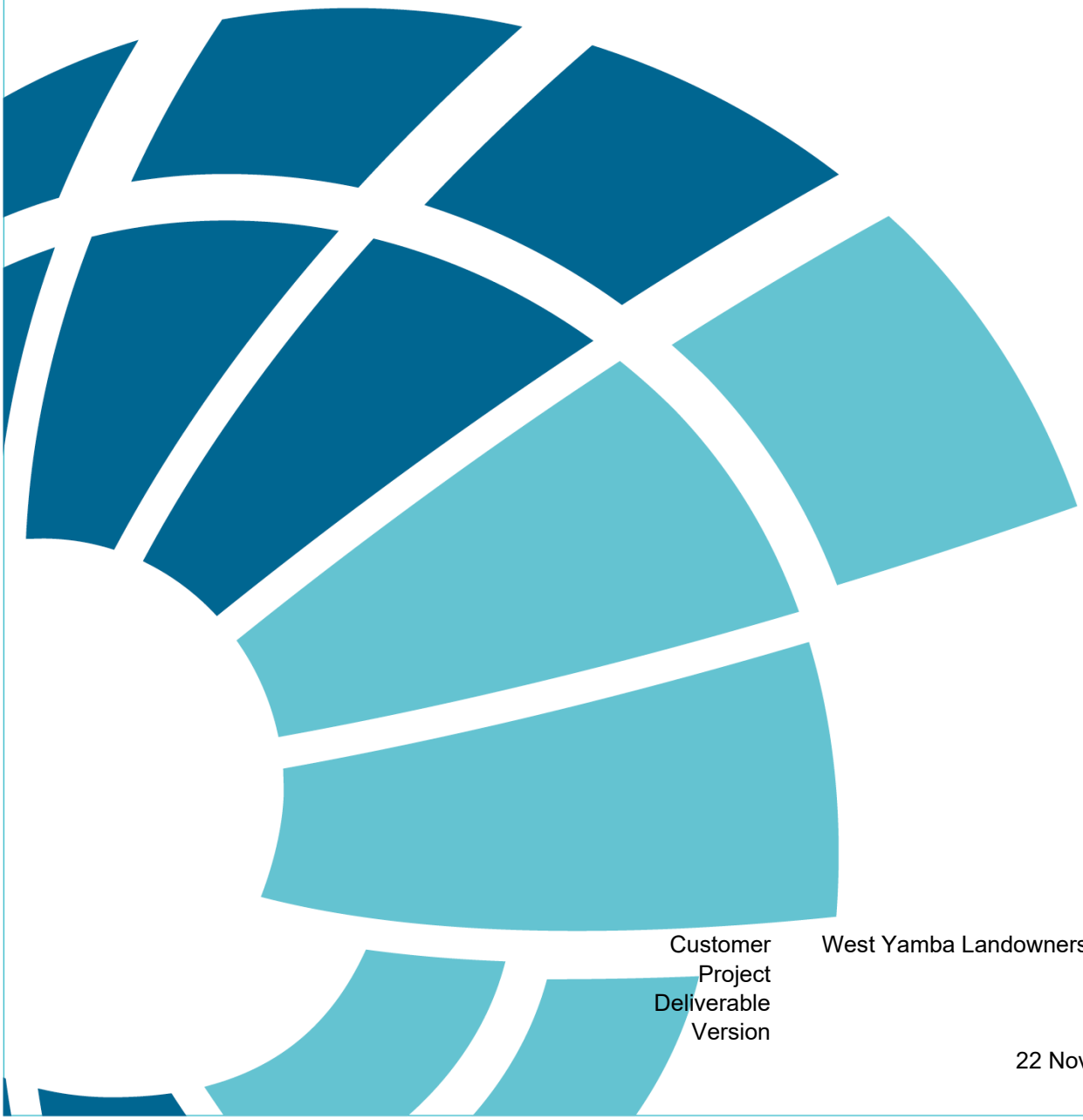
WYURA Flood Impact Assessment



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Executive Summary

West Yamba Landowners Consortium through Mortons Urban Solutions (MUS) has commissioned BMT to undertake a flood impact assessment (FIA) for development within the West Yamba Urban Release Area (WYURA) at Yamba, New South Wales. The current proposed development is referred to as the 'Yamba Gardens' and occupies lots 46 and 47 on DP751395.

The FIA assesses riverine flooding from the Clarence River, including storm surge which can propagate up the river from the ocean. The FIA compares West Yamba development scenarios with a base case (pre West Yamba) case. Changes in peak flood levels are then mapped to show any impacts.

Clarence Valley Council's adopted flood model has been used as the basis of the assessment and has been updated and refined with additional detail and higher resolution in the vicinity of West Yamba. Comparisons of river levels were made between the refined model and Council's model and showed that the refined model was in good agreement and therefore considered suitable for use in the assessment.

The modelled development scenarios reflect different stages of the West Yamba development and have been agreed with Council. The scenarios are designed to capture the cumulative flood impacts of all West Yamba development as opposed to modelling individual sites in isolation. The modelled development scenarios (termed options) are as follows:

- Option 1 includes the proposed Yamba Gardens development and all approved and current WYURA applications.
- Option 2 is as Option 1 but also includes all remaining WYURA development.
- Option 3 is as Option 2 but with the inclusion of a representation of the Yamba Bypass along the northern perimeter of the WYURA.

All three options were assessed for the 1 in 20 and 1 in 100 AEP flood events and the peak flood levels have been compared to the Base Case (pre West Yamba development) flood levels.

The WYURA land includes provision for a floodway within all three options. This has been included in the model and has been widened from that shown in Council mapping in order to minimise offsite impacts.

Overall the flood impacts are minor for all three options and are generally confined to the immediate periphery of the WYURA.

For Option 1, the 1 in 20 AEP flood shows increases in flood levels at two residential properties but the flood level (1.6mAHD) is significantly below the floor level (2.7mAHD). In the 1 in 100 AEP, impacts are shown to occur at an additional property and these impacts occur above floor level, noting that the Base Case 1 in 100 AEP flood levels are also above the floor level of this property.

For Option 2, the 1 in 20 AEP impacts outside of the WYURA are similar to those for Option 1. In the 1 in 100 AEP, increases in peak flood level are apparent at 17 residential properties. Of these, four have impacts that are above dwelling floor level with 13 below floor level. Of the four with impacts above floor level, all four are inundated above floor level in the Base Case. The above floor impacts range between 0.03m and 0.08m.

Option 3 has similar, but slightly reduced, impacts compared to Option 2 for both the 1 in 20 AEP and 1 in 100 AEP. This is due to the bypass corridor allowing slightly greater conveyance from east to west.

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1 Introduction

West Yamba Landowners Consortium through Mortons Urban Solutions (MUS) has commissioned BMT to undertake a flood impact assessment (FIA) for development within the West Yamba Urban Release Area (WYURA) at Yamba, New South Wales. The current proposed development is referred to as the 'Yamba Gardens' and occupies lots 46 and 47 on DP751395.

The FIA assesses the potential for flood impacts (changes in peak flood level or behaviour) from Clarence River flood events (which include storm surges entering the Clarence River from the ocean).

Flood impact assessments have previously been prepared by BMT for Yamba Gardens and for other sites within the WYURA. All previous flood impact assessments have included consideration of the cumulative effect of all development within the WYURA on Clarence River flooding.

This current FIA has been undertaken to account for the latest design landforms for Yamba Gardens. The assessment also incorporates a number of requests from Clarence Valley Council (Council) which primarily relate to including the latest available information for other developments within the WYURA.

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 than was previously feasible.

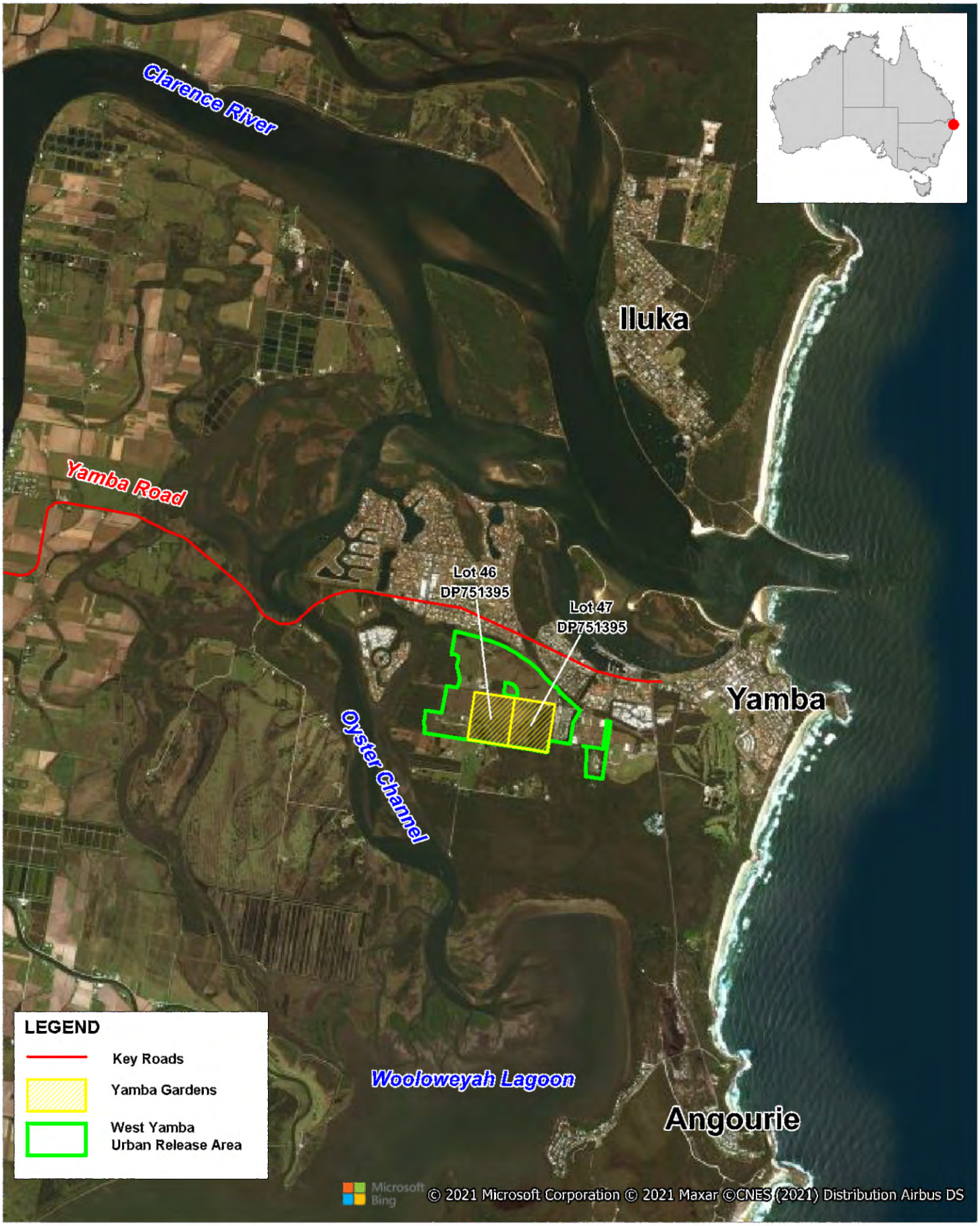
2 Site and Development Description

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 116ha. 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 1m and 2m AHD and due to its elevation, the land is generally flood prone. Figure 2.1 shows the location of the WYURA and the location of Yamba Gardens (Lot 46 and 47 on DP751395) within this.

The Yamba Gardens development and other future developments will include 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 in 100 Annual Exceedance Probability (AEP) design flood level with additional allowances for climate change and freeboard.

The WYURA also includes provision of land for a floodway. The floodway is based on flood modelling undertaken prior to gazetting of the land and is designed to convey floodwater from north to south during a 1 in 100 AEP or rarer event. The Lower Clarence Flood Model Update Study (BMT WBM, 2013), prepared for Clarence Valley Council, shows this floodwater overtops Yamba Road from the north due to a significant ocean storm surge which propagates up the Clarence River estuary. The portion of land within Yamba Gardens, which is indicated in the LEP as being part of the floodway, is not being filled as part of the proposed development and will remain as predominantly low lying land.

Details of how the Yamba Gardens and other WYURA developments have been represented in the flood model are provided in Section 5.2.



Title:
WYURA and Yamba Gardens Location

Figure: 2-1

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3 Model Update

3.1 Council Model

The flood model used in this assessment is based upon that adopted by Council as part of the *Lower Clarence Flood Model Update Study* (BMT WBM, 2013) and was developed using TUFLOW Classic software. The flood model was resolved by Council for adoption on 18 March 2014 and was recommended to be used to inform flood impact assessments in support of planning decision making. From herein the adopted model is referred to as the 'Council model'.

The Council model is fully calibrated and is based on LiDAR data captured in 2010. It is a multi-domain model with higher resolution domains for Grafton and Maclean and a relatively coarse scale domain for all other areas. The Yamba region falls within the coarse scale domain and has a grid resolution of 60m. Of particular note for Yamba are the assumptions around the way in which the modelled tidal (storm surge) boundary is applied. This is outlined below.

Tidal Boundary

The design flood ocean levels used in the Council model are shown in Figure 3.1. It can be seen that the peak ocean level for the 100 year ARI event (1 in 100 AEP) is around 2.6mAHD in elevation and occurs approximately 18 hours into the design model run.

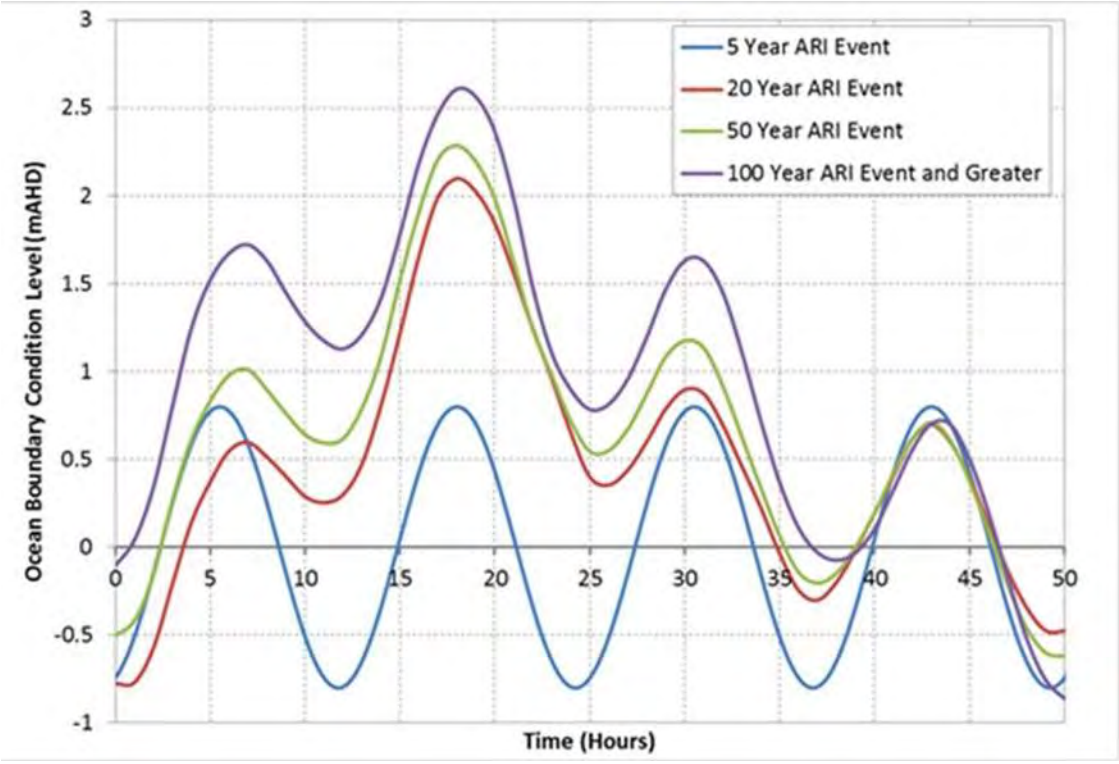


Figure 3.1 Lower Clarence Flood Model Design Tidal Boundaries

The Council model assumes that the peak in catchment rainfall coincides with the storm tide peak, thereby representing a slow moving storm which crosses the coast and moves inland. This boundary configuration results in backwater storm tide inundation at Yamba prior to the arrival of catchment flooding in the lower catchment. This is illustrated in Figure 3.2 where the 100 year ARI (1 in 100 AEP) design flood level is plotted for Harwood. Harwood was selected as the riverine flood peak is clearly

distinguishable. At Yamba, which is closer to the ocean boundary, the riverine flood peak is less pronounced and is lower than the storm tide peak flood level (see Section 4).

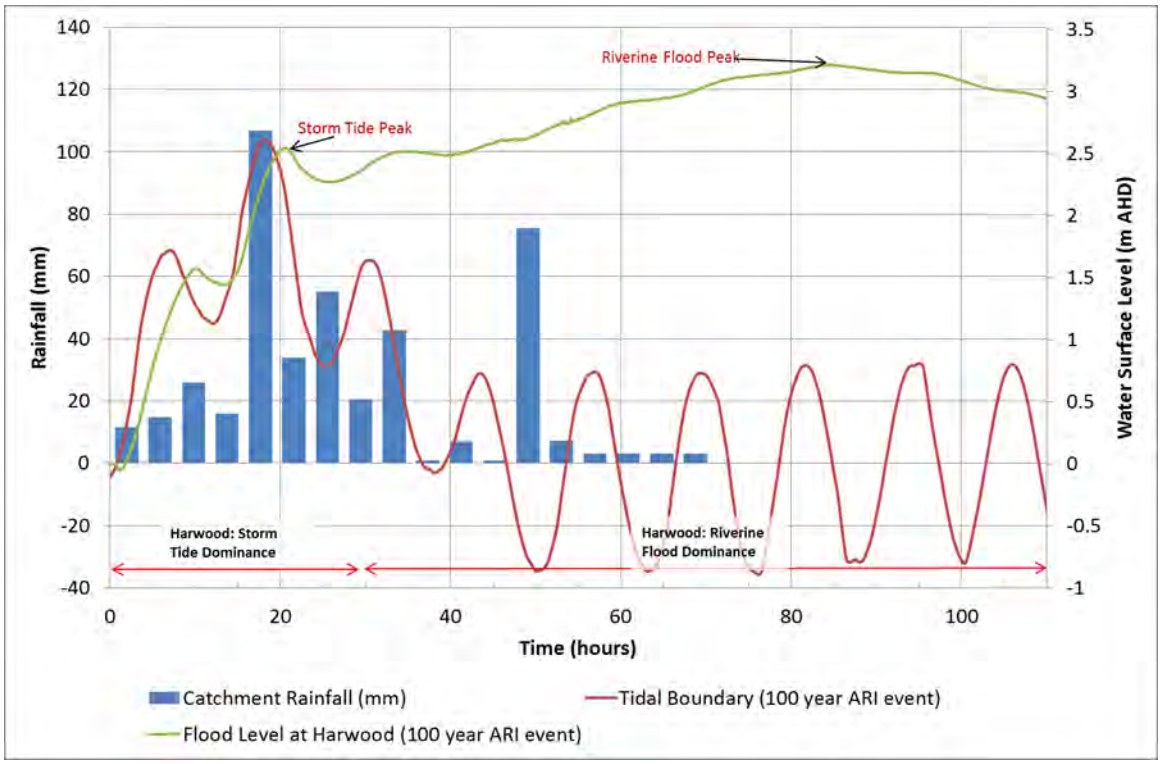


Figure 3.2 Storm Tide / Catchment Flooding Response Time (Harwood)[1]

Due to the significant size of the Clarence River catchment, there is a significant delayed catchment response from the catchment rainfall to when the river responds. Coinciding the storm tide and catchment flooding peaks at the river entrance was considered by Council's flood study to be overly conservative.

3.2 West Yamba Model

Yamba is modelled with a 60m grid schematisation in the Council model. Whilst this is appropriate at the catchment scale, and for ascertaining whether or not developments are likely to result in flood impacts, it remains a relatively coarse tool for quantifying such impacts.

Refinement of the Council model to allow for a more detailed resolution was first undertaken by BMT in 2014 for a FIA prepared for the WYURA. This involved modelling the floodplain downstream of Maclean, including the WYURA, at a 10m resolution (compared to the 60m resolution in the Council model). To achieve this, the upstream model boundary was moved to Maclean and time series water level hydrographs extracted from the Council model at Maclean were used to generate inflows to the West Yamba model. Other minor improvements were also made to incorporate surveyed culvert details for culverts within the vicinity of the WYURA.

Since 2014, there have been significant advancements in both computing performance and modelling software. This includes the release of TUFLOW HPC (Heavily Parallelised Compute) which allows TUFLOW models to be run using GPU graphics cards and allowing faster simulation times and/or higher model resolutions.

[1] Harwood is located downstream of Maclean on the main branch of the Clarence River

Furthermore, Council has also requested that the modelling for the WYURA FIA should use '*BMT's latest technology relating to model resolution'*.

The West Yamba model has therefore been updated to use TUFLOW HPC. Use of TUFLOW HPC's 'Quadtree' feature has also been made, allowing the model resolution to be varied in different parts of the model. This has allowed high resolution (2.5m) domains to be specified at the following locations:

- To represent flow paths along Carrs Drive and Miles Street. In previous WYURA assessments these flow paths were unable to be represented in 2D and use of nested 1D channels was employed. The high resolution 2D 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.

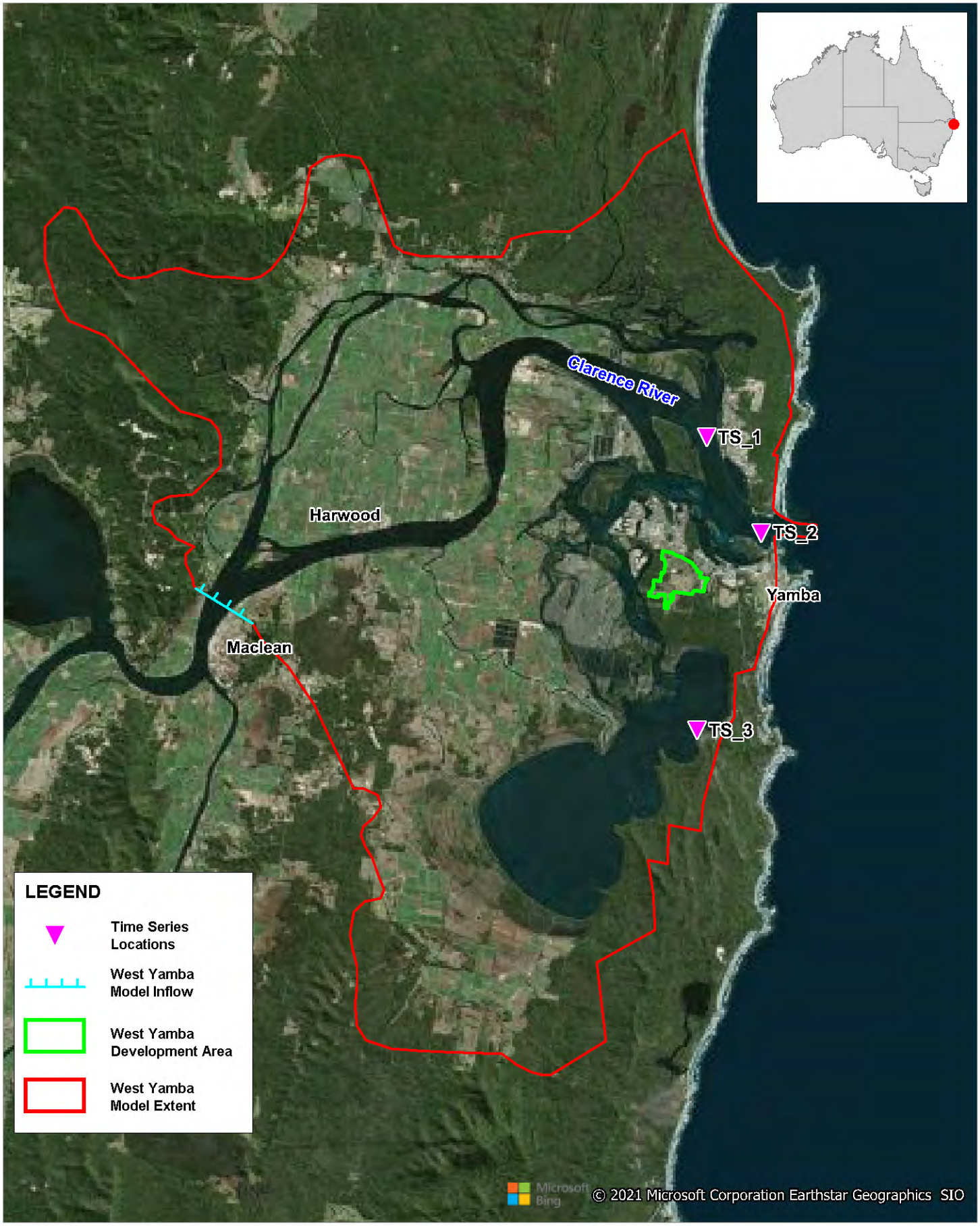
The remainder of West Yamba and surrounding area is modelled using a 10m grid as per the previous West Yamba assessments, with a 40m resolution beyond this. The proposed model schematisation in terms of model grid resolution in the vicinity of West Yamba is illustrated in Figure 3.3.

Figure 3.3 TUFLOW Model Grid Resolutions

The overall extent of the West Yamba model is shown in Figure 3.4. Figure 3.4 also shows three locations at which the results of the West Yamba model have been cross checked against the Council model to ensure there are no significant differences between model results (that is, the models are in general agreement). The cross checks are presented as plots of water level over time for the 1 in 20 AEP and 1 in 100 AEP and are included in Annex A:. Overall the peak flood levels and shapes of the hydrographs are very similar. The shape of the hydrograph at location TS_3 in Wooloweyah Lagoon is slightly different between the two models. This difference is attributed to a change in the inflow location

of local runoff from the Wooloweyah catchment. Previously this was input directly into the Clarence River, but it is considered more appropriate to apply this inflow into the Wooloweyah Lagoon. The peak water levels remain very similar at this location.

Overall, the plots show minimal differences in water level and provide confidence that the updated model gives design water levels consistent with Council's adopted model.



Title:

West Yamba Model Extent

Figure: 3-4

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Approx. Scale

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4 Base Case Flood Behaviour

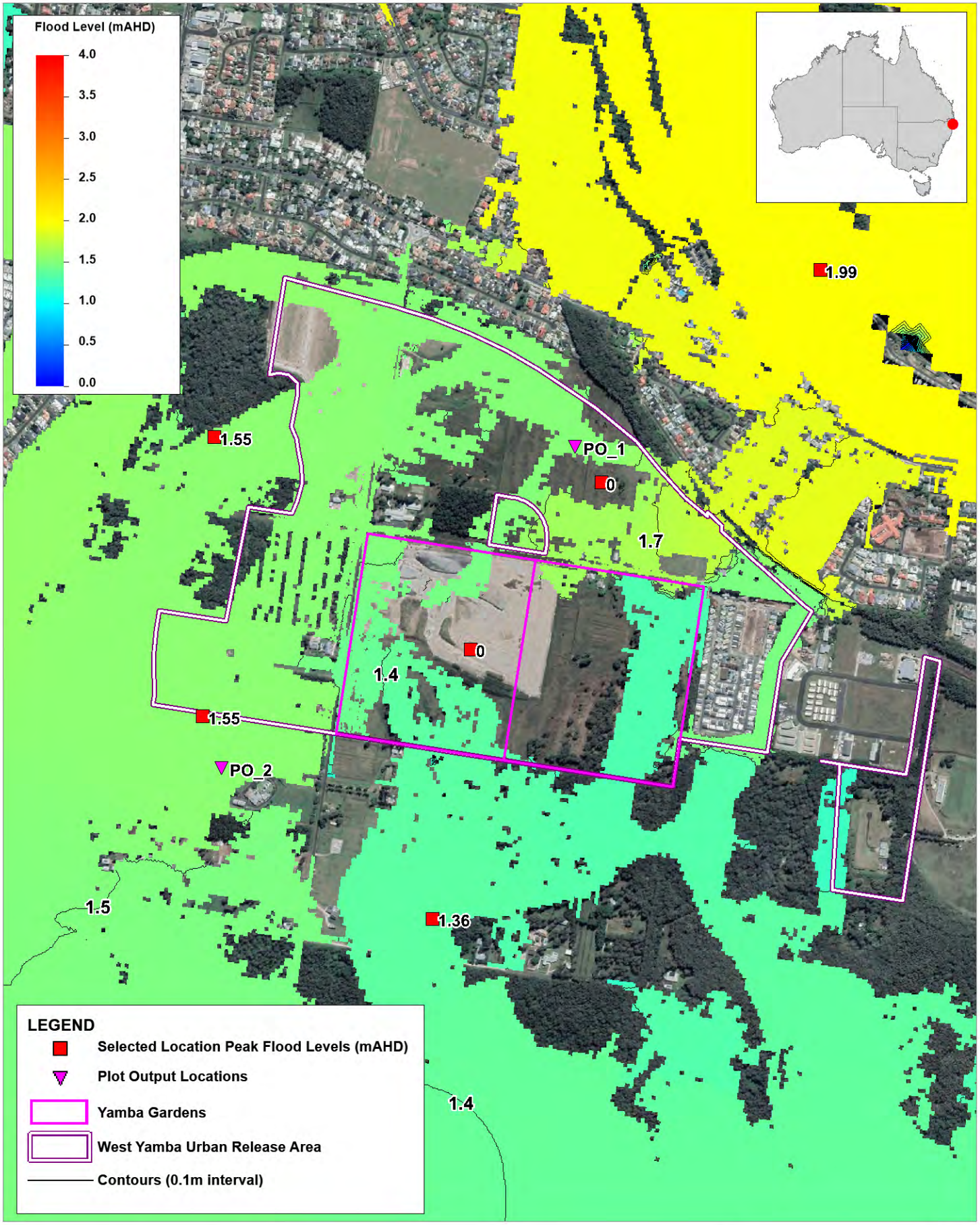
The base case model represents the existing case (i.e. a pre developed case). An understanding of the base case flood behaviour helps to inform the site design.

Figure 4.1 and Figure 4.2 present the base case peak flood elevations across the study area for the 1 in 20 and 1 in 100 AEP events respectively. Annotated flood levels have been included at various locations and two plot output locations are shown at which the time series of modelled water levels have been extracted. These water levels are plotted in Figure 4.3 and Figure 4.4.

It can be seen that the 1 in 20 and 1 in 100 AEP events show predicted inundation of the WYURA during the base case scenario. The plots of water level over time show one notable peak for the 1 in 20 AEP event which results from the storm surge component of the flood. The 1 in 100 AEP event shows two notable clusters of peaks. The first cluster is a double peak and occurs around 20 hours into the model simulation. The double peak is the result of the storm surge with the first peak being the larger one. The second cluster of peaks occurs approximately 80 hours (3 days, 8 hours) later. This cluster is more drawn out and results from the catchment runoff component of the event. This second peak is notably lower than the storm surge peak.

The peak design flood levels across the site as shown in Figure 4.1 and Figure 4.2 therefore result from the storm surge component of the modelled flood events. The storm surge propagates up the Clarence River from the ocean and overtops Yamba Road from the north during the 1 in 100 AEP flood. Once Yamba Road is overtopped, water flows in a general south-westerly direction towards Oyster Channel through existing development and across the WYURA. The rate of flow is relatively slow across the WYURA due to the shallow water surface gradient. The flow is initially confined to depressions within the terrain but as the water level continues to rise the flow occurs across much of the WYURA. The shallow gradient is because the storm surge is causing water to rise in all watercourses around Yamba including Oyster Channel and Wooloweyah Lagoon.

The base case peak flood levels vary across the WYURA. In the 1 in 20 AEP event they range from around 1.7mAHD in the north-east to 1.3mAHD in the south. In the 1 in 100 AEP the peak flood levels range between 2.1mAHD in the north-east to 2.0mAHD in the south of the WYURA. The 1 in 100 AEP peak flood across Yamba Gardens inundates the two lots in their entirety and the peak flood level is relatively consistent around 2.0mAHD.



Title:

1 in 20 AEP Base Case Peak Flood Elevations

Figure: 4-1

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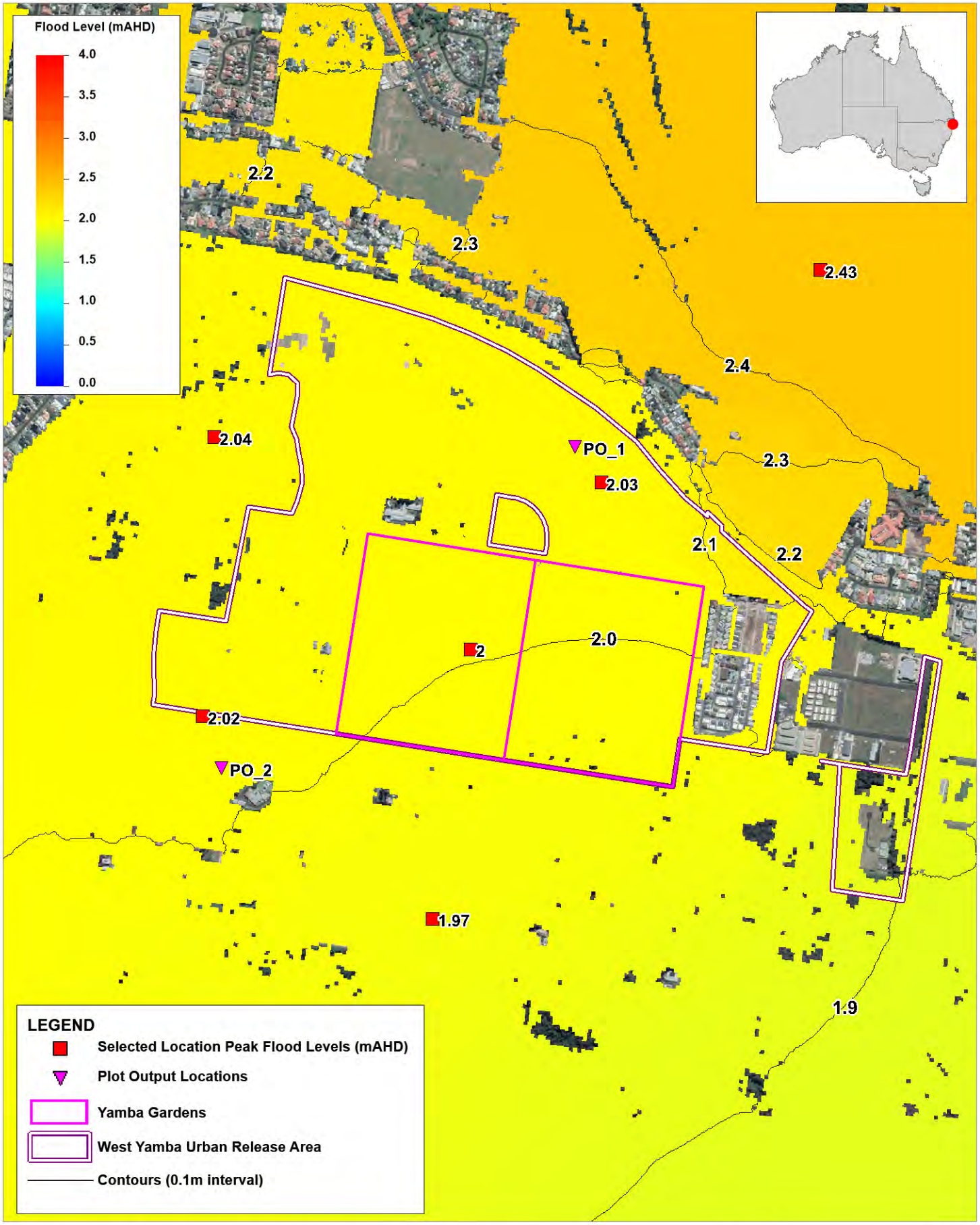

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1 in 100 AEP Base Case Peak Flood Elevations

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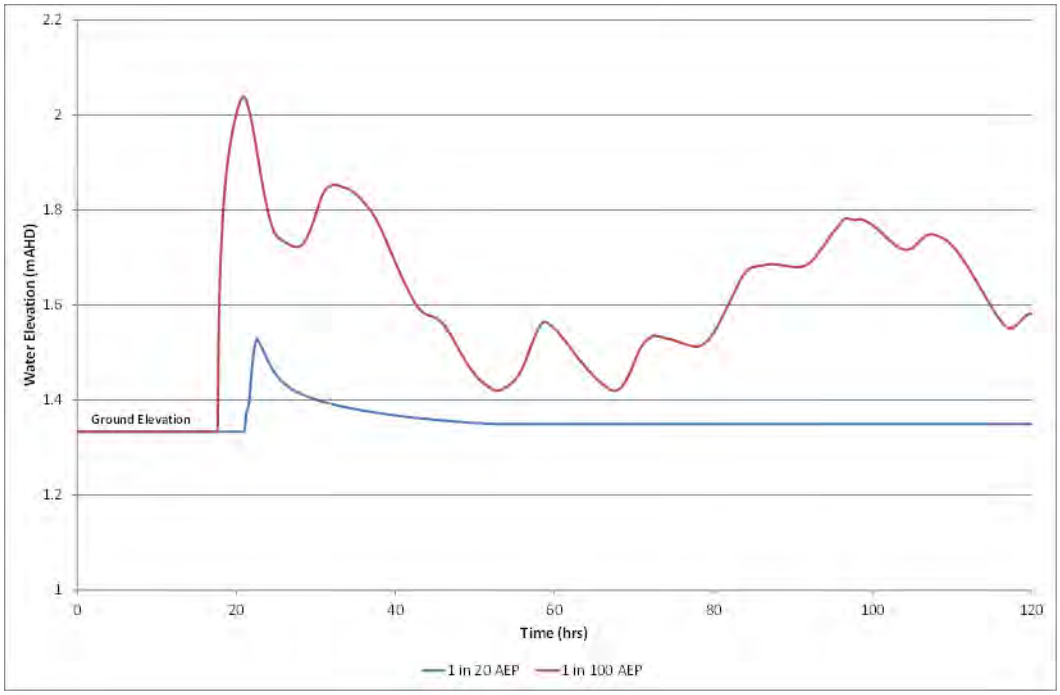


Figure 4.3 Flood Levels with Time (Location PO_1)

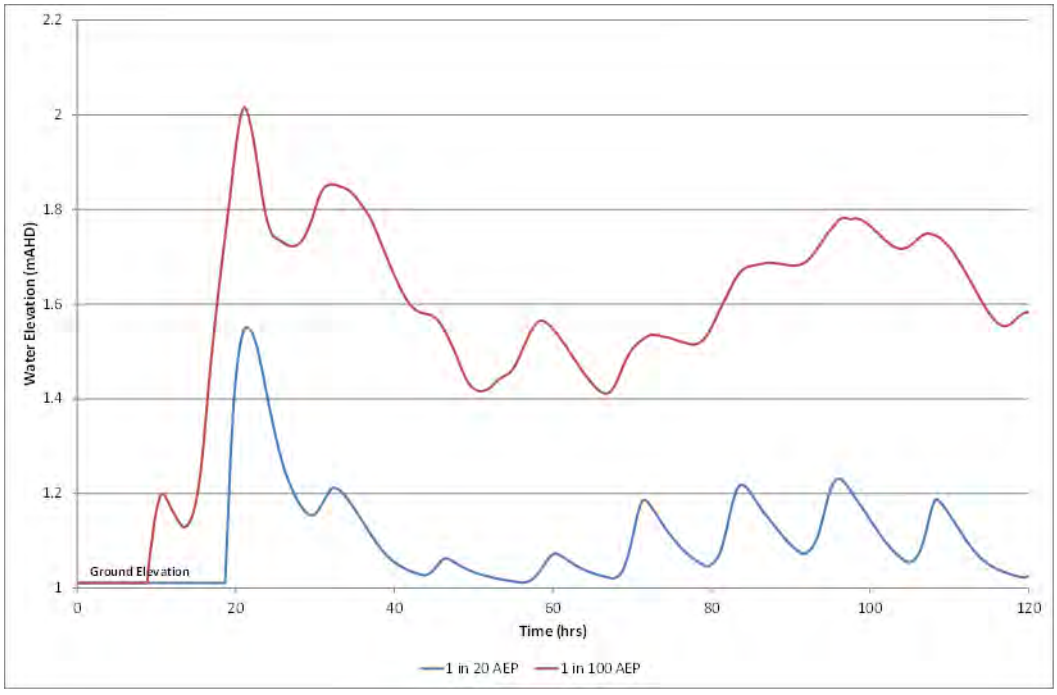


Figure 4.4 Flood Levels with Time (Location PO_2)

5 Flood Impact Assessment

5.1 Introduction

The flood impact assessment compares the peak flood levels between baseline and developed case models to determine if there are any changes in peak flood levels resulting from the development. The impacts assessed are in relation to Clarence River (and storm surge) events. The presented impacts do not cover any potential impacts which could result from localised stormwater runoff. Impacts are shown for any variance in peak flood level by +/- 0.03m or more. Impacts below 0.03m are considered insignificant for the purposes of this assessment which is consistent with previous flood impact assessments undertaken for the WYURA.

5.2 Scenarios

Four scenarios have been modelled to represent different landforms. The scenarios have been defined to capture the cumulative flood impact from all WYURA development at different stages in design/approval. The scenarios have been agreed with Council and are described below.

Base Case

The Base Case is the same as that defined in Section 4 and represents a pre- West Yamba development scenario. The main dataset used to define model topography is LiDAR data captured in 2010 and this has been supplemented with local ground survey where available. This includes surveyed ground levels along Yamba Road and Sullivans Road as well as invert levels of culverts on Deering Street, Yamba Road and Sullivans Road.

Option 1

Option 1 is as the Base Case but includes the proposed Yamba Gardens development and all approved and current applications (Yamba Parklands, Clifton Lifestyle MHE, Golding Street MHE and 52 Seniors Living Units). It also includes recently approved Carrs Drive upgrade plans and includes supplied design for Miles Street. The locations and extent of known fill of these developments are shown in Figure 5.1. Note that Golding Street MHE is already shown to be largely filled within the LiDAR data such that the majority of the site is above the 1 in 100 AEP flood level. Golding Street MHE has therefore not been filled further in this assessment.

Design landforms for Yamba Parklands and 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, the assumption is made that the development has been filled to be above the 1 in 100 AEP flood level (which is considered to be a conservative assumption).

Representation of Carrs Drive was included within the Yamba Parklands design and has been incorporated into the model. A design for Miles Street (between Carrs Drive and Golding Street) was included in the design for Yamba Gardens and has also been incorporated into the model. Both Carrs Drive and Miles Street generally have road elevations of 1.7mAHD or higher. An exception is on Miles Street where it crosses the land set aside for a floodway to connect with Golding Street and where the elevation dips to approximately 1.3mAHD.

The floodway near Golding Street is approximately shown in the Maclean LEP 2001 (Amendment No. 20). This extent has been incorporated into Option 1 insofar 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.

Option 2

Option 2 is as Option 1 but with filling of all remaining lots within the WYURA. 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 within Option 2:

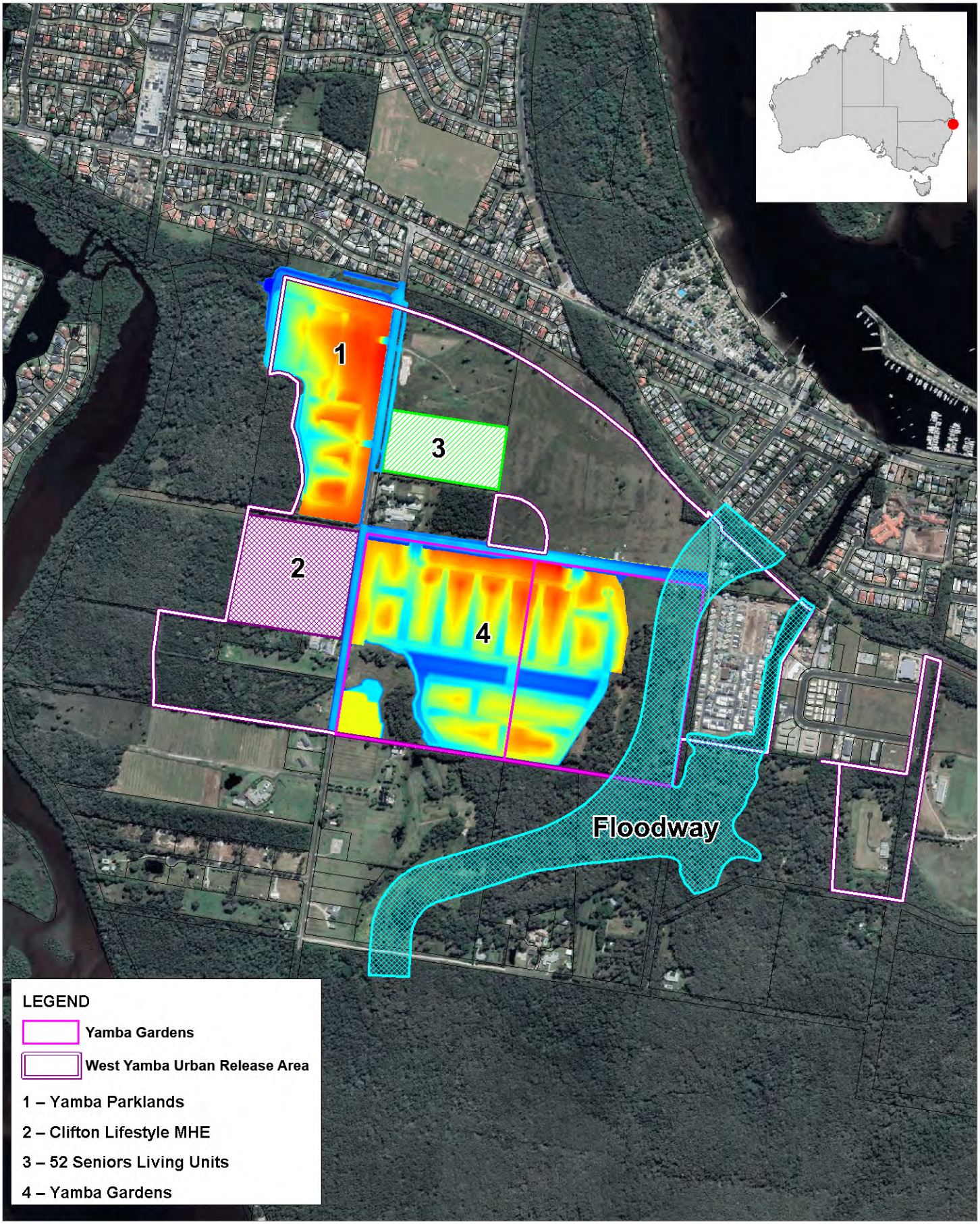
- At its northern end, the floodway is shown to cross three lots north of the former caravan park. These lots have been filled under Option 2 except for the portions which are shown as being within the floodway. These portions are retained at existing (Base Case) ground levels.
- The proposed floodway 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].
- As for Option 1, within Yamba Gardens, the floodway is retained at natural ground levels primarily due to retaining vegetation. The extent of land set aside for a floodway has been 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 = 0.08) 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 5.2 shows all areas modelled as filled under Option 2 and also shows the extent of the Council defined floodway. Land located between 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.

Option 3

Option 3 is as Option 2 but with the additional inclusion of Yamba Bypass. The bypass representation in the model is the same as that used in a previous assessment by BMT for an assessment undertaken in January 2018[3] and extends along the full northern boundary of the WYURA. The bypass road elevations range between 2.0mAHD in the east to and 1.7mAHD in the west and are such the road is overtopped in the 1 in 100 AEP event but remains flood free in the 1 in 20 AEP event.

[2] This land is part of the consortium land and BMT understands from MUS that the floodway can be designed in this way.
[3] West Yamba Urban Release Area Flood Impact Assessment prepared for Site Plus Pty Ltd by BMT, January 2018.



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Model Scenario Option 1
Approved and Current Applications

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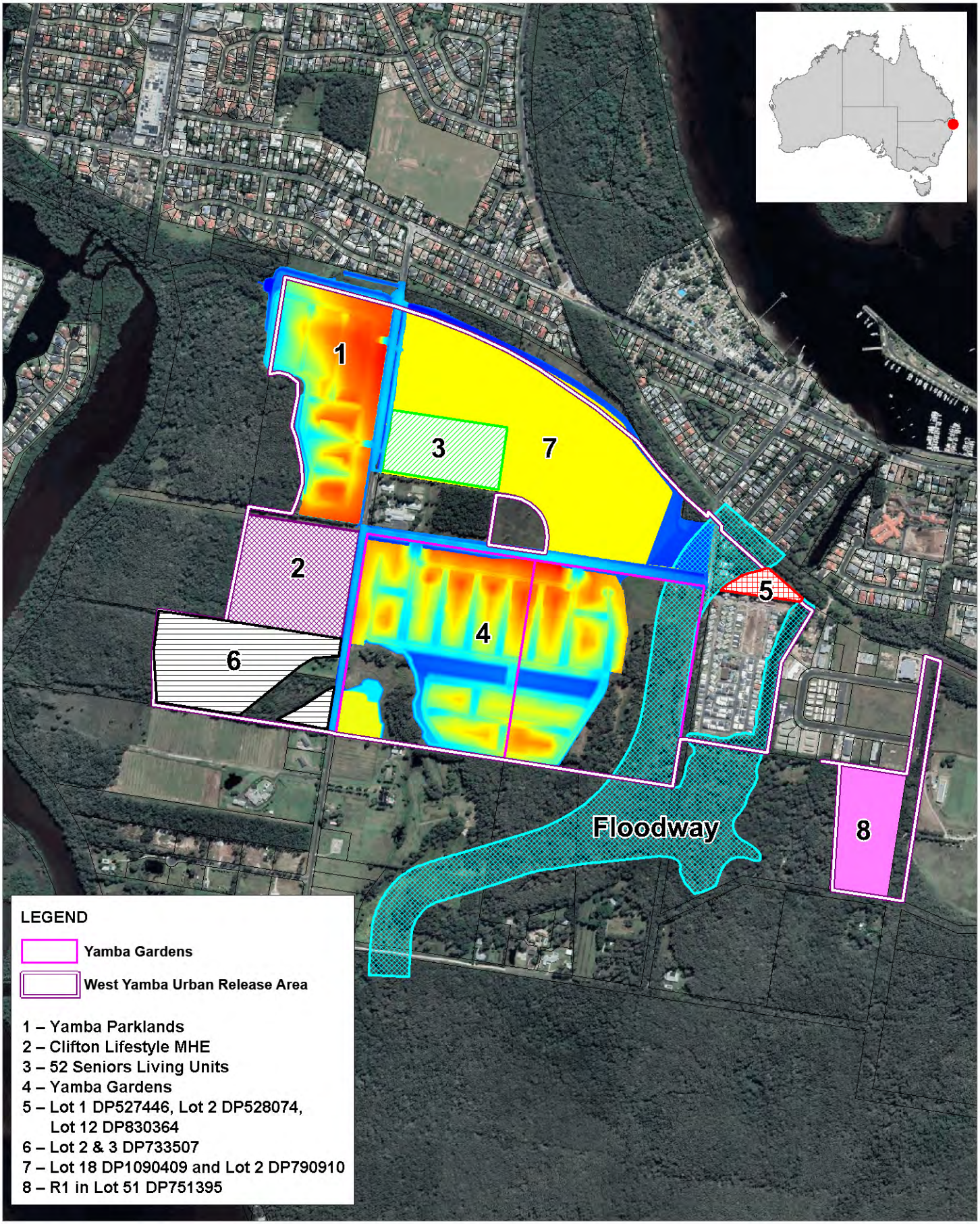

LEGEND

Yamba Gardens

West Yamba Urban Release Area

1 – Yamba Parklands
2 – Clifton Lifestyle MHE
3 – 52 Seniors Living Units
4 – Yamba Gardens
5 – Lot 1 DP527446, Lot 2 DP528074, Lot 12 DP830364
6 – Lot 2 & 3 DP733507
7 – Lot 18 DP1090409 and Lot 2 DP790910
8 – R1 in Lot 51 DP751395

Title:

Model Scenario Option 2 Fully Developed WYURA

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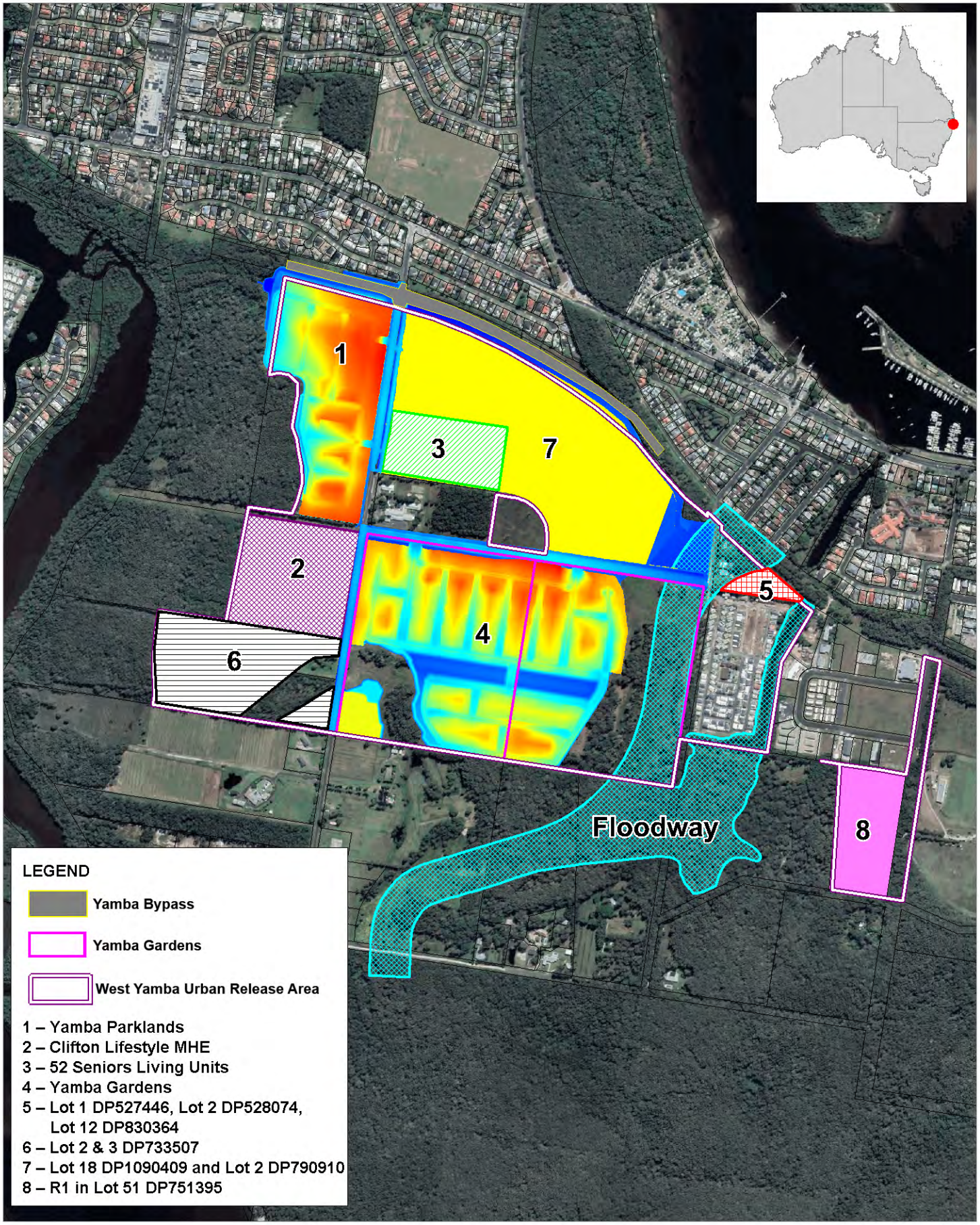

Title:

Model Scenario Option 3
Fully Developed WYURA with Yamba Bypass

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5.3 Results

The FIA results are presented as a series of impact maps (Figure 5.4 to Figure 5.9) which show change in peak flood level for Options 1, 2 and 3 against the Base Case. The impacts are shown for both the 1 in 20 AEP and the 1 in 100 AEP. Brief commentary on the impacts is provided below. Further commentary is also provided in Section 5.4 on flood impacts to existing property.

1 in 20 AEP Impacts Summary

Due to the proposed filling, the areas of the site which were shown to be inundated during the baseline assessment are now shown to be dry. Predicted impacts are generally limited to the immediate perimeter of the site. There are minor increases in peak water level at the northern end of Carrs Drive under Option 1 and Option 2. The increases range between 0.05m and 0.07m and extend onto two properties (No's 2 and 4 Harold Tory Drive) and which were previously vacant but are now understood to be developed. It is understood from Council that these properties have a minimum floor level requirement of 2.7mAHD which is significantly higher than the 1 in 20 AEP flood level of 1.6mAHD at this location. The impacts at the northern end of Carrs Drive are less under Option 3 than for Options 1 and 2. Property floor levels are discussed further in Section 5.4.

1 in 100 AEP Impacts Summary

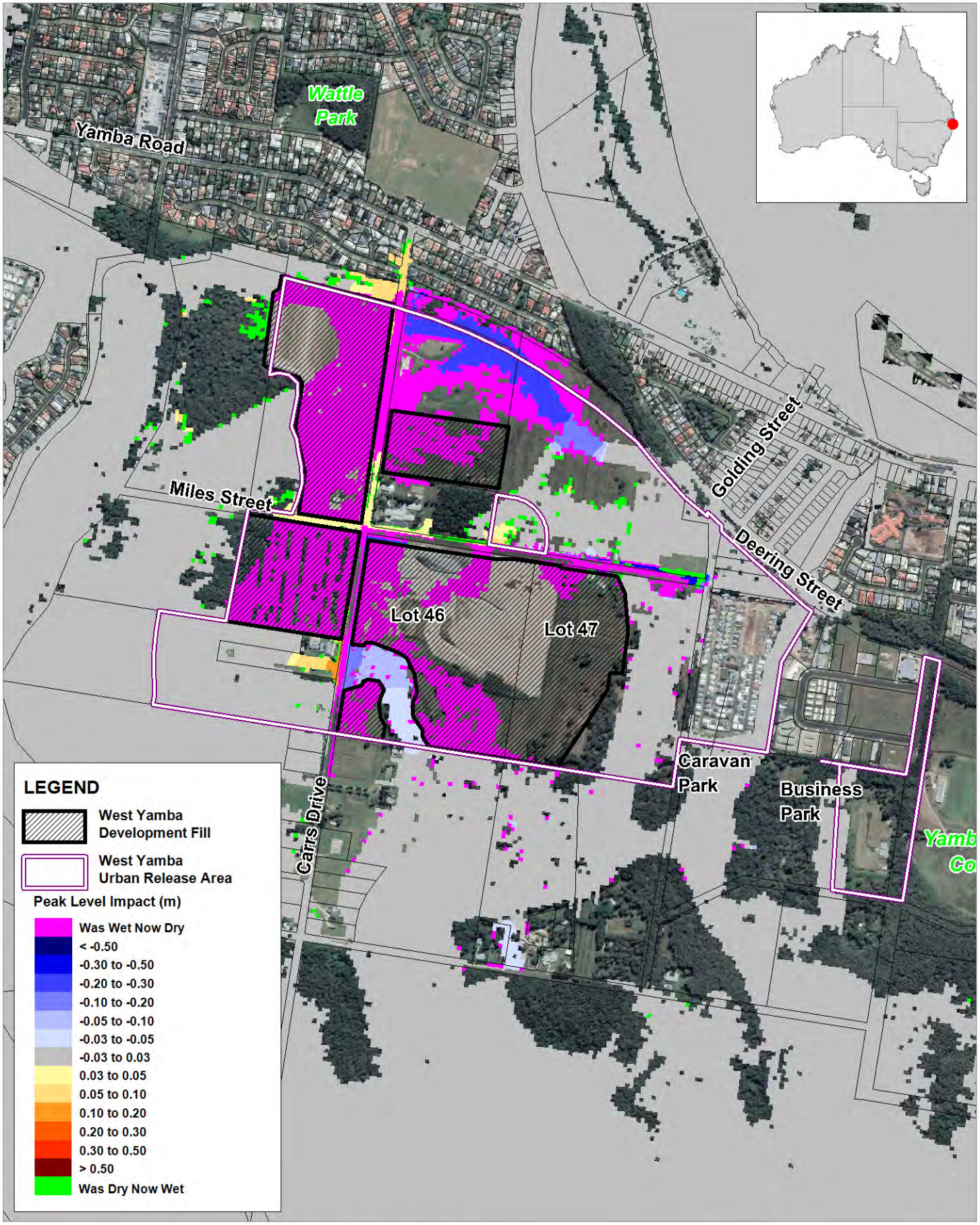
Under Option 1, increases in flood level are apparent across much of the north-eastern portion of the WYURA as this portion is not filled and movement of water from north to south is restricted by fill to the south. The increases in peak flood level extend outside of the WYURA but are mostly confined to the strip of land which is earmarked to become the Yamba Bypass. The increases in peak flood level are also evident at the northern end of Carrs Drive and occur across the same two properties as for the 1 in 20 AEP flood and additionally the lot immediately to the north of them (Lot 161 on DP1265281). The peak flood level increase across the three properties is approximately 0.07m. Option 1 also shows impacts within the grounds of the school on Carrs Drive although these impacts do not extend across the school building.

Under Option 2, the impacts are less extensive (than for Option 1) across the north-eastern portion of the WYURA due to the development fill. This also reduces the impact shown at the School on Carrs Drive although there remain some minor impacts (0.04m) within the school grounds. The extent and magnitude of impacts at the northern end of Carrs Drive remains similar to Option 1 with no additional properties affected.

Six properties on Deering Street show flood impacts across a portion of the properties. These impacts range between 0.03m and 0.08m. Section 5.4 contains additional analysis of property impacts.

Option 2 shows increases in peak flood level within the former Caravan Park. These increases range between 0.03m and 0.12m but appear to be mostly limited to within the roads and existing waterway. Some increases are shown across properties within the former Caravan Park. Given that these properties are new it is expected that they have floor levels at or above the flood planning level. Minor increases in peak level (approximately 0.04m) are also shown within the Business Park to the east of the former Caravan Park.

The impacts under Option 3 are very similar in extent and magnitude to that of Option 2. Of most note, the number of affected properties on Deering Street has reduced from 6 (under Option 2) to 3 (under Option 3). This is attributed to the bypass corridor (which includes the bypass and swales) allowing slightly more flow to pass within it from east to west.



Title:

Model Scenario 'Option 1' - 1 in 20 AEP Peak Flood Level Impact

Figure: 5-4

Rev: A

N

0 200 400m

Approx.Scale

BMT

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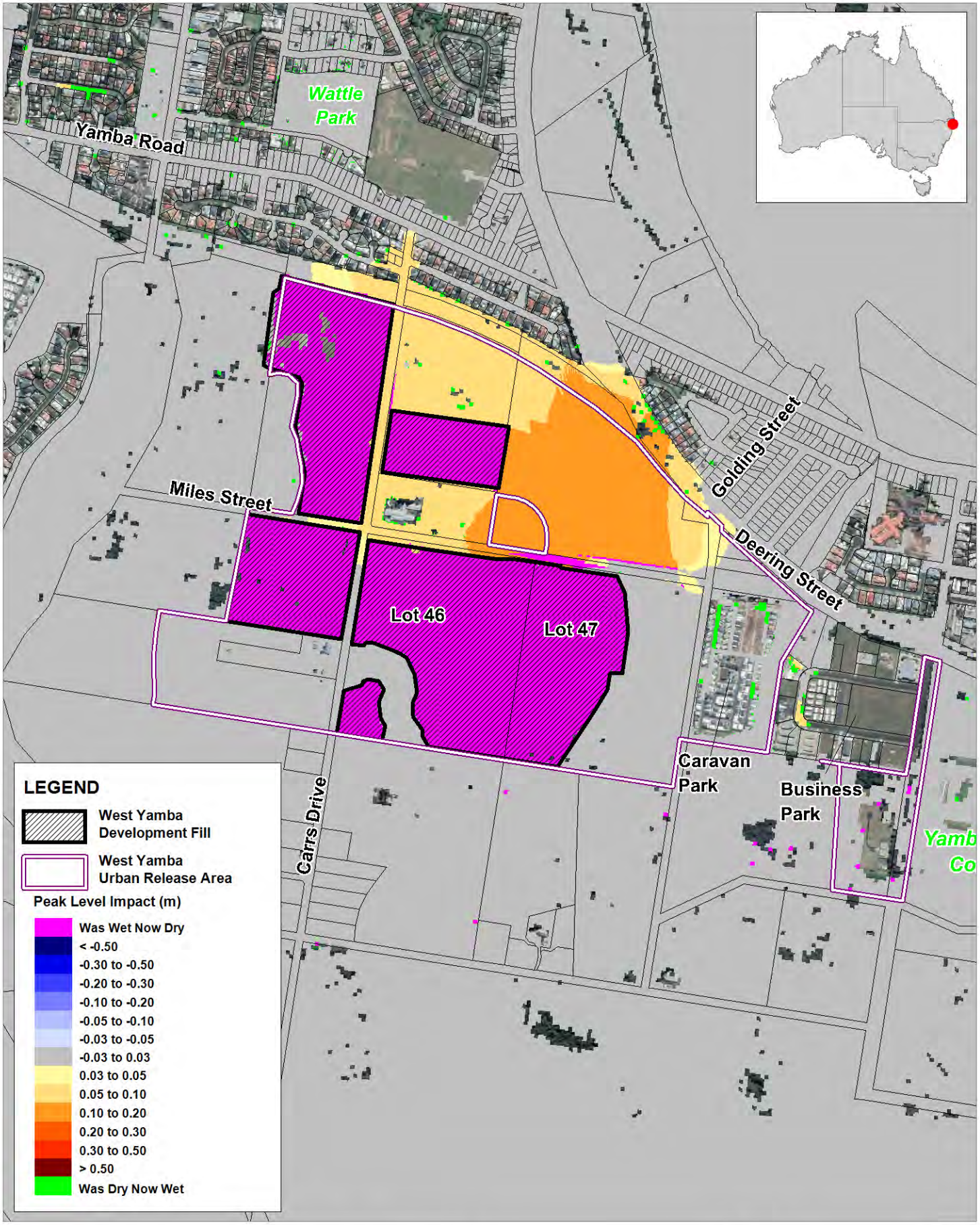

Title:

Model Scenario 'Option 1' - 1 in 100 AEP Peak Flood Level Impact

Figure: 5-5

Rev: A

N

0 200 400m

Approx.Scale

BMT

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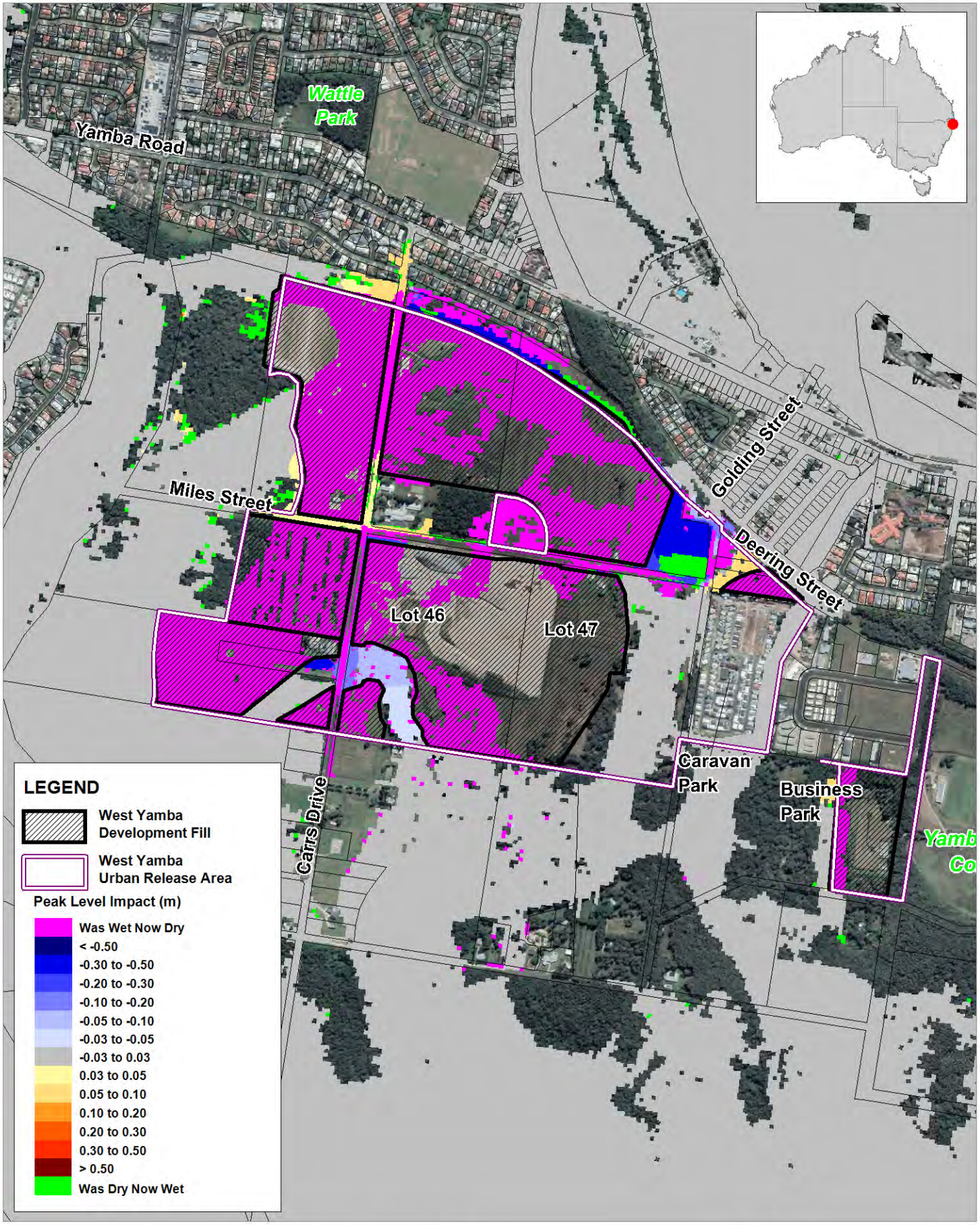
Filepath: "I:\A11309.i.br_West_Yamba\Drg\FLD_011_20211117_WY_dH_Opt1_Q100.wor"



Title:

Model Scenario 'Option 2' - 1 in 20 AEP Peak Flood Level Impact

Figure: 5-6

Rev: A

N

0 200 400m

Approx.Scale

BMT

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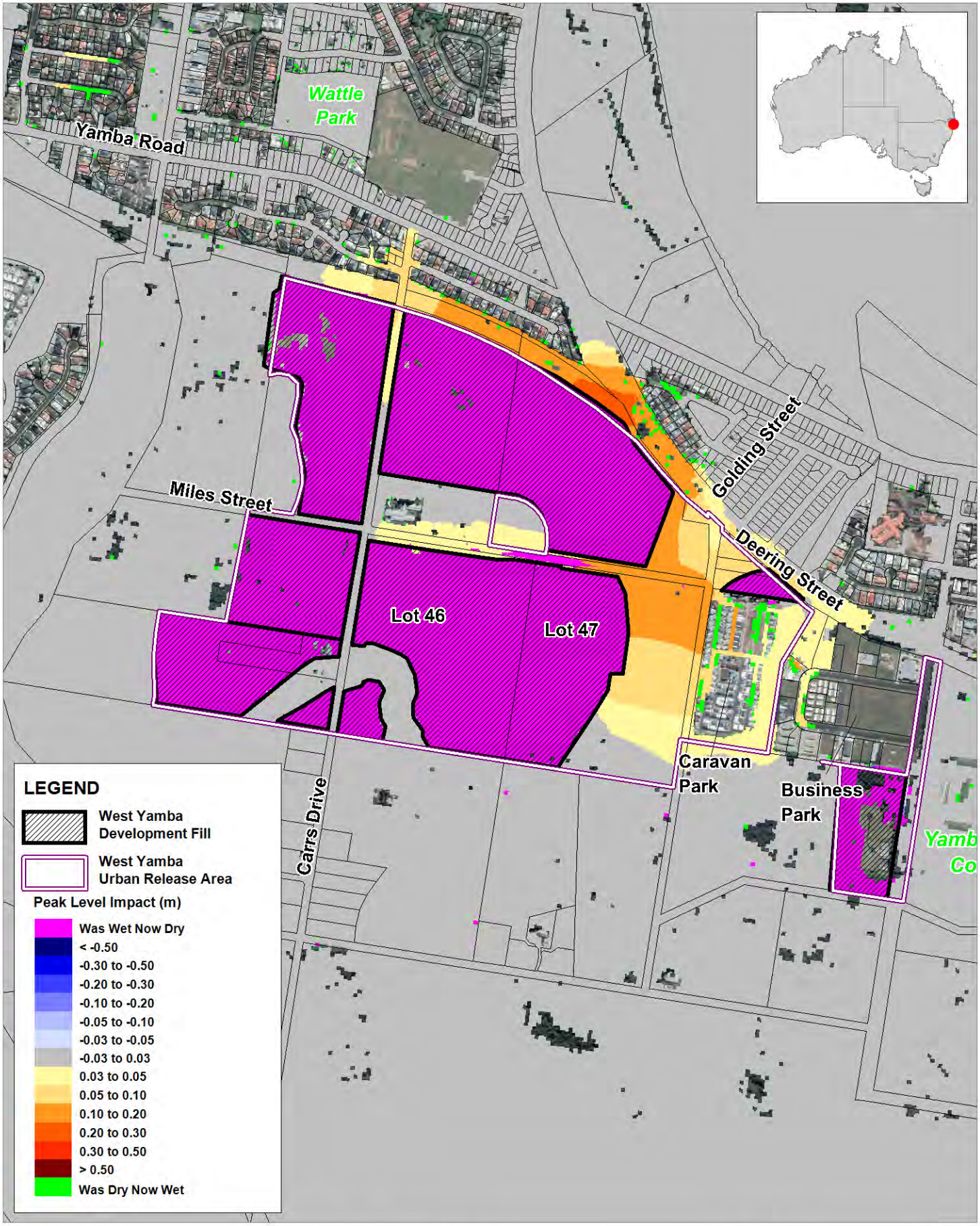
Filepath: "I:\A11309.i.br_West_Yamba\Drg\FLD_012_20211117_WY_dH_Opt2_Q020.wor"



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Model Scenario 'Option 2' - 1 in 100 AEP Peak Flood Level Impact

Figure: 5-7

Rev: A

N

0 200 400m

Approx.Scale

BMT

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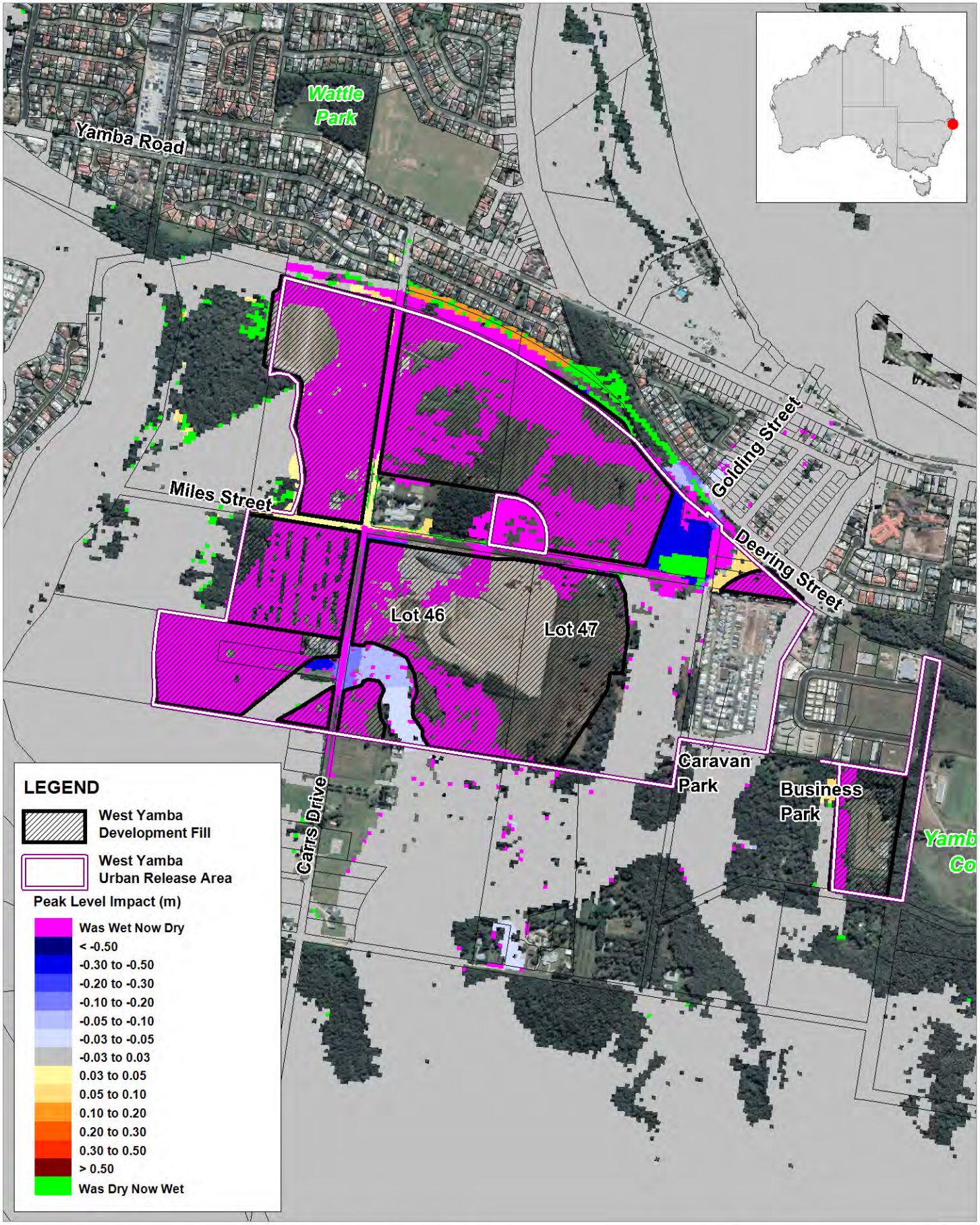
Filepath: "I:\A11309.i.br_West_Yamba\Drg\FLD_013_20211117_WY_dH_Opt2_Q100.wor"



Title:

Model Scenario 'Option 3' - 1 in 20 AEP Peak Flood Level Impact

Figure: 5-8

Rev: A

N

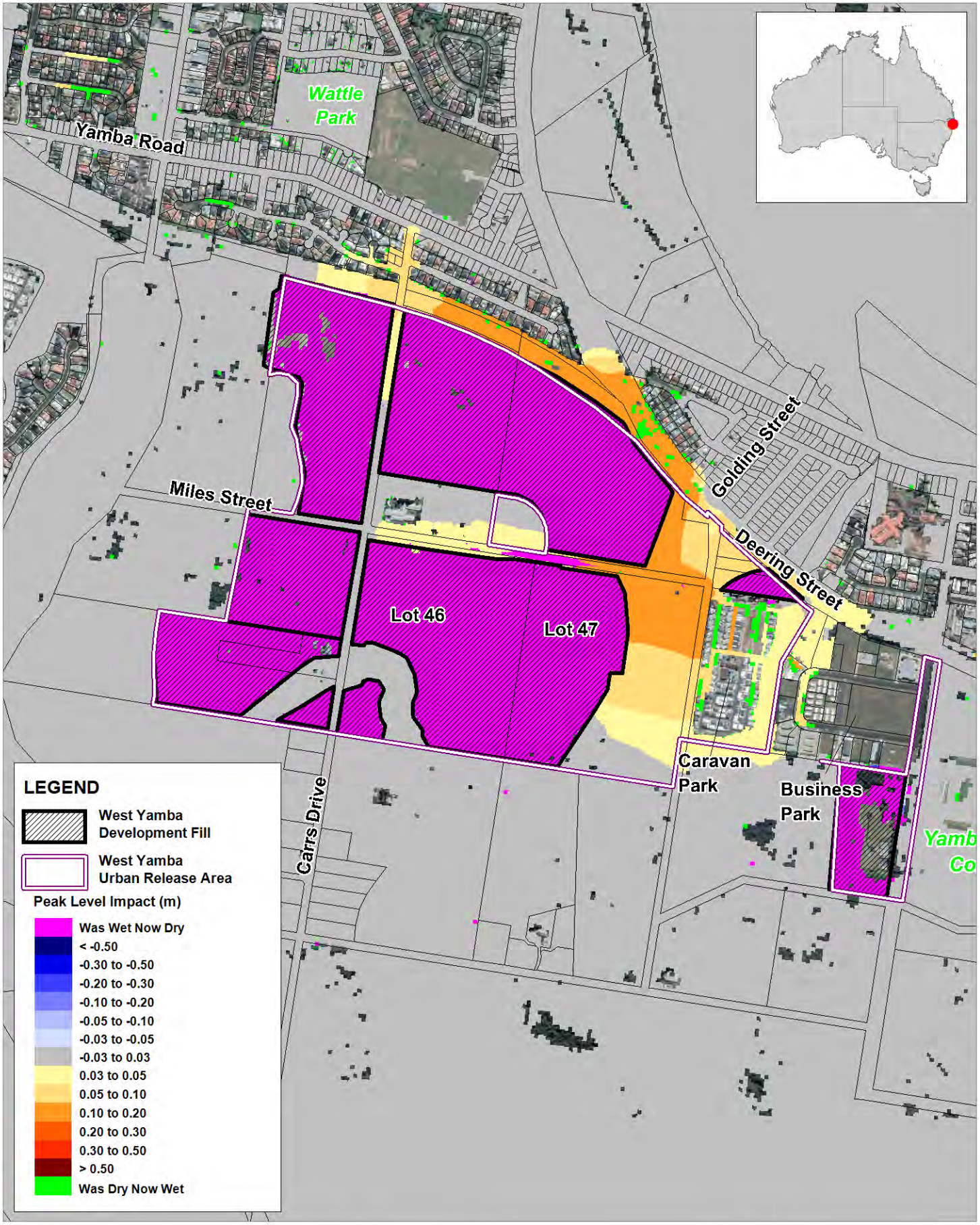
0 200 400m

Approx.Scale

BMT

www.bmt.org

Filepath: "I:\A11309.i.br_West_Yamba\Drg\FLD_014_20211117_WY_dH_Opt3_Q020.wor"



Title:

Model Scenario 'Option 3' - 1 in 100 AEP Peak Flood Level Impact

Figure: 5-9

Rev: A

N

0 200 400m

Approx.Scale

BMT

www.bmt.org

Filepath: "I:\A11309.i.br_West_Yamba\Drg\FLD_015_20211117_WY_dH_Opt3_Q100.wor"

5.4 Flood Impacts to Dwellings

Where the impact mapping has identified an impact to residential property (above the mapping threshold of 0.03m) the peak flood levels (before and after WYURA development) have been compared to property floor levels. This has been done for the 1 in 100 AEP event. The results are tabulated in Table 5.1 below. The impacts relate to the developed case under Option 2 which is almost identical to Option 3 and shows greater impacts than Option 1.

Table 5.1 identifies 17 residential properties that have flood impacts within the property boundary. Of these, four have impacts that are above dwelling floor level with 13 below floor level. Of the four with impacts above floor level, all four are inundated above floor level in the Base Case. The above floor impacts range between 0.03m and 0.08m. It should be noted that one of these four properties, at 28 Golding Street, is within the WYURA and is also within the land identified as 'Floodway'.

Table 5.1 Comparison of 1 in 100 AEP flood levels with floor levels at dwellings

					Peak Flood Level (mAHD)			
Street Numbe	Street Name	Street Type	Floor Level (mAHD	Survey Source	Base Case	Option 2	Impact (m)	Impact Above Floor?
30	Coonawara	Ct	2.49	WYLOC	2.11	2.28	0.18	N
23	Cox	Street	2.27	WYLOC	2.18	2.22	0.04	N
25	Cox	Street	2.13	WYLOC	2.17	2.23	0.05	Y
27	Cox	Street	2.61	WYLOC	2.20	2.24	0.04	N
25	Endeavour	Street	2.56	WYLOC	2.24	2.27	0.03	N
30	Endeavour	Street	3.31	WYLOC	2.24	2.27	0.03	N
26	Golding	Street	2.30	WYLOC	2.12	2.17	0.05	N
28	Golding	Street	2.12	WYLOC	2.11	2.17	0.06	Y
25	Golding	Street	2.11	WYLOC	2.22	2.25	0.03	Y
30	Golding	Street	2.29	WYLOC	2.10	2.16	0.06	N
	Caravan Park		2.79	CVC	2.00	2.09	0.09	N
	Caravan Park		2.78	CVC	2.00	2.09	0.09	N
	Caravan Park		2.80	CVC	2.00	2.09	0.09	N
	Caravan Park		2.87	CVC	2.00	2.09	0.09	N
6	Carrs	Drive	1.92	WYLOC	2.07	2.14	0.08	Y
4	Harold Tory	Drive	2.7*	CVC	2.07	2.14	0.08	N
2	Harold Tory	Drive	2.7*	CVC	2.07	2.14	0.08	N

*Floor level not suveyed but BMT advised by CVC that floor level of 2.7mAHD is required

6 Conclusions

An FIA has been undertaken for proposed development within WYURA. The FIA has considered the Yamba Gardens development along with all other development underway or proposed within the WYURA. The FIA has established the changes in peak flood level due to the development during Clarence River design flood events (which include a significant storm surge component).

The significant size and scale of filling within the WYURA affects flood behaviour by obstructing flow which enters the WYURA from the north during the 1 in 100 AEP flood event. This is mitigated to a significant degree by the inclusion of a floodway within the eastern portion of the WYURA. Residual flood impacts (increases in peak flood level) remain, and these have been mapped and quantified for three options.

The modelling undertaken for Option 1 (approved and current development applications) shows minimal impacts outside of the WYURA except for impacts in close proximity to the northern perimeter of the WYURA. In the 1 in 20 AEP these impacts extend onto two residential properties at the northern end of Carrs Drive but the flood levels are significantly below the floor levels. In the 1 in 100 AEP the impacts extend onto 3 properties at the northern end of Carrs Drive with only 1 property identified as having a dwelling floor level below the flood level as it was in the Base Case.

For Option 2 the 1 in 20 AEP shows minimal flood impacts outside of the WYURA. As for Option 1, the 1 in 20 AEP impacts do extend onto two properties at the northern end of Carrs Drive but the flood levels are significantly below the floor level. In the 1 in 100 AEP the Option 2 impacts are shown to encroach on 17 residential properties, four of which have dwelling floor levels below the flood level. These dwellings are already shown to have above floor flooding in the Base Case but the flood levels will increase by a further 0.03m to 0.08m in a 1 in 100 AEP flood event.

Inclusion of the Yamba Bypass within the modelling (Option 3) results in a slight reduction in both the 1 in 20 and 1 in 100 AEP impacts when compared to Option 2. This is due to the bypass corridor conveying slightly greater flow from east to west.

Annex A: Model Comparison Plots

Figure A.1 to Figure A.6 compare results from the Council model with the revised West Yamba model. The locations TS_1, TS_2 and TS_3 are shown in Figure 3.4. The results have been compared for the 1 in 20 AEP flood and the 1 in 100 AEP flood.

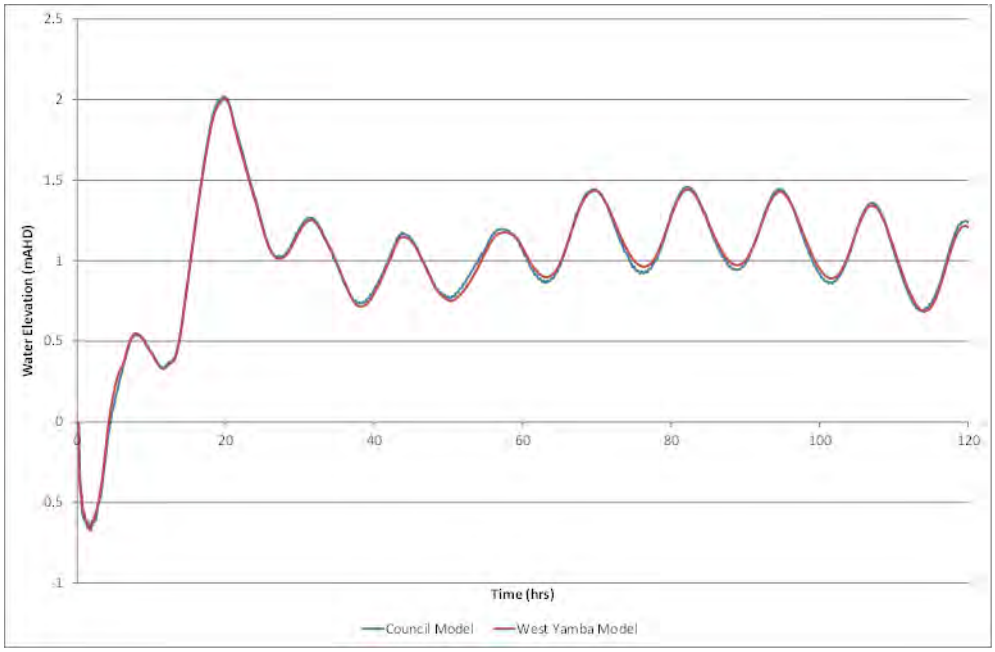


Figure A.1 1 in 20 AEP Model Comparison (Location TS_1)

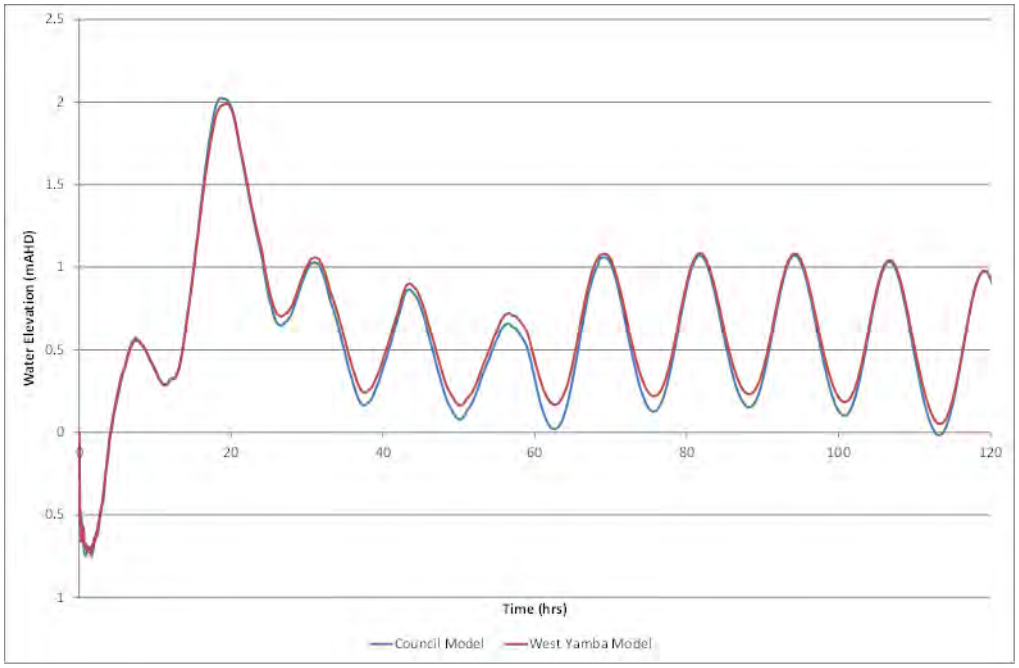


Figure A.2 1 in 20 AEP Model Comparison (Location TS_2)

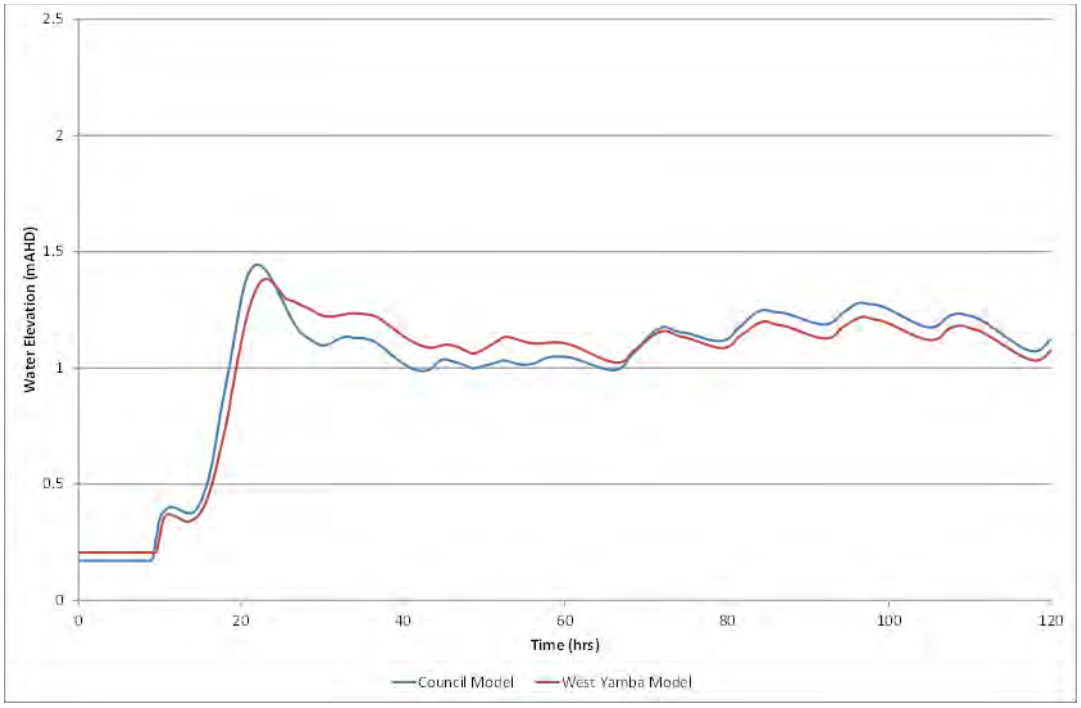


Figure A.3 1 in 20 AEP Model Comparison (Location TS_3)

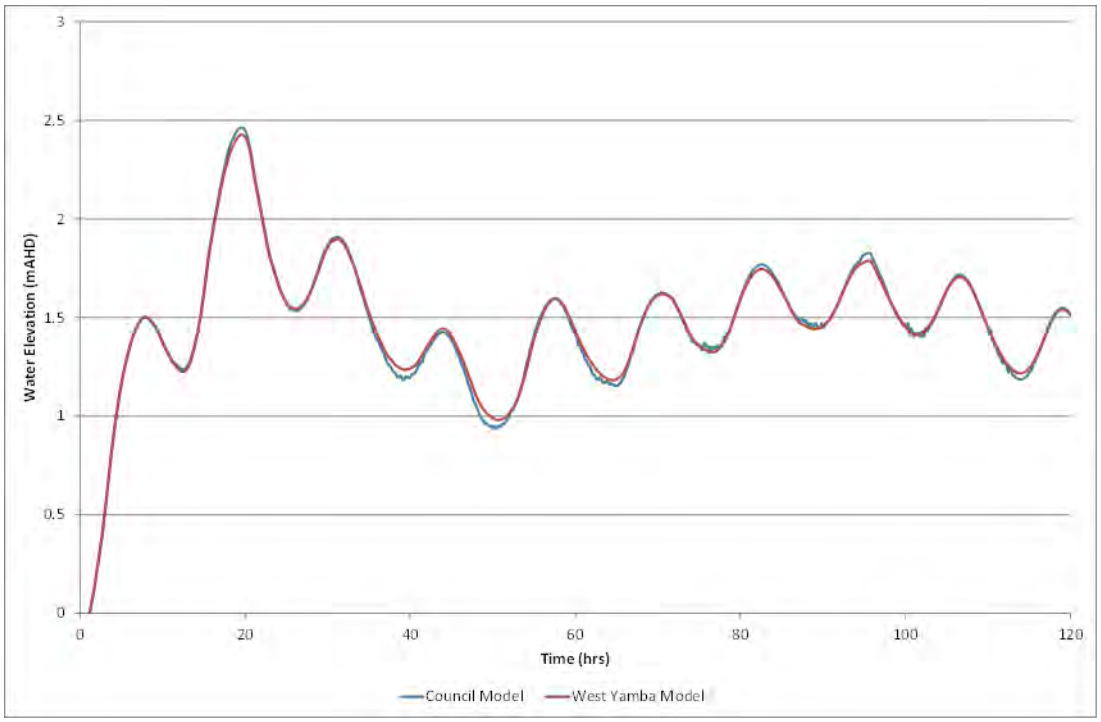


Figure A.4 1 in 100 AEP Model Comparison (Location TS_1)

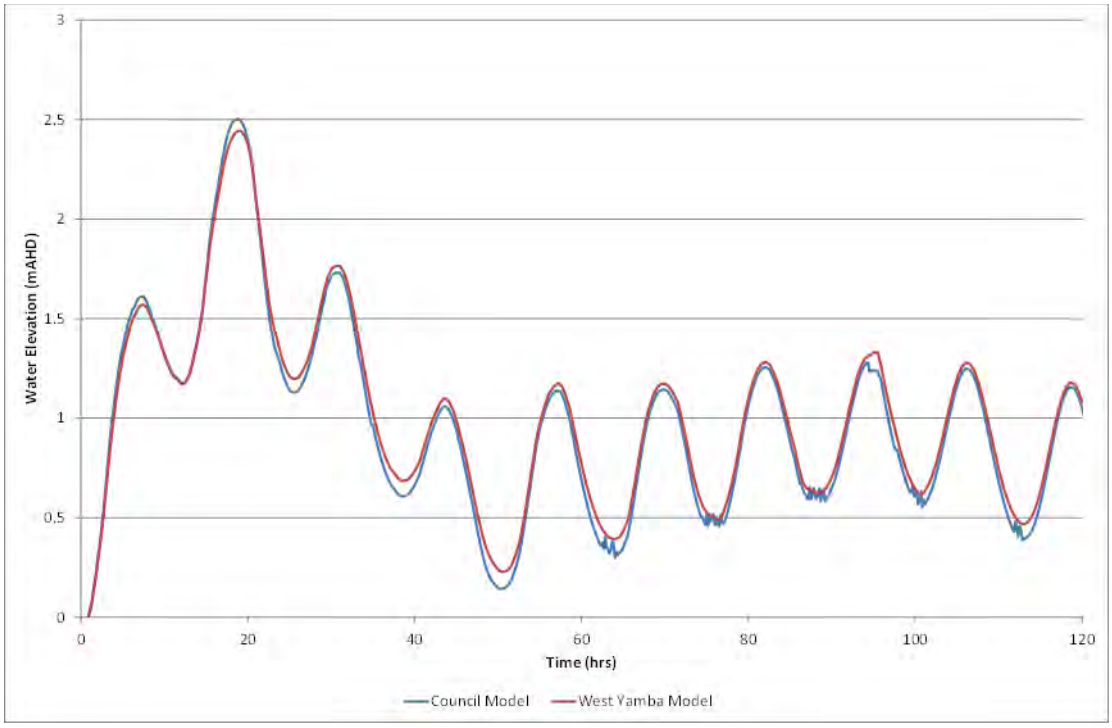


Figure A.5 1 in 100 AEP Model Comparison (Location TS_2)

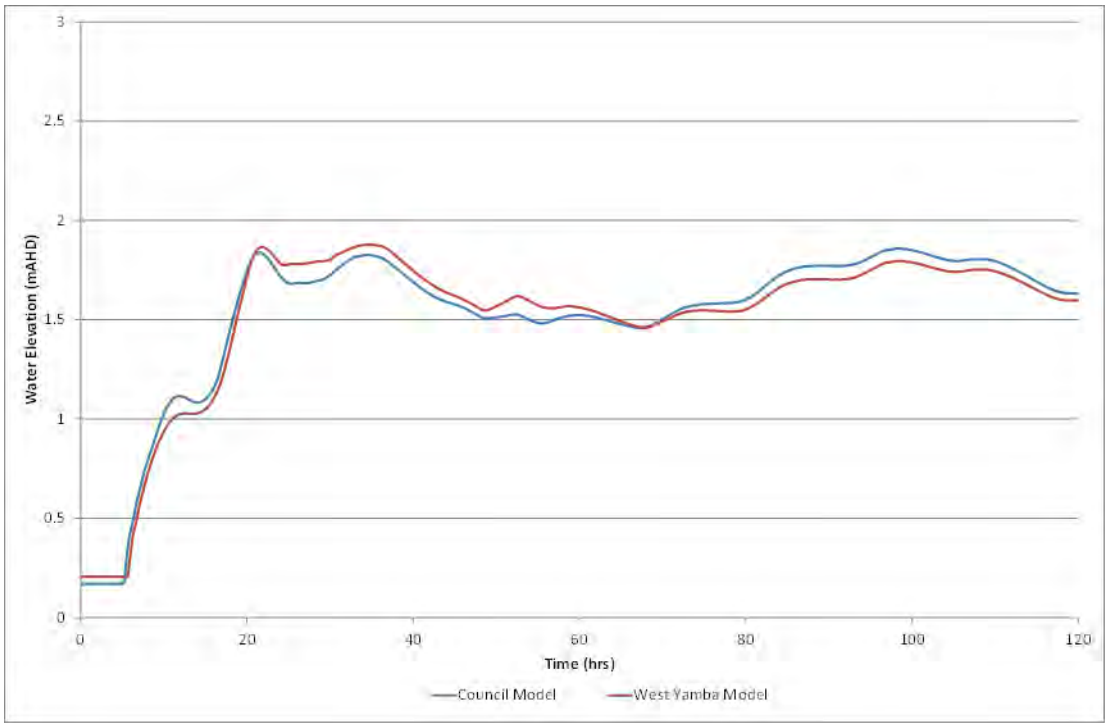
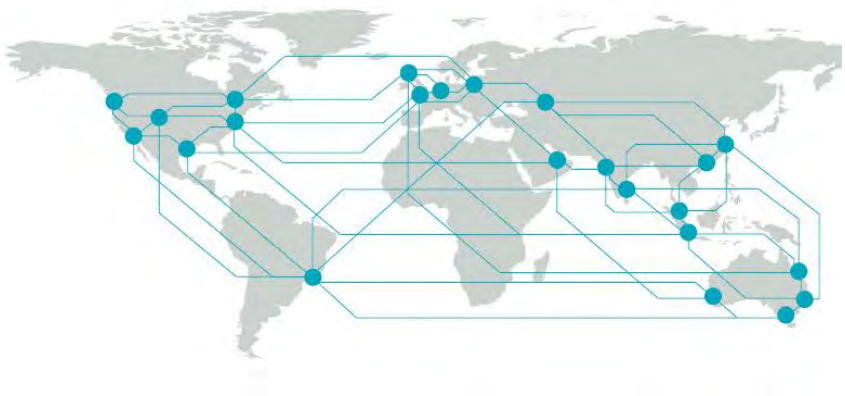


Figure A.6 1 in 100 AEP Model Comparison (Location TS_3)



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