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Floodplain Risk Management Plan Proposed Development at 310 Terrigal Drive, Terrigal

for LoftusLane Capital Partners Pty Ltd

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Floodplain Risk Management Plan
Planning Proposal at 310 Terrigal Drive, Terrigal

Prepared for:

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1. INTRODUCTION

1.1. BACKGROUND

This Flood Study has been prepared on behalf of LoftusLane Capital Partners (**the applicant**), in support of a Planning Proposal relating to land identified as 310 Terrigal Drive, Terrigal, which is legally described as Lot 27 in DP1223375 (**the site**). The Planning Proposal seeks to amend the Central Coast LEP 2022 by increasing the maximum permissible height of buildings to 30m, and the maximum floor space ratio to 1.4:1. The Planning Proposal will enable the site to be redeveloped from a vacant land parcel to a seven-storey residential flat building, with a café activating the corner of Charles Kay Drive and Terrigal Drive at the ground level. The concept drawings prepared by CKDS Architects demonstrate the potential for the site to accommodate 42 residential apartments and 75 car parking spaces across three basement levels.

The site is flood affected based on the results of CCC's catchment-wide Coastal Lagoon Catchments Overland *Flood Study (2020).* As part of the PP submission, LoftusLane Capital Partners has engaged Rienco Consulting to prepare a suitably detailed Floodplain Risk Management Plan that addresses the requirements of, inter alia, the Section 9.1 Direction Clause 4.3, as further described in **Section 1.2**.

1.2. PURPOSE OF THIS REPORT

The purpose of this report is to:

a) Review the flood-related information currently submitted with the PP, including any assessment notes from Central Coast Council (CCC).

b) Prepare a detailed hydrologic and hydraulic model that determines peak flood levels at the subject site for a range of events up to and including the Probable Maximum Flood (PMF).

c) Determine the potential impacts of the proposed development, and the associated flood hazard and risk precinct categorisation.

d) Review the proposed development, together with the hydraulic model results, and assess it against:

   i. The Section 9.1 Direction Clause 4.3 in relation to flooding.

   ii. Clause 5.21 of the Central Coast LEP (2022, as amended).

   iii. Part 3.1.11.6 of the Central Coast DCP 2022

   iv. The pre-lodgement notes made by CCC during the assessment of this PP.

e) Prepare a report summarising the above suitable for lodgement with CCC with the PP.

1.3. LIMITATIONS AND ASSUMPTIONS

This report has been strictly prepared for the purposes stated in this report for exclusive use by the client. No other warranty, expressed or implied, is made as to the advice included in this report. This study specifically focuses on the quantification of flood behaviour at the subject site, given current conditions. This study does not address flood behaviour for other sites within the overall catchment other than where explicitly provided for in this report.

2. AVAILABLE DATA

2.1. SITE DESCRIPTION

The site is approximately 4,262 m^2 in area and is located in Terrigal, NSW. It is bounded to the north by Terrigal Drive and to the east and south by RE1 zoned land and a watercourse. The site is bounded to the west by Charles Kay Drive and the entire site is presently zoned R1 (General Residential). **Figure 2.1-1** presents an aerial image of the site and surrounds.

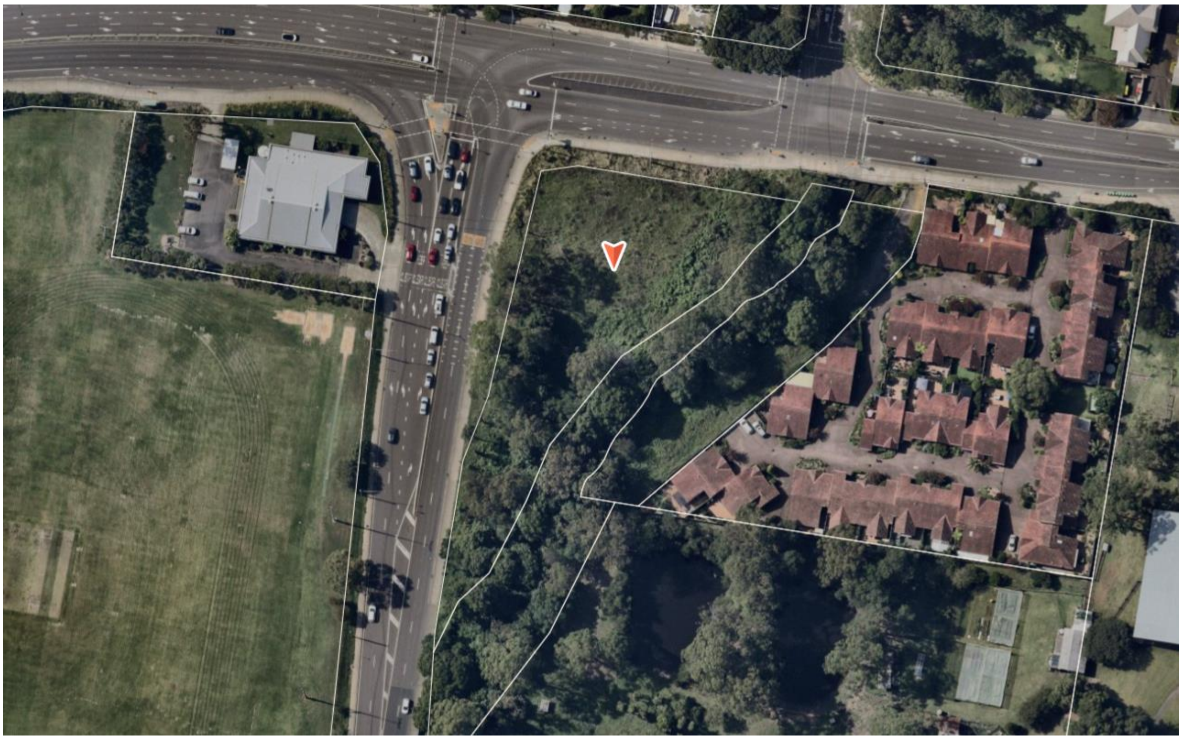


Figure 2.1-1 Subject Site

Note: Image sourced from Nearmap. Subject site is shown by the orange arrow and surrounding cadastral boundary linework.

2.2. SURVEY DATA

A detailed survey has been prepared by Bannister and Hunter (registered surveyors) in April 2022, for the site and surrounds. The survey is a detailed survey of the site, providing details on the site topography, all levels (in m AHD) across the site, existing vegetation and other topographic features. The survey also included numerous details on several culvert structures in and around the subject site. The site survey is included as **Appendix A**.

Additional topographic information was also available, in the form of Airborne Laser Scan (ALS) data. The NSW Government's Land & Property Information department (LPI) have supplied a 1m Digital Elevation Model (DEM) from the 2020 ALS dataset. Aerial imagery (2023) was also supplied for the subject site and surrounds via Nearmap.

2.3. SITE INSPECTION

A detailed site inspection was undertaken by the author in August 2022. The site inspection confirmed the adequacy of the survey information used in this study.

2.4. PREVIOUS STUDIES

The *Coastal Lagoon Catchments Overland Flood Study (2020)* has been prepared for CCC in accordance with the New South Wales Government's Floodplain Development Manual (2005). The outcome of the study was to develop and calibrate hydrologic and hydraulic models for the estimation of overland and mainstream flood behaviour in the study area. The study was been overseen and guided by the Waterways & Coastal Protection Unit of the Central Coast Council.

The *Coastal Lagoon Catchments Overland Flood Study (2020)* has been completed to provide a detailed flooding assessment of Avoca Lagoon, Cockrone Lagoon, Terrigal Lagoon and Wamberal Lagoon. The Study includes hydraulic model results for of a full set of events including the 50%, 20%, 10%, 5%, 2%, 1%, 1 in 200, 1 in 500 AEP and PMF events and represent an envelope of the critical duration/pattern of a selected representative upstream catchment and the critical duration/pattern at the lagoon. The Study notes that *the upper catchments are very flashy with very short critical durations of less than 2h to reach the peak level while the downstream catchments (lagoons), have typical critical durations ranging between 2h and 9h.*

As part of our review of the *Coastal Lagoon Catchments Overland Flood Study (2020),* we do not consider it directly applicable for the purposes of this project, because:

- The catchment delineation is coarse and the 'critical duration' was standardised across the entire study area of the *Coastal Lagoon Catchments Overland Flood Study (2020).* Whilst this approach maximises flood behaviour in the lagoons (being the specific focus of the investigation) it does not provide maximised flood behaviour upstream of the lagoons (i.e. the subject site).

- The base, underlying survey used in the hydraulic model appears to be taken prior to the extensive roadworks and intersection upgrades undertaken over the last 5 years. These works significantly impact flood behaviour at the subject site and do not appear to be included in the *Coastal Lagoon Catchments Overland Flood Study (2020).*

Summarily, the *Coastal Lagoon Catchments Overland Flood Study (2020)* cannot be directly applied at the site.

3. PRE-DEVELOPMENT HYDRAULIC MODELLING

3.1. HYDROLOGY MODEL DEVELOPMENT

A WBNM model has been created for this study, to determine peak flows at the subject site for all events up to and including the PMF. WBNM is an advanced storage-routing model that allows simulation of complex catchment behaviour. Further details of the models capabilities are available in the Research & Development section of www.rienco.com.au. This particular model was considered most appropriate to the task of modelling the study area, given its ability to simulate a wide range of catchment characteristics and its extensive use in the region. The model allowed flows to be established at various locations of interest throughout the model domain.

Model parameters used in WBNM are consistent with locally derived parameters in calibrated and validated WBNM models, and are deemed appropriate for use in this study. A single design rainfall gauge was extracted from the Bureau of Meteorology design IFD system, and all catchment parameters downloaded from the ARR datahub for the catchment centroid. A detailed catchment plan is included as **Appendix B**.

3.2. HYDRAULIC MODEL DEVELOPMENT

3.2.1. Model Grid Construction

The model grid was established as a 2m grid across the entire model domain. The most current ALS data was used exclusively to extract elevation data to the TUFLOW grid. The model grid extent is described in **Figure 3.2-1**.

3.2.2. Model Topography Patches

Only one elevation patch was made in the model, being the patching of the full extent of ground survey as shown in **Appendix A**.

3.2.3. Model Boundary Conditions

In terms of inflow boundary conditions, inflow hydrographs were directly input from the WBNM model results. The inflow hydrographs were taken from WBNM and include all subareas upstream of, and within, the subject site. The downstream boundary condition is sufficiently downstream of the subject site to allow flood behaviour at the site to be satisfactorily determined, and is located well downstream of the Terrigal Drive. The downstream boundary reflects the peak water surface level in the lagoon for each event, as published in the *Coastal Lagoon Catchments Overland Flood Study (2020)*.

3.2.4. Model Structures

The following structures were included in the hydraulic model. Their details were taken from the ground survey (where available) or based on site measurements taken by the author.

- Culvert Under Terrigal Drive (downstream of site) – Rectangular culvert having 4 x 4.0 metres (w) x 1.4m (h) cells, and an invert level of RL +2.5m AHD
- Culvert under Charles Kay Drive (upstream of site) - Rectangular culvert having 1 x 3.0 metres (w) x 1.85m (h) cells, and an invert level of RL +3.0m AHD
- Culvert Under Terrigal Drive (west of playing fields) - Circular culvert having 5 x 900mm (diameter) cells, and an invert level of RL +6.0m AHD

Figure 3.2-1 TUFLOW Grid and Boundary Condition Details

Note: TUFLOW 2m domain shown as red line. Inflow hydrograph BC's shown as blue lines, downstream BC shown as orange lines. Subject site is shown indicatively denoted. Structures are shown indicatively in yellow.

3.2.5. Model Surface Roughness

Manning's surface roughness 'n' values were taken from a detailed site inspection and the typical roughness values associated with those surfaces. **Table 3.2-1** describes the surface characteristics and the associated roughness values.

Table 3.2-1 – Manning's Surface Roughness Values

Surface Description	Assigned 'n' value in TUFLOW
Pavement	0.020
Short, Maintained Grass	0.035
Implicitly Fenced Urban Lots	0.075
Dwellings	1.000
Dense Vegetation	0.150

Figure 3.2-2 describes the surface roughness mapping.

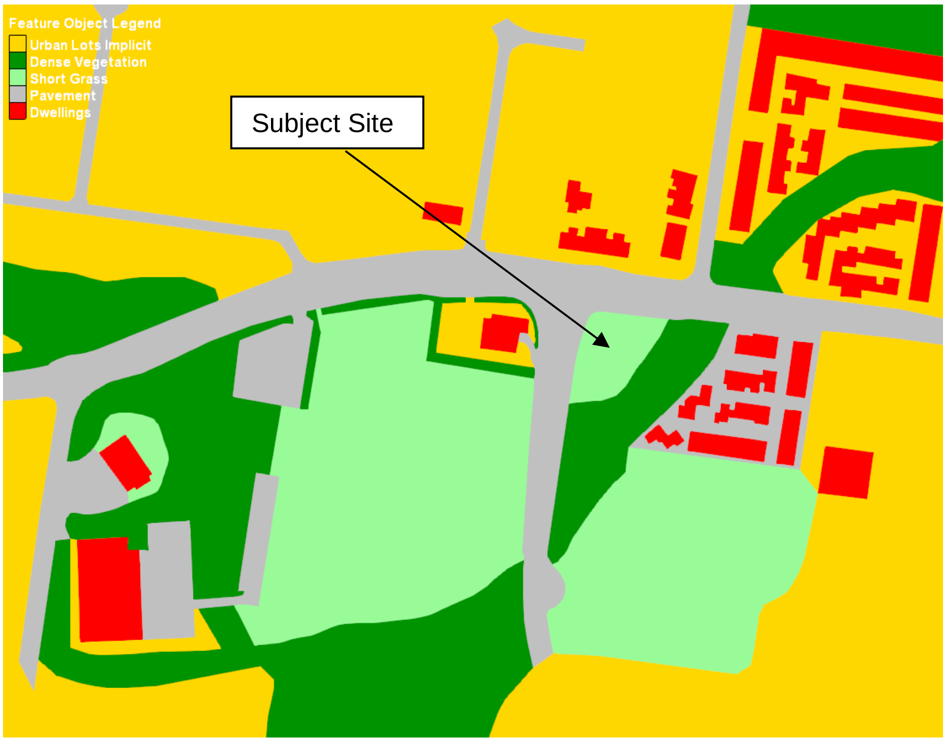


Figure 3.2-2 Pre-Development Manning's Surface Roughness Map

3.3. HYDRAULIC MODEL RESULTS

The model was run for the 20% AEP, 1% AEP and PMF design events. A summary of the model results is described below in **Figure 3.3-1**. A full detailed set of model results is included as **Appendix C**.

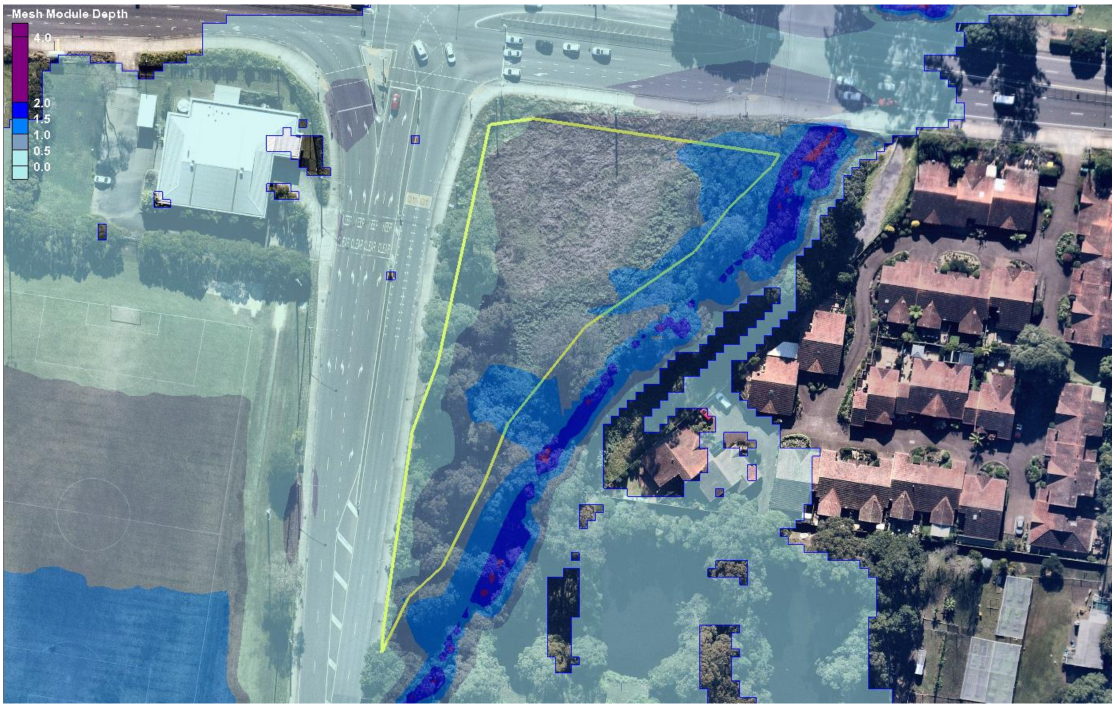


Figure 3.3-1 1% AEP Pre-Development Flood Extent and Depths

Note: Flood depths shaded 0 mm (light blue) to 4,000 mm (dark blue). All depths greater than 2,000 mm are all shaded dark blue. Subject site shown in yellow.

As can be seen in **Figure 3.3-1**, the peak 1% AEP flood depths vary across the site. Towards the creek and within the site (noting that the bed of the watercourse is not on the site) peak 1% AEP flood depths reach 1.5 metres. However, in the vicinity of the site where development is proposed, 1% AEP flood depths range from 400 mm to 900 mm. In the Probable Maximum Flood (PMF) event, peak depths range from 1,600 mm to 2,500 mm in the vicinity of the site where development is proposed.

4. POST-DEVELOPMENT HYDRAULIC MODELLING

4.1. HYDRAULIC MODEL DEVELOPMENT

The TUFLOW input files were modified to simulate the post-development scenario, by including the proposed building (total extent of built form) as a geometry modification. Externally open space areas at the ground floor level were set to RL +5.8m AHD, and all other built form elements extended to above the PMF level.

4.2. HYDRAULIC MODEL RESULTS – POST DEVELOPMENT

The model was run for the 20% AEP, 1% AEP and PMF design events. A summary of the model results is described below in **Figure 4.2-1**. A full detailed set of model results is included as **Appendix C**.

As can be seen in **Figure 4.2-1**, the peak 1% AEP flood is conveyed through the site in materially the same manner as it does pre-development. All ground floor areas of the development are well above the 1% AEP peak flood surface levels.

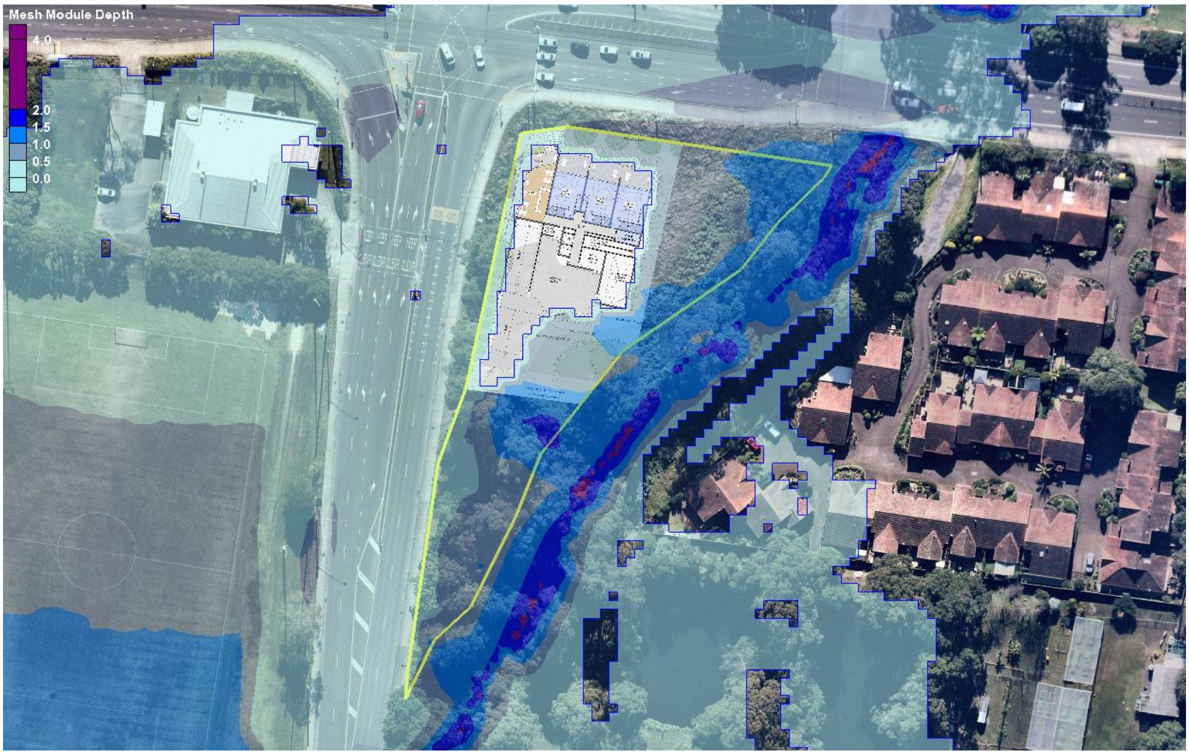


Figure 4.2-1 1% AEP Post-Development Flood Extent and Depths

Note: Flood depths shaded 0 mm (light blue) to 4,000 mm (dark blue). All depths greater than 2,000 mm are all shaded dark blue. Subject site shown in yellow.

5. ADDITIONAL ANALYSIS OF HYDRAULIC MODEL RESULTS

5.1. DEVELOPMENT RELATED IMPACTS ON FLOOD BEHAVIOUR

Figure 5.1-1 describes the impacts on peak flood surface levels in the 1% AEP event, in terms of increases and decreases to peak flood surface levels. A detailed map of these impacts is included in **Appendix C**.

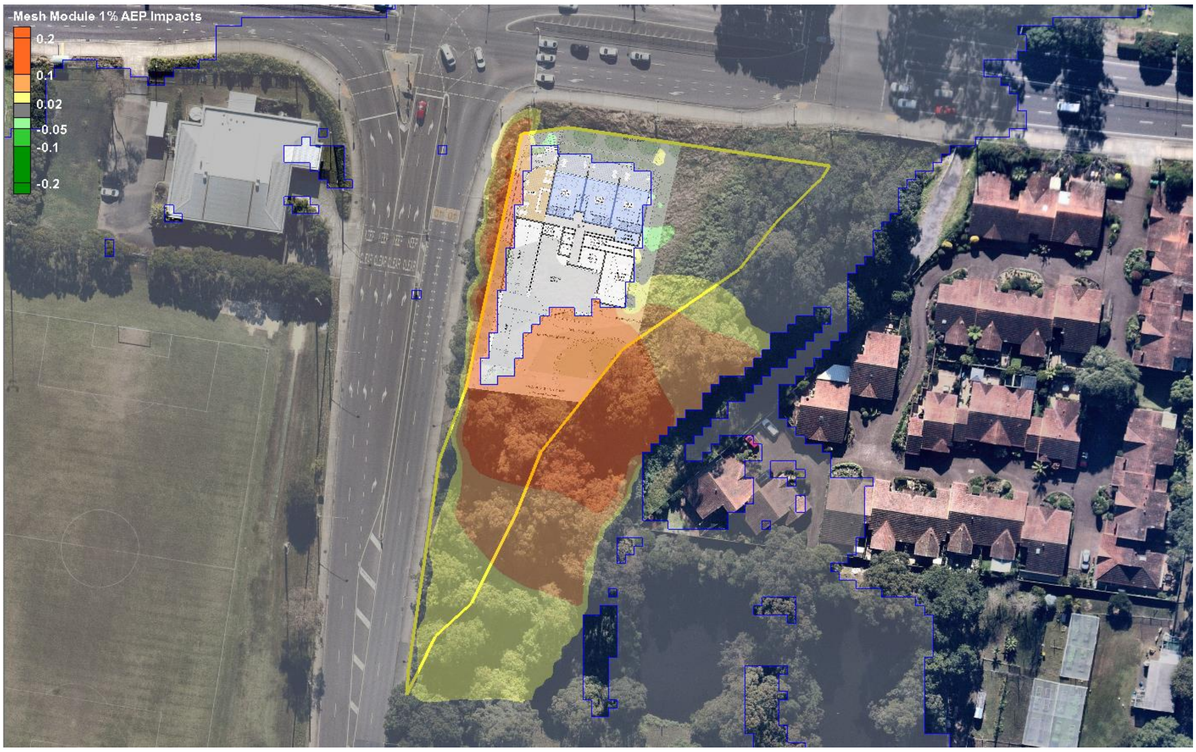


Figure 5.1-1 1% AEP Peak Flood Surface Level Impacts

The impacts resulting from the proposed development are generally isolated to the subject site or the adjoining RE1 zoned watercourse. There is a minor increase in peak flood surface levels adjacent to Terrigal Drive. However, the peak increase is 12 mm, which is only 2 mm above the notional threshold in CCC's DCP. This impact does not affect the trafficability of Terrigal Drive and would only exceed the DCP threshold for a matter of minutes in a 1% AEP event. Further, it is probable that this impact could be reduced further with additional detailed design.

This impact is considered, therefore, to be meritorious in particular where the DCP is applied flexibly, as mandated at S4.15(3A)(b) of the EPA Act. As can be concluded after careful consideration of the model results, the proposed development has no material effect on flood behaviour downstream of the site.

5.2. FLOOD HAZARD

The *Coastal Lagoon Catchments Overland Flood Study (2020)* identifies hazard on the basis of the Technical flood risk management guideline: Flood hazard (Australian Institute for Disaster Resilience, 2012). This shows how flood depths, velocities and depth-velocity product threaten the stability of vehicles, pedestrians and buildings. This guidance identifies six categories (H1 to H6) and is shown in **Figure 5.2-1** below.

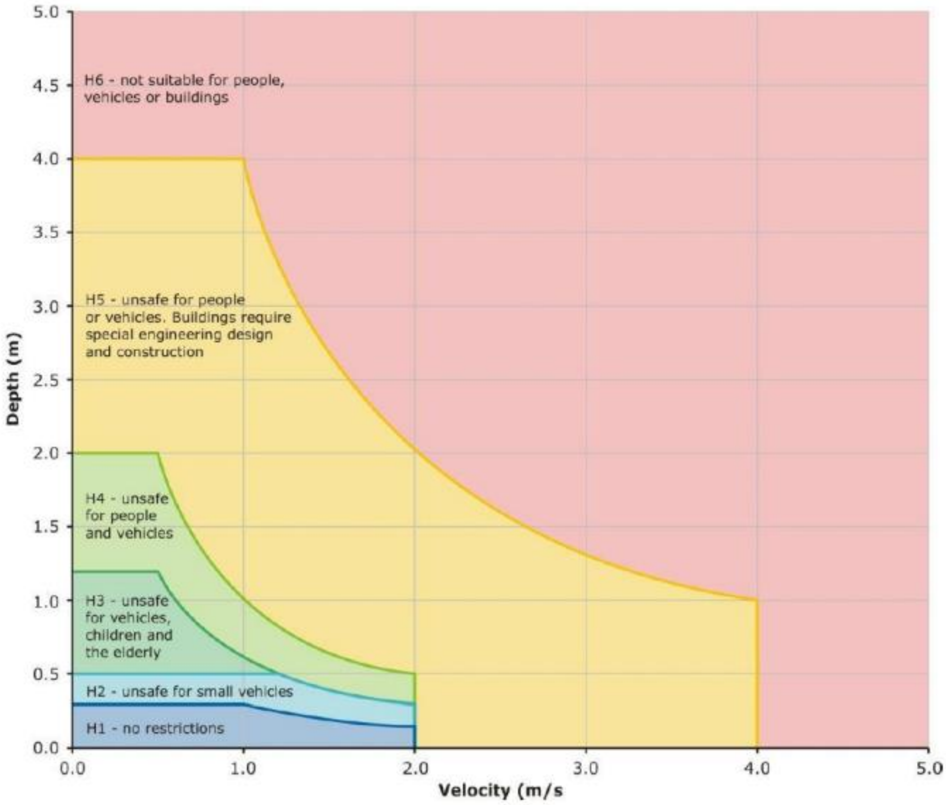


Figure 5.2-1 Flood Hazard Guidelines

Figure 5.2-2 and **Figure 5.2-3** show the pre- and post-development hazard categories across the site and surrounds respectively. The portion of the site where development is proposed is predominantly H3, and it can be interpreted that the development does not affect flood hazard off the site.

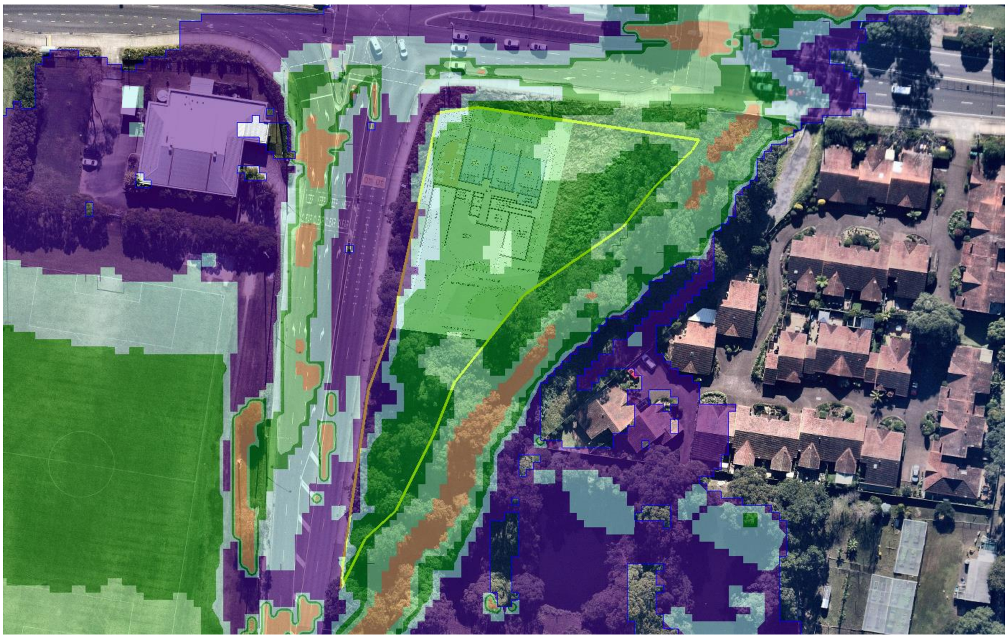


Figure 5.2-2 1% AEP Pre-Development Flood Hazard

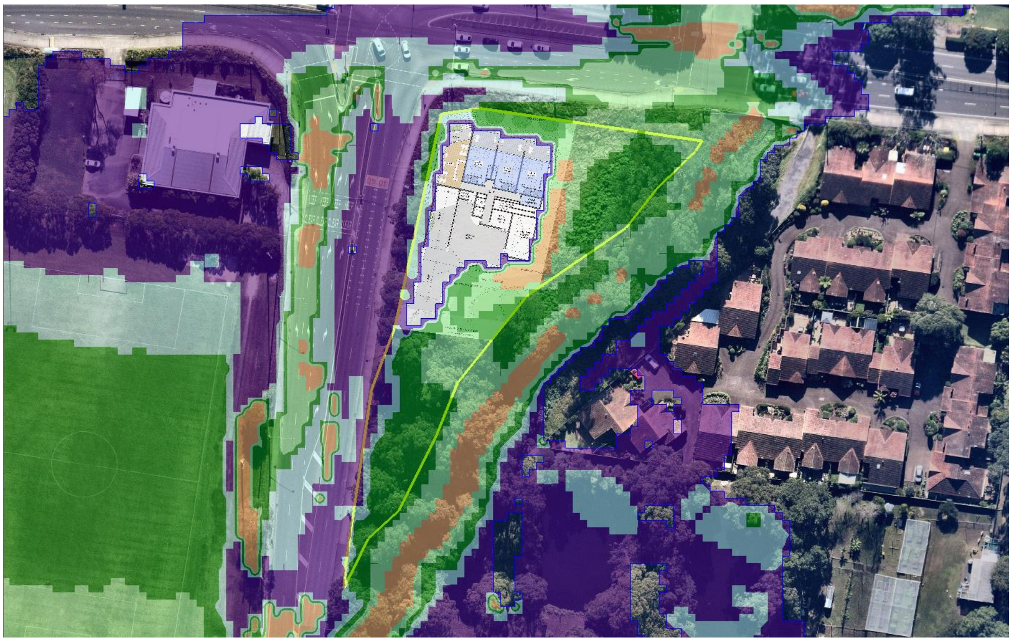


Figure 5.2-3 1% AEP Post-Development Flood Hazard

5.3. FLOOD FUNCTION

The *Coastal Lagoon Catchments Overland Flood Study (2020)* identifies that The Australian Disaster Resilience Handbook (Australian Institute for Disaster Resilience, 2017) describes the following three hydraulic categories of flood-prone land, being Floodway, Flood Storage or Flood Fringe. As noted in the *Coastal Lagoon Catchments Overland Flood Study (2020),* these qualitative descriptions do not prescribe specific thresholds for determining the hydraulic categories in terms of model outputs, and such definitions may vary between floodplains depending on flood behaviour and associated impacts. For the purposes of the *Coastal Lagoon Catchments Overland Flood Study (2020)*, hydraulic categories have been defined as

- Floodway - Velocity x Depth > 0.25 m^2/s
- Flood Storage - Depth > 0.5 m, Not Floodway
- Flood Fringe - Depth < 0.5 m, Not Floodway or Flood Storage

Whilst we these thresholds are exceptionally low, we have adopted these values for this report in an attempt to provide overall consistency with CCC's adopted position on flood function. On that basis, **Figure 5.3-1** below summarises the flood function of the site, based on the above criteria. In **Figure 5.3-1**, all areas shaded red are designated as a floodway, and all areas shaded green are either flood storage or flood fringe.

It can be seen from **Figure 5.3-1** that for the portion of the site where development is proposed, the area functions predominantly as a floodway, with a small area of flood fringe at the western boundary. **Figure 5.3-2** shows the post-development flood function. It can be seen from **Figure 5.3-2** that the proposed development generates no plausible change to the flood function of the site, or other adjoining sites.

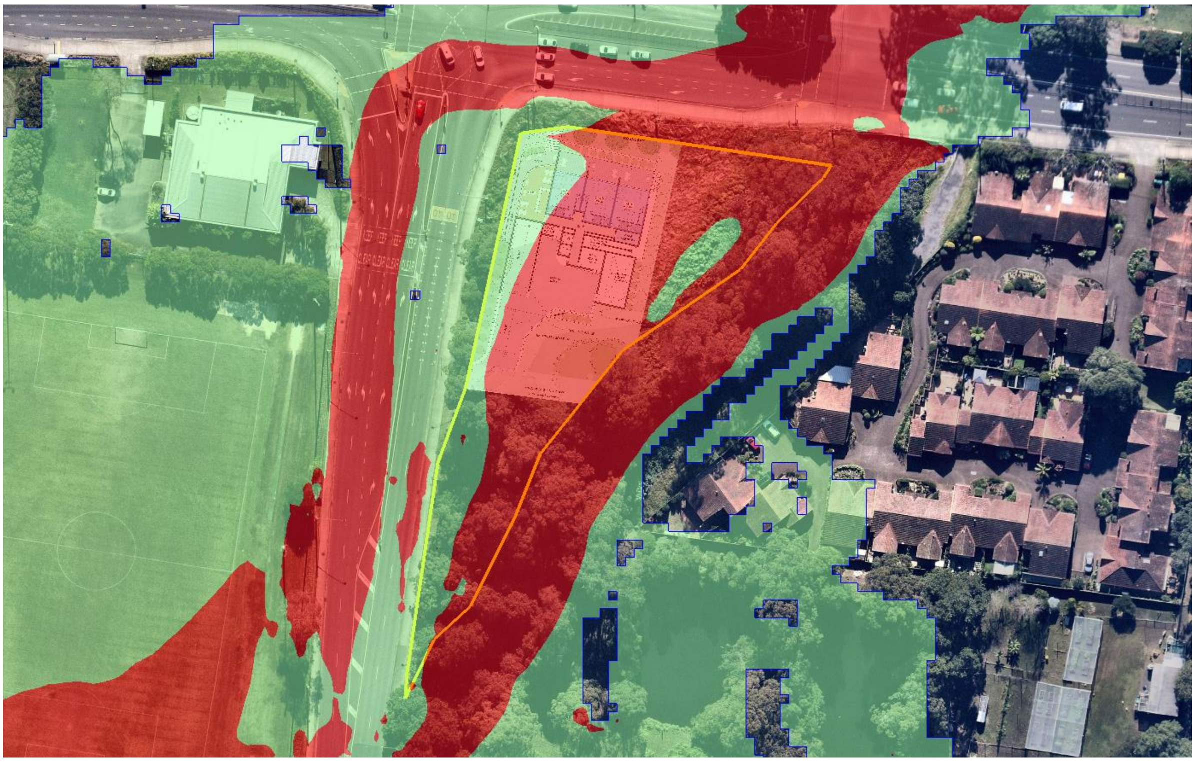


Figure 5.3-1 1% AEP Pre-Development Flood Function

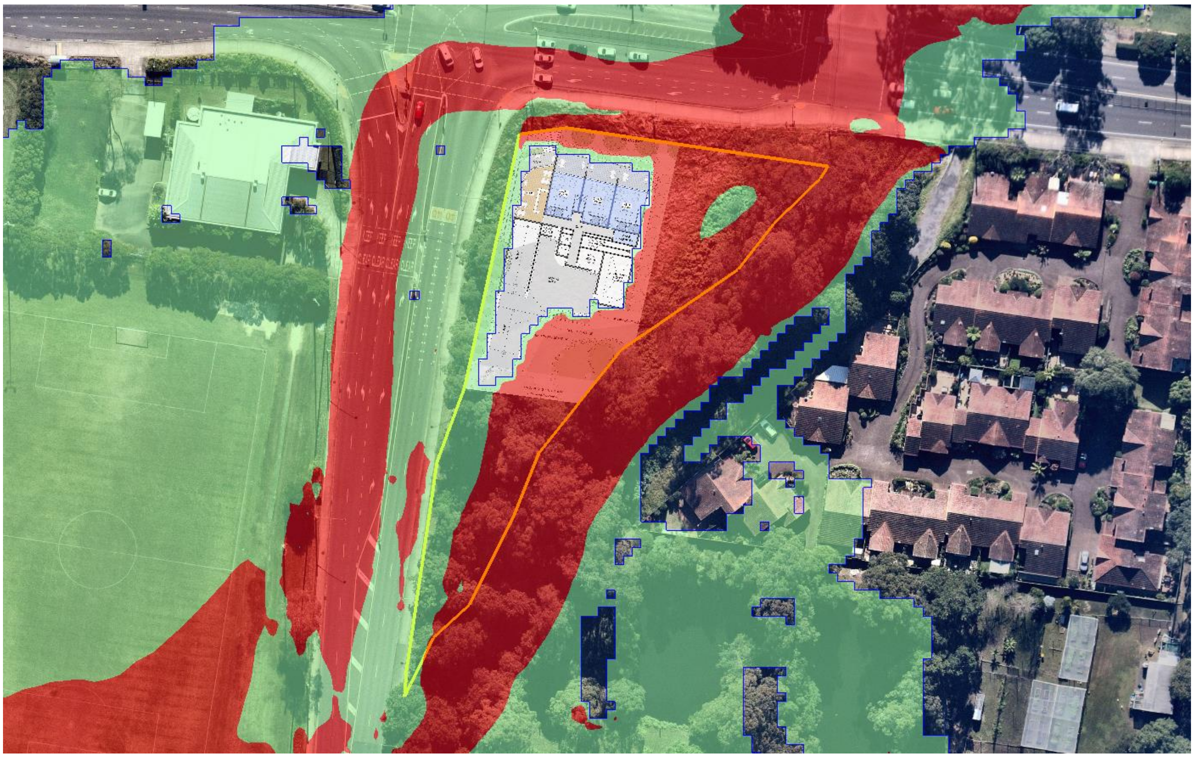


Figure 5.3-2 1% AEP Post-Development Flood Function

6. DEVELOPMENT ASSESMENT

6.1. REQUIREMENTS OF SECTION 9.1 DIRECTION

As the subject site is susceptible to the PMF event, it is defined under NSW legislation as 'Flood Prone Land'. This definition is consistent with the NSW Government's Floodplain Development Manual (2005). As the site is defined as Flood Prone Land, the Section 9.1 Direction (Section 4.3) applies to development on the subject site.

The Ministerial Section 9.1 Direction provides certain objectives and direction on what a relevant planning authority must do if this direction applies. **Table 6.1-1** describes each aspect of the Section 9.1 direction, and advice on how the proposed development already complies, or what design aspects can be incorporated into the development to ensure compliance with the Section 9.1 direction.

Table 6.1-1 – Section 9.1 Direction Requirements

Section 9.1 Requirements	How the Proposal Addresses the Requirement
(1) A planning proposal must include provisions that give effect to and are consistent with: (a) the NSW Flood Prone Land Policy, (b) the principles of the Floodplain Development Manual 2005, (c) the Considering flooding in land use planning guideline 2021, and (d) any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.	The Planning Proposal seeks to amend the Central Coast LEP 2022 by increasing the maximum permissible height of buildings to 30m, and the maximum floor space ratio to 1.4:1
(2) A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Employment, Mixed Use, W4 Working Waterfront or Special Purpose Zones.	The planning proposal does not seek to do this.
(3) A planning proposal must not contain provisions that apply to the flood planning area which: (a) permit development in floodway areas, (b) permit development that will result in significant flood impacts to other properties, (c) permit development for the purposes of residential accommodation in high hazard areas, (d) permit a significant increase in the development and/or dwelling density of that land, (e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors	The Planning Proposal seeks to amend the Central Coast LEP 2022 by increasing the maximum permissible height of buildings to 30m, and the maximum floor space ratio to 1.4:1 Increasing the maximum permissible height of buildings (and therefore, the FSR) does not permit development that is in a floodway or high hazard area any more than the current zone facilitates such development. The Planning Proposal will not result in significant flood impacts to other properties, as quantified in the detailed modelling in this report. The proposal will result in a modest increase in density by 37 dwellings, however noting that residential flat buildings are permitted on the site

housing in areas where the occupants of the development cannot effectively evacuate, (f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent, (g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or (h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	and the proposal would be contained within the footprint that is permitted. Summarily, the planning proposal does not propose: • Development in floodway areas. • Development that will result in significant flood impacts to other properties. • A development which will result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services. • Development to be carried out without development consent. • Significant increase in the development of that land.
(4) A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which: (a) permit development in floodway areas, (b) permit development that will result in significant flood impacts to other properties, (c) permit a significant increase in the dwelling density of that land, (d) permit the development of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate, (e) are likely to affect the safe occupation of and efficient evacuation of the lot, or (f) are likely to result in a significantly increased requirement for government spending on emergency management services, and flood mitigation and emergency response measures, which can include but not limited to road infrastructure, flood mitigation infrastructure and utilities.	As above.
(5) For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.	This report constitutes *a floodplain risk management plan prepared in accordance with the principles and guidelines of the Floodplain Development Manual 2005,* and the planning proposal is in accordance with it.

It can be seen from **Table 6.1-1** that the PP development readily meet the requirements of the Section 9.1 direction.

6.2. REQUIREMENTS OF THE FLOODPLAIN DEVELOPMENT MANUAL

The primary documents used when assessing any development proposal, are in order of weight, the LEP followed by the DCP. It is considered that CCC's DCP 2009 (Part 3.1) contains objectives, design principles and prescriptive controls that are wholly in accordance with the NSW Government's Floodplain Development Manual (2005). As such, compliance with the DCP (as described elsewhere in this report) means compliance with the aims and objectives of the Floodplain Development Manual. As such, there are no additional measures contained within the Floodplain Development Manual that require addressing, beyond those contained within the DCP.

6.3. ADDRESSING CENTRAL COAST LEP CLAUSE 5.21

CCC's Local Environment Plan (LEP) 2022 sets forth its requirements for land for which the LEP applies (i.e. the subject site). **Table 6.3-1** describes each LEP clause in relation to Clause 5.21, and commentary on how the proposed development relates to the requirements of the LEP.

Table 6.3-1 – LEP Requirements Addressed for Proposed Development

LEP Requirement Clause 5.21 (2)	How the Proposal Addresses the Requirement
Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development is compatible with the flood function and behaviour on the land.	The flood function and behaviour has been quantified in this report. The proposed development is within areas of floodway and flood storage, and the proposed development is compatible with those functions as it maintains those functions on the site, via design. It is therefore considered that the consent authority can be satisfied with respect to this clause.
Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties	Impacts on flood behaviour have been quantified in this report for a range of floods, from the 20% AEP to the PMF. The development will not adversely affect design flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties. It is therefore considered that the consent authority can be satisfied with respect to this clause.
Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood	Safe occupation of the land is enhanced by the proposal, as on-site refuge is created. It is therefore considered that the consent authority can be satisfied with respect to this clause.
Development consent must not be granted to development on land the consent authority considers to be within the flood planning area	Appropriate measures to manage risk to life in the event of a flood are achieved when the development includes the prescriptive controls in

unless the consent authority is satisfied the development incorporates appropriate measures to manage risk to life in the event of a flood	the DCP. Principally, this relates to minimum habitable FFL's and a PMF refuge. It is therefore considered that the consent authority can be satisfied with respect to this clause.
Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	The proposed development that interacts with the flood is consistent with the current zoning of the land and does not materially change flood behaviour. Peak flood velocity is changes within portions of the existing adjacent watercourse by ~0.5 m/s in the peak of the 1% AEP design flood. Such a minor impact could not plausibly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses. It is therefore considered that the consent authority can be satisfied with respect to this clause.
LEP Requirement Clause 5.21 (3)	**How the Proposal Addresses the Requirement**
In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the impact of the development on projected changes to flood behaviour as a result of climate change,	The site would be susceptible to increases in rainfall intensity, with peak flood levels likely increasing by a few hundred millimetres. It is not anticipated that the development will impact these changes any further. Therefore, the consent authority can be satisfied that this matter has been sufficiently considered.
In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the intended design and scale of buildings resulting from the development	The design and scale of buildings, insofar as it is appropriate to comment, is consistent with the objectives of the zone. Therefore, the consent authority can be satisfied that this matter has been sufficiently considered insofar as a hydrologist can comment on the design and scale of buildings resulting from the development.
In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,	Appropriate measures to manage risk to life in the event of a flood are achieved when the development includes the prescriptive controls in the DCP. Principally, this relates to minimum FFL's and a PMF refuge. Therefore, the consent authority can be satisfied that this matter has been sufficiently considered.
In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.	There is no need to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding, because they are already located well above the peak 1% AEP flood surface level. The surrounding area is not considered under any material threat from coastal erosion.

	Therefore, the consent authority can be satisfied that this matter has been sufficiently considered.

It can be seen from **Table 6.3-1** that the proposed development meets or exceeds CCC's LEP requirements.

6.4. ADDRESSING CENTRAL COAST LEP DCP PART 3.1

CCC's Development Control Plan (DCP) 2022 sets forth its requirements for land for which the DCP applies (i.e. the subject site).

Part 3.1.11.6 of the DCP is titled 'Flood Targets' and provides objectives and flood-related development controls for development on the floodplain. Table 4 of the DCP provides a characterised 'use' for various developments, for which 'Commercial/Industrial' and 'Residential' apply to the proposed development. Specifically, it is only the commercial and three residential spaces that interact with the flood, as the majority of residential areas are significantly higher than the PMF level. Notwithstanding, the prescriptive controls for both uses are near identical and have been synthesises for the purposes of this assessment.

Table 6.4-1 describes each DCP requirement in relation to the proposed development, and commentary on how the proposed development relates to the requirements of the DCP.

Table 6.4-1 – DCP Requirements Addressed for Proposed Development

DCP Requirement	How the Proposal Addresses the Requirement
Floor Levels Habitable floor levels are to be above the FPL for all new structures	All habitable floor levels are above the 1% AEP plus 500mm level (i.e. the Flood Planning Level). The peak 1% AEP flood surface level adjacent to the café and ground floor residential floors is RL +4.1m AHD, and the FFL is RL +5.8m AHD. The development thus meets this control.
Flood Impacts The development must not: ▪ Affect the safe occupation of any flood prone land. ▪ Be sited on the land such that flood risk is increased. ▪ Adversely affect flood behaviour by raising predevelopment flood level by more than 10mm. ▪ Result in an increase in the potential of flooding detrimentally affecting other development or properties. ▪ Significantly alter flow distributions and velocities to the detriment of other properties or the environment of the floodplain. ▪ Significantly and detrimentally affect the floodplain environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of any riverbank or watercourse.	The development enhances the safe occupation of the land, via a suitable shelter. As demonstrated by the detailed modelling in this report, flood risk or hazard is not increased as a result of the proposal. There are no additionally flood affected lots as a result of the development. The development does not alter flow distributions and velocities to the detriment of other properties or the environment of the floodplain. Peak changes in levels are 12 mm and peak changes in velocity are ~0.5 m/s in the 1% AEP design flood. The development will not result in unsustainable social and economic costs to the flood affected community or general community as a consequence of flooding, as flood damages will be minimal due to the use of flood compatible materials and the FFL and basement controls.

▪ Be likely to result in unsustainable social and economic costs to the flood affected community or general community as a consequence of flooding (including: damage to public property and infrastructure, such as roads, stormwater, water supply, sewerage, and utilities). ▪ Be incompatible with the flow of floodwaters on flood prone land (considering any structures, filling, excavation, landscaping, clearing, fences, or any other works). ▪ Cause or increase any potential flood hazard (considering the number of people, their frailty, as well as emergency service and welfare personnel).	The proposed development does not change the trafficability or hazard on Terrigal Drive or cause an increase in flood hazard for other sites. The development thus meets this control.
Access and Parking in 100 year ARI Flood Event All access roads and driveways, and external parking areas to be above the 100 year ARI Flood Level (FPL less 0.5m) to provide the ability to safely receive and evacuate occupants or contents without having to cross floodwaters in most flood events (assuming 50% blockage of any pipes, culverts or bridges).	All internal manoeuvring areas and carparking areas (including the basement) are well above the 1% AEP peak flood level. The development thus meets this control.
Fencing Fencing within a floodway will not be permissible except for security/ permeable/ open type/ safety fences of a type approved by Council. Fencing in certain areas may also be restricted by current Floodplain Risk Management Plans.	Any proposed fencing can readily comply with this control and this could be conditioned with the development consent. The development thus meets this control.

It can be seen from **Table 6.4-1** that the proposed development meets or exceeds CCC's DCP requirements.

6.5. ADDRESSING PRELIMINARY ASSESSMENT NOTES ON PP

CCC's flood assessment officers made comment on the PP after a review of the proposal at a pre-lodgement meeting. These assessment notes were made available to the applicant, and they have been forwarded to Rienco. **Table 6.5-1** describes each comment made in the assessment notes in relation to stormwater and flooding, and includes comments on how the PP responds to the issue, in either this report, or by the project as a whole.

Table 6.5-1 – Summary of Assessment Notes and Responses

Matter Raised in CCC's Current Assessment of the Proposal	How the Matter has been integrated into this report / the proposal
The consultant has elected to undertake a new Hydrological and 2D Hydraulic Flood Study in lieu of the adopted Coastal Lagoons Overland Flood Study 2020 for the purpose of the assessment. The consultant has provided valid reasons for undertaking the new Flood Study and these reasons are understandable. The methodology and assumptions for the purpose of the study are acceptable. Does the	The downstream lagoon levels have been used as the tailwater level in the Rienco modelling. These levels are well below the peak flood levels on the site and do not influence design flood behaviour at the site.

downstream Lagoon level during a 1%AEP event influence flood levels at this location? Is it reasonable not to consider the tailwater from the model?	
The consultant states that the 1%AEP impact is not considered to be adverse, significant or detrimental. The result mapping appears to show the impact on the roadway to be somewhere between 0.02 and 0.05m. It is generally accepted that a development shall have a flood impact of no more than 0.01m during the 1%AEP event. The design should be revisited to reduce the impact on the roadway to be no more than 0.01m.	The design was revisited and the peak impact has now been reduced to 12 mm. This impact has been fully justified in **Section 5.1** of this report.
The building obstruction significantly increases the velocity of water to the west of the building. The building results in a flow path with velocity of over 4m/s traveling north through the site before discharging onto Terrigal Drive. In the opinion of the consultant does this result in an increased flood risk to people or property compared to the existing. Can the design be modified to reduce the velocity impact caused by the building?	The design was revisited and the peak impact has now been reduced to ~0.5 m/s at the peak of the 1% AEP design flood. Such changes to peak velocity could not plausibly cause any increase in scour, erosion or hazard.
The consultant states that the basement carpark access is designed for access to be above the 1% AEP surface level. For new basement carparks Council requires that the driveway crest shall be at the PMF level to ensure that the basement will not inundate. Can this be achieved at this location?	DCP (Part 3.1) does not specify the PMF as the standard for inundation of basement carparks. Ensuring the basement entrance, as well as all basement entries (i.e. ventilation points, stairwell and lift access etc) is above the PMF is beyond the standard in the DCP. Nonetheless, the proposal achieves this.
It is noted that the consultant proposes shelter in place during the 1% AEP event. What is the duration that the occupants would be isolated due to inundation? An Emergency Response Plan must be submitted with the Planning Proposal. Considering recent flooding recommendations from the NSW Flood Enquiry, flood free evacuation from the site during the 1% AEP event is preferable. Is there a way to ensure flood free evacuation from this site during the 1% AEP event?	For the critical duration 1% AEP design flood, the inundation of the local adjoining road network (to the extent its un-trafficable) is approximately 1 hour. This may be longer for non-critical duration events, but could not plausibly be any longer than 2-3 hours. We appreciate the recommendations from the NSW Flood Enquiry, however it is outside the scope for any development on zoned land to demonstrate flood-free evacuation, on land that is not flood-free or does not have public flood-free roads to begin with. We note that the Terrigal Ambulance Station is located adjacent to the site, and cannot be mobilised during peak flood conditions. It is not logical to require the development to be able to be evacuated, when the ambulance next door can’t even be mobilised. An Emergency Response Plan is provided in **Section 6.6**.

6.6. DEVELOPMENT OF THE SITE EMERGENCY RESPONSE FLOOD PLAN

At the outset, it is not a prerequisite that a Flood Emergency Response Plan requires occupants to be evacuated off site. A site should only be evacuated off site where it is safe to do so, or under guidance from a higher authority (such as the SES) given the particular circumstances on any day. When considering an evacuation strategy, the following aspects are important deliberations:

- Where the duration of flooding is less than a few hours, local Council's and the SES often adopt a 'shelter in place' strategy. The flood behaviour at the subject site fits with this often espoused guideline, as the flood study notes the critical duration event for the site is 2 hours.
- The SES's 'NSW Floodsafe Guide to Flash Flooding' notes that *if you live in an area with a potential for flash flooding, there will be less time for you to act to protect your family* and *property,* and *if you are trapped by rising floodwater, seek refuge in the highest part of a sturdy building*.
- Whether or not there is suitable shelter on site. In the specifics of this site, there is a suitable shelter on site in particular flood events, which is created by the proposed development.
- Duty of Care and the risk of evacuation. Should residents choose to evacuate, there is no guarantee they will get any further than the next intersection, due to unpassable roads that are inundated. Further, it is inappropriate for any evacuation plan to <u>require</u> evacuation, when a suitable shelter in place option exists. Given the risks involved in leaving a known place of safety, and travelling on other inundated roads in the middle of a large and rare rainfall event, any decision to leave the site must be done under the advice of a higher authority.
- Haynes et al (2009) was a key piece of research on 'shelter in place' strategies undertaken by industry and key SES management personnel. It states that *in cases where evacuation may lead to increased exposure to danger and a suitable refuge exists for suitable occupants, sheltering in place may be a better option.*

Based on the above evacuation off site should only occur, and is only proposed, where the SES has ordered it. However, shelter onsite is possible and can occur as proposed in this FERP.

TRIGGER ACTION RESPONSE PLAN (TARP)

A Trigger Action Response Plan (TARP) has been prepared to summarise the emergency response. The following TARP has been developed for the proposal as shown in **Table 6.6-1.**

Table 6.6-1 – Emergency Trigger Action Response Plan (TARP)

Observational Triggers	Normal	Level 1
Inundation	No inundation on site.	Possible inundation on site or actual inundation of the site or adjoining roads.
Actions		
Residents and Occupants	Continue to monitor observational triggers	Continue to monitor observational triggers.

	(including external flood water levels and any information from Council or SES).	Seek shelter within the dwelling or premises. Stay in the dwelling or premises on site as a preference to travelling off site where roads may be inundated. Respond to any direction from the SES.

7. CONCLUSIONS AND RECOMMENDATIONS

Based on the information contained within this report, it can be concluded that:

- The subject site is located at 310 Terrigal Drive, Terrigal and the site is wholly inundated in major design flood scenarios.
- CCC adopted its catchment-wide flood study titled *Coastal Lagoon Catchments Overland Flood Study (2020).* Its results are not applicable to the subject site for quantifying flood behaviour in the pre-development scenario, for the reasons stated in this report.
- A WBNM hydrologic model has been used to determine design flood estimates at the subject site and surrounds.
- A detailed 2D TUFLOW model has been prepared for the subject site and surrounds. Flood behaviour for a range of design floods has been determined for the subject site and surrounds.
- Design flood behaviour has been determined for both the pre- and post-development scenarios, and is quantified in detail in this report.
- The Flood Planning Level for the site is difficult to specify as one level, given the flood gradient across the site. In any case, the Flood Planning Level is determined by the 1% AEP peak flood surface levels in this report plus 500 mm.
- The proposal meets the requirement of the NSW Governments Section 9.1 Direction Clause 4.3, noting that the LEP amendments (i.e. the subject of the rezone) relates to development that is unaffected by flooding.
- The proposal meets the requirements of the Central Coast Council's LEP (2022) Clause 5.21.
- The proposal meets the requirements of the Central Coast Council DCP Part 3.1.11.6
- The proposal addresses the pre-lodgement notes issued by Central Coast Council.
- In an extreme flood event, such as the PMF, future occupants will be safe via their flood free refuge in their homes, which is the preferred approach to managing risk to life from the SES.

Based on the information contained within this report, it is recommended this report is included in the submission to CCC for the proposed development.

Prepared by:

Anthony Barthelmess
Dip. Eng, MEng. MIEAust CPEng RPEQ NER
Managing Director

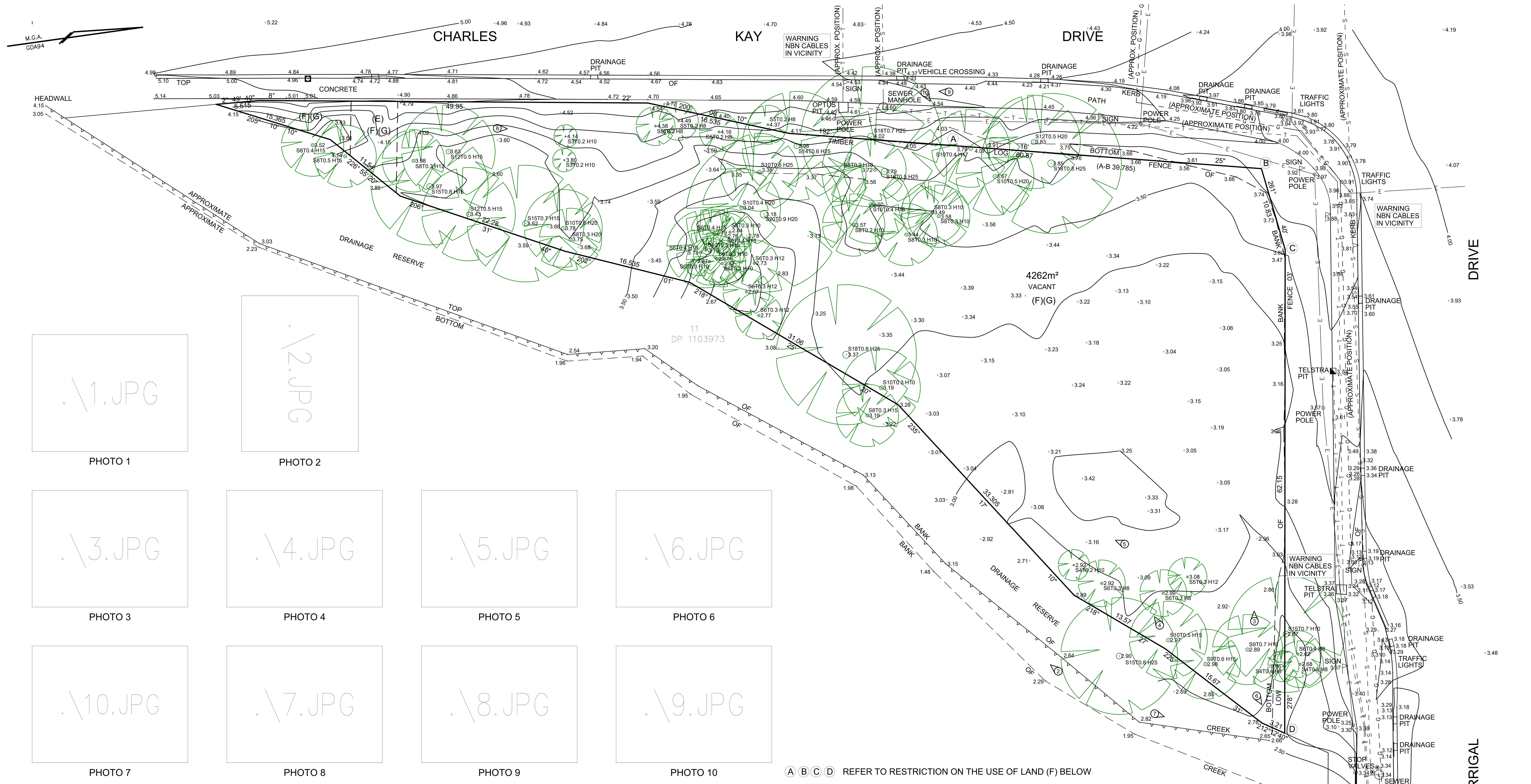
Abbreviations

	Abbreviation Description
AEP	Annual Exceedance Probability; The probability of a rainfall or flood event of given magnitude being equalled or exceeded in any one year.
AHD	Australian Height Datum: National reference datum for level
ALS	Air-borne Laser Scanning; aerial survey technique used for definition of ground height
ARI	Average Recurrence Interval; The expected or average interval of time between exceedances of a rainfall or flood event of given magnitude.
AR&R	Australian Rainfall and Runoff; National Code of Practice for Drainage published by Institution of Engineers, Australia, 1987.
EDS	Embedded Design Storm; synthesised design storm involving embedment of an AR&R design burst within a second design burst of much longer duration
FPDM	Floodplain Development Manual; Guidelines for Development in Floodplains published by N.S.W. State Government, 2005.
FSL	Flood Surface Level;
GIS	Geographic Information Systems; A system of software and procedures designed to support management, manipulation, analysis and display of spatially referenced data.
IFD	Intensity-Frequency-Duration; parameters describing rainfall at a particular location.
ISG	Integrated Survey Grid; ISG: The rectangular co-ordinate system designed for integrated surveys in New South Wales. A Transverse Mercator projection with zones 2 degrees wide (Now largely replaced by the MGA).
LEP	Local Environment Plan; plan produced by Council defining areas where different development controls apply (e.g. residential vs industrial)
LGA	Local Government Area; political boundary area under management by a given local council. Council jurisdiction broadly involves provision of services such as planning, recreational facilities, maintenance of local road infrastructure and services such as waste disposal.
MGA	Mapping Grid of Australia; This is a standard 6° Universal Transverse Mercator (UTM) projection and is now used by all states and territories across Australia.
MHI	Maximum Height Indicator; measuring equipment used to record flood levels
PMF	Probable Maximum Flood; Flood calculated to be the maximum physically possible.
PMP	Probable Maximum Precipitation; Rainfall calculated to be the maximum physically possible.
RCP	Reinforced Concrete Pipe;
km	Kilometre; (Distance = 1,000m)
m	Metre; (Basic unit of length)
m^2	Square Metre; (Basic unit of area)
ha	Hectare; (Area =10,000 m2)
m^3	Cubic Metre; (Basic unit of volume)
m/s	Metres/Second; (Velocity)
m^3/s	Cubic Metre per Second; (Flowrate)
s	Second; (basic unit of time)

Technical Terms

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

APPENDIX A – SITE SURVEY



(A) (B) (C) (D) REFER TO RESTRICTION ON THE USE OF LAND (F) BELOW

(E) EASEMENT TO DRAIN WATER 6m WIDE (VIDE DP 1264687)
(F) RESTRICTIONS ON USE OF LAND (VIDE DP 1264687)
(G) EASEMENT FOR NOISE, DUST & VIBRATION AFFECTING THE WHOLE OF THE LAND (VIDE DEALING AQ641042)

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

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

PLEASE NOTE:

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

Legend:
OVERHEAD ELECTRICITY, POWER POLE
GAS
TELECOM, PIT
SEWER, LAMPHOLE
TOP OF BANK
EXISTING SURFACE CONTOUR — 2.00
PHOTO NUMBER & DIRECTION (SEE SHEET 2 FOR PHOTOS)

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

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

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

www.dialbeforeyoudig.com.au
DIAL1100 BEFORE YOU DIG

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

DATE	NO.	REVISION DESCRIPTION

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

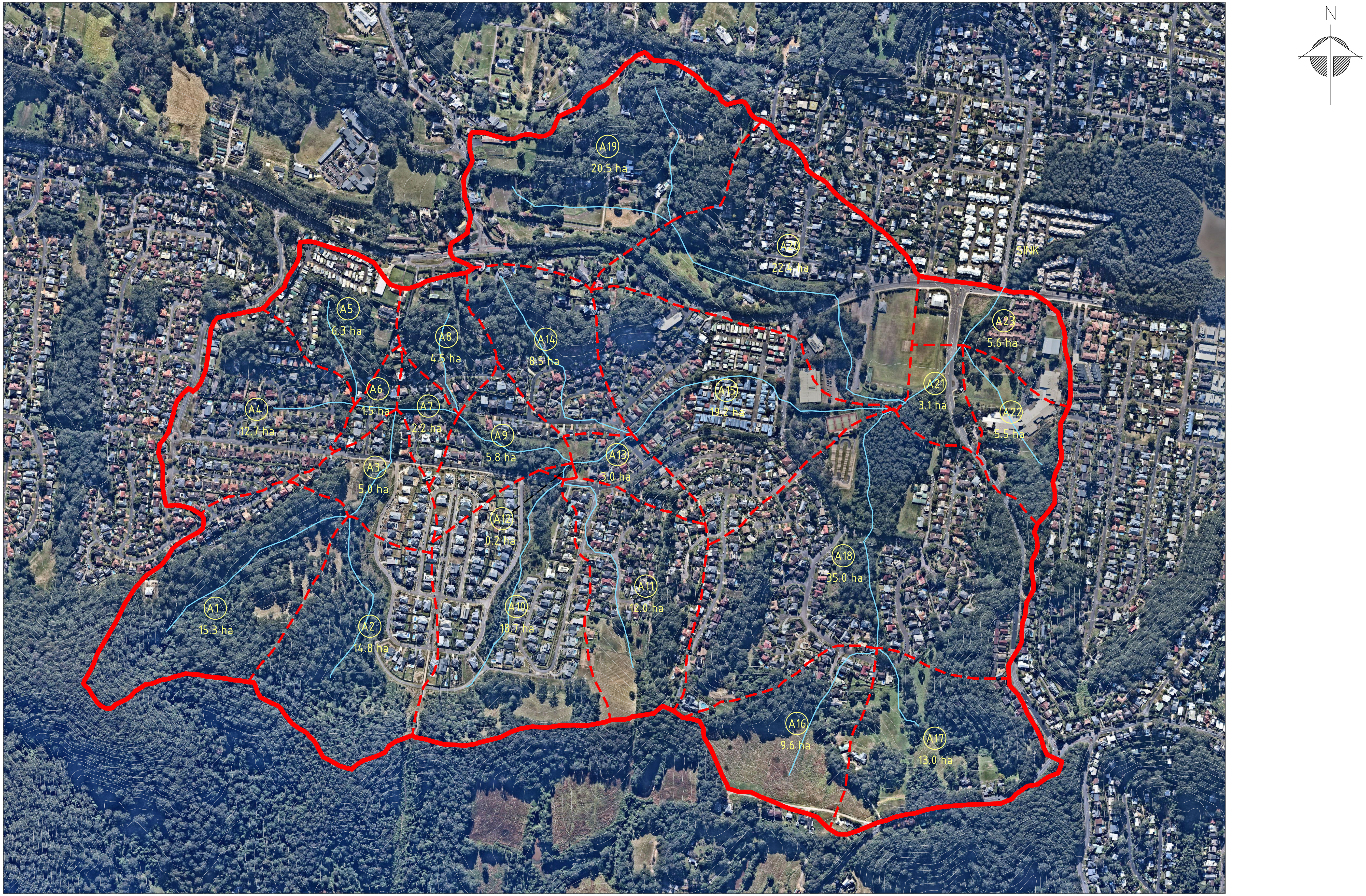
Client: LOFTUSLANE CAPITAL PARTNERS

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

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

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

APPENDIX B – WBNM CATCHMENT PLAN



ISSUE:	DESCRIPTION:	DATE:	BY:
A	ISSUED FOR COORDINATION	Aug '22	AB

RIENCO CONSULTING
Providing Specialist Services in Hydrology and Hydraulics
PO BOX 3094, AUSTINMER NSW 2515
www.rienco.com.au

TITLE: WBNM CATCHMENT PLAN

CLIENT: LoftusLane Capital

LOCATION: 310 Terrigal Drive, Terrigal

DRG No:	SCALE:	DRAWN BY:	REVISION:
1001	NTS	AB	A

APPENDIX C – DETAILED MODEL RESULTS

APPENDIX C1 – 20% AEP MODEL RESULTS – PRE-DEVELOPMENT

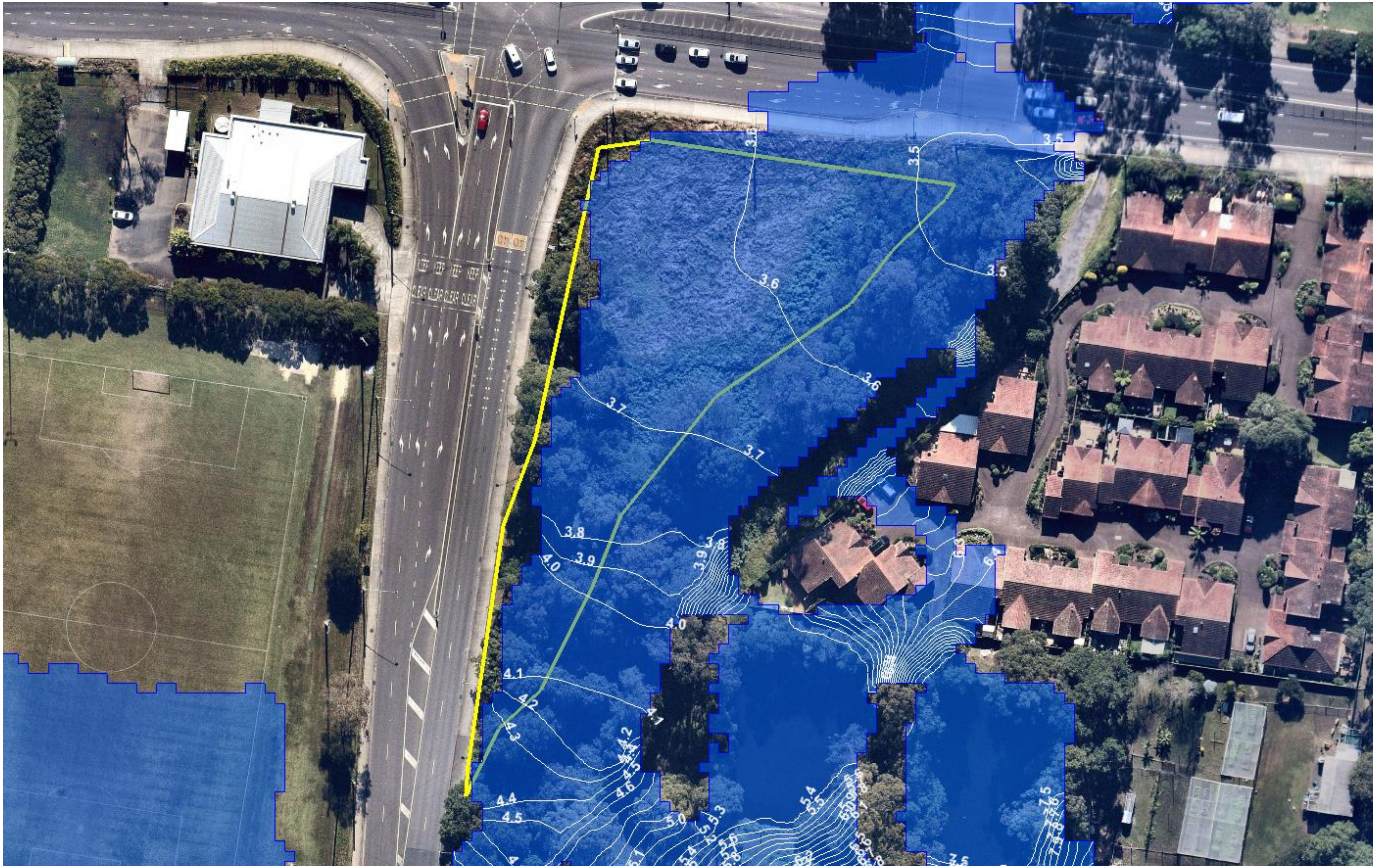


Figure C1.1: 20% AEP Flood Levels – Pre-Development

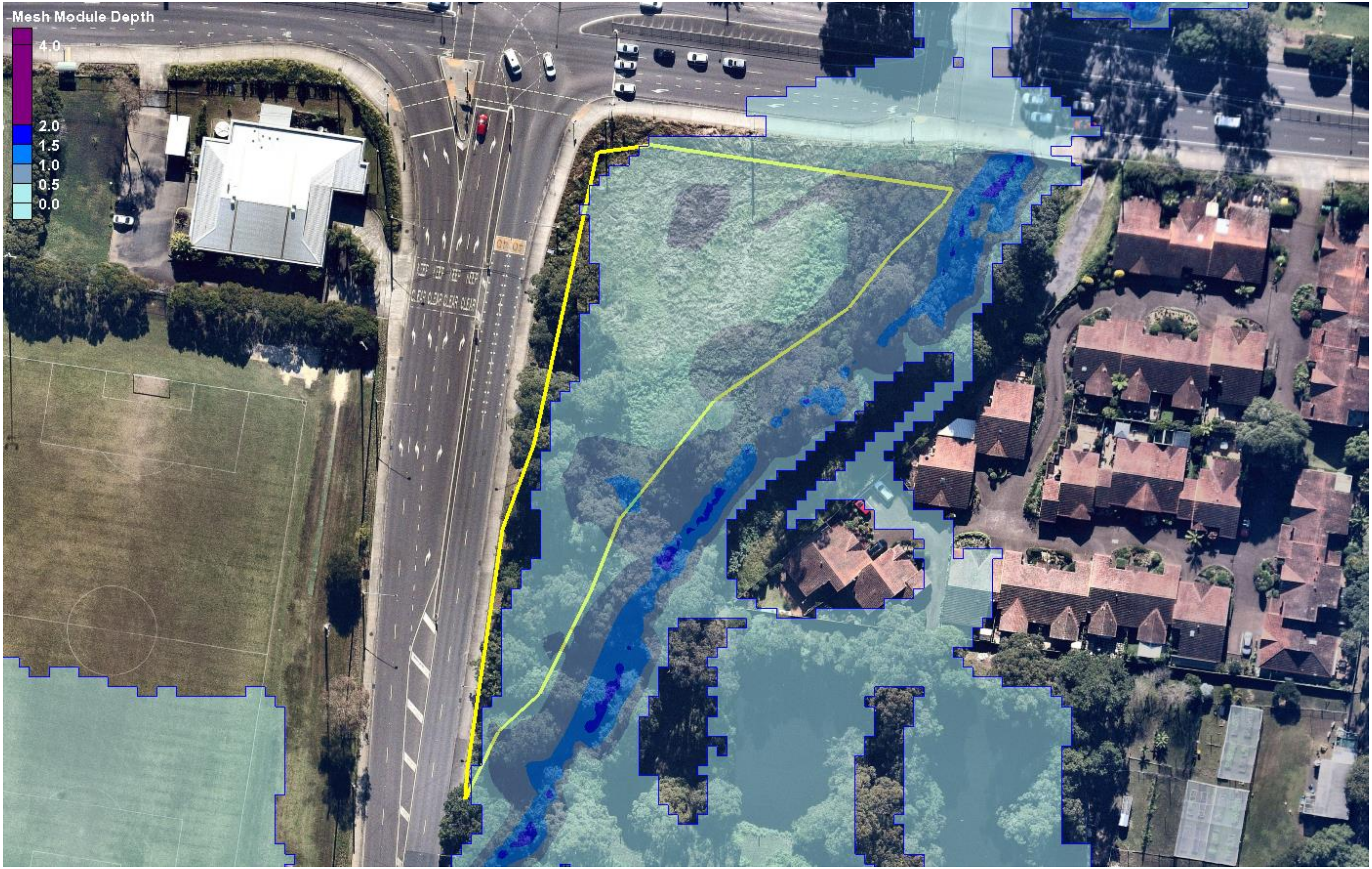


Figure C1.2: 20% AEP Flood Depths – Pre-Development

Note: Flood depths shaded from 0m (light blue) to 4.0m (dark blue). All depths over 2.0m shaded dark blue.

Figure C1.3: 20% AEP Flood Velocity – Pre-Development

Note: Flood velocity shaded from 0 m/s (yellow) to 4.0 m/s (orange). All velocity over 4.0 m/s shaded orange.

APPENDIX C2 – 20% AEP MODEL RESULTS – POST-DEVELOPMENT

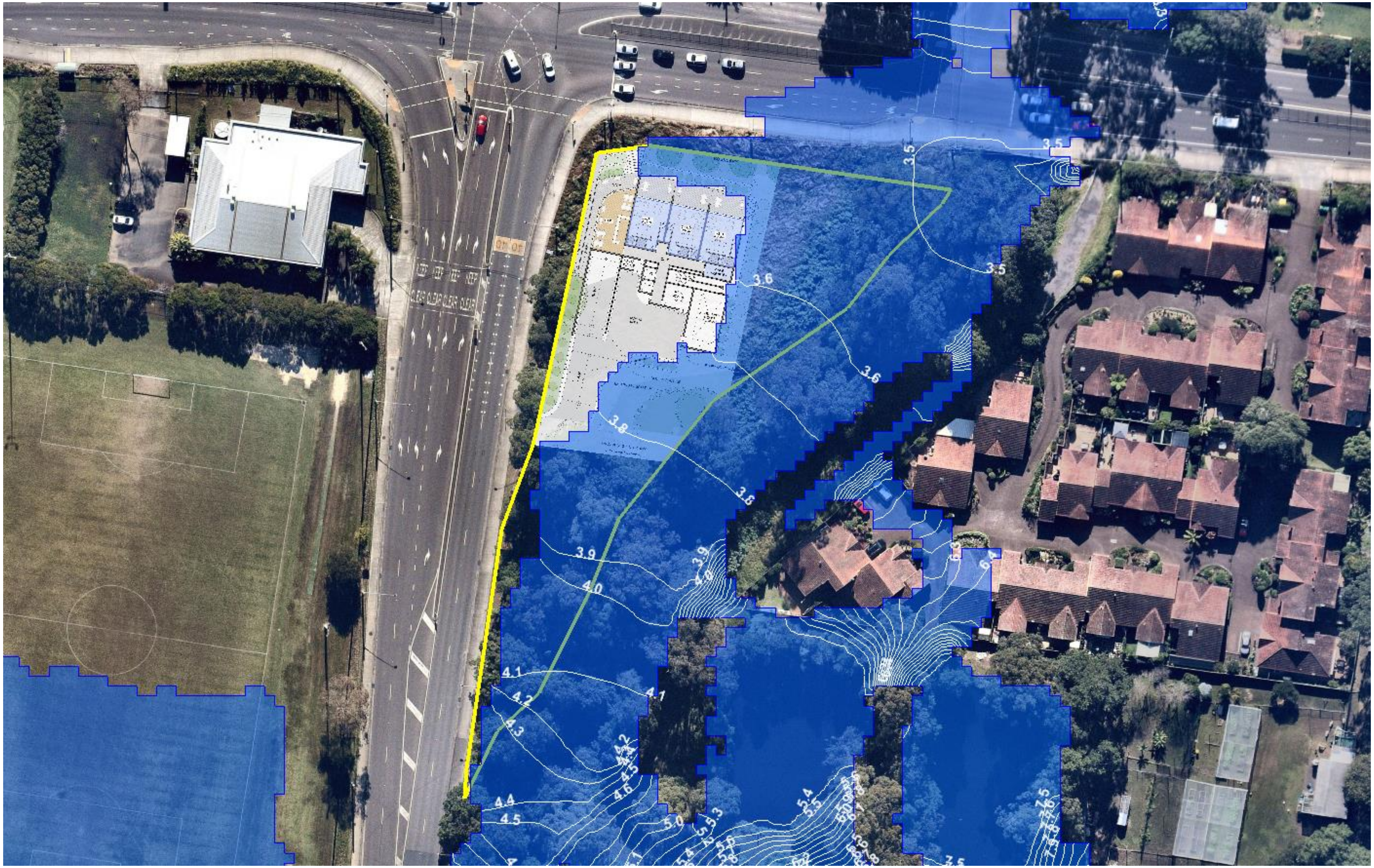


Figure C2.1: 20% AEP Flood Levels – Post-Development

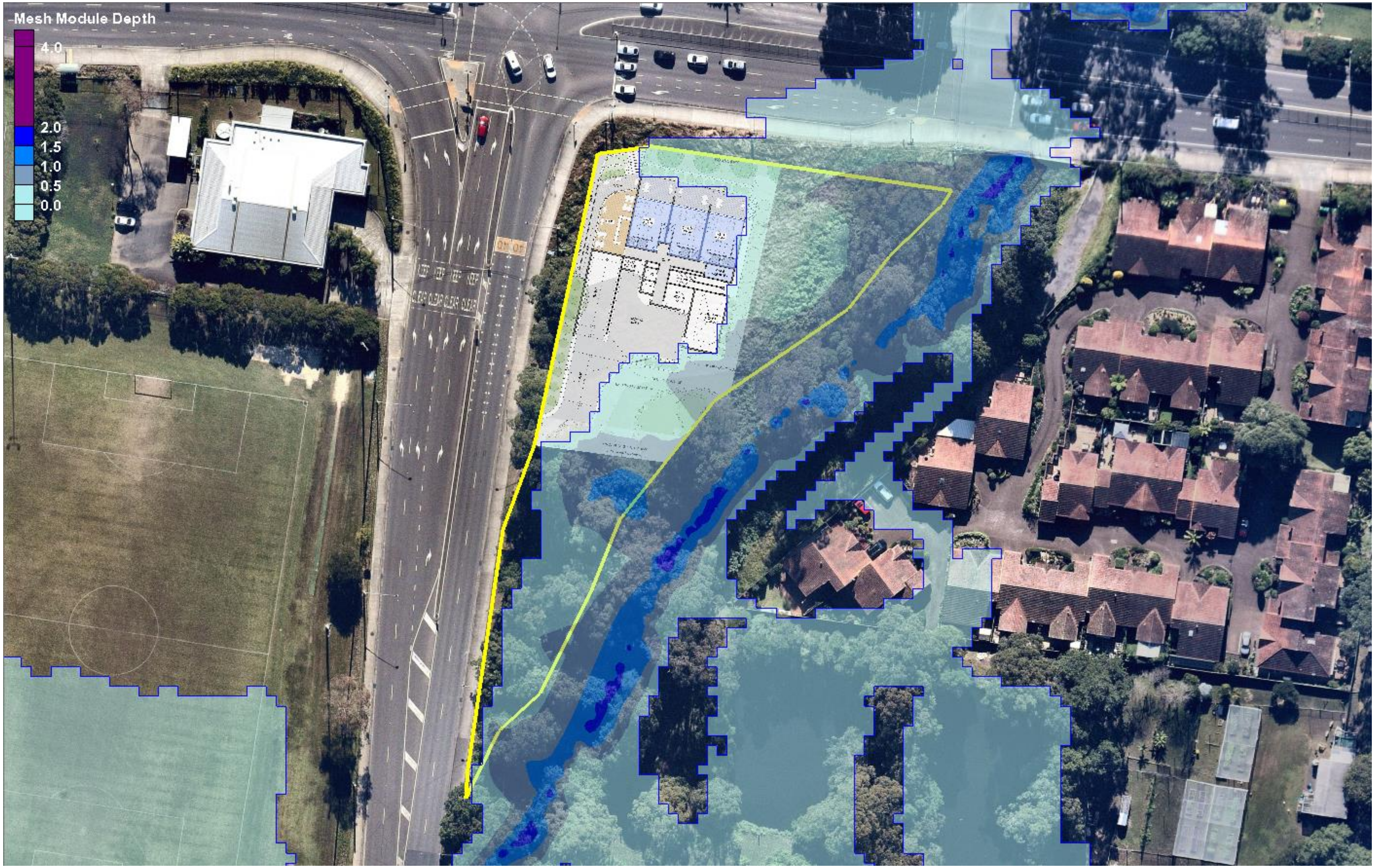


Figure C2.2: 20% AEP Flood Depths – Post-Development

Note: Flood depths shaded from 0m (light blue) to 4.0m (dark blue). All depths over 2.0m shaded dark blue.

Figure C2.3: 20% AEP Flood Velocity – Post-Development

Note: Flood velocity shaded from 0 m/s (yellow) to 4.0 m/s (orange). All velocity over 4.0 m/s shaded orange.

APPENDIX C3 – 1% AEP MODEL RESULTS – PRE-DEVELOPMENT

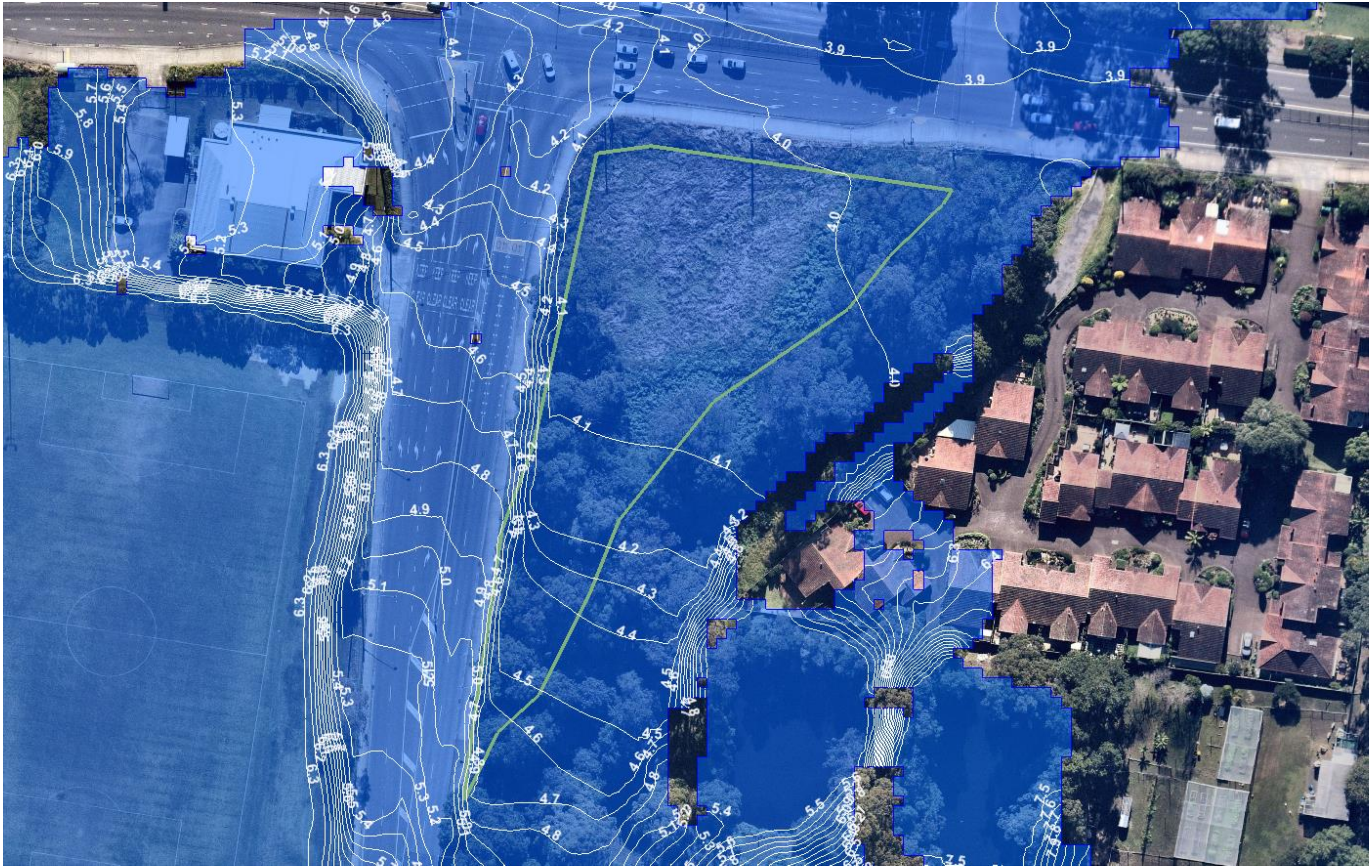


Figure C3.1: 1% AEP Flood Levels – Pre-Development

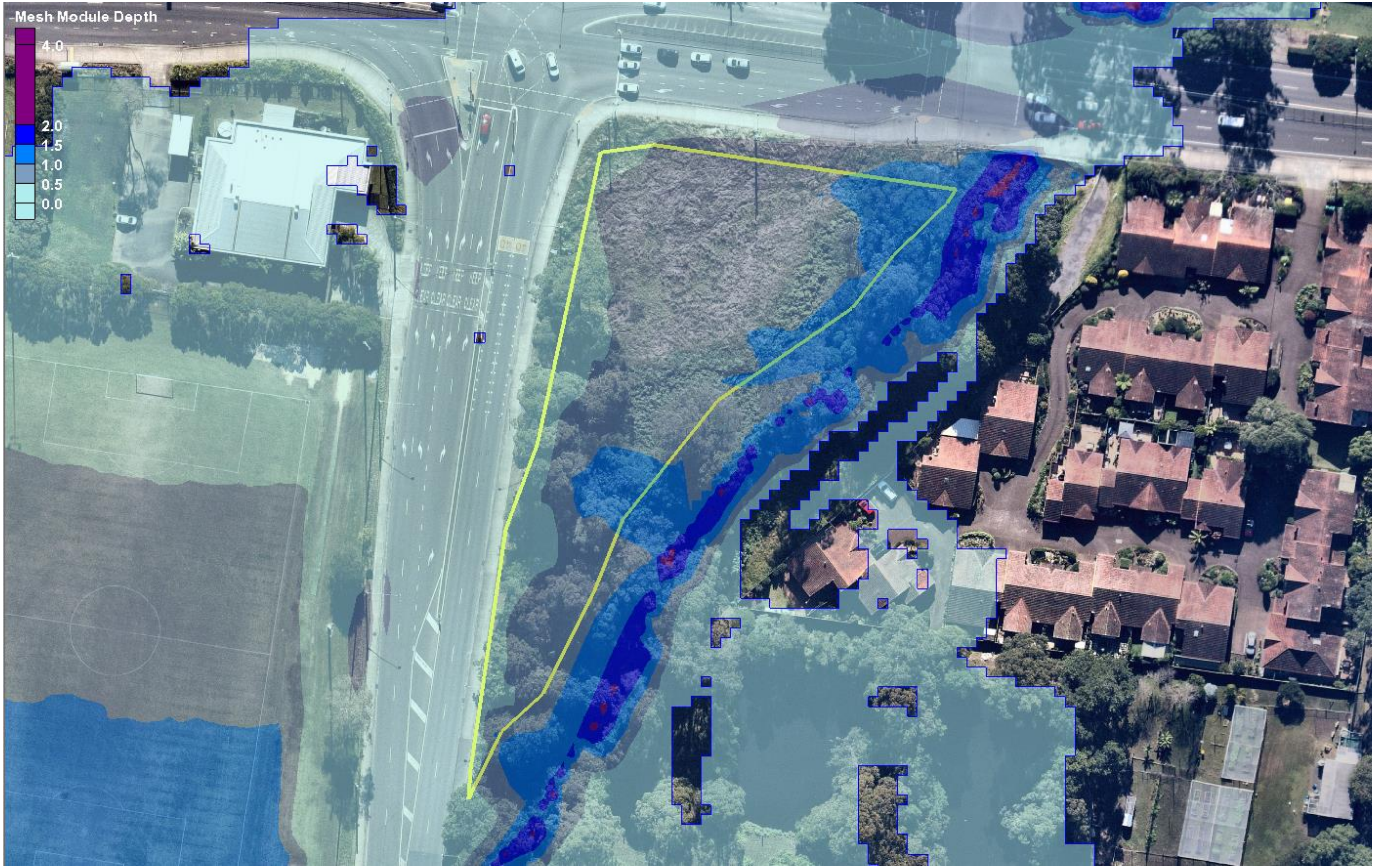


Figure C3.2: 1% AEP Flood Depths – Pre-Development

Note: Flood depths shaded from 0m (light blue) to 4.0m (dark blue). All depths over 2.0m shaded dark blue.

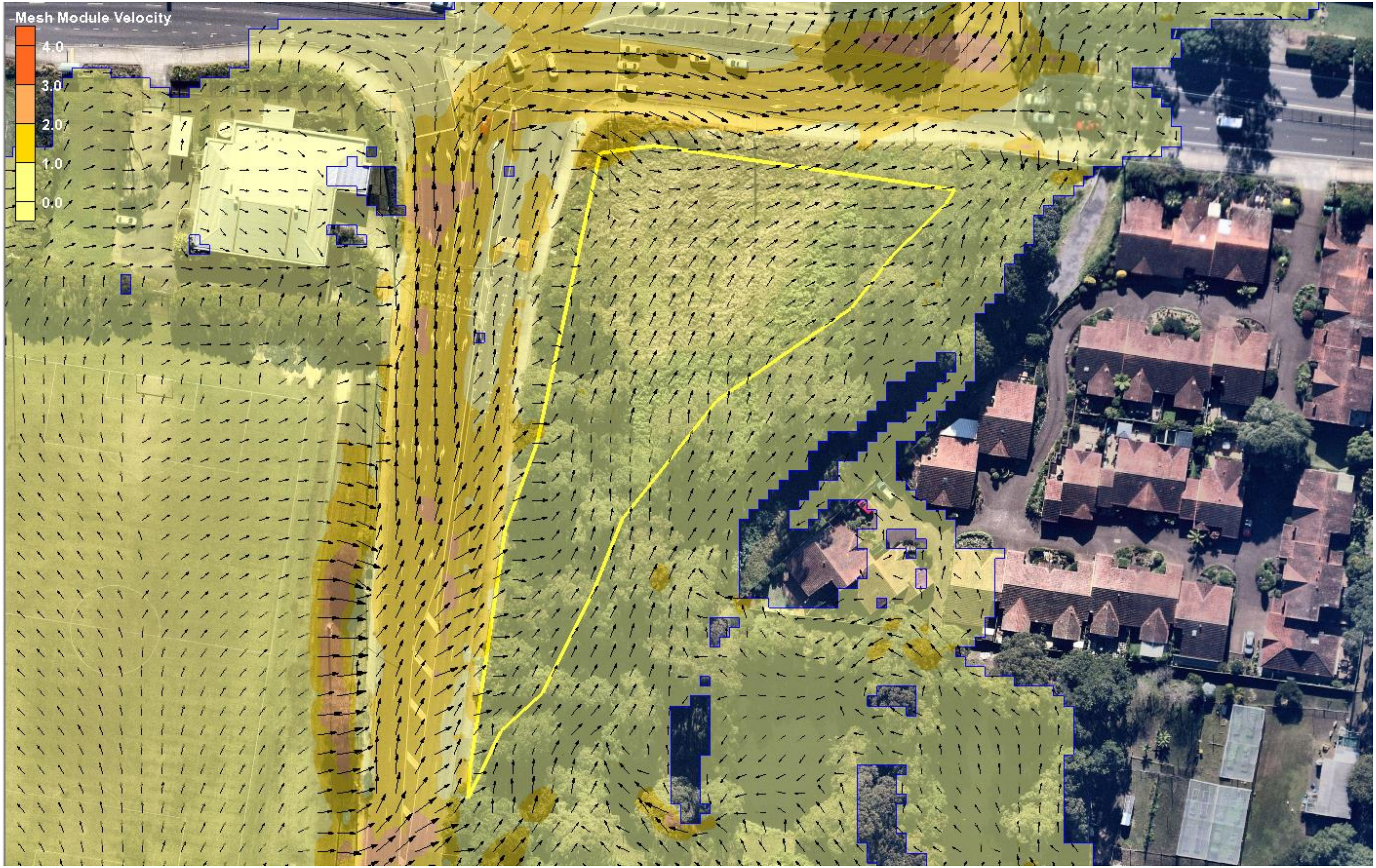


Figure C3.3: 1% AEP Flood Velocity – Pre-Development

Note: Flood velocity shaded from 0 m/s (yellow) to 4.0 m/s (orange). All velocity over 4.0 m/s shaded orange.

APPENDIX C4 – 1% AEP MODEL RESULTS – POST-DEVELOPMENT

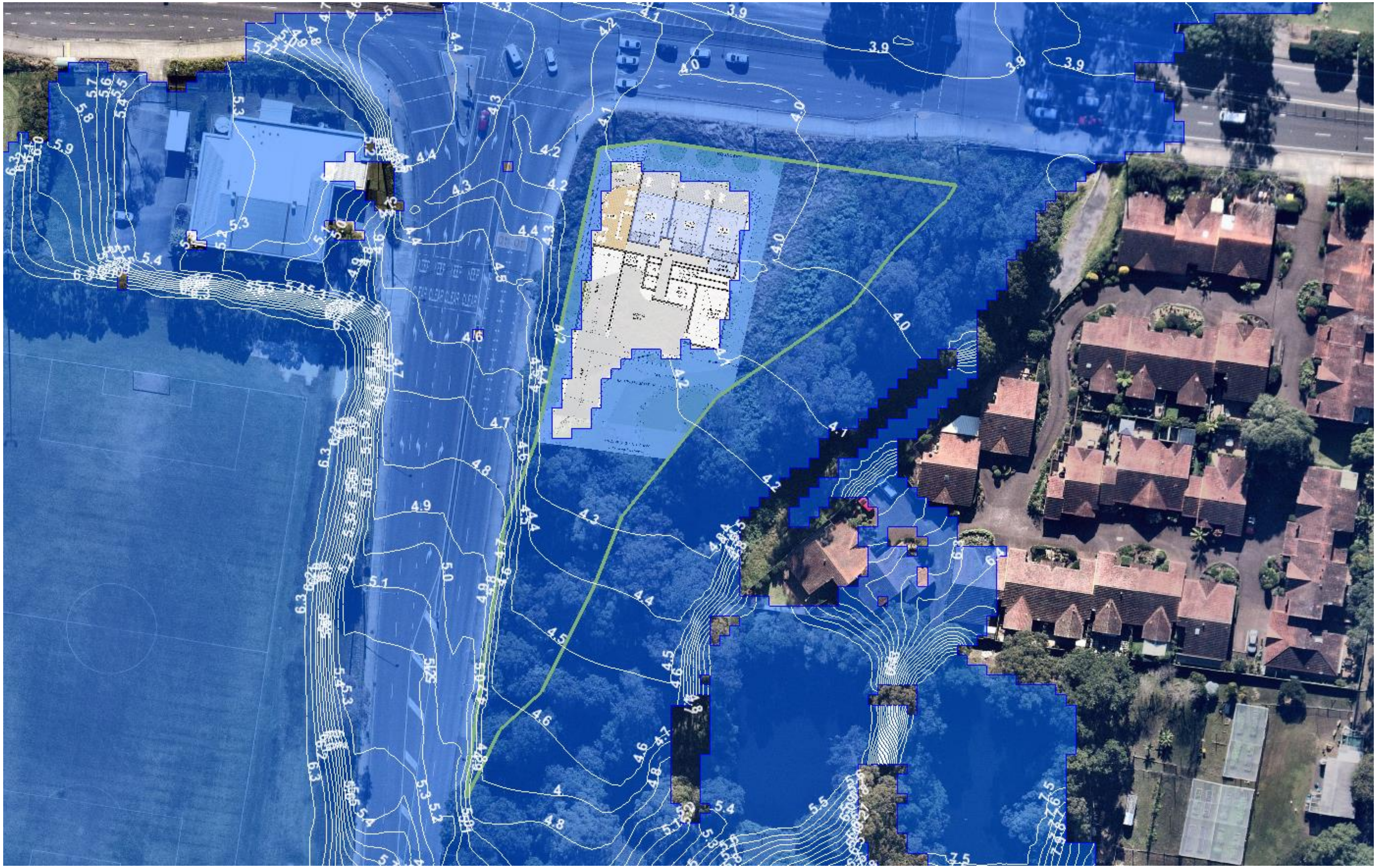


Figure C4.1: 1% AEP Flood Levels – Post-Development

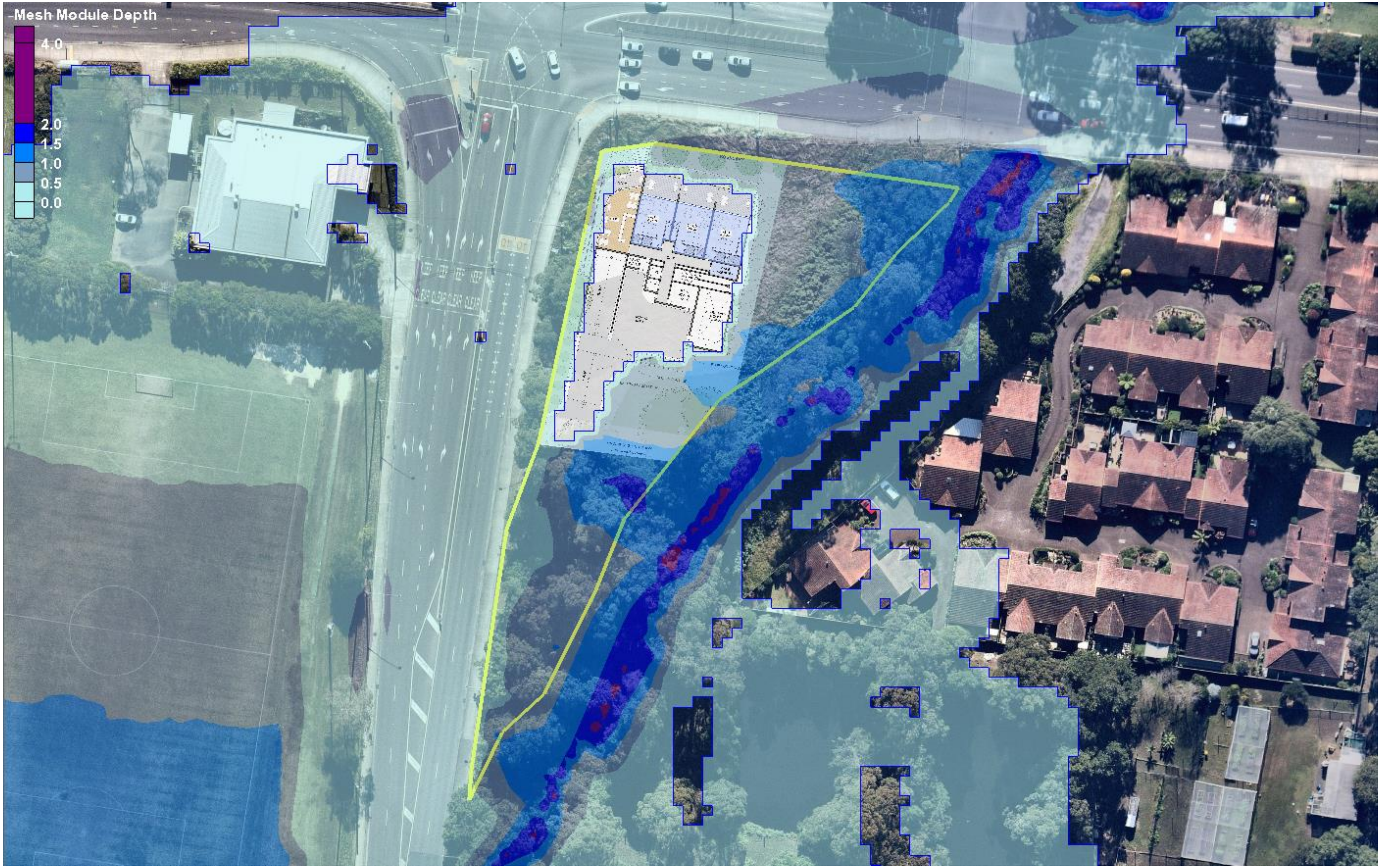


Figure C4.2: 1% AEP Flood Depths – Post-Development

Note: Flood depths shaded from 0m (light blue) to 4.0m (dark blue). All depths over 2.0m shaded dark blue.

Figure C4.3: 1% AEP Flood Velocity – Post-Development

Note: Flood velocity shaded from 0 m/s (yellow) to 4.0 m/s (orange). All velocity over 4.0 m/s shaded orange.

APPENDIX C5 – PMF MODEL RESULTS – PRE-DEVELOPMENT

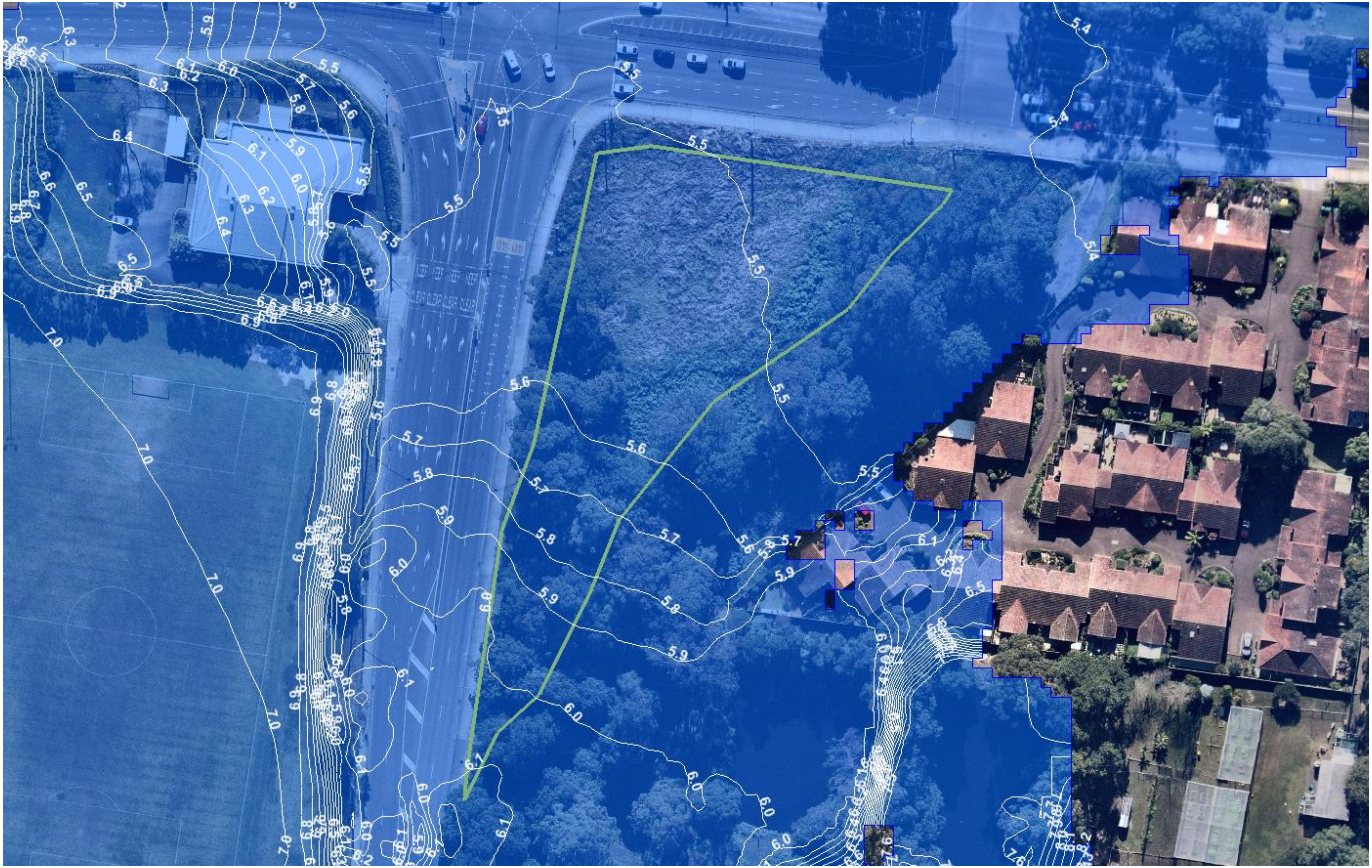


Figure C5.1: PMF Flood Levels – Pre-Development

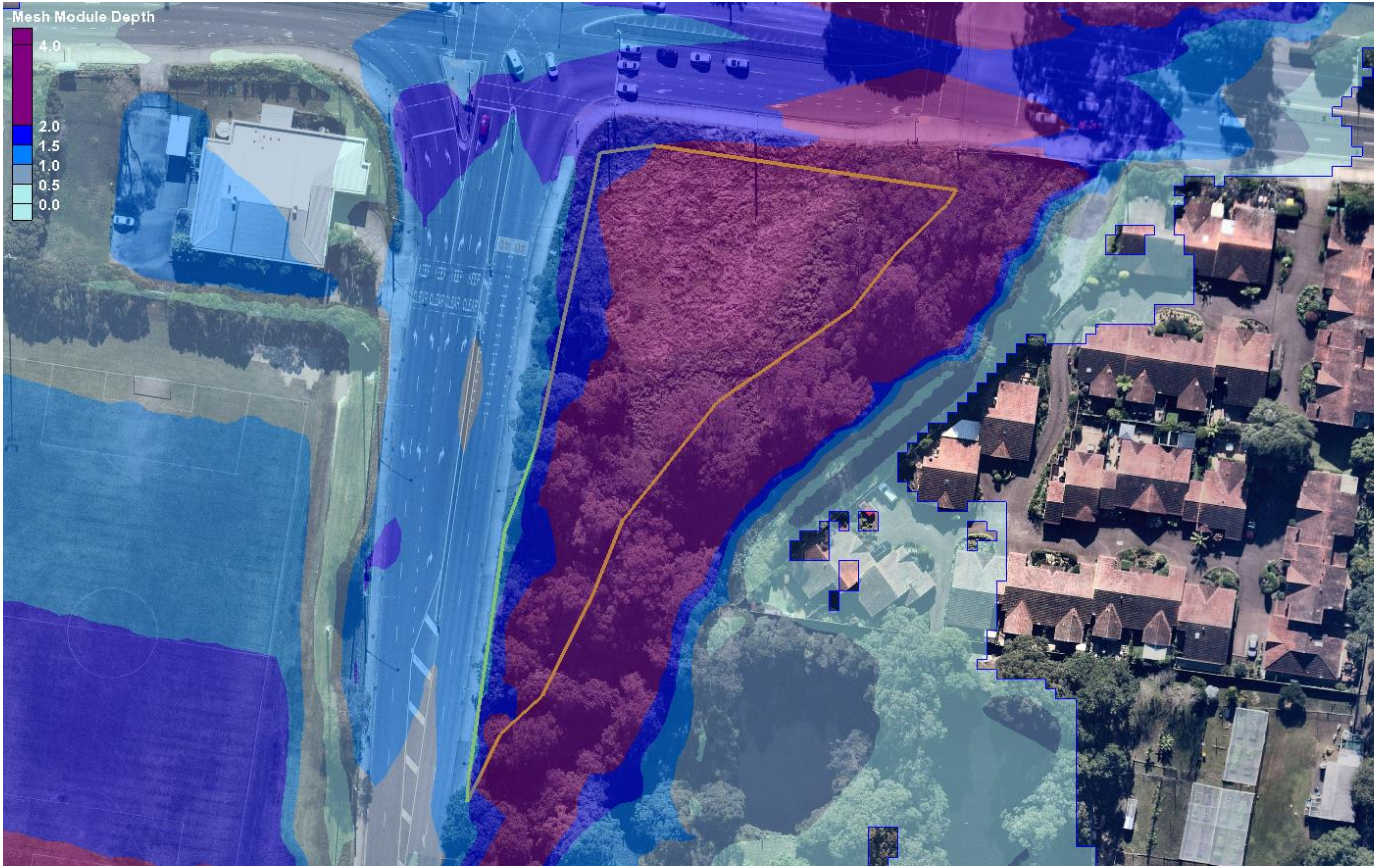


Figure C5.2: PMF Flood Depths - Pre-Development

Note: Flood depths shaded from 0m (light blue) to 4.0m (dark blue). All depths over 2.0m shaded dark blue

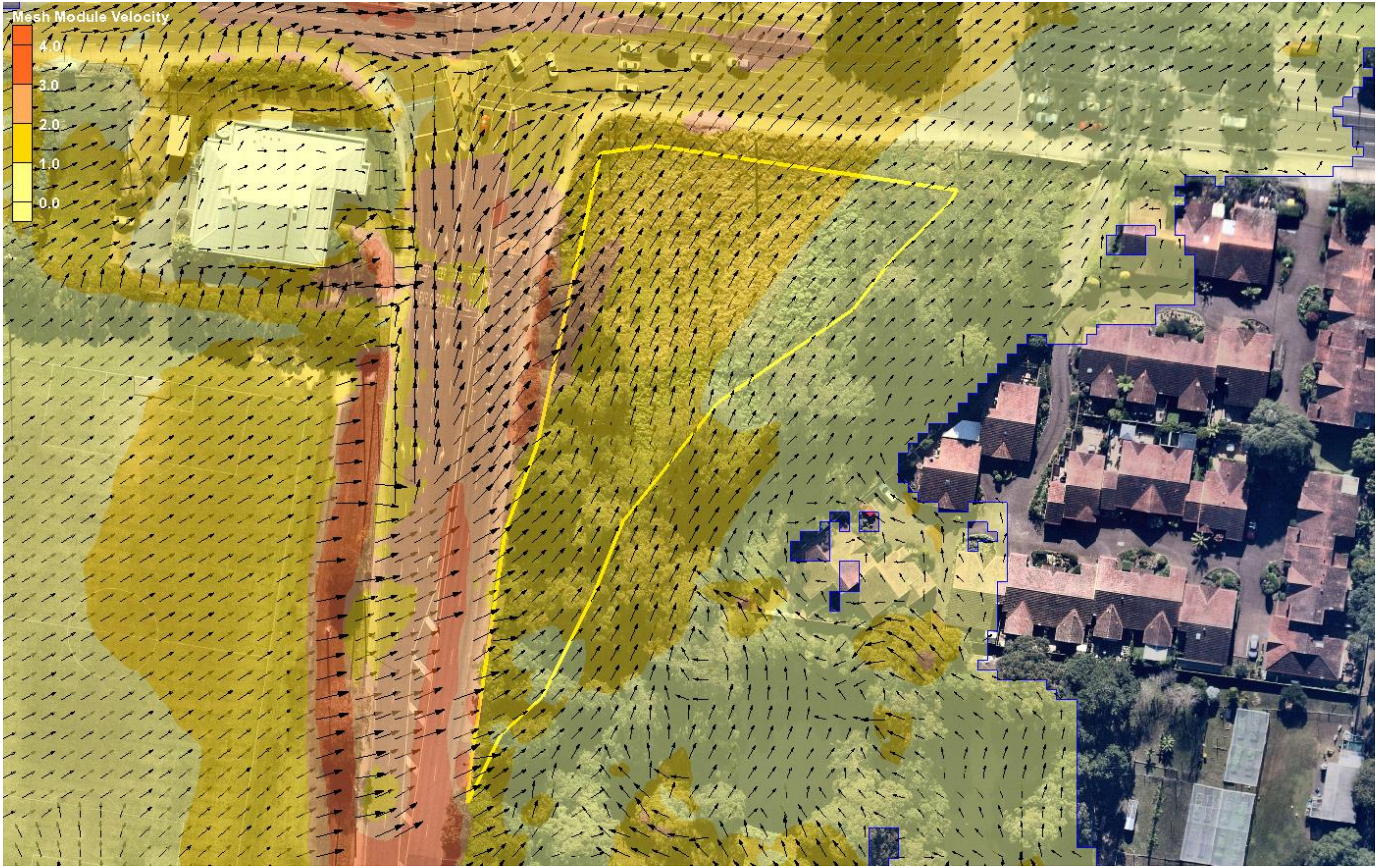


Figure C5.3: PMF Flood Velocity - Pre-Development

Note: Flood velocity shaded from 0 m/s (yellow) to 4.0 m/s (orange). All velocity over 4.0 m/s shaded orange

APPENDIX C6 – PMF MODEL RESULTS – POST-DEVELOPMENT

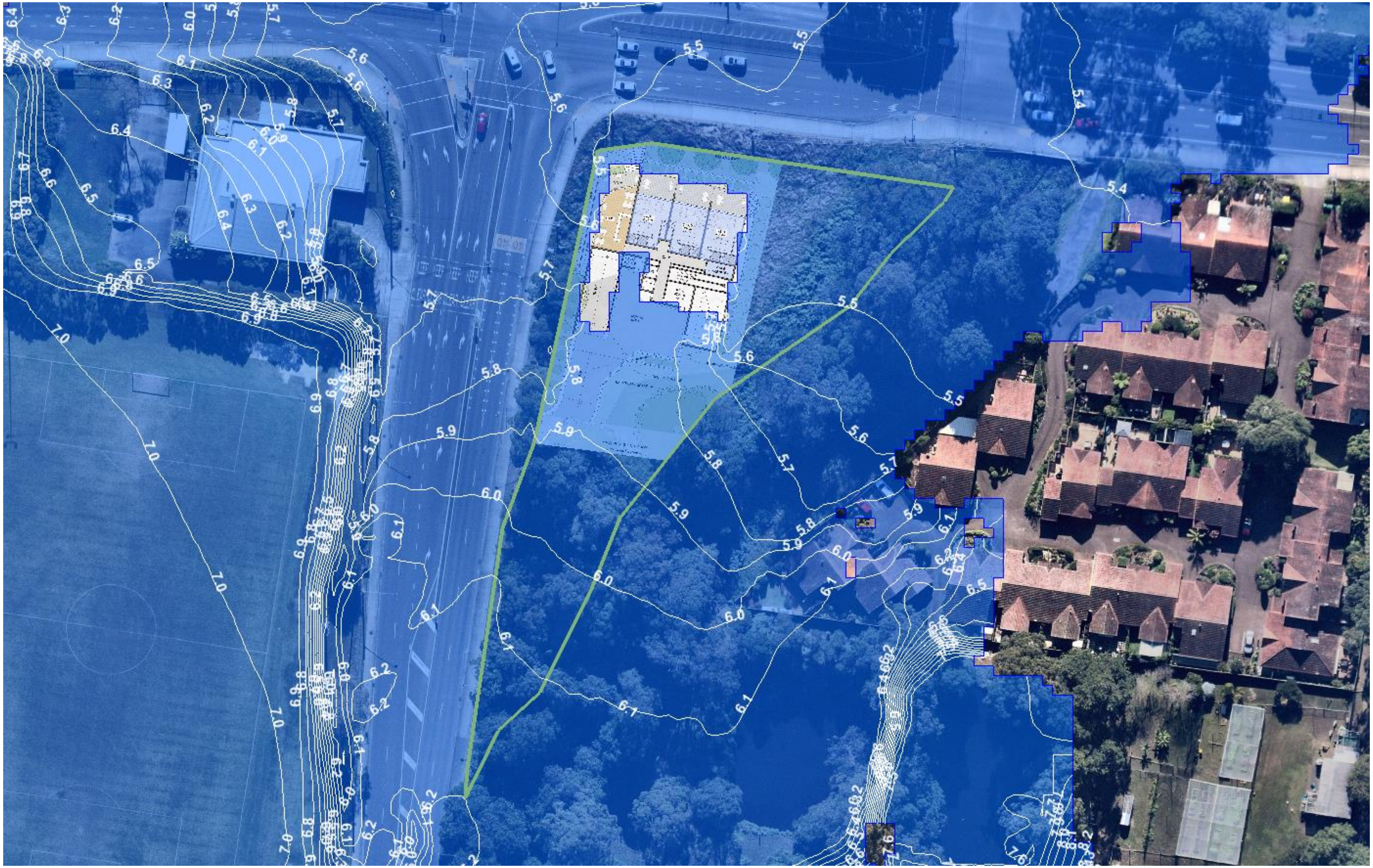


Figure C6.1: PMF Flood Levels - Post-Development

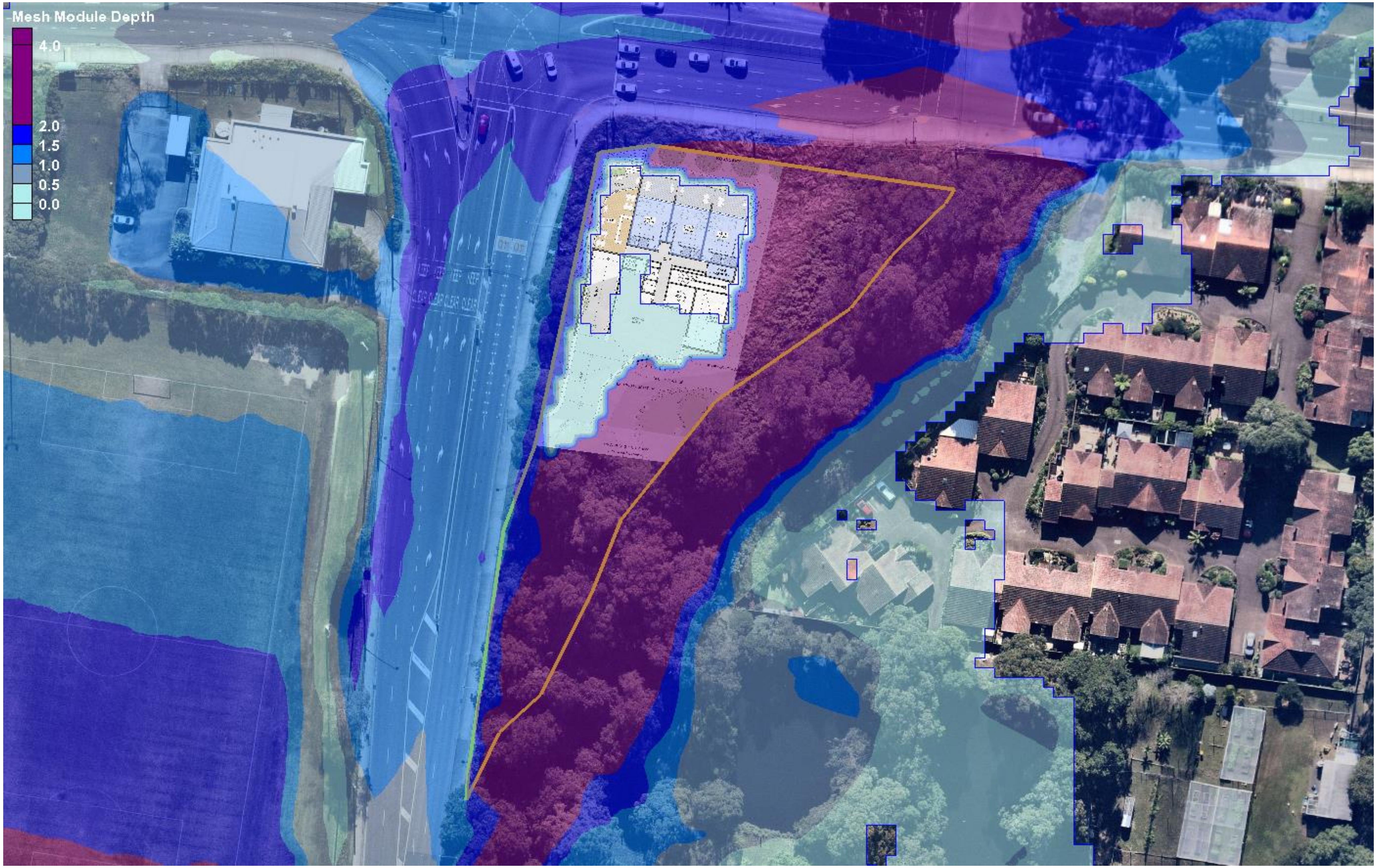


Figure C6.2: PMF Flood Depths - Post-Development

Note: Flood depths shaded from 0m (light blue) to 4.0m (dark blue). All depths over 2.0m shaded dark blue

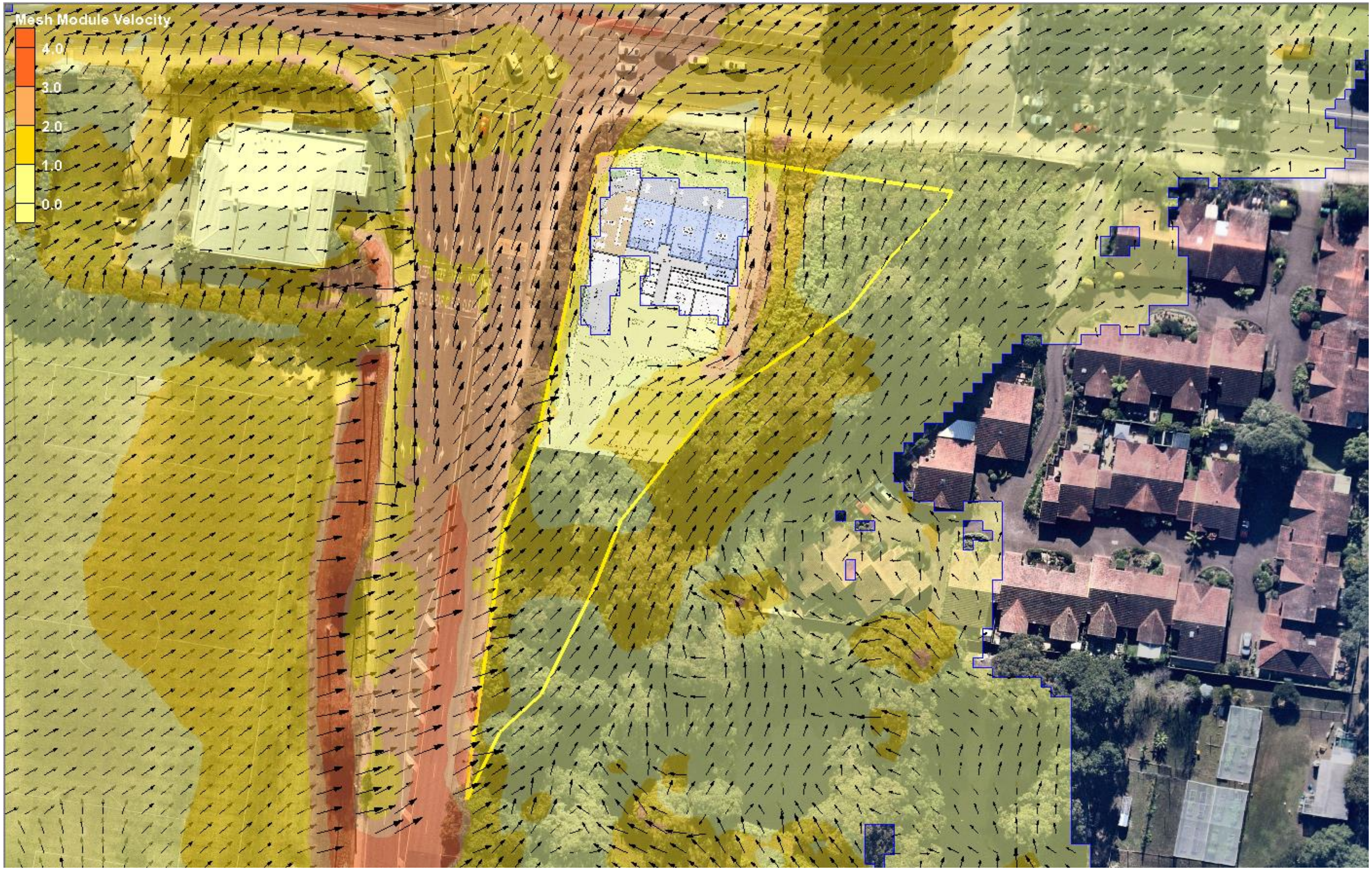


Figure C6.3: PMF Flood Velocity - Post-Development

Note: Flood velocity shaded from 0 m/s (yellow) to 4.0 m/s (orange). All velocity over 4.0 m/s shaded orange

APPENDIX C7 – IMPACT MAPS AND OTHER MODEL DATA

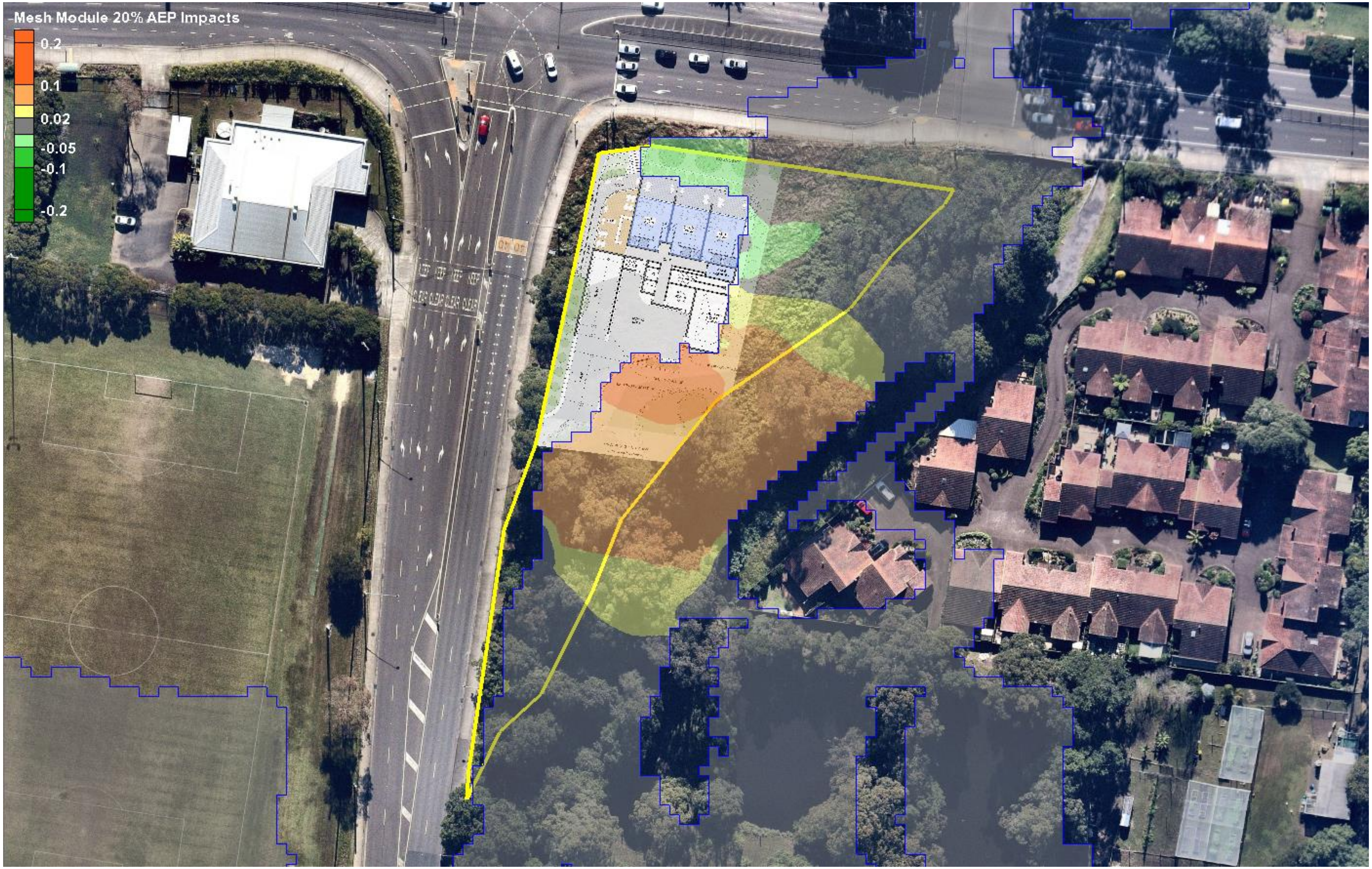


Figure C7.1: 20% AEP Development Related Changes to Peak Flood Surface Levels under Post-Development Conditions

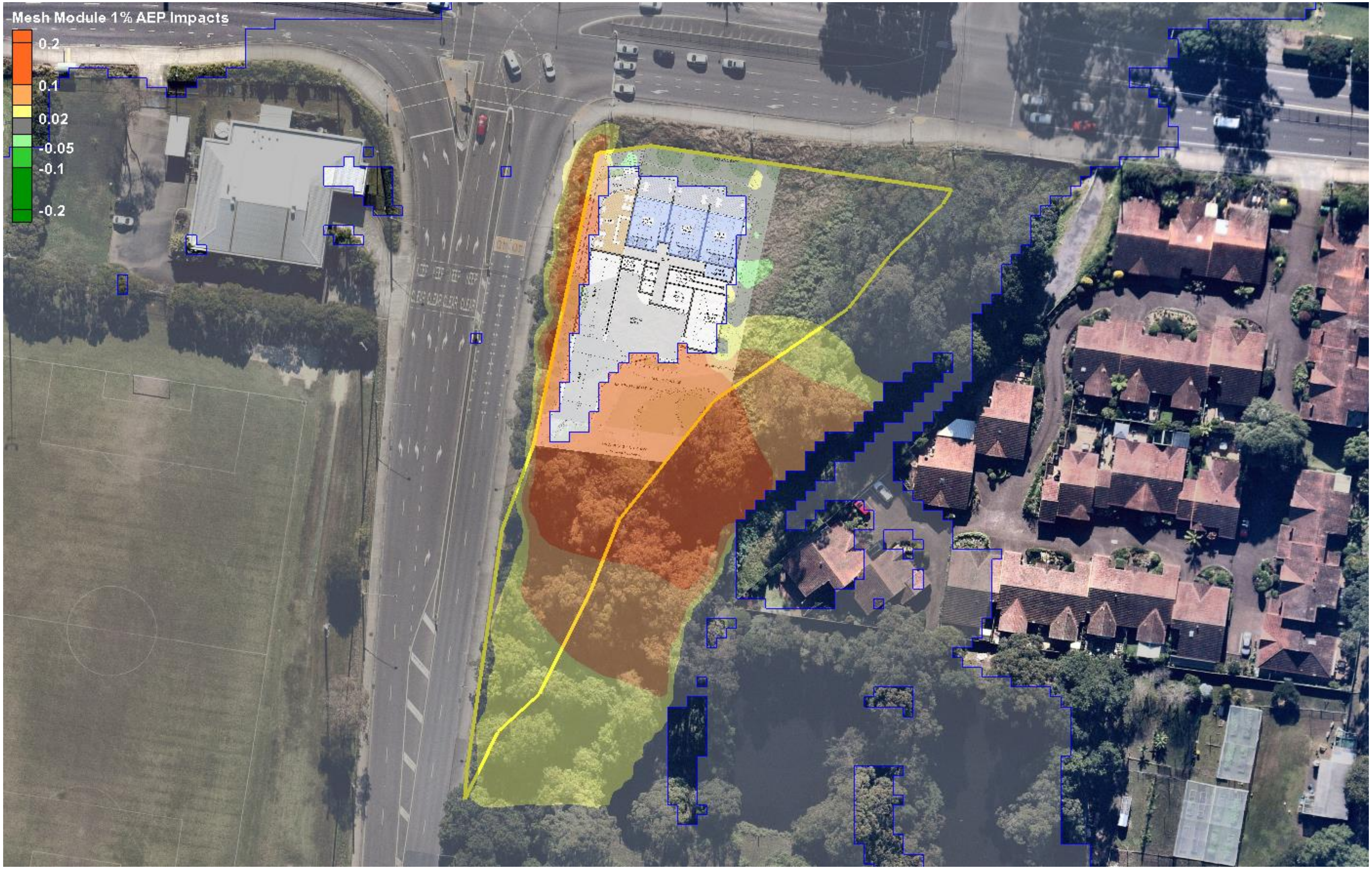


Figure C7.2: 1% AEP Development Related Changes to Peak Flood Surface Levels under Post-Development Conditions

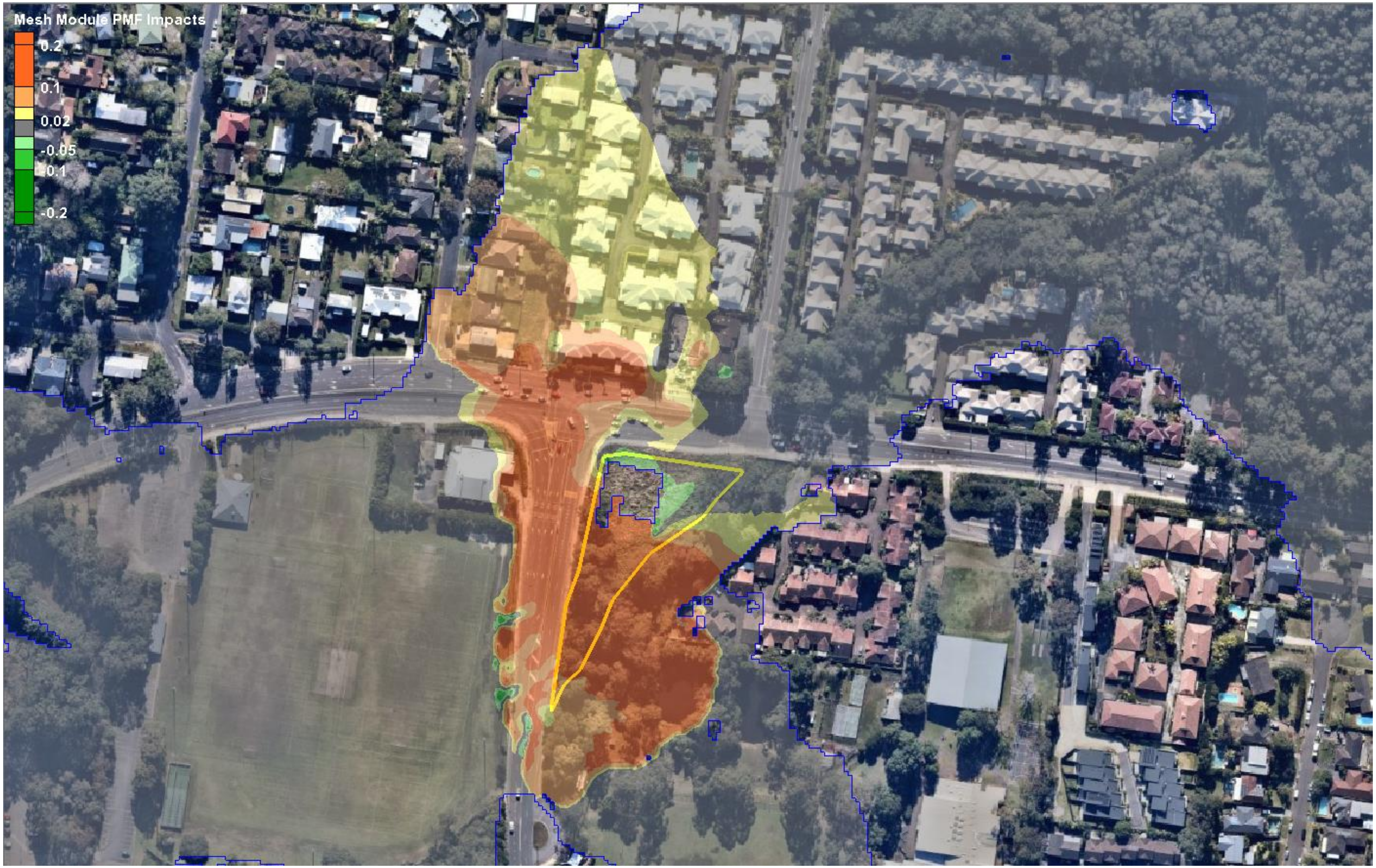


Figure C7.3: PMF Development Related Changes to Peak Flood Surface Levels under Post-Development Conditions