WYURA Flood Impact and Risk Assessment

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Executive Summary

West Yamba Landowners Consortium through Mortons Urban Solutions (MUS) commissioned BMT to update the Flood Impact Assessment (FIA) prepared by BMT in 2021 for the proposed development within the West Yamba Urban Release Area (WYURA) at Yamba, New South Wales, in light of the updated *Lower Clarence Flood Model 2022*, recently adopted by Clarence Valley Council (CVC), and the recent Flood Impact and Risk Assessment (FIRA) guidelines published by NSW Department of Planning and Environment in June 2023.

The present FIRA has assessed riverine flooding from the Clarence River, including storm surge which can propagate up the river from the ocean. The flood impacts were assessed by comparing the pre- and post-development flood conditions in terms of changes in flood extent, level, flow velocity, flood hazard category, and frequency and duration of inundation in accordance with the 2023 FIRA guidelines.

CVC's 2022 Lower Clarence Flood model was used as the basis of the present assessment. The original model was updated and refined with additional detail and higher resolution in the vicinity of West Yamba. The modelled post-development scenario included the entire WYURA development. The scenario was designed to capture the cumulative flood impacts of all West Yamba development as opposed to modelling individual sites in isolation.

The proposed development scenario was assessed for the 10%, 5%, 1%, 0.5%, 0.2% AEP and Probable Maximum Flood (PMF) events. The assessment was also carried out for future climate conditions by considering the 1% AEP 2100 Climate Change Scenario 1 as defined in Council's flood model.

No flood impacts of the proposed development were observed on residential properties in any of the analysed flood events.

A minor increase in flood levels was observed at St James Catholic Primary School in the 0.2% AEP and 1% AEP CC1 events. The increase in flood level at the school is minor (up to 24mm) and does not change the flood hazard category. The school property is already affected by flood hazard category of H3 (i.e., unsafe for vehicles, children and the elderly) in both the 0.2% and 1% AEP CC1 events, therefore, it is expected that the school would be closed or already evacuated during flood events of this magnitude.

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1 Introduction

1.1 Background

West Yamba Landowners Consortium through Mortons Urban Solutions (MUS) commissioned BMT to update the Flood Impact Assessment (FIA) prepared by BMT in 2021 for the proposed development within the West Yamba Urban Release Area (WYURA) at Yamba, New South Wales, in light of the recent updates performed on Council's flood model.

The present assessment was undertaken to account for the updated *Lower Clarence Flood Model 2022*, recently adopted by Clarence Valley Council (CVC), and the recent *Flood Impact and Risk Assessment* (FIRA) guidelines published by NSW Department of Planning and Environment in June 2023.

This FIRA assesses the potential for flood impacts from Clarence River flood events in combination with storm surges entering the Clarence River from the ocean as defined in Council's flood model.

The remainder of this report sets out the flood impact assessment including updates made to the flood model used in the assessment to provide greater detail in the vicinity of the WYURA.

1.2 Design Flood Terminology

Design flood events are hypothetical flood events with a given probability of occurrence. This probability of occurrence is the chance that the flood may occur or be exceeded in any one year and is termed the Annual Exceedance Probability (AEP). A 1% AEP flood is a flood that statistically has a 1% chance of occurring or being exceeded in any given year. This is also sometimes stated as a '1 in 100' chance of occurrence with the two terms being interchangeable. Use of the AEP terminology for describing design floods is in accordance with current best practice as described in Australian Rainfall and Runoff 2019 (ARR2019).

Table 1.1 lists the AEP floods considered by this study in both the percentage and ratio forms. In this report the AEP terminology expressed as a percentage, has been used to describe probability of occurrence.

Table 1.1 Design Flood Terminology

AEP (%)	AEP (1 in Y)
10	10
5	20
1	100
0.5	200
0.2	500

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2 Study Area

2.1 Site and Development Description

The West Yamba Local Environment Plan (LEP), gazetted 23/4/2010, identified part of the land at West Yamba as '2(c) Residential'. This land is referred to as R1 lands in 2011 CV LEP and from herein. The R1 residential land occupies the majority of the WYURA and covers approximately 116 ha. The land is predominantly flat, low-lying land in close proximity to the tidal waters of the Clarence River, Oyster Channel and Lake Wooloweyah. Existing ground elevations typically vary between 1 and 2 mAHD and due to its elevation, the land is generally flood prone. Figure 2.1 shows the location of the WYURA developments within Yamba.

The WYURA development includes residential lots which will be filled to enable 'slab on ground' dwelling construction and provide appropriate flood immunity. The filling is to be undertaken to a sufficient level to enable minimum floor height requirements to be achieved. Minimum floor heights are based on relevant flood planning levels which, in turn, are based on the 1% Annual Exceedance Probability (AEP) design flood level with additional allowances for climate change and freeboard.

The WYURA also includes provision of land for conveyance of floodwater. This land was identified from flood modelling undertaken prior to gazetting of the land and was designed to convey floodwater from north to south during a 1% AEP or rarer event. The previous flood modelling included a very significant storm surge which overtopped Yamba Road[1]. The latest modelling has used the latest OEH (2015) guidelines to refine the storm surge component in the model. As a result, the magnitude of the storm surge has reduced and the inclusion of the floodway is less critical. The floodway has been maintained in the development and mostly retains the land at existing levels and with no change to the assumed vegetation cover. Details of how the WYURA developments have been represented in the flood model are provided in Section 3.2.

2.2 Previous Flood Impact Assessments

A series of FIAs were previously prepared by BMT for a number of sites within the WYURA. All previous flood impact assessments included consideration of the cumulative effect of all development within the WYURA on Clarence River flooding. The most recent FIA was prepared by BMT in 2021 to assess the cumulative impacts of the proposed Yamba Gardens development and future developments.

The 2021 WYURA FIA assessed the changes in flood levels generated by the proposed development in the 1% AEP (1 in 100 AEP) and 5% AEP (1 in 20 AEP) flood events. A threshold of 30 mm was adopted to map the significant increases in flood levels.

The assessment was based on the flood model adopted by Council in 2014 (hereinafter "2014 Council Model"), which simulated the 1% AEP event by considering the combination of a 1% AEP riverine flood event and a 1% AEP storm tide event. The riverine flood and storm tide events were simulated by assuming coincidence of the peak in rainfall intensity with the storm tide peak, which was characterised by a 1% AEP tide level of 2.6 mAHD. In accordance with this model setup, the flood events in Yamba were affected by double inundation peaks, the first due to the storm tide coming from the north-east of WYURA and the second due to overtopping of the Clarence River banks coming from the south-west of WYURA.

[1] Please refer to Table 3.1 for further information on Council's model updates.

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The 2021 WYURA FIA identified a series of dwellings impacted by increases in flood levels higher than 30 mm. The areas impacted by increases in flood levels were located north-east of the proposed filling of the WYURA development, therefore, those impacts were mainly generated by the storm tide component of the flood inundation.

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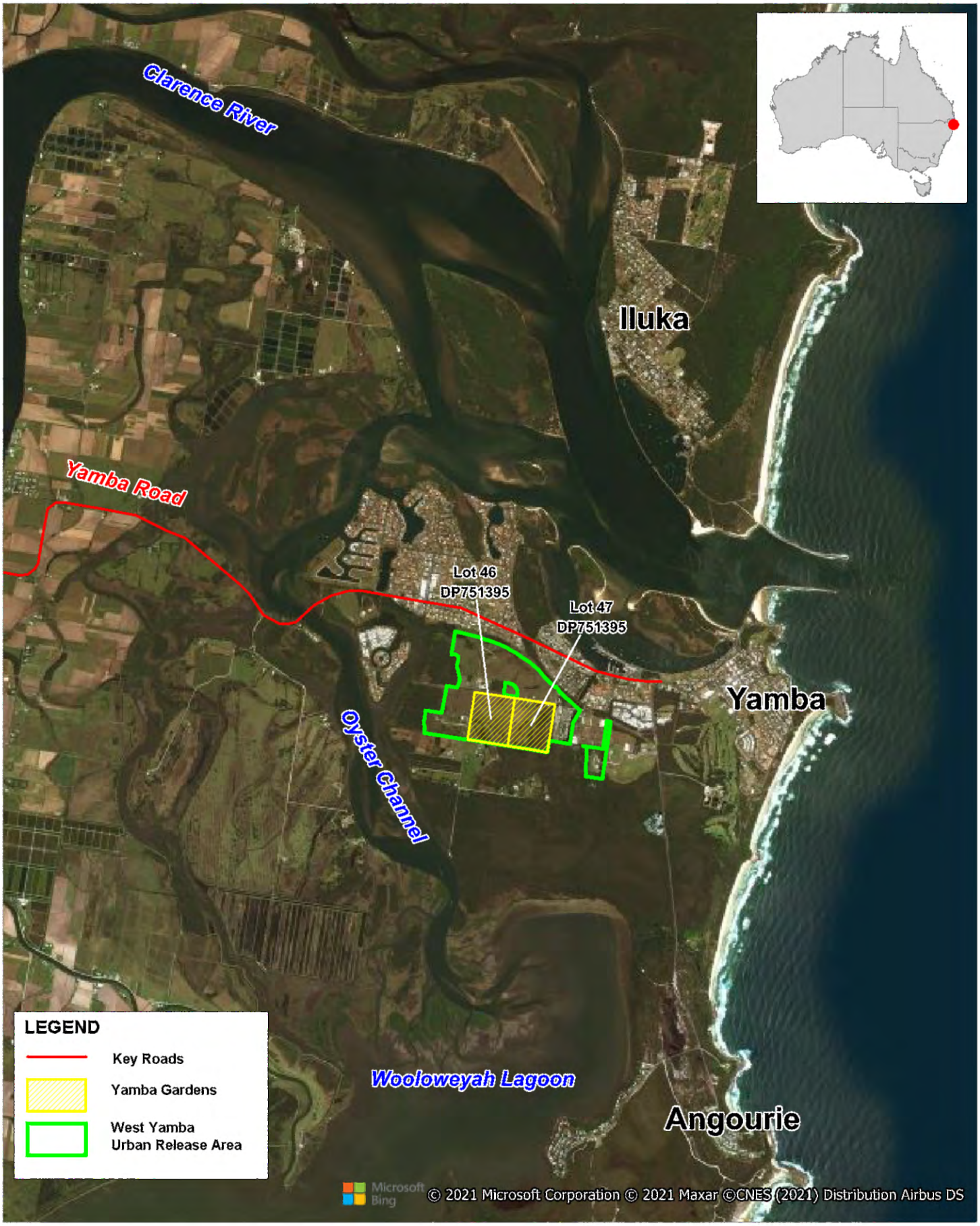

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WYURA and Yamba Gardens Location

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3 Model Update

3.1 Council Model

3.1.1 Model overview

The flood model used in the present assessment is based upon the model adopted by Council as part of the *Lower Clarence Flood Model Update 2022* (BMT, 2023), which was developed using the TUFLOW HPC software (hereinafter termed “2022 Council Model”). The flood model was recommended to be used to inform flood impact assessments in support of planning decision making.

The 2022 Council Model is based on LiDAR data captured in 2010 as this is the latest LiDAR dataset available for the Lower Clarence River floodplain. Local modifications to the topography were performed by including available surveys of new developments and constructions occurred between 2010 and 2022. TUFLOW’s Quadtree feature was used to vary the model resolution within the domain, thus adopting a model grid resolution of 20m in rural areas and a resolution of 10m in urban areas. As such, Yamba is represented using a 10m grid cell size in the 2022 Council Model.

The 2022 Council Model was calibrated against the January 2013, March 2021 and February/March 2022 flood events. The events were selected as they were significant, relatively recent and had good availability of calibration data (i.e., rainfall and river levels).

The coincidental occurrence of riverine and storm tide inundation was simulated by assuming simultaneous occurrence of riverine flood peak and storm tide peak. The selection of storm tide event to apply to each AEP design event was based on the methodology outlined in the recent OEH (2015) guidelines. Please refer to BMT (2023) for a detailed description of the model setup, assumptions and results.

3.1.2 Key updates to Council Model

The model updates performed on the 2022 Council Model compared to the previous 2014 Council Model are summarised in Table 3.1. The following key model updates had significant impacts on the flood modelling results in West Yamba:

- The magnitude of the storm tide adopted in 2022 Council Model is considerably smaller than the storm tide adopted in 2014 Council Model. A 5% AEP storm tide characterised by a peak tide level of 1.57 mAHD was adopted as boundary condition in the 1% AEP simulations.
- The pre-development topography includes all the WYURA development filling completed as of 2022, such as Yamba Parklands, Clifton Lifestyle MHE, Golding St MHE and a portion of Yamba Gardens.

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Table 3.1 Key updates to 2022 Council Model

Feature	2014 Council Model	2022 Council Model
Solver	TUFLOW Classic	TUFLOW Heavily Parallelised Compute (HPC)
Model grid cell size	Most of the modelled area is represented as a 60m grid with parts of Grafton and Maclean modelled at finer 30m and 10m grid resolutions using TUFLOW's Multi Domain feature.	TUFLOW's Quadtree feature was used to adopt a 10m grid cell size in urban areas and a 20m grid cell size in rural areas. As such, in Council Model Yamba was represented using a 10m grid cell size.
Topography	Underlying DEM based on LiDAR data captured in 2010.	The underlying DEM is based on LiDAR data captured in 2010 as in the previous model adopted by Council. However, the base topography is now sampled at a higher resolution within the model.
Topography modifications and enhancements	Please refer to BMT WBM (2013) for a detailed description of the topography modifications included in the model.	Terrain modifications as per 2013 Council Model with the addition of the surveys and topography enhancements to represent new construction and fillings occurred in the meantime. Please refer to Section 3.3 of BMT (2023) for a detailed description of the topography modifications and enhancements.
Boundary locations	• Flood inflows for the Clarence River at Mountain View; • Flood inflows for the Clarence River tributaries downstream of Mountain View; • Runoff resulting from direct rainfall onto the lower floodplain; and • Ocean water levels.	The flood inflows from Clarence River at Mountain view and the Ocean boundary location were retained from 2013 Council Model. A WBNM hydrologic model was developed to estimate the tributary inflows throughout the catchment. The hydrologic model outputs were used in lieu of the tributary inflow unit hydrograph models and the floodplain rainfall runoff inputs from 2013 Council Model.
Manning's n roughness coefficients	Please refer to BMT WBM (2013) for a detailed description of the Manning's n roughness coefficients adopted in the study.	Minor changes to the Manning's n coefficients adopted in 2013 Council Model were applied in order to improve the model calibration against more recent and larger events. These included a revised (smoother) Manning's n value for the river downstream of Maclean to reflect the more fine estuarine sediment.
Downstream boundary conditions (tide)	The 1% AEP event was simulated by applying a 1% AEP storm tide along the ocean boundary of the model. The flood peak and the tide peak were assumed to occur simultaneously to simulate the coincidental occurrence of a flood event and storm tide event. The adopted 1% AEP peak storm tide was 2.6 mAHD.	The 1% AEP event was simulated by applying a 5% AEP storm tide along the ocean boundary in accordance with the OEH (2015) guidelines. A 5% AEP peak storm tide level of 1.57 mAHD was based on the OEH (2015) guidelines and the site-specific storm tide investigation assessment undertaken for Council in 2021 (Risk Frontiers, 2021).

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3.2 WYURA FIRA Model

3.2.1 Model updates

In order to further enhance the schematisation of West Yamba and the proposed development in the model, the following changes were performed on the 2022 Council Model:

- The Quadtree polygon adopted to refine the model grid at Yamba to a 10m grid resolution was enlarged as per Quadtree polygon used in the 2021 WYURA FIA model in order to keep consistency in model resolution across WYURA between the assessments. A 20m model resolution was adopted in the remainder of the model located outside Yamba.
- In order to keep consistency with the 2021 WYURA FIA, high resolution domains characterised by a model grid cell size of 2.5m were specified at the following locations:
  - To represent flow paths along Carrs Drive and Miles Street. The high resolution two-dimensional domain can better account for the variation in road geometry (and associated swales).
  - To represent the channel extending from the Clarence River to behind the former caravan park. This area is also updated to incorporate ground survey data.
  - To represent an area north of West Yamba in the vicinity of Wattle Park to allow for better representation of flow through the road corridors which pass between areas of land filled for development.

The adopted model grid resolution in West Yamba and the surrounding area is illustrated in Figure 3.1.

Figure 3.1 TUFLOW Model Grid Resolutions

3.2.2 Modelled scenarios

Two scenarios have been modelled to represent different landforms. The scenarios have been defined to capture the cumulative flood impact from all WYURA development.

Pre-development scenario (2022 Baseline)

The main dataset used to define the model topography is LiDAR data captured in 2010 and this has been supplemented with local ground survey where available. The pre-development scenario includes all the WYURA development filling completed before 2022, such as Yamba Parklands, Clifton Lifestyle MHE and Golding St MHE. It also includes approved Carrs Drive upgrade plans included within the Yamba Parklands design between Harold Tory Drive and Miles Street.

Design landforms for Yamba Parklands were available and these have been incorporated into the model to show the planned fill levels. For development which does not have a design landform, it was assumed to fill the development to 3 mAHD, which is sufficient to place it above the 1% AEP flood level including climate change. A portion of the Yamba Gardens filling was also included in the pre-development scenario as a uniform filling to 3 mAHD.

The WYURA filling included in the pre-development scenario is shown in Figure 3.2.

Post-development scenario

The post-development scenario was as the pre-development scenario but included the filling of all the lots within WYURA, as shown in Figure 3.3.

Design landforms for Yamba Gardens were available and these have been incorporated into the model to show the planned fill levels. For development which does not have a design landform, it was assumed to fill the development to be above 3.5 mAHD (which is considered to be a conservative assumption).

A design for Miles Street (between Carrs Drive and Golding Street) and Carrs Drive south of Miles Street was included in the design for Yamba Gardens and was also incorporated into the model.

The WYURA land set aside for a floodway near Golding Street is approximately shown in the Maclean LEP 2001 (Amendment No. 20). This extent was incorporated as Yamba Gardens does not include any fill within the floodway, i.e. the floodway is retained at its natural, low-lying ground levels. The extent of land set aside for a floodway has also been increased (extent of development fill reduced) in order to achieve increased conveyance.

The extent of the floodway has been used to inform which parts of the remaining lots will not be filled. The floodway could potentially take numerous forms including being formally excavated to provide increased conveyance capacity or simply be retained at its natural ground level. The following is of note with regards to the representation of the floodway in the post-development scenario:

- At its northern end, the floodway was shown to cross three lots north of the former caravan park. These lots were filled except for the portions which are shown as being within the floodway. These portions are retained at the pre-development ground levels.

- The proposed floodway in land to the north of Miles Street within Lot 18 on DP 1090409, will adopt a more formalised approach with some excavation and also a widening from that shown in Council's floodway plans[2].

[2] This land is part of the consortium land and BMT understands from MUS that the floodway can be designed in this way.

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- Within Yamba Gardens, the floodway was retained at natural ground levels primarily due to retaining vegetation. The extent of land set aside for a floodway was increased (extent of development fill reduced) in order to achieve increased conveyance.

- The portions of the floodway which will be retained at natural ground and vegetation levels adopt the same roughness values as used for the base case. This includes a mix of general pasture (n = 0.06) and medium density forest (n = 0.1). Where the floodway is excavated and formalised within Lot 18 on DP 1090409 a Manning's n value of 0.03 has been applied to represent maintained grass.

Figure 3.3 shows all areas modelled as filled under post-development scenario and also shows the extent of the Council defined floodway. Land located between the development and the floodway and which is not shown to be filled is the additional land set aside to extend the width of the floodway beyond the Council extent.

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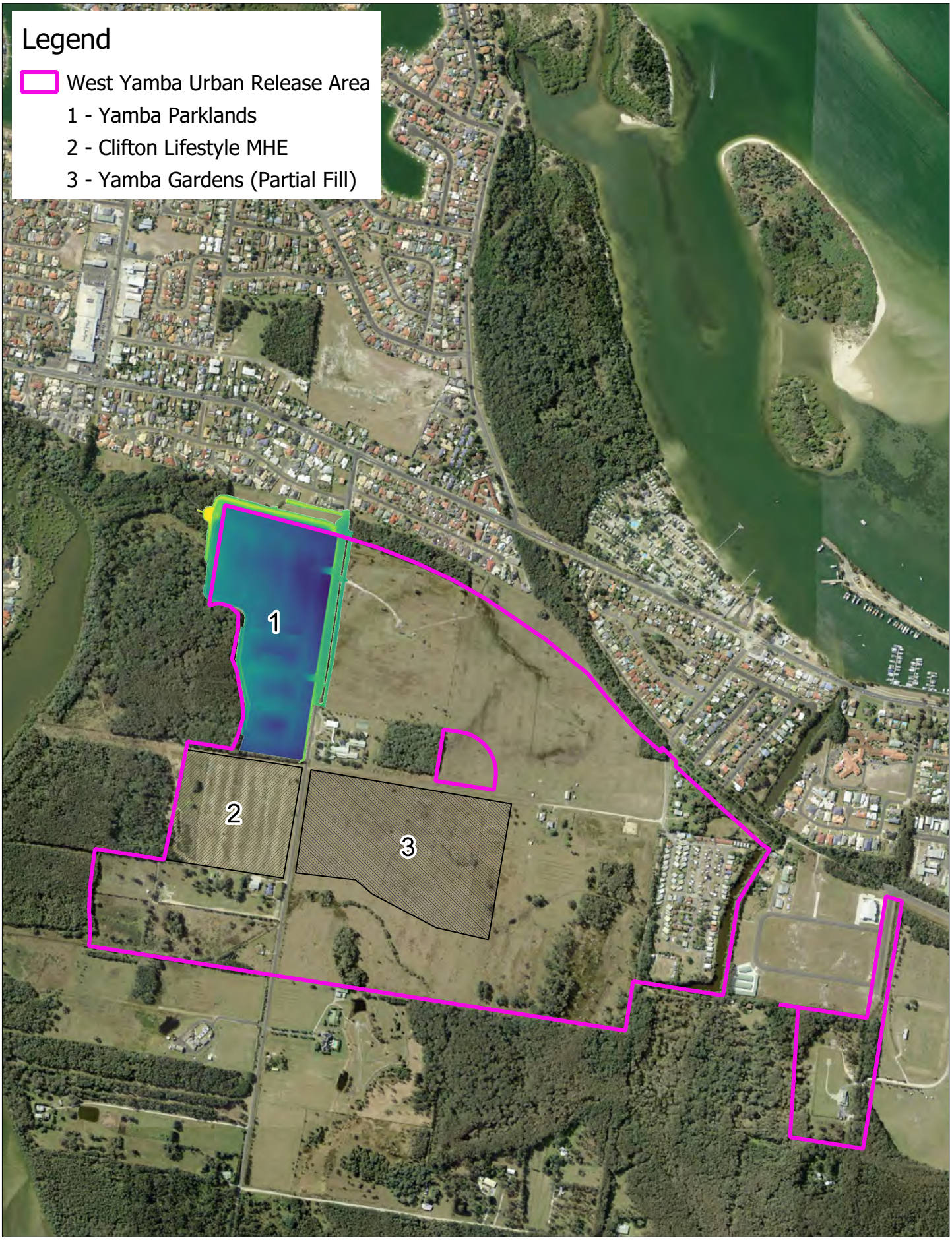

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Pre-Development Scenario

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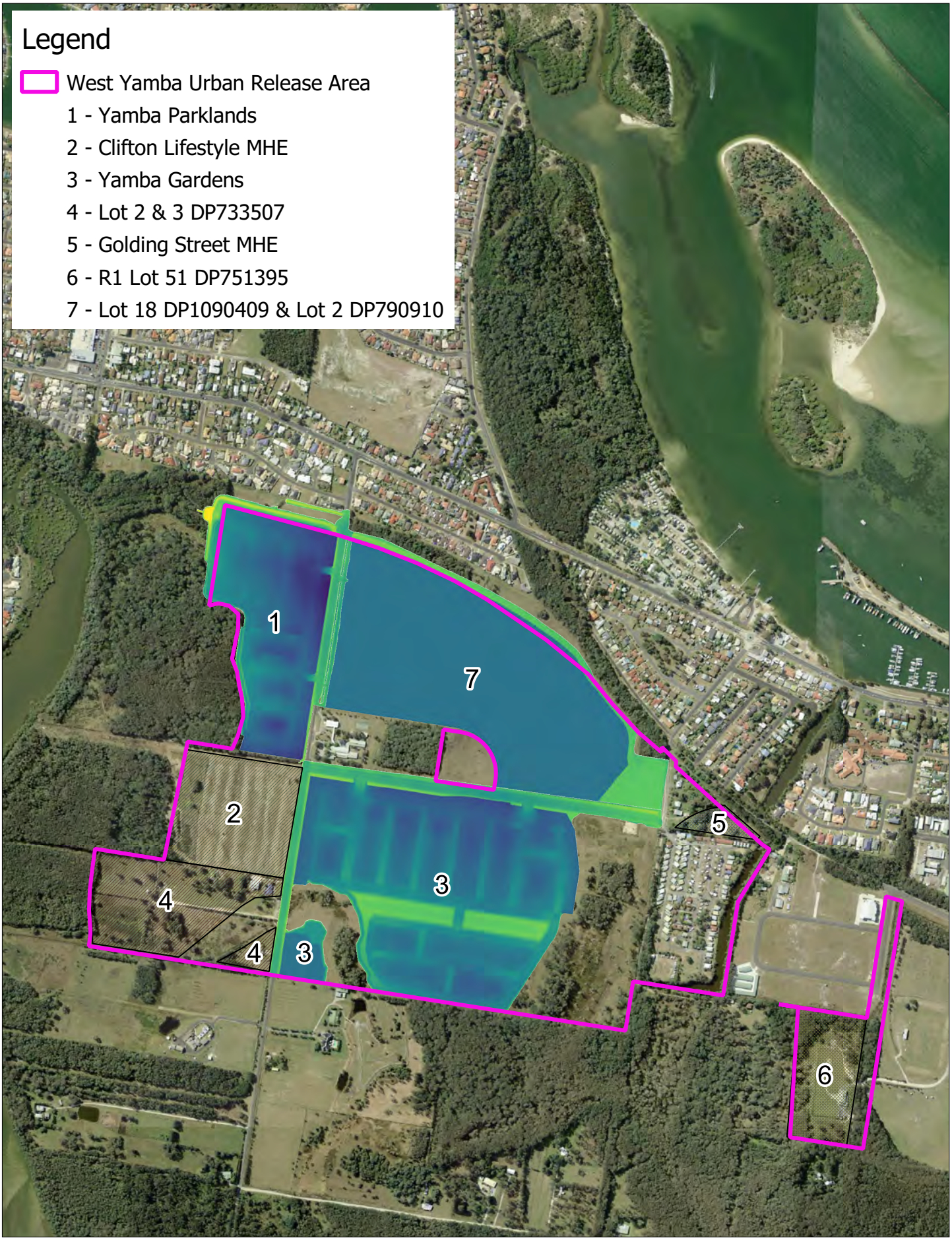

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Post-Development Scenario

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4 Model Results

4.1 Flood Maps

Flood maps showing the flood extent, level, depth, flow velocity, flood hazard and duration of inundation in the 10%, 5%, 1%, 0.2%, 0.5% AEP and PMF events in the pre-development and post-development conditions are provided in Annex A and Annex B, respectively. Flood maps were also prepared for the 1% AEP 2100 Climate Change Scenario 1, hereinafter referred to as 1% AEP CC1.

The flood hazard assessment was based on the flood hazard classification outlined by "*Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*" (AIDR 2017). The flood hazard vulnerability curves adopted in the present flood impact assessment are shown in Figure 4.1 and summarised in Table 4.1.

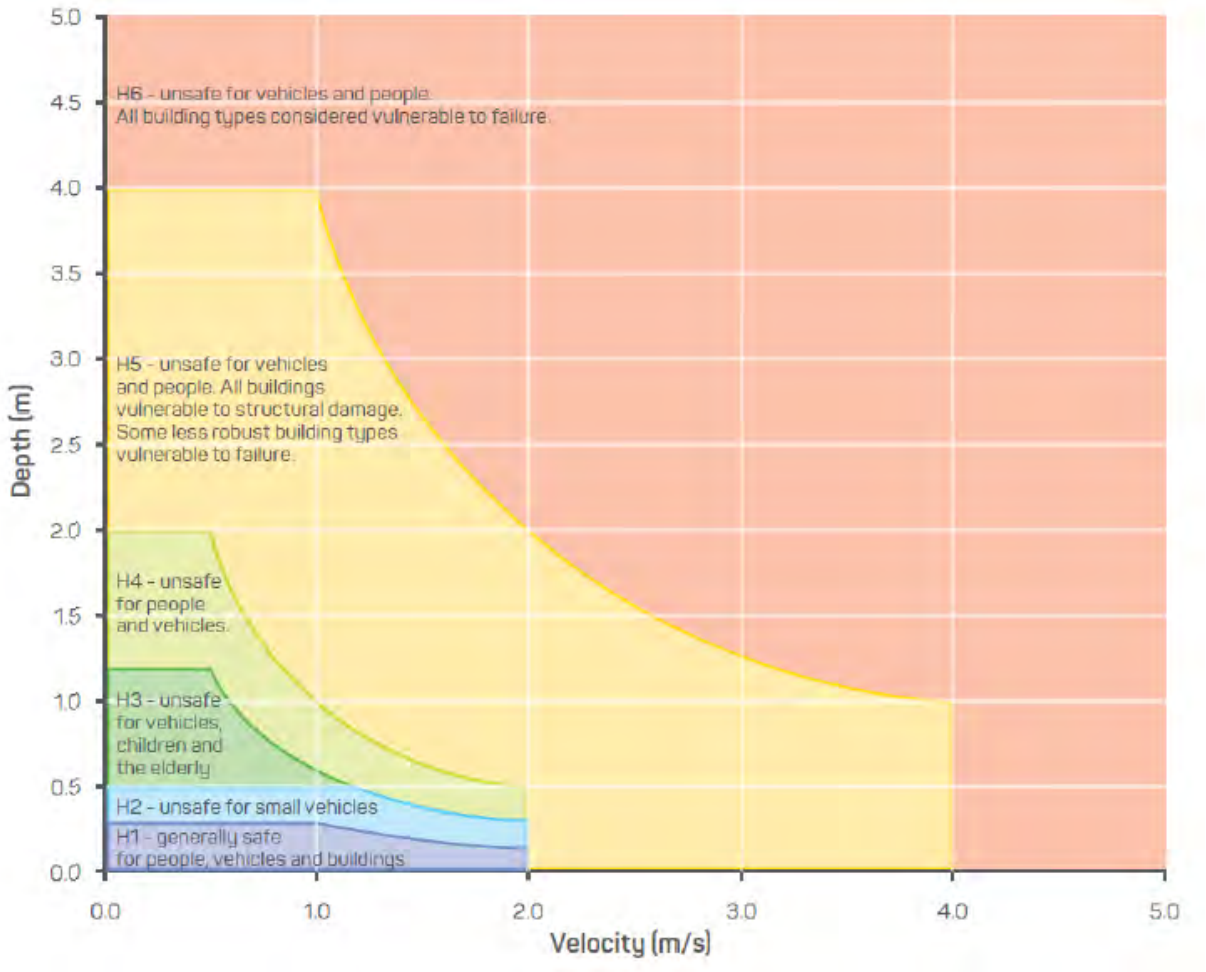

Figure 4.1 Flood hazard vulnerability curves (AIDR 2017)

Table 4.1 Flood hazard classification (AIDR 2017)

Flood Hazard Category	Flood Hazard Description
H1	Generally safe for people, vehicles and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for people and vehicles.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust building types vulnerable to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

4.2 Pre-Development Flood Behaviour

As per 2022 Council Model setup, the design flood levels in West Yamba and the WYURA site are determined by assuming coincidental occurrence of flood peak and storm tide peak in accordance with OEH (2015) guidelines. Consequently, the site is characterised by one single flood peak due to riverine flood inundation as opposed to the double flood peak due to riverine and storm tide inundation highlighted in the previous 2021 WYURA FIA. The riverine flood inundation of the WYURA site and adjacent areas is due to overtopping of the Clarence river banks and generally enters the WYURA from the south-west of the site.

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5 Flood Impact and Risk Assessment (FIRA)

5.1 Introduction

The flood impacts produced by the proposed WYURA development were assessed by comparing the model results in the pre- and post-development scenarios for the 10% AEP, 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP, 1% AEP CC1 and PMF events. The flood impacts were assessed in terms of changes in flood extent, level, flow velocity, flood hazard category, and frequency and duration of inundation between the pre- and post-development scenarios in accordance with Table 3 of the 2023 FIRA guidelines (DPE, 2023).

The present FIRA focused on the impacts generated by the combination of flood inundation from the Clarence River and storm tide events as defined in Council's flood study. The presented impacts do not cover any potential impacts which could result from localised stormwater runoff.

The impacts on flood level are presented as changes of ± 10mm or more. It is worth noting that the approach used in the present assessment maps impacts down to a finer tolerance when compared to the previous flood impact assessments undertaken for the WYURA, where the impacts were considered insignificant for changes in flood levels of ± 30mm.

5.2 Impact Results

Flood impact maps showing the changes in flood extent, level, flow velocity, flood hazard category and duration of inundation between the pre- and post-development scenario for all the analysed design flood events are provided in Annex C.

No adverse flood impacts on residential properties were identified in any of the analysed flood events. The flood impacts generated by the WYURA development are summarised below.

Changes in Flood Extent

No increase in flood extent were observed in any of the analysed flood events. The areas of the site characterised by the proposed filling which were shown to be inundated in the pre-development scenario are now shown to be dry.

Changes in Flood Level

No increase in flood levels affected residential properties in all the analysed flood events. The changes in flood levels affecting non-residential properties can be summarised as follows:

- No changes in 10% AEP flood level were observed in any adjacent properties. An increase in 10% AEP flood levels of 20mm was observed in the drain located along the south-east boundary of Golding Street MHE.

- No changes in 5% AEP flood level were observed in any adjacent properties. An increase in 5% AEP flood levels of 33mm is observed in the drain located along the south-east boundary of Golding Street MHE. A localised increase in flood levels of 28mm was observed on a 35m long section of Carrs Drive in proximity of the drain included in the Clifton Lifestyle MHE development. However, this increase in flood level did not change the flood hazard category of the road in this location, which is classified as H1 (i.e., generally safe for people and vehicles) in both the pre- and post-development scenarios.

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- No changes in flood level affected any residential properties in the 1% and 0.5% AEP events. A reduction in 0.5% AEP flood levels of 12mm was observed along the drain and portion of floodway located north of Lot 18 DP1090409.

- An increase in 0.2% AEP flood levels of 13mm was observed on the property surrounding St James Catholic Primary School located at 87 Carrs Drive. The increase in 0.2% AEP flood levels mainly affected the property surrounding the school and did not affect the school building footprint. The school grounds were already affected by flooding in the pre-development scenario, with 0.2% AEP flood depths ranging between 0.6m and 0.75m. Given that the increase in flood levels is very small compared to the pre-development flood depths, the flood hazard classification affecting the school did not change between the pre- and post-development scenarios. It is noted that the school property was affected by flood hazard category ranging between H2 (i.e., unsafe for small vehicles) and H3 (i.e., unsafe for vehicles, children and the elderly), therefore, the school should already be evacuated during a flood event of this magnitude.

- St James Catholic Primary School was also affected by an increase in flood levels of 24mm in the 1% AEP CC1 event. In this event, the property is affected by pre-development flood depths ranging between 0.8m and 1.3m and flood hazard category of H3 (i.e., unsafe for vehicles, children and the elderly). As such, it is expected that the school would be already closed or evacuated during a flood event of this magnitude. No changes in flood hazard category affected the school property between the pre- and post-development scenarios.

- A reduction in PMF flood levels ranging between 10mm and 22mm was observed on a series of residential properties located north-east of the proposed WYURA development.

Changes in Flow Velocity

The changes in flow velocity are summarised as follows:

- No changes in flow velocity were observed in the 10% and 5% AEP events.

- Increases in flow velocity ranging between 0.1m/s and 0.3m/s were observed along the drain located on the northern boundary of the development in the 1% and 0.5% AEP events.

- An increase in flow velocity of 0.18m/s was observed along Carrs Drive in the section which was upgraded as part of the Yamba Parklands development in the 0.5%, 0.2%, 1% AEP CC1 and PMF events. However, no changes in flood hazard category affected this section of Carrs Drive between the pre- and post-development scenarios as the level of the road has increased resulting in a lower flood depth.

- An Increase in flow velocity up to 0.4 m/s along a section of Miles Street was observed in the 1% AEP CC1 and PMF events. However, this section of the road is affected by a reduction in flood hazard of 1 category from H4 in the pre-development scenario to H3 in the post-development scenario as the level of the road has increased resulting in a lower flood depth.

Changes in Flood Hazard Category

The changes in flood hazard category are summarised as follows:

- No changes in flood hazard category were observed in the 10% and 5% AEP events.

- A reduction in flood hazard category from H3 in the pre-development scenario to H2 in the post-development scenario was observed along Carrs Drive and Miles Street in the 1% AEP event.

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- An increase in flood hazard category from H2 to H3 was observed within the new floodway expansion located east of Lot 18 DP1090409 in the 0.5%, 0.2% AEP and 1% AEP CC1 events.

- A reduction in flood hazard category from H3 to H2 was observed in some sections of Miles Street in the 0.5% and 0.2% AEP events. Even though there is an improvement in the overall flood hazard classification along Miles Street, it is noted that some sections of Miles Street still remain classified as H3 category, i.e. unsafe for vehicles, children and the elderly during the 0.5% and 0.2% AEP events.

- A reduction in flood hazard category from H4 to H3 was observed in a section of Miles Street in the 1% AEP CC1 event. Even though there is an improvement in the overall flood hazard classification along Miles Street, it is noted that some sections of Miles Street still remain classified as H4 category, i.e. unsafe for people and vehicles during the 1% AEP CC1 event.

- No changes in flood hazard category were observed in the PMF event. The reduction in flood hazard category affecting the proposed development fill areas is due to a reduction in flood depths occurring between the pre- and post-development conditions as a result of the filling.

Changes in Duration of Inundation

The changes in duration of inundation are minimal when compared to the duration of inundation in the pre-development scenario. The following key changes in the duration of inundation are observed:

- A significant reduction in duration of inundation of 75% was observed along Miles Street and a reduction of 65% was observed along Carrs Drive in the 1%, 0.5%, 0.2% AEP and 1% AEP CC1 events. This improvement is associated to the proposed road designs, which are characterised by higher ground elevations and by two lateral swales located on both sides of the roads that collect and discharge the stormwater runoff more efficiently than in the pre-development scenario.

- An increase in duration of inundation of 15% was observed along Golding Street in the 1% AEP event. It is noted that the duration of inundation affecting this road in the pre-development conditions ranges between 48 and 60 hours. The increase in duration is due to the low-lying ground elevations characterising this road, which create a pond where the water runoff is trapped a bit longer than in the pre-development scenario. It is noted that this road is affected by flood hazard category H3 (i.e., unsafe for vehicles, children and the elderly) in both the pre- and post-development scenarios.

- An increase in duration of inundation of 2% was observed at the Yamba Community Garden in the 1% AEP CC1 event.

Changes in Frequency of Inundation

No changes in frequency of inundation were observed throughout the study area.

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6 Conclusion

A FIRA was undertaken for the proposed development within WYURA by considering the cumulative impacts of all the development underway or proposed within the WYURA. The FIRA assessed the changes in flood extent, levels, flow velocity, flood hazard category, and duration and frequency of inundation for the 10%, 5%, 1%, 0.5%, 0.2%, 1% AEP CC1 and PMF design events. The flood modelling undertaken to inform the present FIRA was based on the *Lower Clarence River Model Update 2022* (BMT, 2023).

The assessment focused on the impacts due to the combination of Clarence River inundation and storm tide inundation. The model assumed a simultaneous occurrence of riverine flood peak and storm tide peak, therefore, the inundation of the WYURA development mainly occurs from the south-west.

No flood impacts of the proposed development were observed on residential properties in any of the analysed flood events.

An increase in flood levels of 13mm and 24mm was observed at St James Catholic Primary School in the 0.2% AEP and 1% AEP CC1 events, respectively. It is noted that the school is already inundated in the pre-development conditions by flood depths ranging between 0.6m and 0.75m in the 0.2% AEP, and between 0.8m and 1.3m in the 1% AEP CC1 event. Given that the increase in flood levels is very small compared to the established flood depths, no changes in flood hazard category were observed between the pre- and post-development conditions. The school property is already affected by flood hazard category of H3 (i.e., unsafe for vehicles, children and the elderly) in both the 0.2% and 1% AEP CC1 events, therefore, it is expected that the school would be closed or already evacuated during flood events of this magnitude. It is worth noting that the flood level at the school starts to rise 57 hours from the beginning of the 0.2% AEP flood event and that the flood peak is reached after 96 hours from the beginning of the event, thus providing sufficient time for flood warning and evacuation of the school when required.

No significant changes in flow velocity, flood hazard category, duration and frequency of inundation are observed throughout the study area.

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7 References

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Annex A Flood Maps of Pre-Development Conditions

Table A.1. Summary of flood maps included in Annex A

Figure ID	Figure Title
A-1	10% AEP Peak Flood Level | Pre-Development Conditions
A-2	10% AEP Peak Flood Depth | Pre-Development Conditions
A-3	10% AEP Peak Flow Velocity | Pre-Development Conditions
A-4	10% AEP Peak Flood Hazard | Pre-Development Conditions
A-5	5% AEP Peak Flood Level | Pre-Development Conditions
A-6	5% AEP Peak Flood Depth | Pre-Development Conditions
A-7	5% AEP Peak Flow Velocity | Pre-Development Conditions
A-8	5% AEP Peak Flood Hazard | Pre-Development Conditions
A-9	1% AEP Peak Flood Level | Pre-Development Conditions
A-10	1% AEP Peak Flood Depth | Pre-Development Conditions
A-11	1% AEP Peak Flow Velocity | Pre-Development Conditions
A-12	1% AEP Peak Flood Hazard | Pre-Development Conditions
A-13	0.5% AEP Peak Flood Level | Pre-Development Conditions
A-14	0.5% AEP Peak Flood Depth | Pre-Development Conditions
A-15	0.5% AEP Peak Flow Velocity | Pre-Development Conditions
A-16	0.5% AEP Peak Flood Hazard | Pre-Development Conditions
A-17	0.2% AEP Peak Flood Level | Pre-Development Conditions
A-18	0.2% AEP Peak Flood Depth | Pre-Development Conditions
A-19	0.2% AEP Peak Flow Velocity | Pre-Development Conditions
A-20	0.2% AEP Peak Flood Hazard | Pre-Development Conditions
A-21	1% AEP 2100 Climate Change Scenario 1 Peak Flood Level | Pre-Development Conditions
A-22	1% AEP 2100 Climate Change Scenario 1 Peak Flood Depth | Pre-Development Conditions
A-23	1% AEP 2100 Climate Change Scenario 1 Peak Flow Velocity | Pre-Development Conditions
A-24	1% AEP 2100 Climate Change Scenario 1 Peak Flood Hazard | Pre-Development Conditions
A-25	PMF Peak Flood Level | Pre-Development Conditions
A-26	PMF AEP Peak Flood Depth | Pre-Development Conditions
A-27	PMF AEP Peak Flow Velocity | Pre-Development Conditions
A-28	PMF AEP Peak Flood Hazard | Pre-Development Conditions

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Contours
0.05m
Flood Level (mAHD)
<= 1.1
1.1 - 1.2
1.2 - 1.3
1.3 - 1.4
> 1.4

Legend

Title:
10% AEP Peak Flood Level
Pre-Development Scenario

Drawing: **A-1**

Rev: **A**

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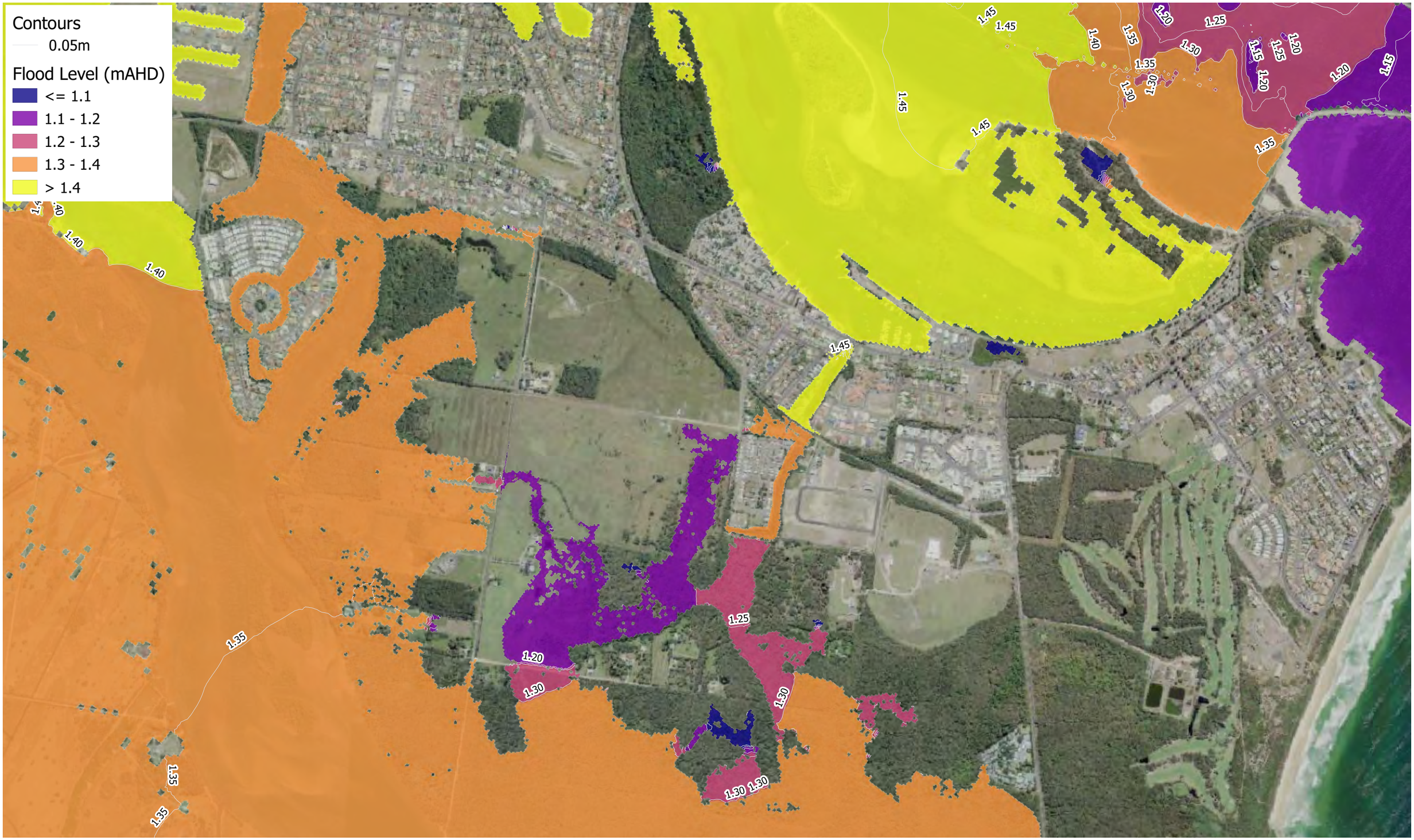
0 300 600 m

BMT
www.bmt.org

Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Title:
5% AEP Peak Flood Level
Pre-Development Scenario

Drawing: **A-2**

Rev: **A**

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Title:
1% AEP Peak Flood Level
Pre-Development Scenario

Drawing: **A-3**

Rev: **A**

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Contours

0.05m

Flood Level (mAHD)

- <= 2.0
- 2.0 - 2.2
- 2.2 - 2.4
- 2.4 - 2.6
- > 2.6

Legend

Title:

0.5% AEP Peak Flood Level
Pre-Development Scenario

Drawing: **A-4**

Rev: **A**

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Title:
0.2% AEP Peak Flood Level
Pre-Development Scenario

Drawing: **A-5**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz

Contours
0.05m
Flood Level (mAHD)
<= 2.8
2.8 - 3.0
3.0 - 3.2
3.2 - 3.4
> 3.4

Legend

Title:
1% AEP 2100 Climate Change Scenario 1 Peak Flood Level Pre-Development Scenario

Drawing: **A-6**

Rev: **A**

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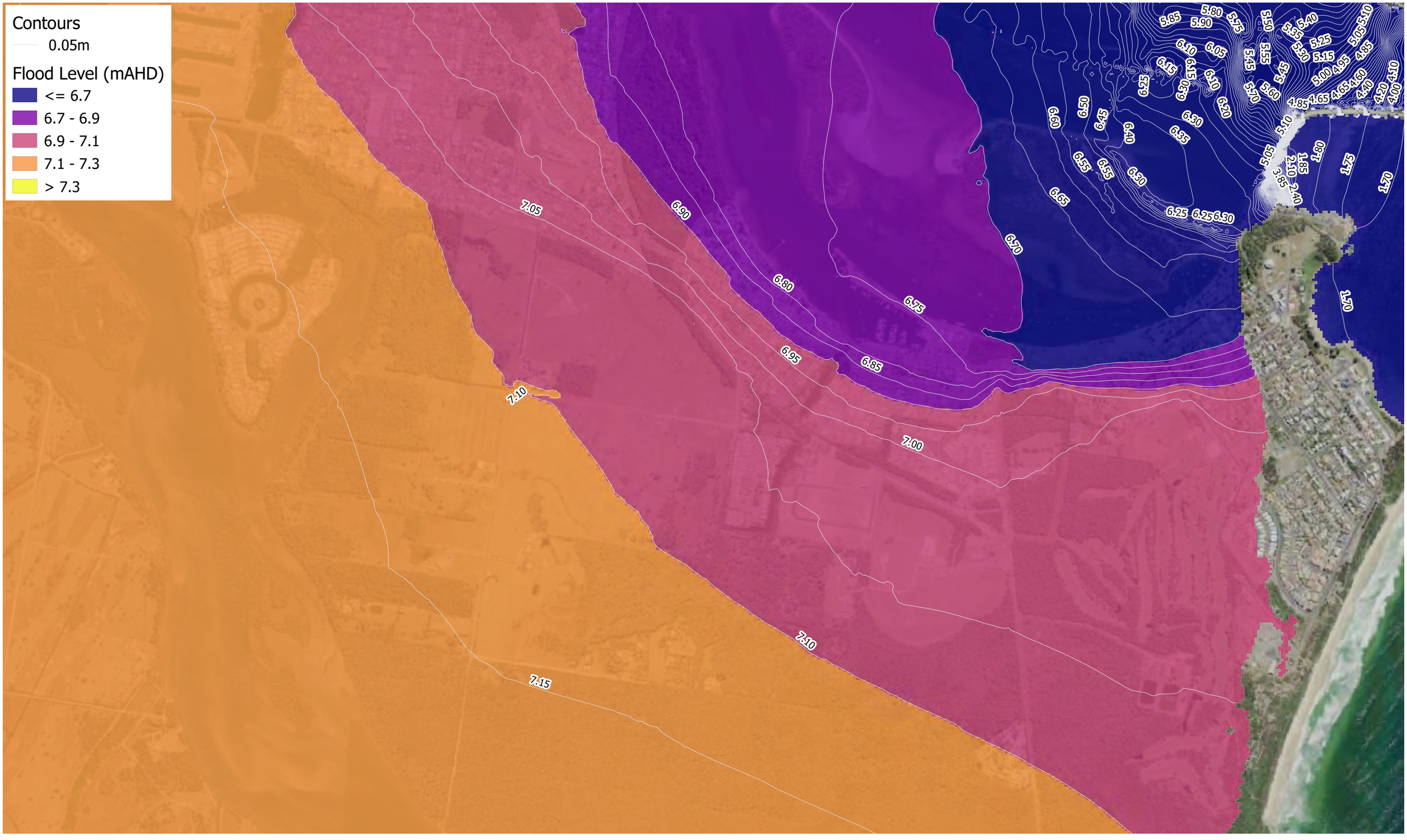

Legend

Title:
PMF Peak Flood Level
Pre-Development Scenario

Drawing: **A-7**

Rev: **A**

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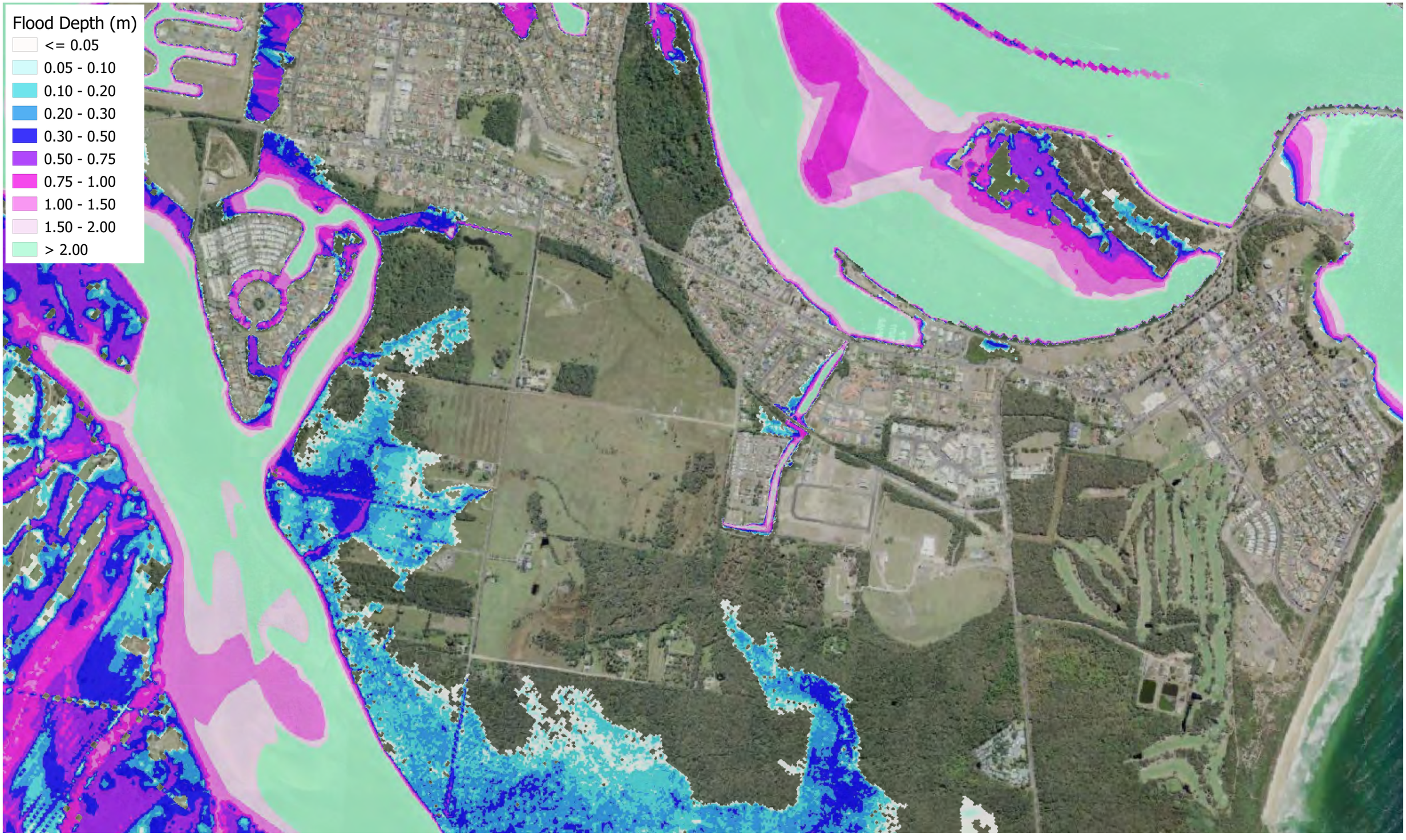

Legend

Title:
10% AEP Peak Flood Depth
Pre-Development Scenario

Drawing: **A-8**

Rev: **A**

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0 300 600 m

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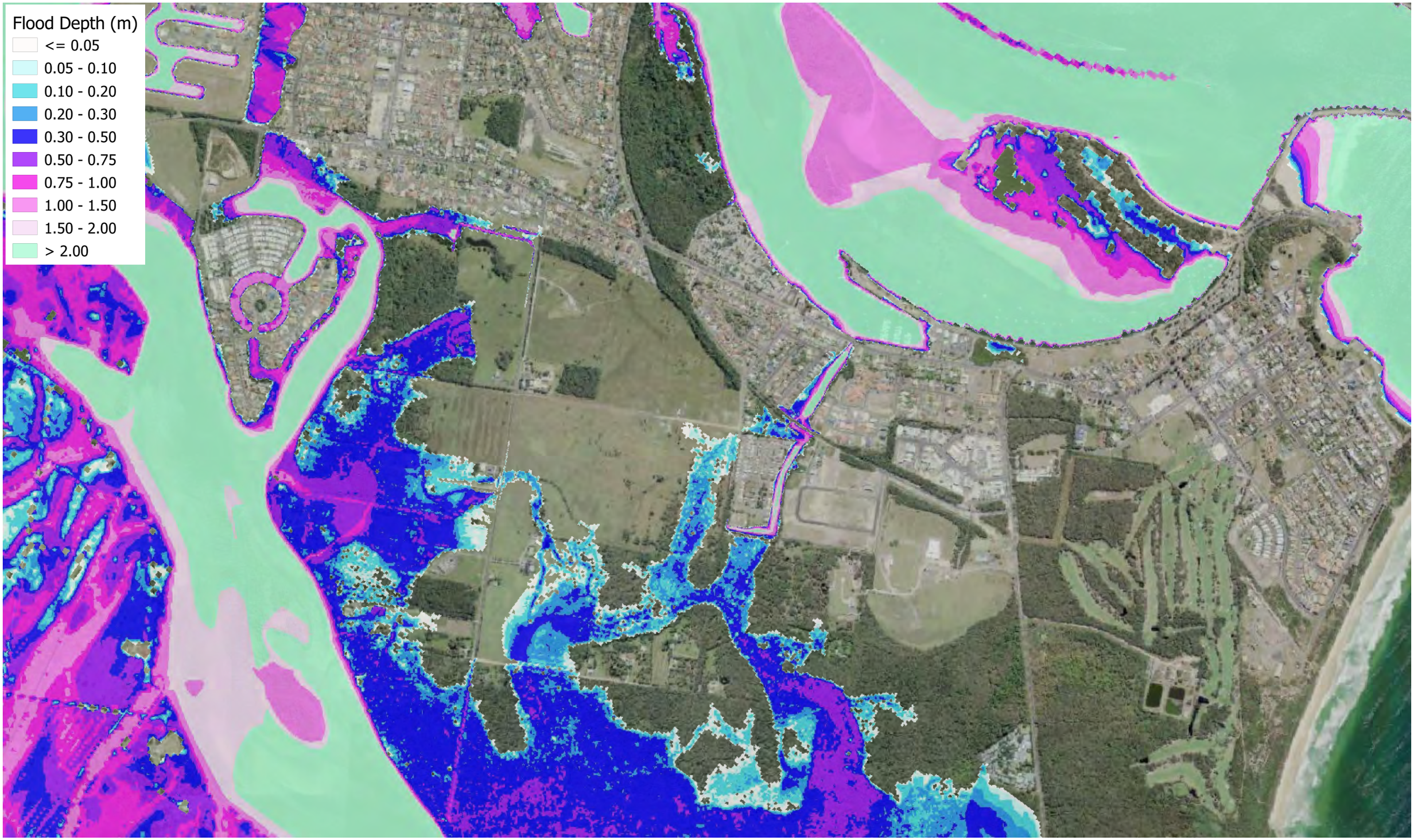

Legend

Title:
5% AEP Peak Flood Depth
Pre-Development Scenario

Drawing: **A-9**

Rev: **A**

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0 300 600 m

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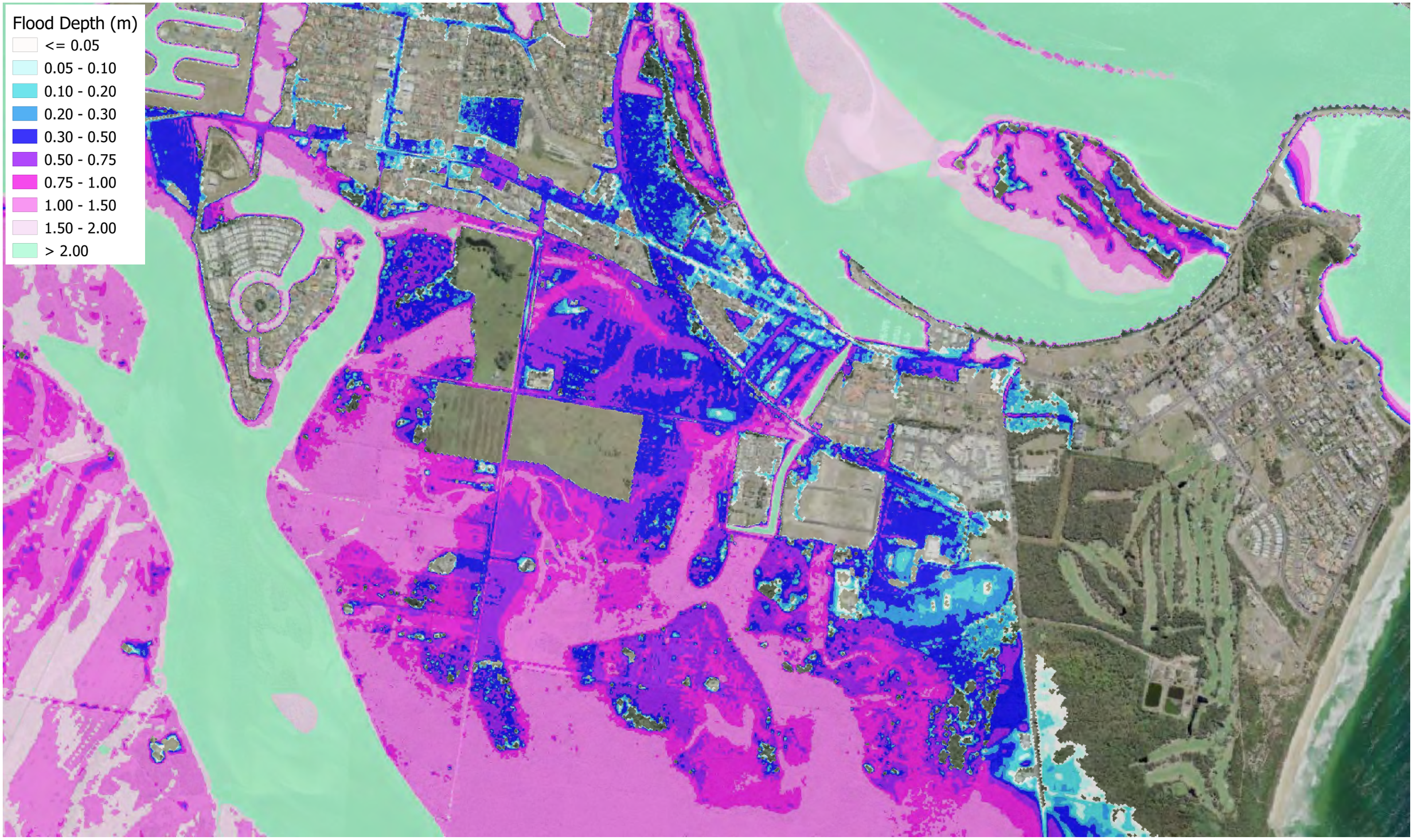

Legend

Title:
1% AEP Peak Flood Depth
Pre-Development Scenario

Drawing: **A-10**

Rev: **A**

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Legend

Title:
0.5% AEP Peak Flood Depth
Pre-Development Scenario

Drawing: **A-11**

Rev: **A**

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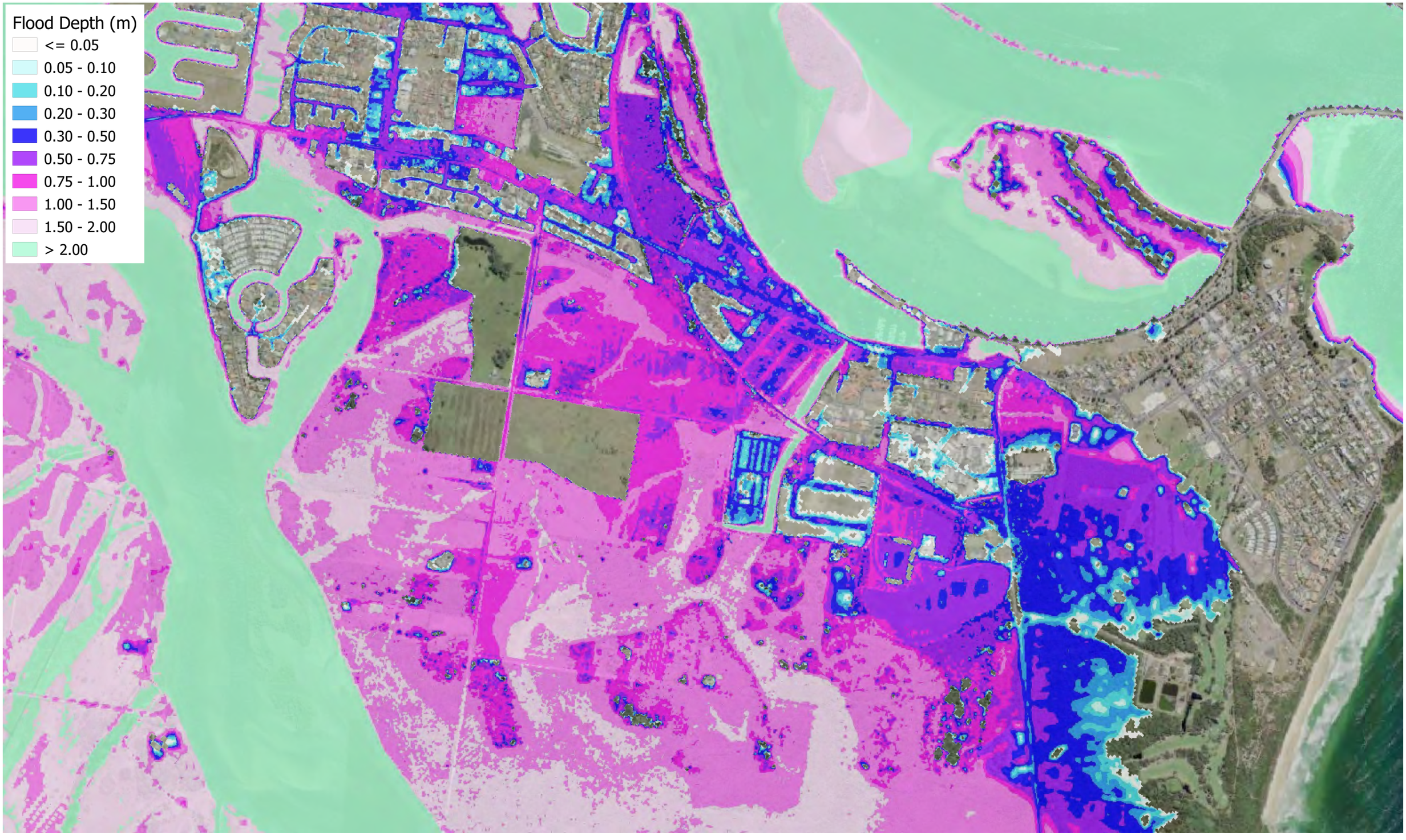

Legend

Title:
0.2% AEP Peak Flood Depth
Pre-Development Scenario

Drawing: **A-12**

Rev: **A**

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Legend

Title:
1% AEP 2100 Climate Change Scenario 1 Peak Flood Depth Pre-Development Scenario

Drawing: **A-13**

Rev: **A**

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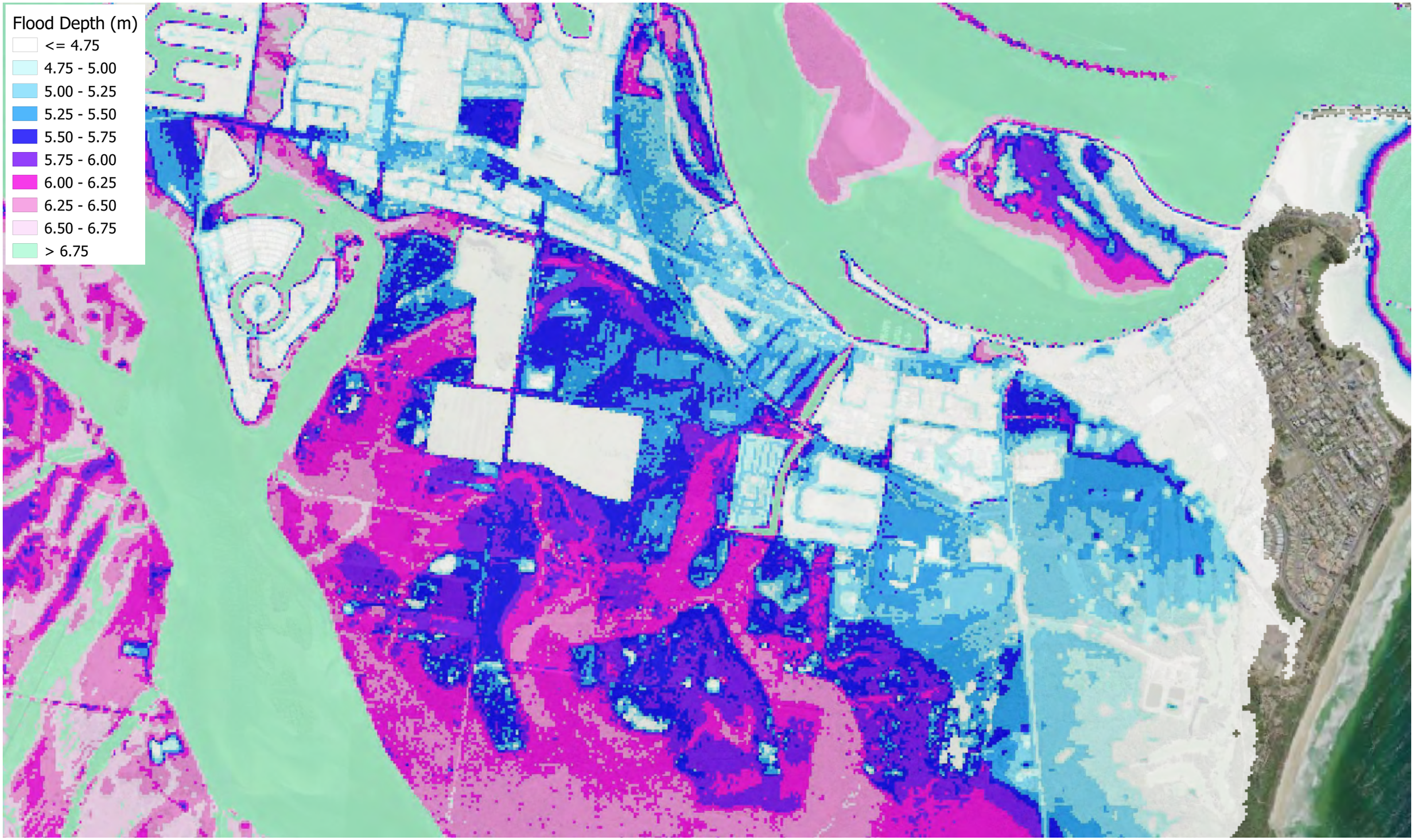

Legend

Title:
PMF Peak Flood Depth
Pre-Development Scenario

Drawing: **A-14**

Rev: **A**

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Title:
10% AEP Peak Flow Velocity
Pre-Development Scenario

Drawing: **A-15**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Title:
5% AEP Peak Flow Velocity
Pre-Development Scenario

Drawing: **A-16**

Rev: **A**

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Legend

Title:
1% AEP Peak Flow Velocity
Pre-Development Scenario

Drawing: **A-17**

Rev: **A**

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Legend

Title:
0.5% AEP Peak Flow Velocity Pre-Development Scenario

Drawing: **A-18**

Rev: **A**

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Legend

Title:
0.2% AEP Peak Flow Velocity
Pre-Development Scenario

Drawing: **A-19**

Rev: **A**

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Legend

Title:
1% AEP 2100 Climate Change Scenario 1 Peak Flow Velocity Pre-Development Scenario

Drawing: **A-20**

Rev: **A**

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Legend

Title:
PMF Peak Flow Velocity
Pre-Development Scenario

Drawing: **A-21**

Rev: **A**

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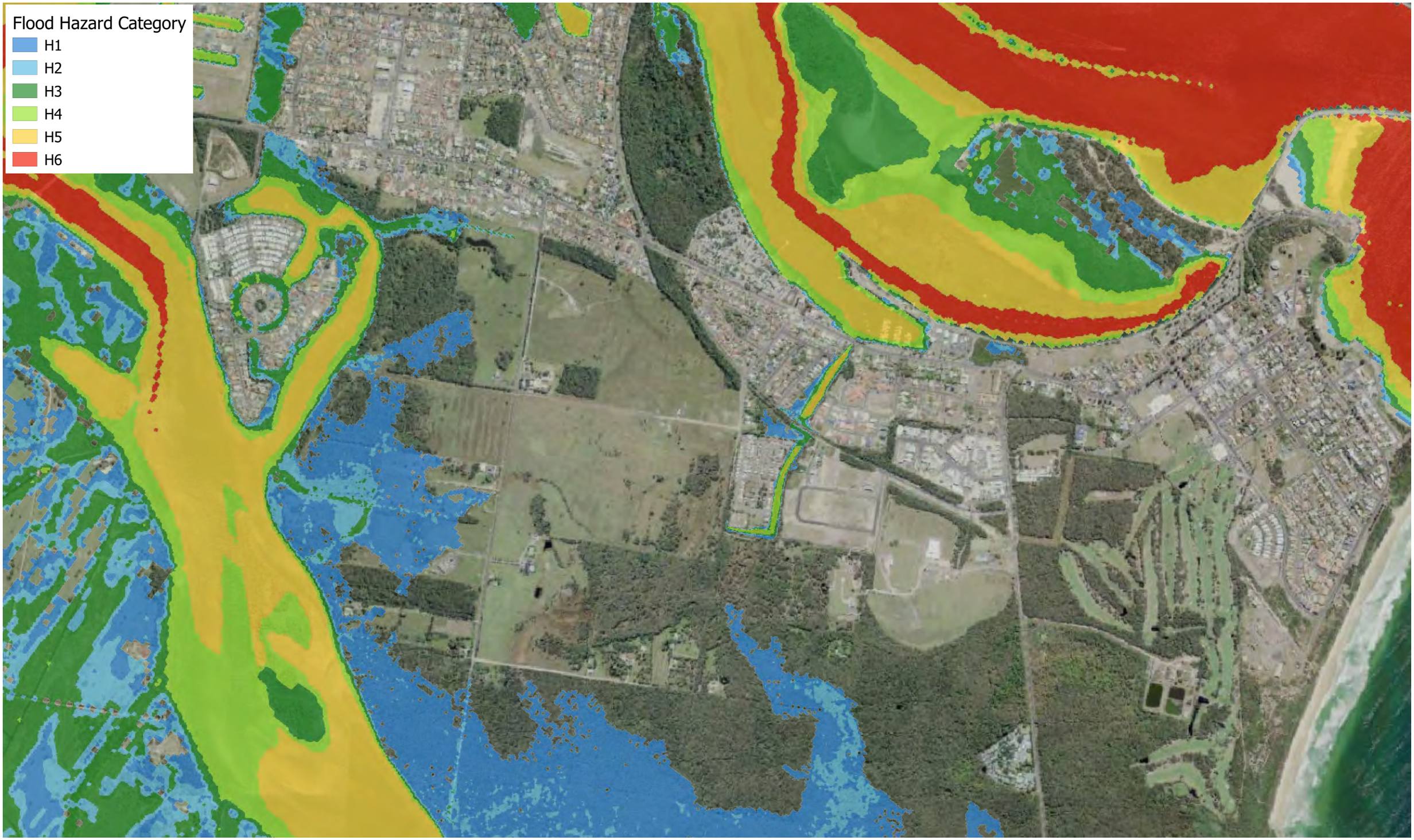

Legend

Title:
10% AEP Peak Flood Hazard
Pre-Development Scenario

Drawing: **A-22**

Rev: **A**

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0 300 600 m

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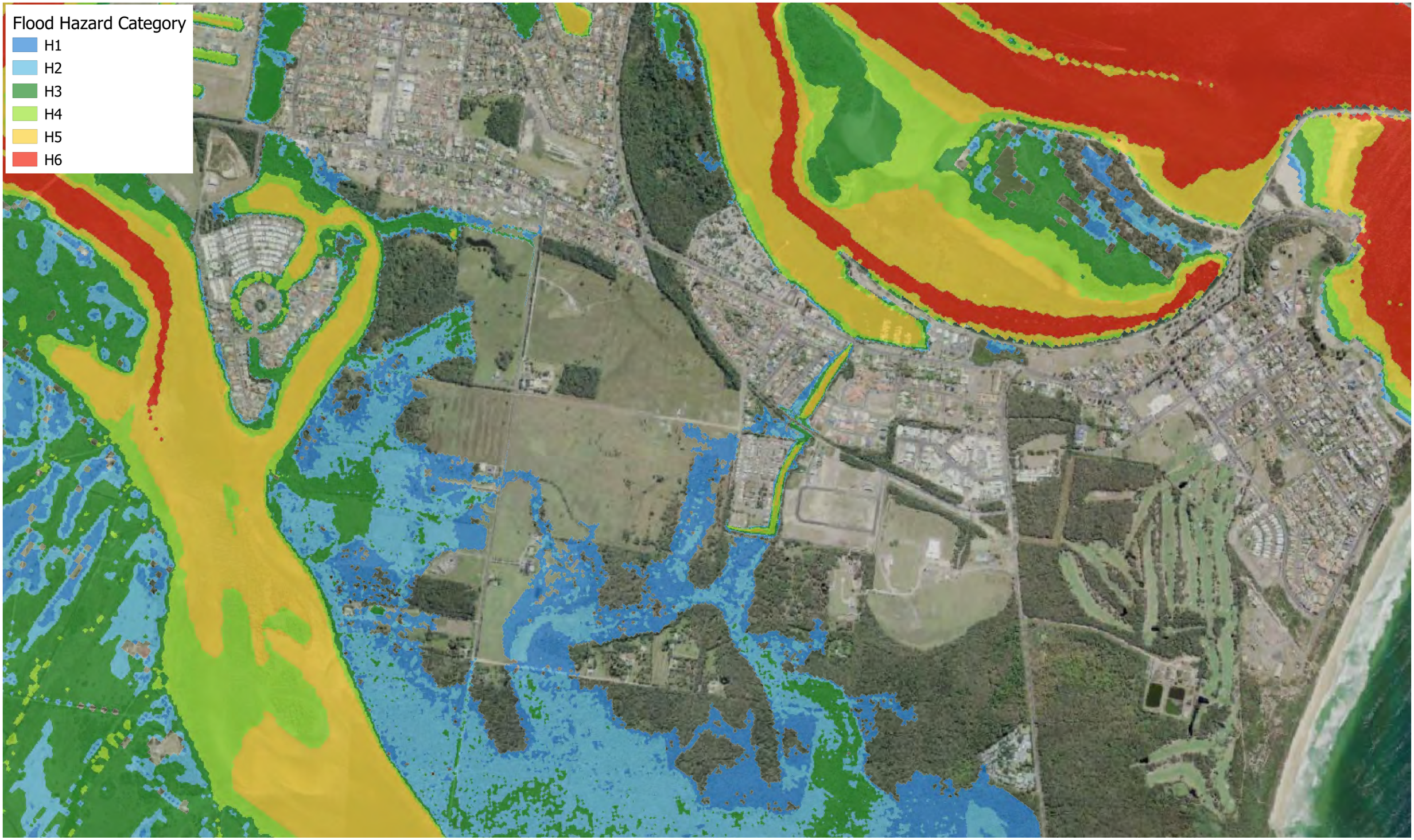

Legend

Title:
5% AEP Peak Flood Hazard
Pre-Development Scenario

Drawing: **A-23**

Rev: **A**

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0 300 600 m

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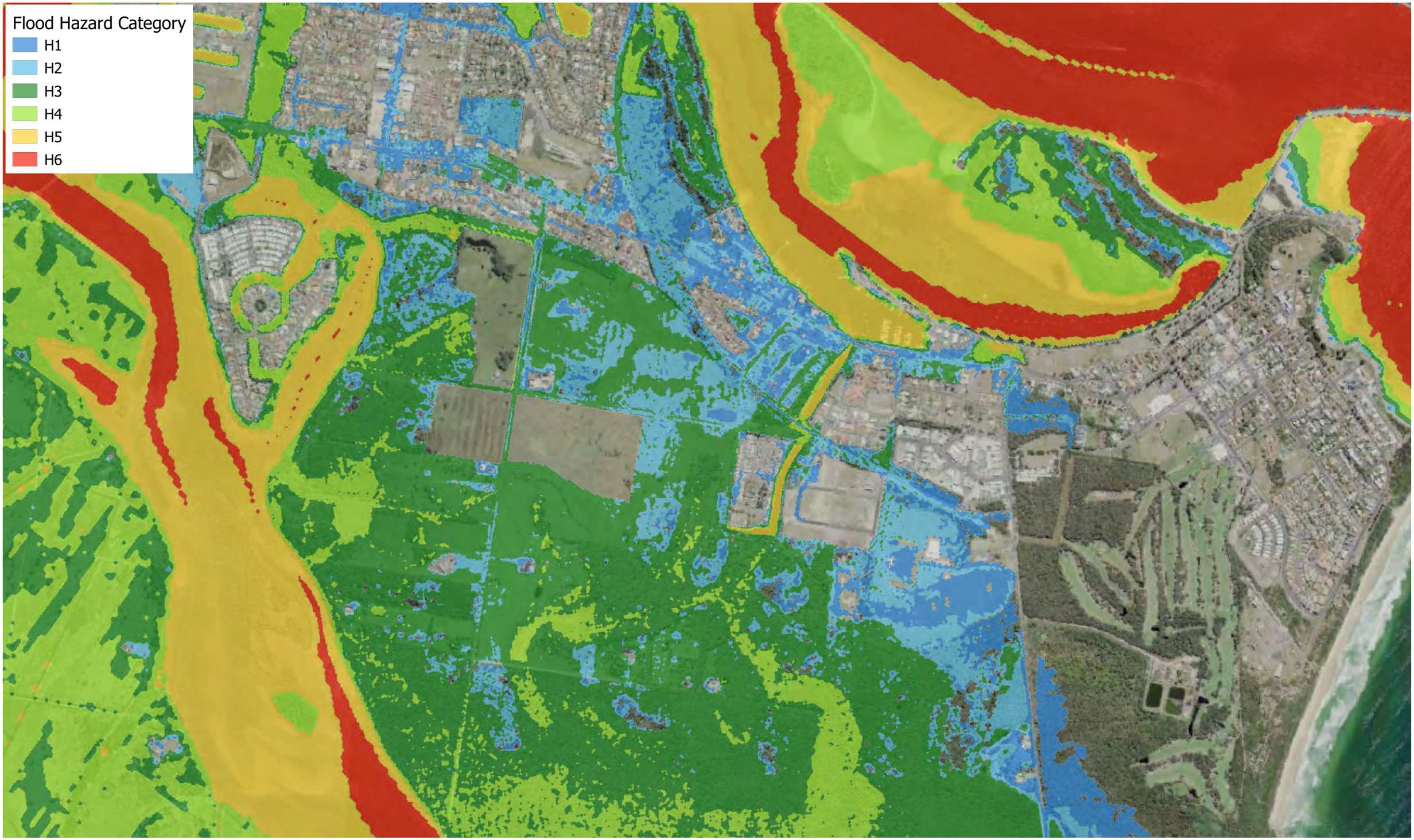

Legend

Title:
1% AEP Peak Flood Hazard
Pre-Development Scenario

Drawing: **A-24**

Rev: **A**

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0 300 600 m

BMT
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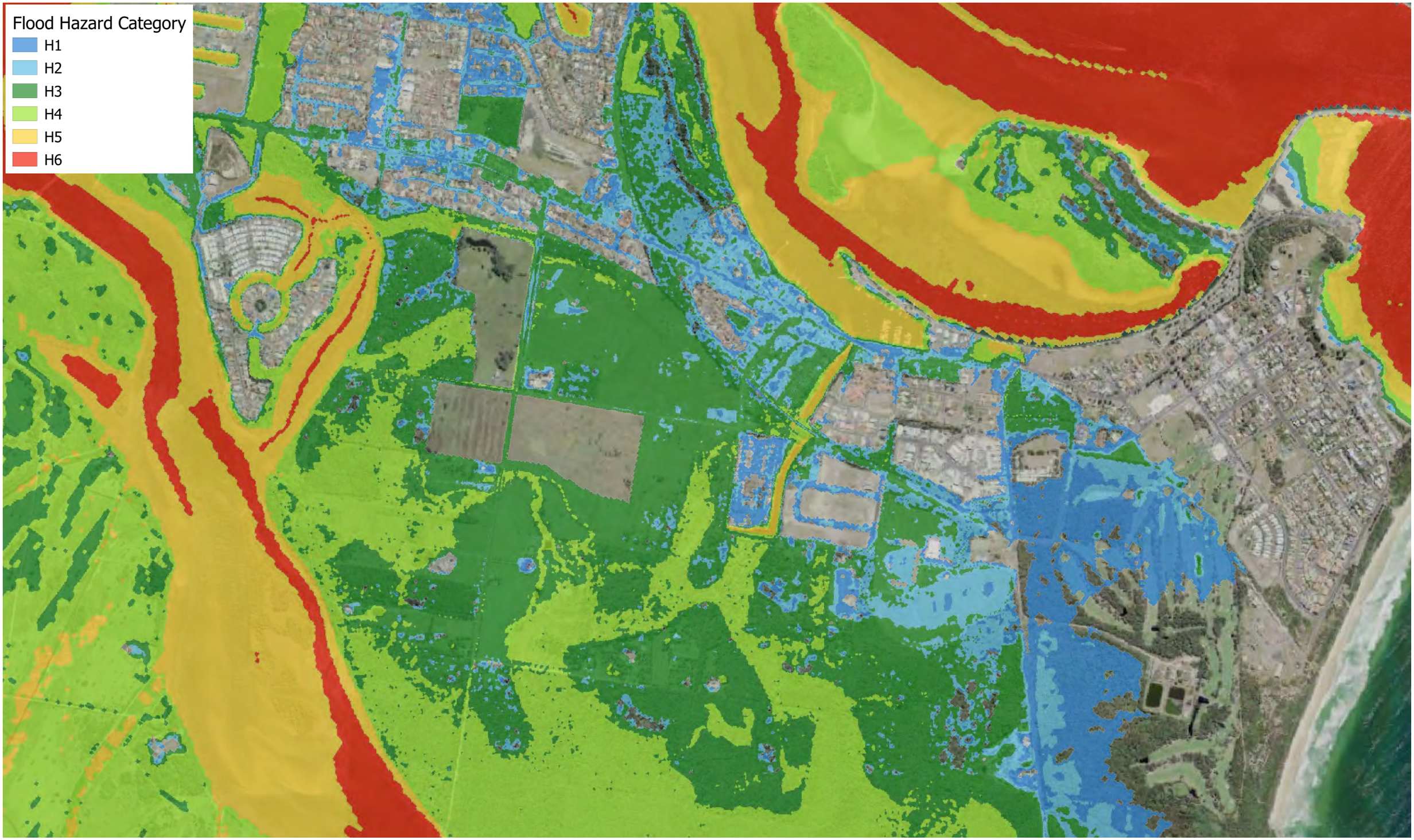

Legend

Title:
0.5% AEP Peak Flood Hazard Pre-Development Scenario

Drawing: **A-25**

Rev: **A**

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0 300 600 m

BMT
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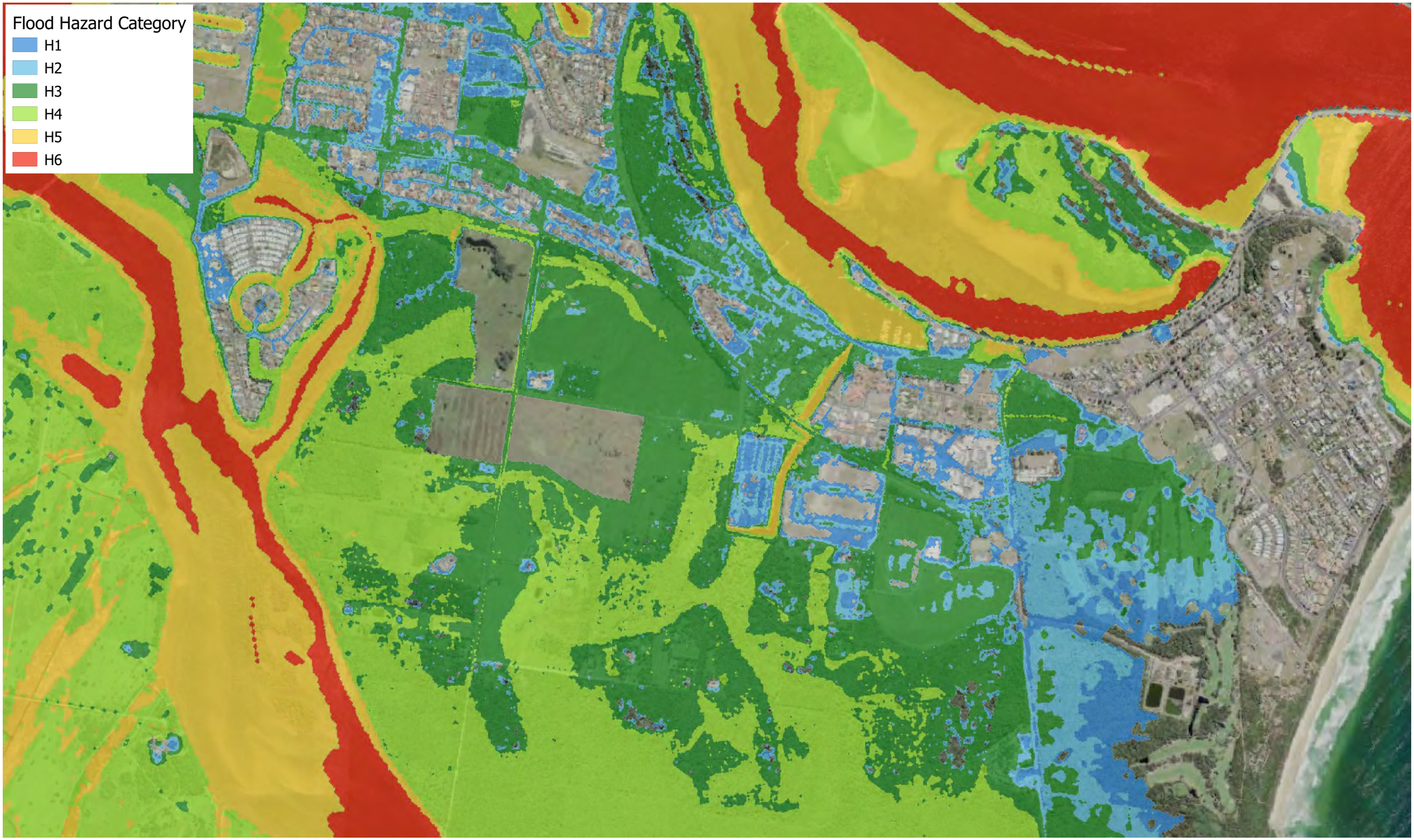

Legend

Title:
0.2% AEP Peak Flood Hazard
Pre-Development Scenario

Drawing: **A-26**

Rev: **A**

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0 300 600 m

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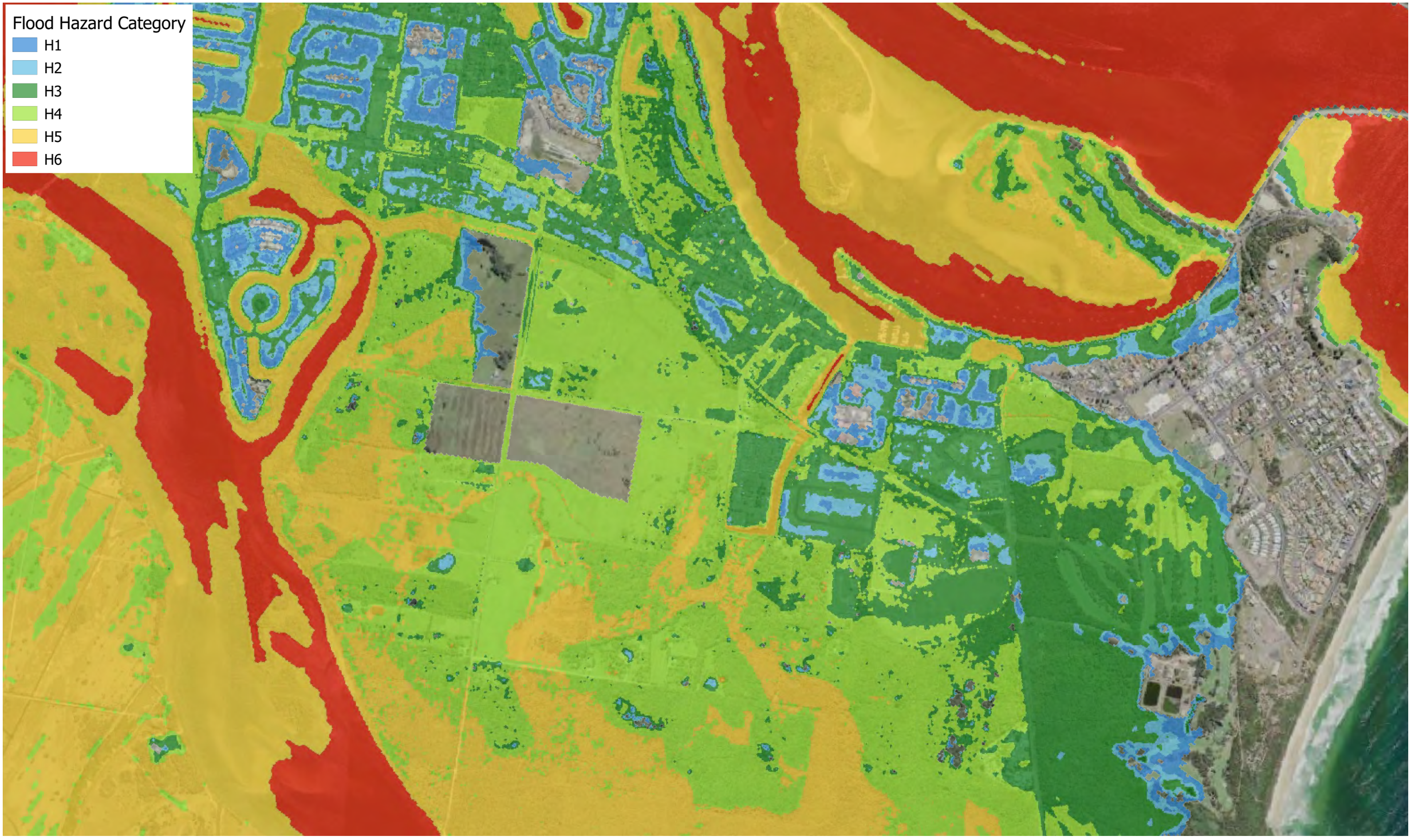

Legend

Title:
1% AEP 2100 Climate Change Scenario 1 Peak Flood Hazard Pre-Development Scenario

Drawing: **A-27**

Rev: **A**

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0 300 600 m

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Legend

Title:
PMF Peak Flood Hazard
Pre-Development Scenario

Drawing: **A-28**

Rev: **A**

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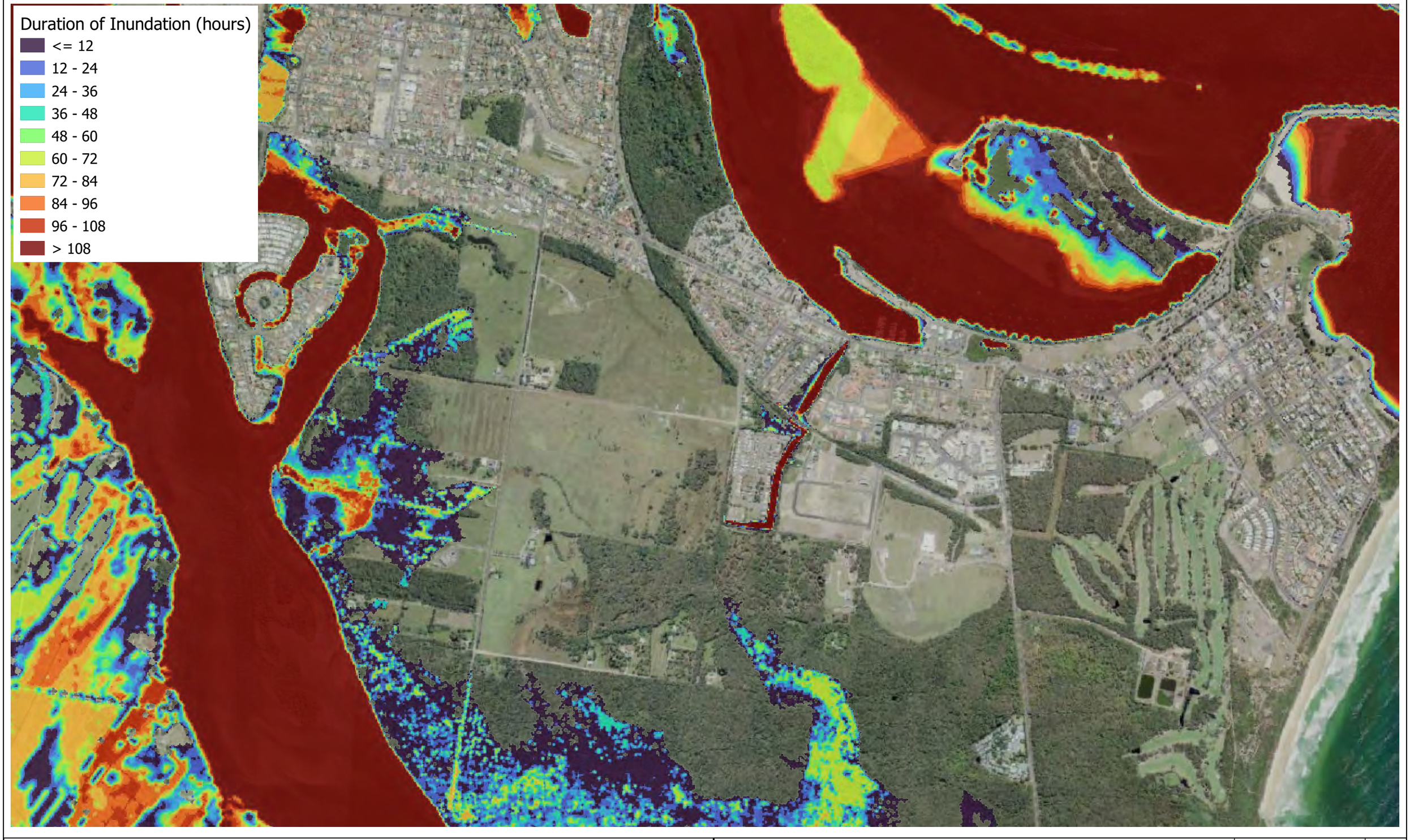

Legend

Title:
10% AEP Duration of Inundation
Pre-Development Scenario

Drawing: **A-29**

Rev: **A**

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0 300 600 m

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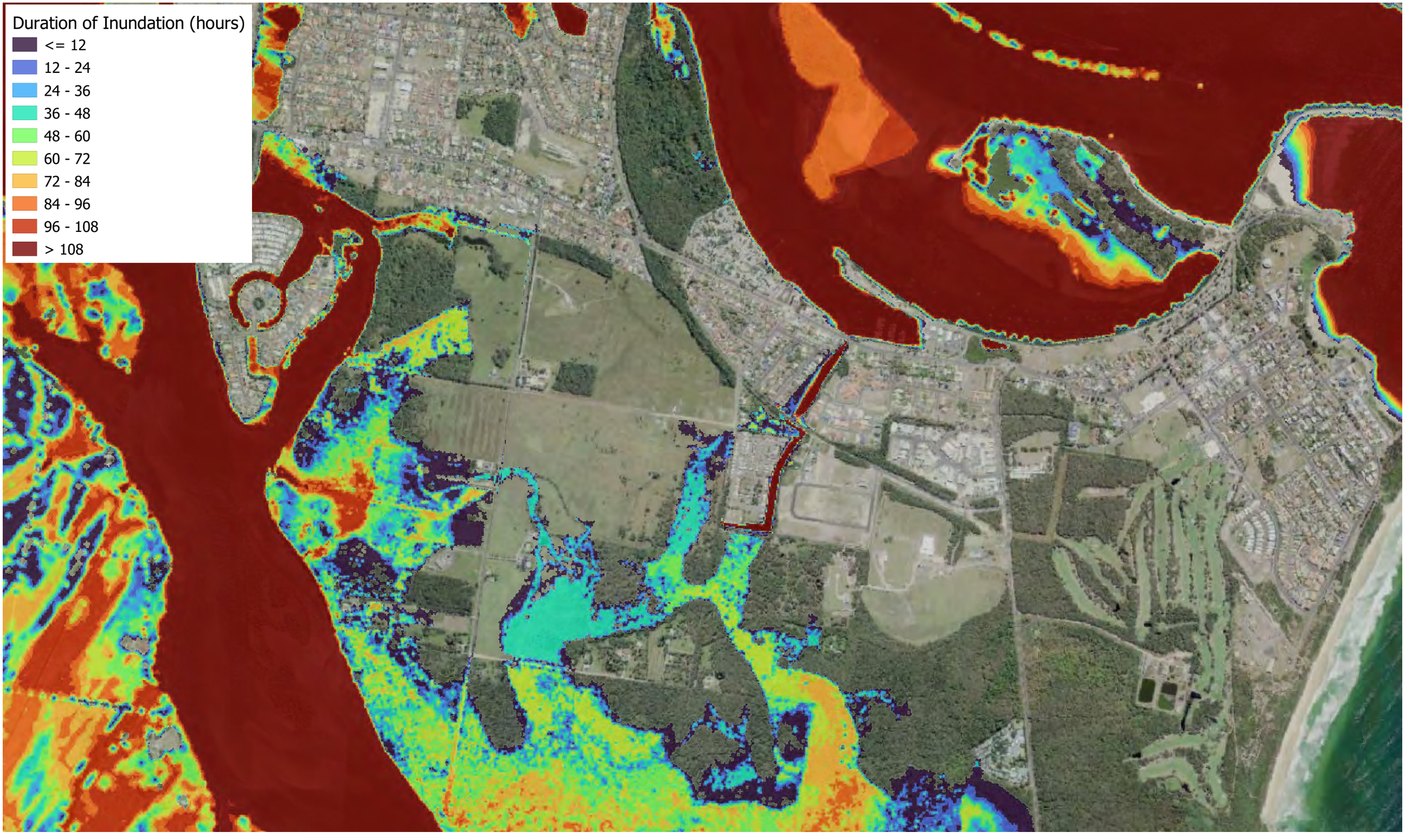
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Title:
5% AEP Duration of Inundation
Pre-Development Scenario

Drawing: **A-30**

Rev: **A**

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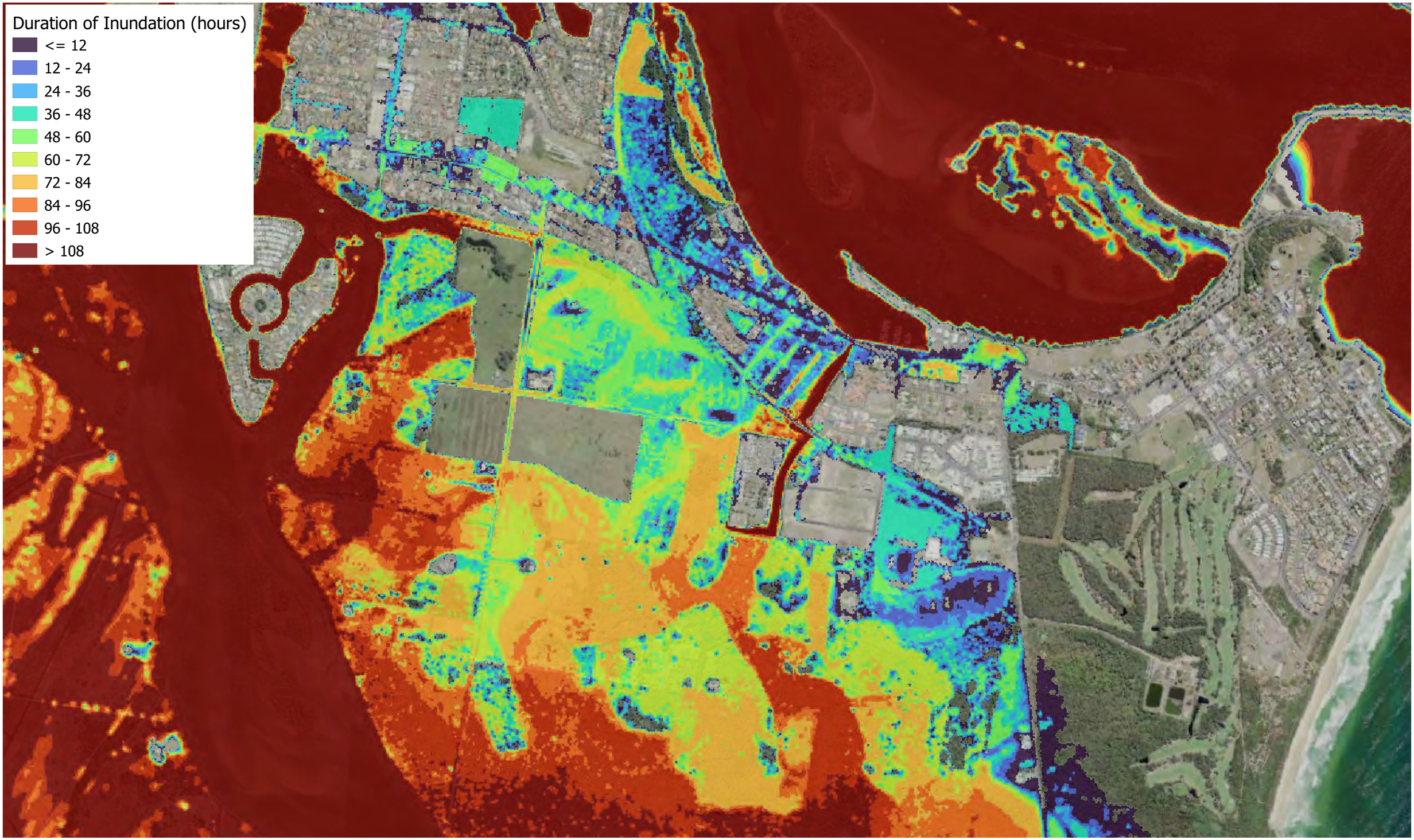
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Title:
1% AEP Duration of Inundation
Pre-Development Scenario

Drawing: **A-31**

Rev: **A**

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0 300 600 m

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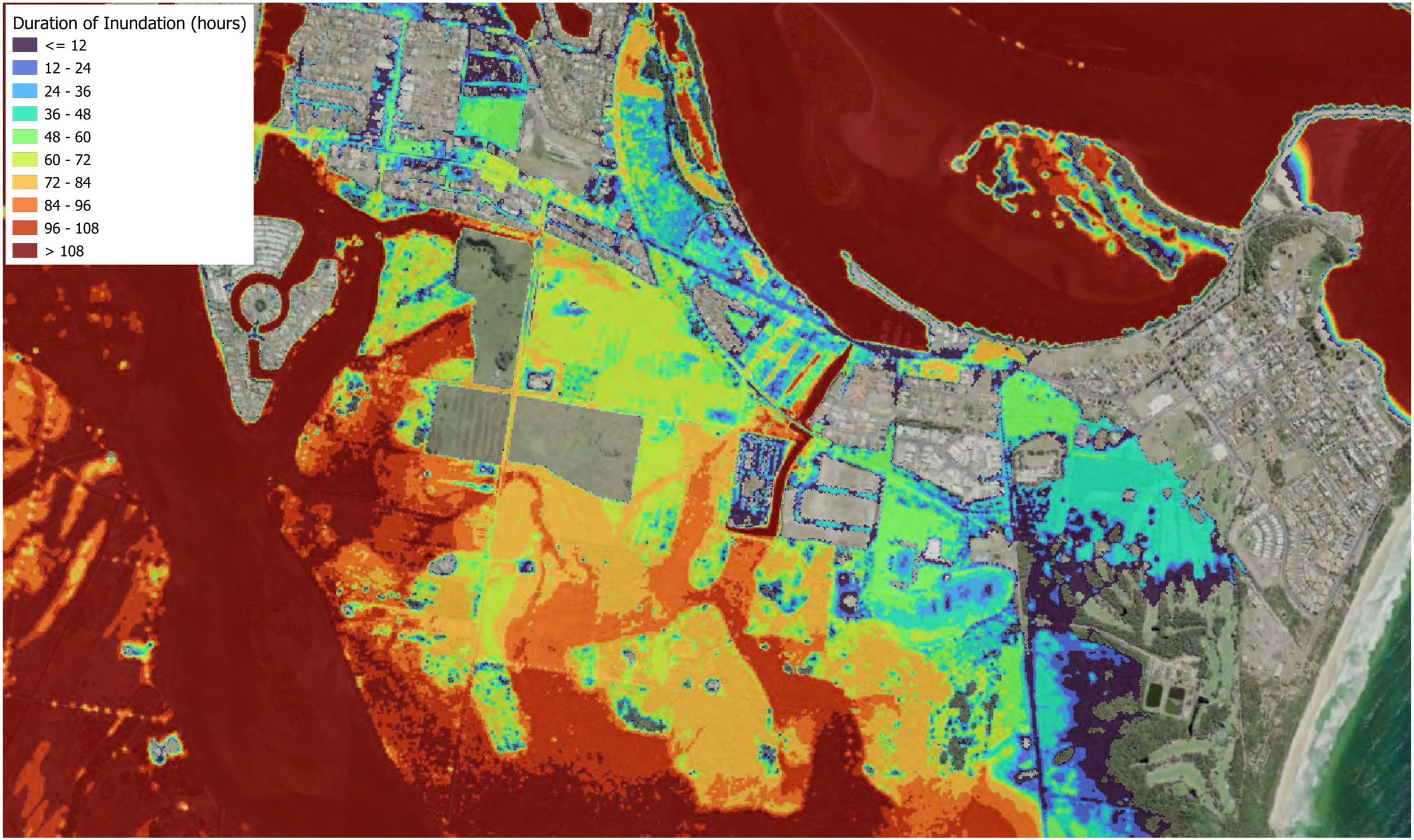
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Title:
0.5% AEP Duration of Inundation Pre-Development Scenario

Drawing: **A-32**

Rev: **A**

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0 300 600 m

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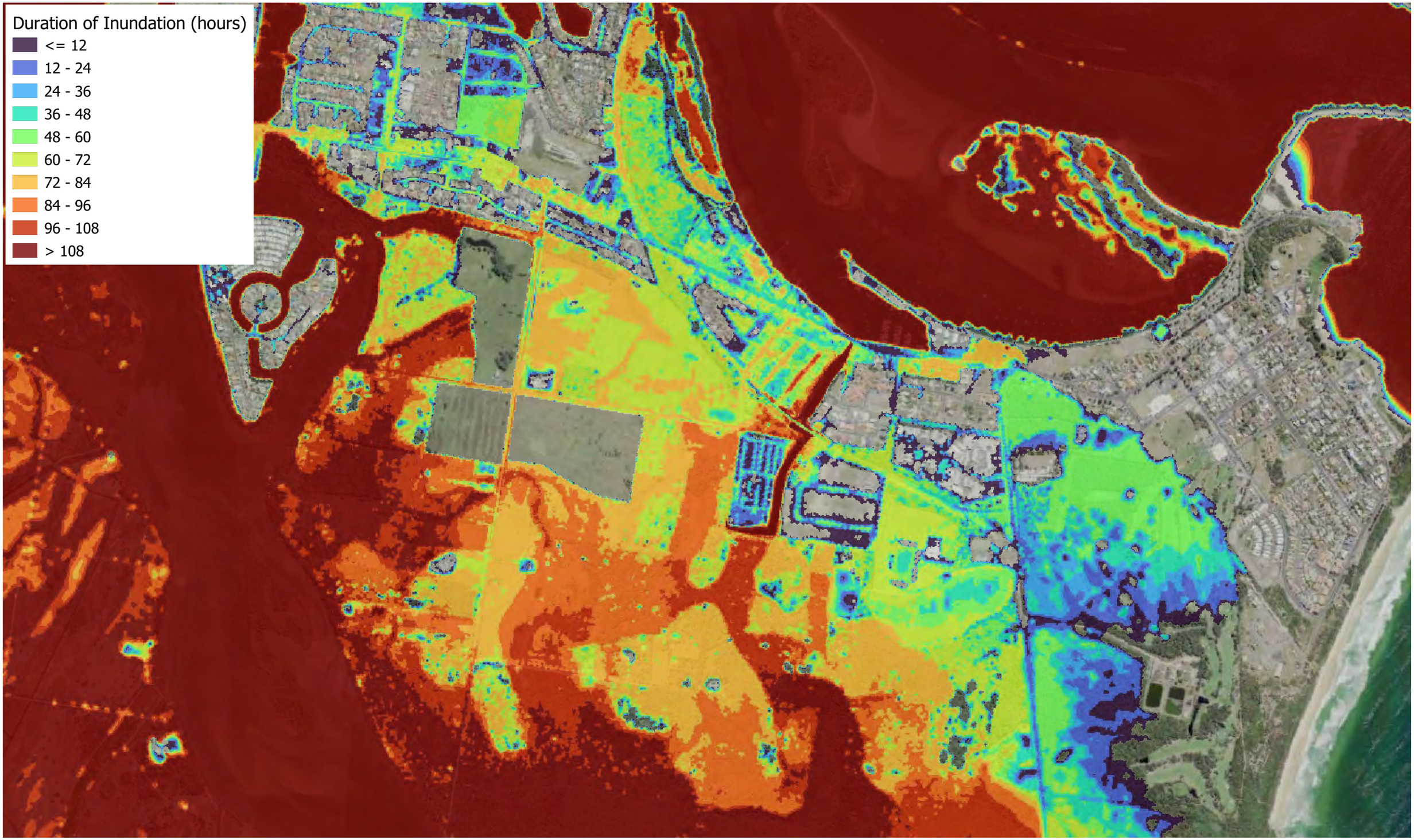
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Title:
0.2% AEP Duration of Inundation
Pre-Development Scenario

Drawing: **A-33**

Rev: **A**

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0 300 600 m

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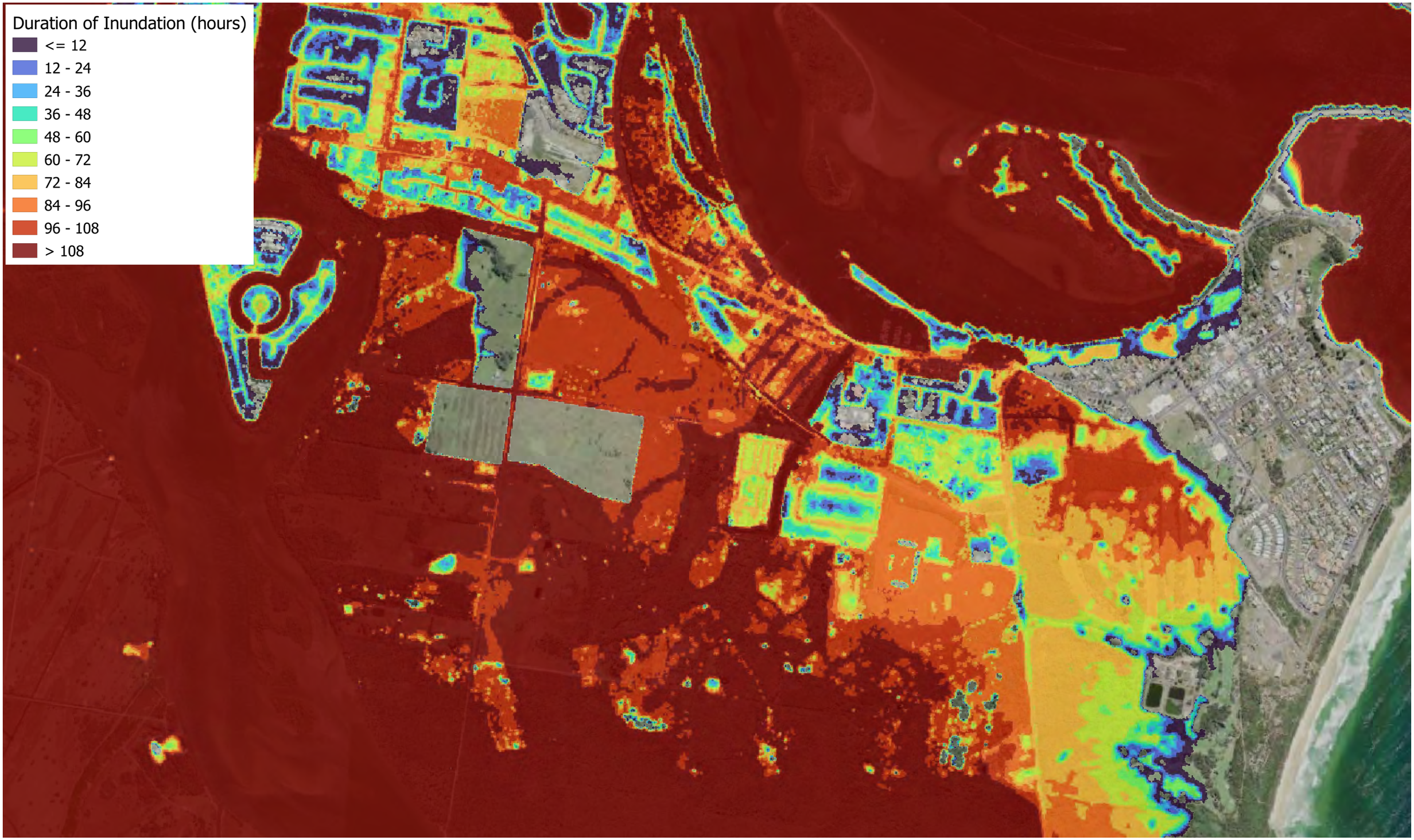
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Title:
1% AEP 2100 Climate Change Scenario 1 Duration of Inundation

Drawing: **A-34**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Title:
PMF Duration of Inundation
Pre-Development Scenario

Drawing: **A-35**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Pre-development_scenario\West_Yamba_MGA_zn56.qgz

Annex B Flood Maps of Post-Development Conditions

Table B.1. Summary of flood maps included in Annex B

Figure ID	Figure Title
B-1	10% AEP Peak Flood Level | Post-Development Conditions
B-2	10% AEP Peak Flood Depth | Post-Development Conditions
B-3	10% AEP Peak Flow Velocity | Post-Development Conditions
B-4	10% AEP Peak Flood Hazard | Post-Development Conditions
B-5	5% AEP Peak Flood Level | Post-Development Conditions
B-6	5% AEP Peak Flood Depth | Post-Development Conditions
B-7	5% AEP Peak Flow Velocity | Post-Development Conditions
B-8	5% AEP Peak Flood Hazard | Post-Development Conditions
B-9	1% AEP Peak Flood Level | Post-Development Conditions
B-10	1% AEP Peak Flood Depth | Post-Development Conditions
B-11	1% AEP Peak Flow Velocity | Post-Development Conditions
B-12	1% AEP Peak Flood Hazard | Post-Development Conditions
B-13	0.5% AEP Peak Flood Level | Post-Development Conditions
B-14	0.5% AEP Peak Flood Depth | Post-Development Conditions
B-15	0.5% AEP Peak Flow Velocity | Post-Development Conditions
B-16	0.5% AEP Peak Flood Hazard | Post-Development Conditions
B-17	0.2% AEP Peak Flood Level | Post-Development Conditions
B-18	0.2% AEP Peak Flood Depth | Post-Development Conditions
B-19	0.2% AEP Peak Flow Velocity | Post-Development Conditions
B-20	0.2% AEP Peak Flood Hazard | Post-Development Conditions
B-21	1% AEP 2100 Climate Change Scenario 1 Peak Flood Level | Post-Development Conditions
B-22	1% AEP 2100 Climate Change Scenario 1 Peak Flood Depth | Post-Development Conditions
B-23	1% AEP 2100 Climate Change Scenario 1 Peak Flow Velocity | Post-Development Conditions
B-24	1% AEP 2100 Climate Change Scenario 1 Peak Flood Hazard | Post-Development Conditions
B-25	PMF Peak Flood Level | Post-Development Conditions
B-26	PMF AEP Peak Flood Depth | Post-Development Conditions
B-27	PMF AEP Peak Flow Velocity | Post-Development Conditions
B-28	PMF AEP Peak Flood Hazard | Post-Development Conditions

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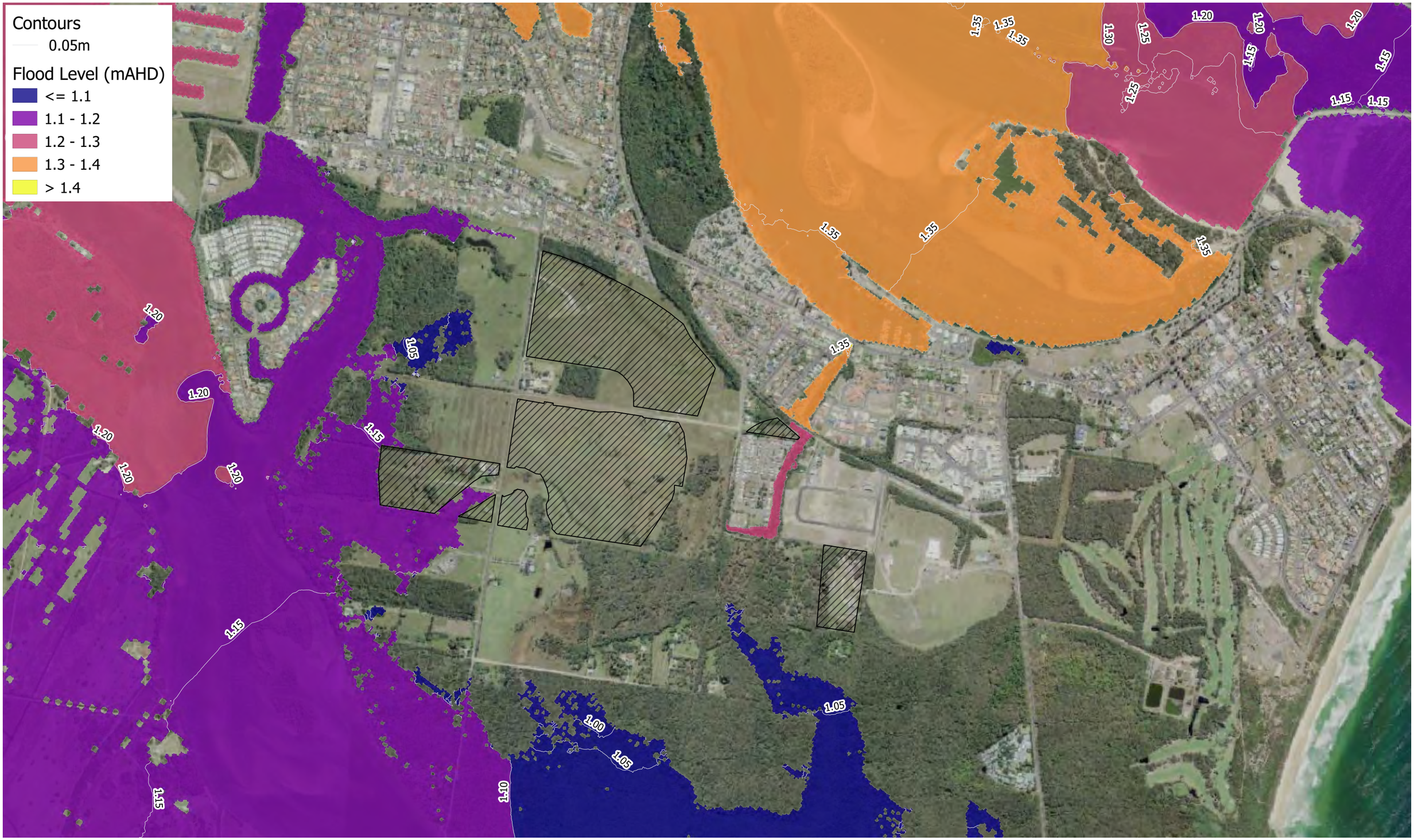

Legend

Development Fill

Title:
10% AEP Peak Flood Level
Post-Development Scenario

Drawing: **B-1**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Contours
0.05m
Flood Level (mAHD)
<= 1.1
1.1 - 1.2
1.2 - 1.3
1.3 - 1.4
> 1.4

Legend

Development Fill

Title:
5% AEP Peak Flood Level
Post-Development Scenario

Drawing: **B-2**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:
1% AEP Peak Flood Level
Post-Development Scenario

Drawing: **B-3**

Rev: **A**

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0 300 600 m

BMT
www.bmt.org

Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Contours
0.05m
Flood Level (mAHD)
<= 2.0
2.0 - 2.2
2.2 - 2.4
2.4 - 2.6
> 2.6

Legend
Development Fill

Title:
0.5% AEP Peak Flood Level
Post-Development Scenario

Drawing: **B-4**
Rev: **A**

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0 300 600 m

BMT
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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Contours

0.05m

Flood Level (mAHD)

- <= 2.0
- 2.0 - 2.2
- 2.2 - 2.4
- 2.4 - 2.6
- > 2.6

Legend

- Development Fill

Title:

0.2% AEP Peak Flood Level
Post-Development Scenario

Drawing: **B-5**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Contours
0.05m
Flood Level (mAHD)
<= 2.8
2.8 - 3.0
3.0 - 3.2
3.2 - 3.4
> 3.4

Legend
Development Fill

Title:
1% AEP 2100 Climate Change Scenario 1 Peak Flood Level Post-Development Scenario

Drawing: **B-6**
Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Contours
0.05m
Flood Level (mAHD)
<= 6.7
6.7 - 6.9
6.9 - 7.1
7.1 - 7.3
> 7.3

Legend

Development Fill

Title:
PMF Peak Flood Level
Post-Development Scenario

Drawing: **B-7**

Rev: **A**

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0 300 600 m

BMT
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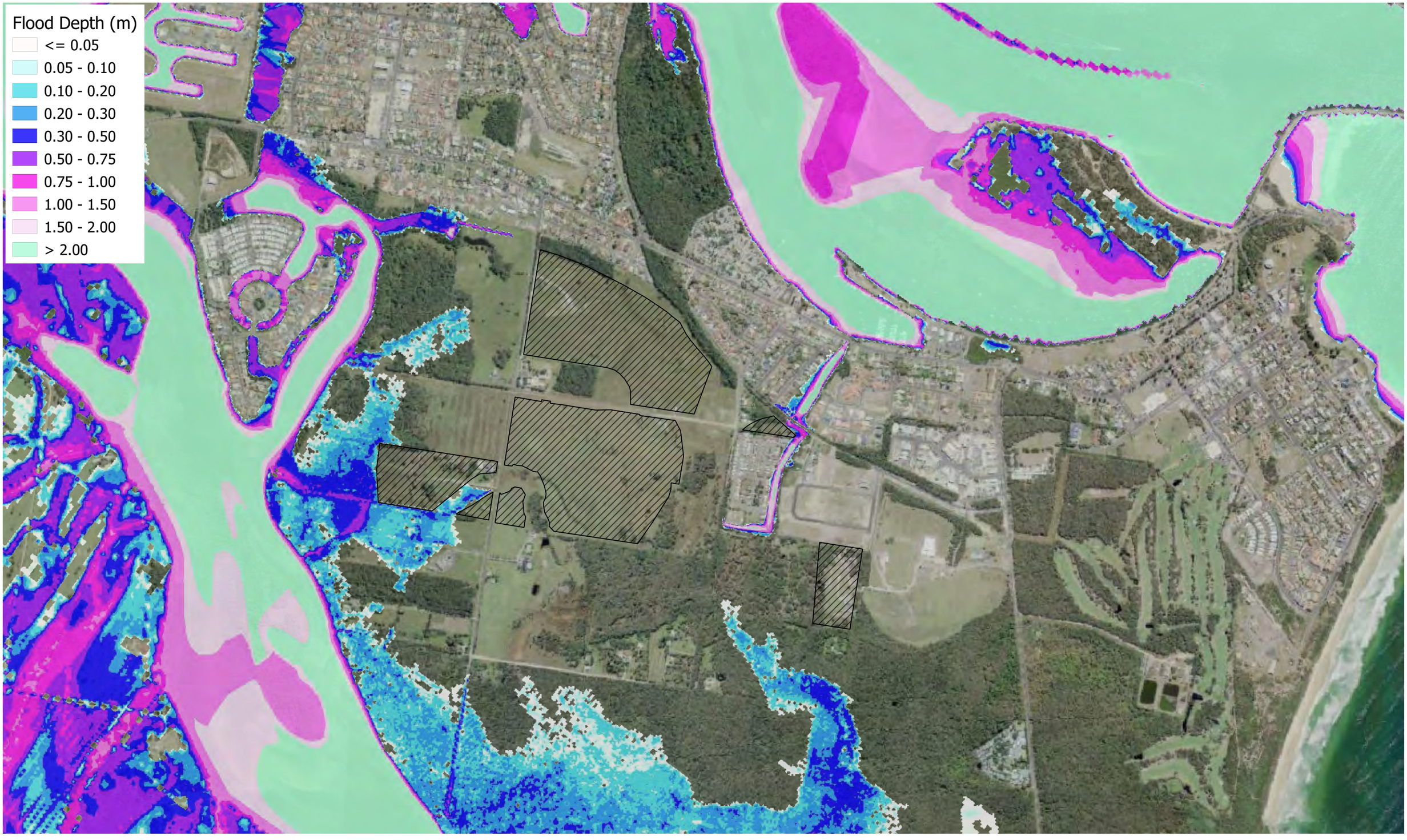
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:
10% AEP Peak Flood Depth
Post-Development Scenario

Drawing: **B-8**

Rev: **A**

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0 300 600 m

BMT
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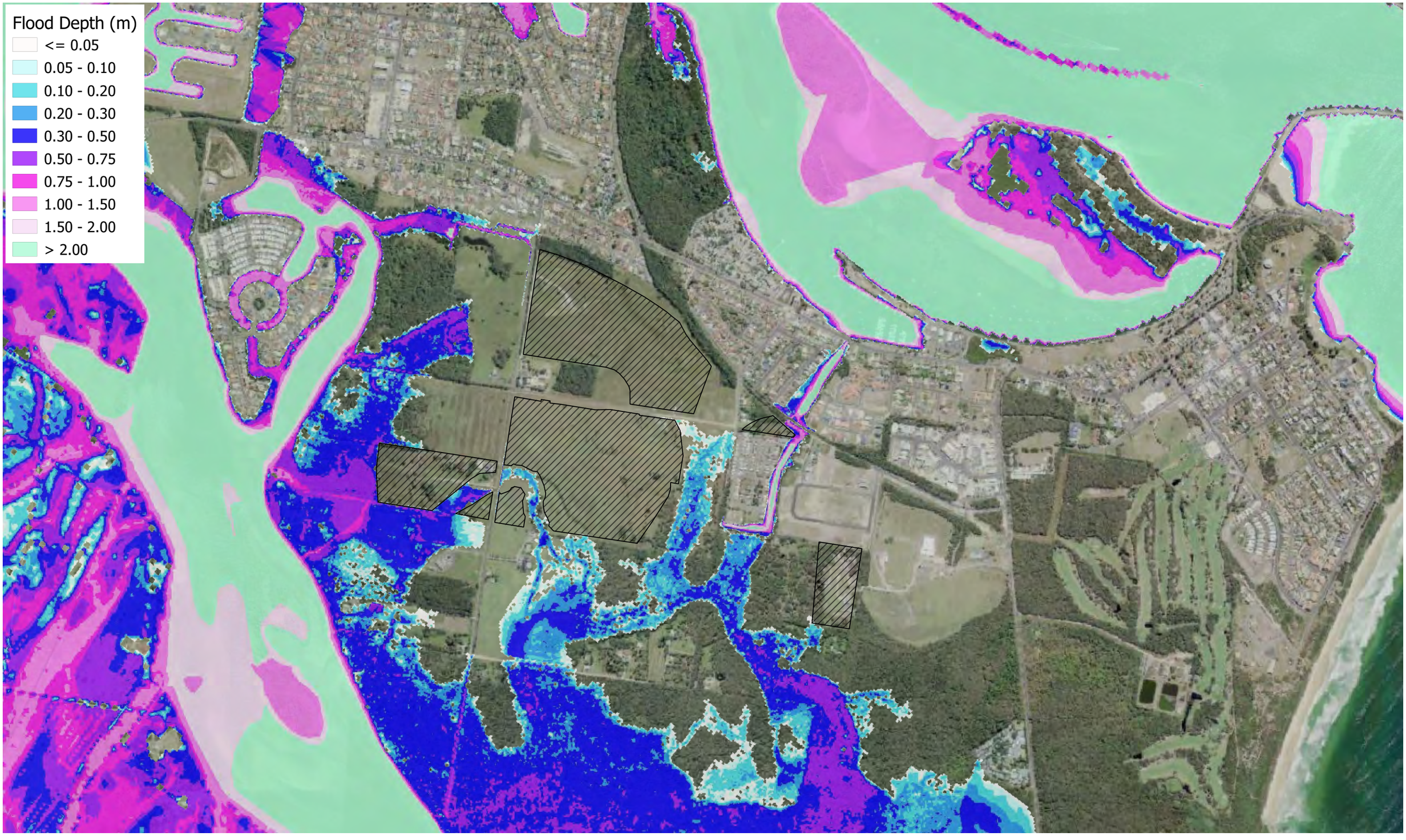
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:
5% AEP Peak Flood Depth
Post-Development Scenario

Drawing: **B-9**

Rev: **A**

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0 300 600 m

BMT
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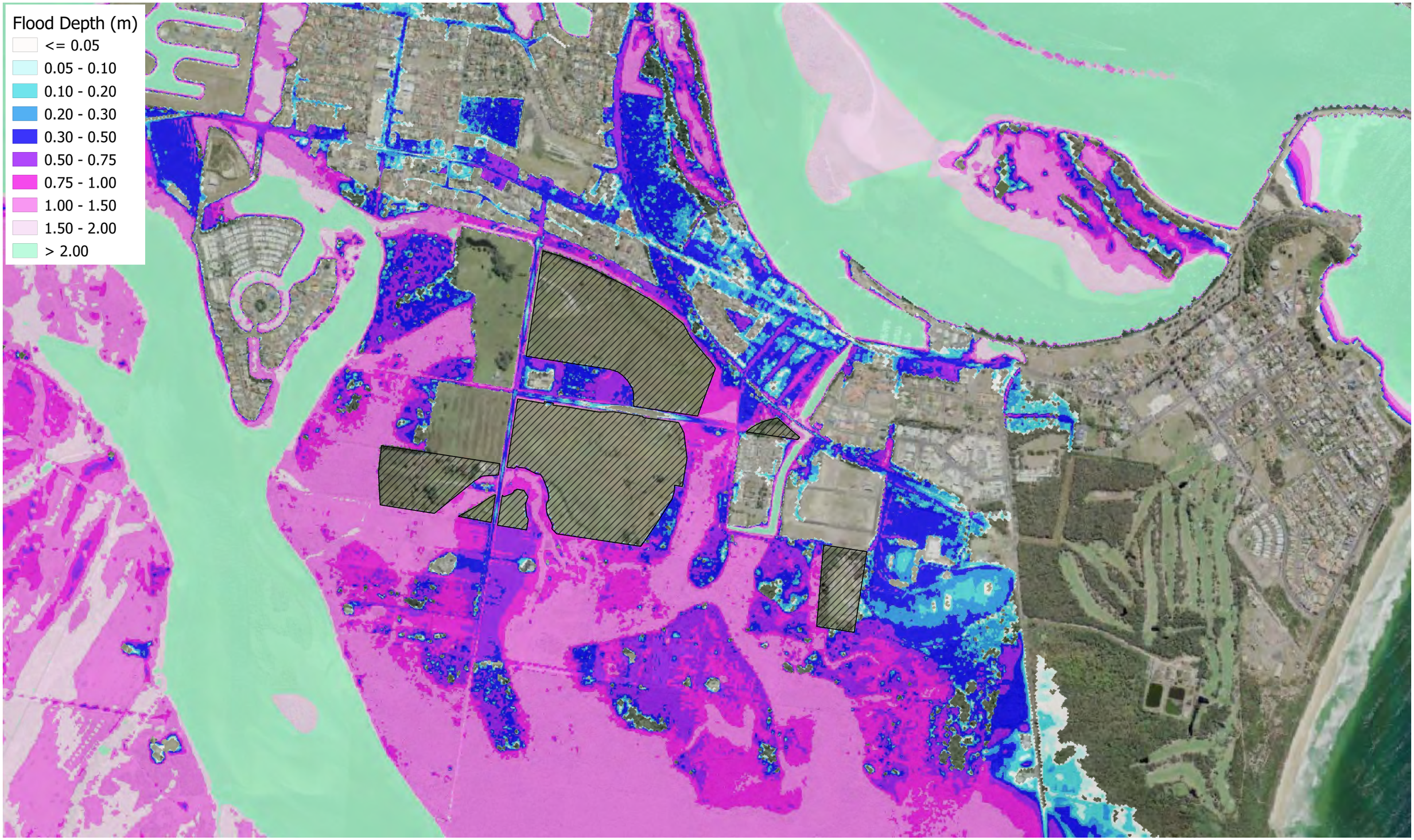
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:
1% AEP Peak Flood Depth
Post-Development Scenario

Drawing: **B-10**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:
0.5% AEP Peak Flood Depth
Post-Development Scenario

Drawing: **B-11**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:
0.2% AEP Peak Flood Depth
Post-Development Scenario

Drawing: **B-12**

Rev: **A**

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:
1% AEP 2100 Climate Change Scenario 1 Peak Flood Depth Post-Development Scenario

Drawing: **B-13**

Rev: **A**

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0 300 600 m

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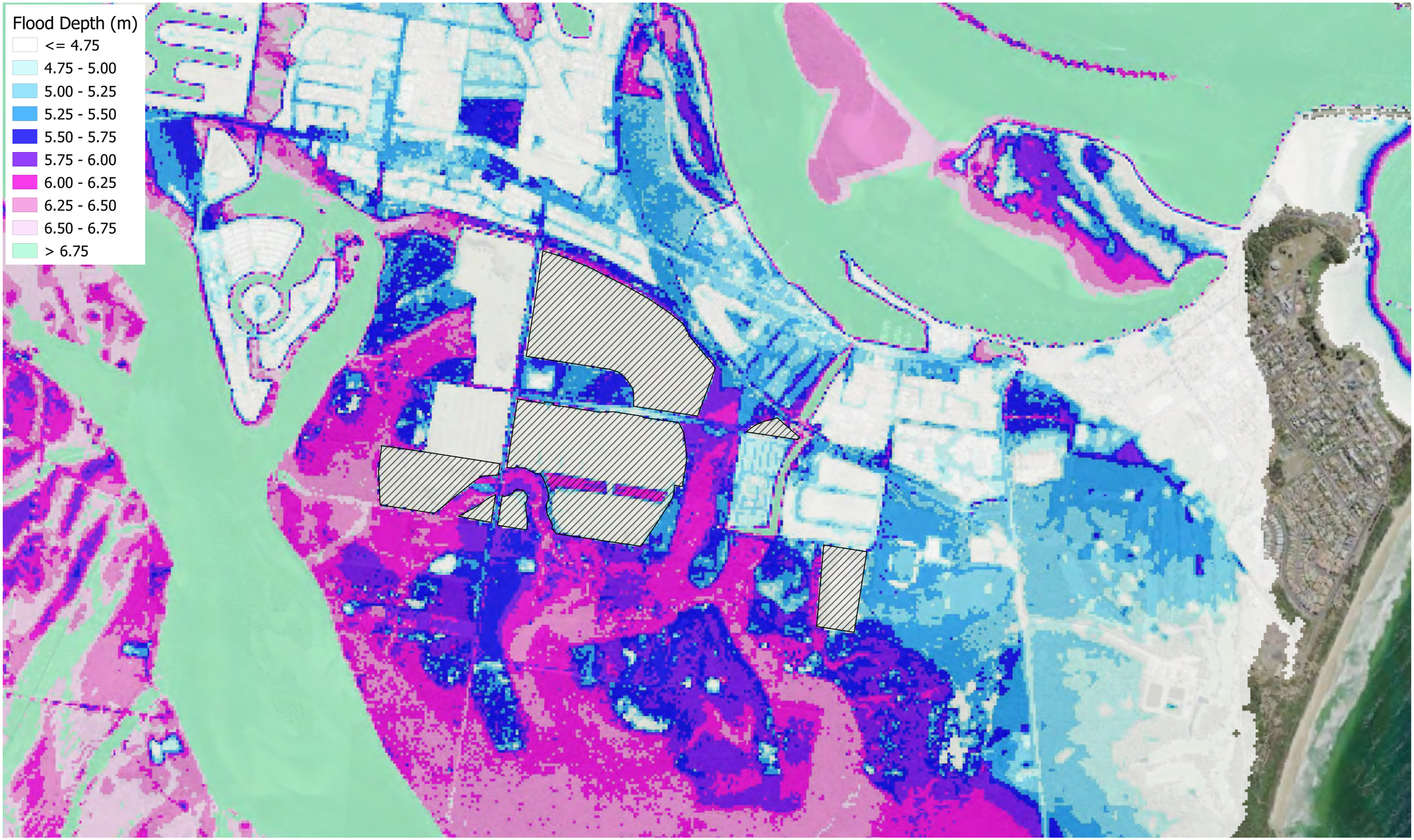

Legend

Development Fill

Title:
PMF Peak Flood Depth
Post-Development Scenario

Drawing: **B-14**

Rev: **A**

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Legend

Development Fill

Title:
10% AEP Peak Flow Velocity
Post-Development Scenario

Drawing: **B-15**

Rev: **A**

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Legend

Development Fill

Title:
5% AEP Peak Flow Velocity
Post-Development Scenario

Drawing: **B-16**

Rev: **A**

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:
1% AEP Peak Flow Velocity Post-Development Scenario

Drawing: B-17

Rev: A

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Legend

Development Fill

Title:
0.5% AEP Peak Flow Velocity
Post-Development Scenario

Drawing: **B-18**

Rev: **A**

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0 300 600 m

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Legend

Development Fill

Title:
0.2% AEP Peak Flow Velocity
Post-Development Scenario

Drawing: **B-19**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:
1% AEP 2100 Climate Change Scenario 1 Peak Flow Velocity Post-Development Scenario

Drawing: **B-20**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:
PMF Peak Flow Velocity
Post-Development Scenario

Drawing: **B-21**

Rev: **A**

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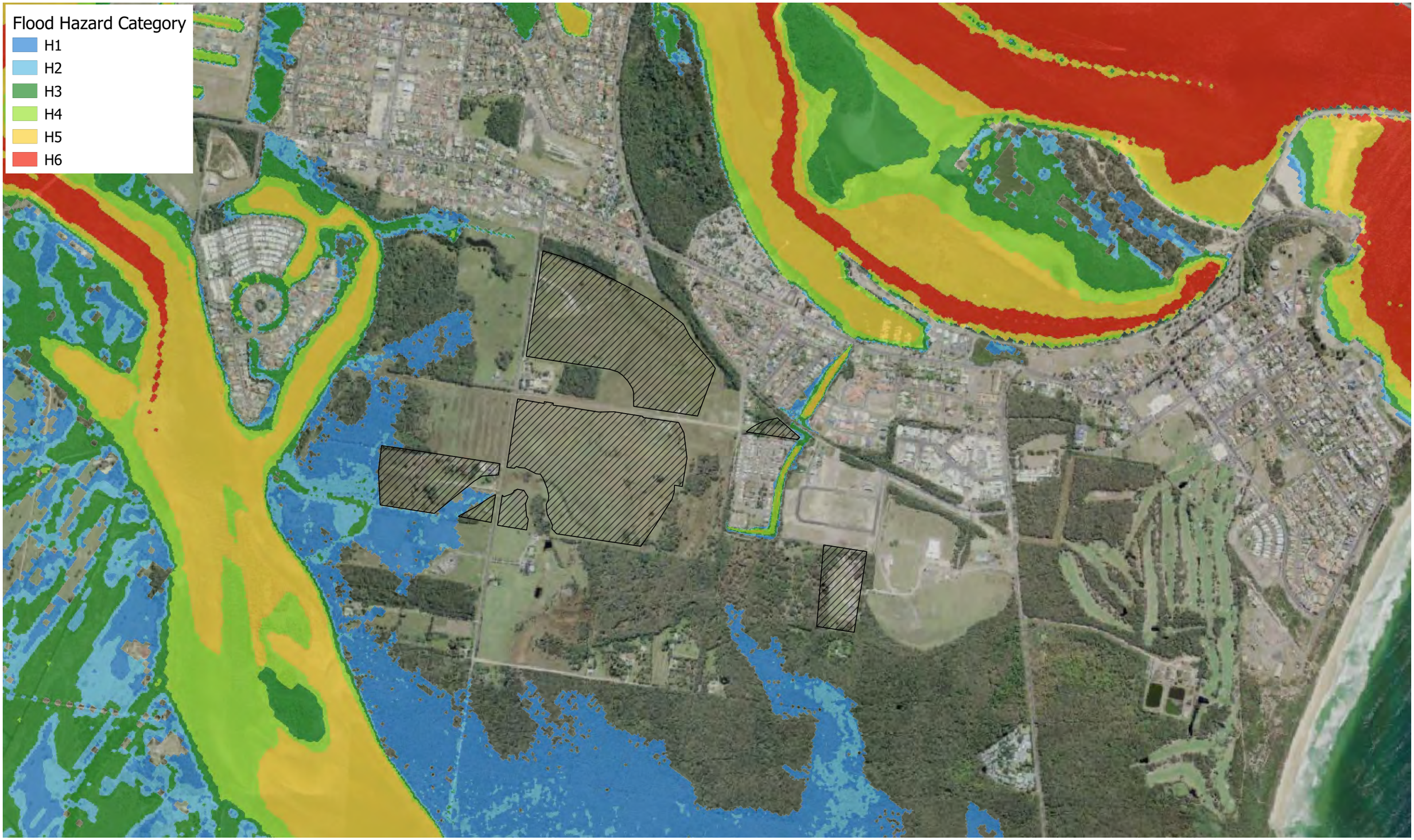

Legend

Development Fill

Title:
10% AEP Peak Flood Hazard
Post-Development Scenario

Drawing: **B-22**

Rev: **A**

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0 300 600 m

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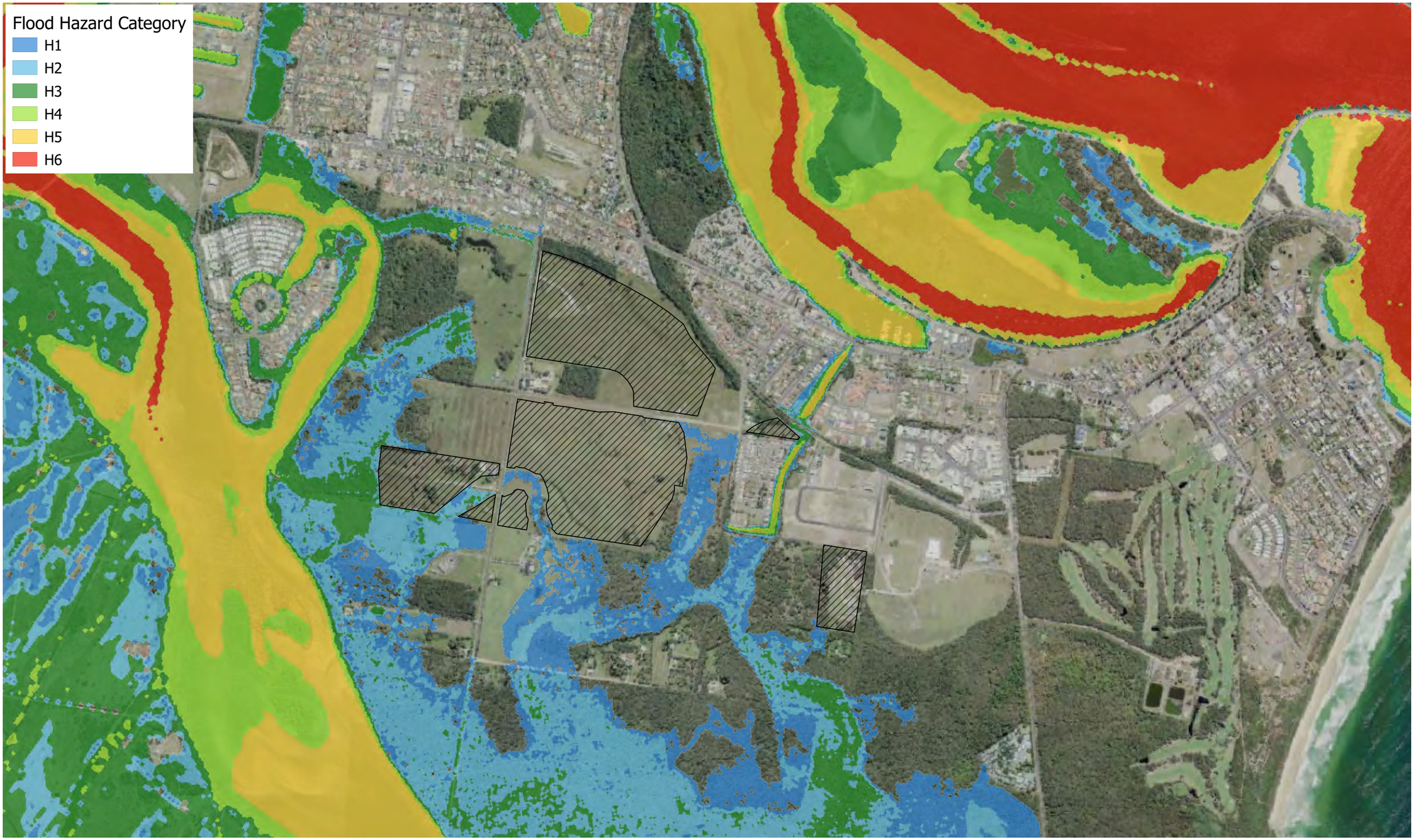

Legend

Development Fill

Title:
5% AEP Peak Flood Hazard
Post-Development Scenario

Drawing: **B-23**

Rev: **A**

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0 300 600 m

BMT
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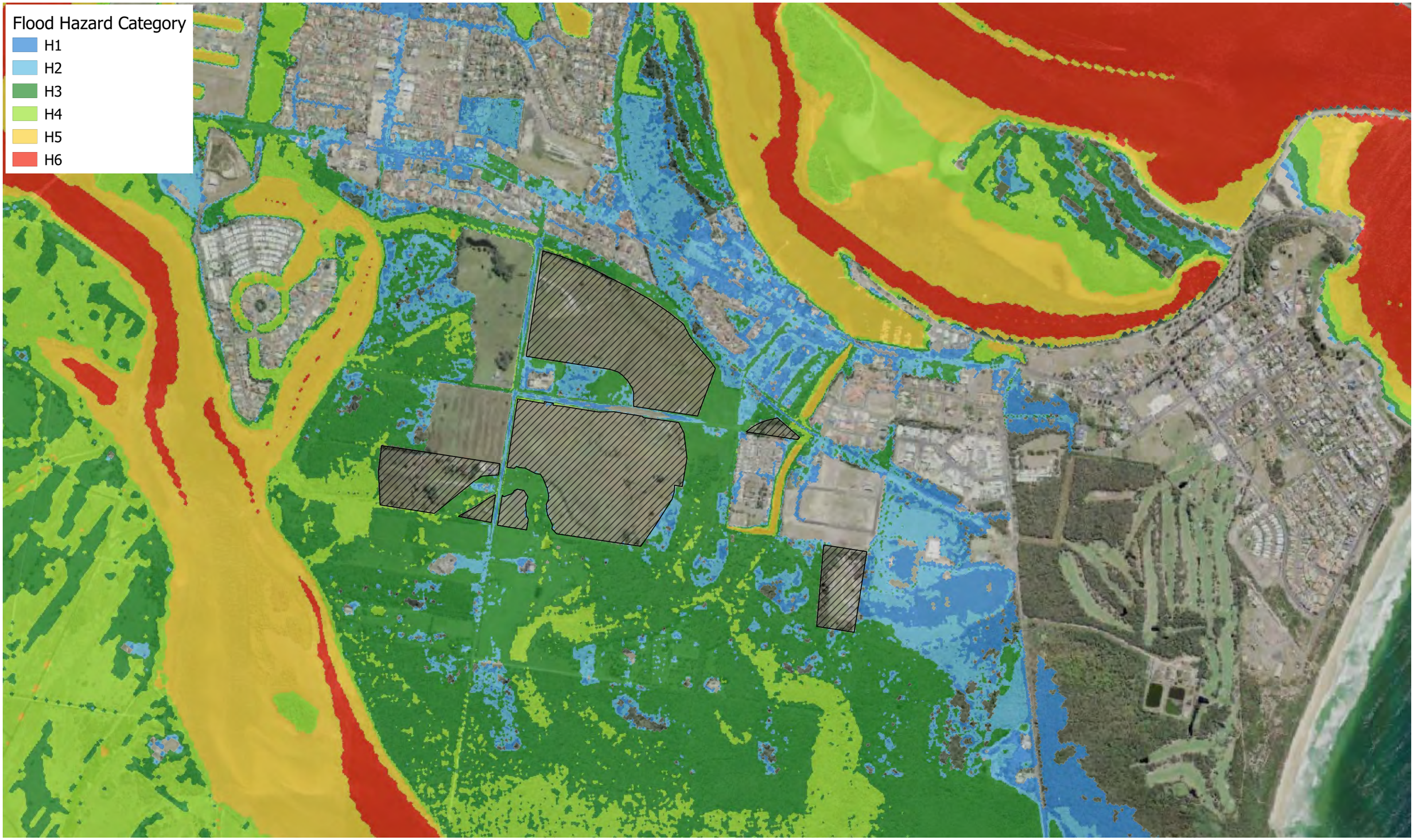
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:
1% AEP Peak Flood Hazard
Post-Development Scenario

Drawing: **B-24**

Rev: **A**

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0 300 600 m

BMT
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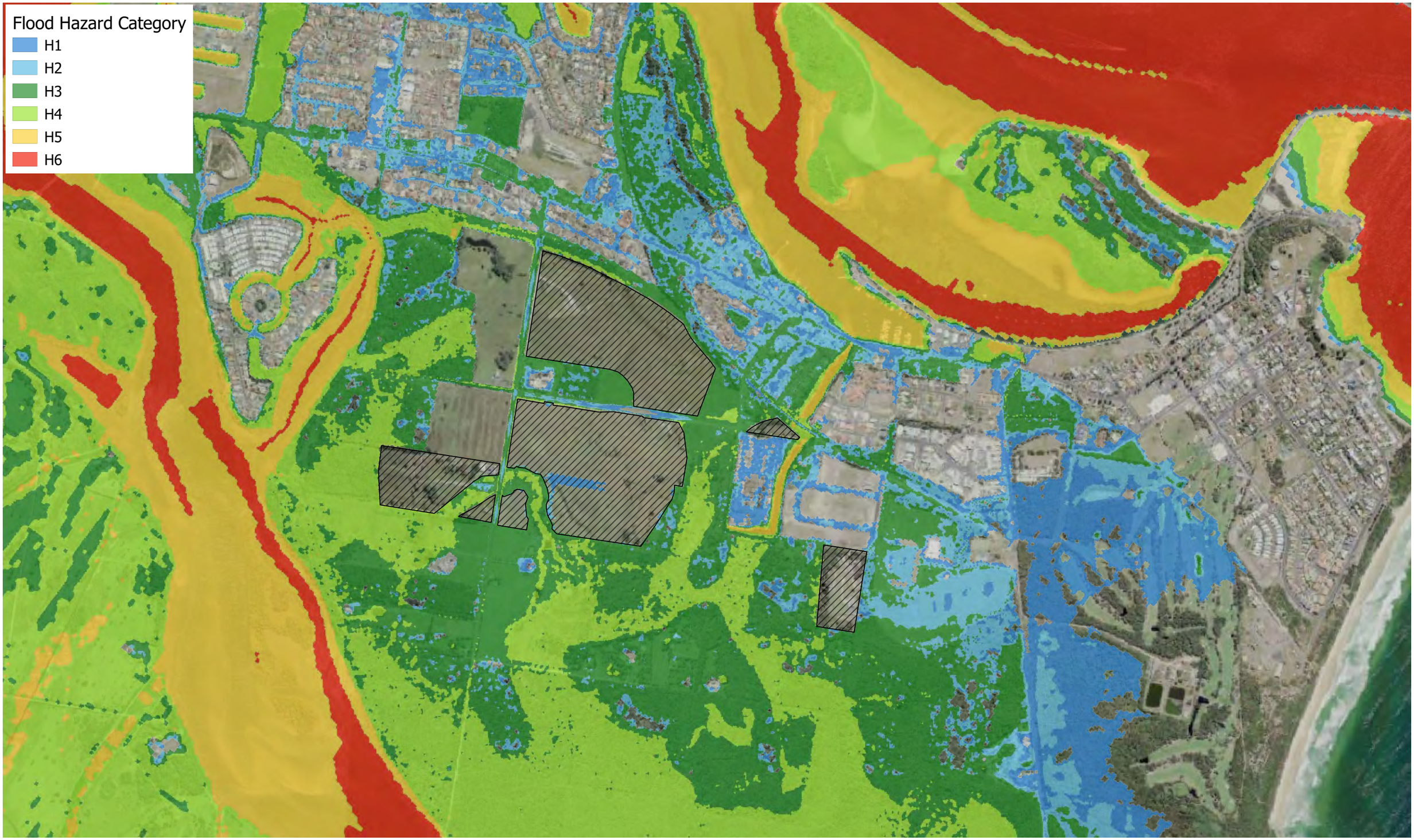
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:
0.5% AEP Peak Flood Hazard
Post-Development Scenario

Drawing: **B-25**

Rev: **A**

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0 300 600 m

BMT
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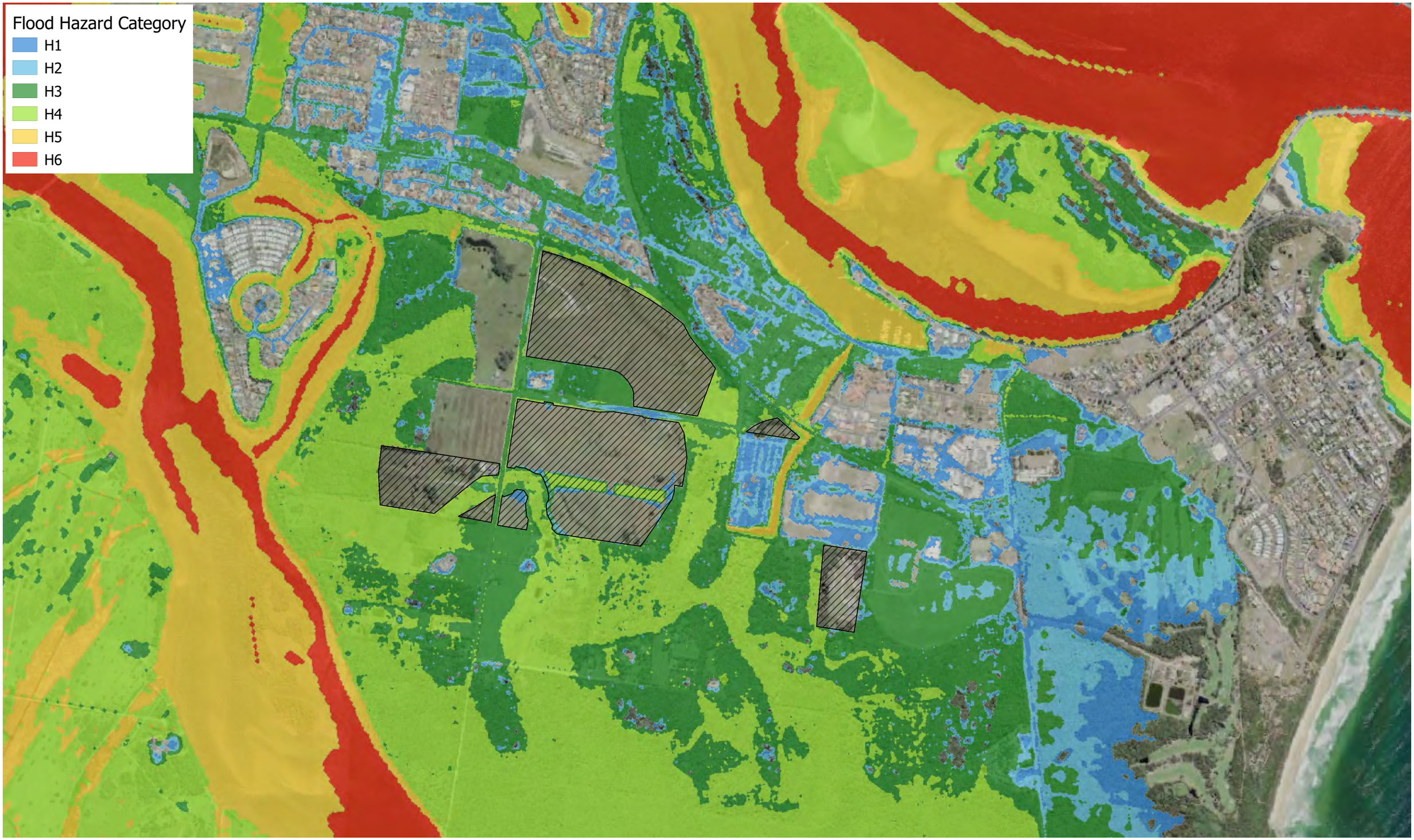
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:
0.2% AEP Peak Flood Hazard
Post-Development Scenario

Drawing: **B-26**

Rev: **A**

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0 300 600 m

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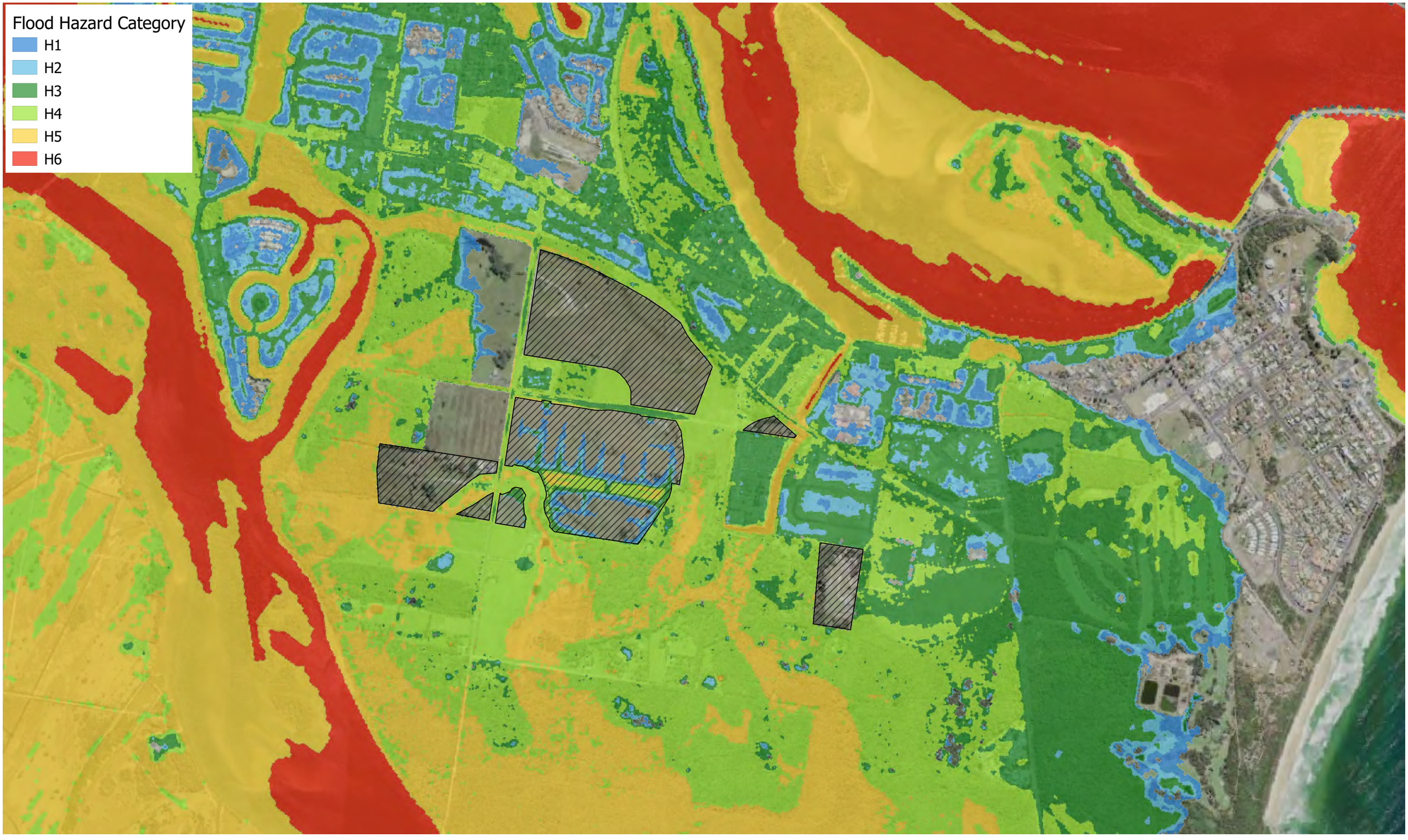

Legend

Development Fill

Title:
1% AEP 2100 Climate Change Scenario 1 Peak Flood Hazard Post-Development Scenario

Drawing: B-27

Rev: A

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0 300 600 m

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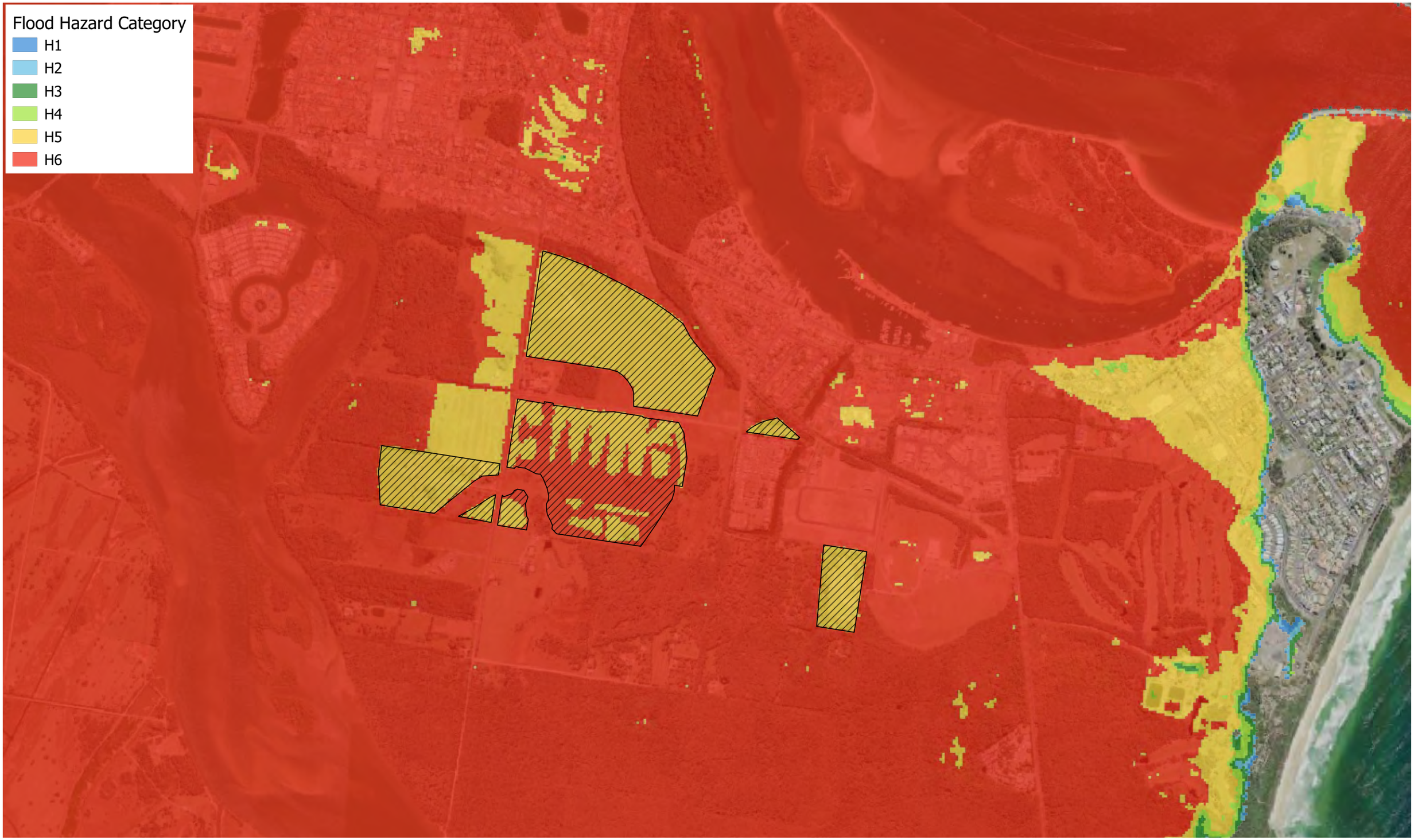
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:
PMF Peak Flood Hazard
Post-Development Scenario

Drawing: **B-28**

Rev: **A**

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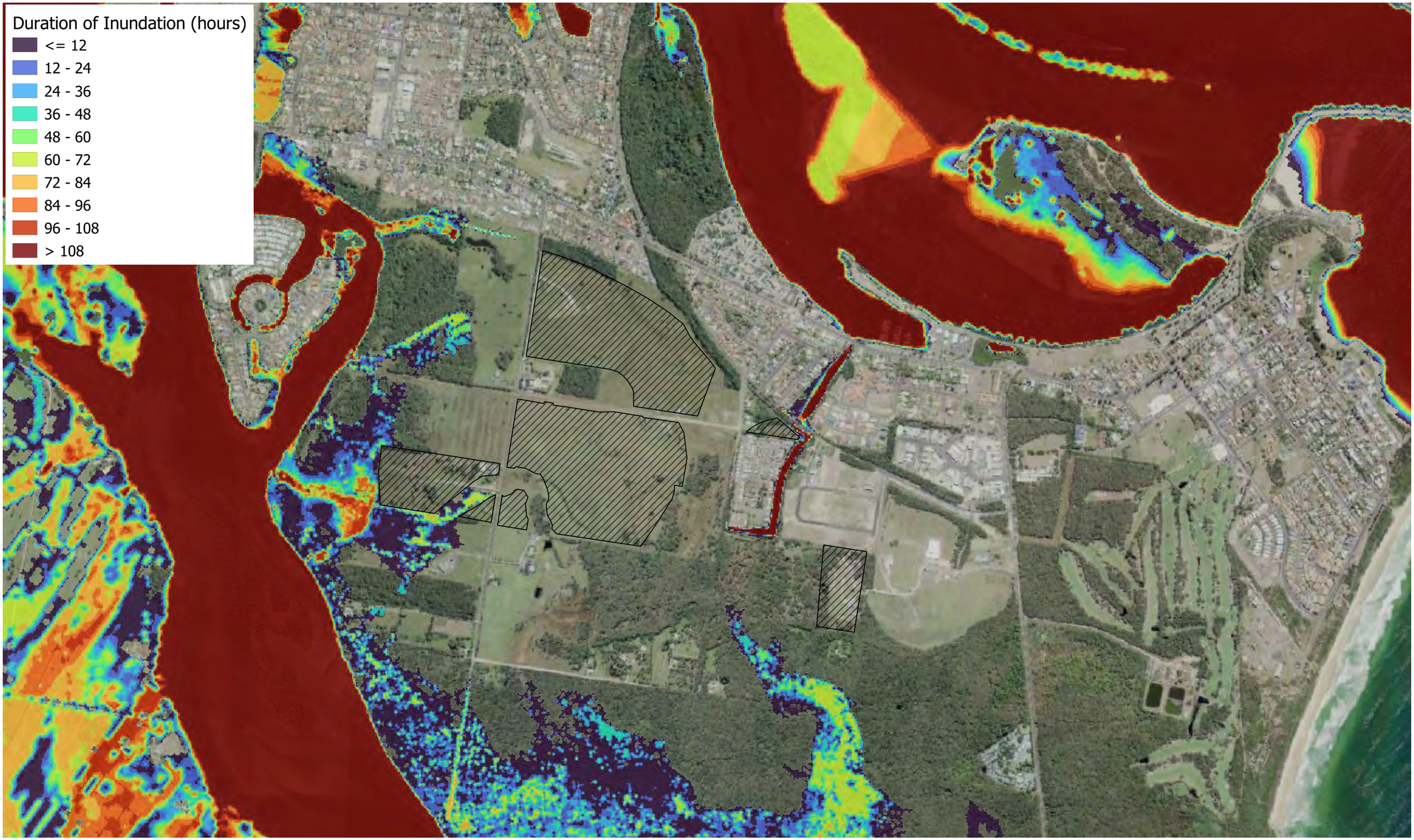

Legend

Development Fill

Title:
10% AEP Duration of Inundation
Post-Development Scenario

Drawing: **B-29**

Rev: **A**

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0 300 600 m

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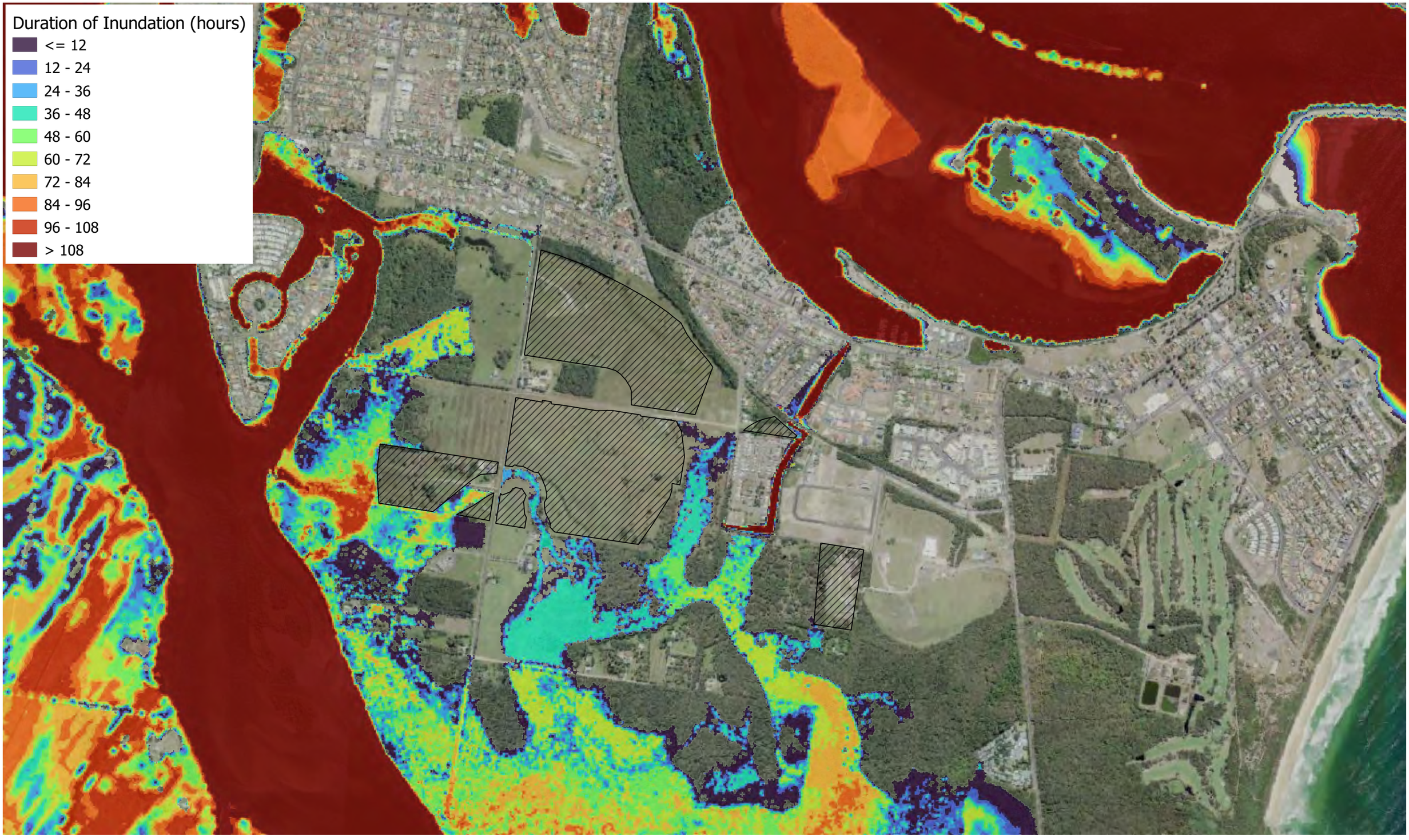

Legend

Development Fill

Title:
5% AEP Duration of Inundation
Post-Development Scenario

Drawing: **B-30**

Rev: **A**

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0 300 600 m

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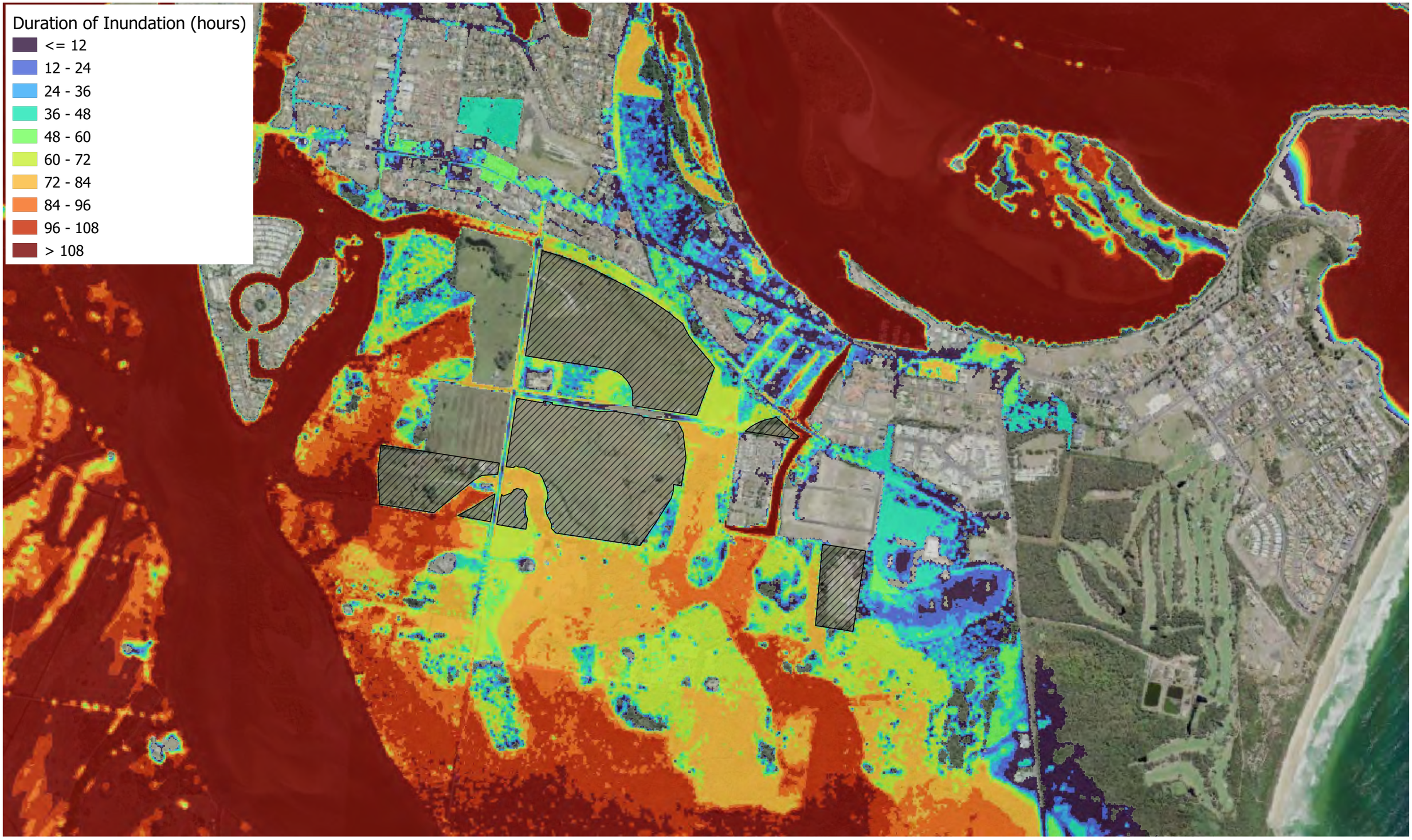
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:
1% AEP Duration of Inundation
Post-Development Scenario

Drawing: **B-31**

Rev: **A**

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0 300 600 m

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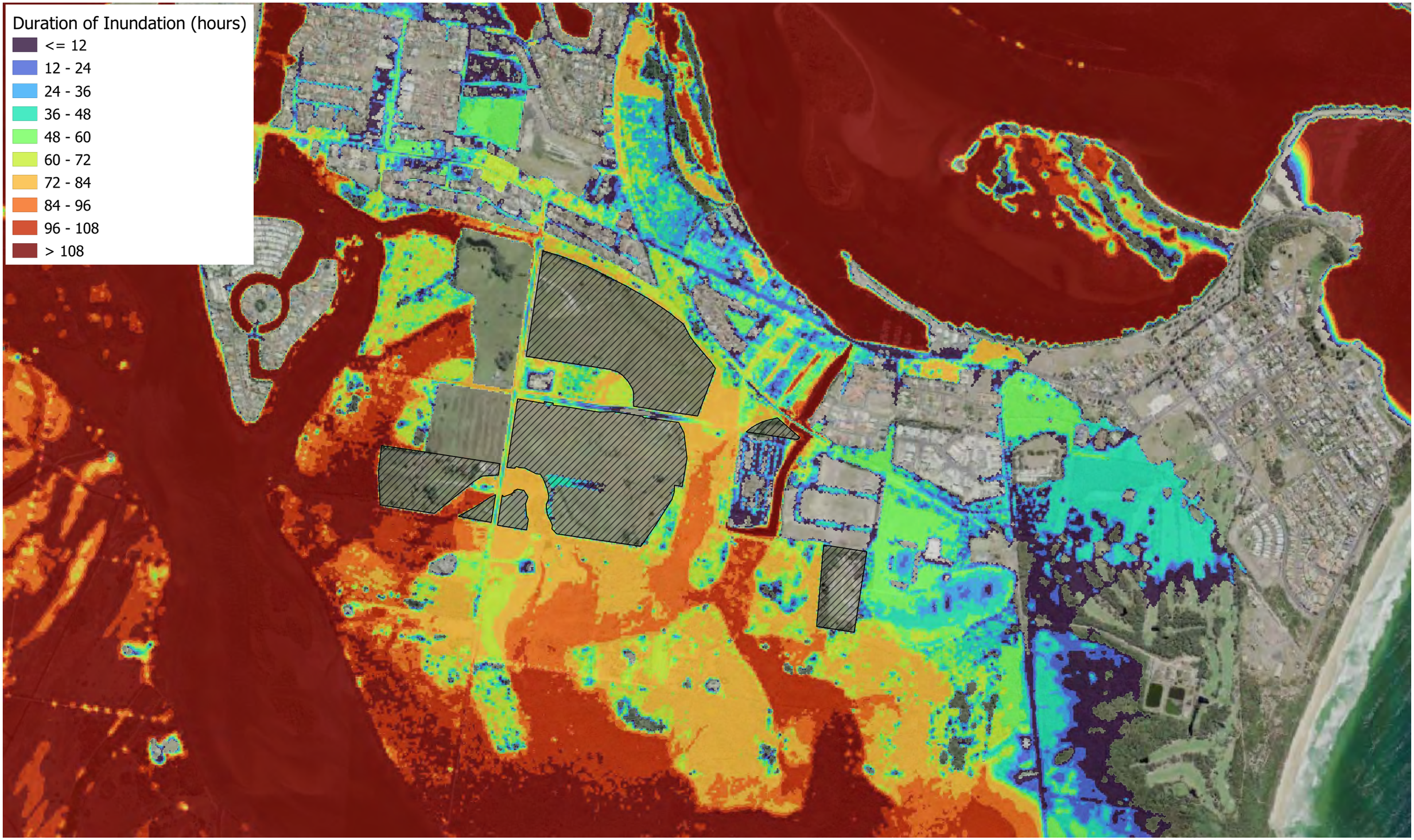
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:
0.5% AEP Duration of Inundation
Post-Development Scenario

Drawing: **B-32**

Rev: **A**

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0 300 600 m

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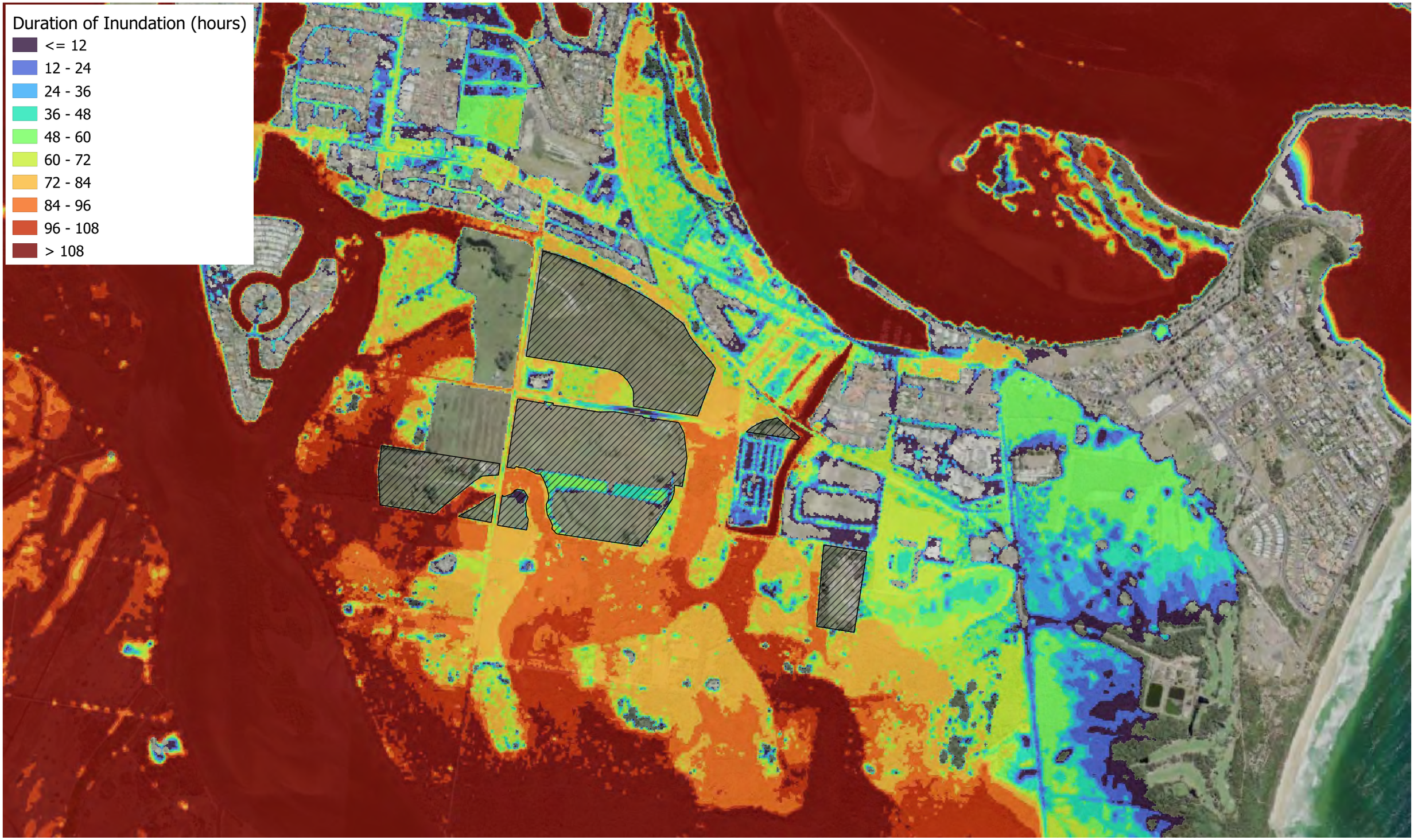

Legend

Development Fill

Title:
0.2% AEP Duration of Inundation
Post-Development Scenario

Drawing: **B-33**

Rev: **A**

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0 300 600 m

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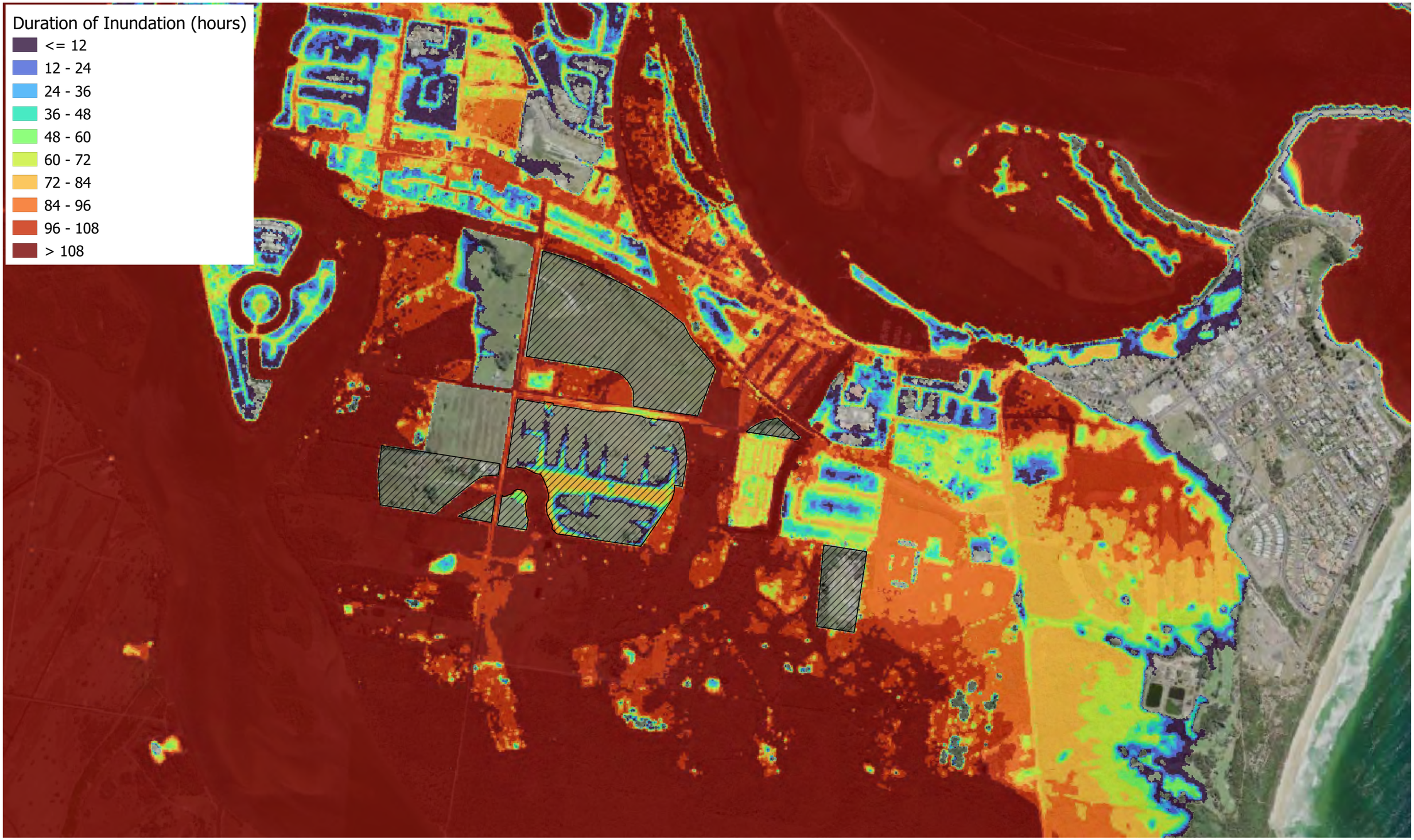
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Post-development_scenario\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:
1% AEP 2100 Climate Change Scenario 1 Duration of Inundation

Drawing: **B-34**

Rev: **A**

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Legend

Development Fill

Title:
PMF Duration of Inundation
Post-Development Scenario

Drawing: **B-35**

Rev: **A**

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Annex C Flood Impact Maps

Table C.1. Summary of flood maps included in Annex C

Figure ID	Figure Title
C-1	Changes in Peak Flood Level | 10% AEP Flood Event
C-2	Changes in Peak Flood Level | 5% AEP Flood Event
C-3	Changes in Peak Flood Level | 1% AEP Flood Event
C-4	Changes in Peak Flood Level | 0.5% AEP Flood Event
C-5	Changes in Peak Flood Level | 0.2% AEP Flood Event
C-6	Changes in Peak Flood Level | 1% AEP 2100 Climate Change Scenario 1 Flood Event
C-7	Changes in Peak Flood Level | Probable Maximum Flood (PMF) Event
C-8	Changes in Peak Flow Velocity | 10% AEP Flood Event
C-9	Changes in Peak Flow Velocity | 5% AEP Flood Event
C-10	Changes in Peak Flow Velocity | 1% AEP Flood Event
C-11	Changes in Peak Flow Velocity | 0.5% AEP Flood Event
C-12	Changes in Peak Flow Velocity | 0.2% AEP Flood Event
C-13	Changes in Peak Flow Velocity | 1% AEP 2100 Climate Change Scenario 1 Flood Event
C-14	Changes in Peak Flow Velocity | Probable Maximum Flood (PMF) Event
C-15	Changes in Peak Flood Hazard Category | 10% AEP Flood Event
C-16	Changes in Peak Flood Hazard Category | 5% AEP Flood Event
C-17	Changes in Peak Flood Hazard Category | 1% AEP Flood Event
C-18	Changes in Peak Flood Hazard Category | 0.5% AEP Flood Event
C-19	Changes in Peak Flood Hazard Category | 0.2% AEP Flood Event
C-20	Changes in Peak Flood Hazard Category | 1% AEP 2100 Climate Change Scenario 1 Flood Event
C-21	Changes in Peak Flood Hazard Category | Probable Maximum Flood (PMF) Event
C-22	Changes in Duration of Inundation | 10% AEP Flood Event
C-23	Changes in Duration of Inundation | 5% AEP Flood Event
C-24	Changes in Duration of Inundation | 1% AEP Flood Event
C-25	Changes in Duration of Inundation | 0.5% AEP Flood Event
C-26	Changes in Duration of Inundation | 0.2% AEP Flood Event
C-27	Changes in Duration of Inundation | 1% AEP 2100 Climate Change Scenario 1 Flood Event
C-28	Changes in Duration of Inundation | Probable Maximum Flood (PMF) Event

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Changes in Flood Extent
- Decrease in Flood Extent
- Increase in Flood Extent

Changes in Flood Level (m)
- < -0.06
- -0.06 to -0.05
- -0.05 to -0.04
- -0.04 to -0.03
- -0.03 to -0.02
- -0.02 to -0.01
- No change
- 0.01 to 0.02
- 0.02 to 0.03
- 0.03 to 0.04
- 0.04 to 0.05
- > 0.05

Legend

- Development Fill

Title:
Changes in Peak Flood Level
10% AEP Flood Event

Drawing: C-1

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flood Level
5% AEP Flood Event

Drawing: C-2

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flood Level
1% AEP Flood Event

Drawing: C-3

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Changes in Flood Extent
Decrease in Flood Extent
Increase in Flood Extent

Changes in Flood Level (m)
< -0.06
-0.06 to -0.05
-0.05 to -0.04
-0.04 to -0.03
-0.03 to -0.02
-0.02 to -0.01
No change
0.01 to 0.02
0.02 to 0.03
0.03 to 0.04
0.04 to 0.05
> 0.05

Legend

Development Fill

Title:
Changes in Peak Flood Level
0.5% AEP Flood Event

Drawing: **C-4**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flood Level
0.2% AEP Flood Event

Drawing: C-5

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flood Level
1% AEP Climate Change Scenario 1 Flood Event

Drawing: C-6

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flood Level
PMF Event

Drawing: C-7

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:
Changes in Peak Flow Velocity
10% AEP Flood Event

Drawing: **C-8**

Rev: **A**

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flow Velocity 5% AEP Flood Event

Drawing: C-9

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flow Velocity 1% AEP Flood Event

Drawing: C-10

Rev: A

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0 300 600 m

BMT
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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flow Velocity
0.5% AEP Flood Event

Drawing: C-11

Rev: A

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0 300 600 m

BMT
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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flow Velocity
0.2% AEP Flood Event

Drawing: C-12

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flow Velocity
1% AEP Climate Change Scenario 1 Flood Event

Drawing: C-13

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Peak Flow Velocity PMF Event

Drawing: C-14

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:
Changes in Flood Hazard Category
10% AEP Flood Event

Drawing: **C-15**

Rev: **A**

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Legend

Development Fill

Title:

Changes in Flood Hazard Category
5% AEP Flood Event

Drawing: C-16

Rev: A

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Legend

Development Fill

Title:

Changes in Flood Hazard Category
1% AEP Flood Event

Drawing: C-17

Rev: A

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0 300 600 m

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Legend

Development Fill

Title:

Changes in Flood Hazard Category
0.5% AEP Flood Event

Drawing: C-18

Rev: A

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Development Fill

Title:

Changes in Flood Hazard Category
0.2% AEP Flood Event

Drawing: C-19

Rev: A

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0 300 600 m

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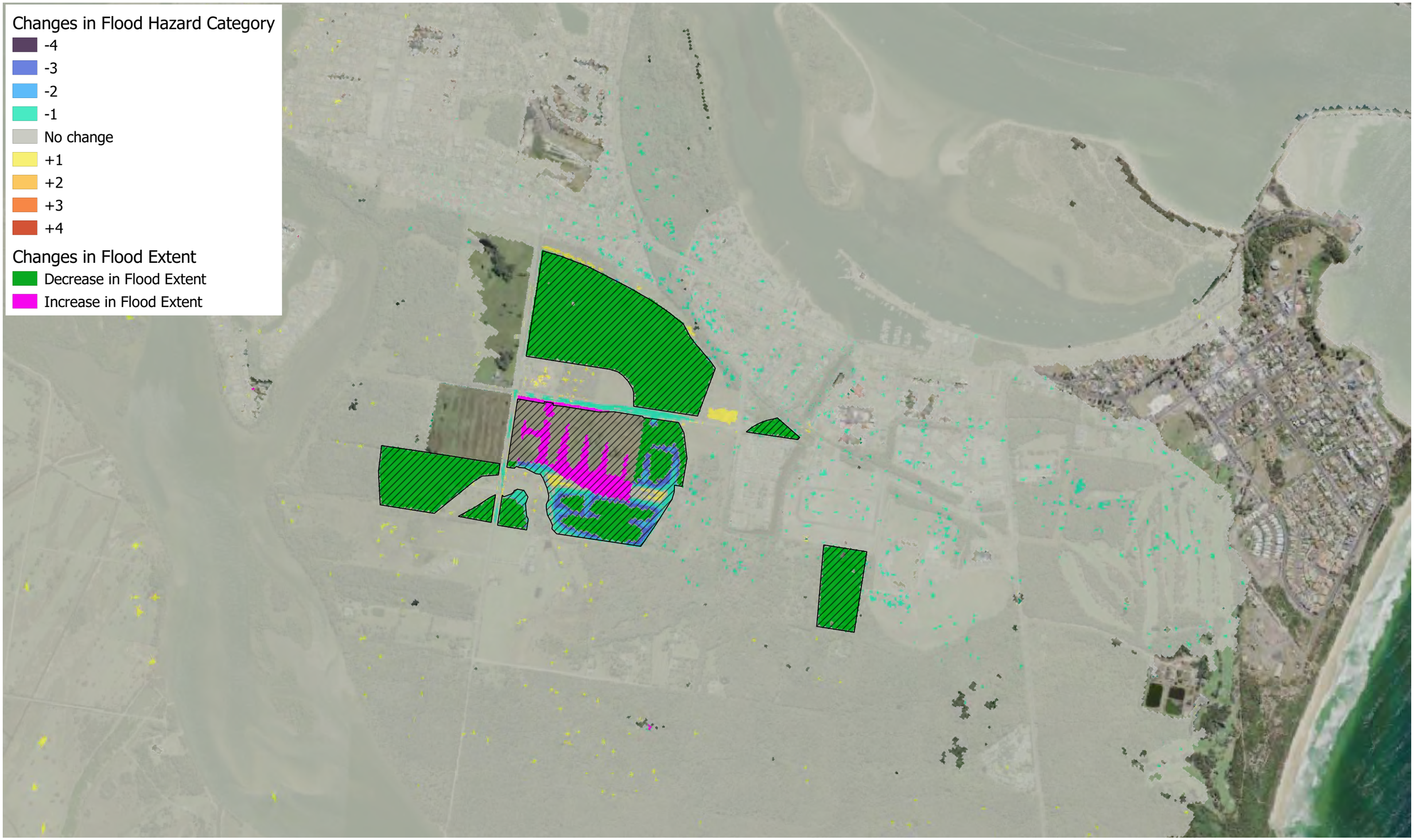

Legend

Development Fill

Title:

Changes in Flood Hazard Category
1% AEP Climate Change Scenario 1 Flood Event

Drawing: C-20

Rev: A

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0 300 600 m

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Development Fill

Title:
Changes in Flood Hazard Category
PMF Event

Drawing: **C-21**

Rev: **A**

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Legend

Development Fill

Title:
Changes in Duration of Inundation
10% AEP Flood Event

Drawing: **C-22**

Rev: **A**

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Development Fill

Title:

Changes in Duration of Inundation
5% AEP Flood Event

Drawing: C-23

Rev: A

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0 300 600 m

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Development Fill

Title:

Changes in Duration of Inundation 1% AEP Flood Event

Drawing: C-24

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Duration of Inundation
0.5% AEP Flood Event

Drawing: C-25

Rev: A

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0 300 600 m

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Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz

Legend

Development Fill

Title:

Changes in Duration of Inundation
0.2% AEP Flood Event

Drawing: C-26

Rev: A

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0 300 600 m

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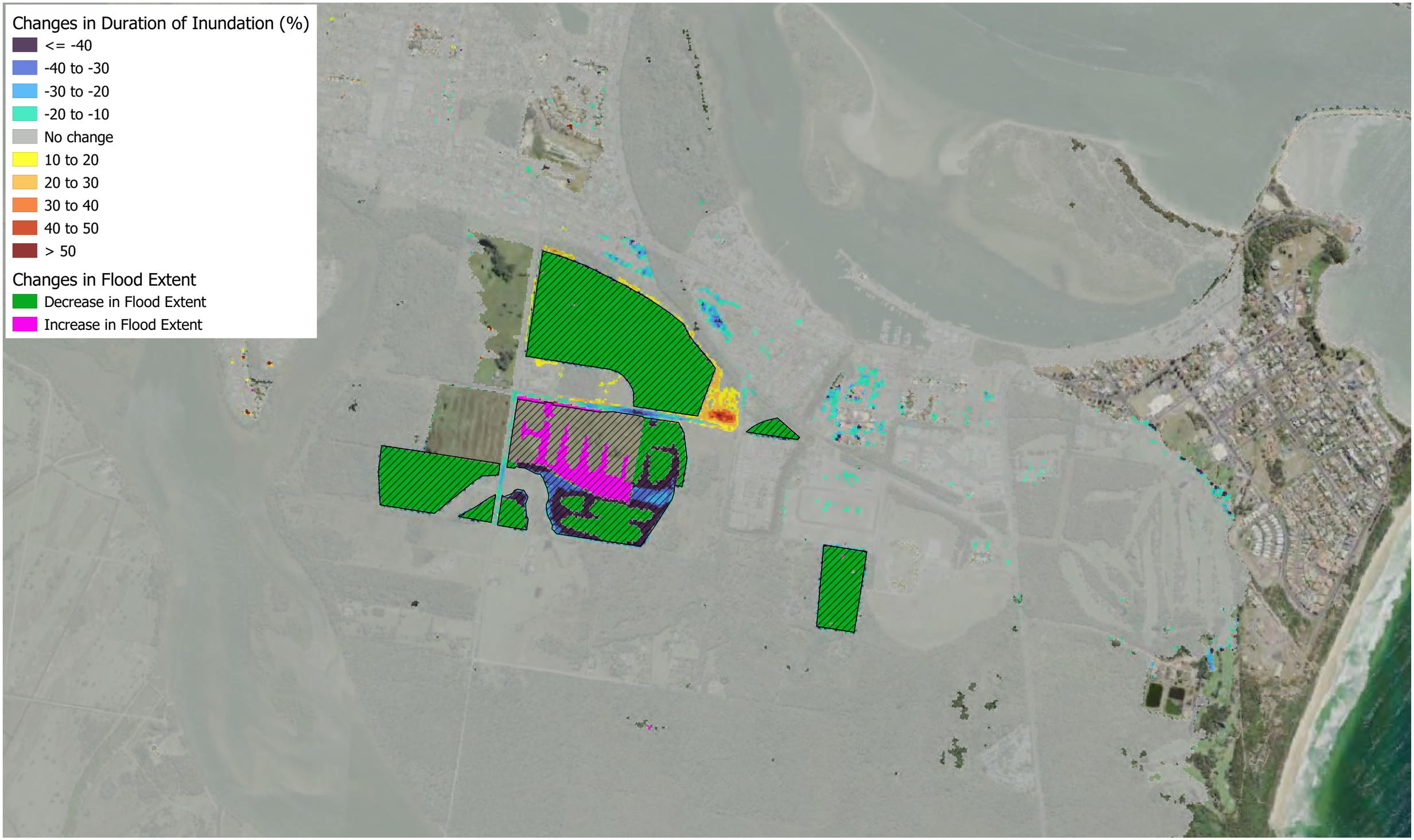

Legend

Development Fill

Title:

Changes in Duration of Inundation
1% AEP Climate Change Scenario 1 Flood Event

Drawing: C-27

Rev: A

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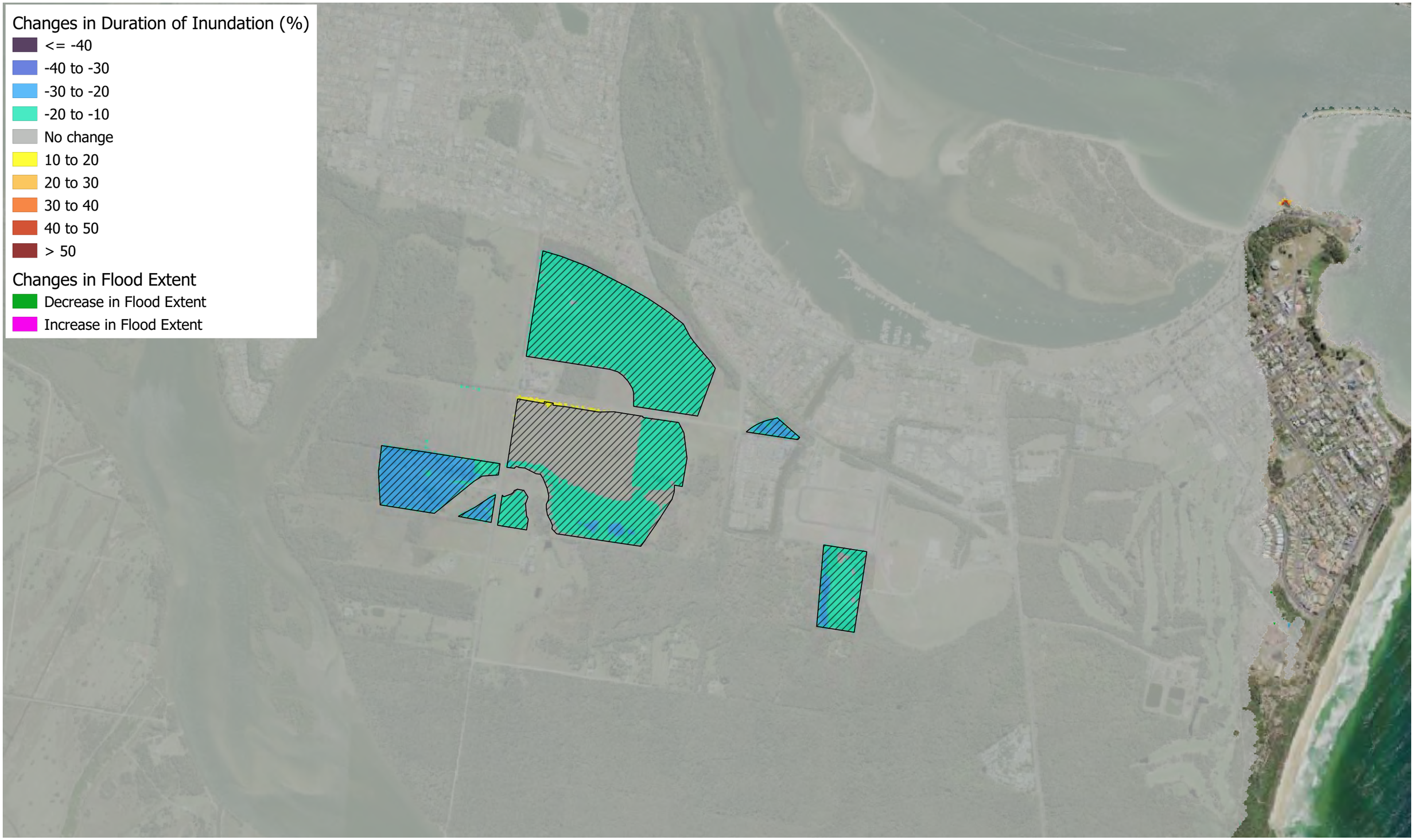
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz



Legend

Development Fill

Title:

Changes in Duration of Inundation
PMF Event

Drawing: **C-28**

Rev: **A**

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0 300 600 m

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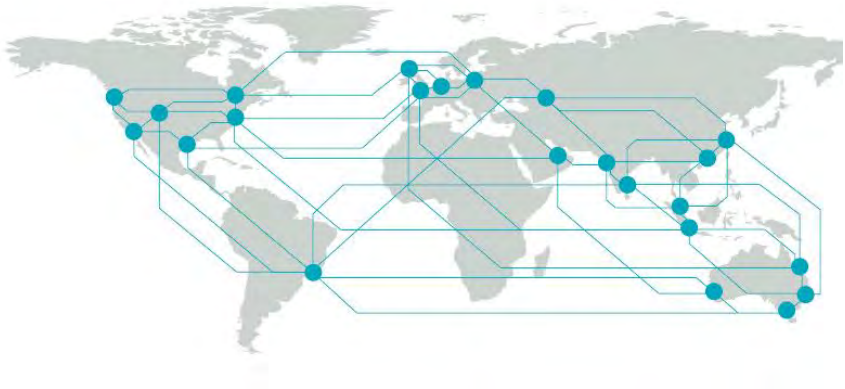
Filepath: K:\003044.g.ls.West_Yamba\2_GIS\Flood_maps\Flood_impacts\West_Yamba_MGA_zn56.qgz



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