Site and Proposed Development

Subject Site

The subject site is located at Epping and includes the parcel of land at 242-242 Beecroft Road otherwise known as Lots 220 & 222 DP1251471. The site area is approximately 1.01 hectares with elevations ranging from approximately 87.31m AHD at Beecroft Road along the eastern boundary to 79.11 m AHD at Ray Road along the western boundary. Grades are relatively steep with a slope of approximately 7% falling from the south-eastern corner to Ray Road to the west.

The site is subject to flooding from Devlin's Creek which is located adjacent to the north-western boundary of the site.

The site has two frontages, one adjacent to Beecroft Road to the east and a second at Ray Road to the west. The site is currently vacant with its former use largely demolished with the exception of its driveways and vehicular access which remain.

The existing site frontages are presented in Photos 1 and 2 below:

Photo 1 – Beecroft Road Frontage (Google Maps 2022), Looking to South

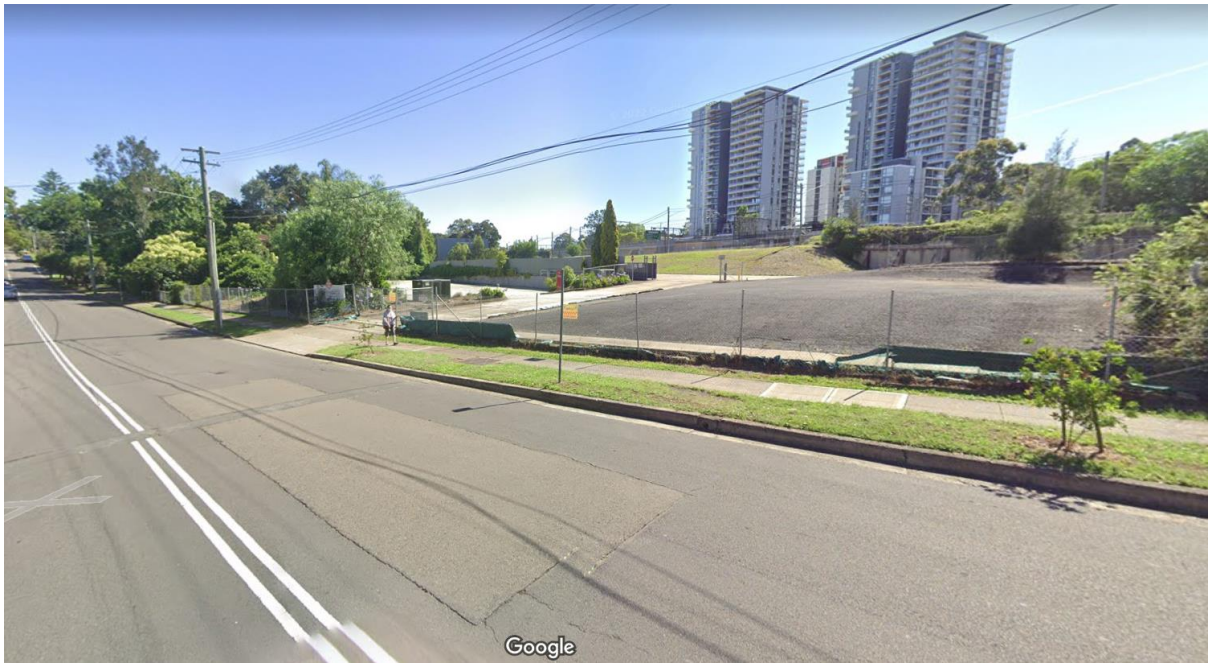


Photo 2 – Ray Road Frontage (Google Maps 2022), Looking to North

Devlin's Creek

The local Devlin's Creek catchment extends to the south and west of the subject site towards West Epping Park and Edna Hunt Sanctuary. The catchment area upstream of Ray Road (and the subject site) is approximately 2.07km^2. The Devlin's Creek catchment is largely urbanised with residential lots and the associated road network covering the majority of the catchment.

Upstream of 7 Ray Road, Devlin's Creek is largely made up of a trapezoidal concrete lined channel as shown in the following Photo 3. Between 7 Ray Road and upstream of the Ray Road crossing, Devlin's Creek has been built over by a vehicular access driveway as shown in the below Photos 4 and 5. A number of large inlet grated pits are located in the driveway and over the Creek at 7 Ray Road. These have been measured on site to be approximately four 3.0m long x 2.3m wide and one 3.9 long x 2.3m wide pits.

At 6 Ray Road, the Creek opens up again prior to continuing beneath Ray Road with a large open pit observed in Photos 5 and 6. Downstream of Ray Road, and adjacent to the subject site, Devlin's Creek continues as an open trapezoidal concrete lined channel as shown in Photo 7, before continuing beneath Kandy Avenue approximately 450m downstream of the subject site.

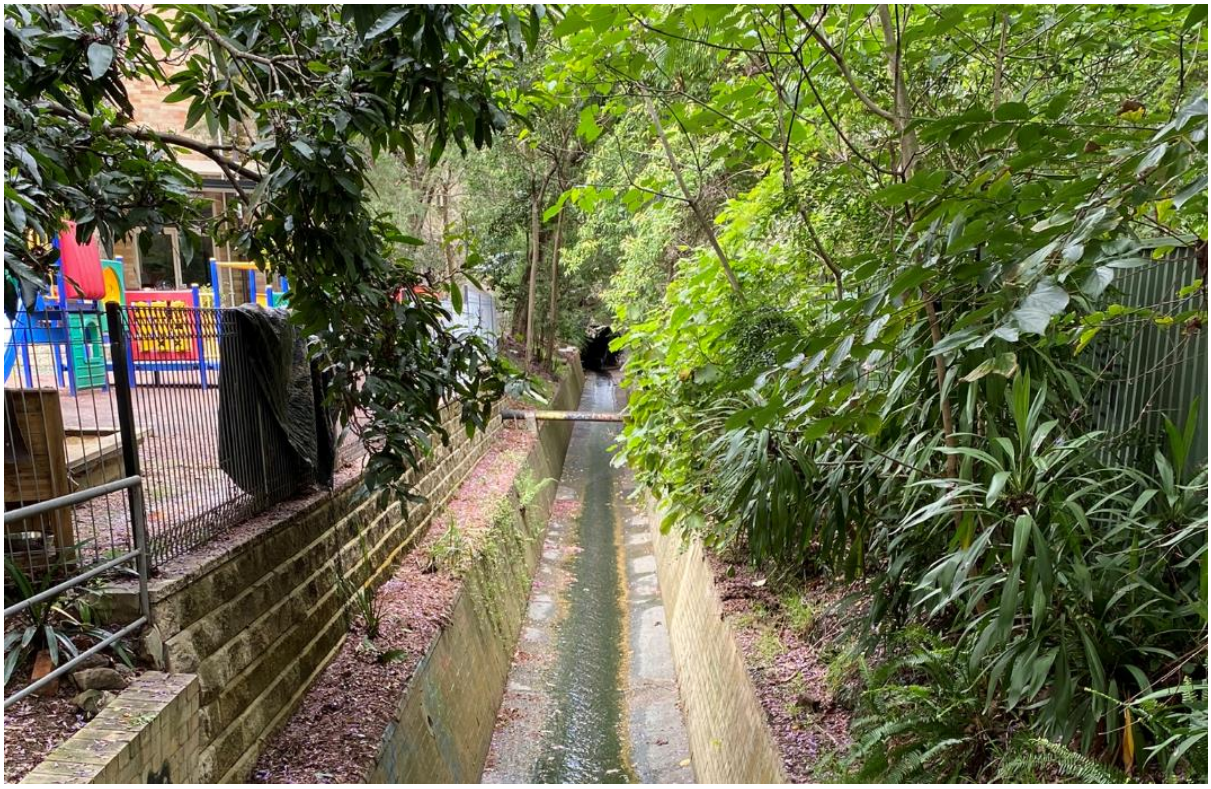


Photo 3 – Devlin's Creek at 7 Ray Road (Looking South towards 3 Ray Road)

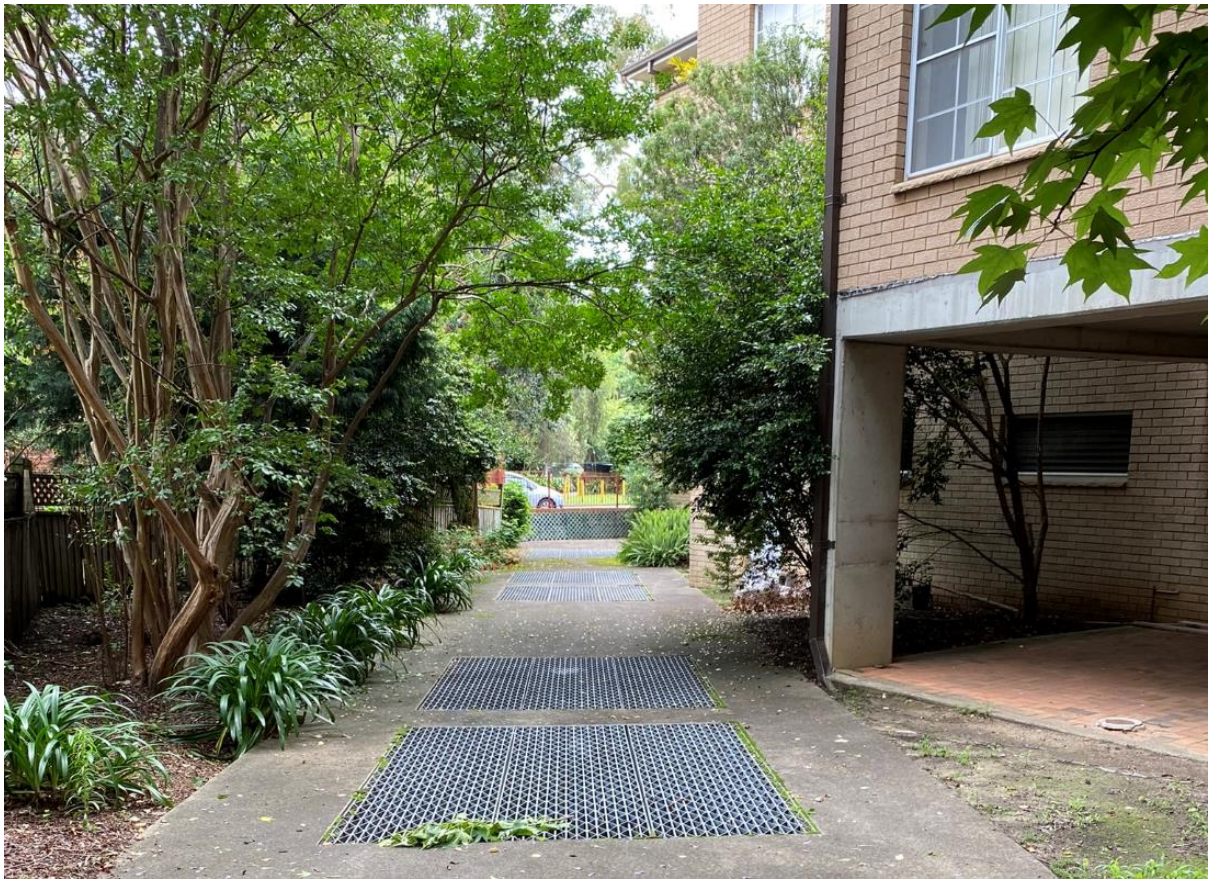


Photo 4 – Devlin's Creek Built Over at 7 Ray Road (Looking North towards 6 Ray Road)

Photo 5 – Devlin's Creek at Ray Road (Looking South towards 6 Ray Road)

Photo 6 – Devlin's Creek Under Ray Road (Looking North)

Photo 7 – Devlin's Creek Downstream of Ray Road (Looking North adjacent to Subject Site)

Proposed Development

The proposed development includes the construction of a new multistorey mixed-use facility with retail/ commercial spaces connecting at the Beecroft Road level (Ground Floor Level) and three residential towers.

Also included is a four-level basement carpark (below the Ground Floor level) with vehicular driveways via both Beecroft and Ray Roads. A vehicular slip lane is proposed off Beecroft Road to enable access to the basement levels below.

A through-site link is also proposed providing pedestrian access between Beecroft and Ray Road.

Architectural plans presenting the development at both Beecroft (Ground Floor) and Ray Road (Basement 01) levels are provided in Figure 2 and Figure 3 respectively.

Figure 2 - Proposed development Basement 01 (Ray Road)

Figure 3 - Proposed development Ground Floor (Beecroft Road)

Local Council Requirements

The Council requirements have been obtained from the City of Parramatta Council's Development Control Plan (DCP) and Engineering Guidelines. The requirements are summarised in the below Table 1. Also presented in Table 1 is a summary of the response to each requirement.

Table 1 - Council Requirements Summary Table

Item	Reference Clause / Document	Requirement	Response
Managing Watercourses and Overland Flow Flooding	General Requirements Clause 1.0	a) Sites impacted by flooding and/or overland flows from rainfall are to be assessed by Council and all designs must be consistent with the requirements of Council's Local Environmental Plans, Development Controls Plans, Stormwater Disposal Policy, and the NSW Flood Plain Development Manual as they relate to flood affected sites. b) Applicants are to obtain flood levels from Council's Catchment Management Unit via an online flood enquiry application where that information is held by Council c) Where Council does not hold that information, a flood study prepared by the applicant will be required. The flood study shall be prepared in accordance with the requirements of this Section and submitted to Council with the DA. d) 1D modelling is generally acceptable (HEC-RAS), however, 2D modelling may be required at the discretion of Council staff depending on the site, the nature of development and catchment complexity. e) It is strongly advised that development proposals on flood prone sites are discussed with Council at a pre-lodgement meeting. f) Sensitive land uses on flood affected sites are discouraged in line with the flood planning matrix located in Council's Development Control Plan. g) Piping and channelling of watercourses is not supported	City of Parramatta Council, Hornsby Shire Council and Sydney Water were all contacted in an attempt to obtain existing flood information for the subject site. No existing information was available. As such, the Flood Study contained herein has been prepared. A 2D TUFLOW hydraulic model has been prepared herein. The proposed development is not considered a sensitive use. An assessment of the proposed development with respect to Council's flood planning matrix is presented in the Discussion section of this report. Piping and Channelising is not proposed as part of the proposal.

Item	Reference Clause / Document	Requirement	Response
	Requirements for a Flood Study Clause 2.0	a) Where a flood study is required by Council, the flood study is to be carried out in accordance with the parameters specified in this Section and a report submitted to Council with the DA which includes the following minimum information. b) Survey plan of the development site and surrounds, noting the location of existing buildings, retaining walls, trees and other structures of hydraulic significance, c) Catchment plan showing: i. the extent and area of the catchment, including delineation of any sub-catchments, ii. size and location of any existing drainage infrastructure, and, overland flow paths, d) Plan showing the hydraulic model layout (centreline of the watercourse or flow path and cross-sections) or digital elevation model including details of structures, any other flow obstructions or ineffective flow areas for both pre and post development scenarios, e) Modelling methodology and model schematics, f) List, description and justification of assumptions used including evidence of any ground-truthing exercises g) Discussion of results including a table and maps showing and comparing the pre and post development flood levels, depths, velocities and hydraulic hazard, h) Where a 2D model is used, maps showing flood depth with water surface level contours and velocity vectors and flood afflux shall also be included, i) Assessment of the development proposal against Council's flood planning controls in the DCP,	a) Parameters are generally in accordance with the Guidelines and are discussed herein. b) Survey for the subject site has been obtained and prepared by LTS. c) A catchment plan is presented in Figure 4 and infrastructure is discussed herein. Infrastructure is presented in **Figure 5**. d) Plans showing the hydraulic model layout and DEM are presented in **Figure 5** to **Figure 9**. e) The modelling methodology is discussed in the Methodology Section of this report, and a schematic of the model is presented in **Figure 5**. f) Assumptions and ground truthing are discussed in the Devlin's Creek and Hydraulic Parameters Sections. g) The results of the investigation are discussed in the Results section and presented Appendix A of this report.

Item	Reference Clause / Document	Requirement	Response
		j) Flood risk management measures to be incorporated into the development proposal, k) Any other information required to support the engineer's conclusion. l) Model files in an electronic format (compressed into a single .zip file).	h) Flood depth, surface contours, velocity and flood afflux figures are all presented in Appendix A. i) The proposed development has been assessed with the DCP requirements herein. j) Flood Risk Management measures are presented in the discussion section of this report. k) Additional supporting information is presented in the Discussion section of this report. l) Previous revisions of the flood model have been provided. Latest Model files can be provided upon request.
Hydrological Modelling Parameters	Catchment Area Clause 3.0	The use of contour maps, based on LIDAR data and obtained from Council or NSW Land Registry Services, can be used to determine the extent and area of the wider catchment. Where these are used, site inspections must also be carried out by the consultant engineer to confirm the catchment boundaries. This is to be complemented with surveyed levels reduced to AHD from a Registered Surveyor within the development site, surrounding properties and other critical locations within the catchment.	A catchment plan has been prepared using NSW LPI LiDAR elevation data and is presented in Figure 4. Survey for the subject site prepared by LTS has been used for the investigation.

Item	Reference Clause / Document	Requirement	Response
	Rational Method Clause 3.1	Rational method calculations carried out in accordance with Chapter 14 of the AR&R may be used to determine the flow rate for small catchments with fairly uniform characteristics. Otherwise, the catchment is to be modelled in a runoff routing model, such as DRAINS or using the direct rainfall method (rainfall on grid). Where the rational method is used, the minimum and maximum times of concentration that will be considered are 5 minutes and 20 minutes respectively.	DRAINS has been used as the hydrological model for this assessment while TUFLOW has been used for the hydraulics.
	Storm Events Clause 3.2	The following storm events are to be considered in the flood study: a) 5% AEP (20 Year ARI), b) 1% AEP (100 Year ARI), and, c) Probable Maximum Flood (PMF).	The 5%, 1% AEP and PMF design storm events have all been considered as part of this investigation.
	Consideration of piped infrastructure Clause 3.3	For the purposes of risk assessment, it is to be assumed that there is no benefit from the piped system, i.e. 100% pipe blockage. In borderline circumstances where development may be precluded due to incompatibility with flood risk (due to hydraulic hazard), the sensitivity of the model can be tested with a 75% pipe blockage assumption (i.e. pipe flow is restricted to 25% of its capacity) to reclassify a site's flood risk. Where this scenario is adopted, flood risk management measures still need to be based on flood levels in the 100% blocked case. Note that augmentation of the flow path (i.e. widening the flow path to allow shallower flow) may be an option to reduce hydraulic hazard and should be explored prior to adjusting this assumption.	As Devlin's Creek is a trunk line and the infrastructure in question is large (2m+ wide), 100% blockage is considered over conservative for the purposes of this investigation. A 50% blockage factor has been used as an alternative for design purposes with a 100% blockage sensitivity test performed to review the implications of this assumption. Additional information is provided in the Hydraulic Model and Discussion Sections of this report.

Item	Reference Clause / Document	Requirement	Response
	Initial and Continuing losses Clause 3.6	All models are to assume a fully saturated catchment. This is equivalent to an Antecedent Moisture Condition (AMC) of 4 in a DRAINS (ILSAX) based model.	The latest ARR 2019 guidelines have been used for this study including the initial and continuing loss model. Pre-burst rainfall has been incorporated into the hydrological model in accordance with the ARR 2019 guidelines which is the latest method of modelling catchment antecedent conditions.
	Probable Maximum Precipitation (PMP) Estimates for The Probable maximum Flood (PMF) Event) Clause 3.7	Estimates of PMP are to be carried out using the Bureau of Meteorology guidebook: The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method (2003). (This guidebook replaces Bulletin 53 referred to in AR&R.)	The PMP depths have been determined using these guidelines as discussed in the Hydrological model Parameters Section of this report.
	Climate Change Clause 3.8	Increases in rainfall intensity associated with climate change shall be consistent with AR&R guidelines.	A sensitivity test, reviewing the effect of climate change has been included in the Discussion Section of this report. Climate change intensities have been prepared in accordance with the latest ARR 2019 guidelines.
	Other Parameters Clause 3.9	Where parameters have not been specified in this section, justification shall be provided for their use in the modelling.	Model parameters have been discussed in the Model Parameters Section of this Report.

Item	Reference Clause / Document	Requirement	Response
Hydraulic Modelling Parameters	Model Selection Clause 4.1	The use of 1D models, such as HEC-RAS, is generally acceptable. However, 2D models, such as TUFLOW, may be required at the discretion of Council staff depending on the site, the nature of development and catchment complexity. The selection of model used in the flood study is to be justified by the consultant engineer.	A two-dimensional TUFLOW model has been prepared for the purposes of this investigation.
	Boundary Conditions Clause 4.2	Appropriate boundary conditions are to be included in the model where it is considered that there will likely be a tailwater influence on the overland flow due to physical obstructions or coincidence with mainstream flooding. This may also require the model to be extended further downstream or replicated with artificial downstream water levels. Details of assumptions are to be included in the report submitted to Council.	Tailwater conditions are discussed in the Model Parameters Section of this report. The TUFLOW model has been extended downstream far enough for tailwater effects to be negligible.
	Surface Roughness Clause 4.4	Surface roughness coefficients (“n”) shall generally be derived from Chapter 14 of the AR&R. Generally, a roughness coefficient of at least 0.1 shall be used in highly urbanised catchments.	Surface roughness is discussed in the Hydraulic Model Parameters Section of this report.
	Grid Size in 2D Models Clause 4.4	An appropriate grid size shall be used in the model to ensure that physical features are adequately represented in the terrain model. This may include increasing the resolution around critical areas to ensure that the results are representative of expected flow conditions.	Grid size is discussed in the Hydraulic Model Parameters Section of this report.
		A sufficient number of cross-sections are to be taken upstream and downstream of the development site and flow splits are to be included to adequately replicate expected flood conditions and to adequately represent the size and shape of flow obstructions. Cross-sections need to be taken perpendicular to the flow direction and “looking upstream”. Ancillary structures such as retaining walls, driveways, stairs, raised landscaping beds, etc. which are likely to cause a flow obstruction are to be considered or otherwise represented by surface roughness assumptions.	Cross Sections were based on available information including Detailed Survey and Works as Constructed provided by Sydney Water. Ancillary structures have been incorporated into the model where the information is available. Buildings have been represented as full flow

Item	Reference Clause / Document	Requirement	Response
		Ineffective flow areas are also to be considered at locations likely to be flooded but not contribute to flow conveyance. The channel is to be defined in the location of the flow path within the development site.	obstructions which is expected to be a conservative assumption.
	Hydraulic Hazard Clause 5.1	Areas subject to high hydraulic hazard are to be identified by the modelling. This is typically defined as areas subject to a velocity depth product greater than 0.4m2 /s or in accordance with Figure L2 in the Floodplain Development Manual. Development should not be exposed to floodwaters with a high hydraulic hazard.	The Floodplain Development Manual (2005) flood hazard conditions have been provided in Figures C5 and D5 respectively. The results presented in these figures suggests a maximum of low flood hazard conditions is observed within the subject site during the 1% AEP design storm event.
Flood Risk Management	Flood Risk Categorisation Clause 5.2	A categorisation of a site's flood risk precinct must be included in all reports. A site's flood risk precinct (FRP) can be determined in accordance with Council's Flood Prone Land Policy and the following definitions: a) High FRP – land below the 100-year flood that is either subject to a high hydraulic hazard or where there are significant evacuation difficulties. b) Medium FRP - land below the 100-year flood that is not subject to a high hydraulic hazard and where there may be some evacuation difficulties. c) Low FRP - all other land within the floodplain (i.e. within the extent of the probable maximum flood) but not identified within either the High Flood Risk or the Medium Flood Risk Precinct.	Based on the results presented in Figure C5 of Appendix A, the site is expected to be classified as not flood prone to a Medium Flood Risk Precinct. That is, a small portion of the site is subject to low flood hazard conditions during the 1% AEP design storm event and a large portion of the site is flood free during the PMF. With vehicular access expected to be available to / from both Ray and Beecroft Roads during the 1% AEP, evacuation difficulties are not expected.

Item	Reference Clause / Document	Requirement	Response
	Flood Impacts Clause 5.3	Development will only be permitted where it can be demonstrated that it will not result in adverse flood impacts on adjoining properties, such as the concentration of flows, increase in flood levels, increase in flood velocities, or increase in flood hazard.	The proposed development is not expected to create significant adverse impacts. Flood impacts are further discussed in the Results section of this report.
	Filling Clause 5.4	Filling within the floodplain is strongly discouraged, however, there may be cases where compensatory earthworks can be used to offset any impact. This can generally only be achieved on large sites which have adequate area for dedicated flood ways.	The proposed development is not expected to create significant adverse impacts. Flood impacts are further discussed in the Results section of this report.
	Piping of overland flow to reduce flood affectation Clause 5.5	The piping or channelling of overland flow or floodwaters to reduce flood risk, affectation or hazard will not be supported by Council.	Piping or channelling of overland flow is not proposed as part of the development.
Site Planning Flooding Clause 2.4.2.1	P.1	New development should not result in any increased risk to human life.	The proposed development is expected to reduce the existing risk to life within the community by providing a pathway from the flood prone Ray Road to flood free land (via the site throughway) and by providing a place for flood refuge if required.

Item	Reference Clause / Document	Requirement	Response
	P.2	The additional economic and social costs which may arise from damage to property from flooding should not be greater than that which can reasonably be managed by the property owner, property occupants and general community.	The proposed development is expected to be of robust construction with all structural components below the Flood Planning Level to be flood compatible. Economic impacts and social costs are expected to be manageable.
	P.3	New development should only be permitted where effective warning time and reliable access is available for the evacuation of an area potentially affected by floods to an area free of risk from flooding. Evacuation should be consistent with any relevant flood evacuation strategy where in existence	Vehicular access to both Ray Road and Beecroft Road is expected to be available during events up to an including the 1% AEP designs storm event, evacuation off site is expected to be possible. Vertical evacuation is expected to be available in the event of an extreme flood event.
	P.4	Development should not adversely increase the potential flood affectation on other development or properties, either individually or in combination with similar developments that are likely to occur within the same catchment	The proposed development is shown in the Flood Effects section of this report to have no significant adverse impact on the existing flood behaviour on the subject site or in adjacent properties.
	P.5	New developments must make allowances for motor vehicles to be relocated to an area with substantially less risk from flooding, within an effective warning time	Basement Carparks are proposed to be protected for all events up to and including the PMF.
	P.6	New developments must provide an evacuation plan detailing procedures that would be in place for an emergency (such as warning systems, signage or evacuation drills).	A Flood Emergency Response Plan can be prepared prior to Construction Certificate and may be enforced as a condition of consent. With vehicular access to both Ray Road and Beecroft Road expected to be

Item	Reference Clause / Document	Requirement	Response
			available during events up to an including the 1% AEP designs storm event, evacuation off site is expected to be possible. Vertical evacuation is expected to be available in the event of an extreme flood event.
	P.7	Flood mitigation measures associated with new developments should not result in significant impacts upon the amenity of an area by way of unacceptable overshadowing of adjoining properties, privacy impacts (eg. by unsympathetic house raising) or by being incompatible with the streetscape or character of the locality (including heritage).	Flood mitigation measures have been incorporated into the proposed development and are expected to complement the proposal.
	P.8	Proposals for raising structures must provide a report from a suitably qualified engineer demonstrating that the raised structure will not be at risk of failure from the forces of floodwaters	The proposal does not include raising existing buildings.
	P.9	Development is to be compatible with any relevant Floodplain Risk Management Plan, Flood Studies, or Sub-Catchment Management Plan.	As mentioned above, there is no available Flood Study for the subject site.
	P.10	Development must not divert flood waters, nor interfere with floodwater storage or the natural function of waterways.	The proposed development is shown in the Flood Effects section of this report to have no significant adverse impact on the existing flood behaviour on the subject site or in adjacent properties.

Item	Reference Clause / Document	Requirement	Response
	P.11	Filling of land up to 1:100 Average Recurrence Interval (ARI) (or flood storage area if determined) is not permitted. Filling of and above 1:100 ARI up to the Probable Maximum Flood (PMF) (or in flood fringe) must not adversely impact upon flood behaviour.	Some regrading is proposed within landscaped zones that are below the 1% AEP to improve site access. The result of this investigation suggests there is no significant adverse impact created as a result of this regrading.
	P.12	New development must consider the impact of flooding resulting from local overland flooding whether it is a result of Local Drainage or Major Drainage.	Flooding from Devlin's Creek and the local catchment along Beecroft Road has been considered as part of this assessment.
	P.13	Where hydraulic flood modelling is required, flow hazard categories should be identified and adequately addressed in the design of the development.	Flood Hazard conditions for both the latest ARR 2019 and the Floodplain Development Manual (2005) are presented in Appendix A.
	P.14	Council strongly discourages basement car parks on properties within the floodplain. Where site conditions require a basement car park on a property within the floodplain, development applications must provide a detailed hydraulic flood study and design demonstrating that the proposed basement car park has been protected from all flooding up to and including the PMF event. An adequate emergency response and evacuation plan must also be provided where basement car parks are proposed in the floodplain.	Basement Carparking is proposed as part of the development. Driveway crests are proposed to rise to the 1% AEP + 500mm with additional passive protection via flood gates to the PMF.

Item	Reference Clause / Document	Requirement	Response
	Design Controls	All proposals are to have regard to the planning matrix at Table 2.4.2.1.2. The procedure to determine which design standards apply to proposed development involves: Step 1: identify the land use category of the development from Table 2.4.2.1.1 Step 2: determine which flood risk category applies to the land (refer to Catchment Management Unit of Council for the Flood Risk Precincts and relevant flood risk mapping); and Step 3: apply the objectives and design principles as outlined in this section and then the design standards in the planning matrix at Table 2.4.2.1.2 as applicable to the floodplain and land use category.	The proposed development incorporates a mixed-use facility with both Residential and Commercial Facilities proposed. As previously mentioned, the worst-case Flood Risk Precinct for the subject site is expected to be the Medium Flood Risk Precinct. The Objectives and design principles are discussed in the Flood Mitigation measures Section of this report.

Model Parameters

Detailed two-dimensional hydraulic modelling was undertaken using the TUFLOW hydrodynamic modelling software. DRAINS software has been used to generate inflows for the TUFLOW model. The hydrological and hydraulic model parameters are presented below.

Hydrological Model

The hydrological model used for the assessment is the DRAINS one-dimensional software. As recommended by the latest ARR 2019 guidelines and NSW OEH advice the initial and continuing loss model, coupled with the latest NSW Specific Probability Neutral Burst Initial Losses have been adopted as part of this study.

The input data for the DRAINS model used in this study includes sub-catchment data, design rainfall, temporal patterns, pre-burst rainfall and the initial and continuing losses. These are summarised below.

Sub-Catchment Properties

Sub-catchments have been digitised using a combination of LiDAR, aerial imagery, cadastral boundaries, and detailed survey. The following Table 2 presents the sub-catchment properties while, the catchment extents are presented in Figure 4 overleaf.

Table 2 - Sub-Catchment Properties

Catchment Reference	Area (ha)	Impervious (%)	Catchment Reference	Area (ha)	Impervious (%)
C01	19.41	70.0	C08	51.01	70.0
C02	10.94	70.0	C09	21.17	70.0
C03	19.34	70.0	C10	1.00	71.1
C04	23.83	70.0	C11	9.96	70.0
C05	15.06	70.0	C12	3.56	70.0
C06	35.41	70.0	C13	2.50	50.0
C07	10.73	70.0	C14	8.19	70.0

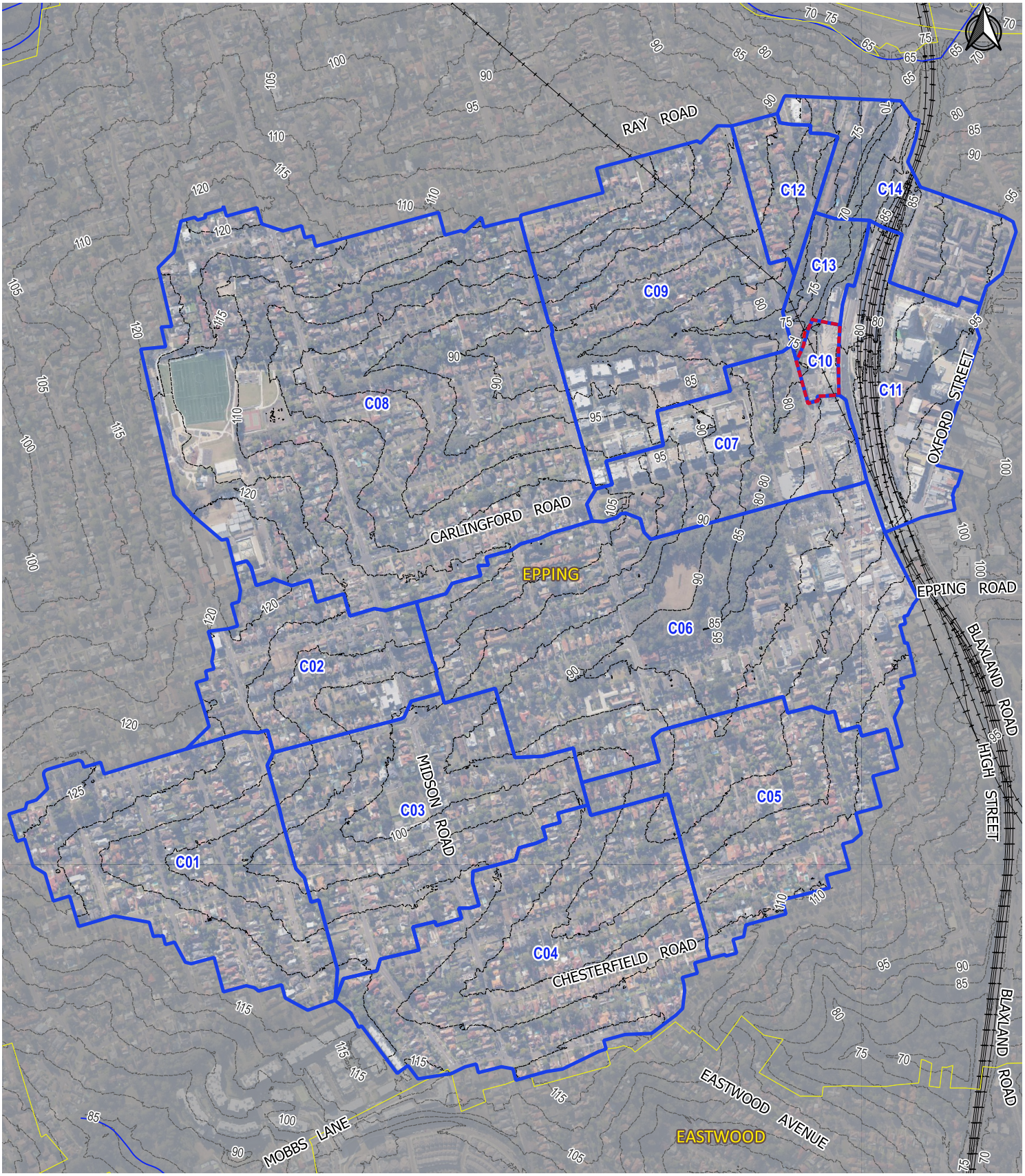
Burst Rainfall

The latest Intensity-Frequency-Duration (IFD) rainfall depths have been obtained from the Bureau of Meteorology (BOM) for a location over the catchment centroid. The latest ARR2019 temporal patterns for the “East-Coast South” region were applied to the 1% AEP design storm depths.

The “East-Coast South” temporal patterns have been obtained from the ARR 2019 data hub and applied to the BOM IFD’s.

The Generalised Short Duration Method (GSDM) and procedures outlined in the Publication *“The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method”* (BOM, 2003) were used to develop design storm depths and patterns for the Probable Maximum Flood (PMF).

The following Table 3 presents the rainfall depths used for the investigation.



Legend

- Site Boundary
- Sub-Catchments
- 5m Ground Contours(mAHD)

0 200 400 600 Metres

1:10,000

Figure 4

Sub-catchment Boundaries

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - NSW Imagery, Cadastre - NSW LPI 2020

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Table 3 - IFD Rainfall Depths

Duration (min)	5% AEP (mm)	1% AEP (mm)	PMP (mm)
10	25.0	32.8	-
15	31.3	41.0	170
20	35.8	46.9	-
25	39.3	51.5	-
30	42.1	55.3	240
45	48.5	63.9	300
60	53.3	70.5	350
90	60.9	81.1	460
120	67.3	90.0	540

Pre-Burst Rainfall

Following concerns from the industry that the nationally derived median losses and pre-burst data were resulting in bias towards under-estimating flows, the NSW Office of Environment and Heritage (OEH) commissioned a review of the storm losses and pre-burst depths for catchments over NSW. As a result, new “Transformational Pre-Burst” rainfall has been developed and can be obtained from the ARR 2019 data hub as presented in the following Table 4. The Transformational Pre-Burst is used in conjunction with the ARR Data Hub storm losses to generate the latest Probability Neutral Burst Losses. As recommended by the latest ARR 2019 guidelines, the 60-minute pre-burst depths have been used for storm durations that are less than 60 minutes.

Table 4 - Transformation Pre-Burst Rainfall (mm)

Duration (min)	5% AEP (mm)	1% AEP (mm)
10	22.0	24.8
15	22.0	24.8
20	22.0	24.8
25	22.0	24.8
30	22.0	24.8
45	22.0	24.8
60	22.0	24.8
90	23.4	25.4
120	23.0	26.1

Losses

The latest ARR 2019 storm losses have been used for this study and were obtained from the ARR Data Hub. Storm initial losses provided by the ARR Data Hub are intended for rural catchments only. Urban catchments are not expected to have the same initial loss when compared to a rural catchment due to the loss of depression storages, vegetation, and potential change in topsoils. As such, rural pervious initial losses have been reduced by a factor of 0.7 over urban areas, generally in accordance

with the latest ARR 2019 guidelines. This is considered a conservative assumption as it is expected to increase peak flows slightly.

As discussed previously, the OEH commissioned a review of the nationally derived losses and pre-burst for catchments over NSW. As a result, the OEH recommends reducing the continuing loss values provided by the ARR Data Hub by a factor 0.4 for un-calibrated models. This methodology has been adopted for this study. A summary of the adopted losses is summarised in the below Table 5.

Table 5 - Loss Parameters

Land-use	Initial Loss (mm)	Continuing Loss (mm/hr)
Rural Pervious (ARR Data Hub)	33.0	1.8
Urban Pervious (Modelled)	23.1	0.72
Urban Impervious (Modelled)	1.5	0.0

Hydraulic Model

The hydraulic model used for this study is the combined one-dimensional / two-dimensional (1D/2D) TUFLOW hydrodynamic engine. For this study, the latest TUFLOW version 2020-10-AA with HPC GPU module has been used.

Two-Dimensional Grid Extent and Size

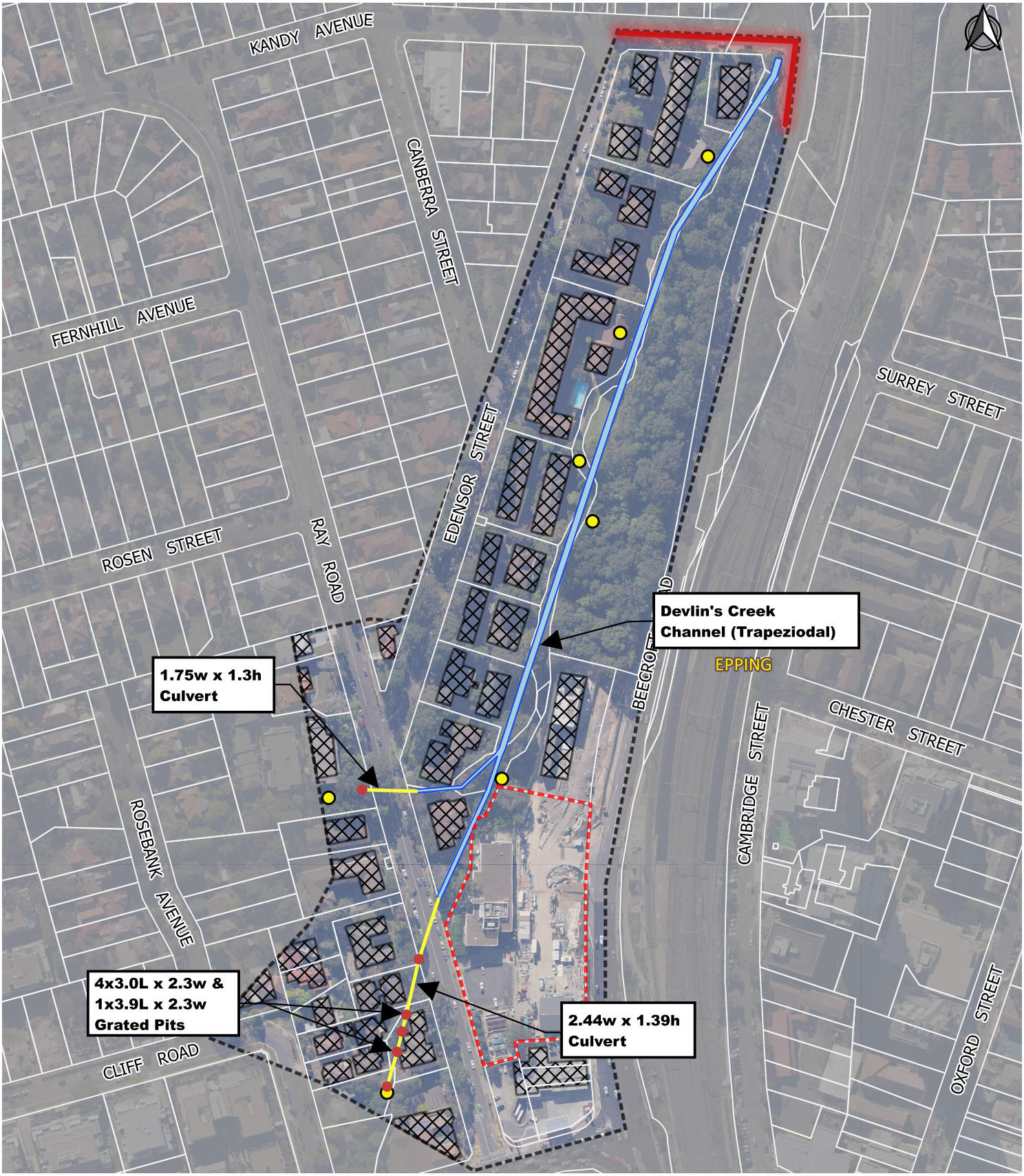
A grid size of 1m was adopted for the two-dimensional model to adequately represent flows through the road carriageway, across the site and through overland flow paths.

The two-dimensional grid extent is shown in **Figure 5**. The grid extends to approximately cliff and Carlington Roads in the southern extent, Edensor Street to the west, Beecroft Road to the east and Kandy Avenue to the north.

Boundary Conditions

The model setup is presented in **Figure 5** overleaf. Flows derived by the DRAINS model have been applied directly to the two-dimensional grid via a series of one-dimensional polygons.

An outlet head boundary has been entered into the two-dimensional model approximately 450m downstream of the subject site at Kandy Avenue. An outflow tailwater condition of RL. 70m AHD has been assumed which is a similar level to Kandy Avenue. This tailwater condition is expected to enable review of the capacity of the Devlin's Creek directly downstream of the subject site and is far enough downstream as to not drown out any potential downstream flood impacts created by the proposed development.



Legend

- Site Boundary
- Model Extent
- Inflow Locations
- Downstream Boundary
- Existing Buildings
- 1D Channel Extent
- 1D Culvert and Pipes
- Pits / Headwalls

0 70 140 210 Metres

1:3,000

Figure 5

2D Model Setup

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - NSW Imagery, Cadastre - NSW LPI 2020

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Catchment Roughness

Catchment roughness was based on a review of hydraulic literature (including ARR 2019 Project 15), aerial imagery and observations made during the site visit. The following **Figure 6**and **Figure 7** presented overleaf show the adopted surface roughness values for the existing and developed case scenarios respectively. The following Table 6 presents the surface roughness values adopted for each land use.

Table 6 – Land use Roughness (Manning's)

Land use	Roughness (Manning's)
Thick Vegetation	0.080
Concrete Pavement	0.014
Grass	0.040
Residential Landscaping (Around Buildings)	0.080
Roads Sealed	0.018

It is noted that buildings have been fully blocked out of the flood model representing 100% flow obstructions. Furthermore, the Devlin's Creek concrete channel has been modelled as a 1D element with a hydraulic roughness of 0.015. In addition, **Figure 7** shows three portions of the proposed building that are to remain open or suspended above ground level. These have been raised to reduce impacts during the worst case PMF event. If these areas were to remain slab-on-ground, PMF flood impacts are expected to be much higher. A blockage factor of 50% has been applied to these areas to account for supporting elements, surrounding louvres and possible build-up of debris.

Terrain

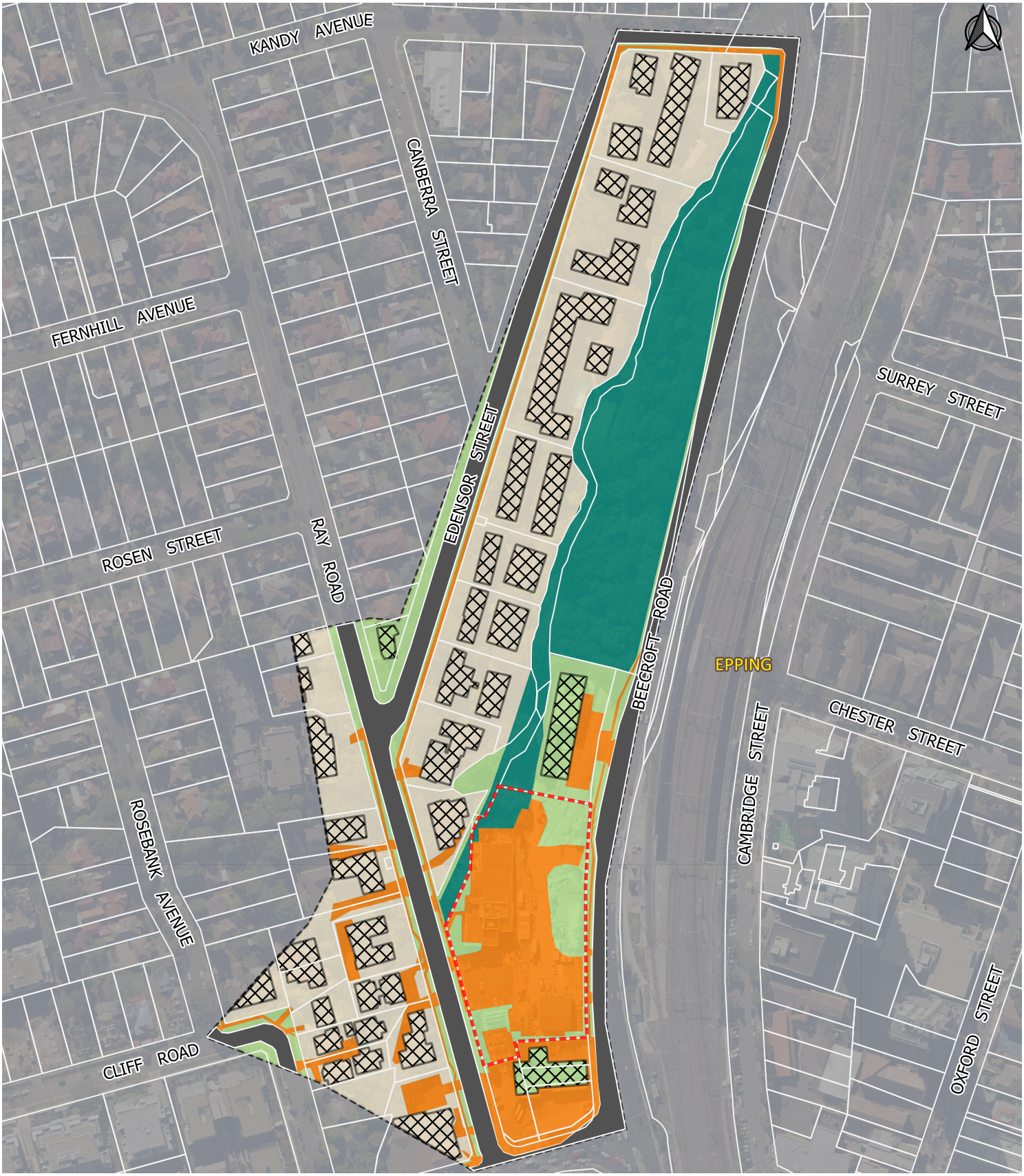
Terrain data used in the development of the model includes a combination of LiDAR elevation data, detailed survey and design surfaces created for the proposed development using the 12D software. Terrain data for the Existing and Developed Case Scenarios are presented in **Figure 8** and **Figure 9** respectively.

Hydraulic Structures

Hydraulic structures in the flood model are made up of the culverts beneath Ray Road and Devlin's Creek. Devlin's Creek has been modelled as a 1D element due to the narrow width of the creek base (varying approx. 1-2m at the base) and the quality of the LiDAR data in the creek. The creek cross sectional profile was based on the available detailed survey and Works as Constructed (WaC) drawings provided by Sydney Water and contained within Appendix B. Similarly, the Ray Road Culverts, and built over sections of Devlin's Creek upstream of Ray Road, were based on a combination of detailed survey, WaC drawings and observations made during a site investigation.

Due to the size of the infrastructure along the Devlin's Creek trunk line, a 50% inlet blockage factor has been applied at the inlet headwalls and a 50% blockage factor has also been applied at major pits at 7 Ray Road. It is understood Parramatta City Council (PCC) typically neglect the below ground network, however due to the size of the infrastructure at this location, this was considered over conservative in this case. It is noted that no changes to Council's regional stormwater network are proposed as part of the flood mitigation strategy presented herein.

A sensitivity test has been performed to review water levels during a 100% blockage, which is presented and further analysed in the Discussion Section of this report. It is noted, the remaining minor network in Ray Road has been neglected from the model.



Legend

- Site Boundary
- Model Extent
- Existing Buildings

Land Use

- Channel - Thick Vegetation
- Concrete Pavement
- Grassland/Low Vegetation
- Residential Areas
- Roads Sealed

0 70 140 210 Metres

1:3,000

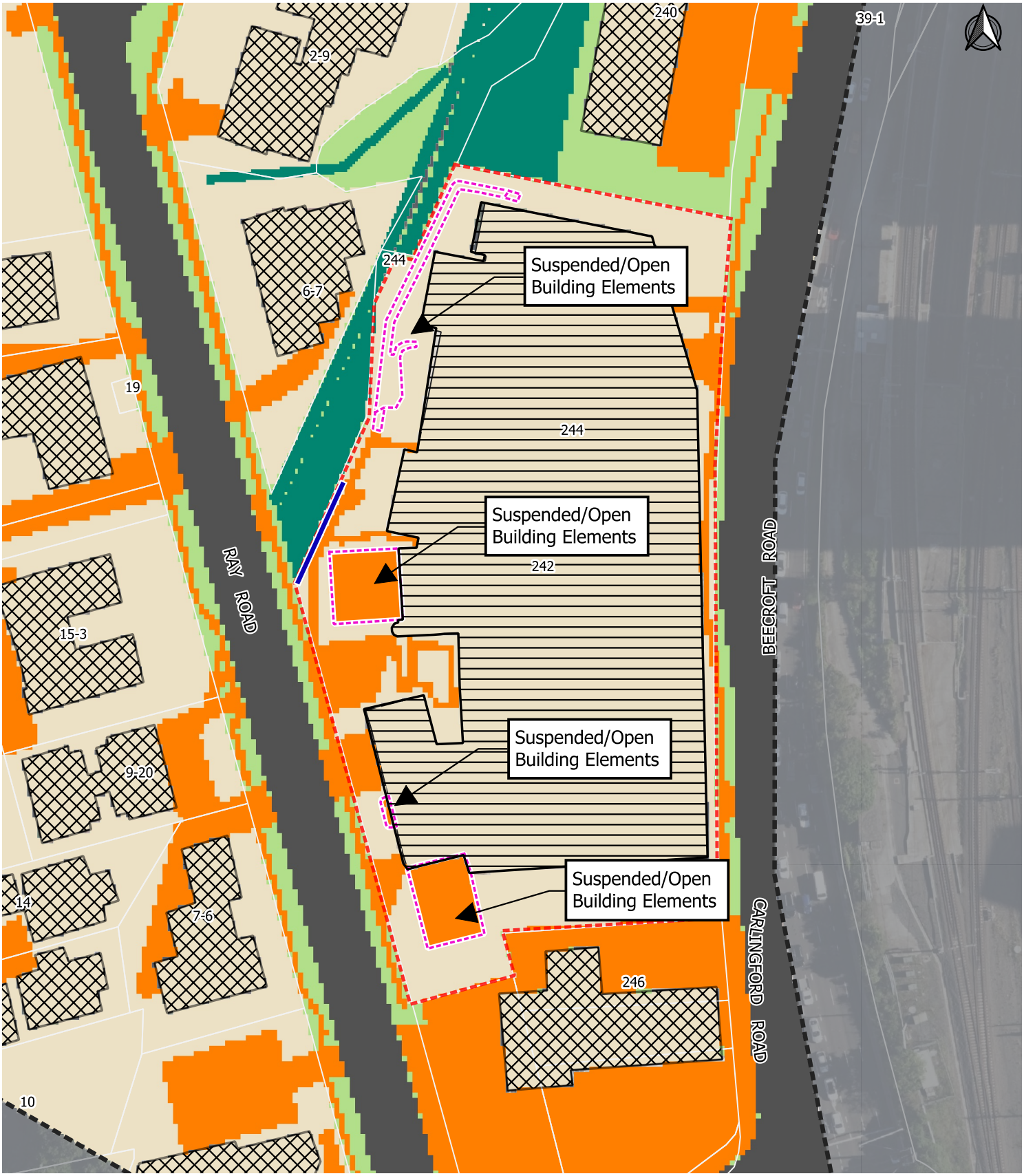
Figure 6

2D Model Land Use
Existing Conditions

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - NSW Imagery, Cadastre - NSW LPI 2020



Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall

Land Use

- Roads Sealed
- Residential Areas
- Channel - Thick Vegetation
- Concrete Pavement

0 20 40 60 Metres

1:1,000

Figure 7 [C]

2D Model Land Use
Developed Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - NSW Imagery, Cadastre - NSW LPI 2020

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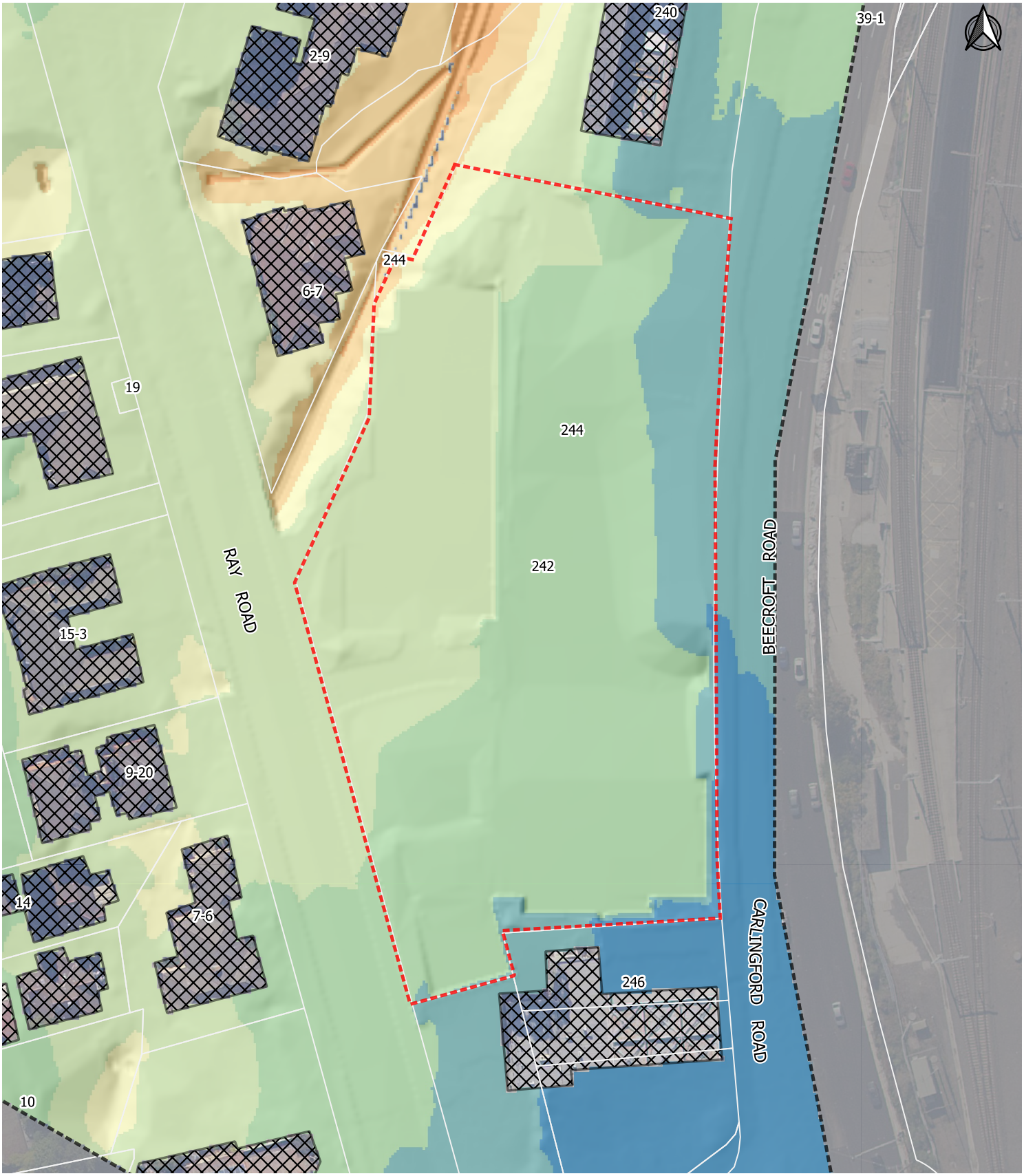


Legend

- Site Boundary
- Model Extent
- Existing Buildings

Elevation(mAHD)

- <= 68.5
- 68.5 - 71.0
- 71.0 - 73.5
- 73.5 - 76.0
- 76.0 - 78.5
- 78.5 - 81.0
- 81.0 - 83.5
- 83.5 - 86.0
- > 86.0

0 20 40 60 Metres

1:1,000

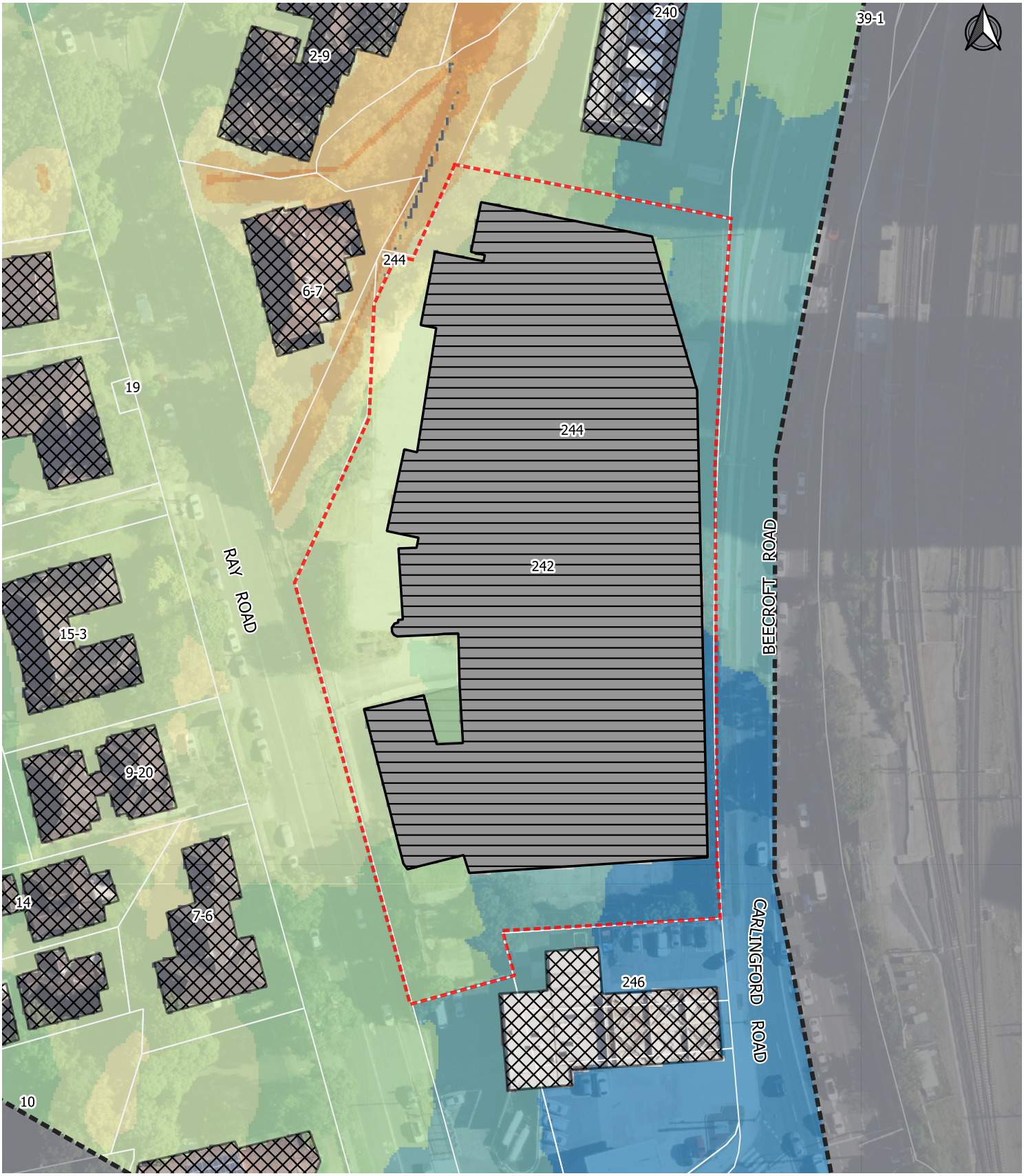
Figure 8

2D Model Terrain
Existing Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - NSW Imagery, Cadastre - NSW LPI 2020



Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building

Elevation(mAHD)

- <= 68.5
- 68.5 - 71.0
- 71.0 - 73.5
- 73.5 - 76.0
- 76.0 - 78.5
- 78.5 - 81.0
- 81.0 - 83.5
- 83.5 - 86.0
- > 86.0

0 20 40 60 Metres

1:1,000

Figure 9 [C]

2D Model Terrain
Developed Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - NSW Imagery, Cadastre - NSW LPI 2020

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Results

Critical Duration

To determine the critical storm duration for the subject site and vicinity the guidance provided in the latest AR&R 2019 guidelines was considered as summarised below:

- Classification of the median value of the ten temporal patterns for each storm duration.
- Selection of the duration that produces the maximum median value for each return interval.

The flood elevation results were used in this investigation to define the maximum median value.

All ten rainfall patterns for the 10, 15, 20, 25, 30, 45 and 60 minute durations were entered into the two-dimensional model to determine the critical storm duration for the 5% AEP and 1% AEP design storm events. Similarly, the 15, 30, 45 and 60 minute durations were used to determine the critical duration for the PMF local catchment flood event.

The two-dimensional TUFLOW modelling indicates that the generally the 15-minute duration was critical upstream of the site while, the 20-minute duration was critical downstream of the site during both the 5% and 1% AEP. The 30-minute storm duration was determined to be critical for the PMF.

Existing Case Behaviour

Maximum modelled water depth, elevation, and velocity maps for the 5% AEP, 1% AEP and PMF design storm events are presented in **Figures C1-C3 and C6-C7** of Appendix A.

Flows derived by the upstream urban areas are captured and conveyed through the concrete lined Devlin's Creek channel and travel in a northerly direction, towards Ray Road and the subject site.

Approximately 80m upstream of the subject site, flows are directed beneath the vehicular driveway at 7 Ray Road and continue below ground before connecting with the Ray Road culvert crossing. Flows that exceed the capacity of this below ground network spill overland, across 7 Ray Road, the nearby residential properties and into the Ray Road reserve.

The depth of overland flow on Ray Road is expected to be controlled by the capacity for flow to breach the eastern road verge and continue into Devlin's Creek along the western boundary of the subject site. As a result, flood levels in Ray Road are relatively flat during the 5% AEP and 1% AEP before spilling back to the Devlin's Creek Channel. Once overland flow within Ray Road falls back to Devlin's Creek it continues north towards Kandy Avenue, beneath the M2 and Beecroft Road and towards North Epping, downstream.

On the subject site, Figure C1 and Figure C2 of Appendix A shows only a minor encroachment of overland flow across the subject site during the 5% AEP and 1% AEP design storm events. Figure C3 suggests flows that cross onto the subject site are expected to have generally low velocities with a maximum of 1.0m/s expected during the 1% AEP design storm event.

During the PMF, Figures C6 and C7 suggest depths of up to 1.0m and velocities of up to 6.0m/s can be expected across the subject site.

Flood hazard conditions have been assessed based on the latest AR&R 2019 hazard categories as presented in Figure 10 below. Flood hazard conditions for both the 1% AEP and PMF design storm events are presented in Figures C4 and C8 of Appendix A.

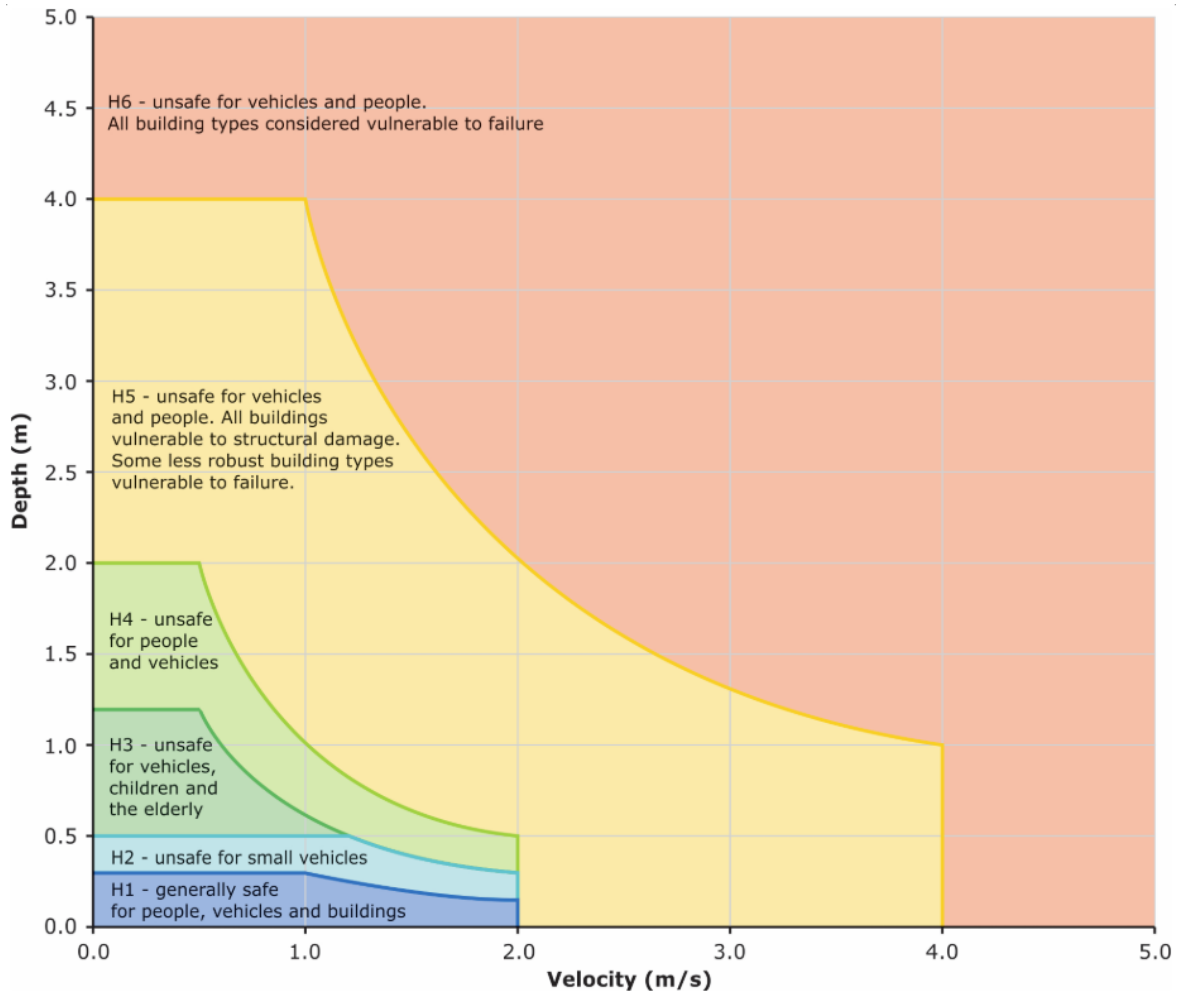


Figure 10 - Australian Rainfall and Runoff (2019) Hazard Categories

As shown in Figure C4 of Appendix A, the existing case flood hazard conditions across the subject site during the 1% AEP are relatively low with only a small portion of the western edge of the site flood affected. This portion of the site is subject to hazard conditions of up to H2, which, review of the above **Figure 10** is safe for pedestrians.

During the PMF, Figure C8 of Appendix A shows flood hazard conditions of up to H5 and H6 across the western portion of the site which the above **Figure 10** suggests is hazardous for people, vehicles, and most building types.

Additional flood hazard categorisations have also been prepared for the purposes of reviewing the Flood Risk Precincts as discussed in the Council Requirements Section above. The Flood Risk Precinct classifications are based on the hazard definitions presented in the Flood Plain Development Manual (2005) (refer to Figure 11 below). The results for the 1% AEP design storm event is presented in Figure C5 of Appendix A with a maximum of low hazard flood behaviour observed across the subject site.

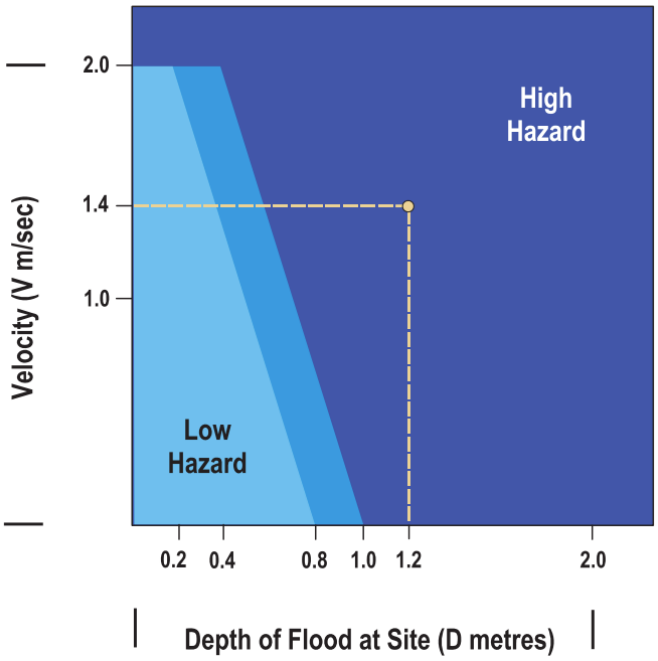


Figure 11 – Floodplain Development Manual (2005) Hazard Categories

Peak flows approaching the subject site and downstream of the subject site have been extracted from the DRAINS model and are presented in **Table 7** below.

Table 7 - Peak flows (Devlin's Creek – Refer to Figure 4 for Locations)

Location	5% AEP	1% AEP	1% AEP CC	PMF
Approaching Ray Road - South (C01-C07)	38.8	51.2	56.2	213
Approaching Ray Road - West (C08-C09)	23.1	31.4	32.9	139
Directly Downstream of Site (C01-C10)	59.8	79.8	85.4	328

Developed Flood Behaviour

Figures representing the developed case flood behaviour for the 5% AEP, 1% AEP and PMF design storm flood events are presented in **Figures D1-D8** of Appendix A.

Review of the results presented in Figures D1-D8 suggests the existing case flood behaviour remains generally un-changed due to the proposed development for the majority of events.

Figures D1 and D2 of Appendix A shows a slight increase in the extent and depth of flooding on the subject site during the 5% AEP and 1% AEP however, Figure D4 of Appendix A shows a maximum of H2 hazard remains. These minor changes are expected to be due to some regrading proposed within the landscaped areas of the subject site. It is noted that, Figure D5 demonstrates a maximum of low flood hazard remains on the subject site during developed conditions and as such, no change to the Flood Risk Precinct Classification is expected.

A comparison of Figures C6 and D6 suggests the extent of the PMF on the subject site has been reduced post development. Flood hazard along the western boundary also remains high with up to H6 observed in the landscaped areas and H5 adjacent to the proposed building.

Flood levels have been reviewed at selected locations along the western edge of the proposed development. These are presented below in **Table** 8.

Table 8 - Developed Condition Flood Levels (Refer to Figures D1, D2 and D6 for Locations)

Location	5% AEP	1% AEP	PMF
Ray Road Sag	79.44	79.55	80.16
Site Western Corner	79.51	79.66	80.67
Ray Road at Existing Site Vehicular Driveway	79.52	79.66	80.94
Devlin's Creek @ Ray Road Outlet	75.84	76.01	77.45
Devlin's Creek @ Site North-West Corner	74.37	74.61	76.46

Flood Effects

Figures demonstrating changes to flood levels are presented below in **Figures E1-E3** of Appendix A.

The results of the modelling indicates no impacts are expected in adjacent private properties during both the 5% AEP and 1% AEP design storm events.

During the PMF, Figure E3 shows increases in flood levels in Ray Road of up to 510mm and increases in adjacent private properties of up to approximately 150mm (300mm isolated). It is noted that an attempt to reduce these impacts has been made by suspending/ opening up under croft areas around the western face the development. These areas do assist to reduce the flood impact however, given the magnitude of the event, eliminating impacts is not expected to be possible without significant changes to the proposed development layout.

It is important to note that the PMF design storm event is an extremely rare event with a nominal 10^{-7} AEP (1 in 10 million) chance of occurring. It is not typically used to guide development and generally, the greatest concern during an event of this nature is reviewing how the residual risk to life can be managed. The only exception to this is typically where critical or sensitive facilities are proposed (i.e. hospitals and other emergency facilities).

A comparison of Figures C8 and D8 suggests that although some increases in flood depth are observed, flood hazard and the risk to life in all affected properties and Council's Ray Road reserve remain the unchanged. For example, H6 hazard conditions are already observed under existing conditions in Ray Road. As such, the increases in Ray Road during the PMF are not expected to adversely alter the existing trafficability or the risk to life of the Road Reserve as hazardous flow conditions are already observed.

Similarly, Figure C8 suggests H5 and H6 flood hazard conditions are already observed in the affected private properties under existing conditions. The increase of up to approx. 150mm (300mm isolated) does not result in higher flood hazard conditions to what is already observed in each lot.

In addition, there are no critical or sensitive sites located in the areas where changes in flood depth are observed. As such, since no critical or sensitive sites are affected, and hazard conditions remain generally the same to the existing conditions, the proposed development is not considered to create a significant adverse change to the existing flood risk.

Discussion

Flood Mitigation Measures

The following Table summarises how the proposed development satisfies, or otherwise, the provisions of Council's Floodplain Matrix (Refer to Table 2.4.2.1.2 of Council's DCP). Note that, the development has been assessed under its worst-case Medium Flood Risk Precinct classification.

Table 9 - The City of Parramatta Council's Flood Controls Matrix Requirements and Response

Consideration	Requirement	How Addressed? / Response
Floor Level	Habitable floor levels to be equal to or greater than the 100-year ARI flood level plus freeboard.	All residential floors are proposed at or above the 1% AEP + 500mm.
	A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5m above finished ground level, confirming that the subfloor space is not to be enclosed.	This is expected to be applicable for the open / under croft areas proposed as part of the development. Louvres (or similar) are proposed around the under-croft spaces to prevent unauthorised access and storage of valuable items.
Building Components	All structures to have flood compatible building components below the 100-year ARI flood level plus freeboard.	All structures are to have flood compatible building components below the 100-year ARI flood level plus 500mm.
Structural Soundness	An engineers report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year ARI flood level plus freeboard.	The proposed building is of robust construction. Flood forces, debris impact loads and buoyancy are not expected to be limiting in design. This will need to be confirmed by a structural engineer prior to Construction Certificate and could form a condition of consent. Given the western face of the building requires protection to the basement level, we expect the structural capacity to resist the PMF will be applicable in this area.
Flood Affectation	An engineers report is required to certify that the development will not increase flood affectation elsewhere, having regard to: (i) loss of flood storage; (ii) changes in flood levels, flows and velocities caused by alterations to flood flows; and (iii) the cumulate impact of multiple potential developments in the vicinity	Flood affectation is discussed in the Flood Effects section of this report. The results suggest the proposed development is not expected to create a significant adverse impact.

Consideration	Requirement	How Addressed? / Response
Car Parking & Driveway Access	Garages capable of accommodating more than 3 motor vehicles on land zones for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100-year ARI flood. Ramp levels to be no lower than 0.5m above the 100-year ARI flood level	Driveway crests at Ray Road are proposed to ramp up to the 1% AEP + 500mm with additional protection via a floodgate to the PMF.
Evacuation	Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (eg. second storey) or off site.	Vertical evacuation above the PMF is available on-site for residents. Basement carparking is proposed to be protected for all events up to and including the PMF.
	Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan.	The proposed development is consistent with the objectives of Council's Development Control Plan. Liaison with City of Parramatta Council, Hornsby Shire Council and Sydney Water representatives suggests no other Flood Risk Management Study or Plan is available for the subject site.
	Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel	Evacuation and reliance on emergency services is not expected to be required as the site is protected during all events up to and including the PMF. It is recommended a Site Emergency Response Flood Plan be prepared prior to Construction Certificate phase.
Management and Design	Site Emergency Response Flood plan required where the site is affected by the 100-year ARI flood level, (except for single dwelling-houses).	It is anticipated a Site Emergency Response Flood Plan will be prepared for the proposed development prior to Construction Certificate. This can be enforced as a Condition of Consent. It is recommended the plan include operation and maintenance requirement of the proposed floodgates.
	Applicant is to demonstrate that area is available to store goods above the 100-year flood level plus freeboard	As the basement levels are protected for all events up to and including the PMF, this is expected to be achievable.

Consideration	Requirement	How Addressed? / Response
	No storage of materials below the 100-year ARI flood level.	As the basement levels are protected for all events up to and including the PMF, this is expected to be achievable. Movement of any materials that may be sited outside the building, and within the 1% AEP flood extent can be incorporated into the Site Emergency Response Flood Plan as required. Louvres (or similar) are proposed around under croft areas to prevent the use of these areas for storage purposes.

Blockage Sensitivity

As previously discussed, a design blockage factor of 50% has been used for the below ground infrastructure upstream of the subject site. It is understood, the City of Parramatta Council typically prefer a 100% blockage factor be used for below ground infrastructure however, in this case, due to the size of the infrastructure (greater than 2m is size), 100% is considered overly conservative.

To review the impact this assumption has on the results of the investigation, a sensitivity test has been performed with a comparison between the 1% AEP design blockage scenario (i.e. 50%) and fully blocked scenario (100%) presented in Figure F1 of Appendix A.

The results presented in Figure F1 suggest a maximum increase adjacent to the proposed development of up to approximately 370mm is observed during the fully blocked scenario. The closest nearby entrance that may be affected by this increase are the Ray Road carpark and loading dock basement entrances. As these entrances are already placed with a crest height at the 1% AEP + 500mm, the increase of 370mm is not expected to force floodwater into the building and is just a reduction of freeboard. Furthermore, floodgates are also proposed across these entrances which extend up to the PMF level. As such, the flood risk to these entrances due to the risk of blockage is considered low.

It is noted that although the blockage factor of 50% at the headwalls is less than what Council's guidelines recommend, this blockage factor is still considered conservative whereby, an assessment using the latest ARR 2019 blockage guidelines (i.e. Book 6 – Chapter 6) is expected to require a blockage factor of approximately 10-15%.

Climate Change Sensitivity

The impact of climate change during the 1% AEP developed case scenario has been reviewed using the latest ARR 2019 guidelines. Given terrain elevations across the subject site are in excess of 75m AHD, sea level rise has not been considered as part of this investigation.

There is, however, the potential for increased rainfall depths due to climate change with the worst-case Representative Concentration Pathway of 8.5 and year 2090 scenario considered for this study. The ARR Data Hub suggests during this worst-case scenario, a predicted increase in rainfall depths of up to 19.7% can be expected.

The results presented in Figure F2 of Appendix A suggests increases in flood depth in Ray Road of generally less than 50mm while, an increase generally less than 100m is also observed in Devlin's Creek along the north-western boundary of the subject site. These increases are considered only a minor reduction of freeboard to the proposed development by the year 2090 and are not expected to warrant further design consideration.

Beecroft Road

An assessment of the capacity of Beecroft Road has been performed to review whether further flood protection may be required along the eastern edge of the development. The previous 1% AEP and PMF DRAINS models prepared for the Devlin's Creek Flood Assessment were amended to include the local Beecroft Road catchment.

A representative road cross section was prepared using a combination of detailed survey and LiDAR elevation data. A section of the road, expected to have the least capacity was used for the assessment. A total catchment area of 1.24ha was determined with an assumed 90% impervious fraction applied. A figure showing the local Beecroft Road catchment and the location of the cross section is presented in Figure 14.

The results of the investigation for both the 1% AEP and PMF design storm events are presented in the below

Figure 12 and Figure 13 respectively. Note that, a 1% AEP and PMF peak flow of 0.75 m^3/s and 2.89m^3/s was determined using DRAINS respectively.

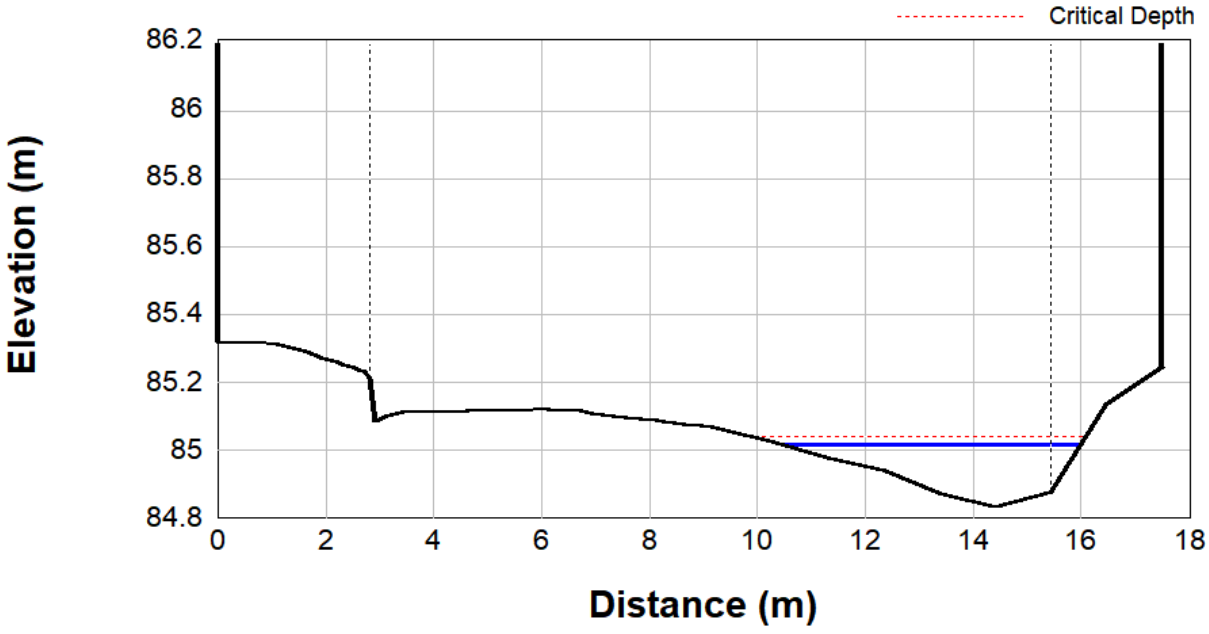


Figure 12 - Beecroft Road Overland Flow Capacity (1% AEP)

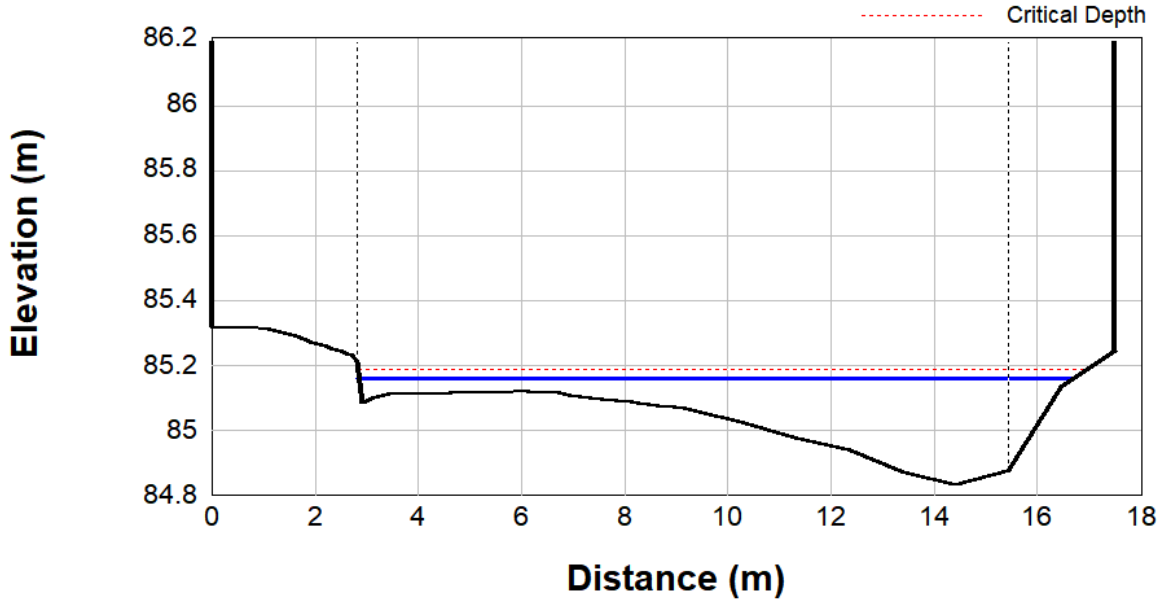
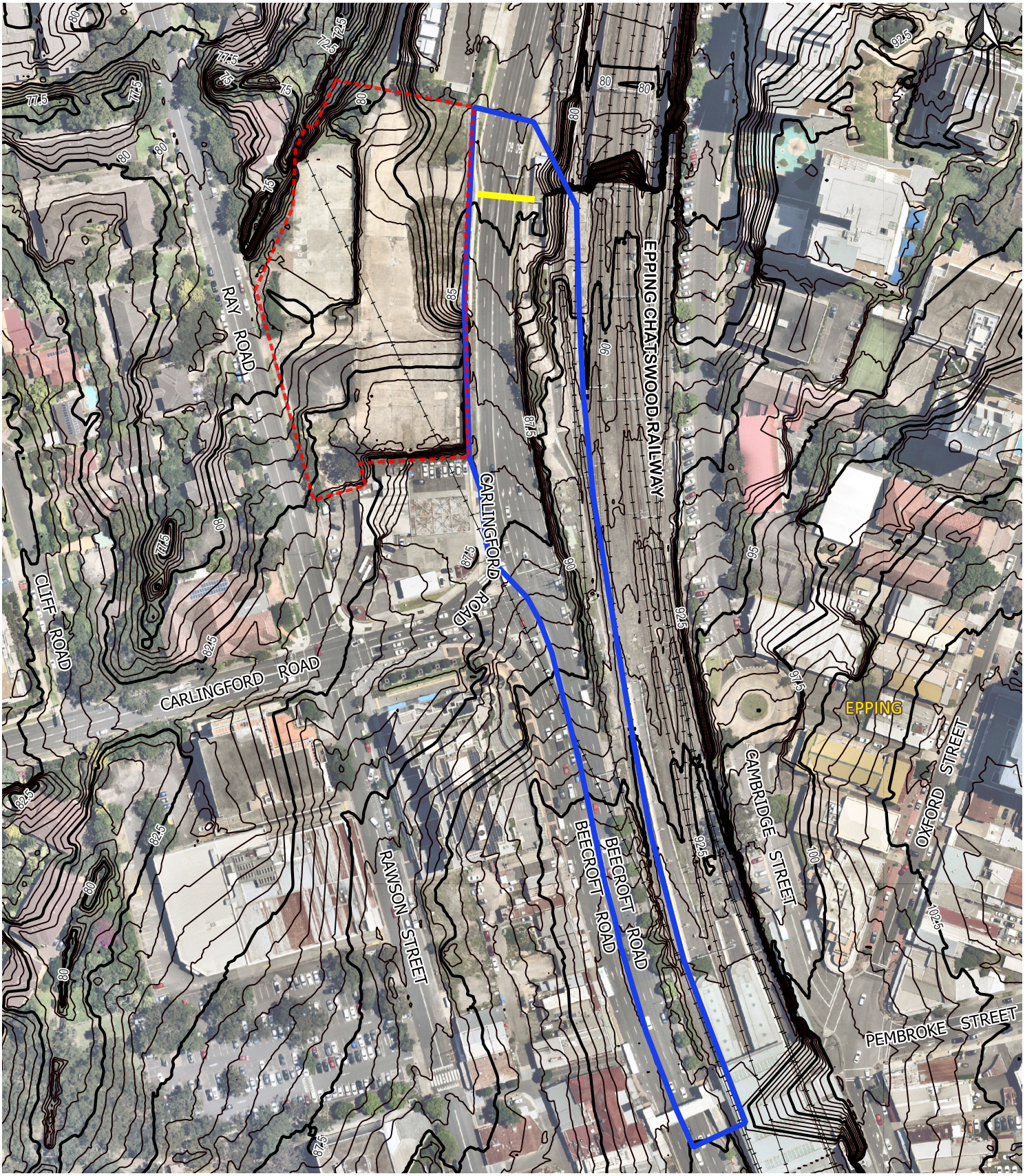


Figure 13 - Beecroft Road Overland Flow Capacity (PMF)

It is noted that as per the CoPC guidelines, the below minor ground pit and pipe network in Beecroft Road has been ignored as part of the analysis.

The results presented in the above

Figure 12 and Figure 13 suggest that due to the width and size of Beecroft Road, it is expected to have the capacity to convey both the 1% AEP and PMF designs storm events. As such, additional flood protection is not expected to be required at the Beecroft Road level.



Legend

- Site Boundary
- Cross Section Location
- Beecroft Catchment
- LiDAR Contours (0.5m)
- LiDAR Contours (2.5m)

0 50 100 150 Metres

1:2,000

Figure 14

Beecroft Road Capacity Assessment

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap Aerial 2021, Cadastre - NSW LPI 2020

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Conclusion

A Flood Risk and Impact Assessment Report has been prepared for the proposed development at 242-244 Beecroft Road, Epping NSW.

It was concluded that the proposed development is not expected to create any significant adverse impacts to the existing flood behaviour on the subject site and on the properties surrounding the subject site.

Furthermore, flood risk in the developed case has been minimised through the selection of flood levels, implementation of flood protection measures and provision of vertical evacuation opportunities.

We commend our findings to the Department and Council for their review.

Limitation Statement

Northrop Consulting Engineers Pty Ltd (Northrop) has been retained to prepare this report based on specific instructions, scope of work and purpose pursuant to a contract with its client. It has been prepared in accordance with the usual care and thoroughness of the consulting profession for the use by Dasco Australia Pty Ltd. The report is based on generally accepted practices and standards applicable to the scope of work at the time it was prepared. No other warranty, express or implied, is made as to the professional advice included in this report.

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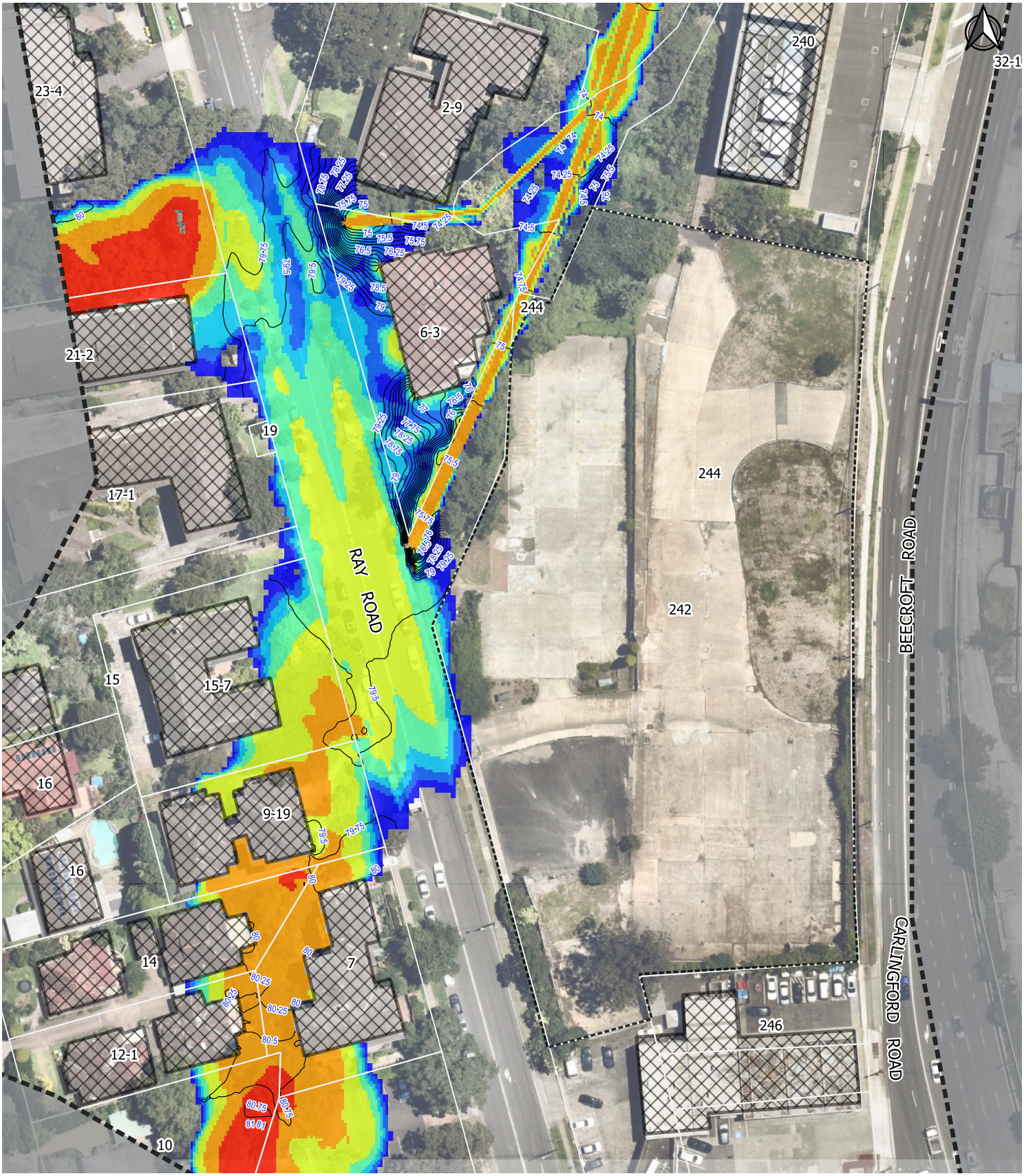
Document Register

Rev	Status	Prepared	Approved	Date
1	DRAFT	LG	GB	21/06/2022
A	APPROVAL	LG	GB	19/07/2022
B	APPROVAL	LG	LG	06/04/2023
C	APPROVAL	LG	LG	05/07/2024
D	APPROVAL	LG	LG	10/07/2024

Appendix A – Flood Figures



Legend

- Site Boundary
- Model Extent
- Existing Buildings
- 0.25m Contours (mAHD)

Depth (m)

- Less than 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- Greater than 2.0

0 20 40 60 Metres

1:1,000

Figure C1 [B]

5% AEP Flood Depth and Elevation
Existing Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

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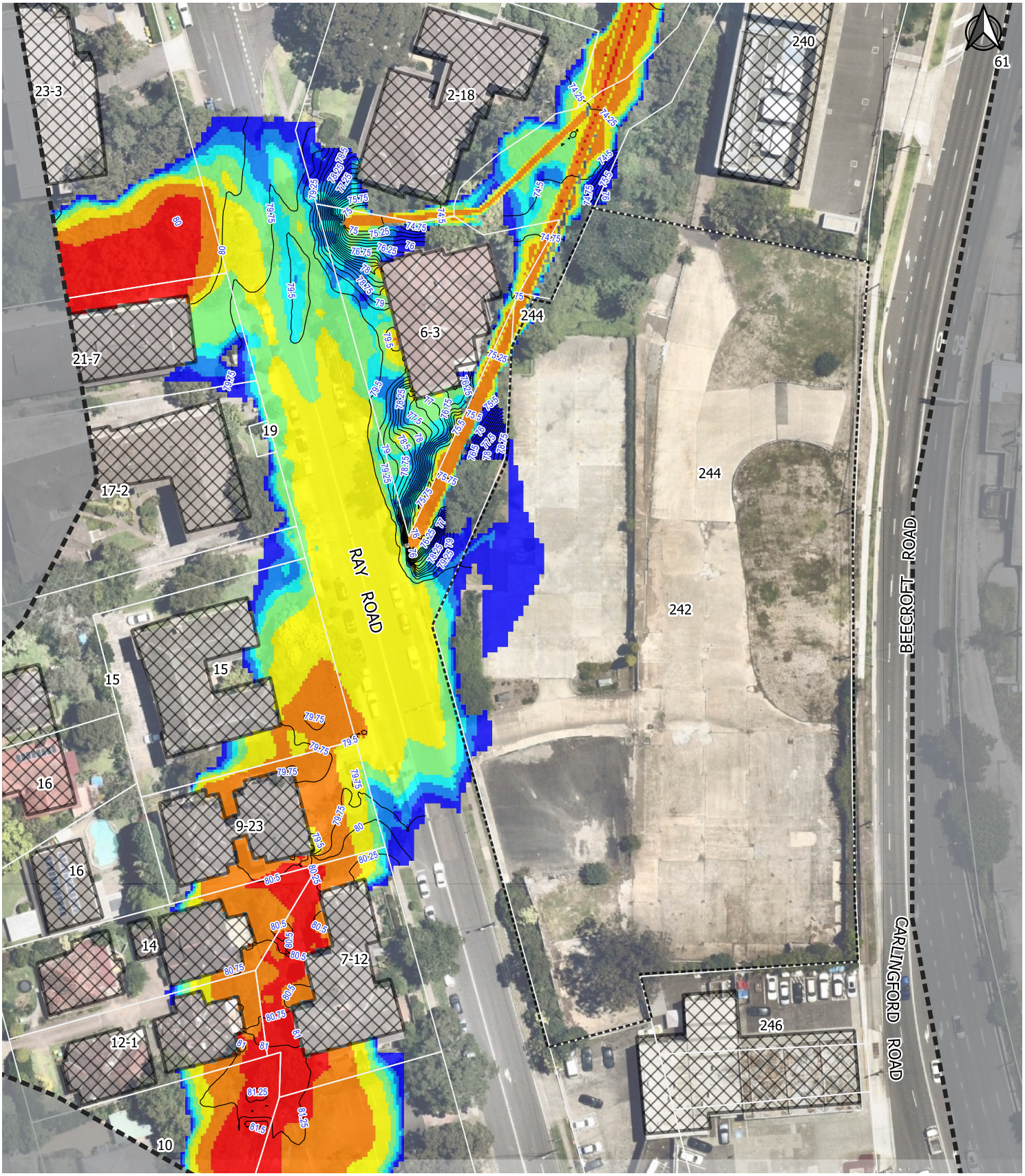

Legend

- Site Boundary
- Model Extent
- Existing Buildings
- 0.25m Contours (mAHD)

Depth(m)

- Less than 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- Greater than 2.0

0 20 40 60 Metres

1:1,000

Figure C2 [B]

1% AEP Flood Depth and Elevation
Existing Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

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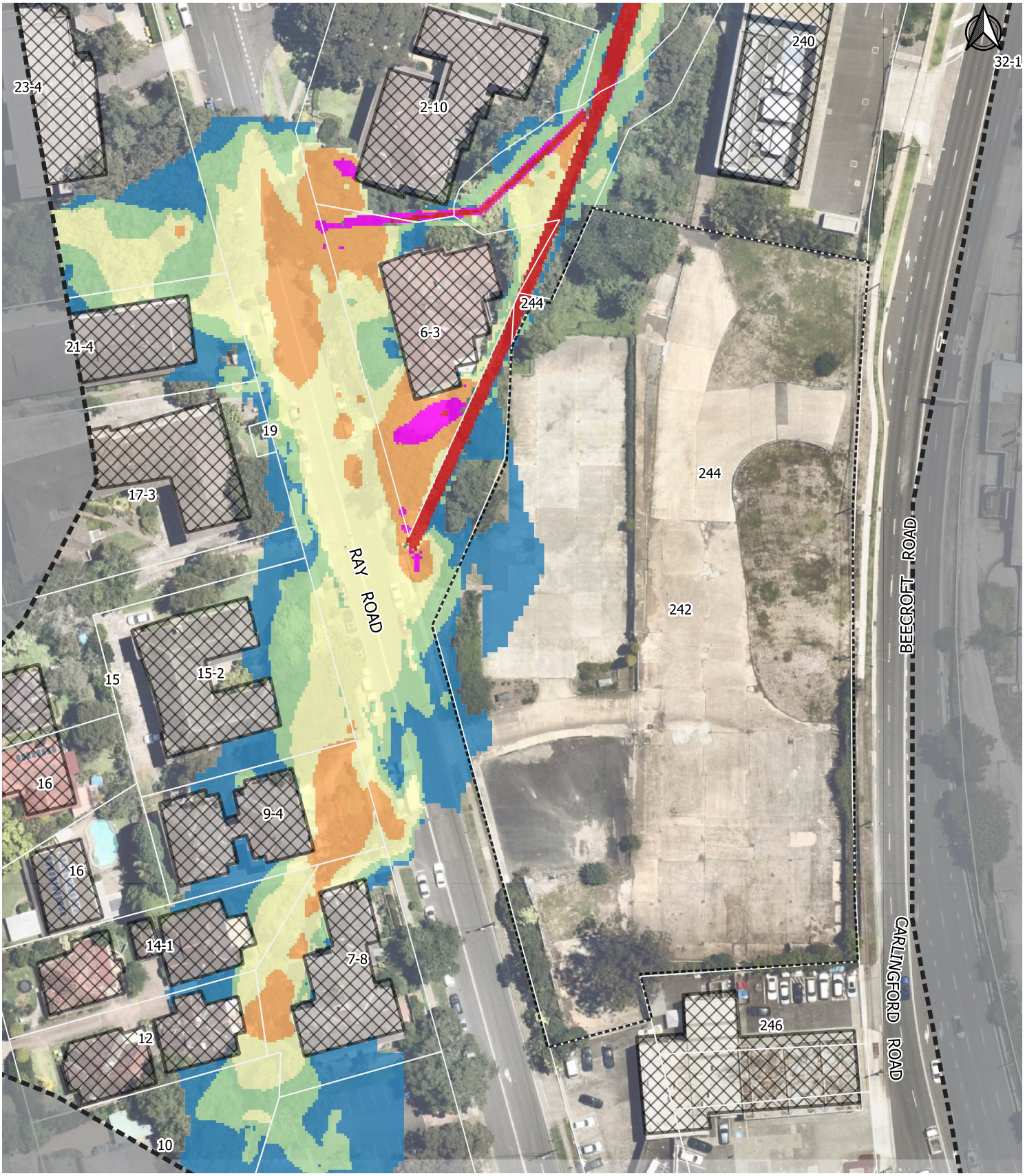

Legend

- Site Boundary
- Model Extent
- Existing Buildings

Velocity(m/s)

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

0 20 40 60 Metres

1:1,000

Figure C3 [B]

1% AEP Flood Velocity
Existing Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

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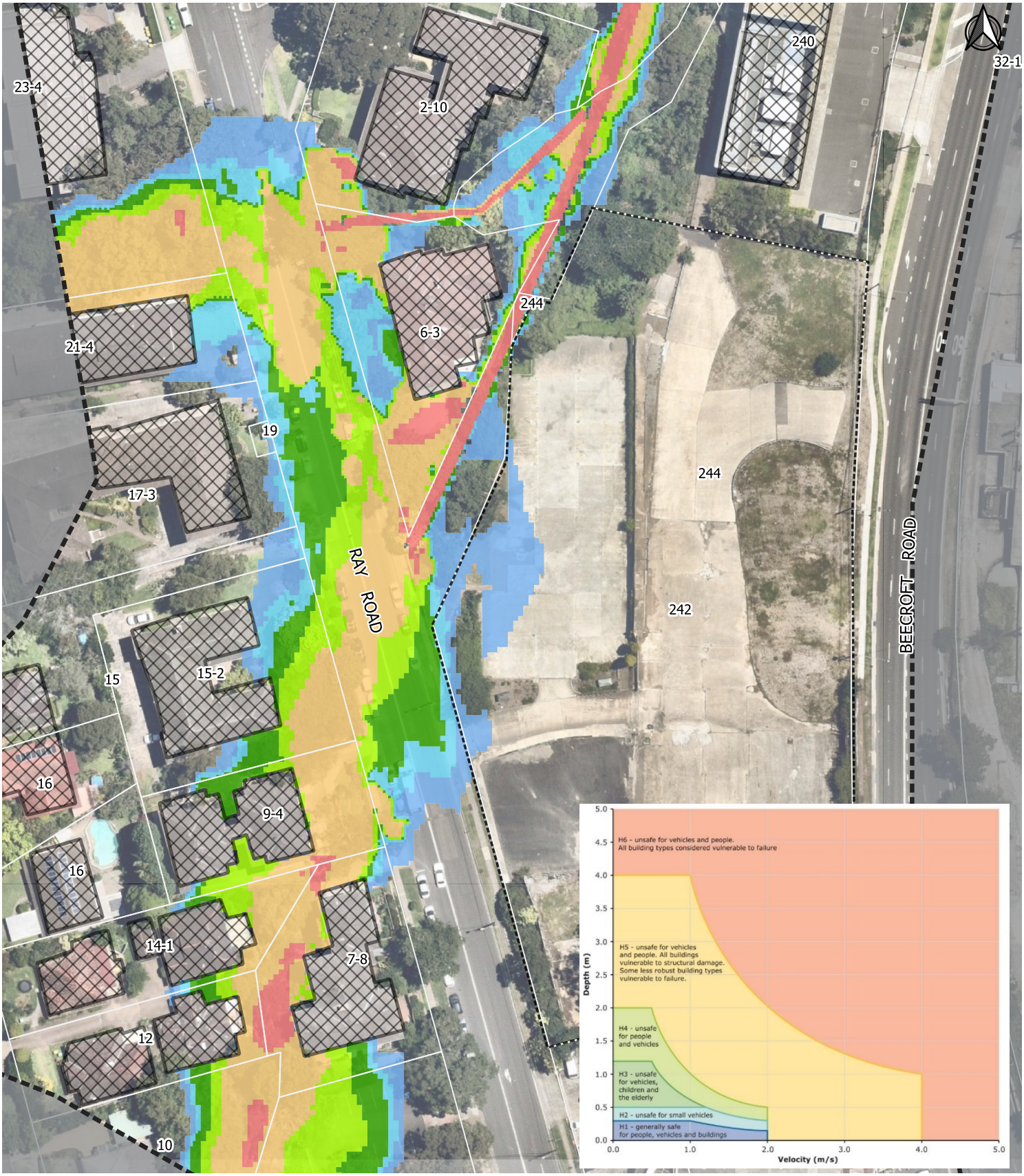


Legend

- Site Boundary
- Model Extent
- Existing Buildings

Hazard Category

- H1
- H2
- H3
- H4
- H5
- H6

0 20 40 60 Metres

1:1,000

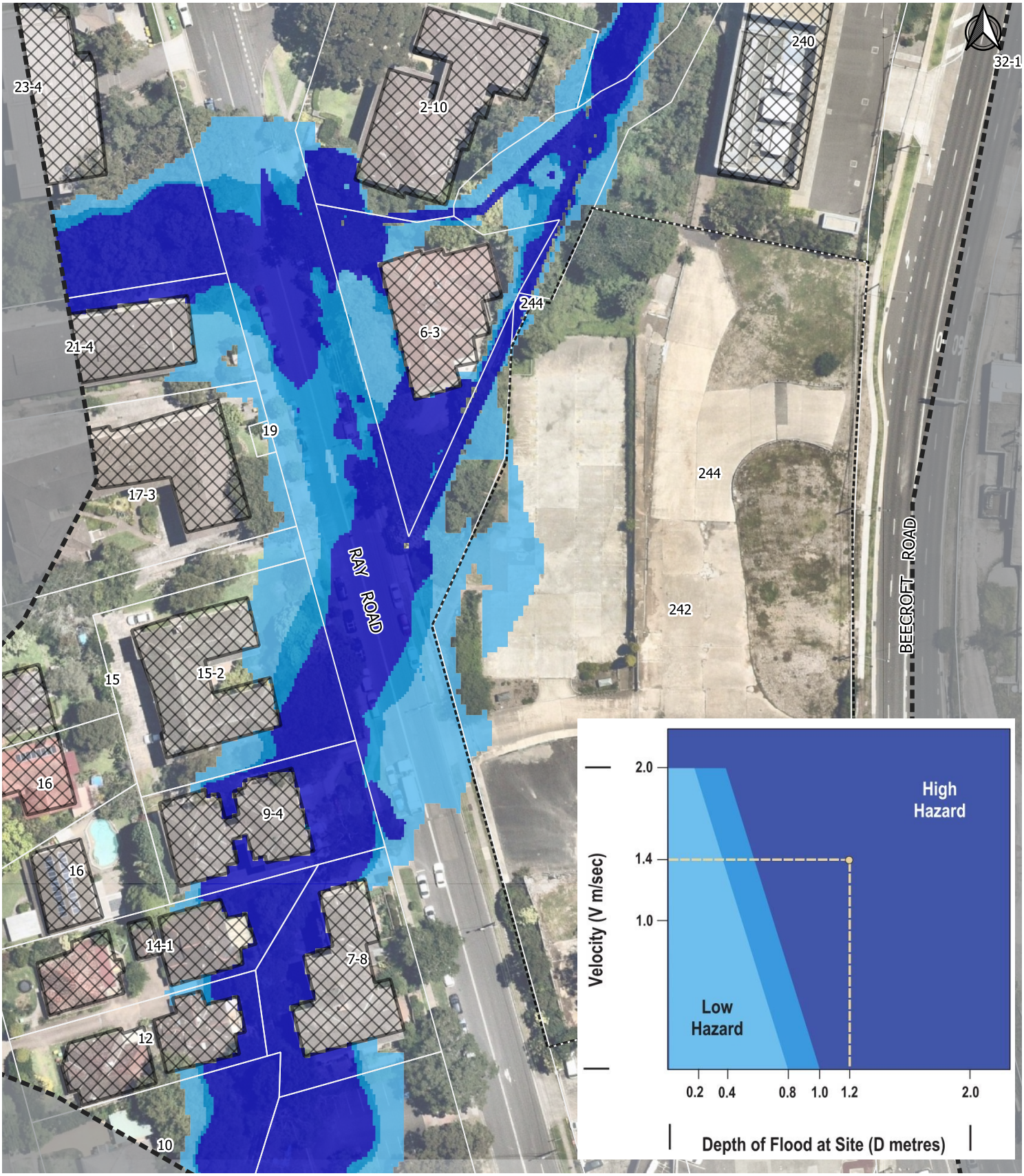
Figure C4 [B]

1% AEP Flood Hazard (ARR 2019)
Existing Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020



Legend

- Site Boundary
- Model Extent
- Existing Buildings

Hazard Category

- Low
- Transition
- High

0 20 40 60 Metres

1:1,000

Figure C5 [B]

1% AEP Flood Hazard (FPDM)
Existing Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

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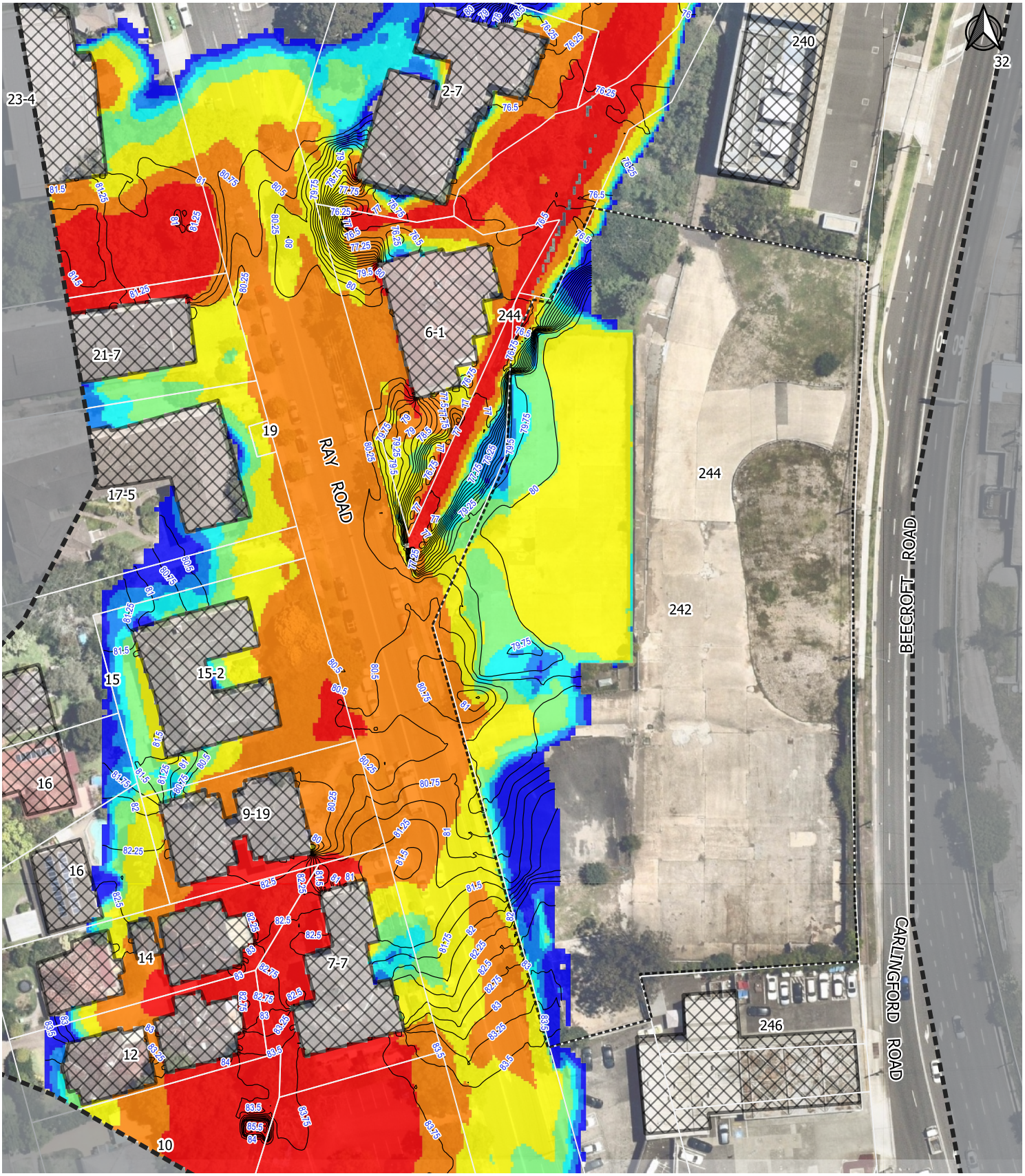

Legend

- Site Boundary
- Model Extent
- Existing Buildings
- 0.25m Contours (mAHD)

Depth(m)

- Less than 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- Greater than 2.0

0 20 40 60 Metres

1:1,000

Figure C6 [B]

PMF Flood Depth and Elevation
Existing Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

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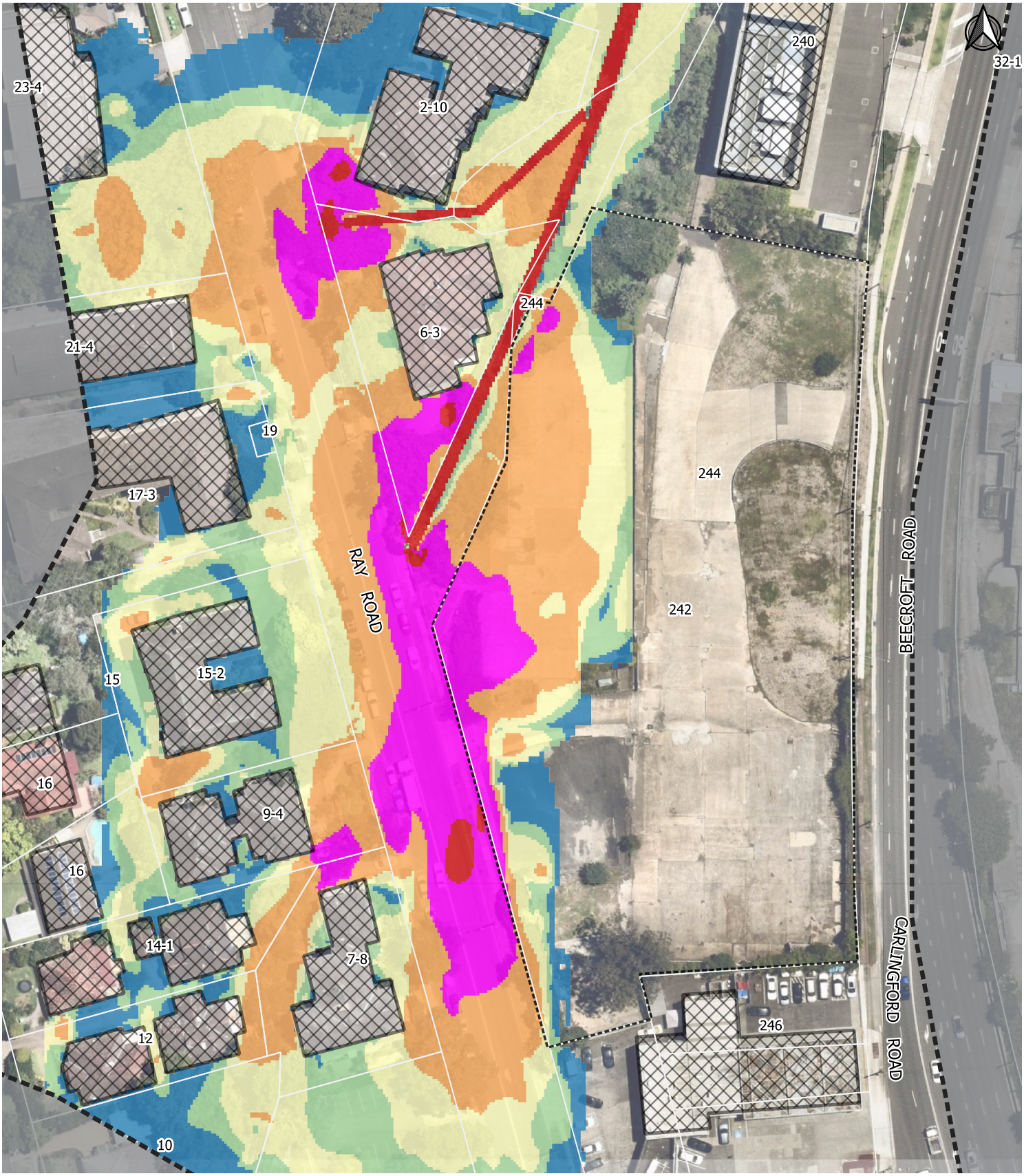


Legend

- Site Boundary
- Model Extent
- Existing Buildings

Velocity(m/s)

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

0 20 40 60 Metres

1:1,000

Figure C7 [B]

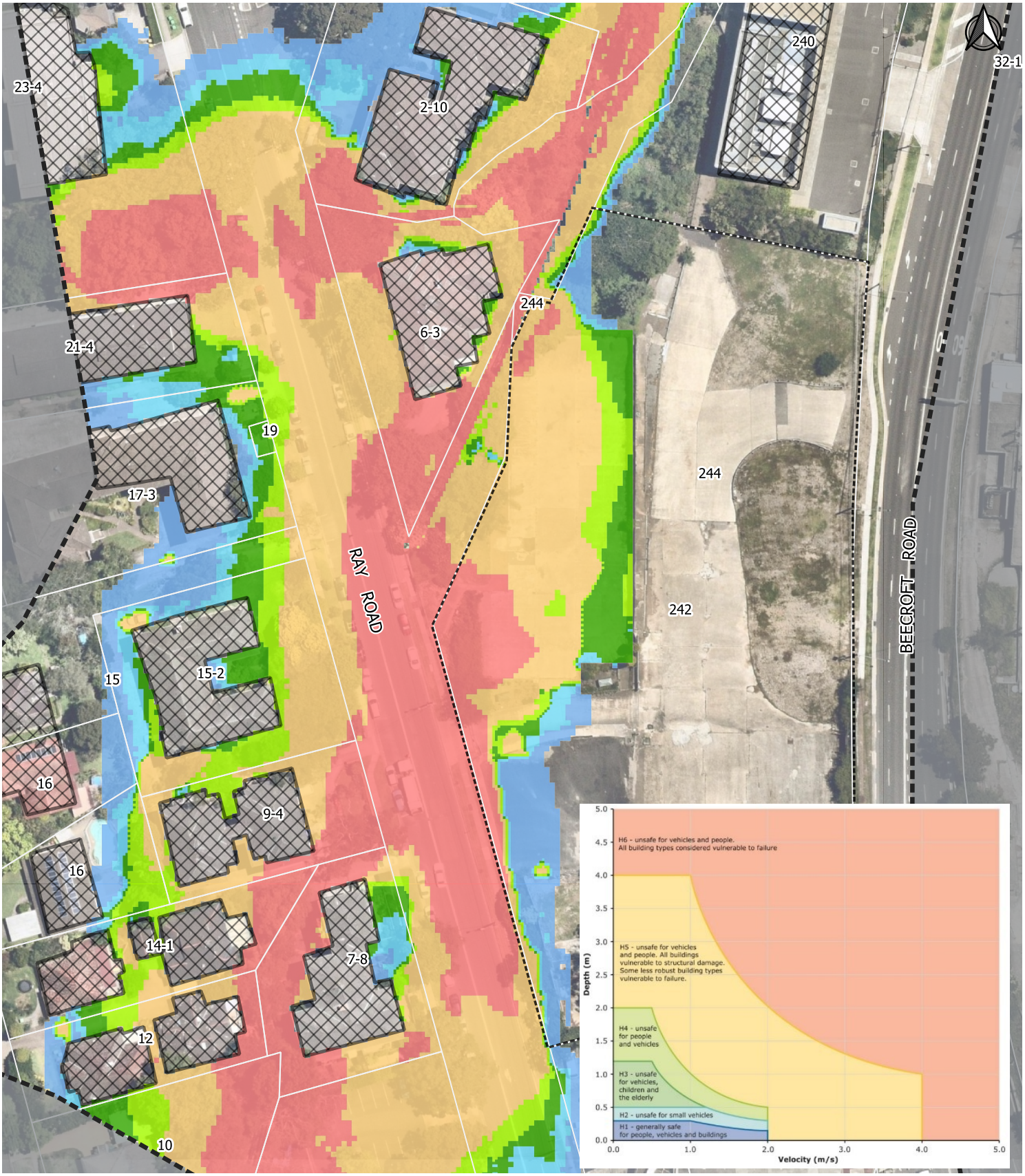
PMF Flood Velocity
Existing Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2020, Cadastre - NSW LPI 2020

6/4/2023 X:\PROJECTS\SYDNEY\2021 Jobs\SY212798 242-244 Beecroft Road, Epping\O - Drawings\MAP\Figures\230404_Report\Figure_C7.qgz



Legend

- Site Boundary
- Model Extent
- Existing Buildings

Hazard Category

- H1
- H2
- H3
- H4
- H5
- H6

0 20 40 60 Metres

1:1,000

Figure C8 [B]

PMF Flood Hazard (ARR 2019)
Existing Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2020, Cadastre - NSW LPI 2020

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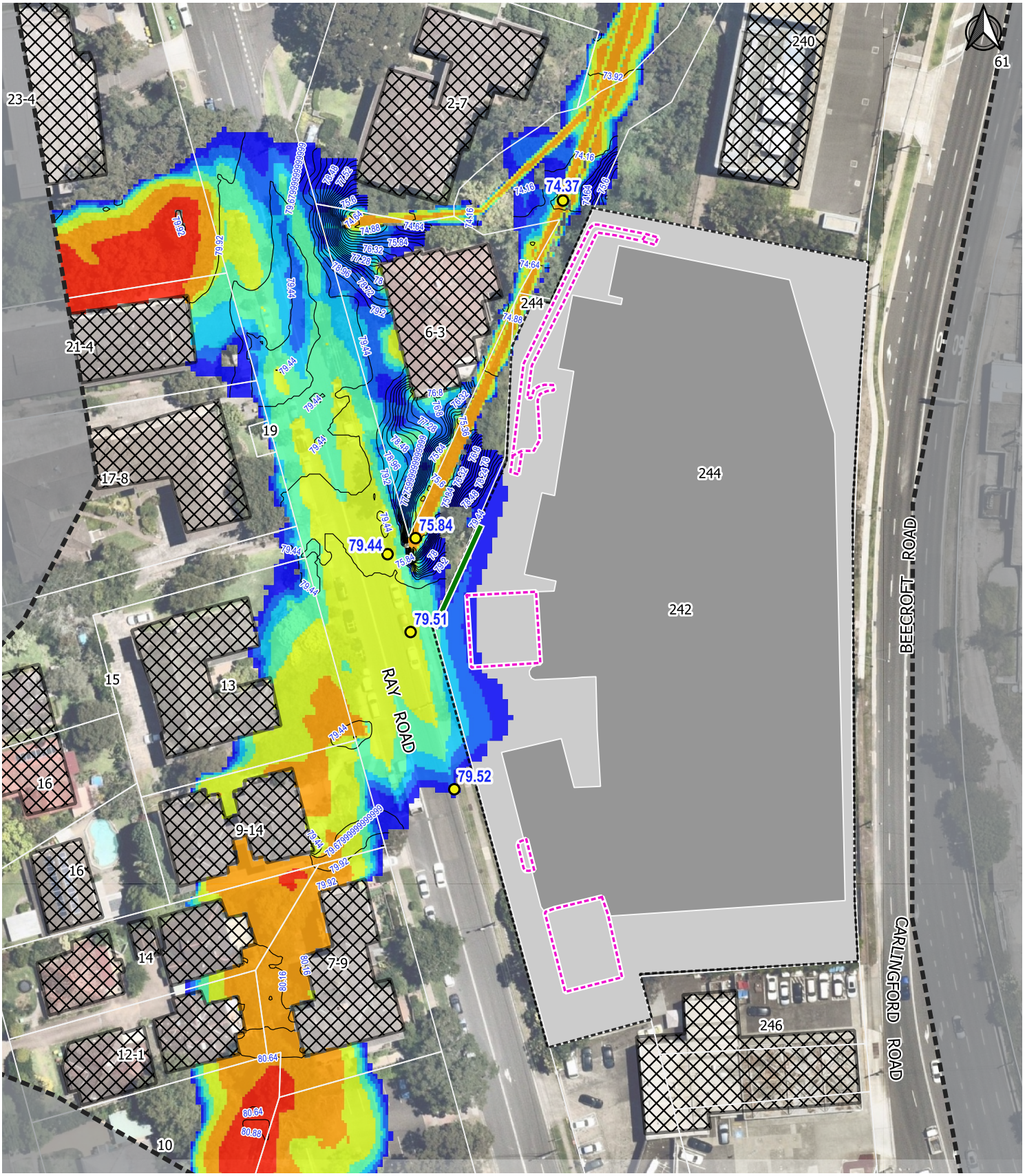

Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- 0.25m Contours (mAHD)
- Spot Elevations (mAHD)
- Suspended Areas
- Flood Wall

Depth (m)

- Less than 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- Greater than 2.0

0 20 40 60 Metres

1:1,000

Figure D1 [C]

5% AEP Flood Depth and Elevation
Developed Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

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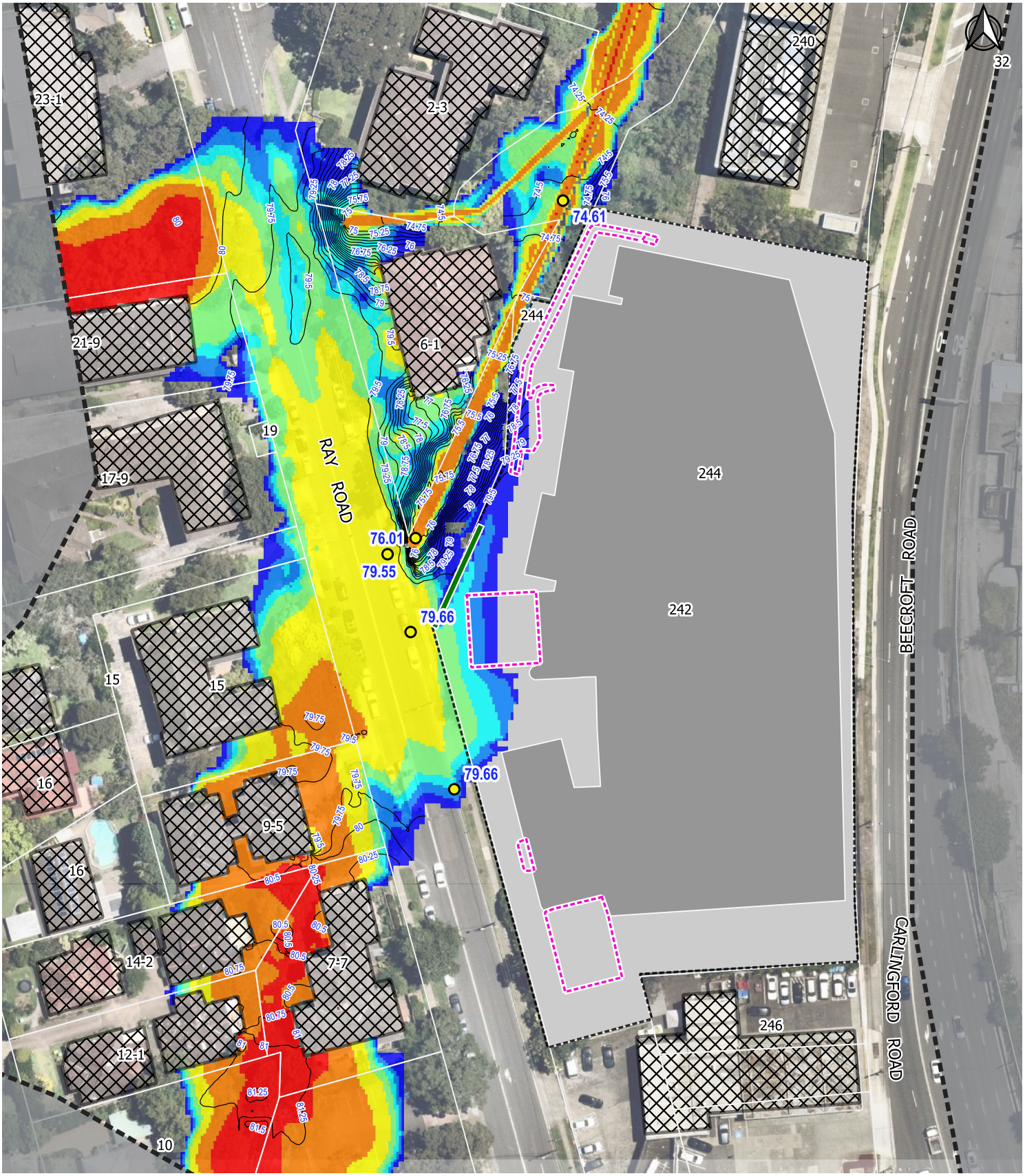

Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- 0.25m Contours (mAHD)
- Spot Elevations (mAHD)
- Suspended Areas
- Flood Wall

Depth(m)

- Less than 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- Greater than 2.0

0 20 40 60 Metres

1:1,000

Figure D2 [D]

1% AEP Flood Depth and Elevation
Developed Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

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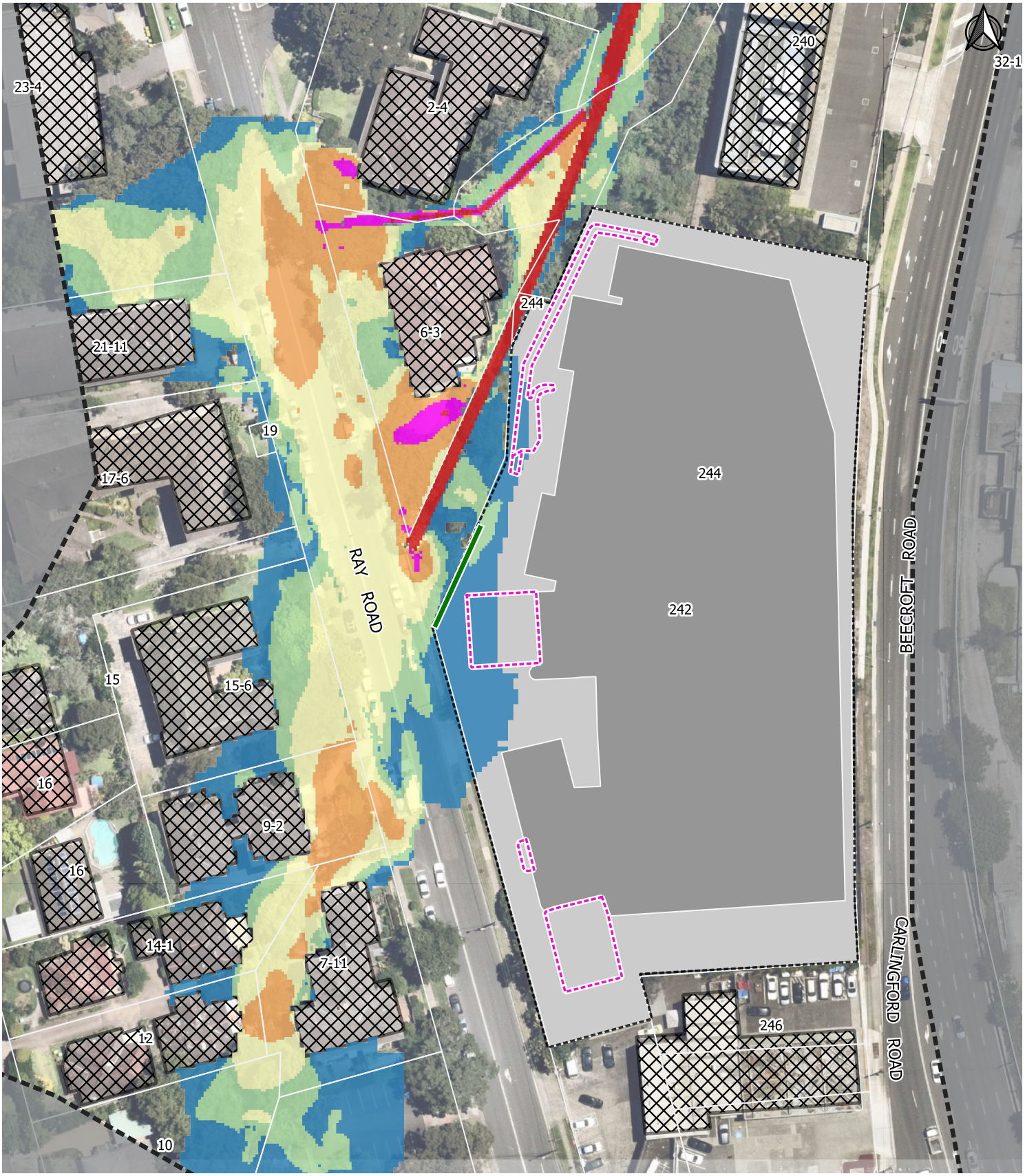

Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall

Velocity(m/s)

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

0 20 40 60 Metres

1:1,000

Figure D3 [C]

1% AEP Flood Velocity
Developed Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2020, Cadastre - NSW LPI 2020

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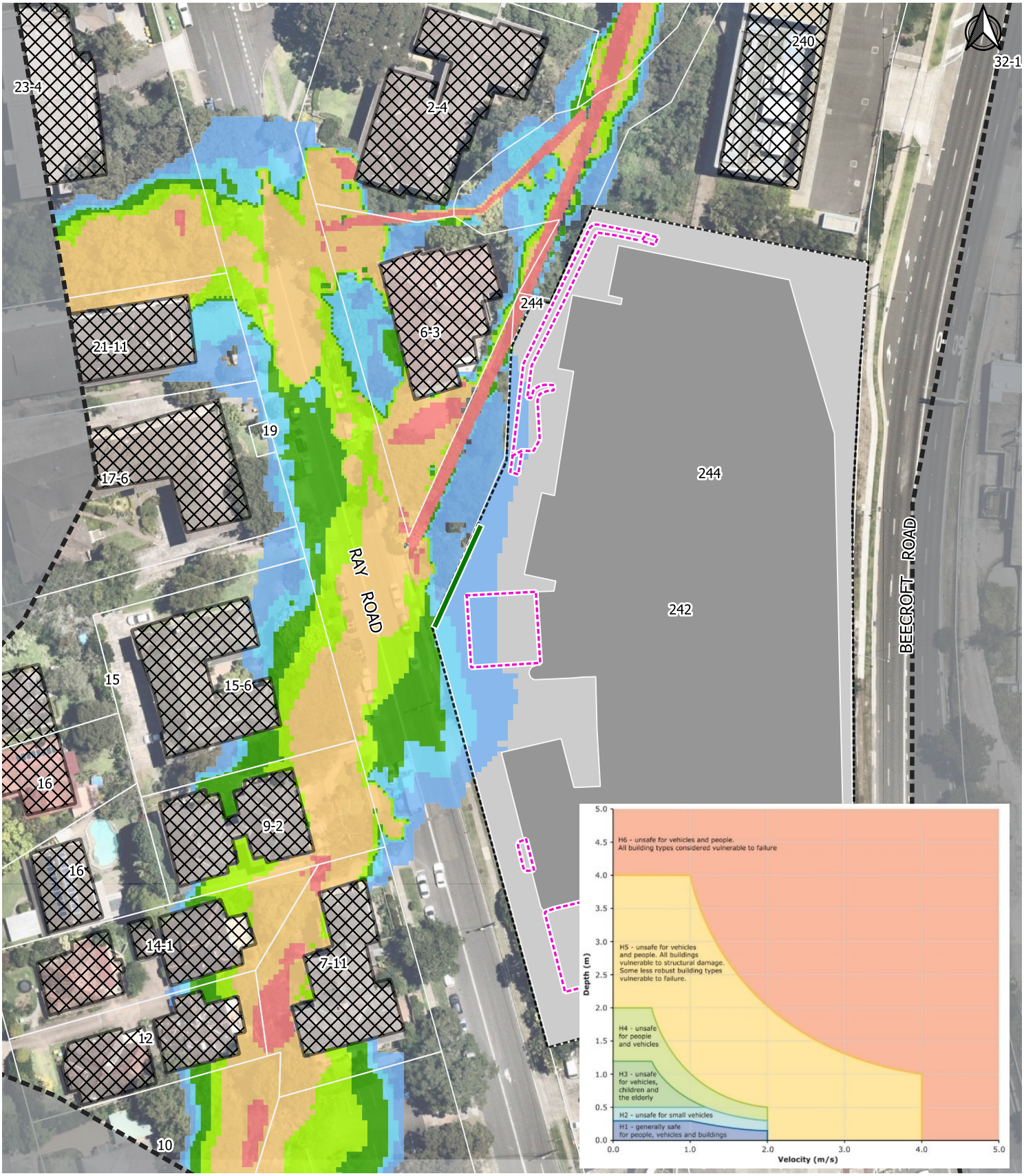

Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall

Hazard Category

- H1
- H2
- H3
- H4
- H5
- H6

0 20 40 60 Metres

1:1,000

Figure D4 [C]

1% AEP Flood Hazard (ARR 2019)
Developed Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2020, Cadastre - NSW LPI 2020

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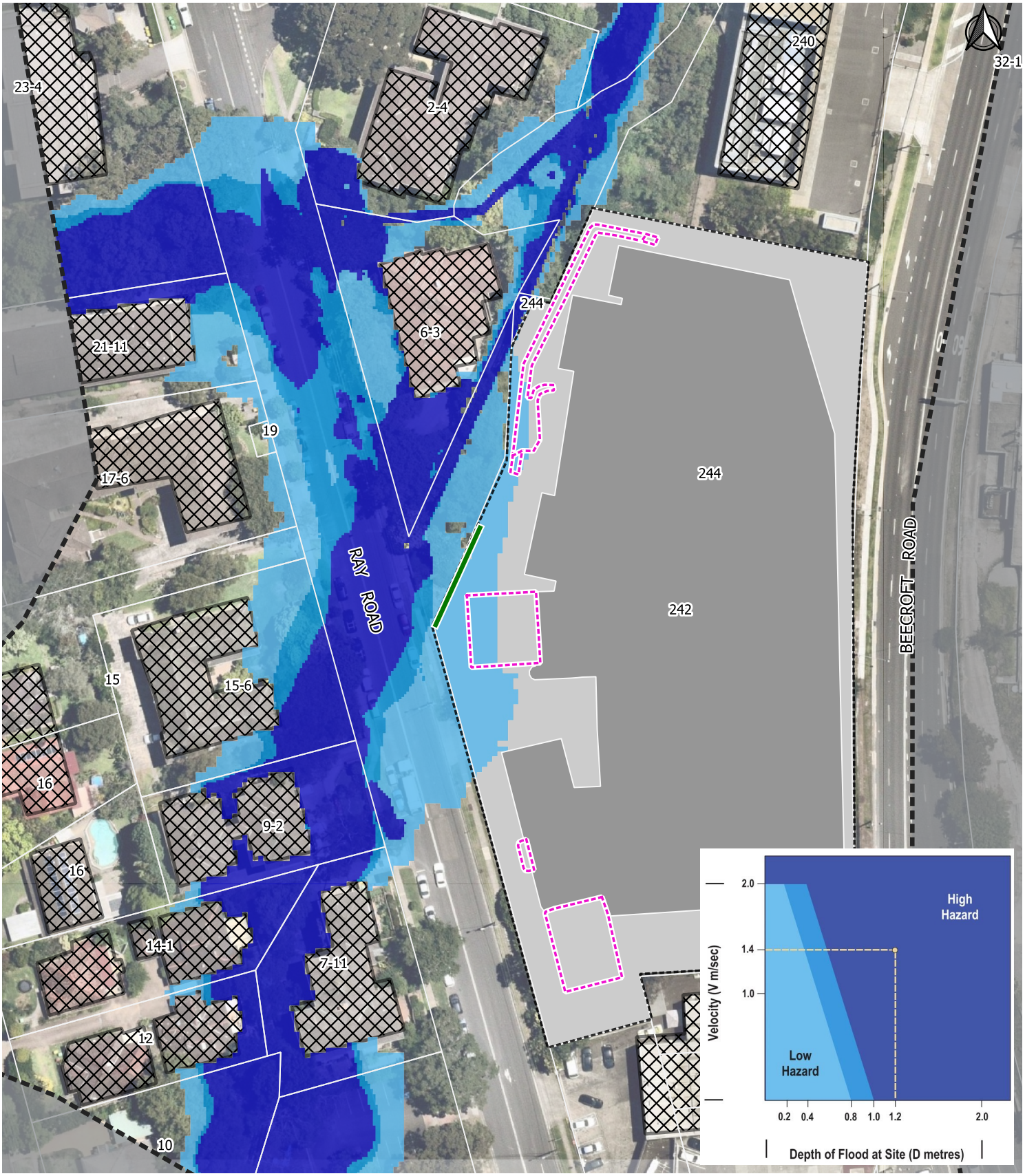

Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall

Hazard Category

- Low
- Transition
- High

0 20 40 60 Metres

1:1,000

Figure D5 [C]

1% AEP Flood Hazard (FPDM)
Developed Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2020, Cadastre - NSW LPI 2020

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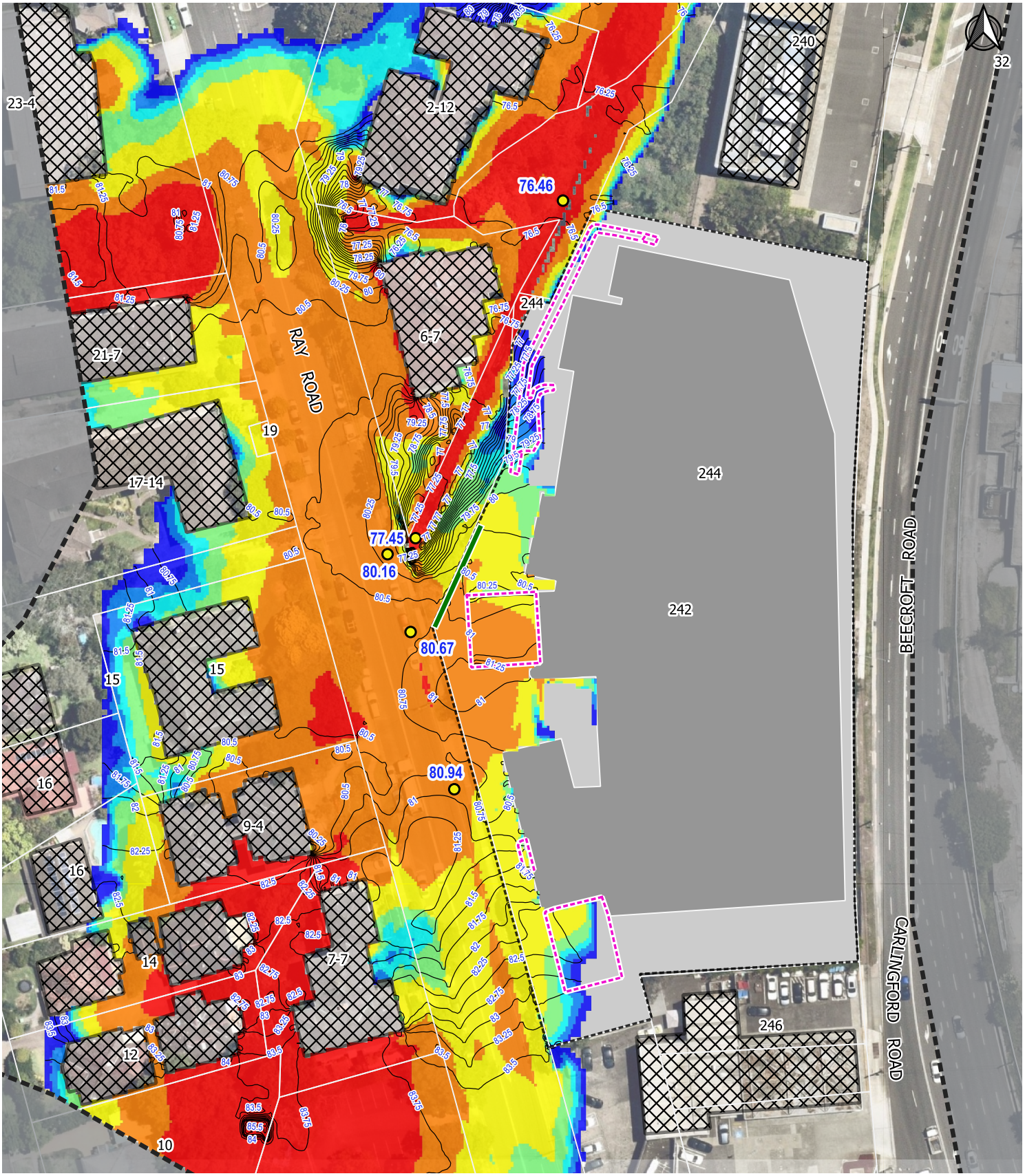

Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- 0.25m Contours (mAHD)
- Spot Elevations (mAHD)
- Suspended Areas
- Flood Wall

Depth(m)

- Less than 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- Greater than 2.0

0 20 40 60 Metres

1:1,000

Figure D6 [E]

PMF Flood Depth and Elevation
Developed Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

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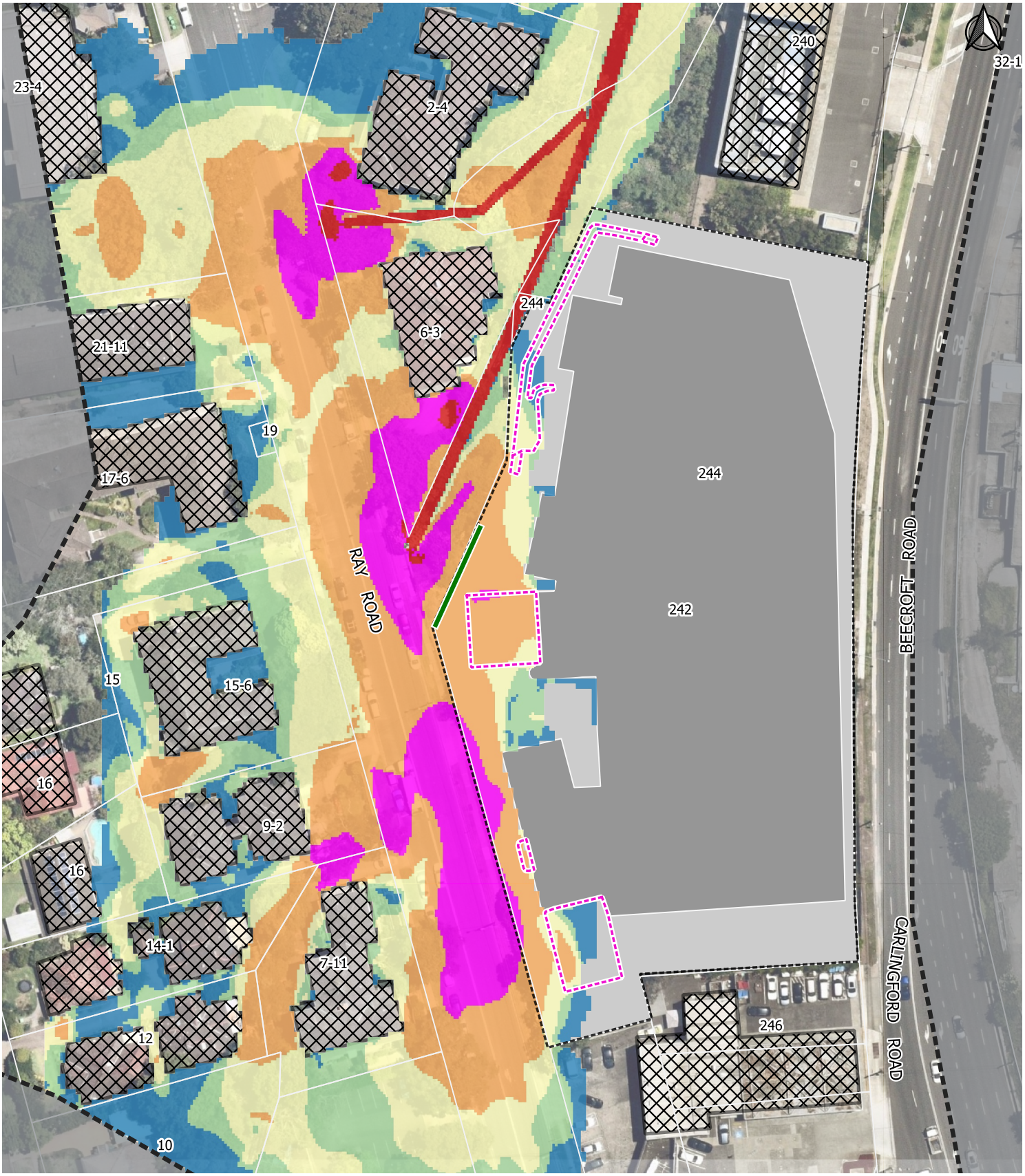


Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall

Velocity(m/s)

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

0 20 40 60 Metres

1:1,000

Figure D7 [C]

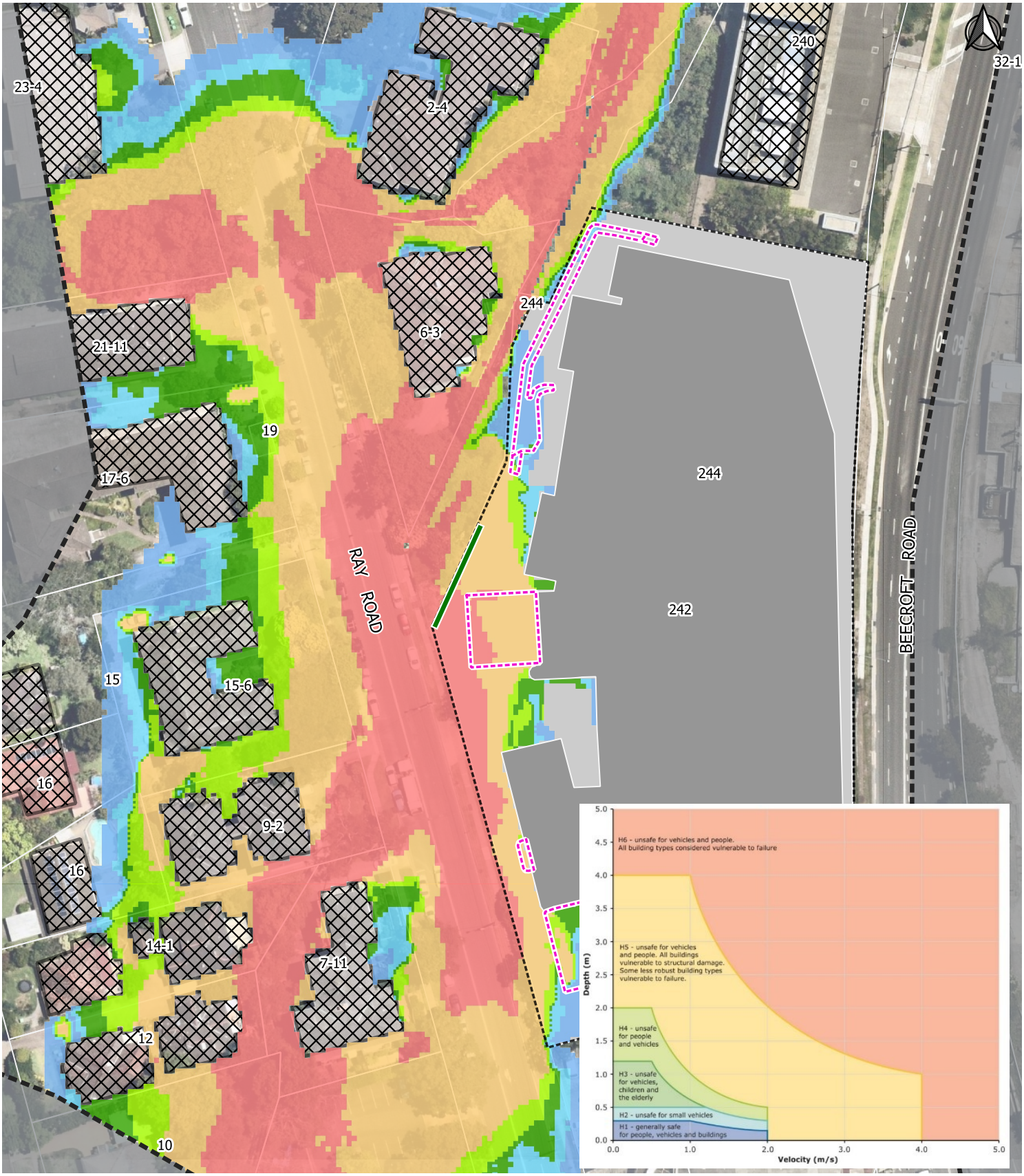
PMF Flood Velocity
Developed Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2020, Cadastre - NSW LPI 2020

3/7/2024 X:\PROJECTS\SYDNEY\2021 Jobs\SY212798 242-244 Beecroft Road, Epping\O - Drawings\MAP\Figures\230404_Report\Figure_D7.qgz



Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall

Hazard Category

- H1
- H2
- H3
- H4
- H5
- H6

0 20 40 60 Metres

1:1,000

Figure D8 [E]

PMF Flood Hazard (ARR 2019)
Developed Case

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2020, Cadastre - NSW LPI 2020

3/7/2024 X:\PROJECTS\SYDNEY\2021 Jobs\SY212798 242-244 Beecroft Road, Epping\O - Drawings\MAP\Figures\240703 - MOD SSDA\Figure_D8.qgz

Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall

Difference (m)

- <= -0.250
- -0.100 - -0.250
- -0.025 - -0.100
- -0.010 - -0.025
- -0.010 - 0.010
- 0.010 - 0.025
- 0.025 - 0.100
- 0.100 - 0.250
- 0.250 - 0.500
- >0.5

0 30 60 90 Metres

1:1,200

Figure E1 [C]

5% AEP Flood
Elevation Difference
Pre-to-Post Comparison

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

4/7/2024 X:\PROJECTS\SYDNEY\2021 Jobs\SY212798 242-244 Beecroft Road, Epping\O - Drawings\MAP\Figures\240703 - MOD SSDA\Figure_E1.qgz

Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall

Difference(m)

- <= -0.250
- -0.100 - -0.250
- -0.025 - -0.100
- -0.010 - -0.025
- -0.010 - 0.010
- 0.010 - 0.025
- 0.025 - 0.100
- 0.100 - 0.250
- 0.250 - 0.500
- >0.5

0 30 60 90 Metres

1:1,200

Figure E2 [E]

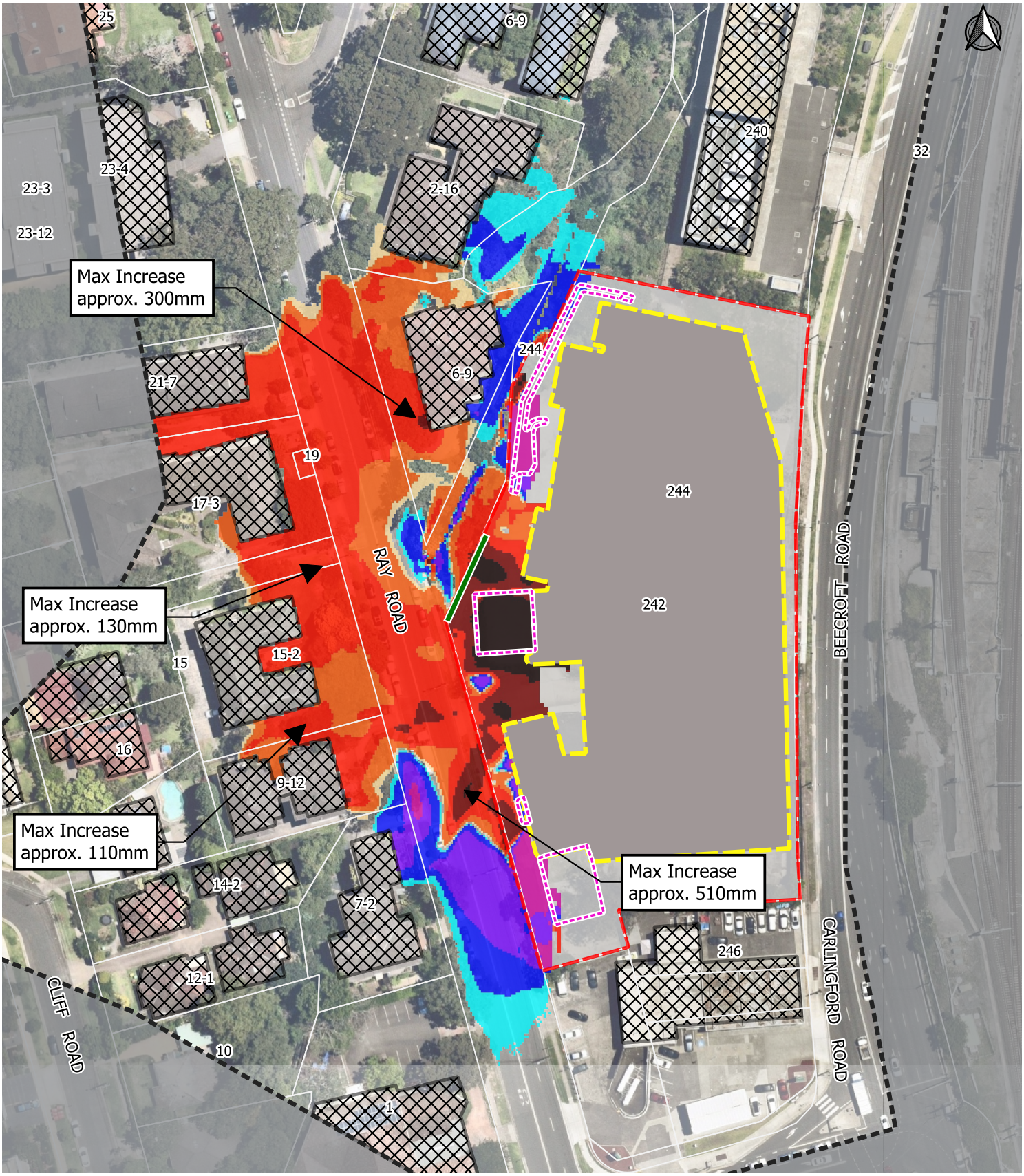
1% AEP Flood
Elevation Difference
Pre-to-Post Comparison

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2020, Cadastre - NSW LPI 2020

3/7/2024 X:\PROJECTS\SYDNEY\2021 Jobs\SY212798 242-244 Beecroft Road, Epping\O - Drawings\MAP\Figures\240703 - MOD SSDA\Figure_E2.qgz



Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall

Difference(m)

- <= -0.250
- -0.100 - -0.250
- -0.025 - -0.100
- -0.010 - -0.025
- -0.010 - 0.010
- 0.010 - 0.025
- 0.025 - 0.100
- 0.100 - 0.250
- 0.250 - 0.500
- >0.5

0 30 60 90 Metres

1:1,200

Figure E3 [E]

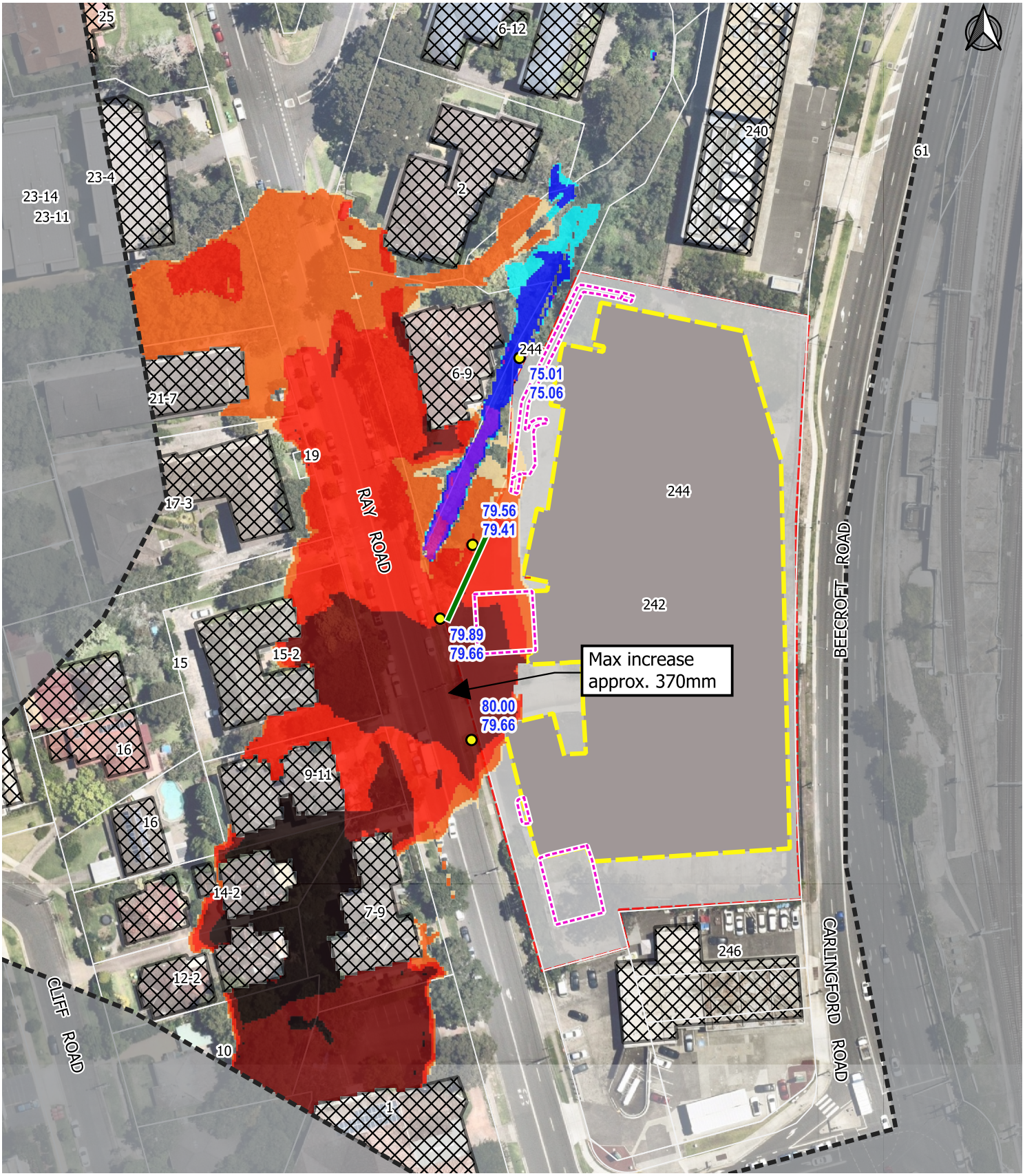
PMF Flood
Elevation Difference
Pre-to-Post Comparison

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

3/7/2024 X:\PROJECTS\SYDNEY\2021 Jobs\SY212798 242-244 Beecroft Road, Epping\O - Drawings\MAP\Figures\240703 - MOD SSDA\Figure_E3.qgz



Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall
- Spot Water Level (mAHD)
  - 79.89 Full Blockage
  - 79.66 Design Blockage

Difference(m)

- <= -0.250
- -0.100 - -0.250
- -0.025 - -0.100
- -0.010 - -0.025
- -0.010 - 0.010
- 0.010 - 0.025
- 0.025 - 0.100
- 0.100 - 0.250
- 0.250 - 0.500
- >0.5

0 30 60 90 Metres

1:1,200

Data Source: Aerial - Nearmap, 2021, Cadastre - NSW LPI 2020

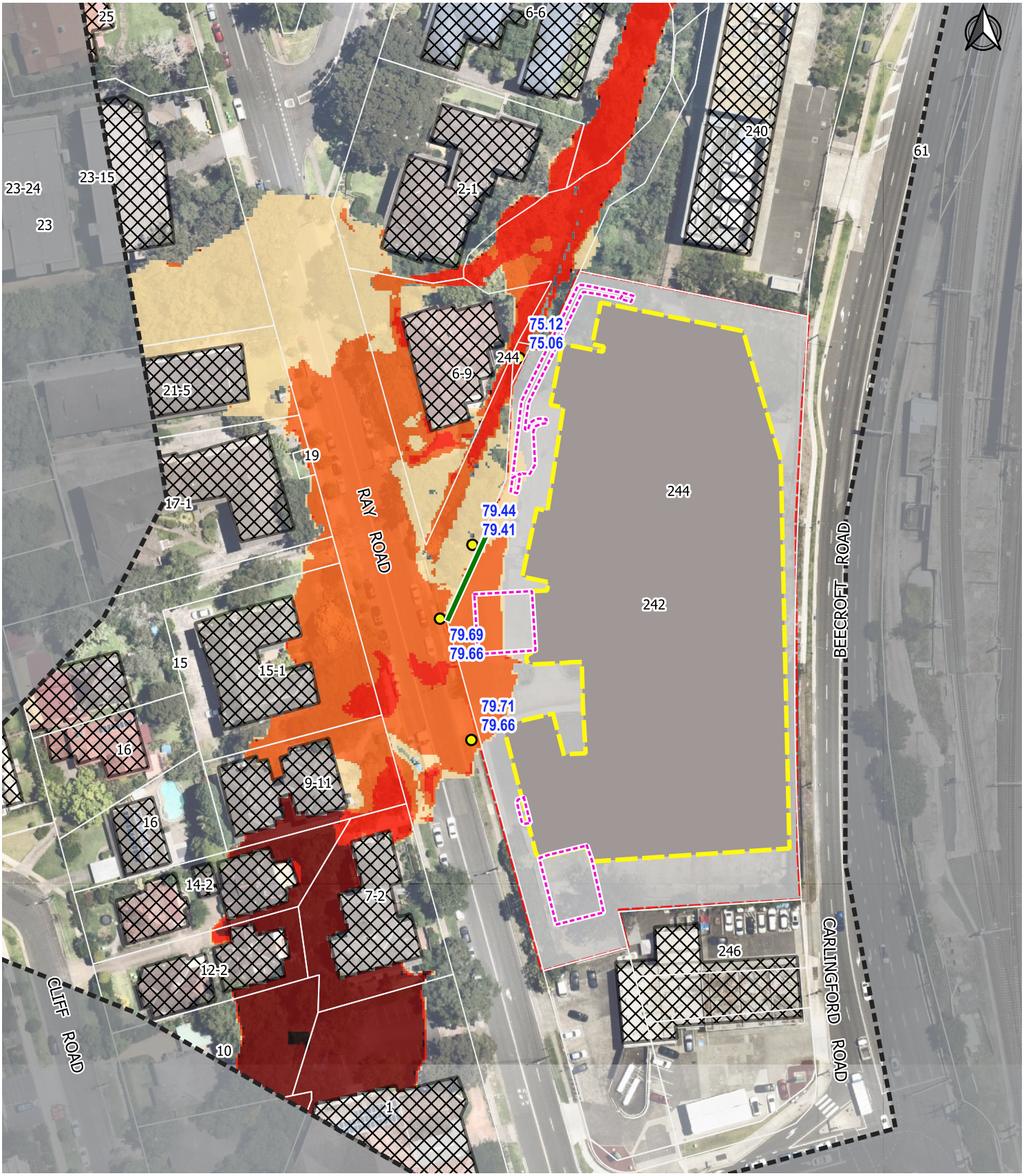
3/7/2024 X:\PROJECTS\SYDNEY\2021 Jobs\SY212798 242-244 Beecroft Road, Epping\O - Drawings\MAP\Figures\240703 - MOD SSDA\Figure_F1.qgz

Figure F1 [C]

1% AEP Flood Elevation Difference
Full Blockage Scenario minus
Design Blockage (50%)

242-244 Beecroft Road, Epping

NORTHROP



Legend

- Site Boundary
- Model Extent
- Existing Buildings
- Proposed Building
- Suspended Areas
- Flood Wall
- Spot Water Levels (mAHD)
  - 79.71 Climate Change
  - 79.66 Current Conditions

Difference (m)

- Less than 0.025
- 0.025 - 0.050
- 0.050 - 0.100
- 0.100 - 0.150
- Greater than 0.150

0 30 60 90 Metres

1:1,200

Figure F2 [C]

1% AEP Flood Elevation Difference Climate Change minus Design Blockage

242-244 Beecroft Road, Epping

NORTHROP

Data Source: Aerial - Nearmap, 2020, Cadastre - NSW LPI 2020

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Appendix B – Sydney Water WaC Drawings

SHEET 1

PARRAMATTA

DUNDAS

HORNSBY SHIRE

BORONIA PARK

Cont: No 92 32/33

Reserve for Public Recreation

Timber accommodation bridge about 8ft wide on 3/12"x6" bearers with timber handrails. Constructed by P.W.D. (To be transferred to M.M.S.& D.B.H.)

Timber accommodation bridge about 4ft. wide on 2/8" bearers timber handrail. Constructed privately. (To remain under private control.)

Timber footbridge 12 feet wide separate from channel constructed by private owner (to remain under control of private owner)

Single cell concrete box culvert forms part of channel constructed by P.W.D (to be transferred to Met. Water Sewerage & Drainage Board).

Timber: Foot-bridge 5'6" wide. Separate from Channel. Privately Constructed. (To remain under private control.)

Timber Bridge 20 feet wide on masonry pier and abutments separate from channel constructed by Hornsby Shire Council (to remain under control of Hornsby Shire Council)

Timber accommodation bridge 5ft wide. Constructed by P.W.D. (To be transferred to M.M.S.& D.B.H.)

Triple cell concrete road bridge forms part of channel constructed by Main Roads Board. (to remain under control of Main Roads Board).

Concrete Bridge in Course of Construction

Start of Contract

To Hornsby

Railway Culvert.

Bridge constructed by Dept. of Main Roads.

Reserve for Storage

Recreation

Reserve

Not Constructed

DIAGRAM
Bridge at Intersection of Main Channel with Ray Road.
Scale 40' = 1 Inch

PLAN
Scale
FEET 132 99 66 33 0 100 200 300 400 FEET

SEWERAGE DATUM

Plotted from Mt. Surveyor Lanyon's F.B.N 726 L.B.N 620

WORK AS EXECUTED PARRAMATTA

DRAWN ACA
TRACED 2-11-37
CHECKED 29-11-37

- DRAFTSMAN - IN - CHARGE -

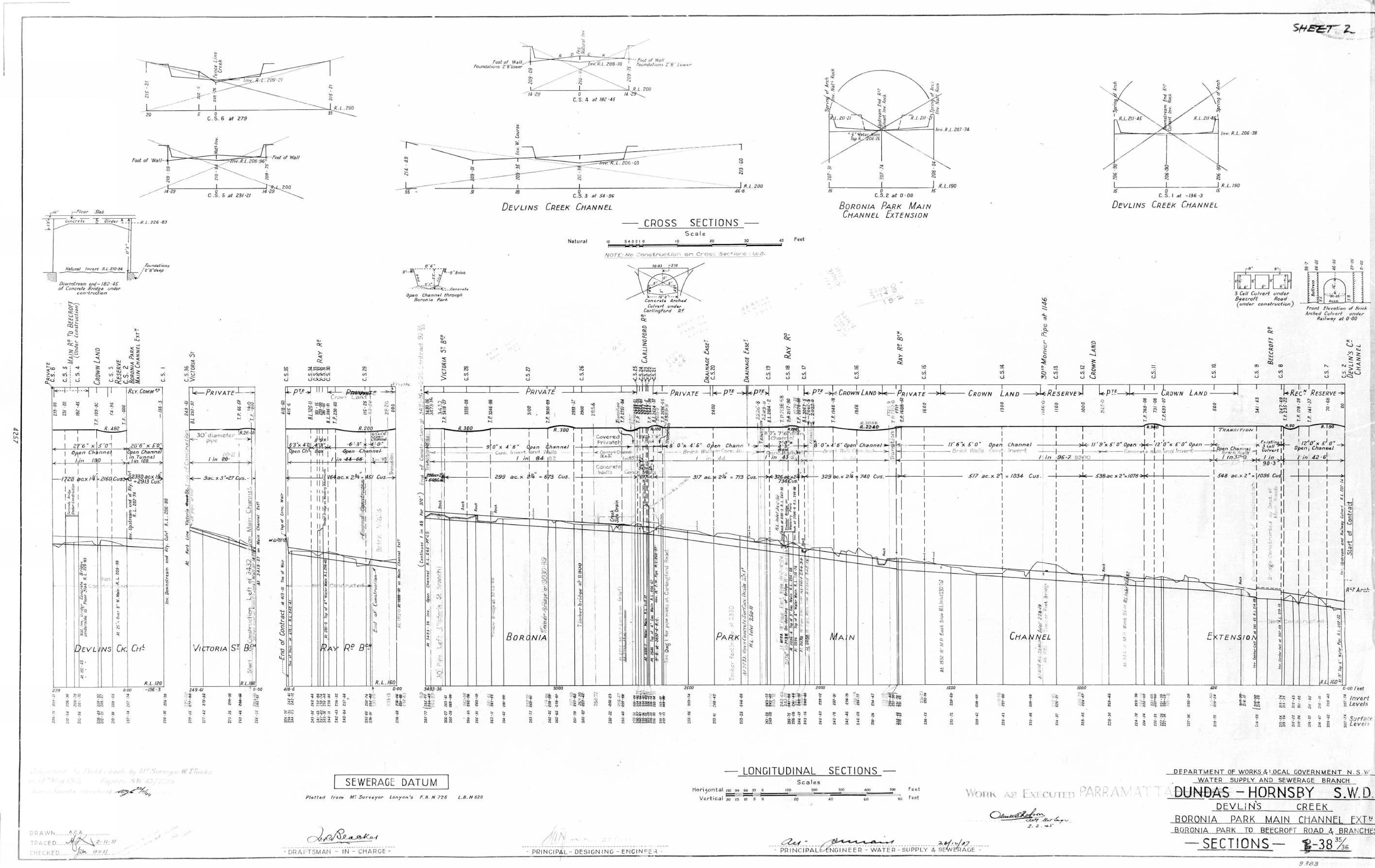
- PRINCIPAL - DESIGNING - ENGINEER -

23/12/37
- PRINCIPAL ENGINEER - WATER - SUPPLY & SEWERAGE -

DEPARTMENT OF WORKS & LOCAL GOVERNMENT N.S.W.
WATER SUPPLY AND SEWERAGE BRANCH
DUNDAS – HORNSBY – S.W.D.
DEVLINS CREEK
BORONIA PARK MAIN CHANNEL EXTN
BORONIA PARK TO BEECROFT ROAD & BRANCHES
– PLAN – C C 38 35/36

9383.

MICROBOX 86



SHEET 3

Gutter Level
Inv. R.L. 277·80
C. S. Nº 36 at 249·61
End of Construction
VICTORIA ST BRANCH
Inv. R.L. 242·41
Along Top of Weir
R.L 240
C. S. Nº 35 at 415·6
Inv. R. L. 240·44
S.W.B.L. Ray Road
C. S. Nº 34 at 325·11
Footway — Decking R.L. 257·94
Inv. R.L. 239·88
R.L. 235
C. S. Nº 33 at 301·15
Metal — Metal
Center of Decking
Centre Ray Road
Inv. R.L. 239·74
C. S. Nº 32 at 293·00
footway — Decking R.L. 258·75
Inv. R.L. 239·46
R.L. 230
C. S. Nº 31 at 281·55
Inv. R.L. 238·89
C. S. Nº 30 at 258·51
Inv. R.L. 235·74
R.L. 225
C. S. Nº 29 at 115·25
RAY Rº BRANCH
Construction on Ray Rd Bch ends at 93·50

Main Channel Construction ends at 3+93·36
Inv. R.L. 262·58
R.L. 250
C. S. Nº 28 at 3333·08
Inv. R.L. 259·81
R.L. 250
C. S. Nº 27 at 3100
Inv. R.L. 257·42
R.L. 250
C. S. Nº 26 at 2900
Stone Wall
Approx line of Fill
In Creek
Inv. R.L. 254·92
Carlingford Road
R.L. 250
C. S. Nº 25 at 2689·51
Inv. R.L. 254·67
R.L. 245
C. S. Nº 24 at 2668·85
Existing Culvert
Inv. R.L.
Center Metalled Road
C. S. Nº 23 at 2657
Inv. R.L. 254·16
R.L. 250
C. S. Nº 22 at 2646·5

Fence Corner
In Creek
Inv. R.L.
N.B.L. Carlingford Road
C. S. Nº 21 at 2624·37
Corner Fence
Creek Fork
Inv. R.L. 248·42
C. S. Nº 20 at 2400
Corner Fence
End of Brick Wall
Creek
Inv. R.L. 243·40
S.W.B.L. Ray Road
C. S. Nº 19 at 2184·2
Stone Channel Very Clean Walls
Inv. R.L. 241·86
Center Ray Road
C. S. Nº 18 at 2117·90
Stone Channel Very Clean Walls
Inv. R.L. 240·46
N.E.B.L. Ray Road
C. S Nº 17 at 2057·5
Inv. R.L. 239·24
Creek
C. S. Nº 16 at 1856
Inv. R.L. 230·74
C. S. Nº 15 at 1600

Rising
Creek Rock Bed
Rising Steeply
Inv. R.L. 227·60
C. S. Nº 14 at 1300
Inv. R.L.
In Creek on Rock
C. S. Nº13 at 1100
Inv. R.L. 224·47
C. S. Nº12 at 1000
Inv. R.L. 227·66
C. S. Nº 11 at 731·08
Inv. R.L. 219·24
C. S. Nº 10 at 500
Top of Slab Inv Outer Cell
Inv Centre Cell
Inv. R.L. 215·92
Inv Outer Cell Top of Slab
Roof Form
C. S. Nº 9 at 341·43
Construction starts at 341·43
No Construction below Cross Section Nº 9.
Top of Roof Inv Outer Cell
Inv Centre Cell
Inv Outer Cell Top of Slab
Roof Form
C. S. Nº 8 at 247·49
R.C. Fence
Inv. R.L. 209·40
C. S. Nº 7 at 70·68
BORONIA PARK MAIN CHANNEL EXTn

No Construction on Cross Sections 29-35

427

SEWERAGE DATUM
Plotted from Mt Surveyor Lanyon's F.B. N 726 L.B. N 620

CROSS SECTIONS
Scale
Natural 10 5 4 3 2 1 0 10 20 30 40

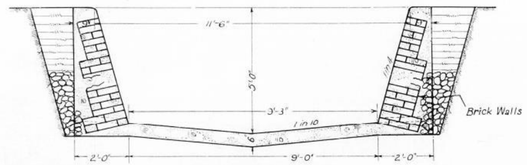
PARRAMATTA –
WORK AS EXECUTED

DEPARTMENT OF WORKS & LOCAL GOVERNMENT N.S.W.
WATER SUPPLY AND SEWERAGE BRANCH
~~DUNDAS~~ – HORNSBY S.W.D.
DEVLIN'S CREEK
BORONIA PARK MAIN CHANNEL EXTn
BORONIA PARK TO BEECROFT ROAD & BRANCHES
CROSS SECTIONS — 3-38 5/36

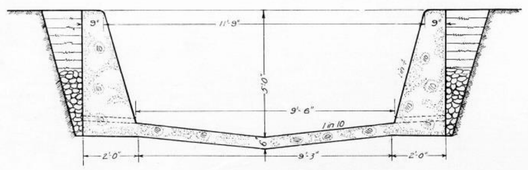
DRAWN A.F.A.
TRACED 2-11-37
CHECKED

– DRAFTSMAN – IN – CHARGE –
– PRINCIPAL – DESIGNING – ENGINEER –
– PRINCIPAL – ENGINEER – WATER – SUPPLY & SEWERAGE –

9383

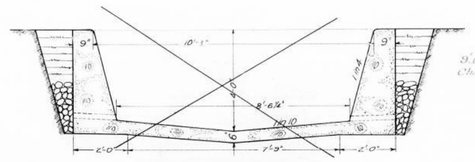


C.S. OF 11'-6" x 5'-0" OPEN CHANNEL
CH. 1000' TO ~~1388·52'~~ 1717·2'



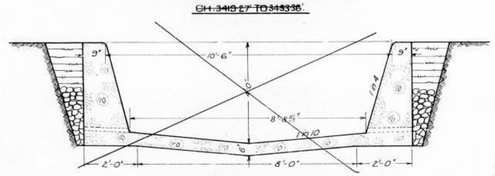
C.S. OF 11'-9" x 5'-0" OPEN CHANNEL
CH. 769·08' TO 1000'

769·08' to 925·0' Concrete Walls
925' to 1000' Brick Walls



C.S. OF 10'-3" x 4'-0" OPEN CHANNEL
~~CH. 3410·27' TO 3433·36'~~

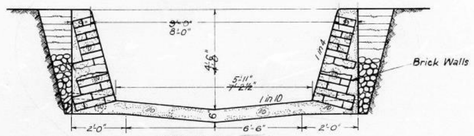
9'-0" x 4'-6" Open Channel
Chainage 2857 to 3473.36'



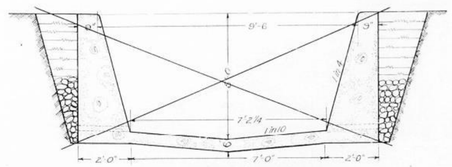
C.S. OF 10'-6" x 4'-0" OPEN CHANNEL
~~CH. 2608·85' TO 3413·27'~~

9'-0" x 5'-0" Covered Channel
Vide Drawing N°7
Chainage 2717 to 2854.

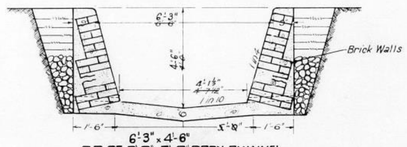
8'-6" x 7'-6" Concrete Box Channel
Chainage 2613.6 to 2639.



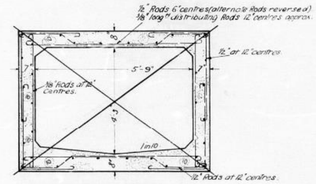
8'-0" x 4'-6"
C.S. OF ~~9'-0" x 4'-6"~~ OPEN CHANNEL
CH. ~~2484·20' TO 2624·32'~~ 2226·80' TO 2585·50'



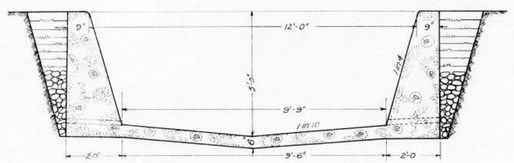
C.S. OF 9'-6" x 5'-0" OPEN CHANNEL
~~CH. 341·43' TO 500·0'~~



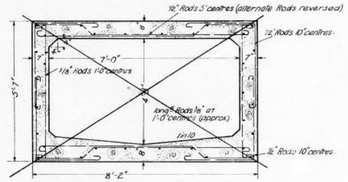
6'-3" x 4'-6"
C.S. OF ~~6'-6" x 5'-0"~~ OPEN CHANNEL
RAY ROAD BRANCH
CH. 1200 TO ~~1545·60'~~ 93·50'



C.S. OF 5'-9" x 4'-3" BOX CULVERT
RAY ROAD
~~RAY ROAD BRANCH CHANNEL~~

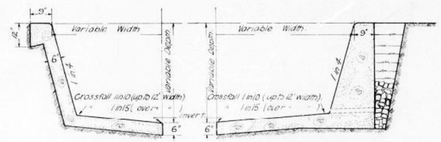


C.S. OF 12'-0" x 5'-0" OPEN CHANNEL
CH. 500 TO 765·08'



C.S. OF 7'-0" x 4'-3" BOX CULVERT
AT RAY ROAD
(MAIN CHANNEL)
~~CH. 2057·56' TO 2144·26'~~

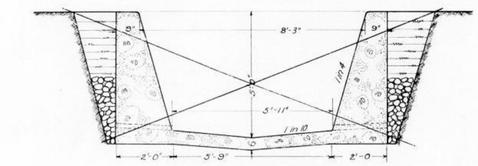
8'-10" x 7'-6" open channel
Vertical Concrete Walls
Chainage 2042·5' to 2203'



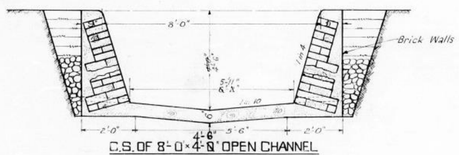
HALF SECTION-ALL ROCK TYPE
HALF SECTION-OTHER THAN ROCK TYPE

TYPE CONCRETE CHANNEL SECTIONS
Scale ½"-1'-0"

Note: Concrete (Gravity Type) Walls 3' dia. Weepholes 6'-0" centres in Two Rows 12" apart.



C.S. OF 8'-3" x 5'-0" OPEN CHANNEL
~~CH. 0·0' TO 247·19'~~



C.S. OF 8'-0" x 4'-6" OPEN CHANNEL
CH. 1688·52' TO ~~2057·60'~~ 1725·50' TO 2022'

WORK AS EXECUTED
W. H. Hall
METROPOLITAN ENGINEER
10-3-51

Subjected to Field Check by Mr Surveyor Timbs
on 14th May 1943. Papers S.W. 43/2239
Amendments Checked H.E.J. 16-1-51

MAIN CHANNEL

DRAWN ~~[illegible]~~
CHECKED ~~[illegible]~~

PRINCIPAL DESIGNING ENGINEER

PRINCIPAL ENGINEER WATER SUPPLY AND SEWERAGE 29/11/36

CHIEF ENGINEER FOR PUBLIC WORKS

DEPARTMENT OF PUBLIC WORKS N.S.W.
WATER SUPPLY AND SEWERAGE BRANCH.

DUNDAS S.W. DRAINAGE

DEVLINS CREEK - BORONIA PARK EXTENSION
DETAILS

~~5385~~ 35/56