



Coast, Estuary & Floodplain Advisory Sub-Committee

Business Paper

date of meeting: Thursday 30 March 2017

location: Committee Room
Port Macquarie-Hastings Council
17 Burrawan Street
Port Macquarie

time: 3.00pm

Note: Council is distributing this agenda on the strict understanding that the publication and/or announcement of any material from the Paper before the meeting not be such as to presume the outcome of consideration of the matters thereon.

Coast, Estuary & Floodplain Advisory Sub-Committee

CHARTER

Adopted: OC 18/11/15

1. Advise Council on conditions and management issues for the coast, estuaries and floodplains of the Port Macquarie-Hastings local government area.
2. Advise Council on the development of coastal zone, estuary and floodplain risk management plans for the Port Macquarie-Hastings local government area.
3. Advise Council on the implementation of adopted coastal zone, estuary and floodplain risk management plans.
4. Act as a committee for the purpose of relevant NSW guidelines as they relate to estuary, coastline and floodplain management.



**PORT MACQUARIE
HASTINGS**

Coast, Estuary & Floodplain Advisory Sub-Committee

ATTENDANCE REGISTER

Member	29/09/15	09/02/16	24/11/16		
Councillor Mike Cusato	✓	✓	A		
Adrian Button (Waterways User Rep.)	A	✓	A		
Alan MacIntyre (Community Rep.)	✓	✓	✓		
Bob Jolly (Community Rep. - Lake Cathie)	✓	✓	✓		
John Hough (Community Rep.)	✓	✓	X		
Kingsley Searle (Oyster Industry)	✓	✓	✓		
Laurie Lardner (Community Rep.)	A	✓	✓		
Patrick McEntee (Community Rep.)	✓	✓	A		
Paul Hyde (Hastings River Fisherman's Co-op)	X	✓	X		
Tony Troup (Oyster Industry)	✓	✓	✓		
Staff					
Matt Rogers (PMHC)	✓	✓	✓		
Tim Molloy (PMHC)	✓	A	A		
Gordon Cameron (PMHC)	✓	✓	✓		
Thor Aaso (PMHC)	✓	✓	A		
Jesse Dick (PMHC)	✓	✓	✓		
Agencies					
Tina Clemens Jaimee Vlastuin (Lands Department)	A ✓	✓	✓		
Lee Burdett Michael Northam (alternate) (DPI - Fisheries)	✓	✓	✓		
Steve Atkins Eric Claussen Shaun Kerrigan (National Parks Wildlife Service)	A ✓	A ✓	✓		
John Schmitt Nic Denshire Toong Chin (Office of Environment & Heritage)	A	✓ ✓ A	✓		
Matt Dawson Andre Uljee (Maritime Division - RMS)	✓	✓	A A		
Anthony Day Ray Richards Maria Fraser (SES Rep)	A ✓	✓	✓ ✓		

Key: ✓ = Present
A = Absent With Apology
X = Absent Without Apology



**PORT MACQUARIE
HASTINGS**

Coast, Estuary & Floodplain Advisory Sub-Committee Meeting
Thursday 30 March 2017

Items of Business

Item	Subject	Page
01	Acknowledgement of Country	<u>5</u>
02	Apologies.....	<u>5</u>
03	Confirmation of Minutes	<u>5</u>
04	Disclosures of Interest.....	<u>11</u>
05	Business Arising from Previous Minutes.....	<u>15</u>
06	Hastings River Climate Change Modelling - Final Report	<u>17</u>
07	Implementation Update on Floodplain Risk, Estuary and Coastal Zone Management Plan Projects	<u>160</u>
08	Lake Cathie Coastal Management Development Control Plan Provisions.....	<u>171</u>
09	Update of Biodiversity Strategy and EcoHealth Monitoring	<u>179</u>
10	General Business	



**PORT MACQUARIE
HASTINGS**

Item: 01

Subject: ACKNOWLEDGEMENT OF COUNTRY

"I acknowledge that we are gathered on Birpai Land. I pay respect to the Birpai Elders both past and present. I also extend that respect to all other Aboriginal and Torres Strait Islander people present."

Item: 02

Subject: APOLOGIES

RECOMMENDATION

That the apologies received be accepted.

Item: 03

Subject: CONFIRMATION OF PREVIOUS MINUTES

RECOMMENDATION

That the Minutes of the Coast, Estuary & Floodplain Advisory Sub-Committee Meeting held on 24 November 2016 be confirmed.

PRESENT

Members:

Alan MacIntyre (Community Rep.)
Bob Jolly (Community Rep)
Kingsley Searle (Oyster Industry)
Laurie Lardner (Community Rep)
Tony Troup (Oyster Industry)

Staff:

Matt Rogers (PMHC)
Gordon Cameron (PMHC)
Jesse Dick (PMHC)

Other Attendees:

Tina Clemens (Lands Department)
Michael Northam (DPI - Fisheries)
Steve Atkins (National Parks Wildlife Service)
John Schmitt (Office of Environment & Heritage)
Maria Fraser & Ray Richards (SES)

The meeting opened at 3:10pm.

01 ACKNOWLEDGEMENT OF COUNTRY

The Acknowledgement of Country was delivered.

02 APOLOGIES

CONSENSUS:

That the apologies received from the following members be accepted:

Councillor Michael Cusato, Adrian Button (Waterways User Rep.), Patrick McEntee (Community Rep.), Andre Uljee (Maritime Division - RMS), Matt Dawson (Maritime Division - RMS), Tim Molloy (PMHC) and Thor Aaso (PMHC).

03 CONFIRMATION OF MINUTES

CONSENSUS:

That the Minutes of the Coast, Estuary & Floodplain Advisory Sub-Committee Meeting held on 9 February 2016 be confirmed.

04 DISCLOSURES OF INTEREST

There were no disclosures of interest presented.

05 BUSINESS ARISING

Item 10.01: Michael Northam (DPI - Fisheries) outlined the progress of the Camden Haven Prawn study & summarised the draft report which was presented to committee members. Michael to notify Council staff upon completion of the final report so that the report author (Dr Matthew Taylor) can be present the findings of the study to the committee members.

A colour of the draft report findings will be sent to the committee members for their perusal.

This item along with item 10.02 proposed to form a standalone agenda item at an upcoming committee meeting.

Item 10.02: Michael Northam (DPI - Fisheries) confirmed that seagrass mapping study is ongoing. Michael to notify Council staff upon completion of the final report so that the report author (Dr Matthew Taylor) can be present the findings of the study to the committee members.

This item along with item 10.01 proposed to form a standalone agenda item at an upcoming committee meeting.

Item 10.10: Alan McIntyre requested confirmation on when the landowner was consulted regarding control of the Papyrus weed on the corner of the Boulevard & Diamond Head Road, Dunbogan. Thor Aaso to follow up.

Blue Star Weed: Alan McIntyre requested further information regarding control of the Blue Star weed on his property and neighbouring properties in the Camden Haven. Thor Aaso to discuss with Council's Invasive Weeds Officer - Grant Taylor and provide an update to Alan.

Item 05: Vegetation Mapping, Biodiversity Strategy & Eco Health Monitoring: An update on the Biodiversity Strategy is proposed to form a standalone agenda item at an upcoming committee meeting. Vegetation mapping can be display as part of the meeting agenda.

06 IMPLEMENTATION UPDATE ON FLOODPLAIN RISK, ESTUARY AND COASTAL ZONE MANAGEMENT PLAN PROJECTS

There was general discussion on various aspects of the project status document.

It was noted that many projects have been started or completed since the last time an update on the status of the outstanding projects was provided to the committee in September 2015.

An A3 colour copy of the project status document is to be mailed to all committee members for their information.

CONSENSUS:

That the Committee note the status of action for each Coast, Estuary and Floodplain Risk Management Plan.

07 DRAFT LAKE CATHIE COASTAL MANAGEMENT DEVELOPMENT CONTROL PLAN (DCP) PROVISIONS

There was general discussion on various aspects of the draft DCP provisions. It was noted that the provisions are an update of the existing Interim Development Controls and include a trigger point for the removal of relocatable structures.

Staff advised committee members that the provisions need to be reported to Council as soon as possible so that updated controls could be in place to guide development applications that are likely to be submitted.

Committee members wished to note that due to the short timeframe between the agenda being issued and the committee meeting that some members had only a short time to review the DCP provisions.

Matt Rogers confirmed that committee members will have further opportunity to consider and provide comment on the draft DCP provisions during the statutory exhibition period.

CONSENSUS:

That it be a recommendation to Council that the Lake Cathie Coastal Management Development Control Plan (DCP) provisions be placed on public exhibition for a period of 28 days.

08 COAST, ESTUARY & FLOODPLAIN GRANT APPLICATION UPDATE

There was general discussion on the various grant funded projects.

A review of unsuccessful grant applications will be undertaken by Council staff in consultation with stakeholder representatives within coming months.

Steve Atkins (NPWS) was supportive of the North Brother Local Catchments Flood Study project and requested that NPWS be consulted throughout the duration of the project as they are a direct stakeholder.

CONSENSUS:

That the status of the Coast, Estuary and Floodplain Grants be noted.

09 LAKE CATHIE COASTAL ZONE MANAGEMENT PLAN MINISTERIAL CERTIFICATION

There was general discussion on various aspects of the ministerial certification of the Lake Cathie CZMP.

It was noted that further works are required on a funding model for the implementation of the Plan. It was acknowledged that significant ground work had been completed via the Cost Benefit analysis which formed part of the CZMP.

John Schmidt (OEH) advised that grant funding was available for planning works which can be applied for at any time where a certified CZMP is in place and this funding could be used to further develop a funding model as suggested by the Minister.

CONSENSUS:

That the Ministerial certification of the Lake Cathie Coastal Zone Management Plan be noted.

10 GENERAL BUSINESS

10.01 COASTAL REFORMS

John Schmidt (OEH) confirmed that due to the recent changes to Coastal & Estuary Management Grant programs, only projects listed in certified plans are eligible for grant funding. The committee discussed how new plans could be developed and there was a view that separating estuary management from coastal management would enable a smoother transition to the new regime for coastal planning. Alan McIntyre requested that a link to the coastal reforms be sent to all committee members. A coastal reform community information session will be held at the Glasshouse on Tuesday, 29th November at 11 - 12.30pm.

10.02 CROWN LANDS LEGISLATIVE REFORMS

Tina Clements (Lands department) provided an update on the Crown lands Management Bill and Act. Crown lands have been subject to a detailed review of the past four years. Information, including detailed factsheets on the changes is available on the Crown Lands website.

The meeting closed at 5:00pm.

Item: 04
Subject: DISCLOSURES OF INTEREST

RECOMMENDATION

That Disclosures of Interest be presented

DISCLOSURE OF INTEREST DECLARATION

Name of Meeting:
Meeting Date:
Item Number:
Subject:

I, declare the following interest:

☐

Pecuniary:

Take no part in the consideration and voting and be out of sight of the meeting.

☐

Non-Pecuniary - Significant Interest:

Take no part in the consideration and voting and be out of sight of the meeting.

☐

Non-Pecuniary - Less than Significant Interest:

May participate in consideration and voting.

For the reason that:
.....

Name:

Signed: Date:

(Further explanation is provided on the next page)

Further Explanation

(Local Government Act and Code of Conduct)

A conflict of interest exists where a reasonable and informed person would perceive that a Council official could be influenced by a private interest when carrying out their public duty. Interests can be of two types: pecuniary or non-pecuniary.

All interests, whether pecuniary or non-pecuniary are required to be fully disclosed and in writing.

Pecuniary Interest

A pecuniary interest is an interest that a Council official has in a matter because of a reasonable likelihood or expectation of appreciable financial gain or loss to the Council official. (section 442)

A Council official will also be taken to have a pecuniary interest in a matter if that Council official's spouse or de facto partner or a relative of the Council official or a partner or employer of the Council official, or a company or other body of which the Council official, or a nominee, partner or employer of the Council official is a member, has a pecuniary interest in the matter. (section 443)

The Council official must not take part in the consideration or voting on the matter and leave and be out of sight of the meeting. The Council official must not be present at, or in sight of, the meeting of the Council at any time during which the matter is being considered or discussed, or at any time during which the council is voting on any question in relation to the matter. (section 451)

Non-Pecuniary

A non-pecuniary interest is an interest that is private or personal that the Council official has that does not amount to a pecuniary interest as defined in the Act.

Non-pecuniary interests commonly arise out of family, or personal relationships, or involvement in sporting, social or other cultural groups and associations and may include an interest of a financial nature.

The political views of a Councillor do not constitute a private interest.

The management of a non-pecuniary interest will depend on whether or not it is significant.

Non Pecuniary – Significant Interest

As a general rule, a non-pecuniary conflict of interest will be significant where a matter does not raise a pecuniary interest, but it involves:

- (a) A relationship between a Council official and another person that is particularly close, for example, parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descendant or adopted child of the Council official or of the Council official's spouse, current or former spouse or partner, de facto or other person living in the same household.
- (b) Other relationships that are particularly close, such as friendships and business relationships. Closeness is defined by the nature of the friendship or business relationship, the frequency of contact and the duration of the friendship or relationship.
- (c) An affiliation between a Council official an organisation, sporting body, club, corporation or association that is particularly strong.

If a Council official declares a non-pecuniary significant interest it must be managed in one of two ways:

1. Remove the source of the conflict, by relinquishing or divesting the interest that creates the conflict, or reallocating the conflicting duties to another Council official.
2. Have no involvement in the matter, by taking no part in the consideration or voting on the matter and leave and be out of sight of the meeting, as if the provisions in section 451(2) apply.

Non Pecuniary – Less than Significant Interest

If a Council official has declared a non-pecuniary less than significant interest and it does not require further action, they must provide an explanation of why they consider that the conflict does not require further action in the circumstances.

SPECIAL DISCLOSURE OF PECUNIARY INTEREST DECLARATION

By <i>[insert full name of councillor]</i>	
In the matter of <i>[insert name of environmental planning instrument]</i>	
Which is to be considered at a meeting of the <i>[insert name of meeting]</i>	
Held on <i>[insert date of meeting]</i>	
PECUNIARY INTEREST	
Address of land in which councillor or an associated person, company or body has a proprietary interest (<i>the identified land</i>)	
Relationship of identified land to councillor [Tick or cross one box.]	<input type="checkbox"/> Councillor has interest in the land (e.g. is owner or has other interest arising out of a mortgage, lease trust, option or contract, or otherwise). <input type="checkbox"/> Associated person of councillor has interest in the land. <input type="checkbox"/> Associated company or body of councillor has interest in the land.
MATTER GIVING RISE TO PECUNIARY INTEREST	
Nature of land that is subject to a change in zone/planning control by proposed LEP (<i>the subject land</i>) ⁱⁱⁱ [Tick or cross one box]	<input type="checkbox"/> The identified land. <input type="checkbox"/> Land that adjoins or is adjacent to or is in proximity to the identified land.
Current zone/planning control [Insert name of current planning instrument and identify relevant zone/planning control applying to the subject land]	
Proposed change of zone/planning control [Insert name of proposed LEP and identify proposed change of zone/planning control applying to the subject land]	
Effect of proposed change of zone/planning control on councillor [Tick or cross one box]	<input type="checkbox"/> Appreciable financial gain. <input type="checkbox"/> Appreciable financial loss.

Councillor's Name:

Councillor's Signature: **Date:**

Important Information

This information is being collected for the purpose of making a special disclosure of pecuniary interests under sections 451 (4) and (5) of the *Local Government Act 1993*. You must not make a special disclosure that you know or ought reasonably to know is false or misleading in a material particular. Complaints made about contraventions of these requirements may be referred by the Director-General to the Local Government Pecuniary Interest and Disciplinary Tribunal.

This form must be completed by you before the commencement of the council or council committee meeting in respect of which the special disclosure is being made. The completed form must be tabled at the meeting. Everyone is entitled to inspect it. The special disclosure must be recorded in the minutes of the meeting.

-
- i. Section **443** (1) of the *Local Government Act 1993* provides that you may have a pecuniary interest in a matter because of the pecuniary interest of your spouse or your de facto partner or your relative^{iv} or because your business partner or employer has a pecuniary interest. You may also have a pecuniary interest in a matter because you, your nominee, your business partner or your employer is a member of a company or other body that has a pecuniary interest in the matter.
 - ii. Section **442** of the *Local Government Act 1993* provides that a **pecuniary interest** is an interest that a person has in a matter because of a reasonable likelihood or expectation of appreciable financial gain or loss to the person. A person does not have a pecuniary interest in a matter if the interest is so remote or insignificant that it could not reasonably be regarded as likely to influence any decision the person might make in relation to the matter or if the interest is of a kind specified in section **448** of that Act (for example, an interest as an elector or as a ratepayer or person liable to pay a charge).
 - iii. A pecuniary interest may arise by way of a change of permissible use of land adjoining, adjacent to or in proximity to land in which a councillor or a person, company or body referred to in section **443** (1) (b) or (c) of the *Local Government Act 1993* has a proprietary interest..
 - iv. **Relative** is defined by the *Local Government Act 1993* as meaning your, your spouse's or your de facto partner's parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descendant or adopted child and the spouse or de facto partner of any of those persons.

Item: 05

Subject: BUSINESS ARISING FROM PREVIOUS MINUTES

Item:	10.01	Date:	24/11/2016
Subject:	Camden Haven Prawn Study:		
Action Required:	Michael Northam (DPI - Fisheries) outlined the progress of the Camden Haven Prawn study & summarised the draft report which was presented to committee members. Michael to notify Council staff upon completion of the final report so that the report author (Dr Matthew Taylor) can be present the findings of the study to the committee members.		
Current Status:	This item along with item 10.02 proposed to form a standalone agenda item at an upcoming committee meeting.		

Item:	10.02	Date:	24/11/2016
Subject:	Seagrass Mapping:		
Action Required:	Michael Northam (DPI - Fisheries) confirmed that seagrass mapping study is ongoing. Michael to notify Council staff upon completion of the final report so that the report author (Dr Matthew Taylor) can be present the findings of the study to the committee members.		
Current Status:	This item along with item 10.01 proposed to form a standalone agenda item at an upcoming committee meeting.		

Item:	10.10	Date:	24/11/2016
Subject:	Papyrus Weed - Intersection of The Boulevard & Diamond Head Road:		
Action Required:	Alan McIntyre requested confirmation on when the landowner was consulted regarding control of the Papyrus weed on the corner of the Boulevard & Diamond Head Road, Dunbogan.		
Current Status:	Thor Aaso has spoken with landowner and land is currently under power of attorney. Current landowner is not willing to undertake control. Council staff will liaise with future landowner to gauge interest in controlling weed.		

Item:		Date:	24/11/2016
Subject:	Blue Star Weed:		
Action Required:	Alan McIntyre requested further information regarding control of the Blue Star weed on his property and neighbouring properties in the Camden Haven. Thor Aaso to discuss with Council's Invasive Weeds Officer - Grant Taylor and provide an update to Alan.		
Current Status:	Thor Aaso followed up on the initial enquiry and requested that Alan pursue a collective landowner response to the matter before engaging Council's Invasive Weeds Officer. Blue Star weed on Council's roadside reserves have been sprayed.		

Item:	05	Date:	24/11/2016
Subject:	Vegetation Mapping, Biodiversity Strategy & EcoHealth Monitoring		
Action Required:	Updates on the Eco Health report, Vegetation Mapping & Biodiversity Strategy are now listed as an ongoing item on the agenda.		
Current Status:	Refer to report in this agenda for further details.		

Item:		Date:	
Subject:	Pollution Incident Management - Queens Lake		
Action Required:	Notification protocols for environmental incidents in PMHC estuaries to be updated to include notification of local DPI fisheries representatives & local RMS Boating Safety Officers.		
Current Status:	<p>Council staff contacted DPI fisheries staff to collate a list of contacts for future events. Council's sewer teams have updated their SOP's so that local representatives are contacted for similar events in the future.</p> <p>DPI fisheries also provided advice to Council to refrain from warning against fishing. Public advisory messages concerning pollution events are encouraged however Council does not have the power to regulate fishing activity. Ongoing water quality testing by Council and referral of this information to the Food Authority/DPI Fisheries to determine risk to public health is the preferred management measure.</p>		

Item: 06

Subject: HASTINGS RIVER CLIMATE CHANGE MODELLING - FINAL REPORT

Presented by: Development and Environment Services, Matt Rogers

RECOMMENDATION

That the Committee note that a report will be presented to Council to place the Hastings River Climate Change report on public exhibition.

Discussion

Council engaged Advisian Pty Ltd (formally Worley Parsons) to update the flood modelling completed for the *Hastings River Flood Study (2006)* to include five (5) climate change scenarios.

The modelling of these climate change scenarios were outlined as a high priority action in the *Hastings River Floodplain Risk Management Plan (2014)*.

The existing Hastings River flood model has been upgraded to align with the modelling completed for the *Camden Haven River & Lakes System Flood Study (2013)*, specifically for the purpose of simulating the range of climate change scenarios considered under the Camden Haven study.

The climate change scenarios were based on combinations of increased rainfall intensities in the catchment and increased ocean elevation due to predicted sea level rise, in accordance with the best available State Government information and guidelines.

The scenarios modelled are as follows:

- **Scenario 1** – 1% Average Exceedance Probability (AEP) catchment event with 10% increase in rainfall intensity + 900mm Sea Level Rise (SLR)
- **Scenario 2** – 1% AEP catchment event with 900mm SLR
- **Scenario 3** – 1% AEP catchment event with 10% increase in rainfall intensity + 400mm SLR
- **Scenario 4** – 1% AEP catchment event with 400mm SLR
- **Scenario 5** – Probable Maximum Flood (PMF) with 900mm SLR

In addition to climate change scenario modelling, the hydraulic model (RMA-2) software has been updated to improve computational performance and reliability.

The digital terrain model (DTM) has been updated to include a number of land development (subdivisions) since its completion in 2006. These changes to landform have been included in the model to improve flood estimating and reliability.

The DTM has also been updated to include significant changes to topography such as the Pacific Highway and Oxley Highway embankments and associated bridge and culvert structures.

The network definition around the periphery of the model has been modified to ensure that flood storage volumes and flood extents are more reliably represented in the model.

The primary tasks completed as part of the project are as follows:

- Preparation of revised RMA-2 model inflow and outflow boundary conditions for each of the five (5) climate change scenarios listed above.
- Simulation of the 5 climate change scenarios using the latest Hastings River RMA-2 flood model.
- Preparation of a waterRIDE presentation package showing the predicted peak flood levels, flow velocities and extents for each for the climate change scenarios. The presentation package will also include layers comparing each of the climate change scenarios to the existing case 1% AEP flood. This comparison will allow Council to easily assess the potential risks to the community for each scenario; i.e., risks associated with increased flood levels and increased flood affectation.
- Hastings River Flood Study Climate Change Assessment.

Results and Findings

The report undertook detailed flood modelling for five climate change scenarios which provides an extensive analysis of the potential impacts of climate change on predicted peak flood levels in the Lower Hastings Valley. The report recommends that Council adopt Climate Change Scenario 1 for the purpose of flood planning and floodplain management. This is in line with best assessment practice for climate change, the approach taken in the *Camden Haven River & Lakes System Flood Study (2013)* and the *Port Macquarie-Hastings Flood Policy (2015)*. Both council documents already refer to this scenario for the purpose of floodplain planning and management.

The modelling results show that Scenario 1 provides the most conservative estimate (*aside from the PMF modelling in Scenario 5*) for flood level increases, both across tidally influenced areas and areas further upstream. Scenario 1 is consistent with the previous NSW Sea Level Rise Policy Statement benchmarks, existing planning directions of Port-Macquarie-Hastings Council, and reflects the uncertainties of sea level rise while acknowledging the limitations of the predicted rainfall increases.

The report also recommends that Council adopt the updated 1% AEP flood modelling to define present day flood characteristics for the study area. The updated modelling is based on a version of the RMA-2 model that has undergone significant upgrades since it was originally developed for the Hastings River Flood Study in 2006. The model updates have included a significant increase to the resolution of the model network through the inclusion of over 35,000 additional nodes and elements. This greatly improves the reliability of the model mesh to replicate channel and floodplain features which, would result in a much more reliable reflection of flood behaviour across the study area.

The RMA-2 model updates have also included significant changes to the floodplain that have occurred since 2006. These include, but are not limited to, construction of

the extensive roadway embankments and bridge and culvert structures associated with upgrades to the John Oxley Highway and realignment of the Pacific Highway. Inclusion of these changes is required to ensure the model is predicting flood behaviour that is reflective of present-day floodplain conditions.

Implications of the updated 1% AEP results on existing flood hazard mapping

The updated 1% AEP modelling resulted in changes to the hazard category mapping documented in the Floodplain Risk Management Study (2012). The changes are not significant given the updated modelling is predicting peak 1% AEP flood levels that are largely consistent with the FRMS (2012) or are within +/- 0.05 metres.

Localised changes to flood hazards are to be expected due in part to the addition of over 35,000 nodes though, recognising that flood hazard categorisations are based on the magnitude of depths and velocities, and the combination of both (i.e., depth and velocity product). Any changes to hazards that may occur as an outcome of the updated modelling are considered to reflect a more reliable representation of flood hazards.

Implications of the updated 1% AEP results on existing hydraulic category mapping

A detailed review of the existing hydraulic category mapping documented in the FRMS (2012) has not been undertaken as part of this study. Notwithstanding, based on the methodology that was applied to determine the existing hydraulic categories, it is not expected that there should be any change to the floodway extent. This is because the floodway extent determined as part of the FRMS (2012) considered not only the 1% AEP flood, but also rarer events such as the 0.5% AEP flood. The minor changes in flood behaviour predicted as a result of the updated 1% AEP mapping is considered to have effectively been accounted for in the original floodway determination investigations.

Based on the above, it is unlikely the floodway corridor will require any changes to be compatible with the updated 1% AEP results. Further blockage modelling as had been undertaken for the FRMS (2012) would be required to test any changes to the floodway. Accordingly no changes are proposed to hydraulic categories.

The approach previously adopted as part of the FRMS (2012) to delineate the boundary between flood storage and fringe categories has been modified in the updated hydraulic category mapping included within the report.

In that regard, for the FRMS (2012) the boundary between storage and fringe was generated based on a two-step approach that included manual manipulation of the boundary. That is, although the boundary was based on a depth criteria of 0.3 metres, the final boundary was based on manual re-alignment to take into consideration cadastral boundaries and relevant topographic features.

It is no longer recommended that this final step of manual manipulation be undertaken which is a reflection of the recently adopted *Port Macquarie-Hastings Flood Policy (2015)* and updated procedures adopted as part of the hydraulic category mapping for the *Camden Haven Flood Study (2013)*. Accordingly, the mapping of flood storage and fringe extents is based solely on a 0.3 metre depth criteria.

Implications of adopting climate change scenario 1 on the FPL

Selection of Scenario 1 as the benchmark climate change scenario will result in an increase in the FPL for areas to the west and east of the Pacific Highway of between 0.4 to 0.5 metres and 0.2 and 0.5 metres, respectively.

Council proposes to undertake further analysis of the FPL implications to determine any amendment required to the Flood Planning Area. The analysis will clarify the extent of properties affected and will need to be undertaken before a report is presented to Council recommending exhibition.

As part of the exhibition, Council will write to landowners potentially impacted by the new flood levels to explain any changes.

Attached is a copy of the *Hastings River Flood Study Climate Change Assessment*.

Attachments

1 [View](#). Hastings River Flood Study Climate Change Assessment



Hastings River Flood Study Climate Change Assessment

13th March 2017

Level 17, 141 Walker St
North Sydney NSW 2060
Australia

FINAL DRAFT

rp301311-13455rg_crt170313_Hastings FS CC Assessment.docx
Revision C

www.advisian.com



Advisian

WorleyParsons Group



Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

Disclaimer

This report has been prepared on behalf of and for the exclusive use of Port Macquarie-Hastings Council, and is subject to and issued in accordance with the agreement between Port Macquarie-Hastings Council and Advisian (trading as WorleyParsons Services Pty Ltd).

Advisian accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

Copying this report without the permission of Port Macquarie-Hastings Council and Advisian is not permitted.

Project: HASTINGS RIVER FLOOD STUDY CLIMATE CHANGE ASSESSMENT

Rev	Description	Author	Review	Advisian Approval	Date
A	Draft Report (Issued for Internal Review)	RG	CRT		5/12/2016
B	Draft Report (Issued for Client Review)	RG	CRT		30/1/2017
C	Final Draft Report	RG	CRT	CRT	14/03/2017



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

Table of Contents

1	INTRODUCTION	1
2	UPDATED RMA-2 FLOOD MODEL	2
2.1	Background	2
2.2	Updated RMA-2 Flood Model Network	3
2.3	Re-Modelling of the 1% AEP Event.....	4
2.3.1	Updated 1% AEP Flood Characteristics	4
2.3.2	Updated 1% AEP Flood Behaviour Mapping	6
2.4	Updated 1% AEP Flood Model Findings	7
3	CLIMATE CHANGE ASSESSMENT	8
3.1	Background	8
3.2	CLIMATE CHANGE MODELLING.....	9
3.2.1	RMA-2 Model Boundary Conditions	9
3.2.2	Predicted Flood Levels and Extents	10
3.2.3	Predicted Increase in Flood Levels above the Base Case 1% AEP Event	11
3.3	Planning Recommendations	13
3.3.1	Implications of Adopting Climate Change Scenario 1 on the FPL.....	13
3.3.2	Implications of the Updated 1% AEP Results on Existing Flood Hazard Mapping.....	14
3.3.3	Implications of the Updated 1% AEP Results on Existing Hydraulic Category Mapping.....	14
3.3.4	Complete Set of Flood Mapping	15
4	CONCLUSIONS	16
5	REFERENCES	17



Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

List of Figures

- Figure 2.1 Comparison of Updated and 2006 Flood Study RMA-2 Networks**
- Figure 2.2 Comparison of Updated and 2006 Flood Study RMA-2 Networks**
[Extent 1 of 4]
- Figure 2.3 Comparison of Updated and 2006 Flood Study RMA-2 Networks**
[Extent 2 of 4]
- Figure 2.4 Comparison of Updated and 2006 Flood Study RMA-2 Networks**
[Extent 3 of 4]
- Figure 2.5 Comparison of Updated and 2006 Flood Study RMA-2 Networks**
[Extent 4 of 4]
- Figure 2.6 Predicted Flood Levels at the Peak of the Updated 1% AEP Flood Event**
- Figure 2.7 Predicted Flood Levels at the Peak of the Updated 1% AEP Flood Event**
[Extent 1 of 4]
- Figure 2.8 Predicted Flood Levels at the Peak of the Updated 1% AEP Flood Event**
[Extent 2 of 4]
- Figure 2.9 Predicted Flood Levels at the Peak of the Updated 1% AEP Flood Event**
[Extent 3 of 4]
- Figure 2.10 Predicted Flood Levels at the Peak of the Updated 1% AEP Flood Event**
[Extent 4 of 4]
- Figure 2.11 Peak 1% AEP Flood Level Differences as a result of Recent Updates to the Hastings River RMA-2 Model**
- Figure 2.12 Peak 1% AEP Flood Level Differences as a result of Recent Updates to the Hastings River RMA-2 Model** [Extent 1 of 4]
- Figure 2.13 Peak 1% AEP Flood Level Differences as a result of Recent Updates to the Hastings River RMA-2 Model** [Extent 2 of 4]
- Figure 2.14 Peak 1% AEP Flood Level Differences as a result of Recent Updates to the Hastings River RMA-2 Model** [Extent 3 of 4]
- Figure 2.15 Peak 1% AEP Flood Level Differences as a result of Recent Updates to the Hastings River RMA-2 Model** [Extent 4 of 4]
- Figure 3.1 Design Floodwater Surface Profiles Along the Hastings River**
- Figure 3.2 Design Floodwater Surface Profiles Along the Hastings River**
[Extent 1 of 2]
- Figure 3.3 Design Floodwater Surface Profiles Along the Hastings River**
[Extent 2 of 2]
- Figure 3.4 Design Floodwater Surface Profile Along the Maria/Wilson River**
- Figure 3.5 Predicted Flood Levels at the Peak of Climate Change Scenario 1**

**Advisian**

WorleyParsons Group

Port Macquarie Hastings Council

Hastings River Flood Study Climate Change
Assessment

- Figure 3.6** Predicted Flood Levels at the Peak of Climate Change Scenario 1
[Extent 1 of 4]
- Figure 3.7** Predicted Flood Levels at the Peak of Climate Change Scenario 1
[Extent 2 of 4]
- Figure 3.8** Predicted Flood Levels at the Peak of Climate Change Scenario 1
[Extent 3 of 4]
- Figure 3.9** Predicted Flood Levels at the Peak of Climate Change Scenario 1
[Extent 4 of 4]
- Figure 3.10** Predicted Flood Levels at the Peak of Climate Change Scenario 2
- Figure 3.11** Predicted Flood Levels at the Peak of Climate Change Scenario 2
[Extent 1 of 4]
- Figure 3.12** Predicted Flood Levels at the Peak of Climate Change Scenario 2
[Extent 2 of 4]
- Figure 3.13** Predicted Flood Levels at the Peak of Climate Change Scenario 2
[Extent 3 of 4]
- Figure 3.14** Predicted Flood Levels at the Peak of Climate Change Scenario 2
[Extent 4 of 4]
- Figure 3.15** Predicted Flood Levels at the Peak of Climate Change Scenario 3
- Figure 3.16** Predicted Flood Levels at the Peak of Climate Change Scenario 3
[Extent 1 of 4]
- Figure 3.17** Predicted Flood Levels at the Peak of Climate Change Scenario 3
[Extent 2 of 4]
- Figure 3.18** Predicted Flood Levels at the Peak of Climate Change Scenario 3
[Extent 3 of 4]
- Figure 3.19** Predicted Flood Levels at the Peak of Climate Change Scenario 3
[Extent 4 of 4]
- Figure 3.20** Predicted Flood Levels at the Peak of Climate Change Scenario 4
- Figure 3.21** Predicted Flood Levels at the Peak of Climate Change Scenario 4
[Extent 1 of 4]
- Figure 3.22** Predicted Flood Levels at the Peak of Climate Change Scenario 4
[Extent 2 of 4]
- Figure 3.23** Predicted Flood Levels at the Peak of Climate Change Scenario 4
[Extent 3 of 4]
- Figure 3.24** Predicted Flood Levels at the Peak of Climate Change Scenario 4
[Extent 4 of 4]
- Figure 3.25** Predicted Flood Levels at the Peak of Climate Change Scenario 5

**Advisian**

WorleyParsons Group

Port Macquarie Hastings Council

Hastings River Flood Study Climate Change
Assessment

- Figure 3.26 Predicted Flood Levels at the Peak of Climate Change Scenario 5**
[Extent 1 of 4]
- Figure 3.27 Predicted Flood Levels at the Peak of Climate Change Scenario 5**
[Extent 2 of 4]
- Figure 3.28 Predicted Flood Levels at the Peak of Climate Change Scenario 5**
[Extent 3 of 4]
- Figure 3.29 Predicted Flood Levels at the Peak of Climate Change Scenario 5**
[Extent 4 of 4]
- Figure 3.30 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 1**
- Figure 3.31 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 1** [Extent 1 of 4]
- Figure 3.32 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 1** [Extent 2 of 4]
- Figure 3.33 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 1** [Extent 3 of 4]
- Figure 3.34 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 1** [Extent 4 of 4]
- Figure 3.35 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 2**
- Figure 3.36 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 2** [Extent 1 of 4]
- Figure 3.37 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 2** [Extent 2 of 4]
- Figure 3.38 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 2** [Extent 3 of 4]
- Figure 3.39 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 2** [Extent 4 of 4]
- Figure 3.40 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 3**
- Figure 3.41 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 3** [Extent 1 of 4]
- Figure 3.42 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 3** [Extent 2 of 4]
- Figure 3.43 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 3** [Extent 3 of 4]
- Figure 3.44 Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 3** [Extent 4 of 4]

**Advisian**

WorleyParsons Group

Port Macquarie Hastings Council

Hastings River Flood Study Climate Change
Assessment

- Figure 3.45** Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 4
- Figure 3.46** Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 4 [Extent 1 of 4]
- Figure 3.47** Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 4 [Extent 2 of 4]
- Figure 3.48** Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 4 [Extent 3 of 4]
- Figure 3.49** Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 4 [Extent 4 of 4]
- Figure 3.50** Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 5
- Figure 3.51** Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 5 [Extent 1 of 4]
- Figure 3.52** Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 5 [Extent 2 of 4]
- Figure 3.53** Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 5 [Extent 3 of 4]
- Figure 3.54** Predicted Change in Flood Levels as a Consequence of Climate Change Scenario 5 [Extent 4 of 4]

Appendices

- Appendix A** Flood Behaviour Plots for the Updated 1% AEP Flood
[Depths, Velocities, Hazards and Hydraulic Categories]
- Appendix B** RMA-2 Boundary Conditions – Inflow Hydrographs and
Ocean Boundary Conditions
- Appendix C** Flood Behaviour Plots for Climate Change Scenario 1
[Depths, Velocities, Hazards and Hydraulic Categories]



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

1 INTRODUCTION

A climate change assessment for the Lower Hastings River has been completed in accordance with recommendations documented in the Hastings Floodplain Risk Management Study (2012) and the Hastings Floodplain Risk Management Plan (2014). The detailed investigations include flood modelling of various climate change scenarios which were identified in the 2012 and 2014 studies to provide Council with an understanding of the potential future changes to flood characteristics along the Hastings River downstream of the Bains Bridge crossing near Beechwood.

The following climate change scenarios were adopted for the assessment:

- Scenario 1 - 100 year ARI catchment event with 900 mm Sea Level Rise (SLR) + 10% increase in rainfall intensity and volume
- Scenario 2 - 100 year ARI catchment event with 900 mm SLR
- Scenario 3 - 100 year ARI catchment event with 400mm SLR + 10% increase in rainfall intensity and volume
- Scenario 4 - 100 year ARI catchment event with 400 mm SLR
- Scenario 5 - PMF event with 900 mm SLR
(900mm SLR applied to the adopted 100yr Tide_2.2 mAHD)

A detailed review of Council's existing two-dimensional RMA-2 flood model was also undertaken as part of the assessment. The review involved the consolidation of various amendments to the flood model that have occurred over the decade since it was developed for the Hastings River Flood Study (2006). This exercise was completed prior to modelling of the climate change scenarios to ensure the results were determined using a model that was to present-day standards and which more accurately reflected present-day floodplain topography and features.

Given the RMA-2 flood model was updated an initial exercise was also undertaken to re-assess the predicted flood behaviour for the 1% Annual Exceedance Probability (AEP) flood event. The predicted peak flood levels and extents for the 1% AEP flood based on the 2006 Flood Study and updated RMA-2 models were compared to assess the locations and magnitudes of any changes.

This report details the findings of the updated flood model and climate change investigation including predicted changes to peak flood levels and changes to flood extents.



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

2 UPDATED RMA-2 FLOOD MODEL

2.1 Background

Flood behaviour for the lower Hastings, Maria and Wilson Rivers is currently defined by the results of flood modelling that was completed between 2004 and 2006 as part of the *Hastings Flood Study (2006)*. A two-dimensional hydrodynamic flood model was developed as part of the Flood Study using the RMA-2 software package. The model was calibrated against significant historical floods including the 1963 and 1969 events, and was applied to simulate a range of design floods including the 1% Annual Exceedance Probability (AEP) flood (*also referred to as the 100 year Average Recurrence Interval flood*).

The RMA-2 model was developed from available bathymetric data for the major tributaries and Aerial Laser Survey (ALS) data that was obtained for floodplain areas extending to the predicted extent of the Probable Maximum Flood (PMF). It covered the full extent of the Hastings River floodplain from the Bains Bridge crossing near Beechwood to the ocean entrance at Port Macquarie. The model also included the floodplains of the Wilson and Maria Rivers extending downstream from the Pacific Highway crossing of the Wilson River near Telegraph Point and south along the Maria River from its headwaters near the Port Macquarie-Hastings LGA and Kempsey Shire LGA boundary.

The extent of the 2006 RMA-2 flood model is shown in **Figure 2.1**.

The 2006 RMA-2 model was limited in size and level of detail by the processing limitations of both the modelling software and the computer hardware that was available at the time. It is important to recognise that although the Flood Study was formally adopted in 2006, the network generation and flood modelling was largely completed by December 2004. There have been many advancements in both the software and the processing capacity of computers over the intervening decade.

The 2006 model was based on topographic elevations defined at 12,900 nodes and floodplain roughness defined across 14,450 model elements. The 2006 RMA-2 model network is shown in **Figure 2.1**.

Between 2006 and 2015, the RMA-2 model was used as the basis for numerous flood related investigations. These included the following:

- Hydrology and Hydraulics investigations for the Pacific Highway Upgrade between the Oxley Highway and Kundabung

This included investigations for the river crossings of the Hastings and Wilson Rivers and their associated floodplains for the Environment Impact Statement, the detail design and the construction phases of the project.

- The *Hastings Floodplain Risk Management Study (2012)*.

This involved an assessment of range of flood modification measures aimed at reducing potential flood damages that could be experienced in rural, commercial and residential areas.



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

In addition, the RMA-2 flood model has been used extensively as a tool to assess residential and commercial development applications proposed throughout the floodplain including, but not limited to, at Wauchope, Sancrox, Hibbard, North Shore and Port-Macquarie.

Each of the investigations completed post 2006 has involved varying degrees of updates to the 2006 RMA-2 flood model. The updates have in most cases been confined to localised network refinements completed to ensure the topography in the vicinity of the area of interest was reliably defined. In many cases, this has involved the inclusion of updated topographic data based on detailed site survey, such as for the Pacific Highway Upgrade Project to define the post-development road surface and drainage infrastructure.

The updates to the RMA-2 model between 2006 and 2015 led to a significant increase in model size with the total number of nodes and elements increasing to 31,600 and 35,700, respectively. This represents a 250% increase in the number of model nodes and elements relative to 2006 and is reflective of the greater level of topographic detail that was incorporated into the model over this period. This greater level of floodplain delineation within the model network enables more reliable results to be produced by the model that captures many of the localised changes in flood behaviour that may have been previously missed.

Unlike the RMA-2 model, the XP-RAFTS hydrologic model that was developed as part of the Flood Study (2006) has not been modified or updated. In that regard, the same inflow hydrographs have been used for all simulations and model iterations and are therefore consistent with the Flood Study (2006).

2.2 Updated RMA-2 Flood Model Network

In order to ensure that the assessment of climate change impacts on flood characteristics is reliable, the RMA-2 flood model that was developed as part of the *Hastings Flood Study (2006)*, and updated as part of subsequent flood investigations in the years since, was updated. This was undertaken in order to ensure the latest version of the RMA-2 model, including all recent and major changes to the floodplain, was used for the climate change impact simulations.

The 1% Annual Exceedance Probability (AEP) event was also re-simulated in order to establish whether changes to the model geometry manifest as a material impact on 1% AEP flood characteristics documented in the 2006 Flood Study.

Accordingly, further updates to the RMA-2 model were undertaken as part of this assessment in order to formalise the network changes that have occurred since 2006 and to ensure the model can be reliably used to model climate change conditions. This includes the following network changes:

- Consolidation of all previous model updates to create the most up-to-date representation of the Hastings River floodplain;
- Inclusion of the recently constructed Oxley Highway between Port Macquarie and Thrumster; and,
- Model refinement along the peripheries of the floodplain in particular for areas between the 1% AEP and PMF flood extents.

**Advisian**

WorleyParsons Group

Port Macquarie Hastings CouncilHastings River Flood Study Climate Change
Assessment

The changes outlined above and those discussed in **Section 2.1** have led to an increase in the RMA-2 model nodes and elements from 12,900 and 14,450 to 49,300 and 57,800, respectively. In that regard, the present-day version of the RMA-2 model is based on four times the number of nodes and elements to define the topography and roughness throughout the floodplain compared to the 2006 version.

A detailed comparison of the evolution of the RMA-2 model network between 2006 and 2016 is provided in **Figures 2.1 to 2.5**. The comparison shows the extent to which additional detail has been incorporated into the RMA-2 model across most of the study area.

2.3 Re-Modelling of the 1% AEP Event

The updated RMA-2 model network was used to re-simulate the 1% AEP flood event. The 1% AEP flood was re-simulated in order to determine any changes to predicted flood characteristics including peak flood levels and flood extents.

It is important to note that the updated 1% AEP flood simulation was based on inflow hydrographs that were unchanged from those adopted in the 2006 Flood Study. In that regard, the only change between this updated 1% AEP event simulation and the simulation documented in the 2006 Flood Study is the use of an updated RMA-2 model network and model topography. Any changes to flood behaviour can therefore be attributed entirely to the RMA-2 model modifications.

2.3.1 Updated 1% AEP Flood Characteristics

Peak flood levels and extents for the 1% AEP event are shown in **Figures 2.6 to 2.10**. As shown, the updated modelling includes changes to flood behaviour and extents associated with the recently constructed Oxley Highway and the Pacific Highway Upgrade (*currently under construction*).

Figures 2.11 to 2.15 show changes in predicted 1% AEP flood level between the updated and original RMA-2 flood modelling. Locations where the updated 1% AEP modelling predicts higher flood levels are shown as varying shades of red according to the magnitude of change. Any decreases in peak flood level are shown as shades of blue. Where changes are less than +/- 0.05 m the shading is white.

Figures 2.11 to 2.15 also provide a comparison of the 1% AEP flood extent predicted using the original and updated RMA-2 models. Locations where the updated model predicts an increase or decrease in flood extent are shown as yellow or green shading, respectively.

A comparison of 1% AEP flood levels predicted between the updated and original RMA-2 networks is shown in **Table 2.1** for selected points throughout the study area. The selected points typically coincide with key locations along the Hastings, Wilson and Maria Rivers (*such as upstream of key bridge crossings or at confluences with tributaries*) or across significant flood storages such as at Wauchope and south of the Port Macquarie Airport.


Advisian

WorleyParsons Group

Port Macquarie Hastings Council

Hastings River Flood Study Climate Change
Assessment

Table 2.1 Comparison of Peak 1% AEP Flood Levels Predicted based on the Original and Updated RMA-2 modelling

Flood Level Comparison Points ^A	Original 2006 1% AEP Flood Levels (mAHD)	Updated 1% AEP Flood	
		Flood Level (mAHD)	Level Difference (m)
A Wauchope Railway Crossing	8.76	8.83	+ 0.07
B Stoney Creek Road Crossing	7.70	7.70	+ 0.00
C Wauchope Flood Storage	7.12	7.13	+ 0.01
D Kings Creek Confluence	7.10	7.10	+ 0.00
E Sancrox Bridge	4.76	4.82	+ 0.06
F Dennis Bridge	3.82	3.82	+ 0.00
G Maria River Confluence	3.53	3.54	+ 0.01
H Flood Storage South of Airport	3.31	3.38	+ 0.07
I Hibbard Ferry	3.02	3.00	- 0.02
J Settlement Point Ferry	2.73	2.65	- 0.08
K Pacific Highway Crossing at Telegraph Point	3.71	3.73	+ 0.02
L Wilson & Maria River Confluence	3.68	3.70	+ 0.02

^A Point locations are identified on the peak 1% AEP flood level mapping figures and flood level difference figures shown as **Figures 2.6 to 2.10** and **Figures 2.11 to 2.15**, respectively.

The flood level difference mapping indicates that the updated RMA-2 model network, incorporating the Pacific Highway and Oxley Highway upgrades, generates peak 1% AEP flood levels that are on average within +/- 0.05 metres of those documented in the 2006 Flood Study. This is reflected in **Figures 2.11 to 2.15** by the white shading that covers the majority of the floodplain.

Flood level differences are predicted to be higher at several locations such as parts of Wauchope upstream of the Railway Crossing of the Hastings River, to the west of Rawdon Island and across some parts of Hibbard and Settlement Point. These changes in flood levels can be directly attributed to the updated RMA-2 definition at those locations.

**Advisian**

WorleyParsons Group

Port Macquarie Hastings Council

Hastings River Flood Study Climate Change
Assessment

Figure 2.14 and **Figure 2.15** show two locations where the updated modelling is predicted to result in a reduction in peak 1% AEP flood level over a large area of the floodplain. Both of these locations are flood storage areas across which peak flood levels are influenced by both the hydrograph length and the flood behaviour to the entrance to the storages. The updated modelling predicts a lower flood level across these flood storage areas as a result of improved network definition at the storage entrances. This has reduced the rate at which the storages 'fill-up', which for the same inflow hydrographs results in a lower peak flood level being reached.

The southern end of the Kooloonbung Creek storage area (*south of Port Macquarie*) is also predicted to reach lower peak 1% AEP flood levels than originally predicted in the 2006 Flood Study (*refer Figure 2.11*). The decrease in peak 1% AEP flood level at this southern limit is predicted to be 0.39 metres with the updated modelling predicting peak 1% AEP flood levels of 2.04 mAHd compared to 2.43 mAHd as documented in the 2006 Flood Study.

As with the other storage areas referenced above, the decrease in flood levels across this section of the Kooloonbung Creek flood storage area is attributed to the updated RMA-2 network more reliably picking-up topographic elevations at the inflow locations to the storage area. For this case, this has resulted in a reduction in the size of the inflow area, causing a lower volume of floodwaters to enter the area over the course of the 1% AEP flood event resulting in a lower level of ponding. Based on these results we consider that the 2006 flood modelling had over-predicted flood levels at this location.

2.3.2 Updated 1% AEP Flood Behaviour Mapping

The predicted variation in 1% AEP flood depths and flow velocities based on the updated RMA-2 model are shown in **Figures A1 to A10** in **Appendix A**.

Updated flood hazard and hydraulic category mapping for the 1% AEP event are also included in **Appendix A** as **Figures A11 to A20**.

It is noted that only the flood storage and flood fringe areas have been updated as part of the hydraulic category mapping, with the extent of the floodway corridor remaining unchanged and consistent with the extent derived as part of the Floodplain Risk Management Study (2012). This recognises the detailed investigations completed as part of the FRMS 2012 to delineate the floodway corridor which included modelling of blockage scenarios to confirm the floodway extents. In that regard, unless detailed blockage analysis was to be re-done we do not believe it is appropriate to modify the floodway corridor based on the minor changes to flood behaviour shown to occur between the original and updated 1% AEP model results.

It is further noted that the approach to delineating the boundary between flood storage and fringe categories has been modified to that adopted as part of the FRMS (2012). For the FRMS (2012) the boundary between storage and fringe was generated based on a two-step approach that involved manual manipulation of the boundary. That is, although the boundary was based on a depth criteria of 0.3 metres, the final boundary was based on manual re-alignment to take into consideration cadastral boundaries.

**Advisian**

WorleyParsons Group

Port Macquarie Hastings Council

Hastings River Flood Study Climate Change
Assessment

It is no longer recommended that this final step of manual manipulation be undertaken which is a reflection of the recently adopted flood policy (2015) and updated procedures adopted as part of the hydraulic category mapping for the Camden Haven Flood Study (2013). Accordingly, the mapping of flood storage and fringe extents in **Figures A16 to A20** is based solely on a 0.3 metre depth criteria.

2.4 Updated 1% AEP Flood Modelling Findings

The additional nodes and elements that have been added to the updated RMA-2 model provide a more reliable representation of the floodplain. In addition, the updated model more closely reflects 'present-day' conditions due to the inclusion of the road embankments associated with the upgrades to the Pacific Highway and the Oxley Highway within the network.

The comparison of 1% AEP flood levels based on the original and updated RMA-2 models indicates that changes in levels are on average within +/- 0.05 metres. Changes in flood levels of +/- 0.10 metres are considered reasonable given the scale of the updates that have been incorporated into the model. Where changes are larger than +/- 0.10 metres (*i.e.*, *Kooloonbung Creek*), these level differences have arisen due to the updated RMA-2 network more reliably picking-up topographic elevations at the inflow locations to the storage areas.

It is recommended that the updated 1% AEP flood results be adopted as the basis for determining the planning flood level in the lower Hastings River Valley.

As a result, the updated results have been adopted as the present day benchmark for comparison with the results of Climate Change modelling simulations.



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

3 CLIMATE CHANGE ASSESSMENT

3.1 Background

To date, the NSW Government has published a number of documents which provide guidance to account for climate change impacts on flooding. These documents include:

- Department of Environment and Climate Change (DECC) Floodplain Risk Management Guideline titled: *'Practical Consideration of Climate Change'* (2007).
This guideline provides an estimate of the range for increases in sea level associated with climate change. It also provides an estimate for the change in "Extreme Rainfall" in different parts of NSW.
- Department of Environment, Climate Change & Water (DECCW) Draft Flood Risk Management Guide titled: *'Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments'* (2009).
This document provides direction on appropriate risk mitigation techniques for flood planning areas, as well as an updated direction for the assessment of ocean boundary conditions in flood modelling.
- DECCW Technical Note titled *'Derivation of the NSW Government's Sea Level Risk Planning Benchmarks'* (2009).
This document provides the technical background for the sea level rise projections adopted in the above documents.

These documents do not represent an exhaustive list of the information prepared by the NSW Government. However, they are considered the most pertinent to the scope of this assessment.

As addressed in the above documents, there are two main drivers for climate change flood impacts:

1. Sea Level Rise (SLR) - Assessment of the impacts using the NSW Government's SLR benchmarks of 0.4 m by 2050 and 0.9 m by 2100.
2. Changes to rainfall intensity - The guideline recommends consideration of increased rainfall intensities and storm volumes of 10%, 20% and 30%.

Modelling suggests that rainfall intensity on the Mid North Coast may either increase or decrease by up to 10% on present day levels over the next 60 years. There is less certainty in this aspect (*compared to SLR*) and research is currently being carried out to provide greater confidence on the changes to rainfall intensity. Given this uncertainty a 10% increase in rainfall intensity and volume has been adopted. This is consistent with the available guidance documents and existing Port Macquarie-Hastings Council flood studies; for example, the Camden Haven Flood Study (2013).

It should be noted that it is beyond the scope of this study to examine the:

- (i) Impacts of CC on all aspects of flood behaviour including possible changes to hydraulic and hazard classifications.
- (ii) Impacts of CC on present development, infrastructure and the environment.
- (iii) Impacts of CC on potential or proposed flood risk management measures including structural measures such levees and emergency response management protocols.



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

3.2 CLIMATE CHANGE MODELLING

Five flood simulations were undertaken to investigate the flood related impacts of climate change under a range of potential scenarios. The scenarios that were modelled are as follows:

- Scenario 1 - 100 year ARI catchment event with 900 mm Sea Level Rise + 10% increase in rainfall intensity and volume
- Scenario 2 - 100 year ARI catchment event with 900 mm SLR
- Scenario 3 - 100 year ARI catchment event with 400mm SLR + 10% increase in rainfall intensity and volume
- Scenario 4 - 100 year ARI catchment event with 400 mm SLR
- Scenario 5 - PMF event with 900 mm SLR
(900mm SLR applied to the adopted 100yr Tide_2.2 mAHD)

Each of these scenarios has been modelled using the updated RMA-2 flood model to determine the potential changes in flood characteristics. Climate Change Scenarios 1 and 3 required initial hydrologic modelling to determine appropriate inflow hydrographs that reflected a 10% increase in rainfall intensity. This hydrologic modelling was completed using Council's existing XP-RAFTS model of the catchment.

The hydrologic (XP-RAFTS) and hydraulic (RMA-2) modelling results are discussed in the following.

3.2.1 RMA-2 Model Boundary Conditions

Upstream Boundary Conditions - Inflow Hydrographs

The XP-RAFTS hydrologic model that was developed as part of the Flood Study was adopted in order to determine the inflow hydrographs to be used for the simulation of Scenarios 1 and 3. In that regard, hydrologic modelling was required to determine the increase in flow magnitude that would result from a 10% increase in rainfall intensity across the catchment.

Peak flow hydrographs for the 1% AEP event with and without provision for a 10% increase in rainfall intensity are included in **Appendix B** for the upstream inflow boundaries of the flood model; that is, at the upstream points of the model along each of the Hastings, Wilson and Maria Rivers.

As shown in **Table 3.1**, a 10% increase in rainfall intensities during the design 1% AEP rainfall event is predicted to increase peak flows entering the study area by between 15.3% and 19.3%.

The highest increase in flows is predicted to occur at the Maria River inflow where 1% AEP inflows are predicted to increase from 2,707 m³/s to 3,122 m³/s as a result of the 10% increase in flood producing rainfall intensity.

The inflow hydrograph for the PMF event as used for simulation of Climate Change Scenario 5 is superimposed on **Figure B1** in **Appendix B**.



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

Table 3.1 Comparison between Existing and Predicted Year 2100 Flood Flows

Inflow Location	Peak Flow (m^3/s)		Difference (%)
	1% AEP Event	1% AEP Event with 10% Rainfall Increase	
Hastings River	6,848	7,896	+15.3
Wilson River	2,707	3,122	+15.3
Maria River	711	848	+19.3

Downstream Boundary Conditions – Tidal Hydrographs

The ocean boundary conditions used for modelling of the 1% AEP event as part of the 2006 Flood Study were adopted as the basis for the climate change investigations. That is, the base 1% AEP tidal hydrograph was modified for each scenario accordingly based on the magnitude of SLR included; i.e., increased by either 900 mm or 400 mm.

The ocean boundary conditions adopted for base case modelling of the 1% AEP event and for each of the climate change scenarios are presented in **Figure B2 of Appendix B**

3.2.2 Predicted Flood Levels and Extents

The results for each of the climate change scenarios have been processed and incorporated into waterRIDE™ for detailed analysis. A Water Surface Profile (WSP) has been extracted along the Hastings and Wilson/Maria Rivers to show the variation in levels along the river centre lines. WSP plots are particularly informative when comparing the impacts of tidal variations as the extent of influence is easily identified.

WSP plots for the Hastings River and Wilson/Maria Rivers are shown in **Figures 3.1 to 3.4**. The WSP plots indicate that the 400 mm and 900 mm SLR scenarios would have less than a 50 mm impact on peak flood levels by a location 3 km upstream of the Rawdon Island Bridge crossing along the Hastings River and a location 1.5 km upstream of the Pacific Highway Bridge crossing along the Wilson River.

Peak flood levels and extents for each of the climate change scenarios are shown in **Figures 3.5 to 3.29**. Several locations have been selected throughout the study area to provide a point comparison of the predicted peak flood levels under each climate change scenario (refer points marked on **Figures 3.5 to 3.29**).



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

3.2.3 Predicted Increase in Flood Levels above the Base Case 1% AEP Event

Flood level difference mapping was prepared for each climate change scenario to compare the predicted climate change and updated 1% AEP base case flood levels. Locations where the flood levels are higher due to climate change are shown as varying shades of red according to the magnitude of change. Areas shaded white indicate that the predicted change in level less than ± 0.05 m.

Flood level difference mapping for each of the climate change scenarios are presented according to the following figure break-up:

- Scenario 1 (10% Rainfall Increase + 0.9m SLR) - **Figure 3.30 to Figure 3.34**
- Scenario 2 (0.9m SLR) - **Figure 3.35 to Figure 3.39**
- Scenario 3 (10% Rainfall Increase + 0.4m SLR) - **Figure 3.40 to Figure 3.44**
- Scenario 4 (0.4m SLR) - **Figure 3.45 to Figure 3.49**
- Scenario 5 (PMF + 0.9m SLR) - **Figure 3.50 to Figure 3.54**

Table 3.2 on the following page provides a comparison of the predicted climate change flood levels to those predicted for the updated 1% AEP base case scenario. The magnitude of flood level increase is indicated in red text at each comparison point.

As expected, climate change is predicted to have the greatest impact on flood levels near the ocean entrance at Port Macquarie and between Wauchope and Bain Bridge (*i.e.*, *upstream of Rocks Ferry Bridge*). Flood level increases are highest here due to a combination of the SLR component and because of the constriction to flows that occurs at and upstream of the ocean entrance (*refer Table 3.2*).

Flood level increases are also high between Wauchope and Bain Bridge (*i.e.*, *upstream of Rocks Ferry Bridge*) for those climate change scenarios adopting a 10% increase in rainfall intensities. The higher increase in peak flood levels of up to 0.75 metres is attributed to the increased flows combined with the constriction in the floodplain that occurs at the Stoney Creek Road crossing of the Hastings River. As shown in **Table 3.2** (*refer location A*) and **Figure 3.31** and **Figure 3.41**, flood level increases upstream of Wauchope and the Stoney Creek Road crossing are predicted to generally exceed 0.60 metres and reach a maximum of over 0.7 metres across the northern floodplain.

The climate change scenario that would result in the greatest increase in flood levels above the base 1% AEP flood event is Scenario 5. This is to be expected given Scenario 5 reflects an 'ultimate' or 'worst-case' flood event where the Probable Maximum Precipitation (PMP) catchment event occurs simultaneously with extreme ocean conditions.



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

Table 3.2 Comparison of Peak Flood Levels Predicted for the Climate Change Scenarios and the Updated 1% AEP Flood

Flood Level Comparison Points ^A	Updated 1% AEP Flood	Climate Change Scenarios (mAHD)				
		1 10% Rainfall + 0.9m SLR	2 0.9m SLR	3 10% Rainfall + 0.4m SLR	4 0.4m SLR	5 PMF + 0.9m SLR
A Wauchope Railway Crossing	8.83	9.53 (+0.70)	8.86 (+0.02)	9.44 (+0.61)	8.83 (+0.00)	12.70 (+3.87)
B Stoney Creek Road Crossing	7.70	8.20 (+0.50)	7.50 (-0.20)	8.00 (+0.30)	7.72 (+0.02)	11.30 (+3.60)
C Wauchope Flood Storage	7.13	7.65 (+0.52)	7.17 (+0.04)	7.62 (+0.49)	7.16 (+0.03)	11.36 (+4.23)
D Kings Creek Confluence	7.10	7.62 (+0.52)	7.15 (+0.05)	7.60 (+0.50)	7.13 (+0.03)	11.13 (+4.03)
E Sancroix Bridge	4.82	5.40 (+0.58)	4.98 (+0.16)	8.00 (+3.18)	4.92 (+0.10)	8.24 (+3.42)
F Dennis Bridge	3.82	4.42 (+0.60)	4.12 (+0.30)	4.24 (+0.42)	4.94 (+0.12)	7.15 (+3.33)
G Maria River Confluence	3.54	4.22 (+0.68)	3.92 (+0.38)	4.01 (+0.47)	3.70 (+0.16)	6.99 (+3.45)
H Flood Storage South of Airport	3.38	4.03 (+0.65)	3.75 (+0.37)	3.81 (+0.43)	3.48 (+0.10)	6.79 (+3.41)
I Hibbard Ferry	3.00	3.75 (+0.75)	3.55 (+0.55)	3.52 (+0.52)	3.22 (+0.22)	6.60 (+3.60)
J Settlement Point Ferry	2.65	3.50 (+0.85)	3.37 (+0.72)	3.18 (+0.53)	2.99 (+0.34)	6.35 (+3.70)
K Pacific Highway Crossing at Telegraph Point	3.73	4.39 (+0.66)	4.08 (+0.35)	4.18 (+0.45)	3.89 (+0.16)	7.09 (+3.36)
L Wilson & Maria River Confluence	3.70	3.36 (+0.74)	4.05 (+0.35)	4.16 (+0.46)	3.85 (+0.15)	7.07 (+3.37)

^A Point locations are identified on **Figures 2.6 to 2.10** and **Figures 3.5 to 3.29** for the updated 1% AEP flood and the Climate Change Scenarios, respectively.



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

3.3 Planning Recommendations

The modelling results for the various climate change scenarios highlights the variability in predicting the potential future flood level increases due to the impacts of increased rainfall intensity and sea level rise.

In October 2015, Port Macquarie-Hastings Council adopted a new Flood Policy to guide development within the Local Government Area (LGA), including across floodplain areas. The policy recognises the risks that climate change will pose to existing and future development within the LGA.

The Flood Policy seeks to address this risk by specifying Flood Planning Levels (FPL) for the LGA that incorporate an allowance for climate change. This climate change allowance is in addition to a standard freeboard of 500 mm.

As detailed climate change modelling had not been completed for the Hastings River the following 'interim' climate change allowances have been applied in the flood policy:

- 400 mm allowance for areas to the east (*downstream*) of the Pacific Highway, and
- 100 mm allowance for areas to the west (*upstream*) of the Pacific Highway.

Climate Change Scenario 1 is to be adopted for the purpose of flood planning and floodplain management (i.e., a 1% AEP event with 900 mm Sea Level Rise and 10% increase in rainfall intensity). Adopting Scenario 1 would provide a conservative approach to addressing climate change along the Hastings River whereby it represents the most conservative estimate (*aside from the PMF modelling in Scenario 5*) for flood level increases, both across tidally influenced areas and areas further upstream. This is also consistent with the Camden Haven Flood Study (2013).

Scenario 1 is also consistent with the NSW Sea Level Rise Policy Statement benchmarks, existing planning directions of Port-Macquarie Hastings Council, and reflects the certainties of sea level rise while acknowledging the limitations of the predicted rainfall increases. Although the NSW Sea Level Rise Policy is no longer in effect, the guideline documents are still considered to represent a reliable guide to the potential changes to sea levels and rainfall intensities due to climate change.

It is recommended that Scenario 1 be adopted by Council as the benchmark climate change scenario for the Lower Hastings Valley for use in Council's Flood Policy for setting Flood Planning Levels (FPL).

3.3.1 Implications of Adopting Climate Change Scenario 1 on the FPL

Selection of Scenario 1 as the benchmark climate change scenario will result in an increase in the FPL for areas to the west and east of the Pacific Highway of between 0.4 to 0.5 metres and 0.2 and 0.5 metres, respectively. This has been determined based on subtraction of the interim climate change allowances currently referenced within the Flood Policy (400mm and 100mm for areas to the east and west of the Pacific Highway) from the change in flood levels predicted between the updated 1% AEP event and Climate Change Scenario 1. In that regard, the difference mapping shown in **Figures 3.5 to 3.9** indicates differences in levels between the updated 1% AEP flood and

**Advisian**

WorleyParsons Group

Port Macquarie Hastings Council

Hastings River Flood Study Climate Change
Assessment

climate change scenario 1 of between 0.5 and 0.6 metres to the west of the Pacific Highway and 0.6 to 0.9 metres higher for areas to the east.

3.3.2 Implications of the Updated 1% AEP Results on Existing Flood Hazard Mapping

The updated 1% AEP modelling will result in changes to the hazard category mapping documented as Figures 2.1 to 2.5 in the Floodplain Risk Management Study (2012). The changes are not expected to be significant given the updated modelling predicting peak 1% AEP flood levels that are largely consistent with the FRMS (2012) or within +/- 0.05 metres.

Localised changes to flood hazards are to be expected though, recognising that flood hazard categorisations are based on the magnitude of depths and velocities, and the combination of both (*i.e.*, *depth and velocity product*). In that regard, the addition of over 35,000 nodes to 'pick-up' additional topographic detail will certainly lead to localised changes in peak flow velocities which will in turn have the potential to change hazards; even if flood levels are generally within +/- 0.05 metres.

Any changes to hazards that may occur as an outcome of the updated modelling are supported and considered to reflect a more reliable representation of flood hazards. An updated set of hazard maps are provided as **Figures A11 to A15 in Appendix A**.

3.3.3 Implications of the Updated 1% AEP Results on Existing Hydraulic Category Mapping

A detailed review of the existing hydraulic category mapping documented in the FRMS (2012) has not been undertaken as part of this study. Notwithstanding, based on the methodology that was applied to determine the existing hydraulic categories, it is not expected that there should be any change to the floodway extent. This is because the floodway extent determined as part of the FRMS (2012) considered not only the 1% AEP flood, but also rarer events such as the 0.5% AEP flood. The minor changes in flood behaviour predicted as a result of the updated 1% AEP mapping is considered to have effectively been accounted for in the original floodway determination investigations.

Based on the above, it is unlikely the floodway corridor will require any changes to be compatible with the updated 1% AEP results. Further blockage modelling as had been undertaken for the FRMS (2012) would be required to test any changes to the floodway.

The approach previously adopted as part of the FRMS (2012) to delineate the boundary between flood storage and fringe categories has been modified in the updated hydraulic category mapping included within this report.

In that regard, for the FRMS (2012) the boundary between storage and fringe was generated based on a two-step approach that included manual manipulation of the boundary. That is, although the boundary was based on a depth criteria of 0.3 metres, the final boundary was based on manual re-alignment to take into consideration cadastral boundaries and relevant topographic features.

**Advisian**

WorleyParsons Group

Port Macquarie Hastings CouncilHastings River Flood Study Climate Change
Assessment

It is no longer recommended that this final step of manual manipulation be undertaken which is a reflection of the recently adopted Port Macquarie-Hastings Flood Policy (2015) and updated procedures adopted as part of the hydraulic category mapping for the Camden Haven Flood Study (2013). Accordingly, the mapping of flood storage and fringe extents shown in **Figures A16 to A20** is based solely on a 0.3 metre depth criteria.

An updated set of hydraulic category maps for the 1% AEP flood event are provided as **Figures A16 to A20** in **Appendix A**.

3.3.4 Complete Set of Flood Mapping

Predicted changes in peak flood depths and flow velocities for Climate Change Scenario 1 are shown in **Figures C1 to C10** of **Appendix C**. Updated flood hazard and hydraulic category mapping for Climate Change Scenario 1 are also included in **Appendix C** as **Figures C11 to C20**.

As discussed in **Section 3.3.3**, only the flood storage areas and flood fringes have changed. The floodway corridor is unchanged, recognising that it was delineated as part of the FRMS (2012) based on consideration of the full range of flood events. In effect, the floodway corridor was delineated based on consideration of events of a similar frequency to the adopted climate change scenario; i.e., Scenario 1.



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

4 CONCLUSIONS

Detailed flood modelling completed for the five climate change scenarios provides an extensive analysis of the potential impacts of climate change on predicted peak flood levels in the Lower Hastings Valley. It is recommended that Council adopt Climate Change Scenario 1 for the purpose of flood planning and floodplain management. Scenario 1 is based on the Year 2100 1%AEP event being equivalent to the current 1% AEP event with a 10% increase in catchment rainfall intensity and a 900 mm increase in ocean tailwater level due to Sea Level Rise.

The modelling results show that Scenario 1 provides the most conservative estimate (*aside from the PMF modelling in Scenario 5*) for flood level increases, both across tidally influenced areas and areas further upstream. Scenario 1 is consistent with the previous NSW Sea Level Rise Policy Statement benchmarks, existing planning directions of Port-Macquarie-Hastings Council, and reflects the certainties of sea level rise while acknowledging the limitations of the predicted rainfall increases.

It is also recommended that Council adopt the updated 1% AEP flood modelling to define present day flood characteristics for the study area. The updated modelling is based on a version of the RMA-2 model that has undergone significant upgrades since it was originally developed for the Hastings River Flood Study in 2006. The model updates have included a significant increase to the resolution of the model network through the inclusion of over 35,000 additional nodes and elements. This greatly improves the reliability of the model mesh to replicate channel and floodplain features which, would result in a much more reliable reflection of flood behaviour across the study area.

The RMA-2 model updates have also included significant changes to the floodplain that have occurred since 2006. These include, but are not limited to, construction of the extensive roadway embankments and bridge and culvert structures associated with upgrades to the John Oxley Highway and realignment of the Pacific Highway. Inclusion of these changes is required to ensure the model is predicting flood behaviour that is reflective of present-day floodplain conditions.



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

5 REFERENCES

- NSW Government (April 2005), 'Floodplain Development Manual: the Management of Flood Liable Land'; ISBN 0 7347 5476 0
- Port Macquarie-Hastings Council (2006), 'Hastings River Flood Study'; prepared by Patterson Britton & Partners (now WorleyParsons)
- Port-Macquarie Hastings Council (2012), 'Hastings River Floodplain Risk Management Study', prepared by WorleyParsons
- Port Macquarie – Hastings Council (September, 2015), 'Port Macquarie Hastings LGA Flood Policy'
- Port Macquarie – Hastings Council, 'Port Macquarie-Hastings Council – Development Control Plan 2013'
- Port Macquarie-Hastings Council (2011), 'Port Macquarie-Hastings Local Environmental Plan 2011'
- Port-Macquarie Hastings Council (July 2013), 'Camden Haven River and Lakes System Flood Study', prepared by WorleyParsons
- NSW State Emergency Services (November 2013), 'Port Macquarie-Hastings Local Flood Plan'
- Department of Environment & Climate Change (2007), 'Floodplain Risk Management Guideline – Practical Consideration of Climate Change'
- Department of Environment, Climate Change & Water (2009), 'Scientific Basis of the 2009 Sea Level Rise Benchmark – Draft Technical Note'
- Department of Environment, Climate Change & Water (2009), 'Draft Flood Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments'
- Department of Infrastructure, Planning & Natural Resources (May 2005), 'Floodplain Risk Management Guideline No 5 – Ocean Boundary Conditions'; Developed by the State Urban Flood Unit



Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

Figures



FIGURE 2.1

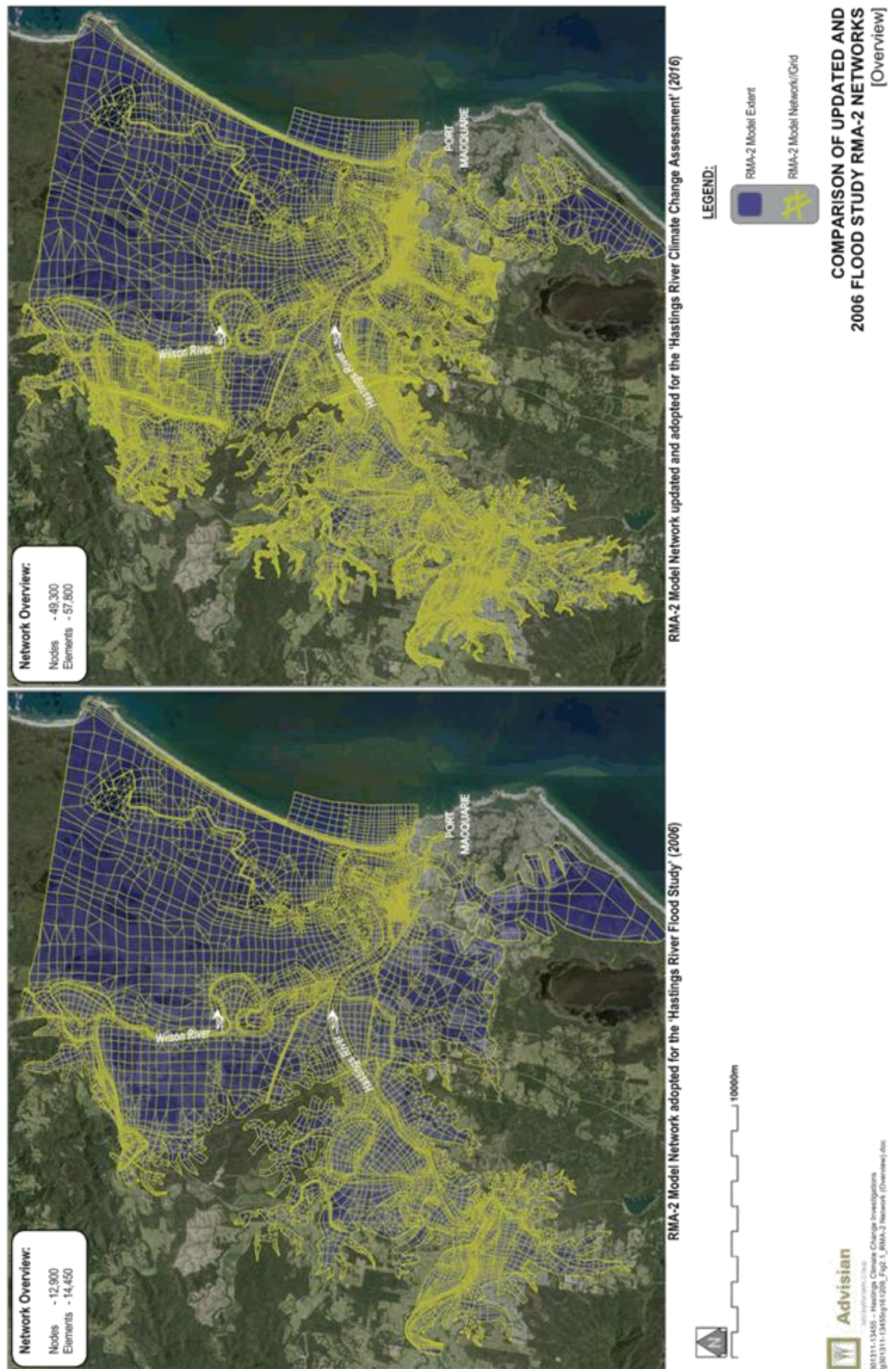


FIGURE 2.2

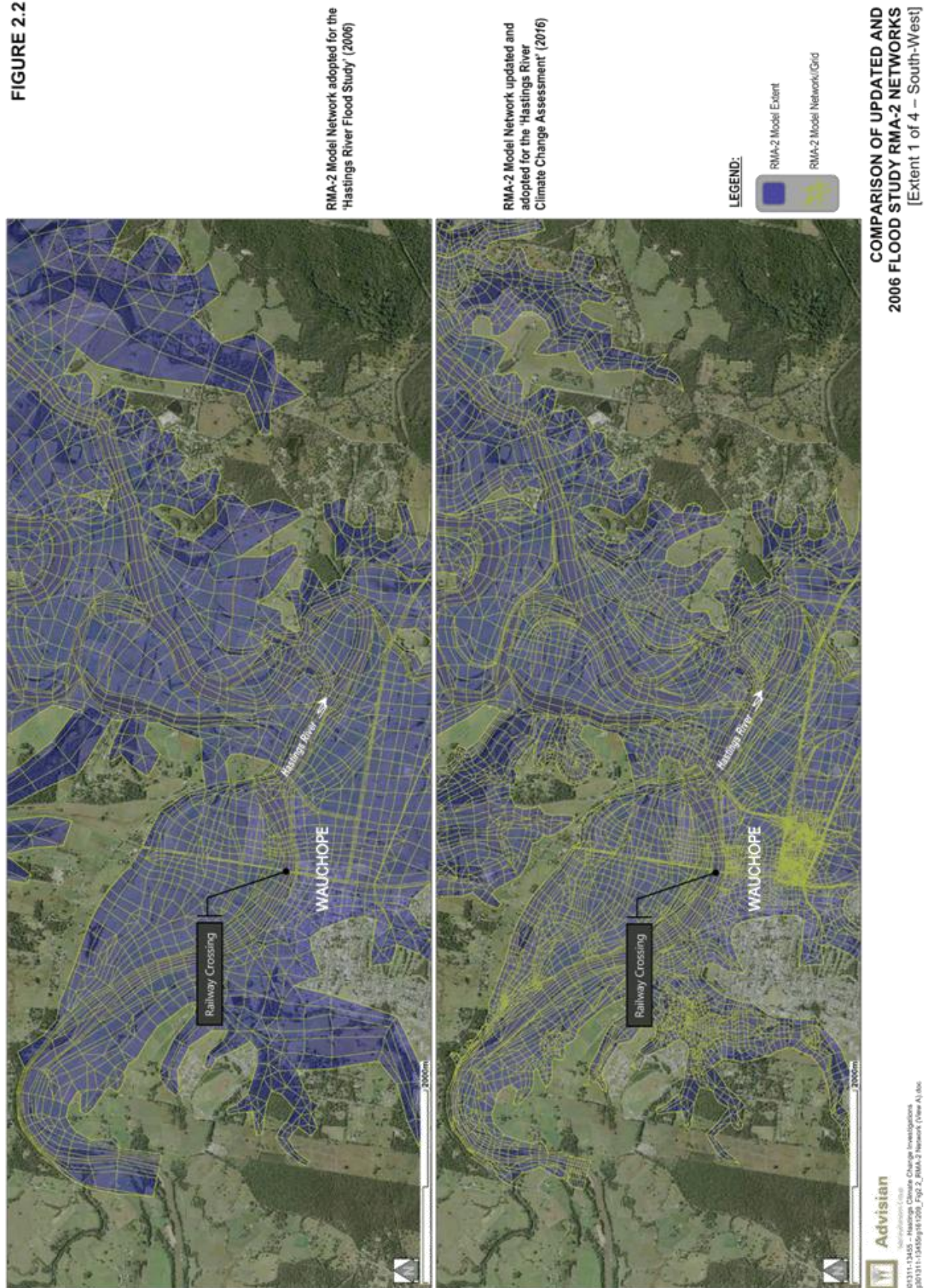


FIGURE 2.3

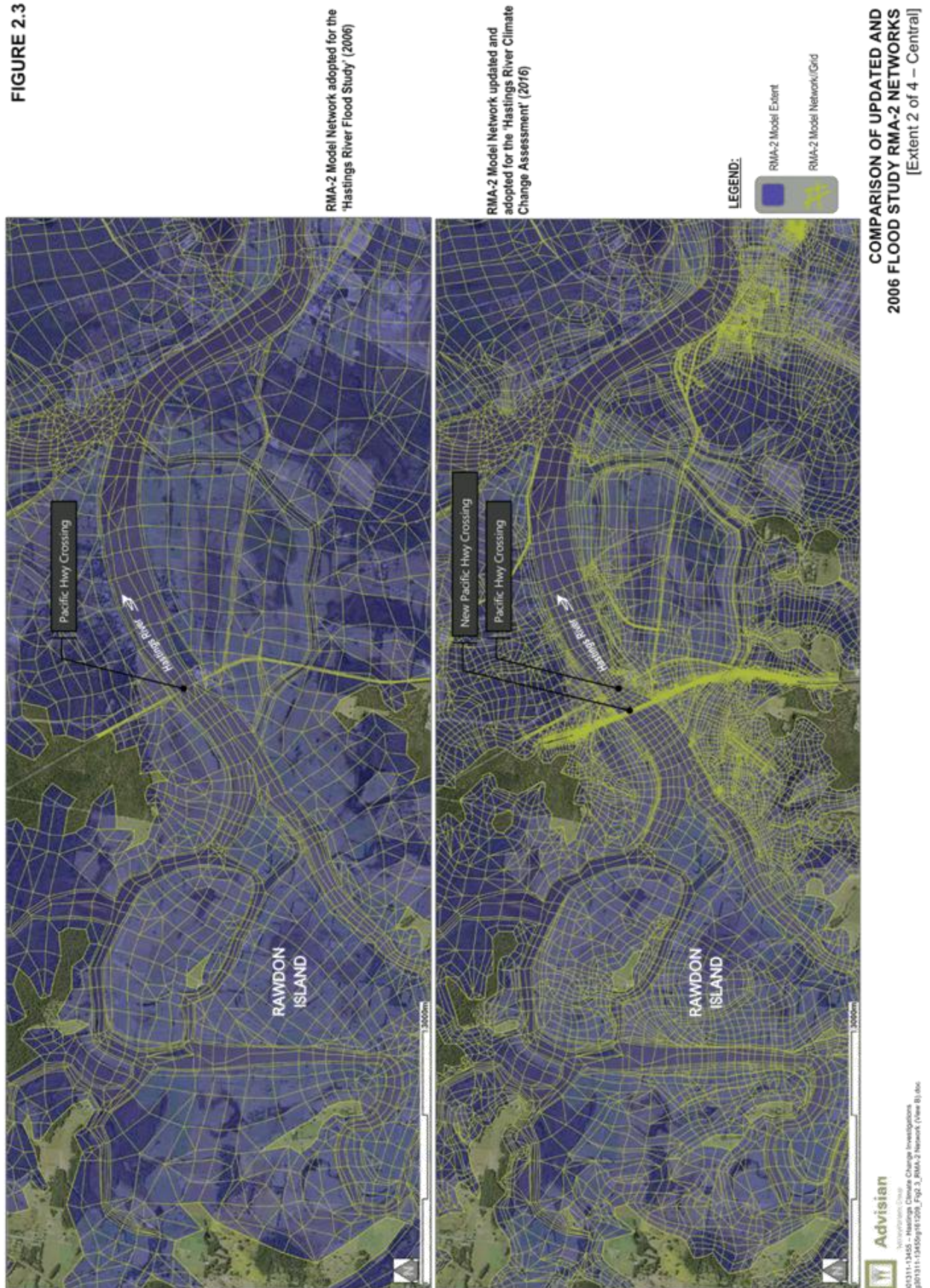
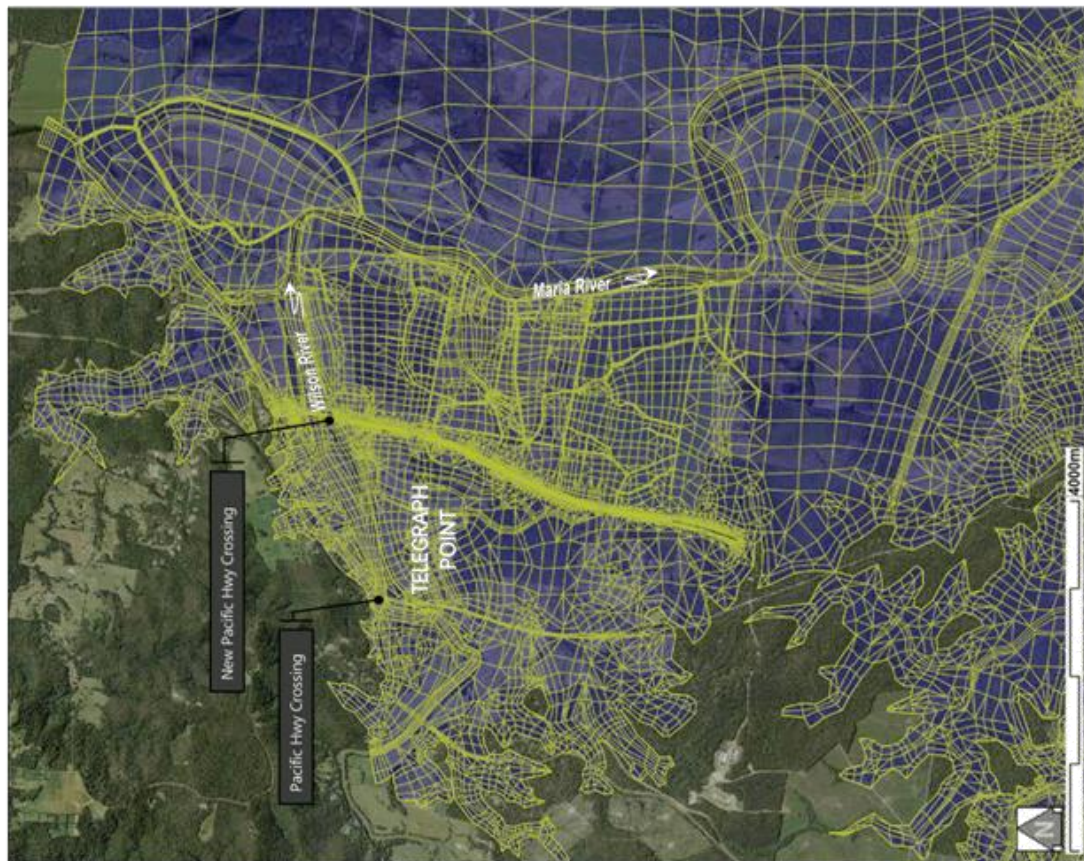


FIGURE 2.4

RMA-2 Model Network updated and adopted for the 'Hastings River Climate Change Assessment' (2016)



RMA-2 Model Network adopted for the 'Hastings River Flood Study' (2006)

COMPARISON OF UPDATED AND
2006 FLOOD STUDY RMA-2 NETWORKS
[Extent 3 of 4 – North]

Advisian
 Environmental & Planning
 30/3/11-13455 – Hastings Climate Change Investigations
 13/03/11-13455/13455_Fig 4_RMA-2 Network (New C) 60c

FIGURE 2.5

RMA-2 Model Network updated and adopted for the 'Hastings River Climate Change Assessment' (2016)

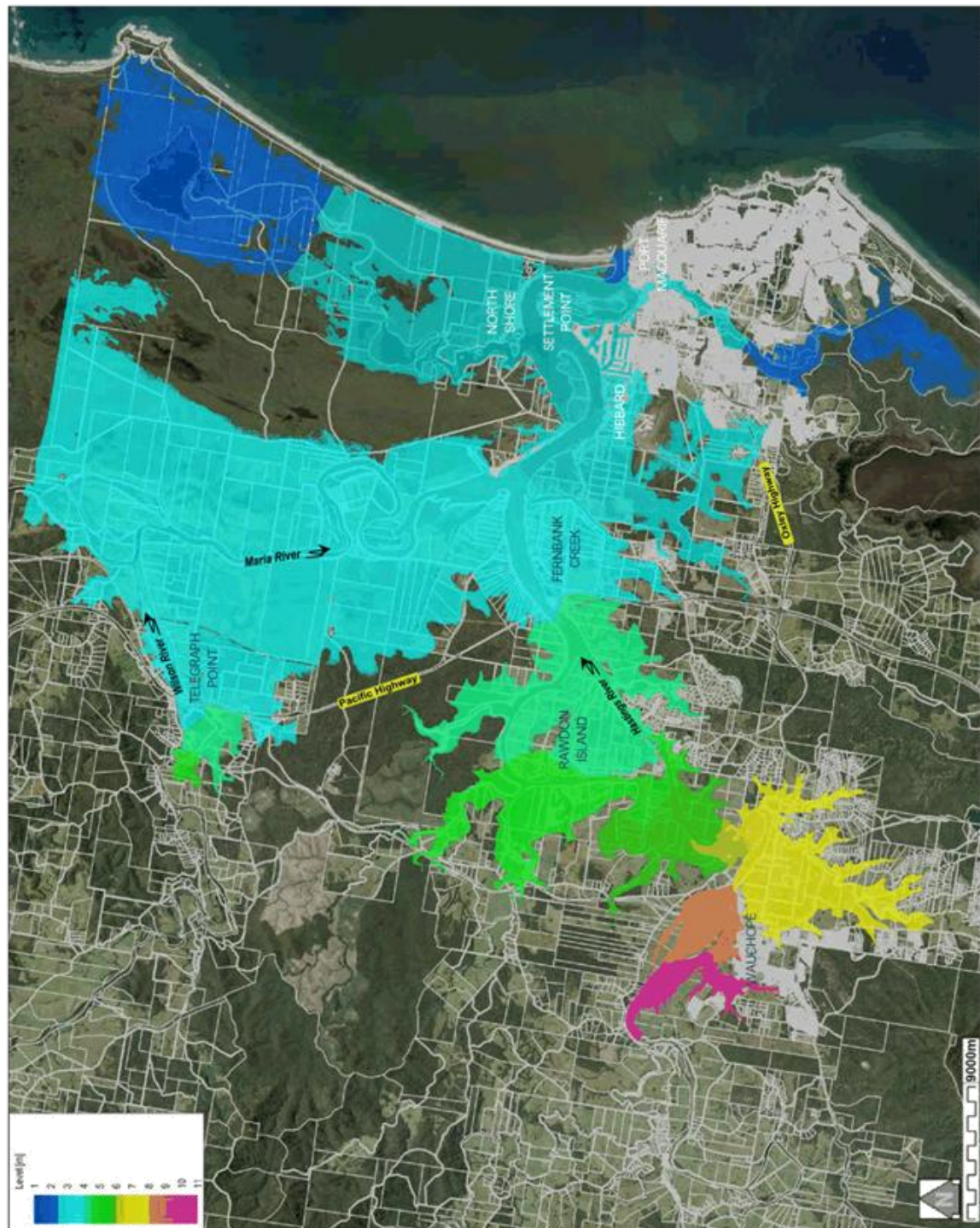


RMA-2 Model Network adopted for the 'Hastings River Flood Study' (2006)

COMPARISON OF UPDATED AND
2006 FLOOD STUDY RMA-2 NETWORKS
[Extent 4 of 4 – South East/Town]

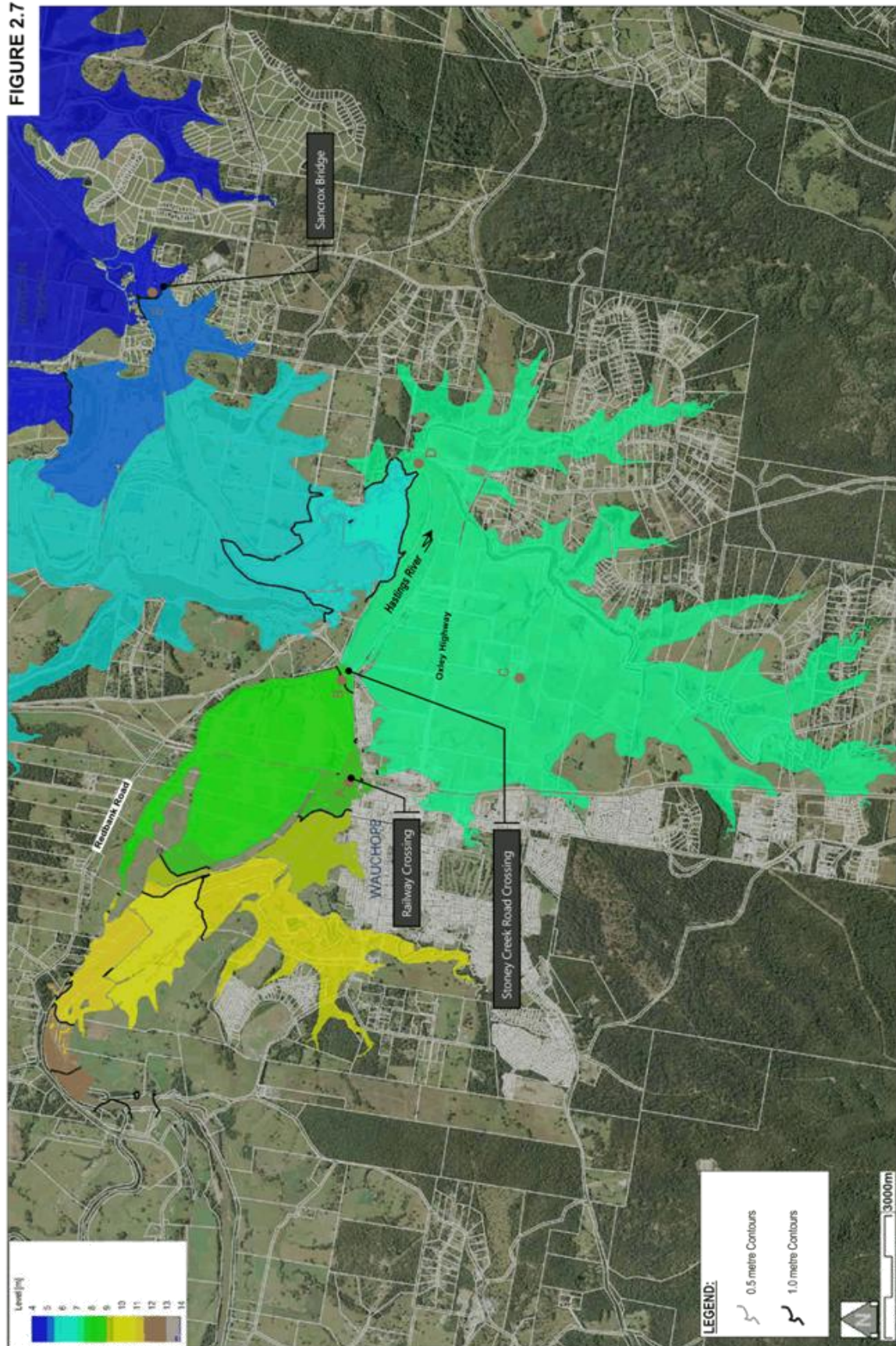
Advisian
30/311-13455 - Hastings Climate Change Investigations
19/01/11-13455/1209_Fig 3_RMA-2 Network (New D) doc

FIGURE 2.6



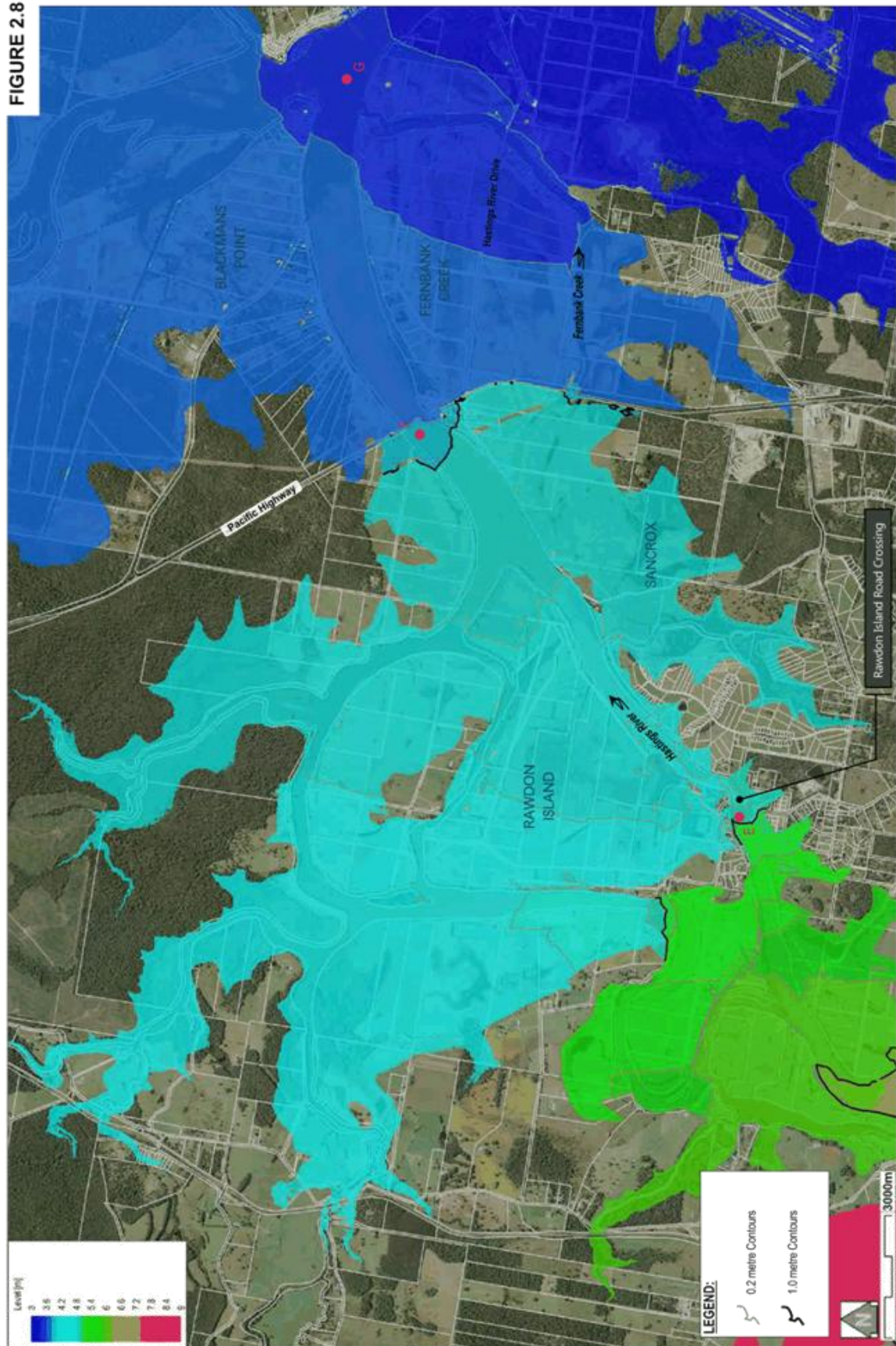
PREDICTED FLOOD LEVELS AT THE
PEAK OF THE 1% AEP FLOOD EVENT
(Based on Updated RMA-2 Model)

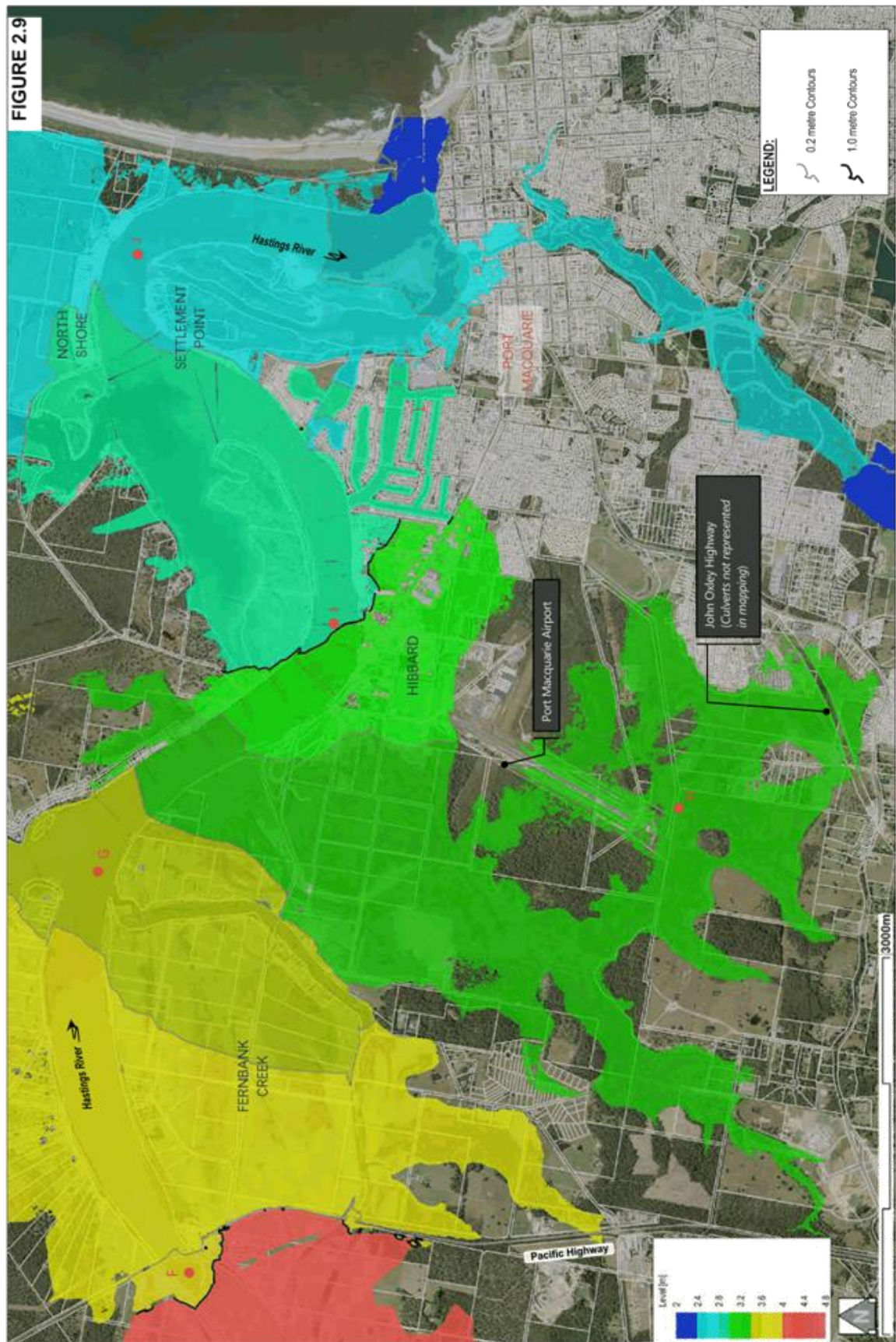
FIGURE 2.7



PREDICTED FLOOD LEVELS AT THE
PEAK OF THE 1% AEP FLOOD EVENT
[Extent 1 of 4 - South-West]

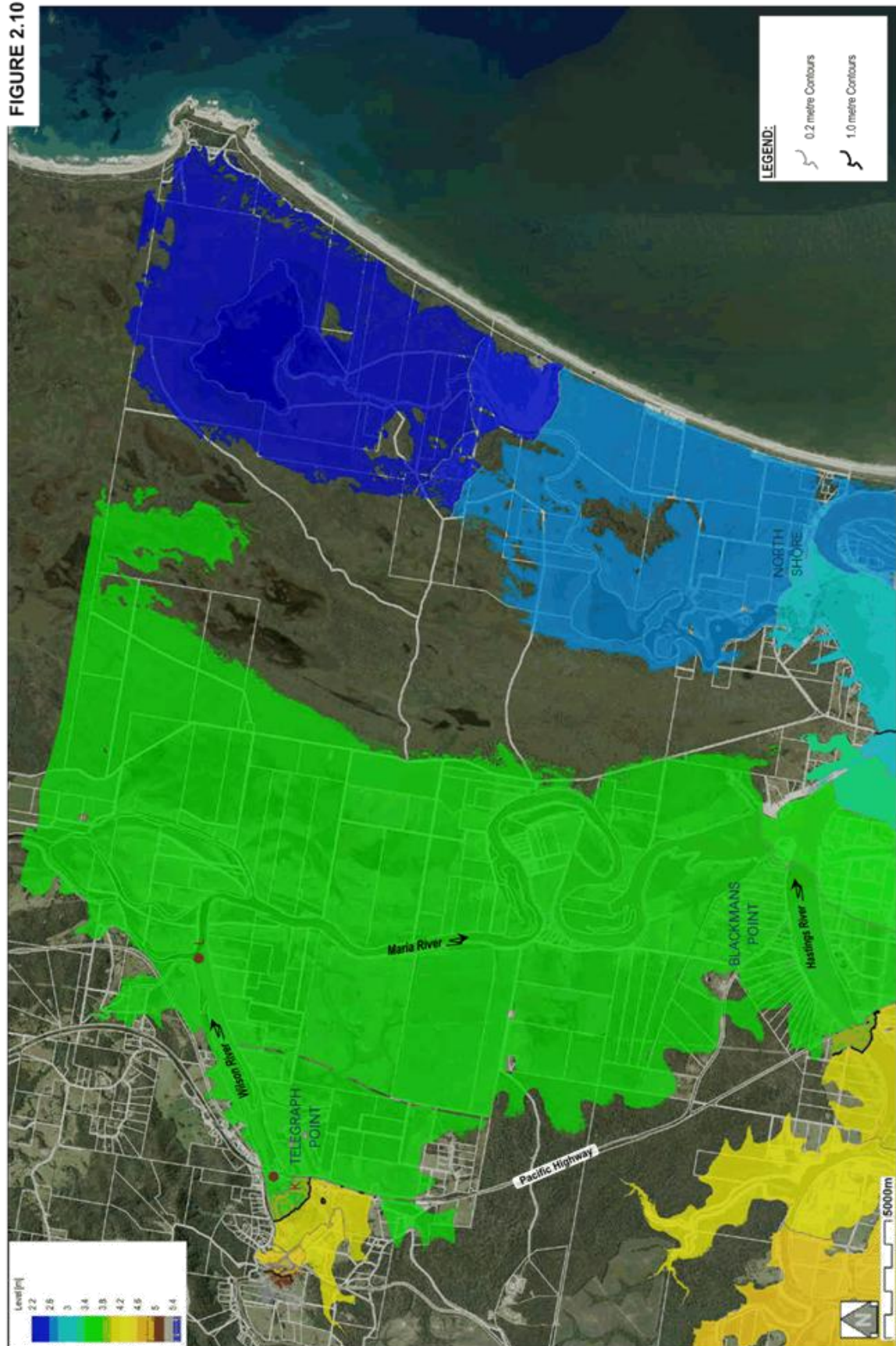
FIGURE 2.8





**PREDICTED FLOOD LEVELS AT THE
PEAK OF THE 1% AEP FLOOD EVENT**
[Extent 3 of 4 - South-East]

FIGURE 2.10



PREDICTED FLOOD LEVELS AT THE
PEAK OF THE 1% AEP FLOOD EVENT
[Extent 4 of 4 – North-West]

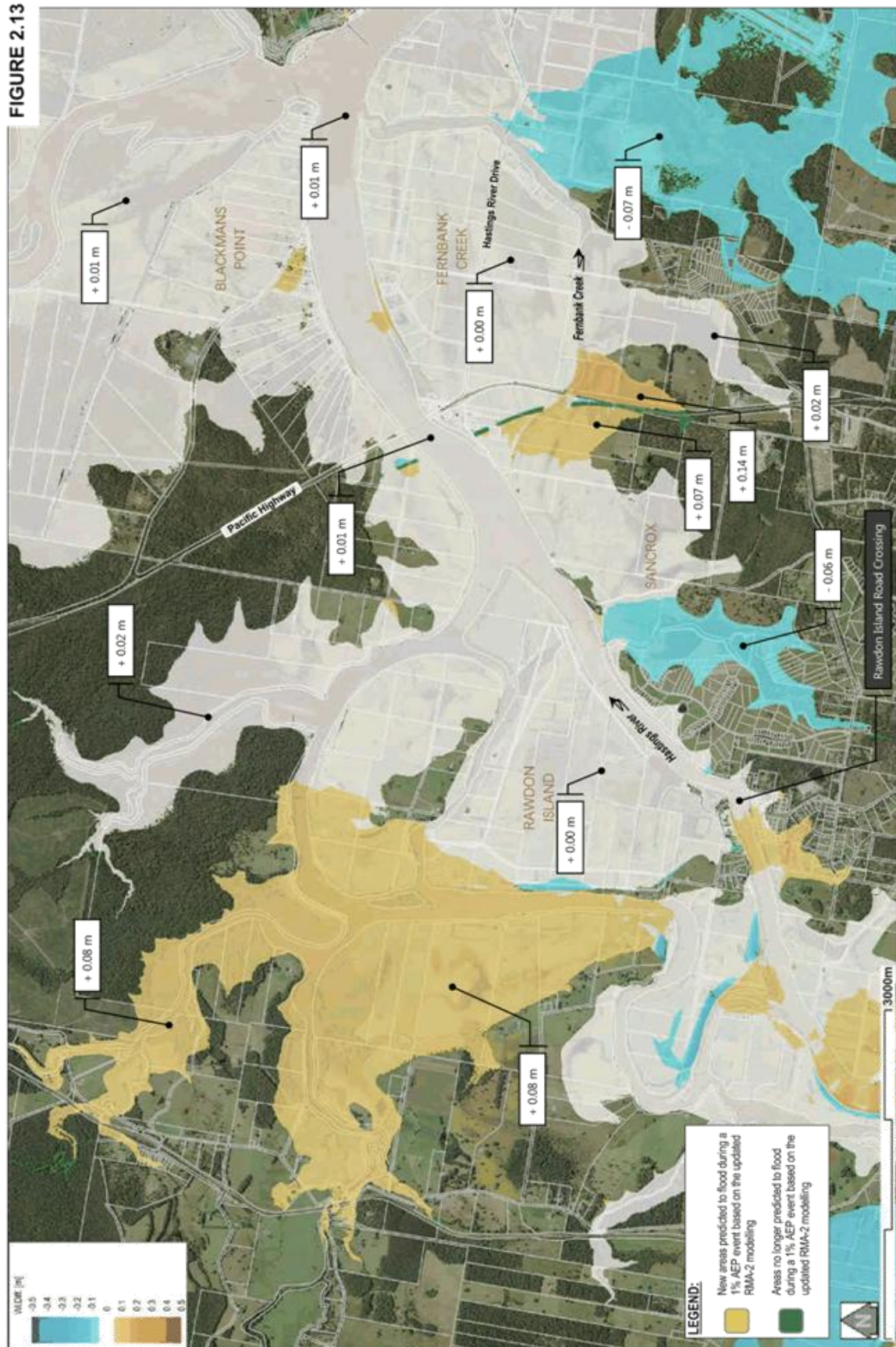
FIGURE 2.11



**PEAK 1% AEP FLOOD LEVEL DIFFERENCES
AS A RESULT OF RECENT UPDATES
TO THE HASTINGS RIVER RMA-2 MODEL**
[Extent 1 of 4 – South-West]

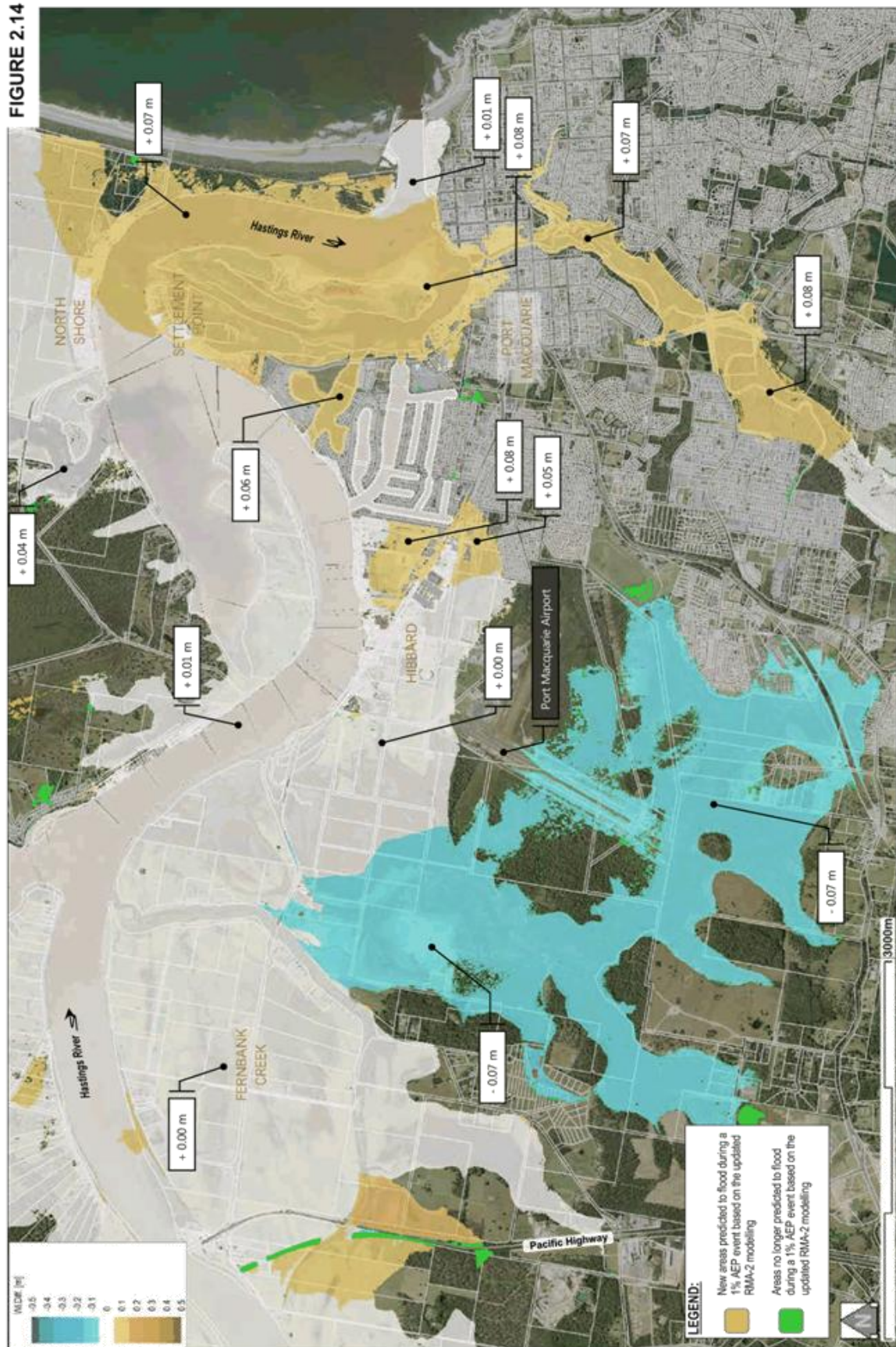


FIGURE 2.13



PEAK 1% AEP FLOOD LEVEL DIFFERENCES
AS A RESULT OF RECENT UPDATES
TO THE HASTINGS RIVER RMA-2 MODEL
[Extent 2 of 4 – Central]

FIGURE 2.14



PEAK 1% AEP FLOOD LEVEL DIFFERENCES
AS A RESULT OF RECENT UPDATES
TO THE HASTINGS RIVER RMA-2 MODEL
[Extent 3 of 4 – South-East]

FIGURE 2.15



PEAK 1% AEP FLOOD LEVEL DIFFERENCES
AS A RESULT OF RECENT UPDATES
TO THE HASTINGS RIVER RMA-2 MODEL
[Extent 3 of 4 - North-West]

FIGURE 3.1

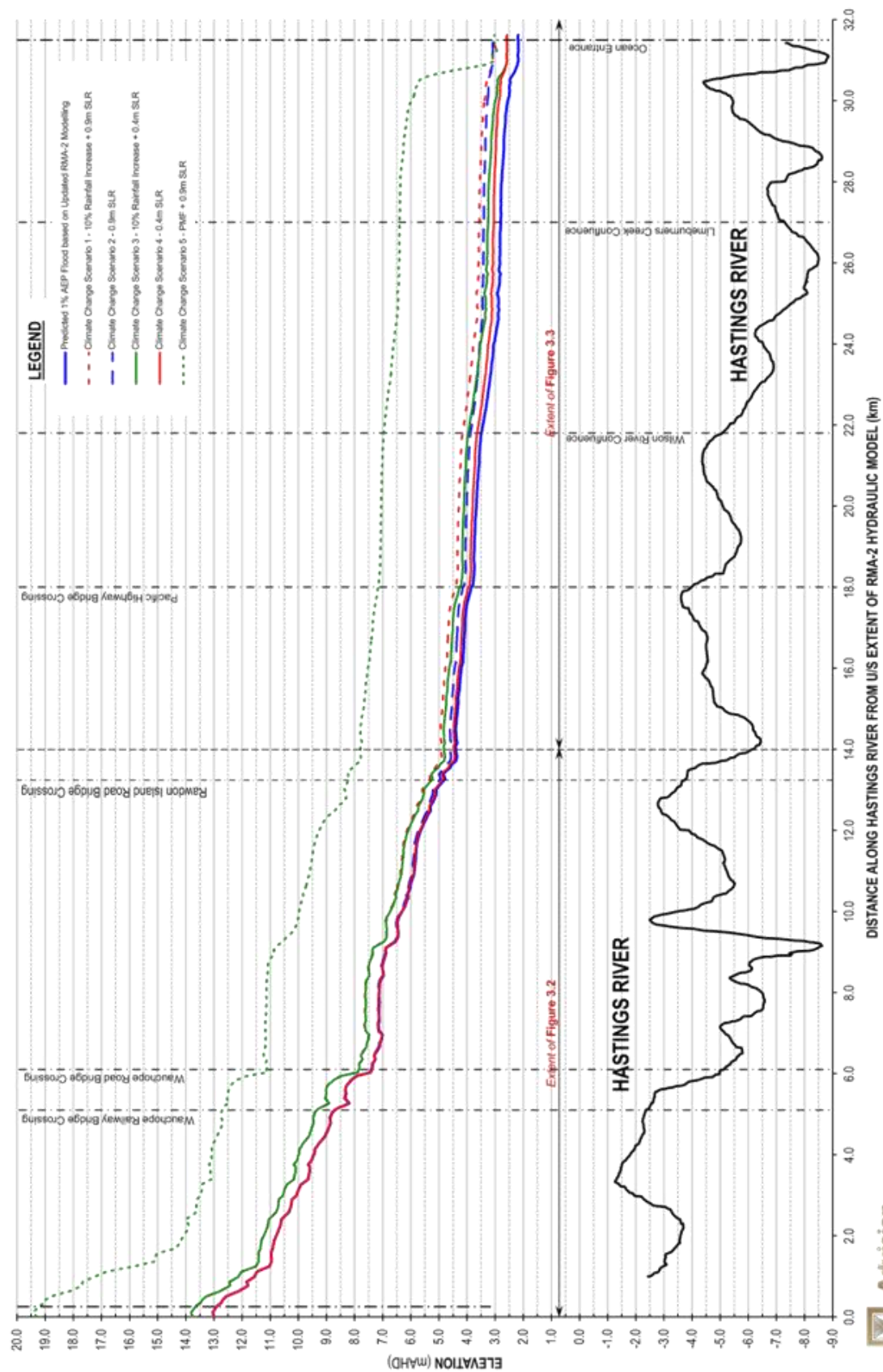


FIGURE 3.2

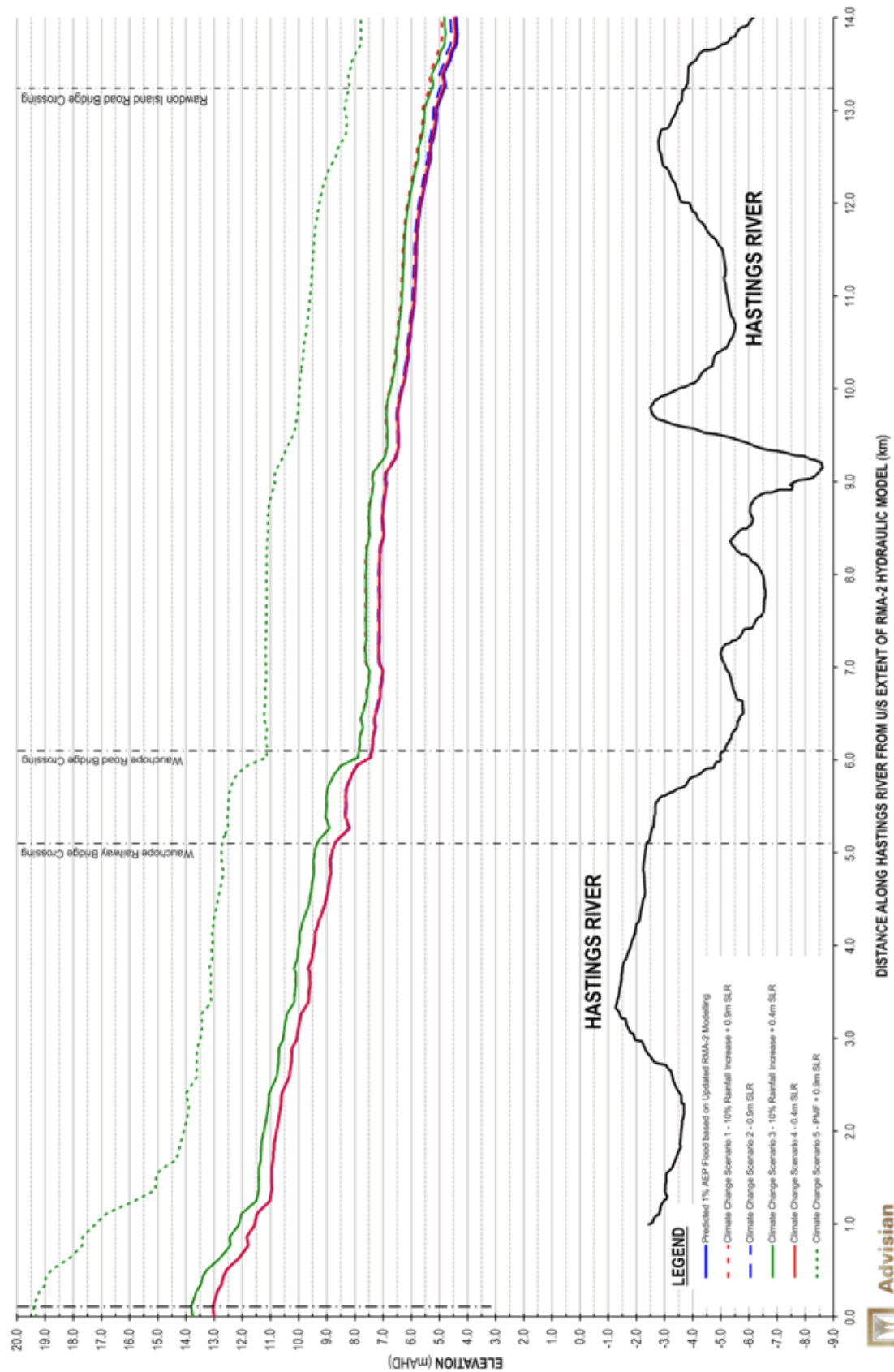


FIGURE 3.3

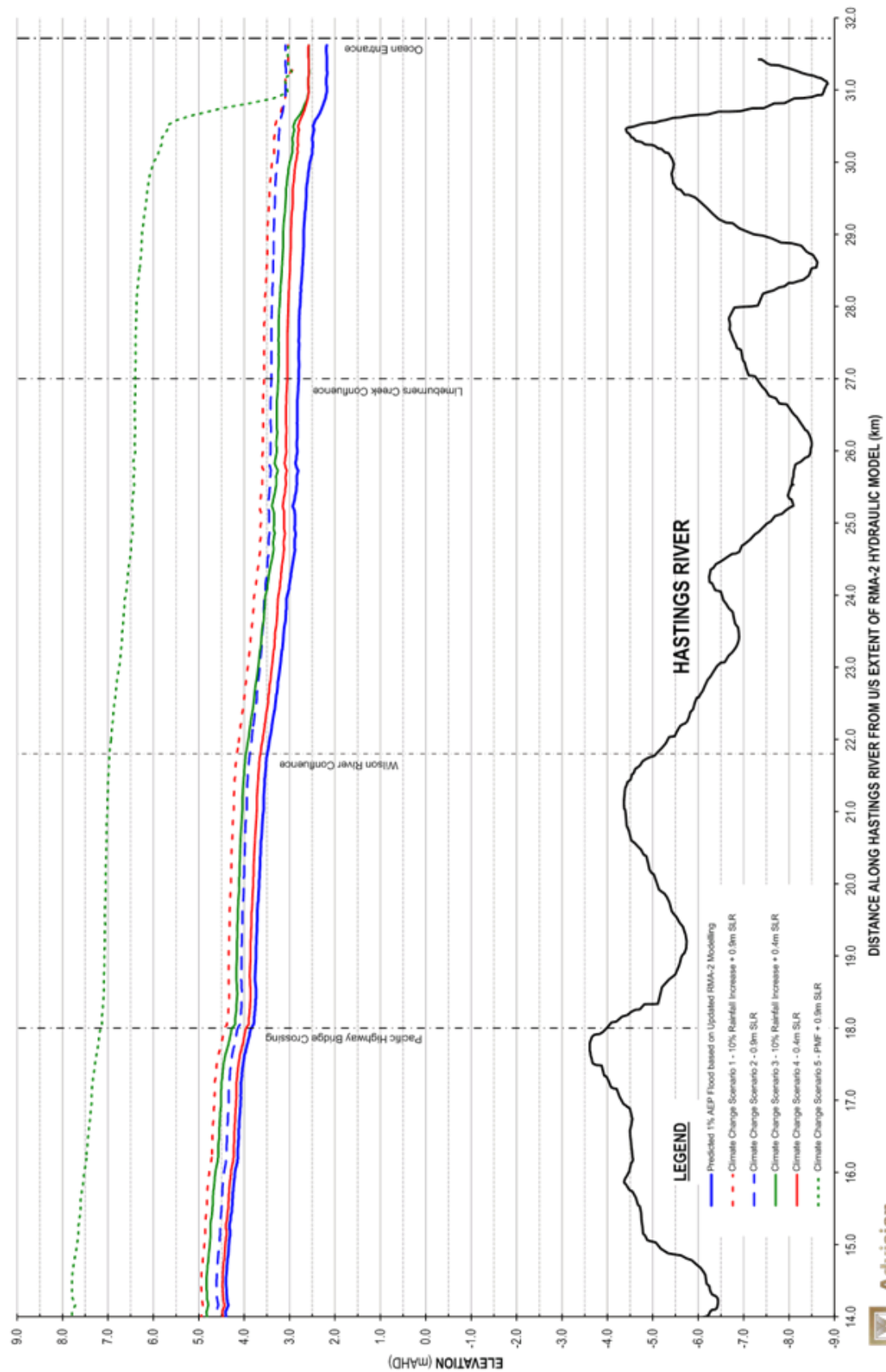
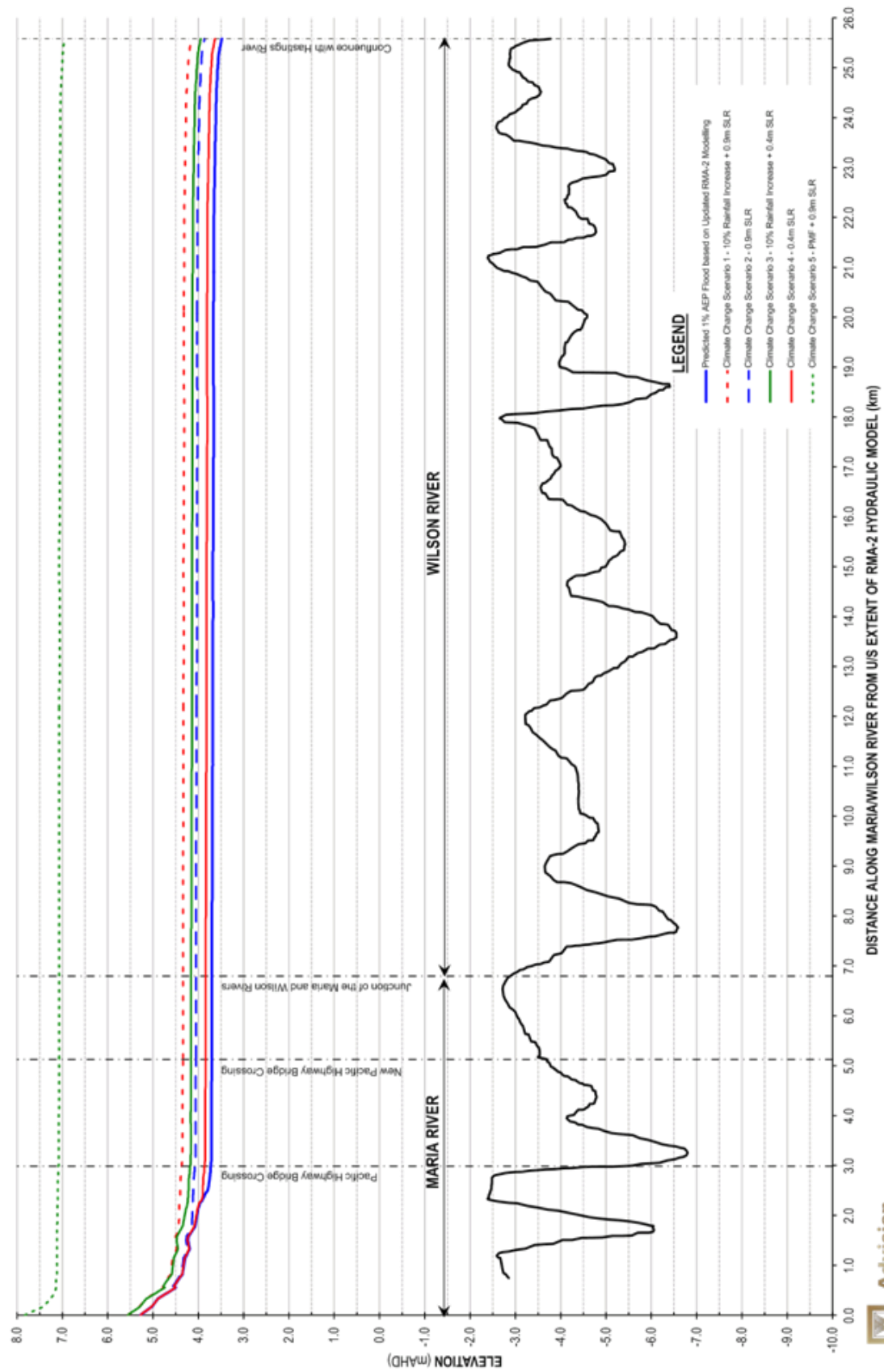


FIGURE 3.4



PREDICTED FLOOD LEVELS AT THE PEAK OF CLIMATE CHANGE SCENARIO 1
(+10% Rainfall and +0.9m Tide)
[Overview]

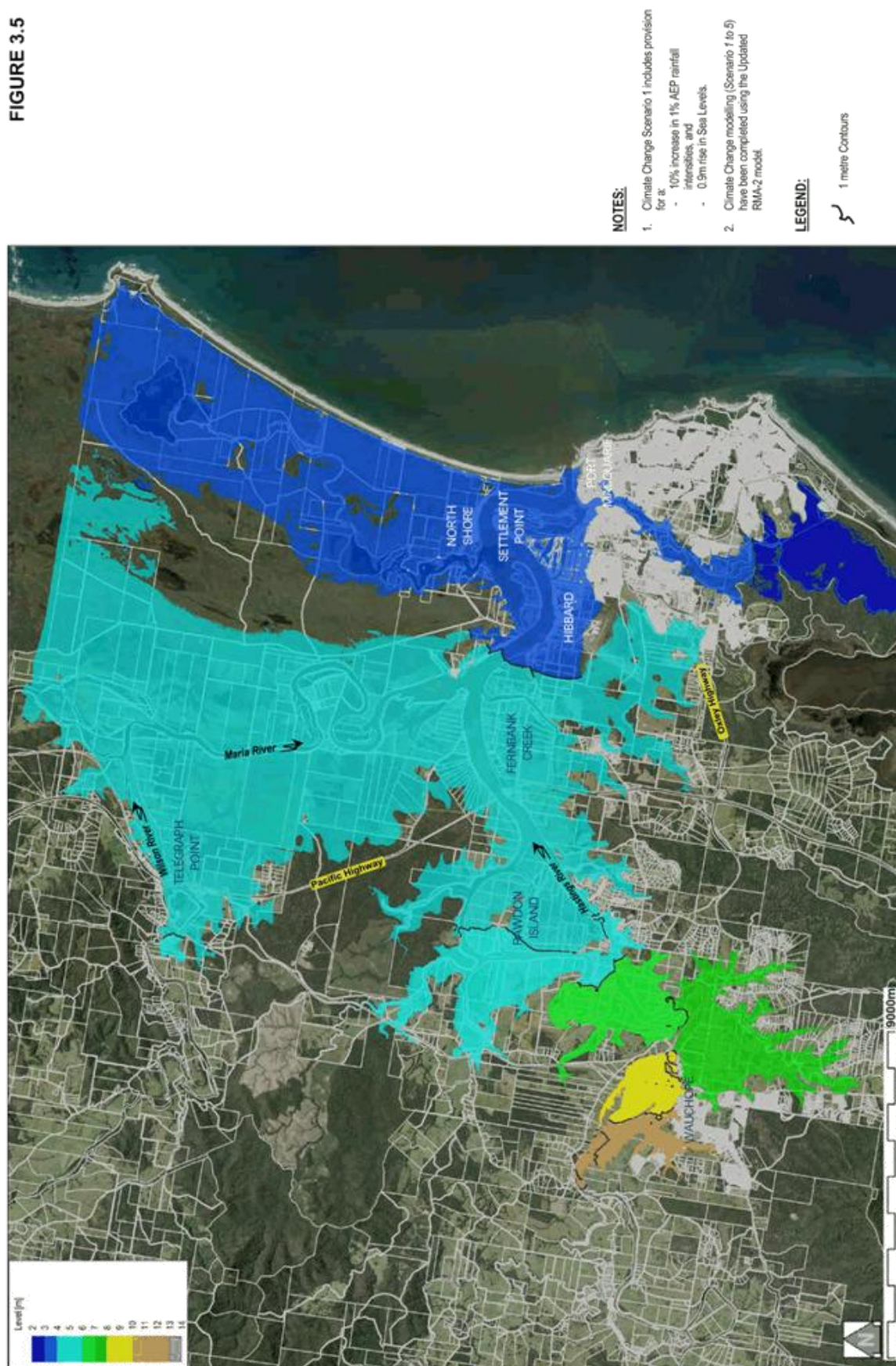
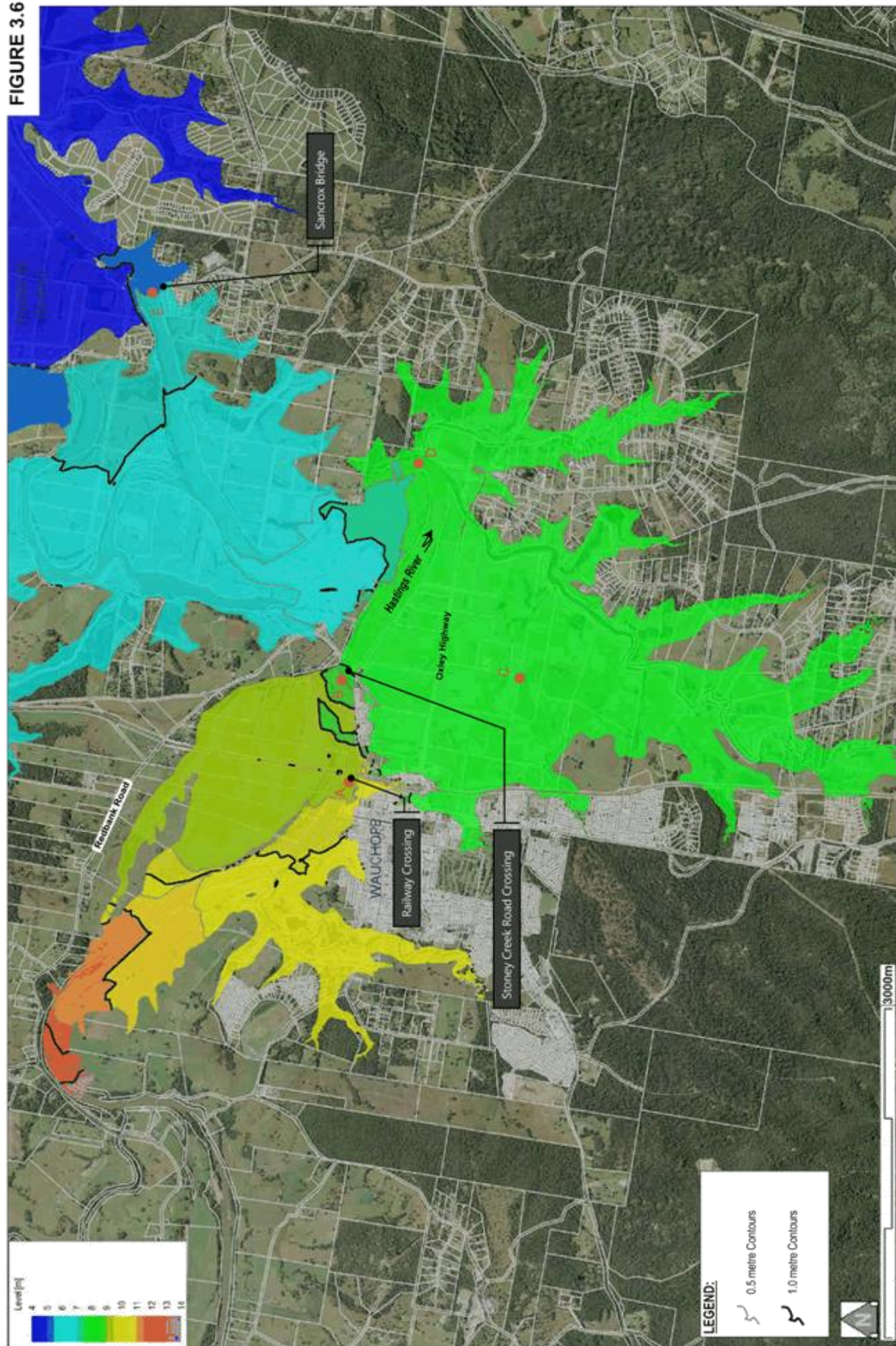
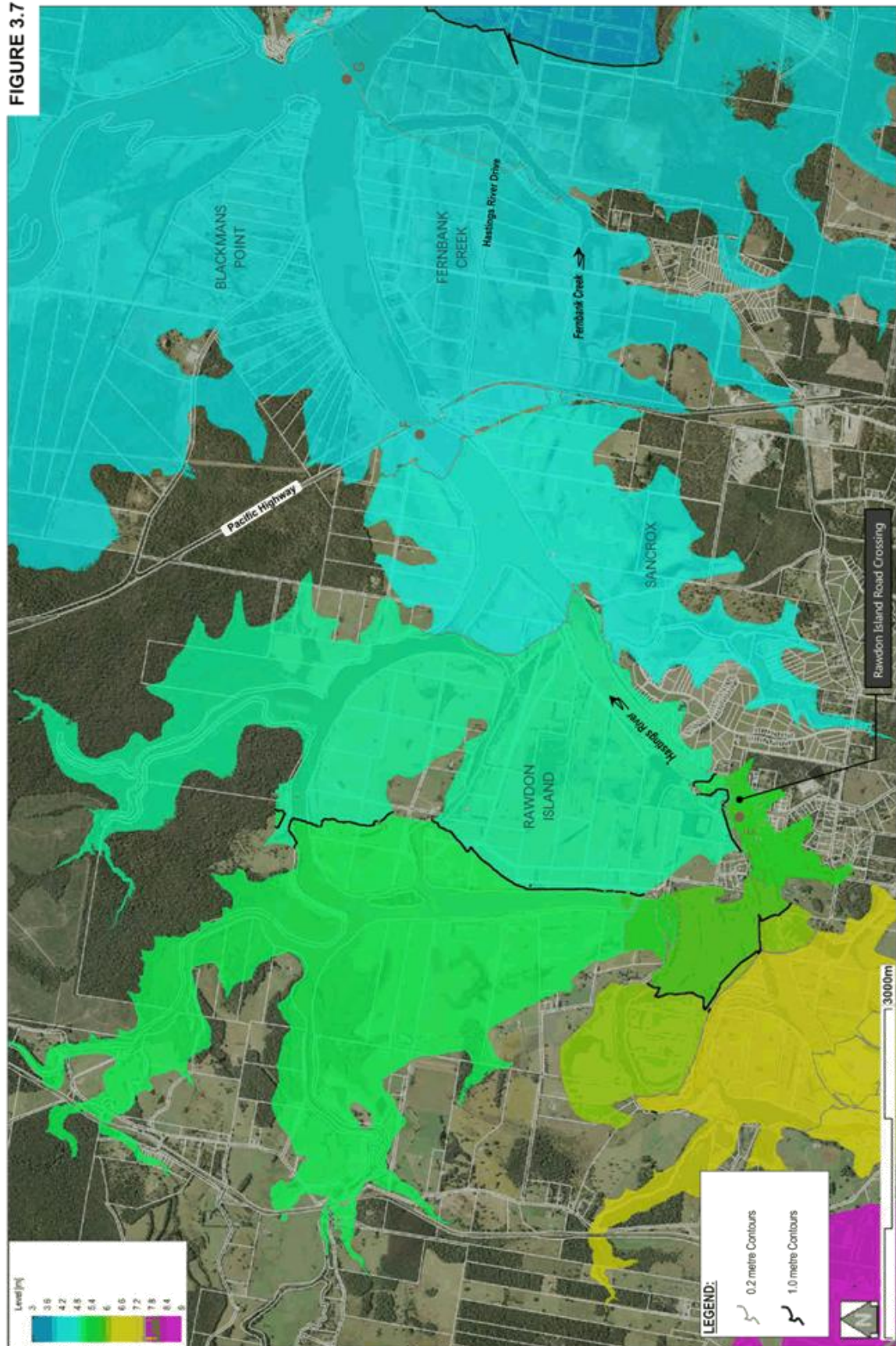


FIGURE 3.6



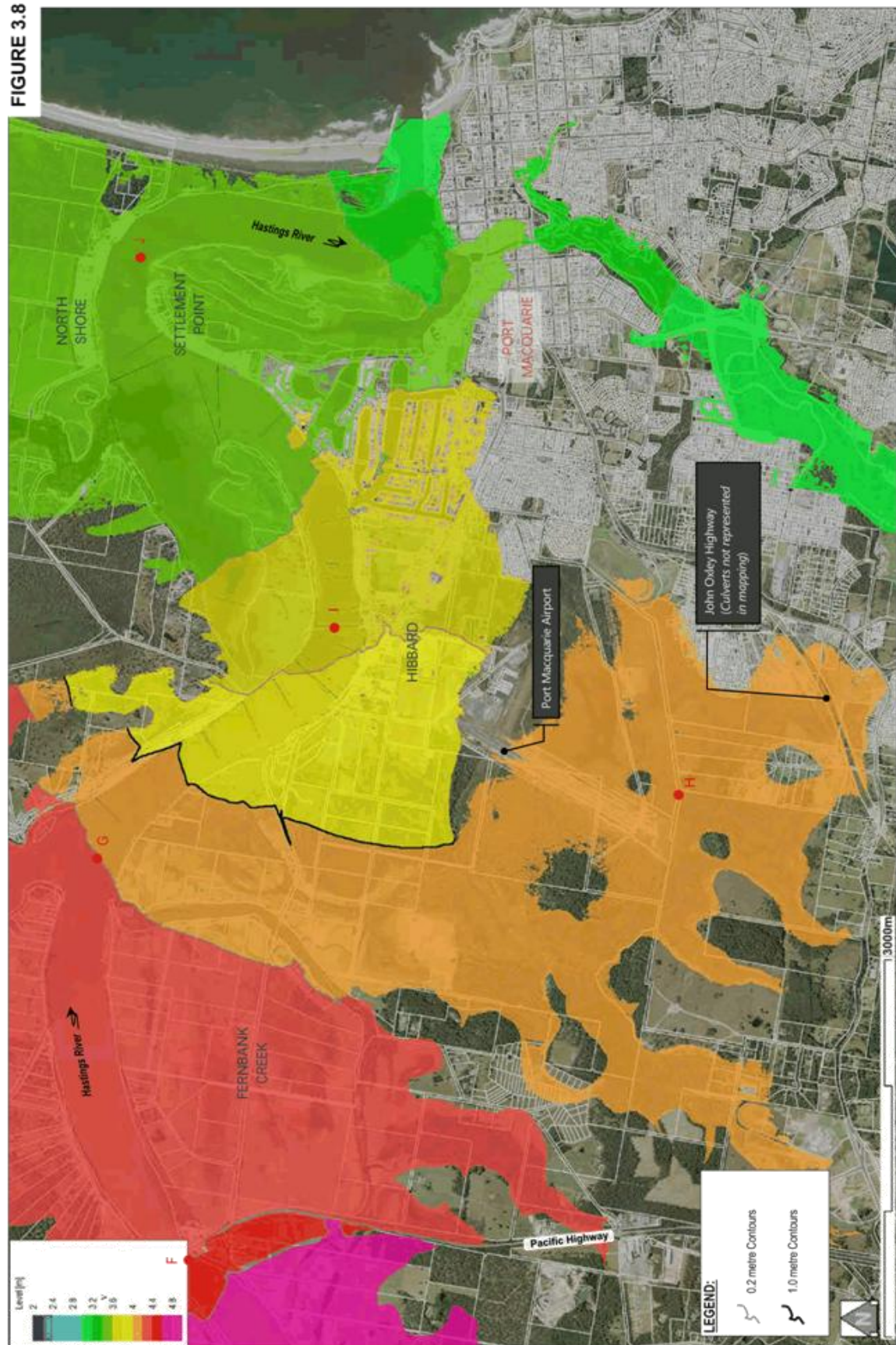
PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 1
(+10% Rainfall and +0.9m Tide)
[Extent 1 of 4 - South-West]

FIGURE 3.7



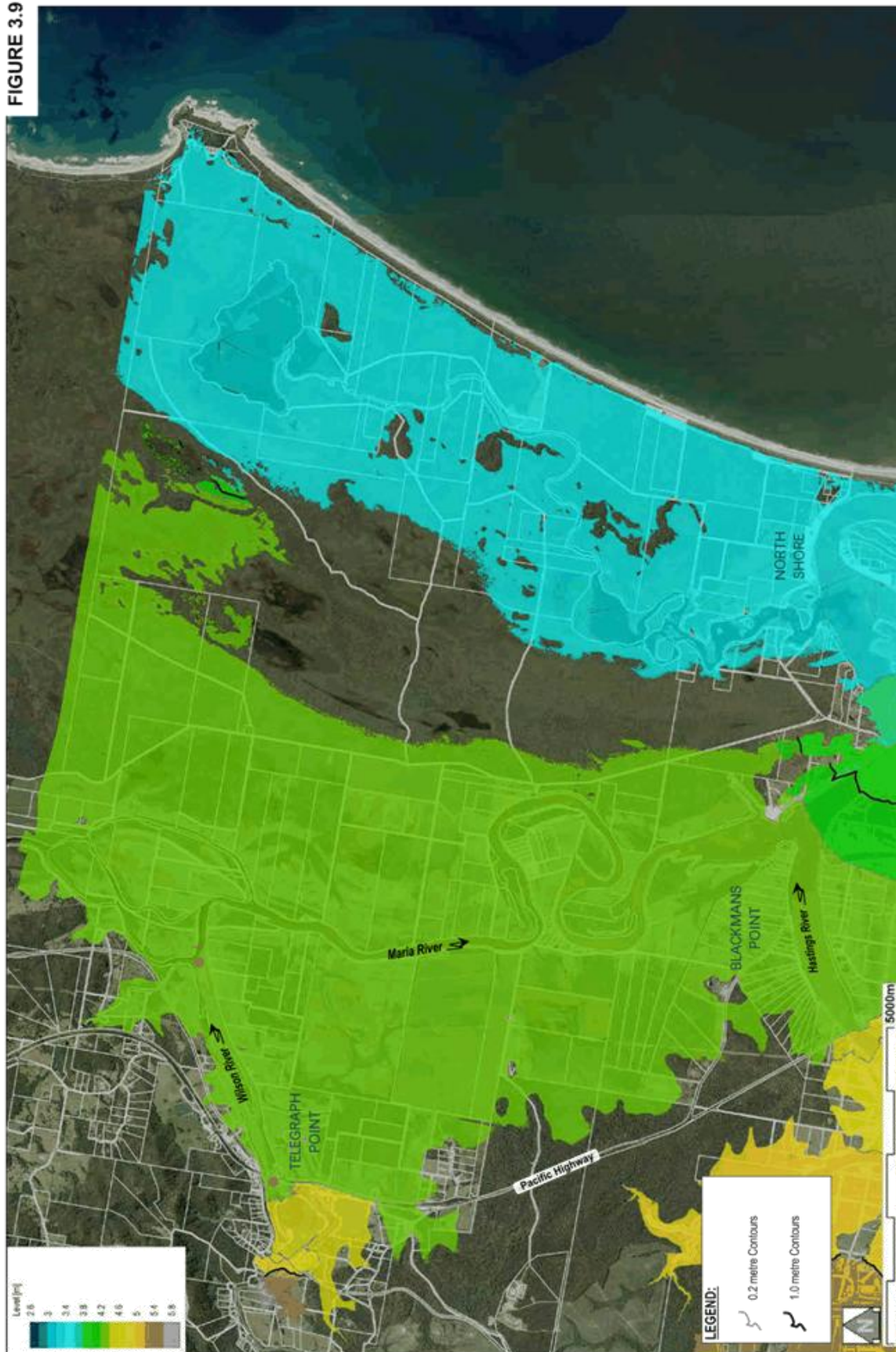
PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 1
(+10% Rainfall and +0.9m Tide)
[Extent 2 of 4 - Central]

FIGURE 3.8



**PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 1
(+10% Rainfall and +0.9m Tide)**
[Extent 3 of 4 - South-East]

FIGURE 3.9



PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 1
(+10% Rainfall and +0.9m Tide)
[Extent 4 of 4 - North-West]

FIGURE 3.10

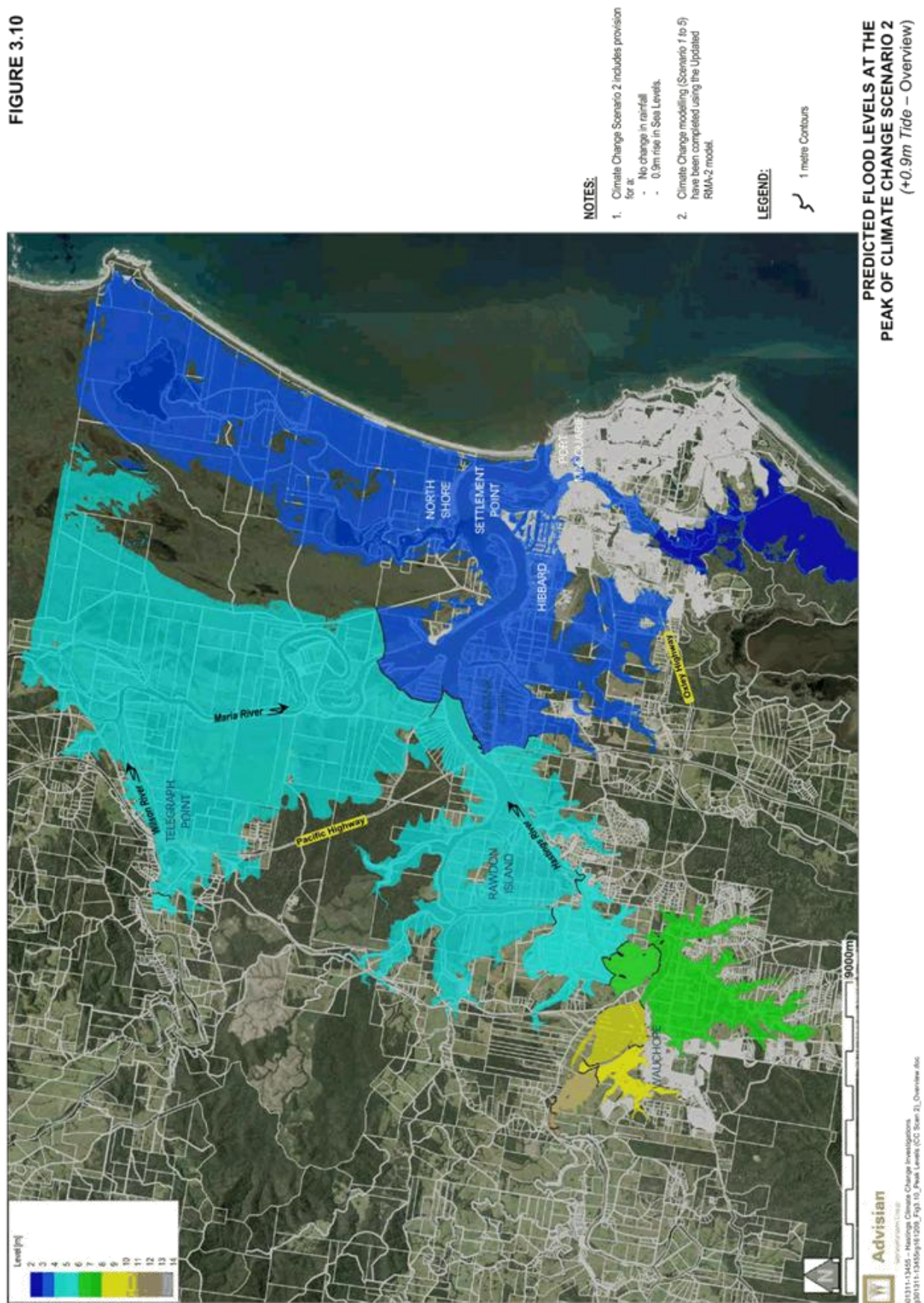
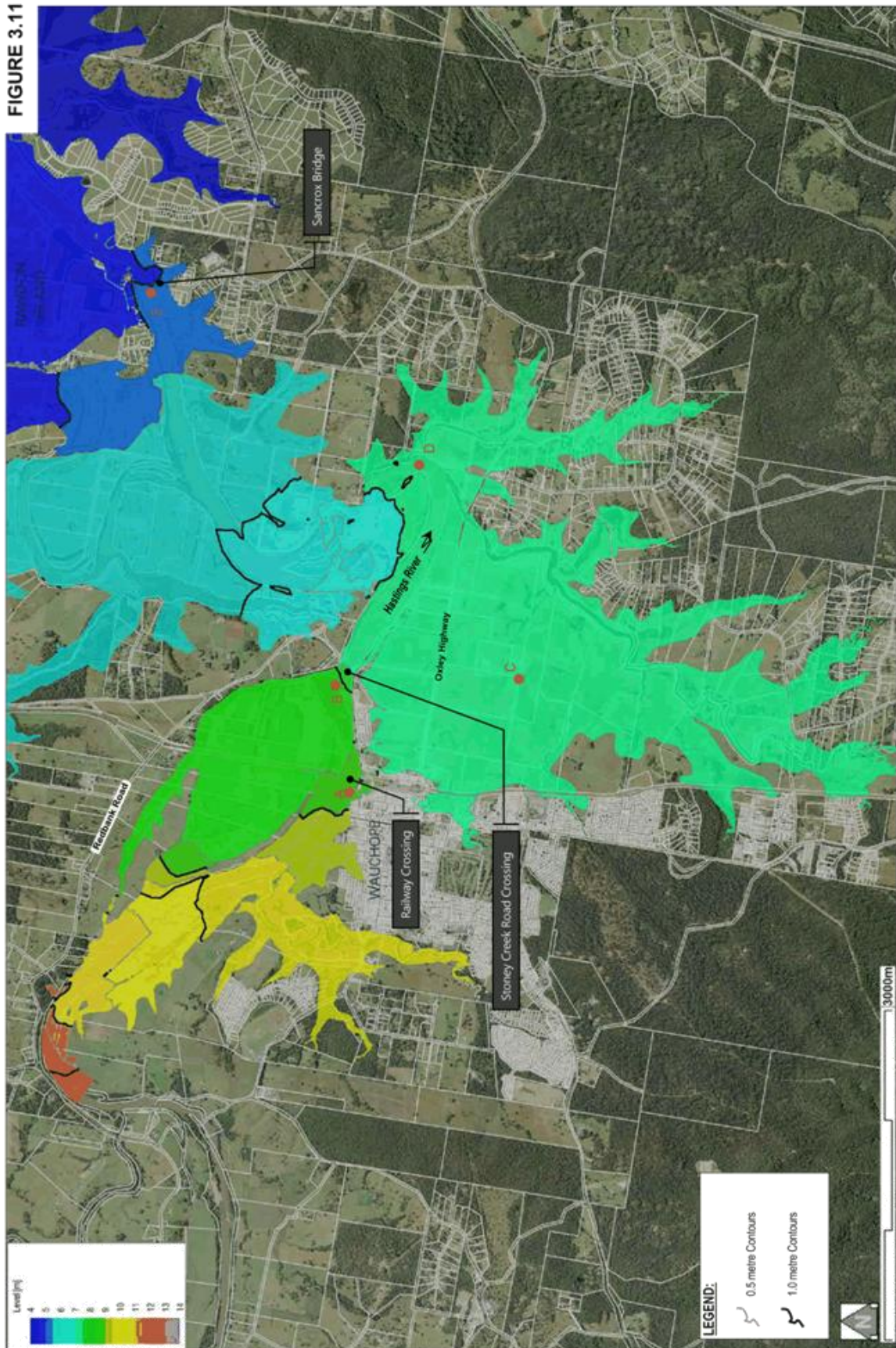


FIGURE 3.11



PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 2
(+0.9m Tide - Extent 1 of 4 - South-West)

Advisian
30/3/11-13455 - Hastings Climate Change Investigations
9/30/11-13455/94/1200_Fig 3.11_Peak Levels (CC Scan 2)_BW.doc

Figure 3.12 is a map of the Rawdon Island area, showing flood contours. The map displays the coastline of Rawdon Island, with various land parcels and water bodies. Key features include Blackmans Point, Fernbank Creek, Sanchox, and the Rawdon River. The map is overlaid with a color-coded flood contour system. A legend in the bottom right corner indicates that the colors represent different levels of flood risk: 0.2 metre contours (lightest blue) and 1.0 metre contours (darkest blue). A scale bar in the bottom right corner shows a distance of 3000m. The map also includes labels for 'Pacific Highway' and 'Rawdon Island Road Crossing'.

**PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 2
(+0.9m Tide – Extent 2 of 4 – Central)**

FIGURE 3.13

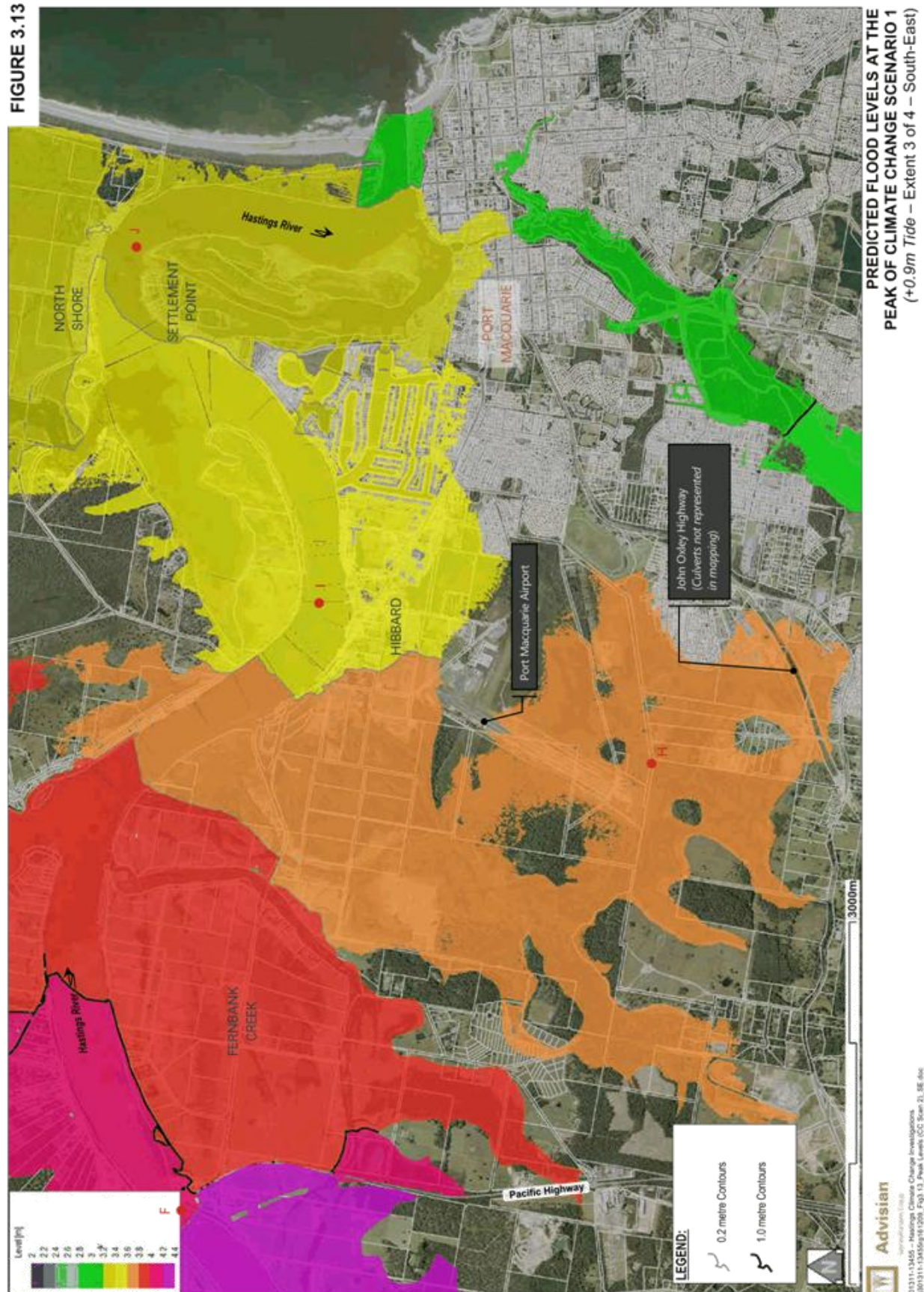


FIGURE 3.14

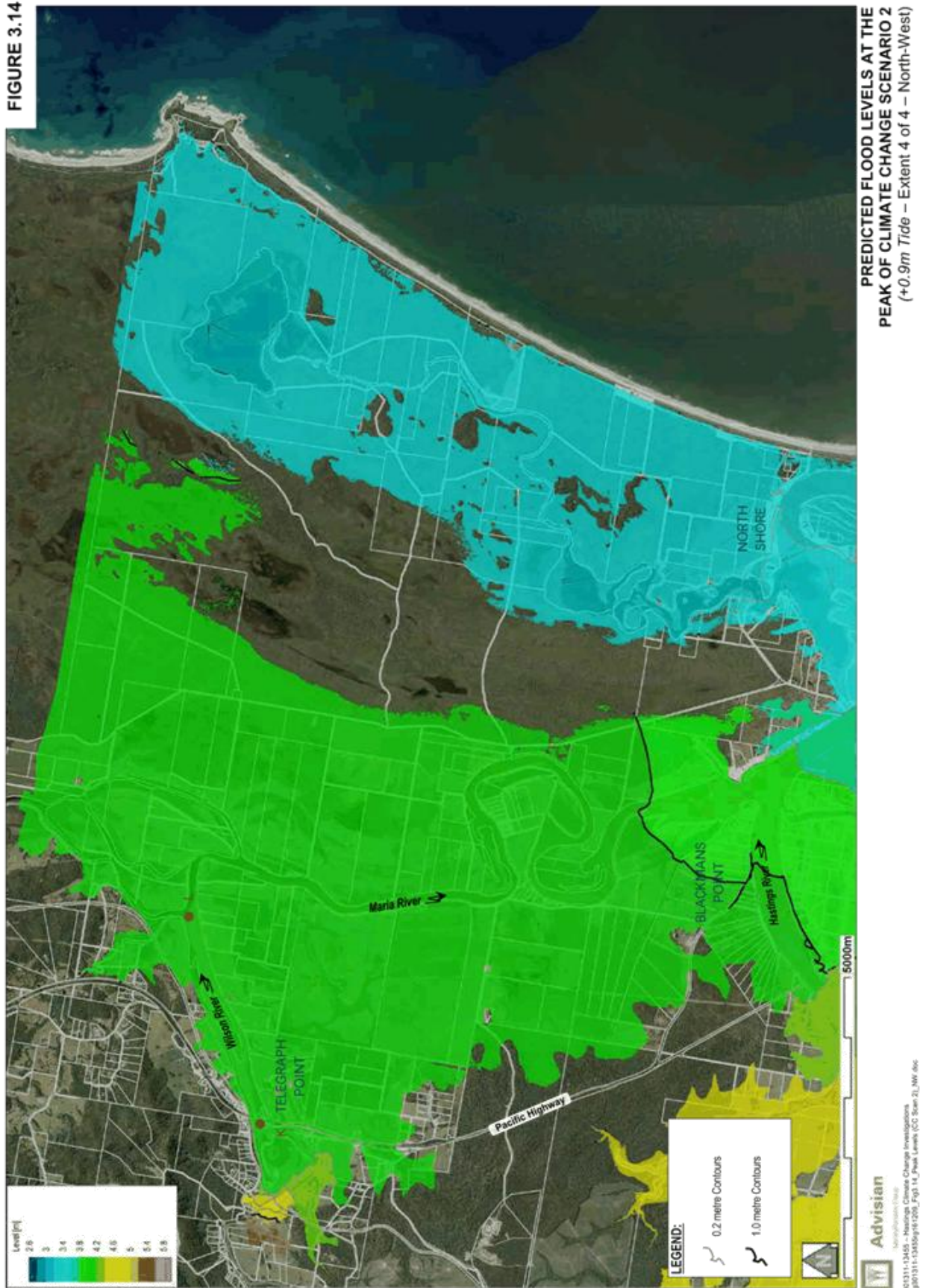


FIGURE 3.15

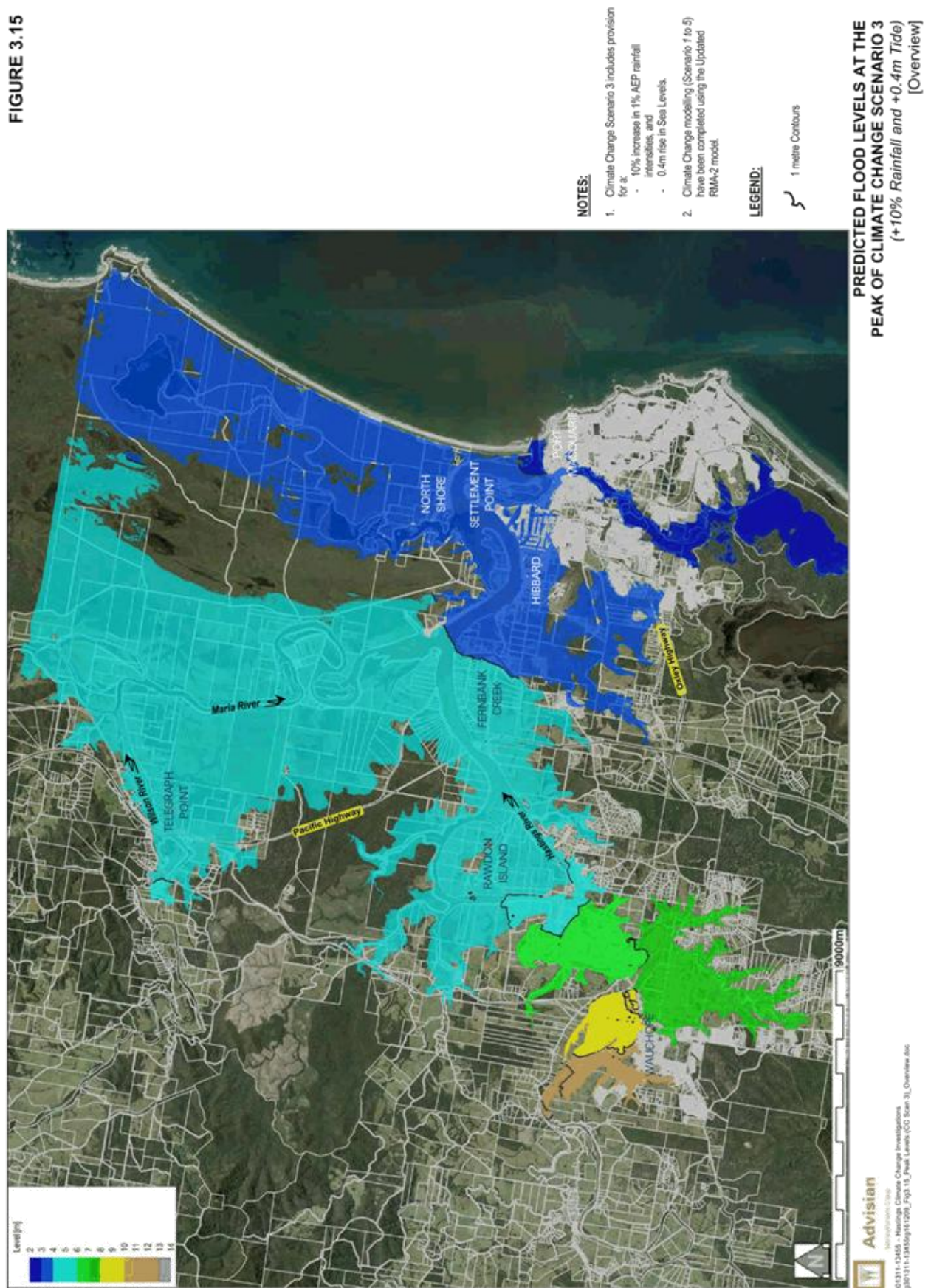
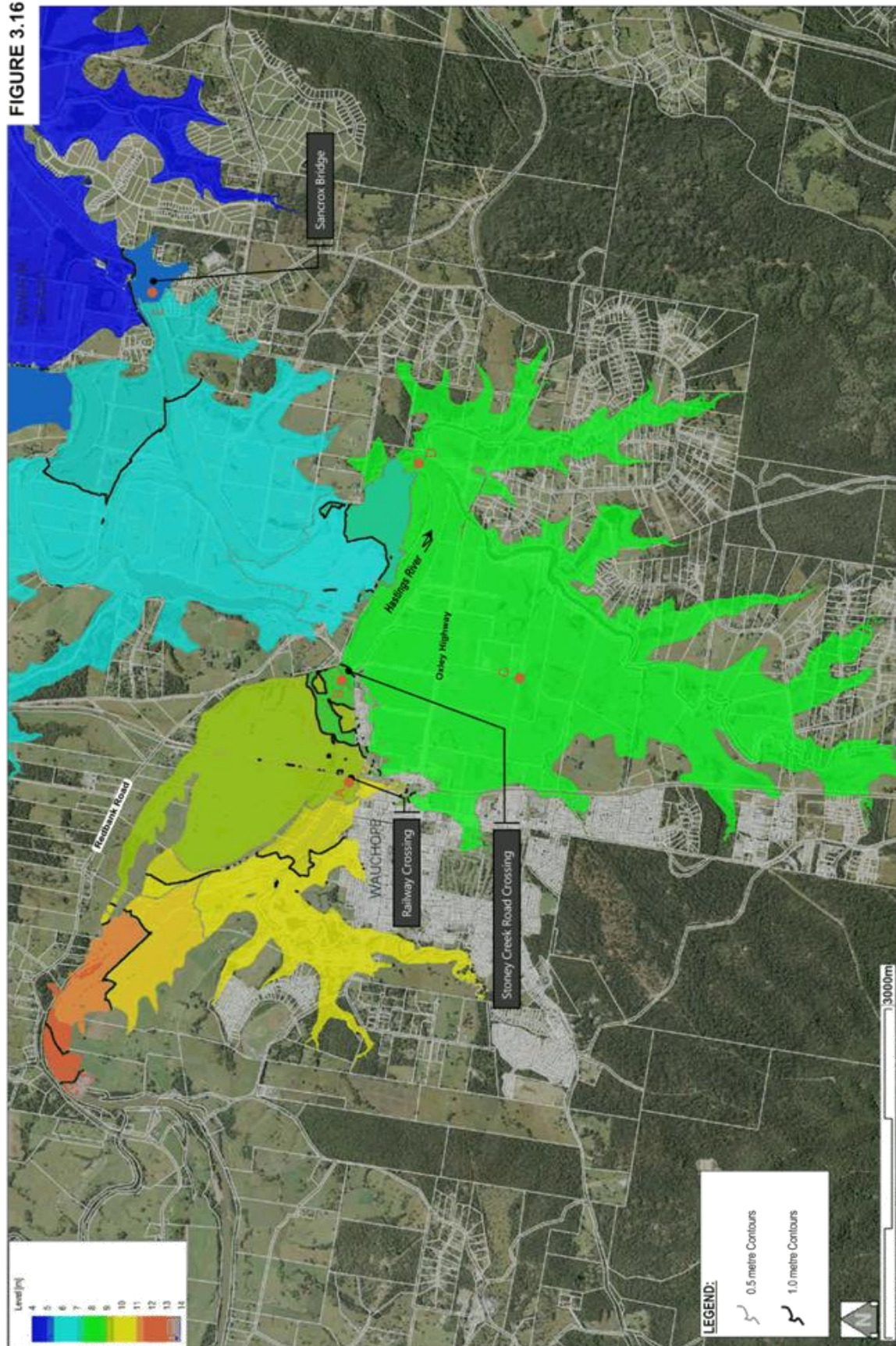
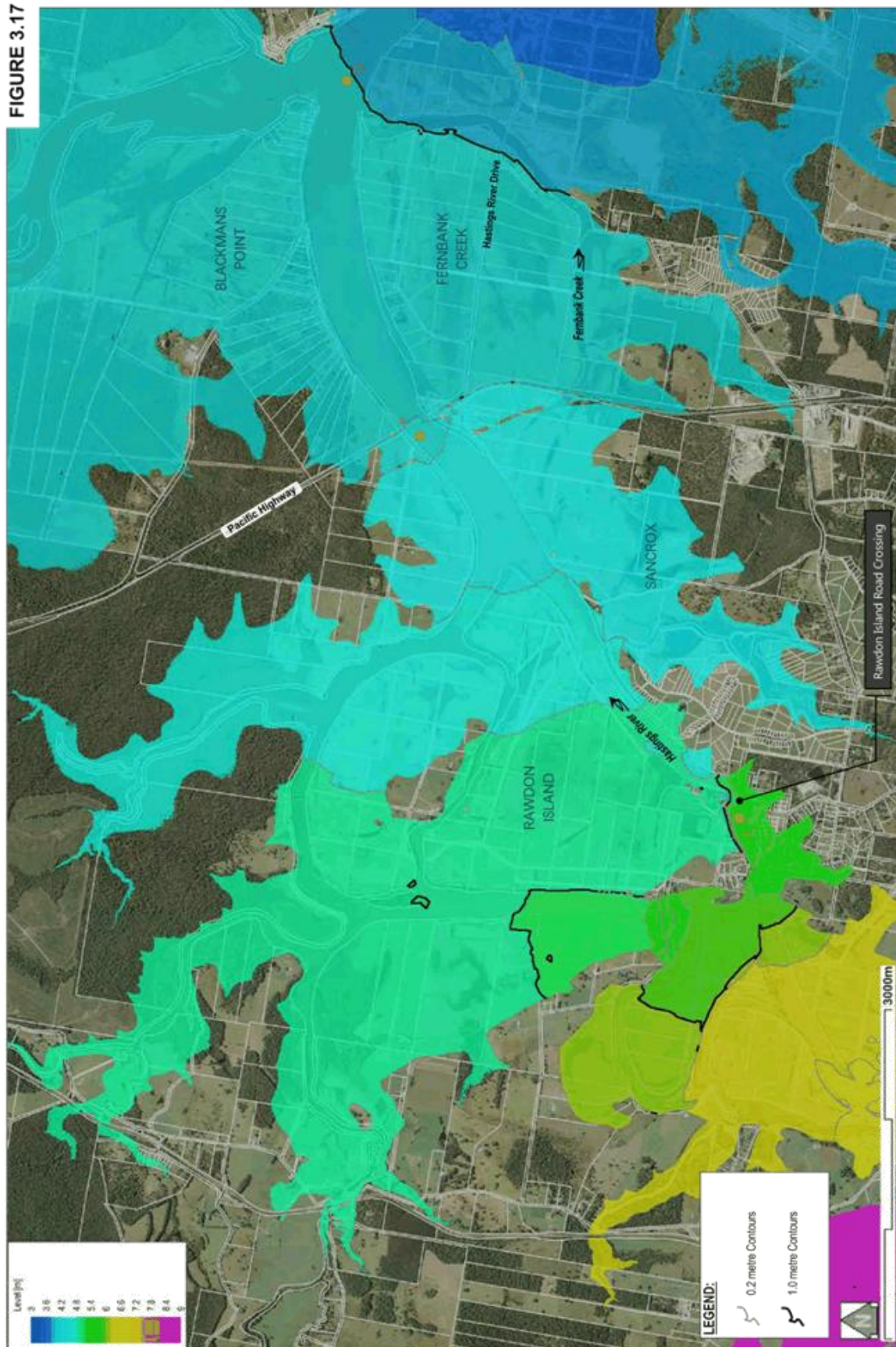


FIGURE 3.16

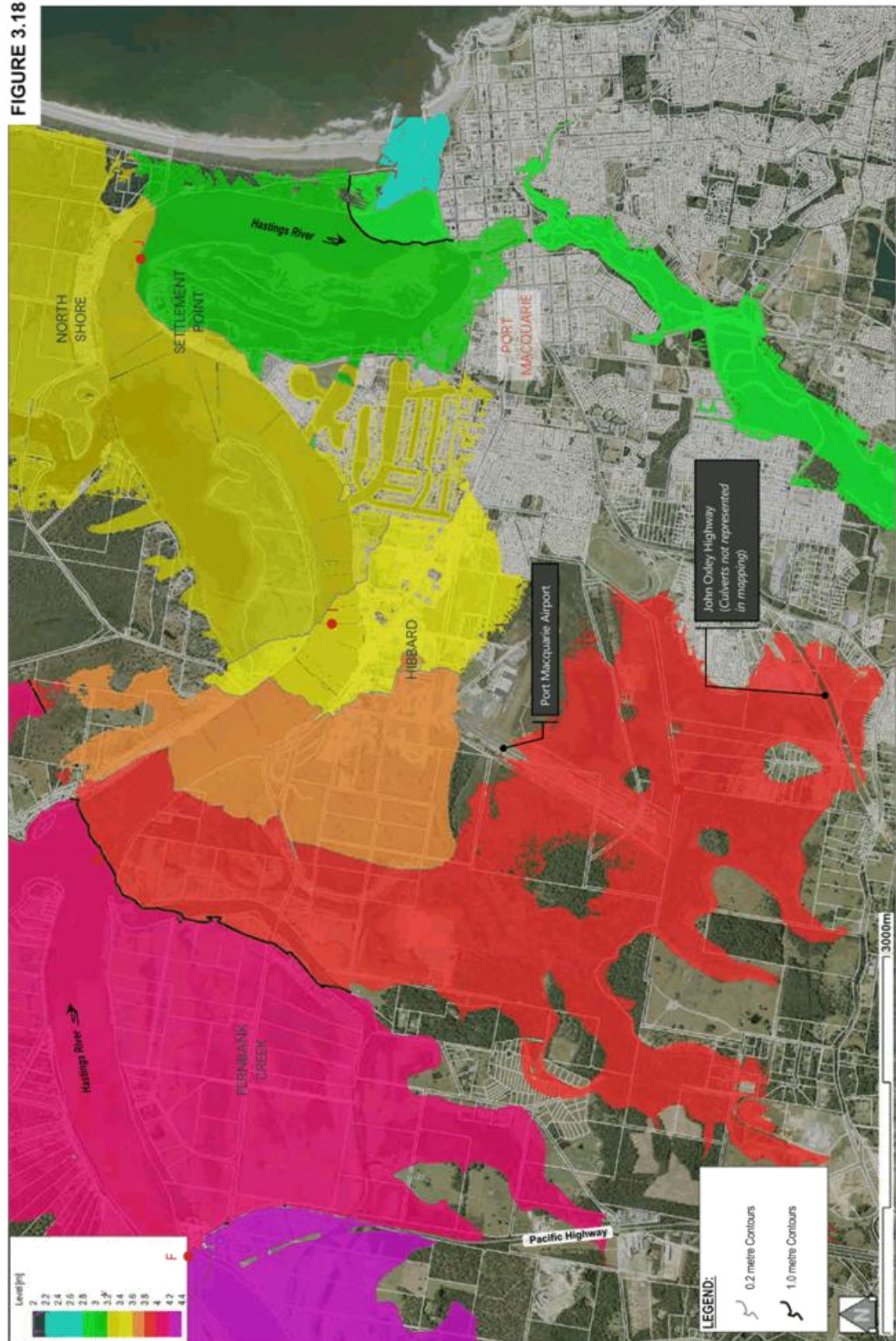


PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 3
(+10% Rainfall and +0.4m Tide)
[Extent 1 of 4 - South-West]

FIGURE 3.17



PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 3
(+10% Rainfall and +0.4m Tide)
[Extent 2 of 4 – Central]



**PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 3
(+10% Rainfall and +0.4m Tide)**
[Extent 3 of 4 – South-East]

FIGURE 3.19

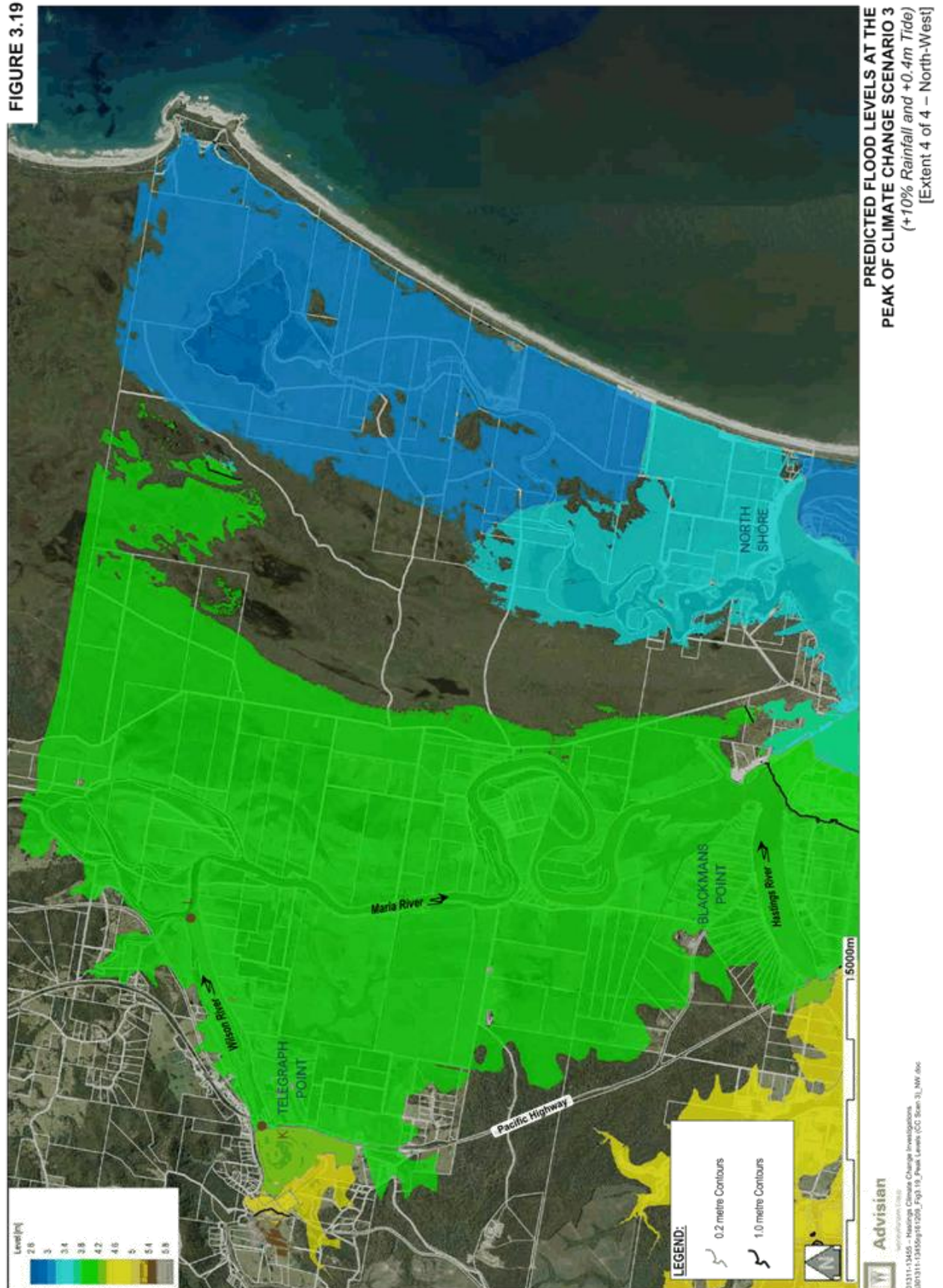


FIGURE 3.20

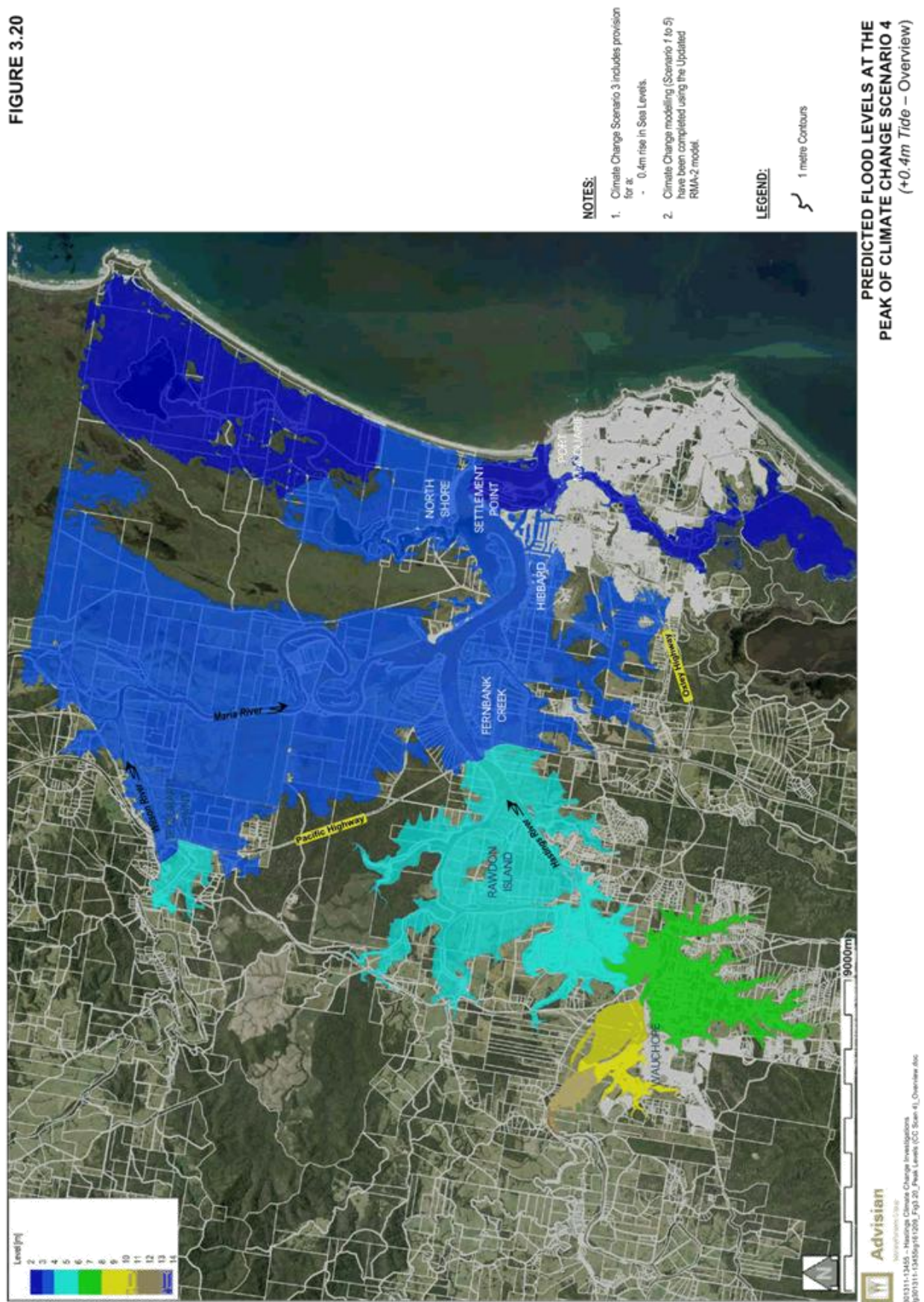
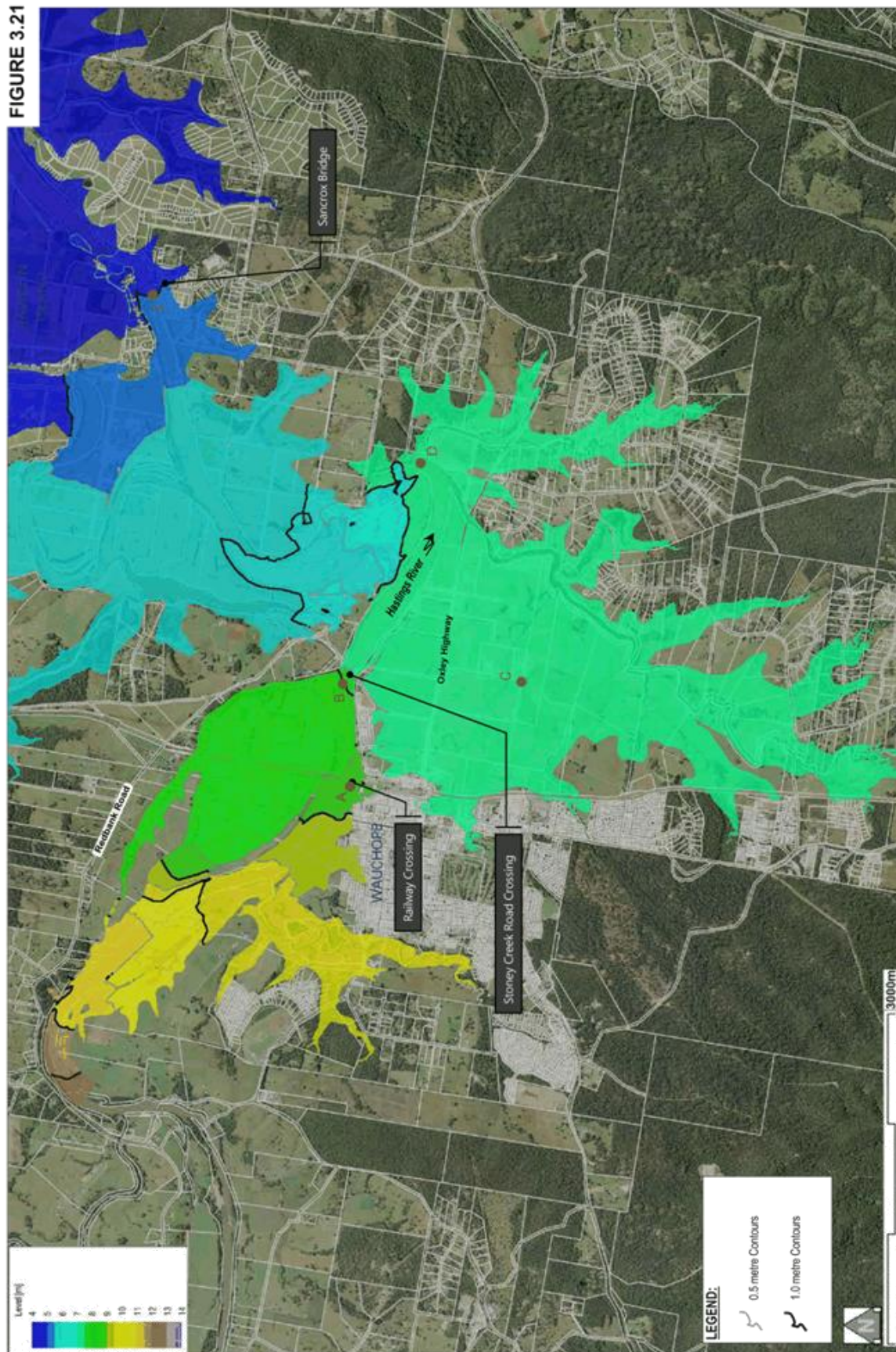
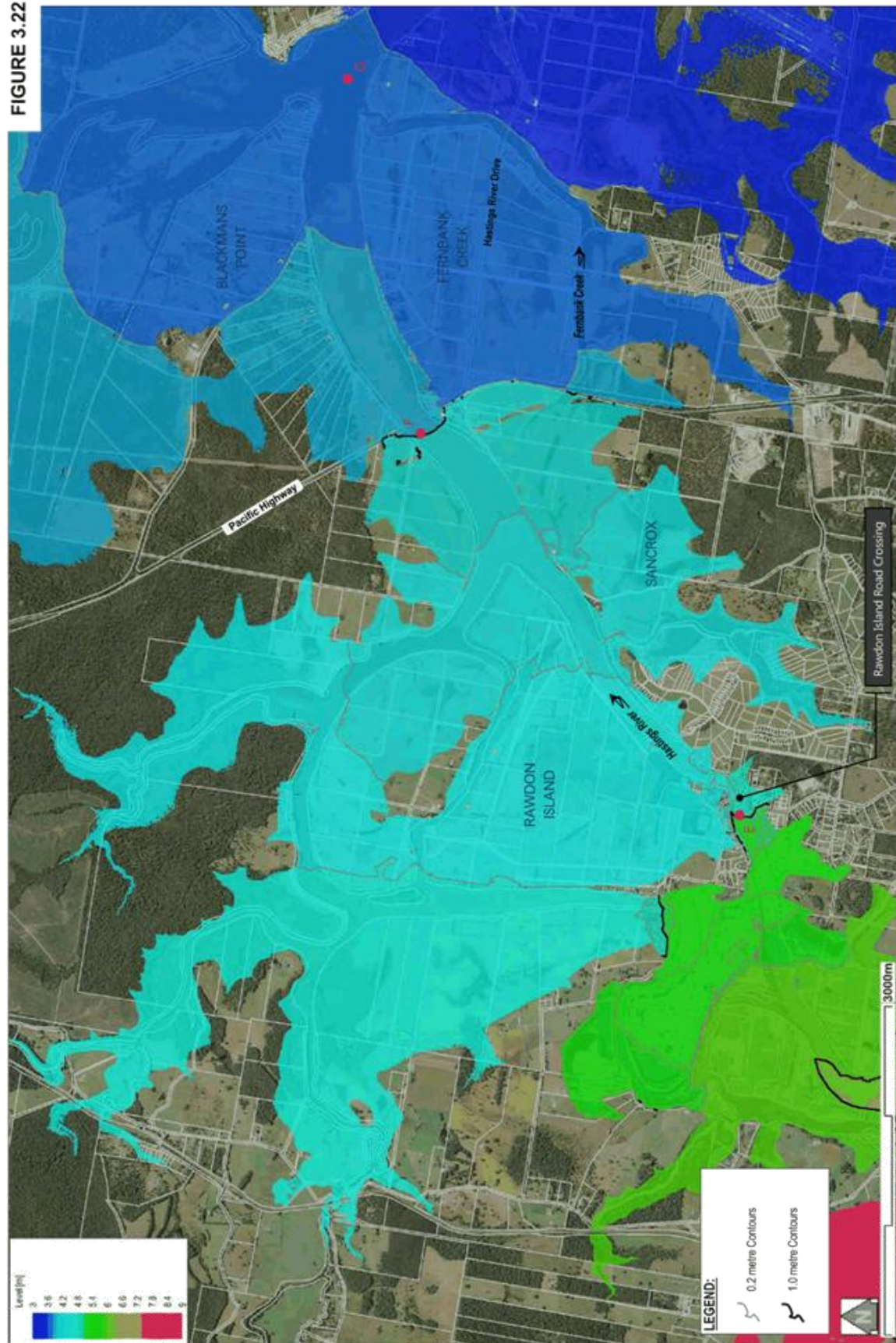


FIGURE 3.21



PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 4
(+0.4m Tide - Extent 1 of 4 - South-West)

FIGURE 3.22



PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 4
(+0.4m Tide - Extent 2 of 4 - Central)

Advisian

30/331-13455 - Hastings Climate Change Investigations
9/30/31-13455/94/1200_Fig 3.22_Peak Levels (CC Scen 4)_Central.doc

FIGURE 3.23

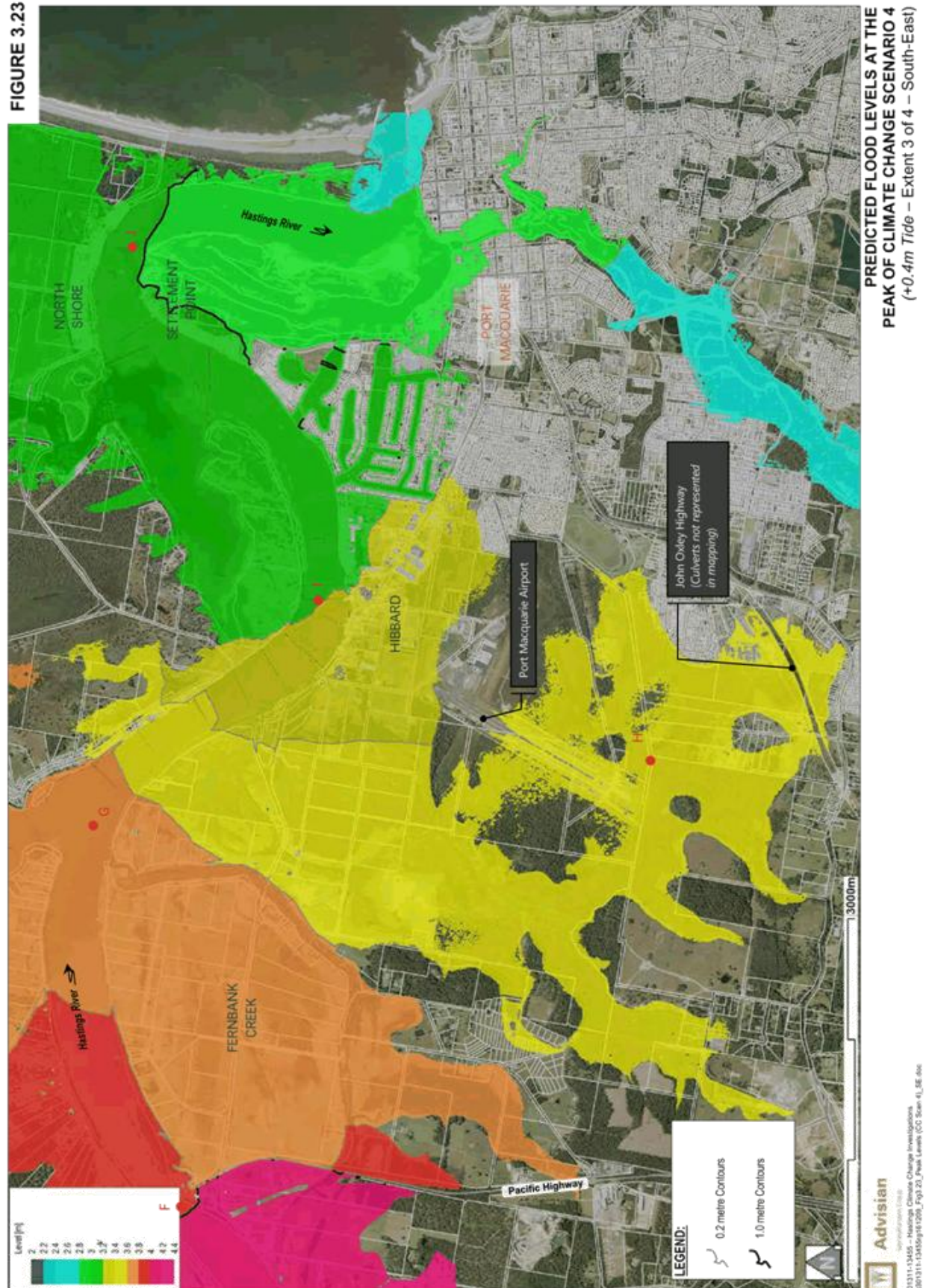


FIGURE 3.24

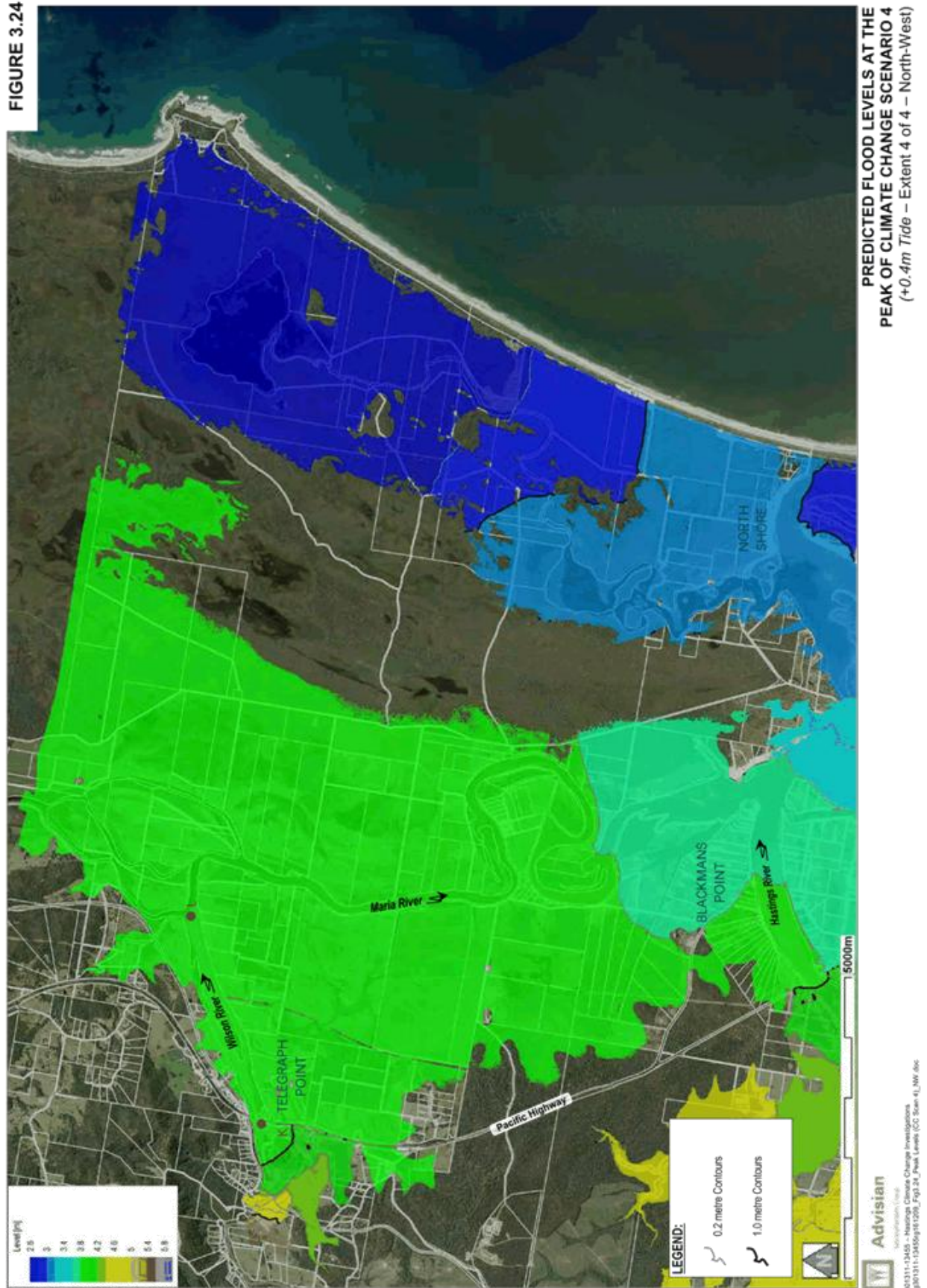
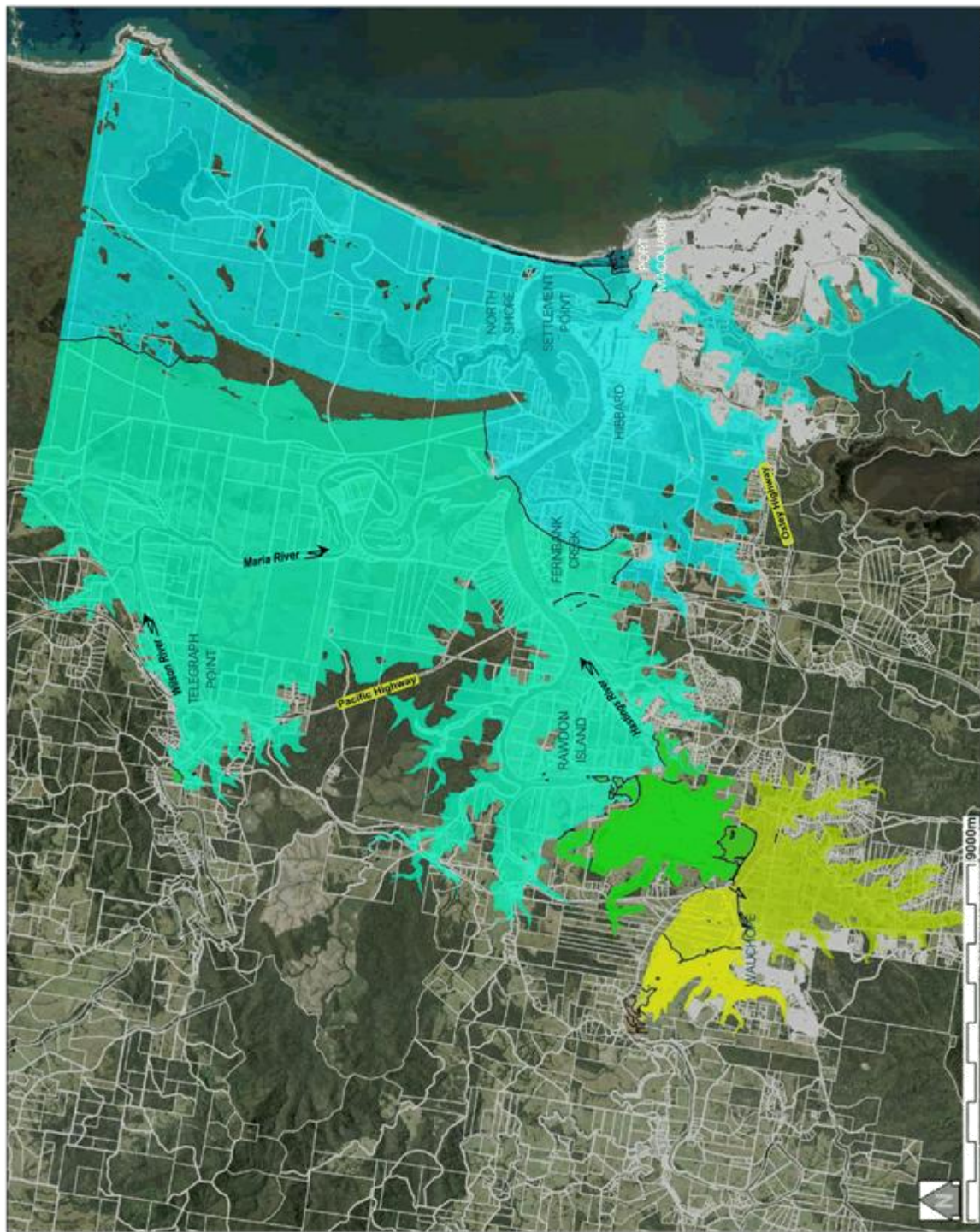


FIGURE 3.25

**NOTES:**

1. Climate Change Scenario 5 is based on simulation of the Probable Maximum Flood (PMF) with a 0.4 metre increase in Tide Levels
2. Climate Change modelling (Scenario 1 to 5) have been completed using the Updated RMA-2 model.

LEGEND:

1 metre Contours

**PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 5
(PMF +0.4m Tide)**
[Overview]

Advisian
Sustainable Design

30/03/17-13455 - Hastings Climate Change Investigations
19/03/17-13455/94/1209_Fig 3.25_Peak Levels (CC Scan 5)_Overview.doc

FIGURE 3.26

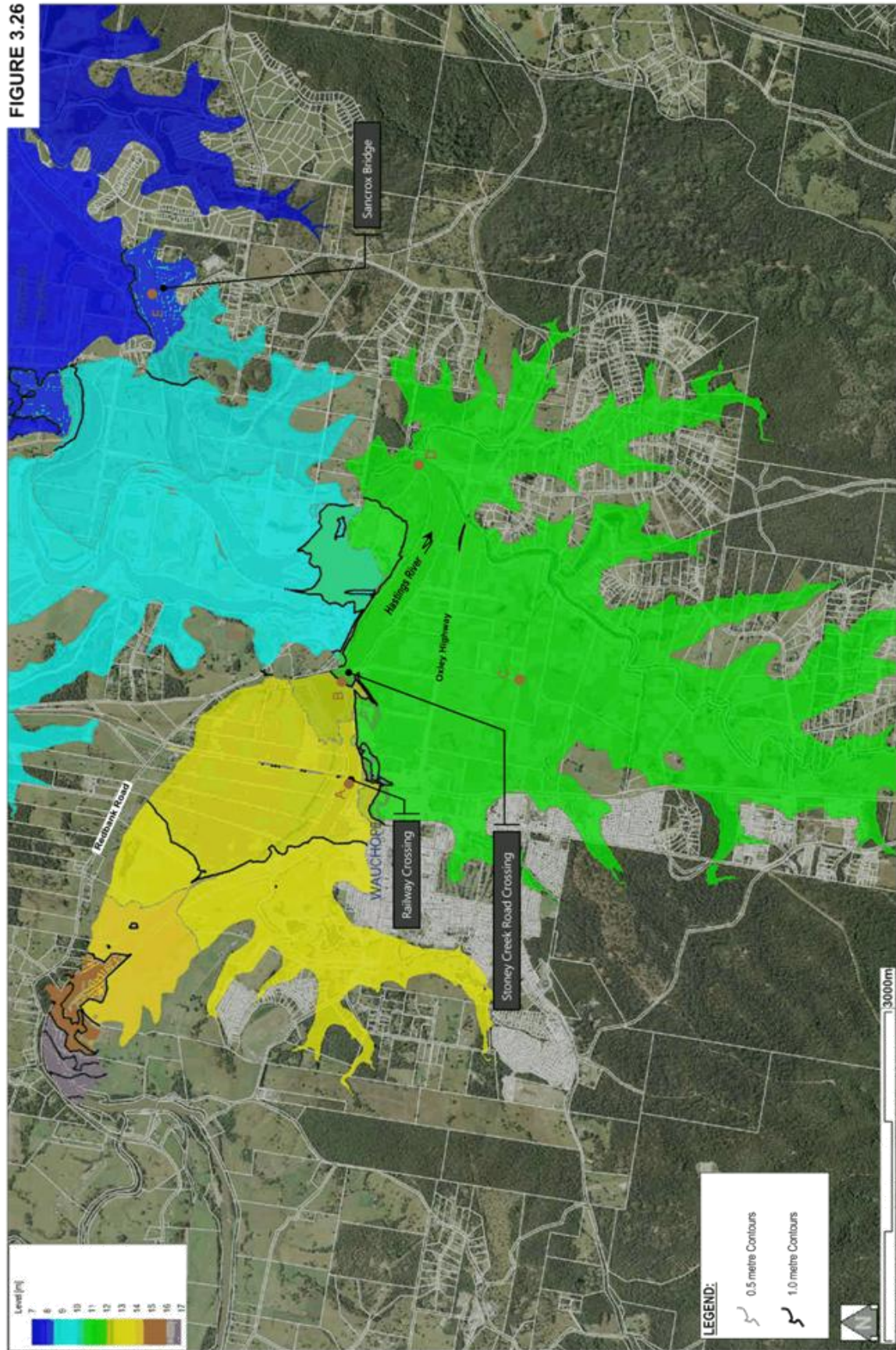
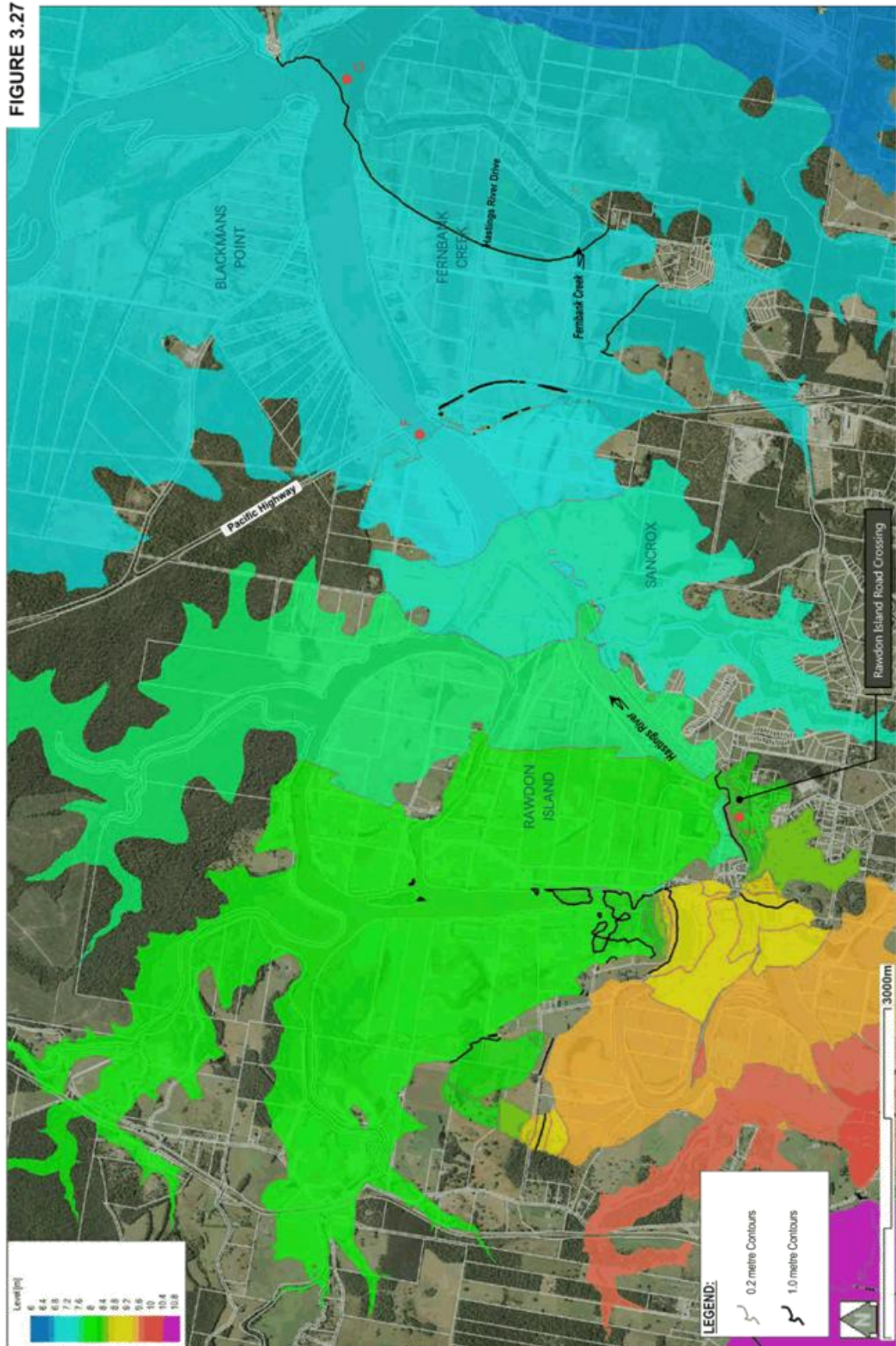
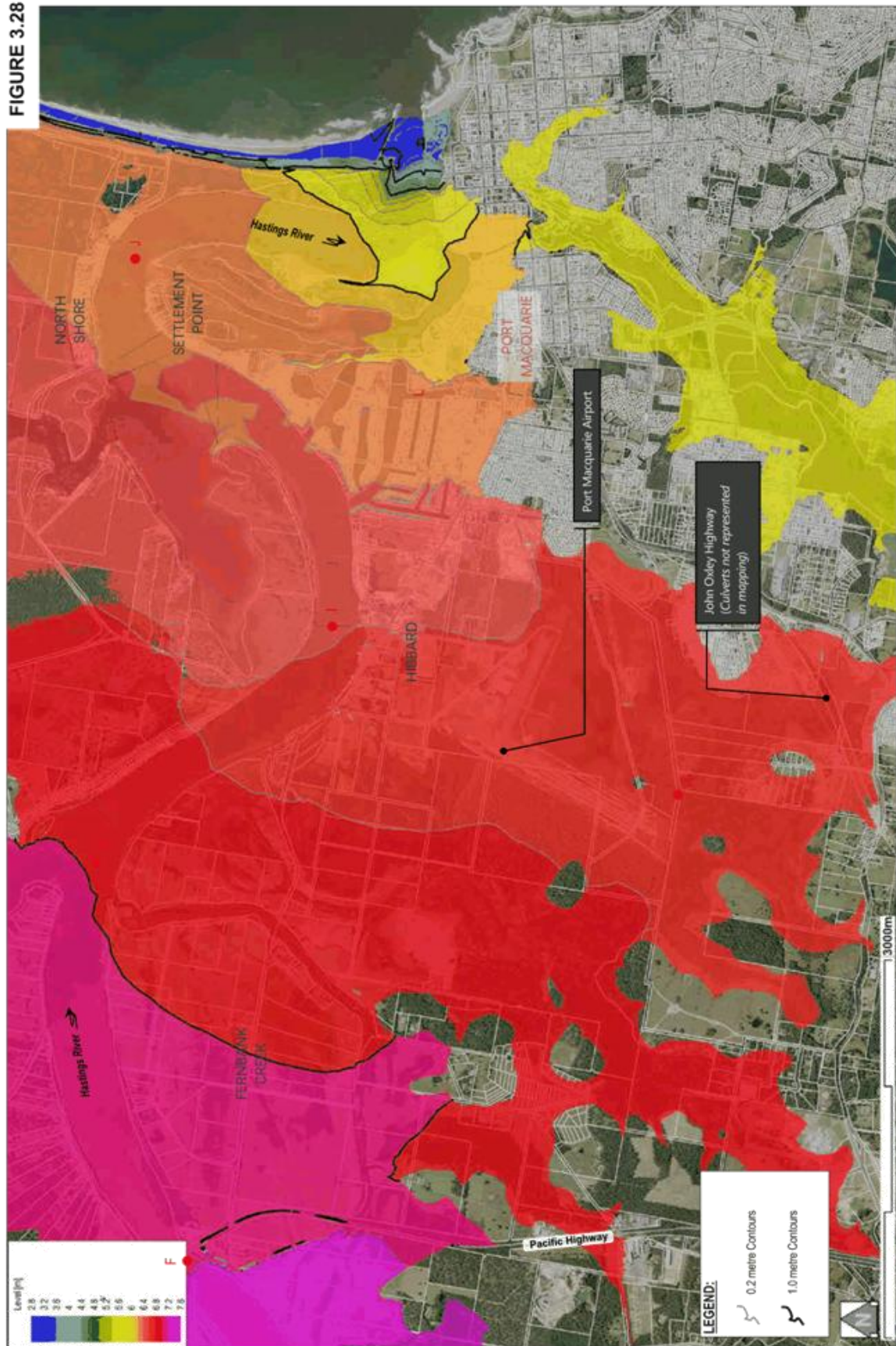


FIGURE 3.27



**PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 5
(PMF and +0.4m Tide)
[Extent 2 of 4 - Central]**

FIGURE 3.28



**PREDICTED FLOOD LEVELS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 5
(PMF and +0.4m Tide)**
[Extent 3 of 4 – South-East]

FIGURE 3.29

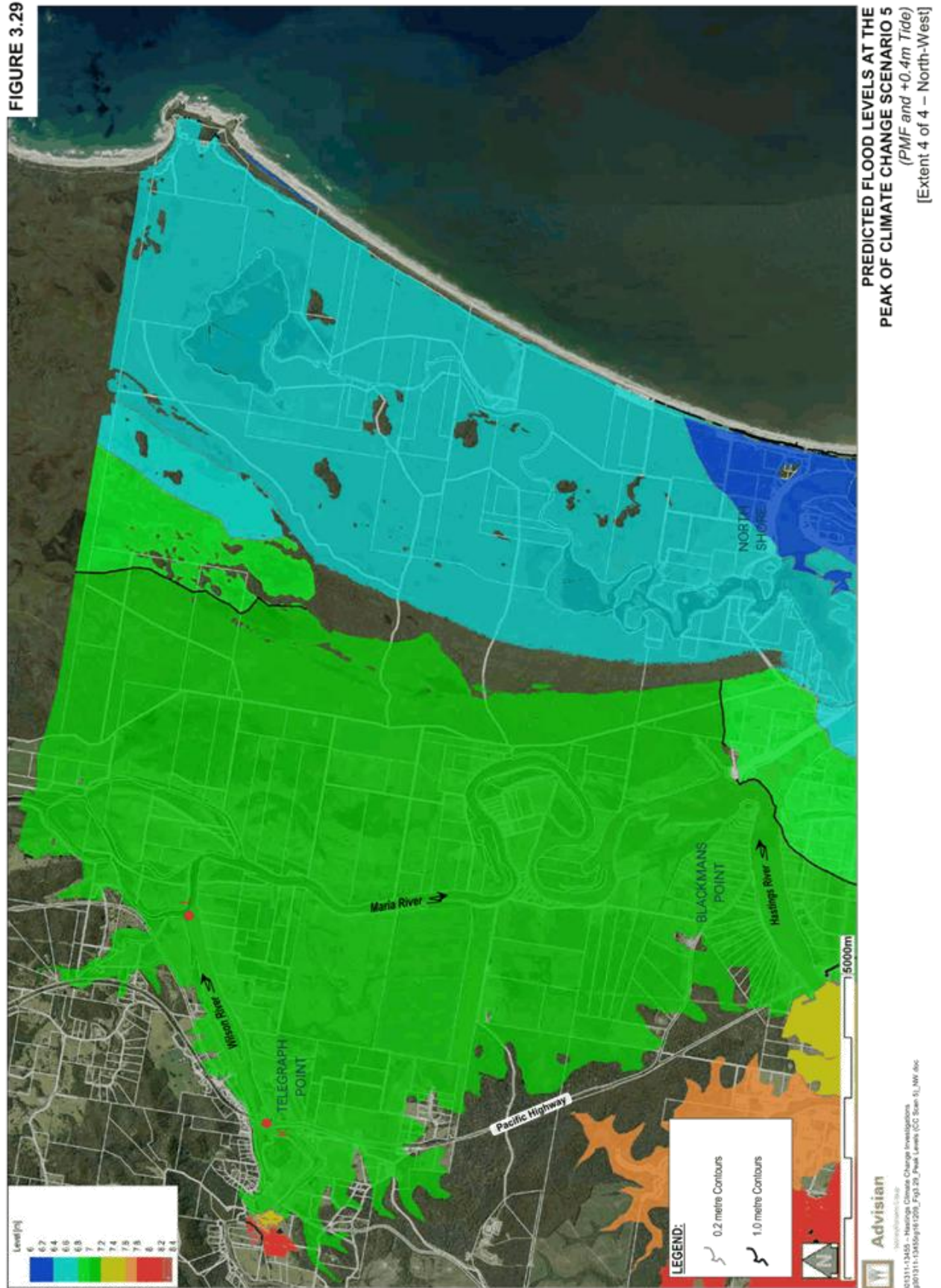
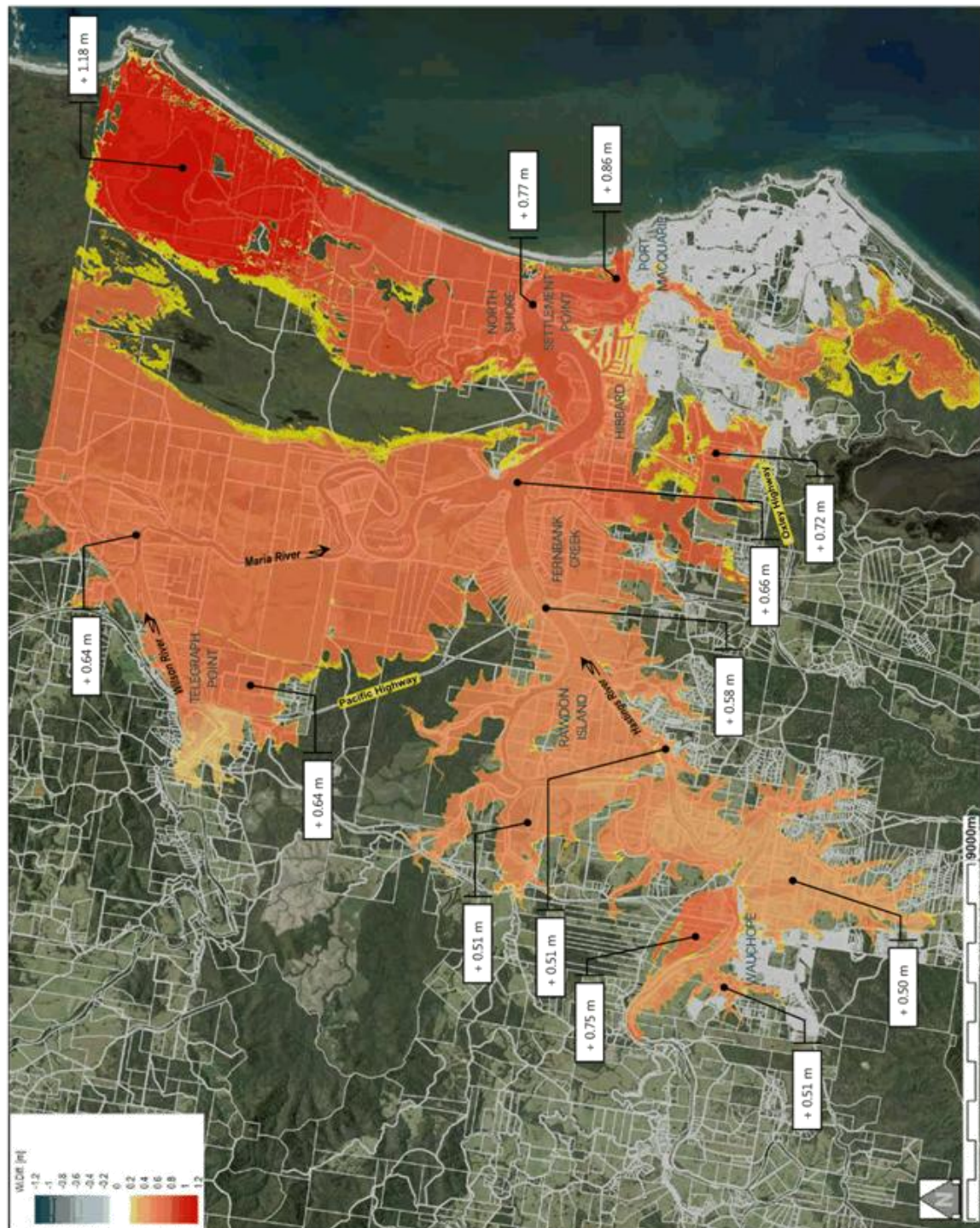
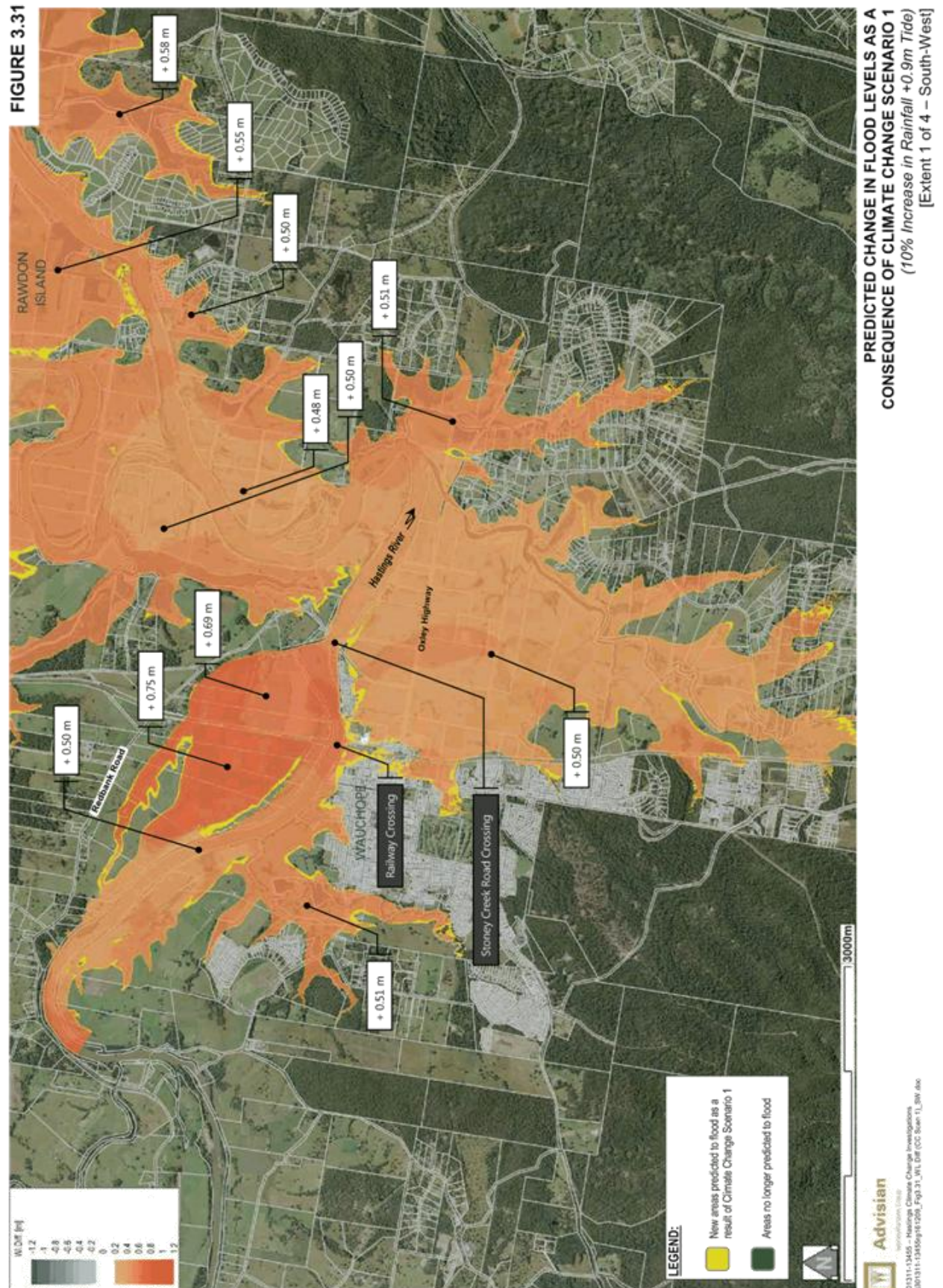


FIGURE 3.30





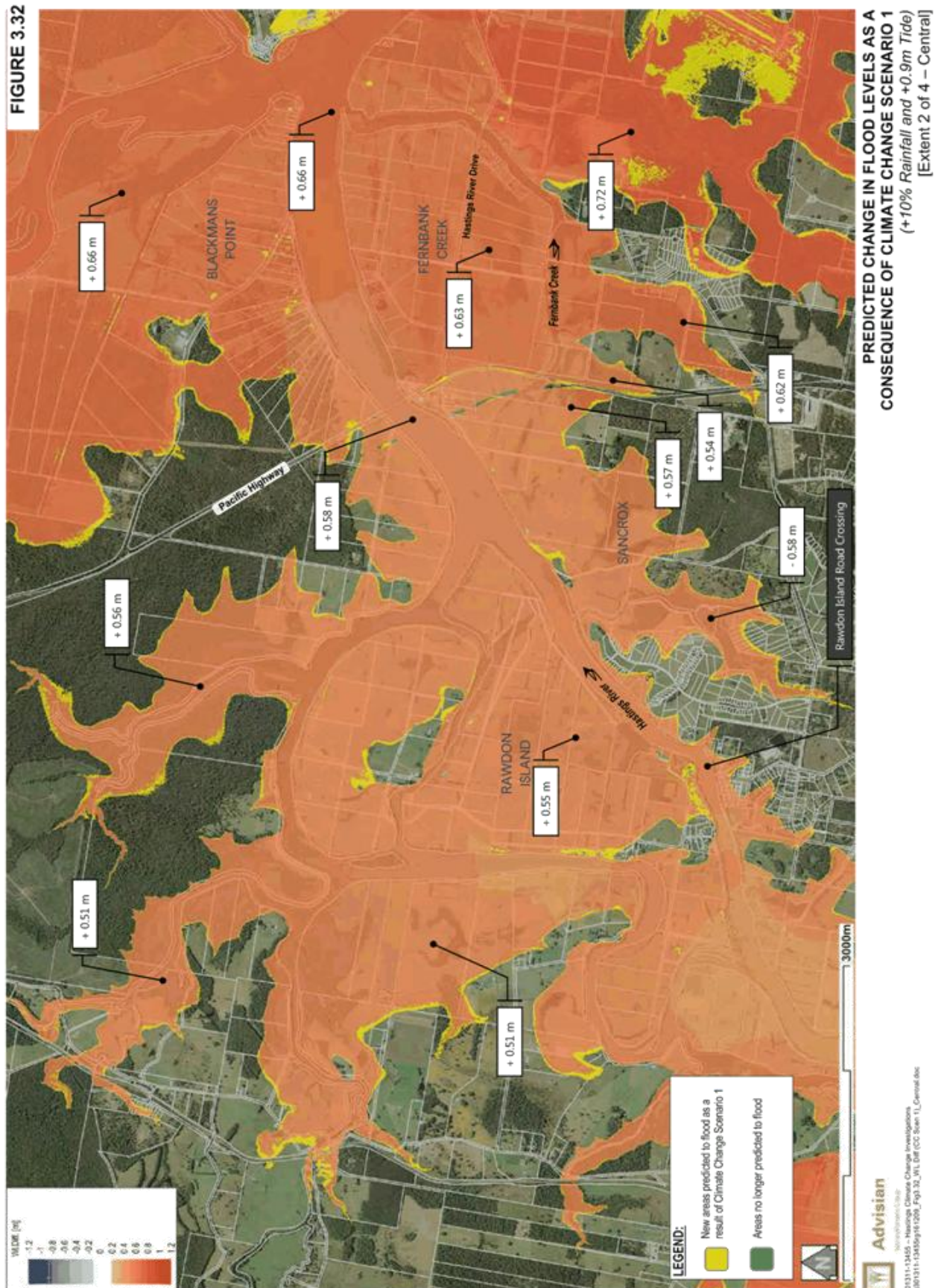
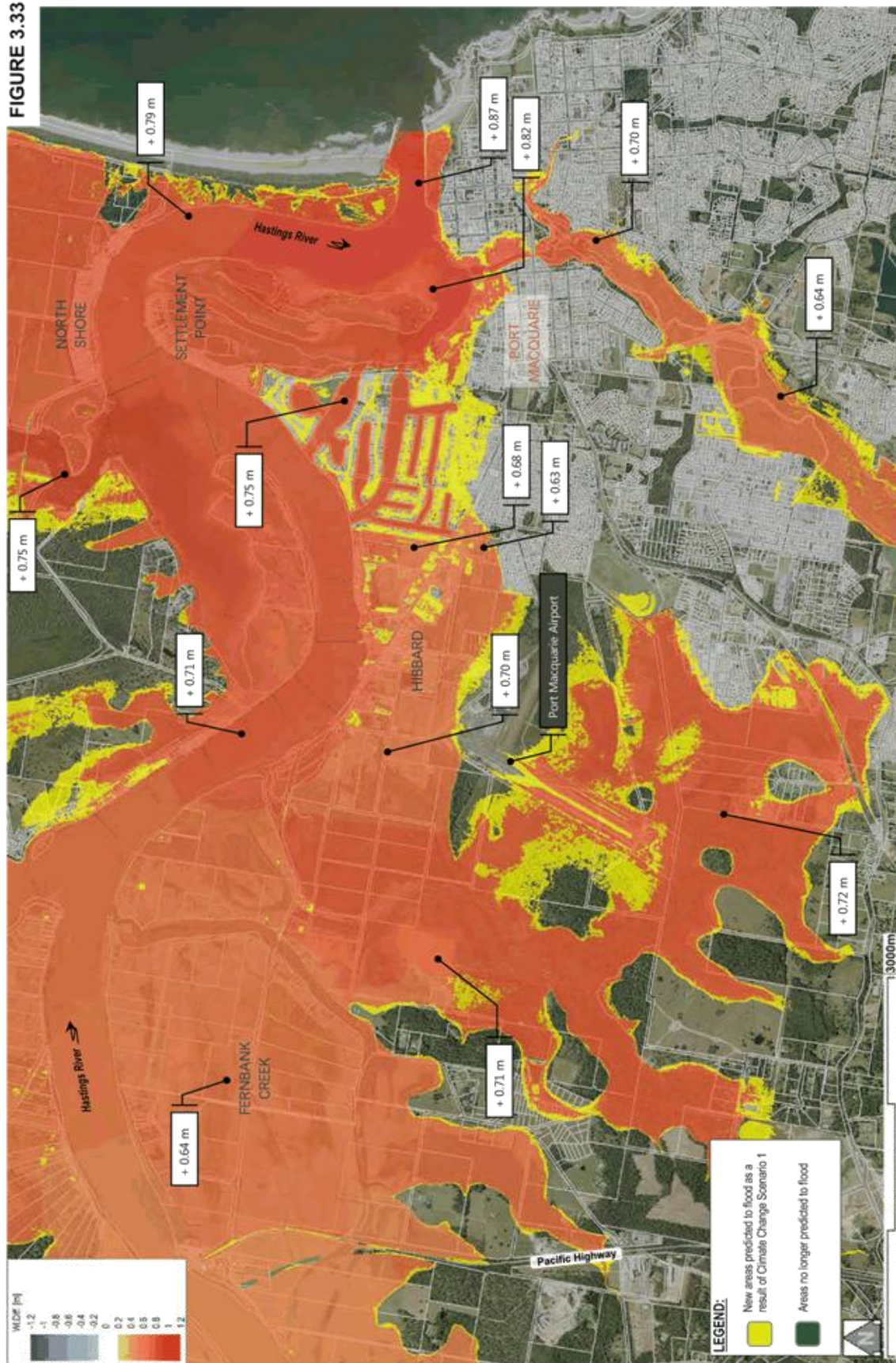


FIGURE 3.33



PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 1
(+10% Rainfall and +0.9m Tide)
[Extent 3 of 4 – South-East]

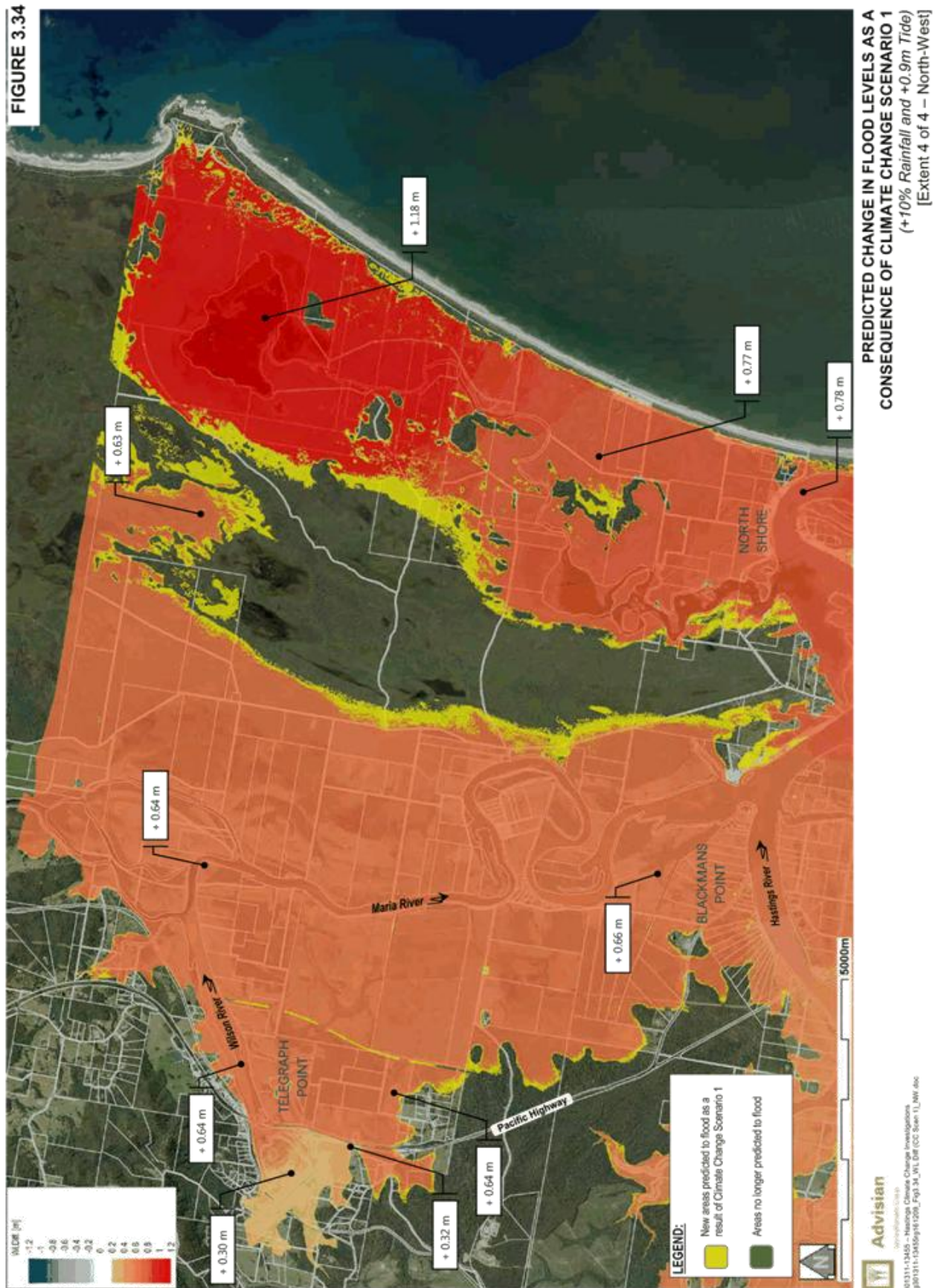
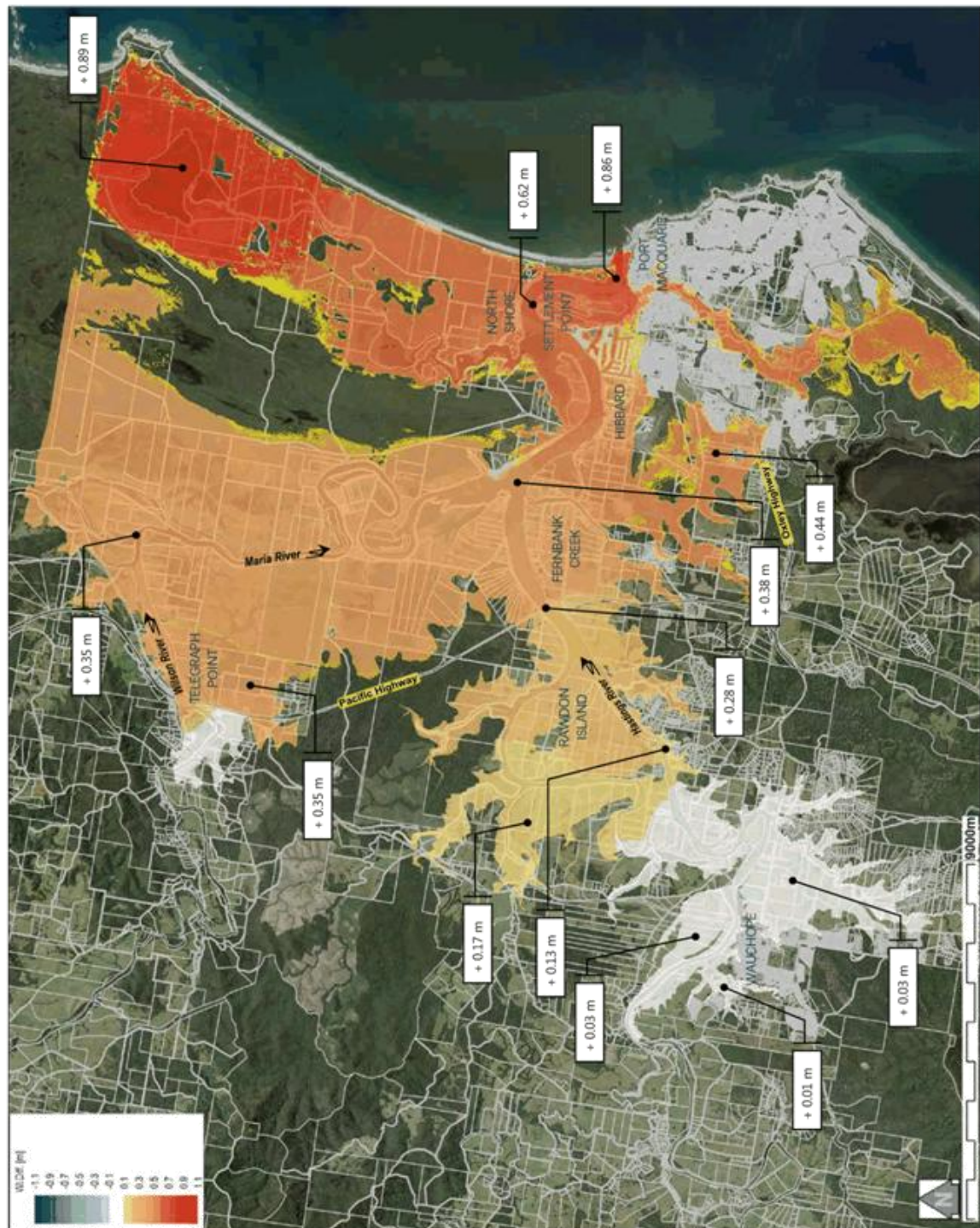


FIGURE 3.35

PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 2
(+0.9m Tide)

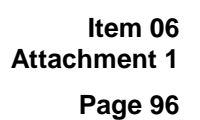
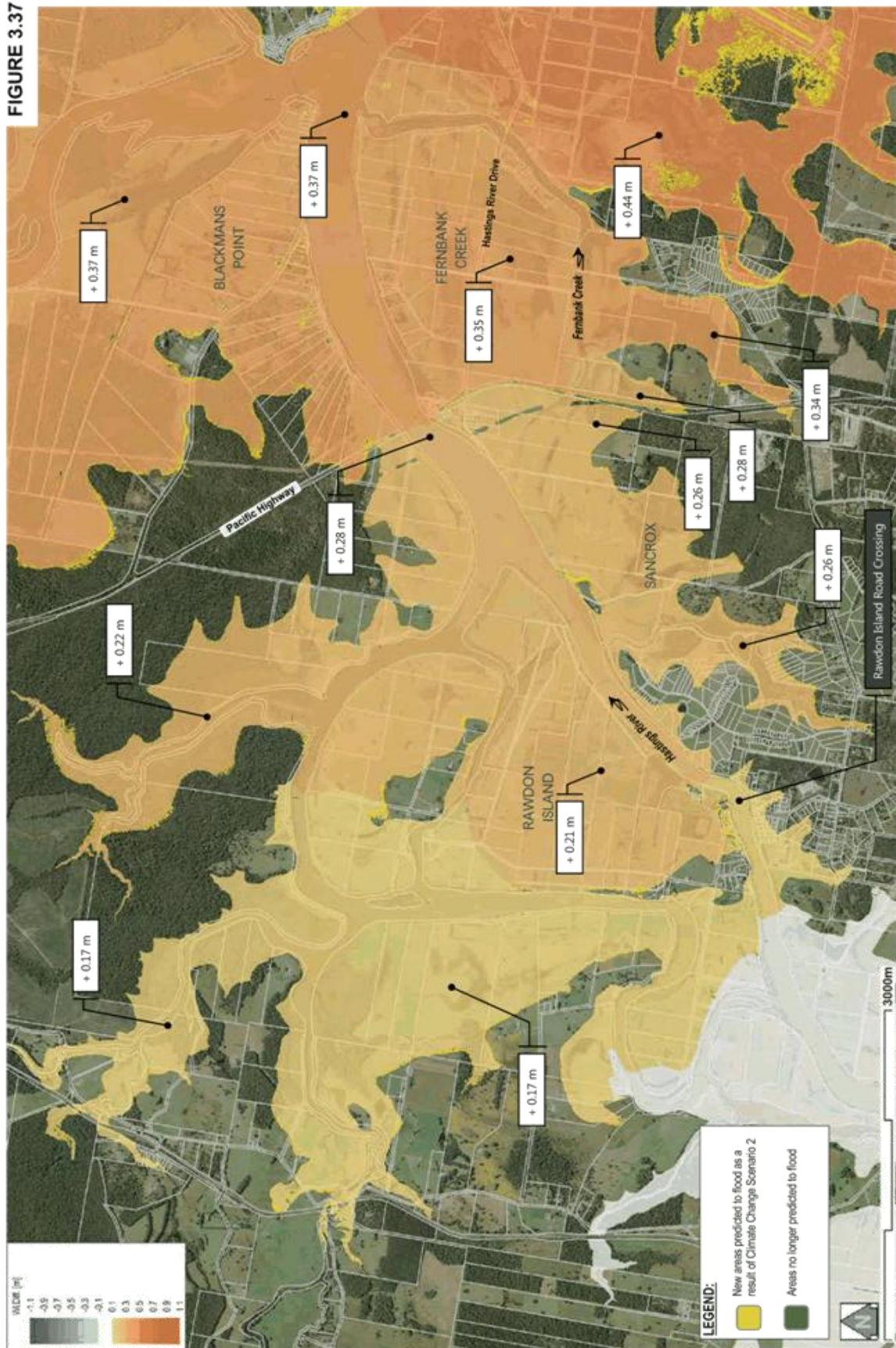
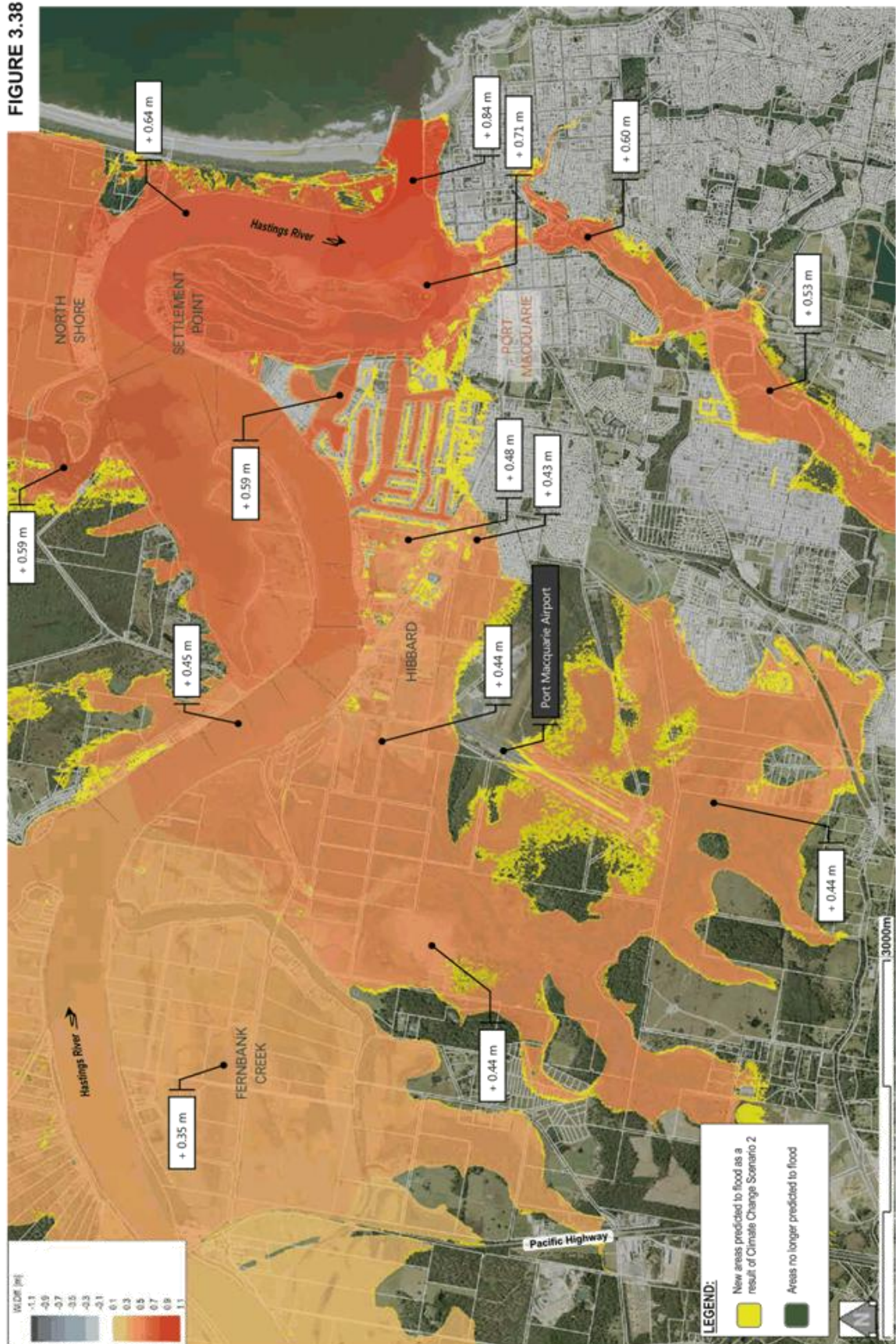


FIGURE 3.37



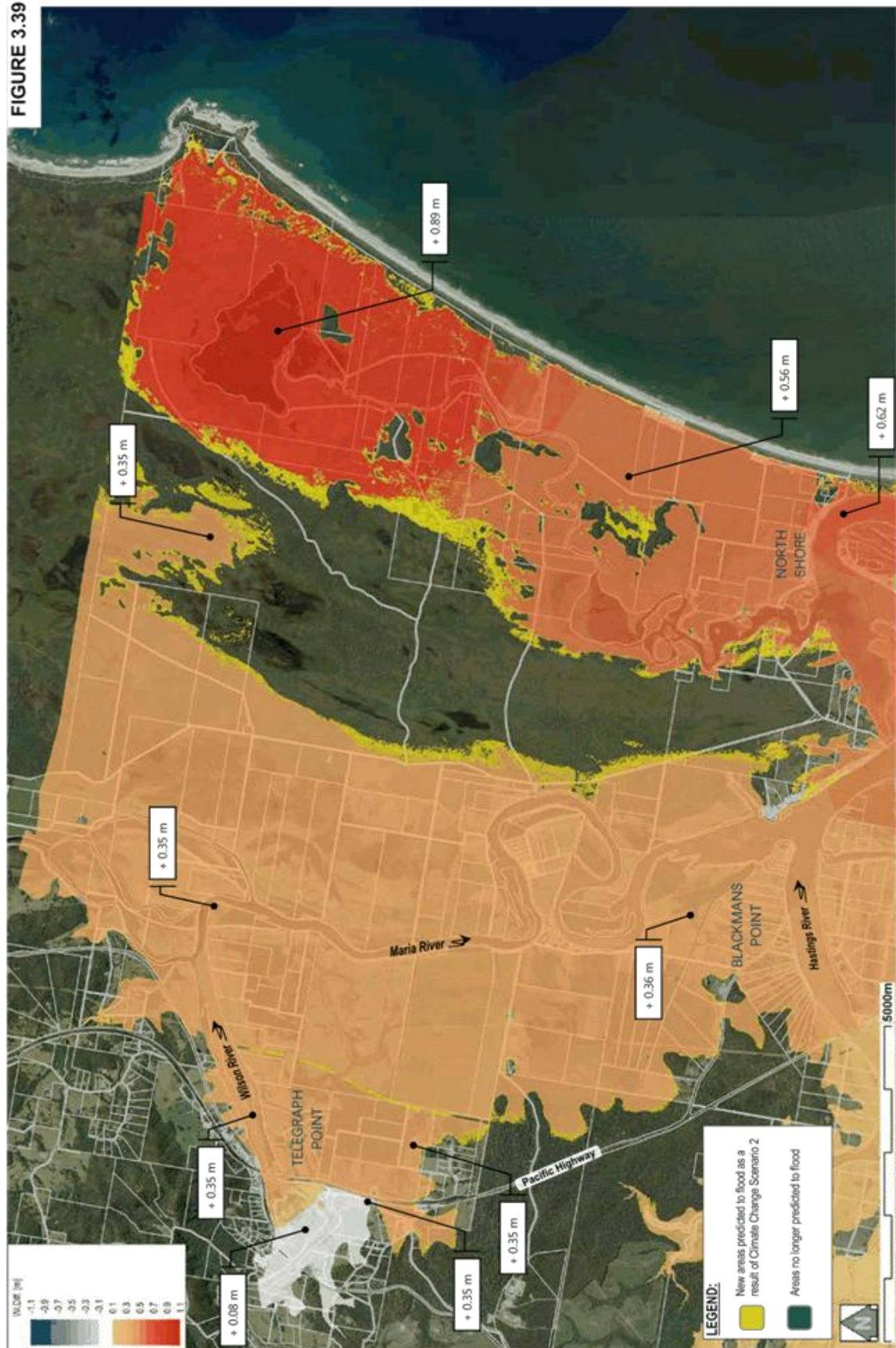
PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 2
(+0.9m Tide)
[Extent 2 of 4 - Central]

FIGURE 3.38



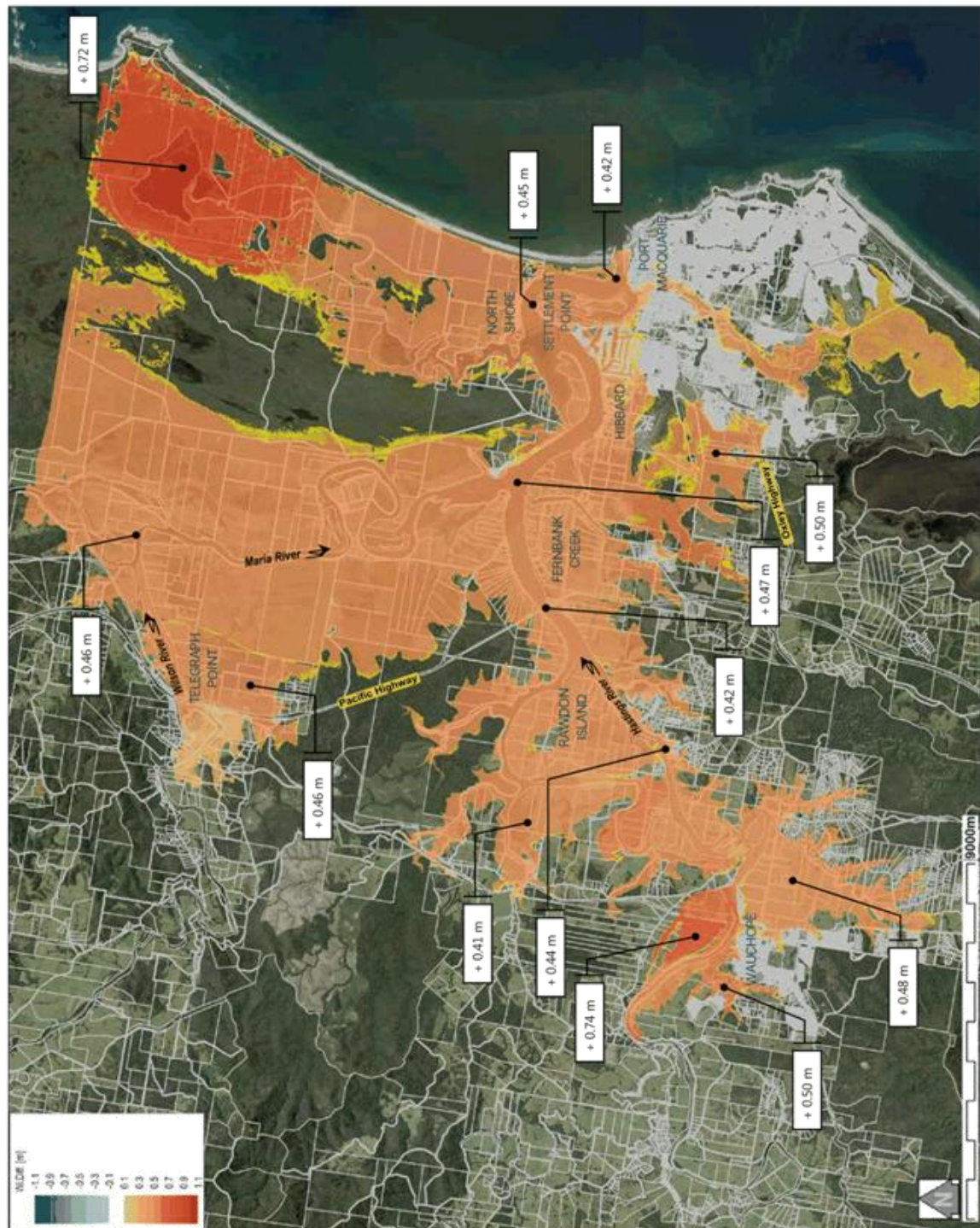
PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 2
(+0.9m Tide)
[Extent 3 of 4 – South-East]

FIGURE 3.39



PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 2
(+0.9m Tide)
[Extent 4 of 4 – North-West]

FIGURE 3.40



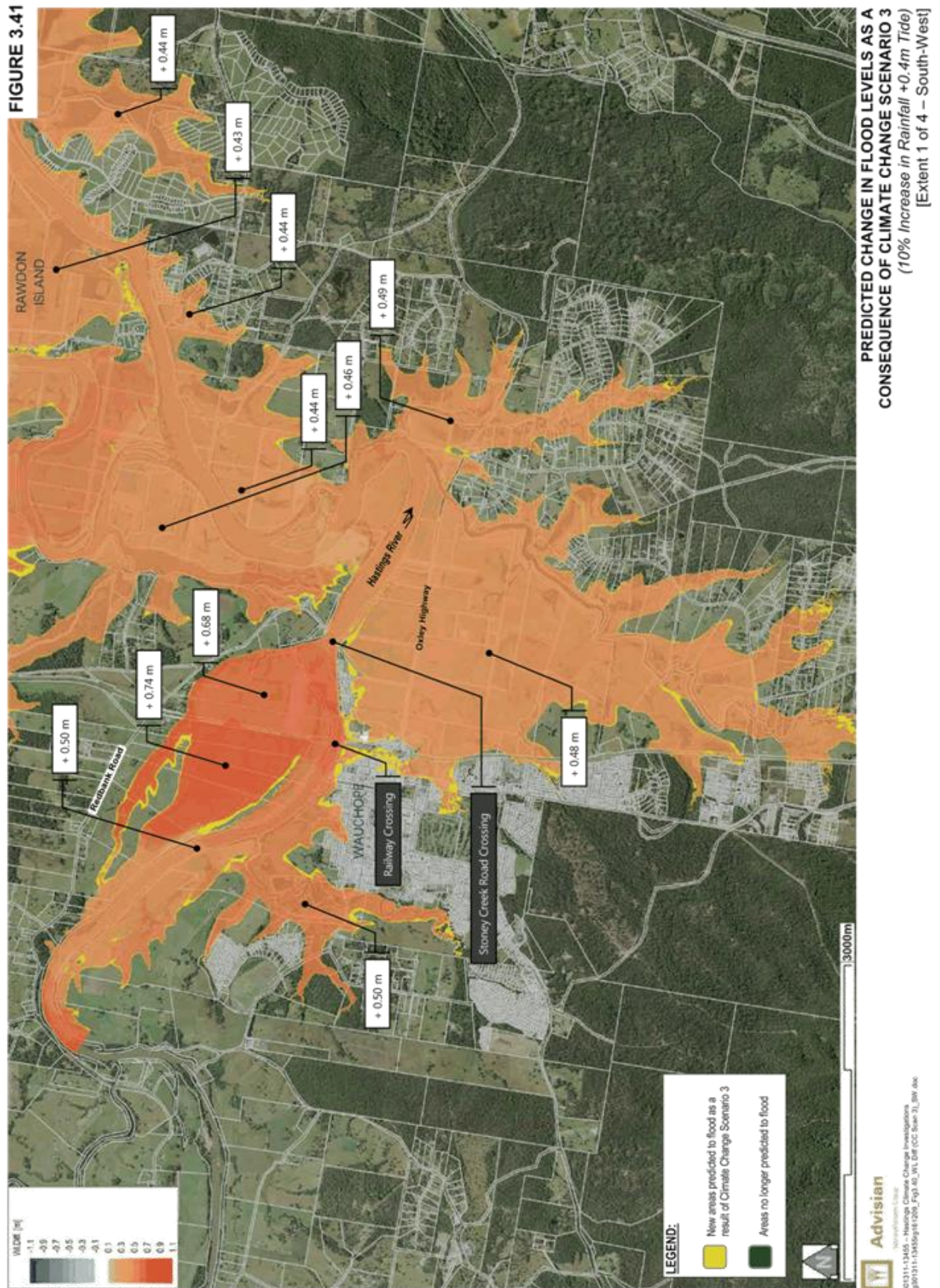
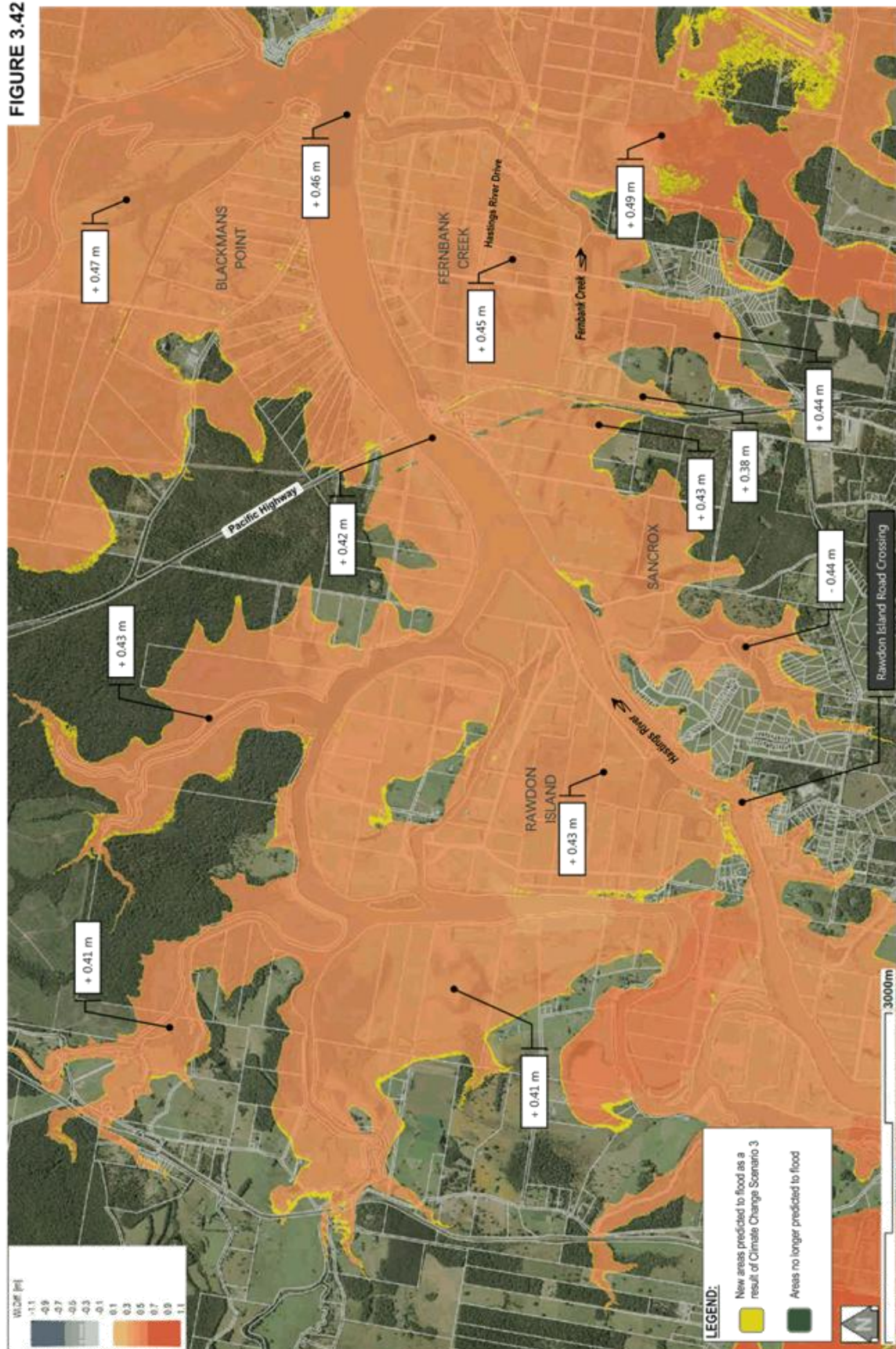
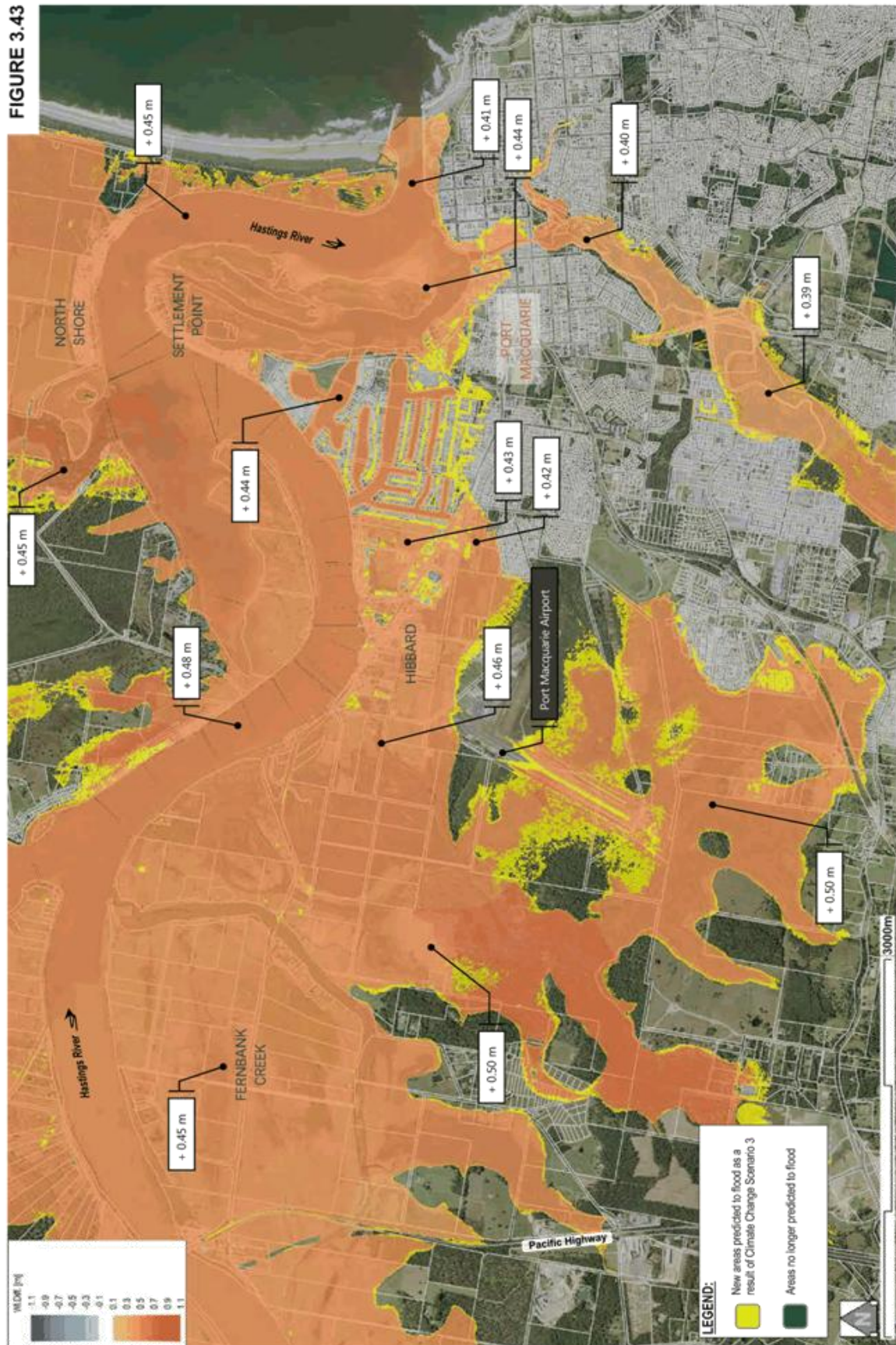


FIGURE 3.42



PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 3
(+10% Rainfall and +0.4m Tide)
[Extent 2 of 4 – Central]



**PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 3
(+10% Rainfall and +0.4m Tide)
[Extent 3 of 4 – South-East]**

FIGURE 3.44



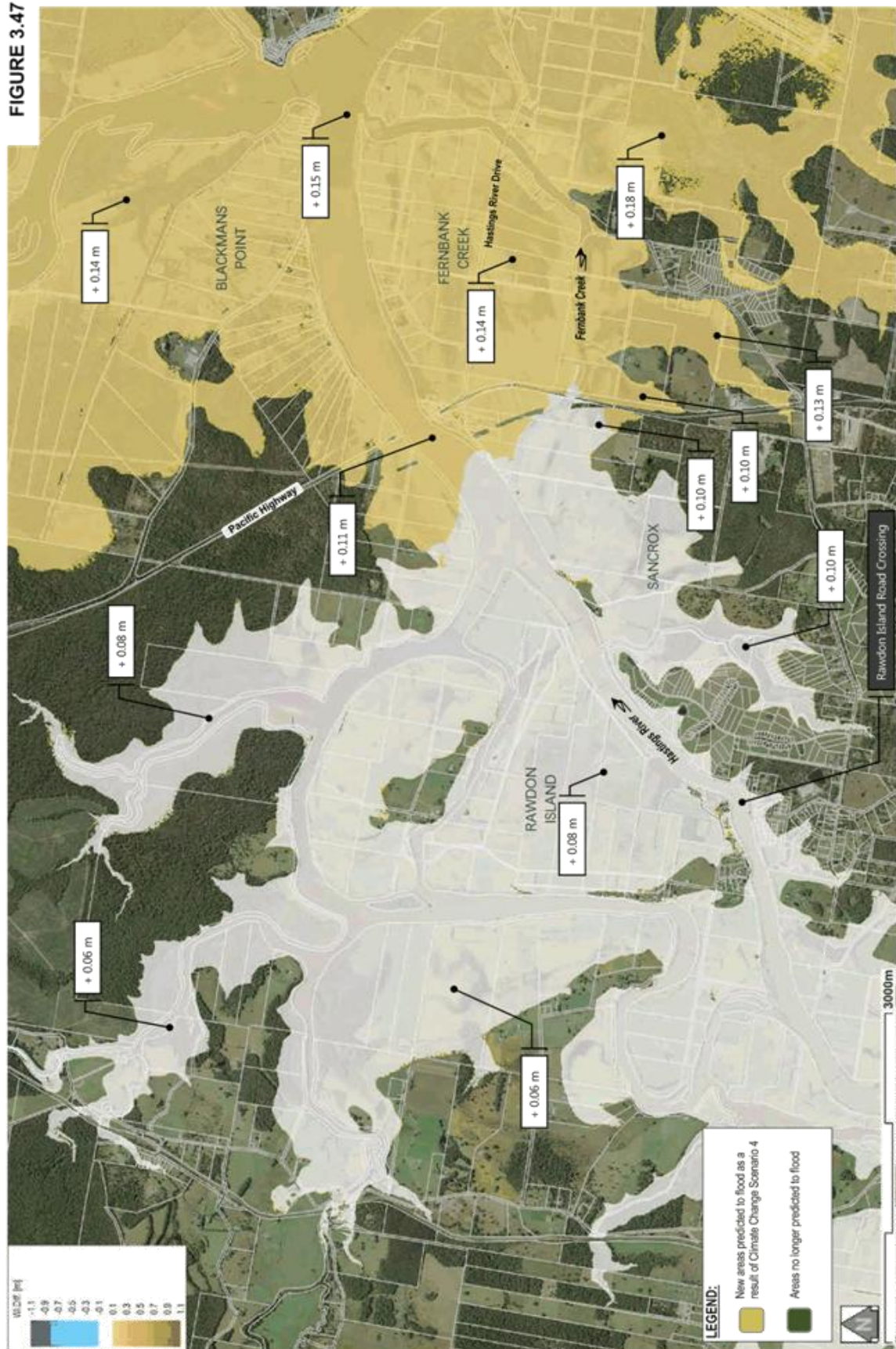
PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 3
(+10% Rainfall and +0.4m Tide)
[Extent 4 of 4 – North-West]

FIGURE 3.45



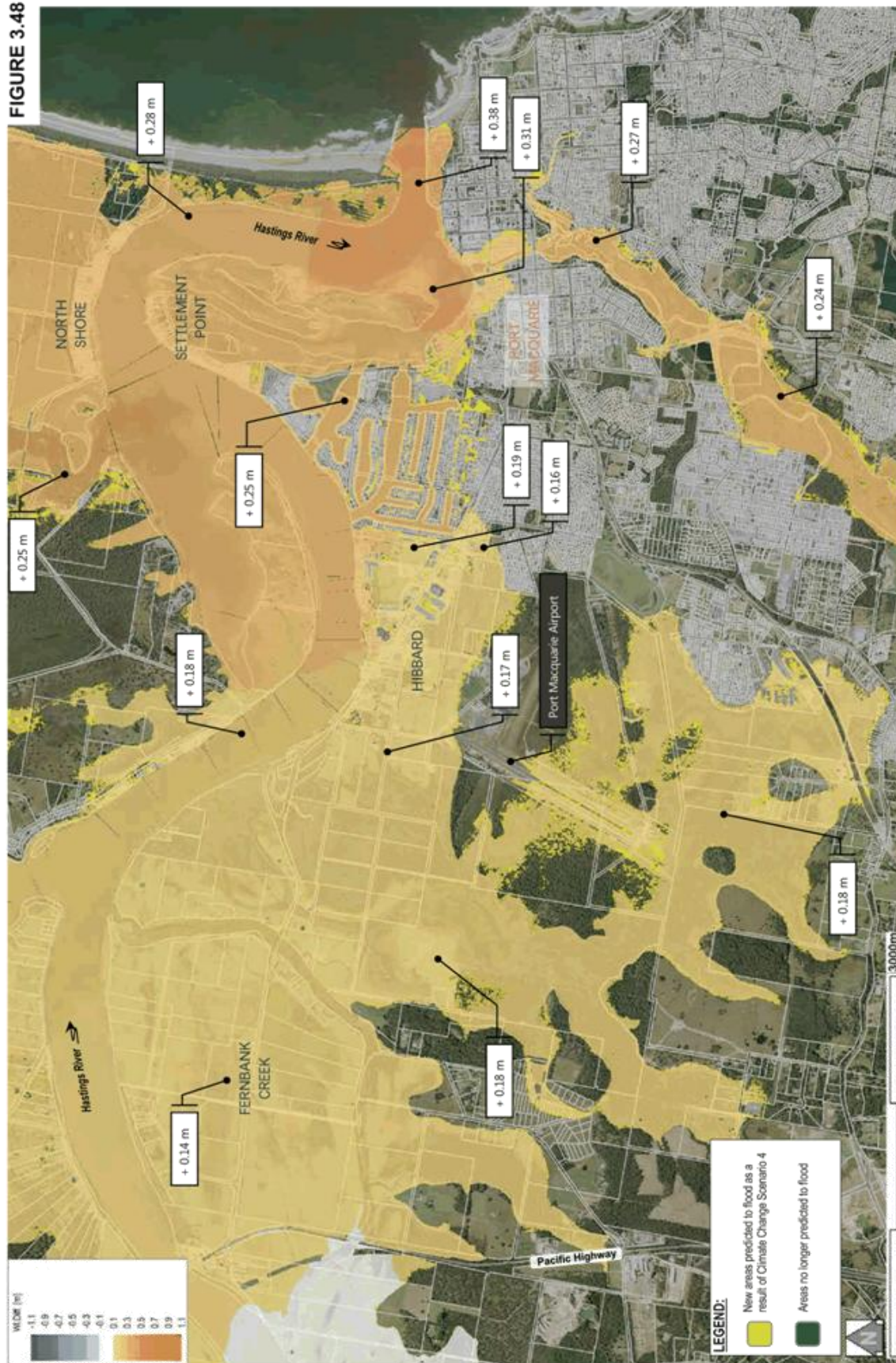


FIGURE 3.47



PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 4
(+0.4m Tide)
[Extent 2 of 4 – Central]

FIGURE 3.48



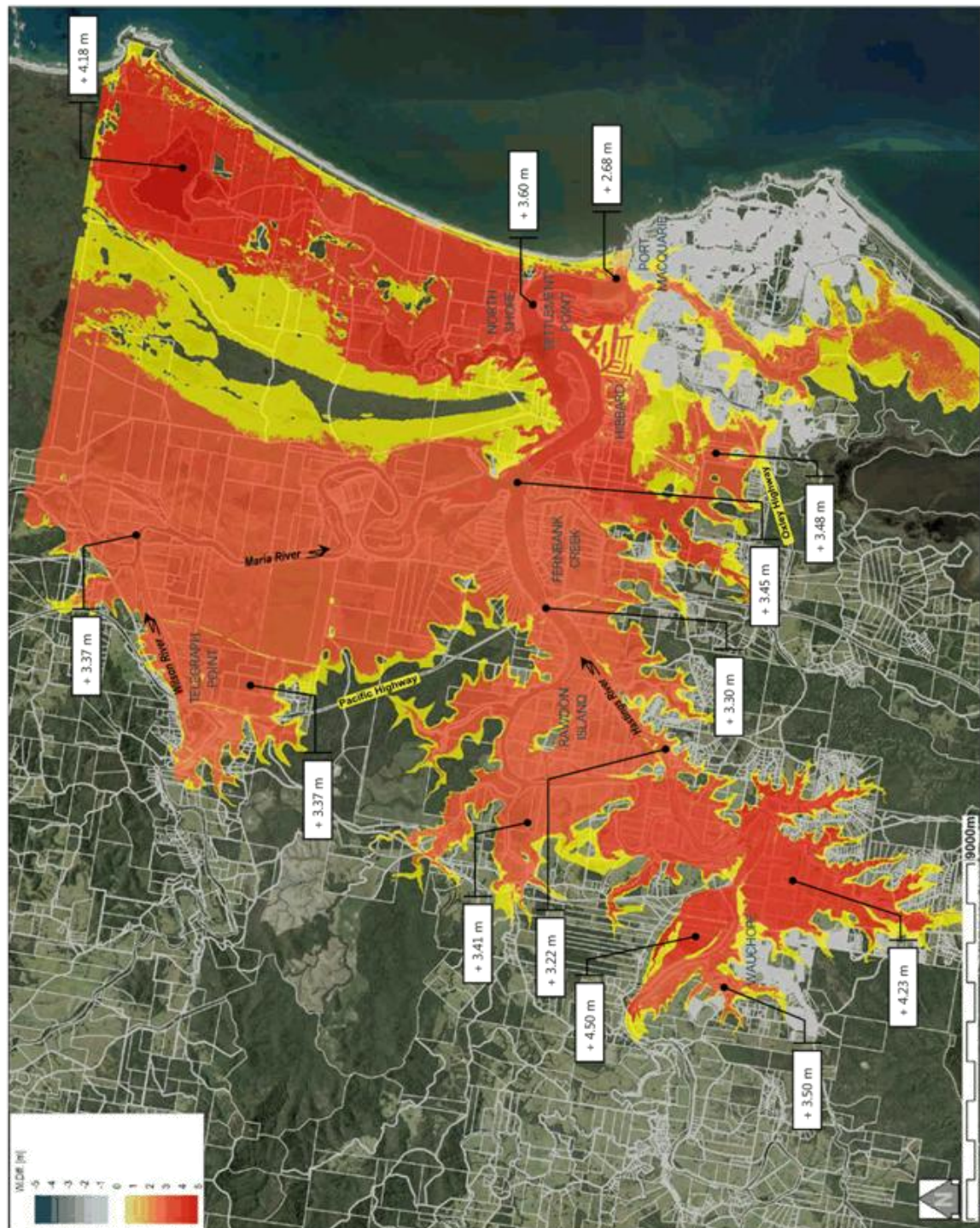
PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 4
(+0.4m Tide)
[Extent 3 of 4 – South-East]

FIGURE 3.49



PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 4
(+0.4m Tide)
[Extent 4 of 4 – North-West]

FIGURE 3.50



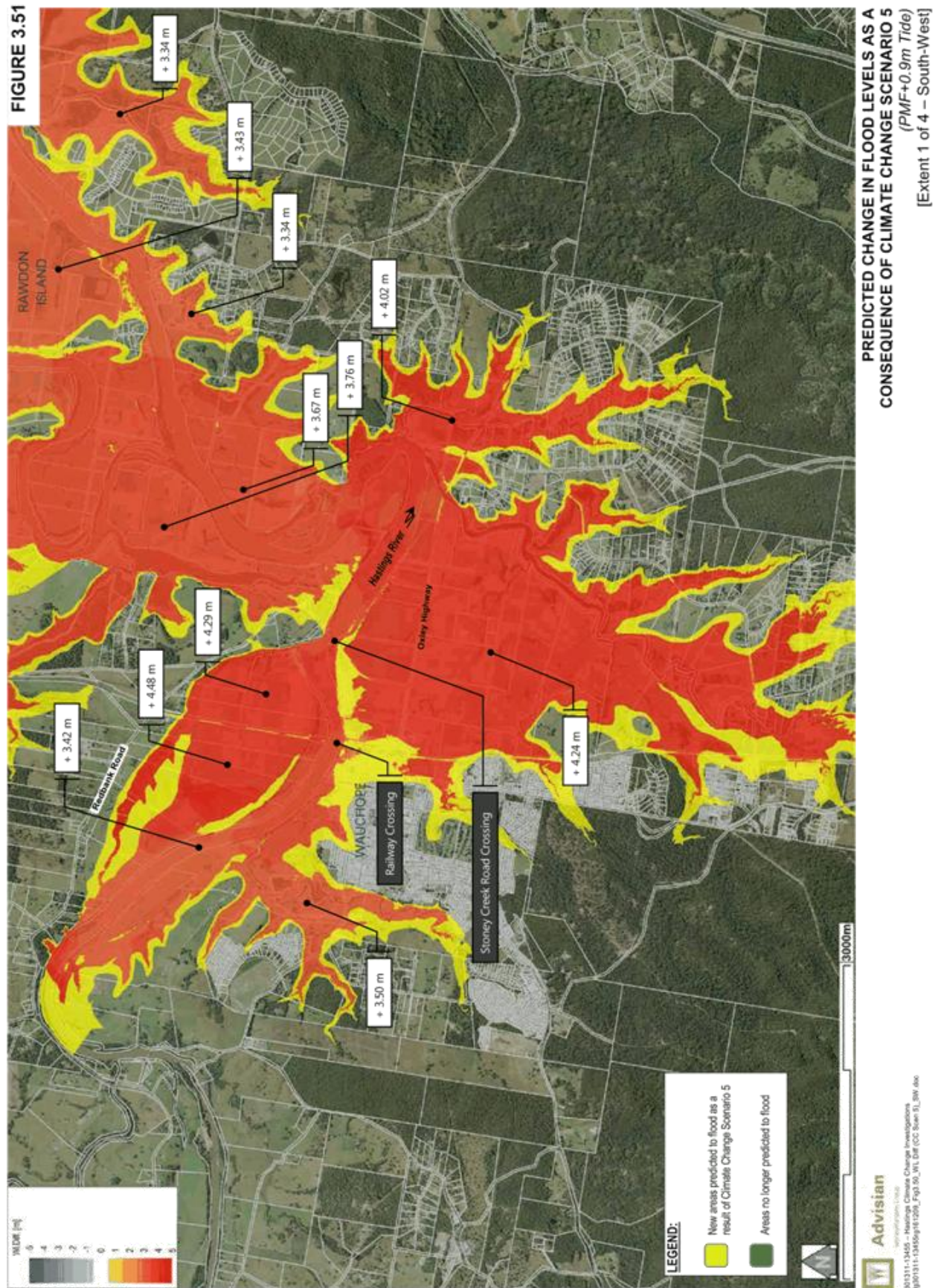
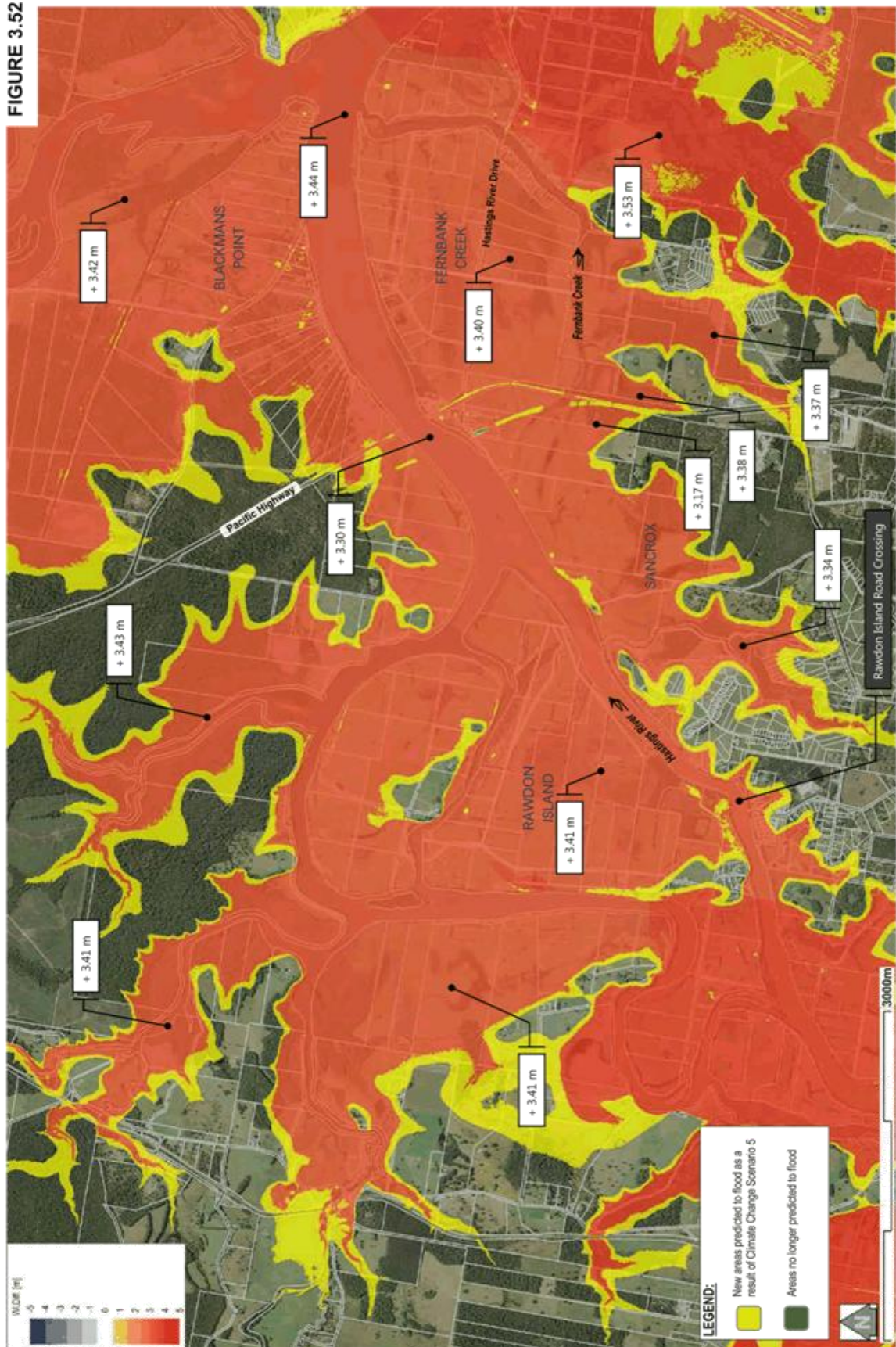
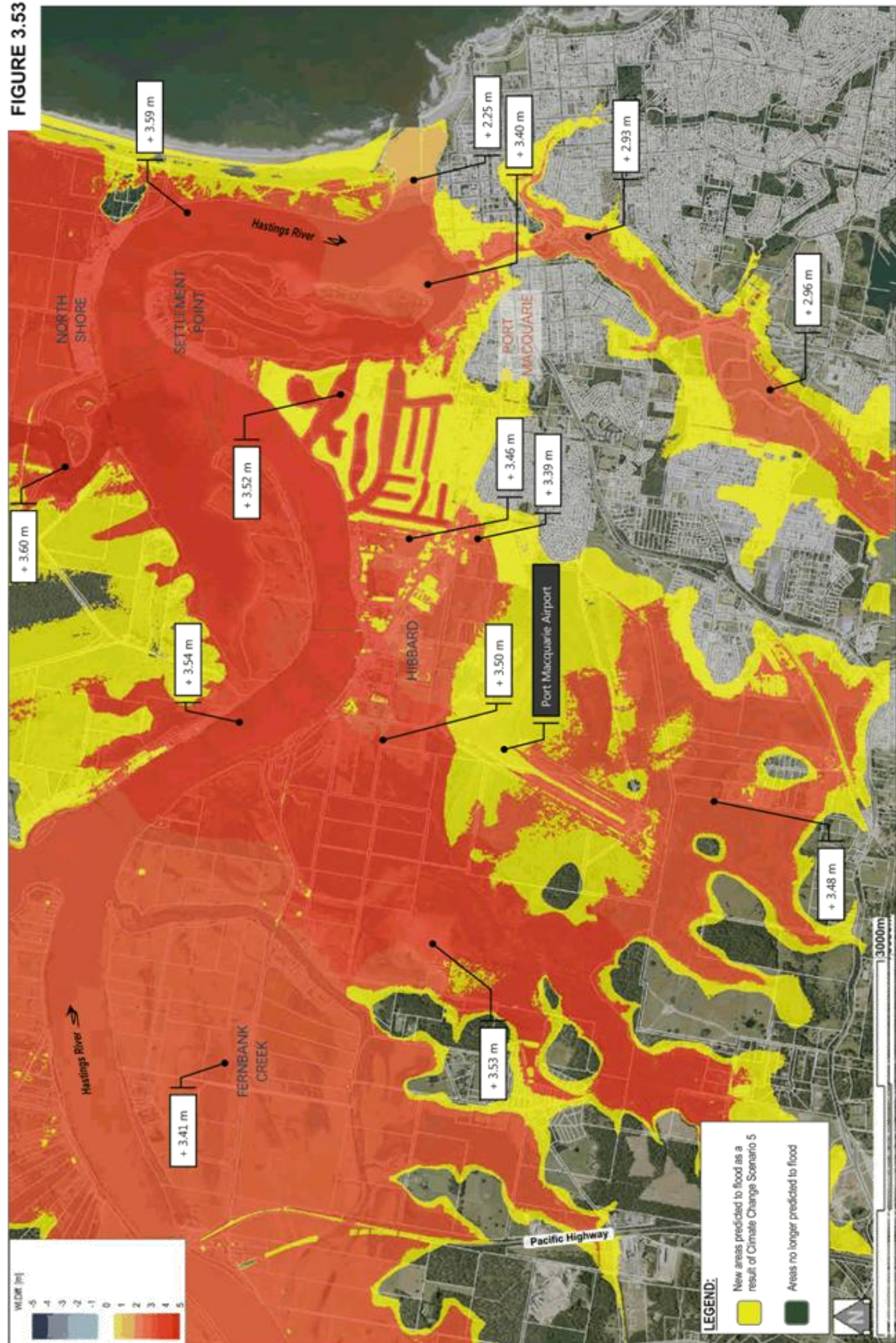


FIGURE 3.52



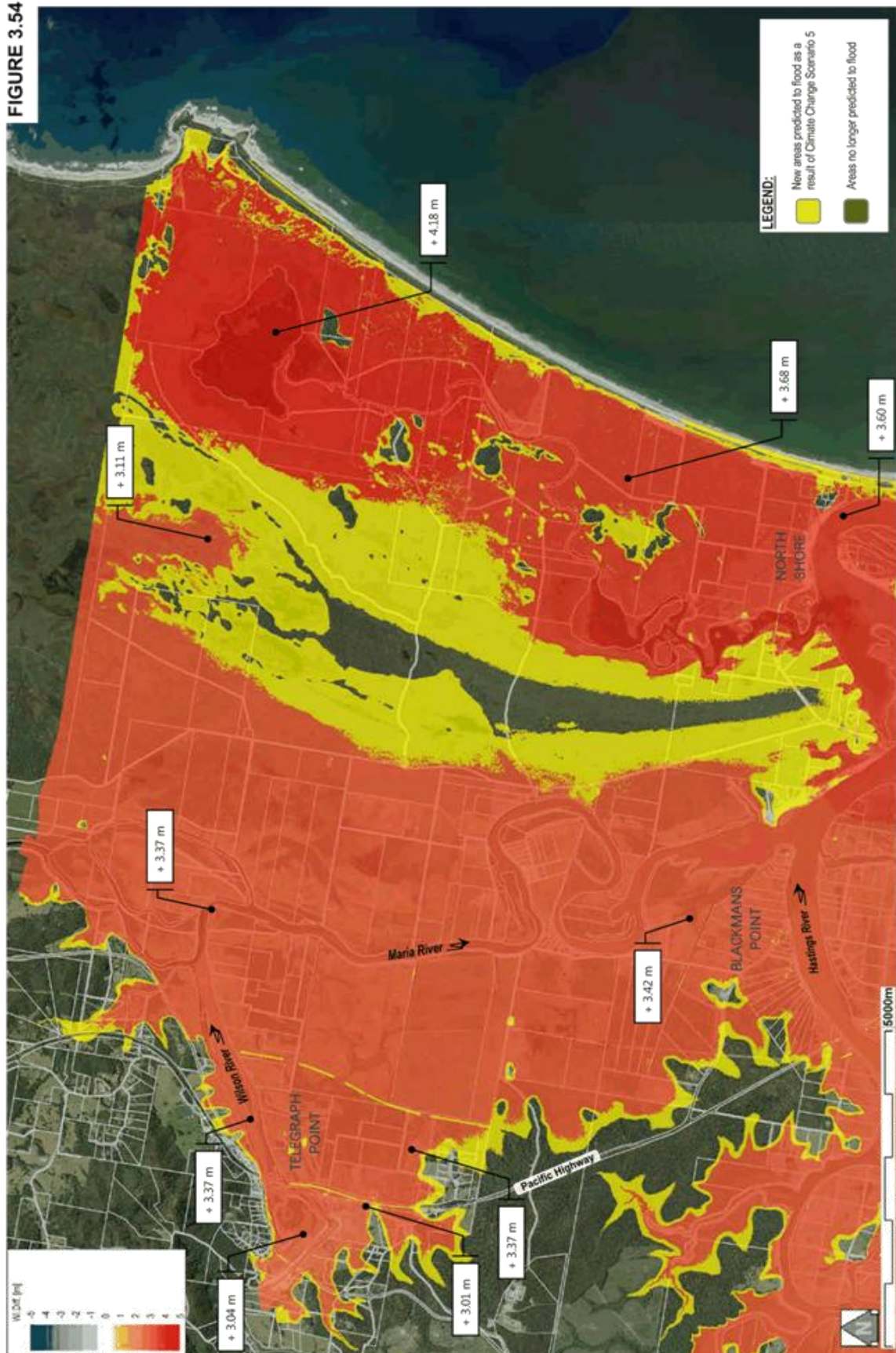
PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 5
(PMF+0.9m Tide)
[Extent 2 of 4 - Central]

FIGURE 3.53



PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 5
(PMF+0.9m Tide)
[Extent 3 of 4 – South-East]

FIGURE 3.54



**PREDICTED CHANGE IN FLOOD LEVELS AS A
CONSEQUENCE OF CLIMATE CHANGE SCENARIO 5
(PMF +0.9m Tide)**

[Extent 4 of 4 – North-West]



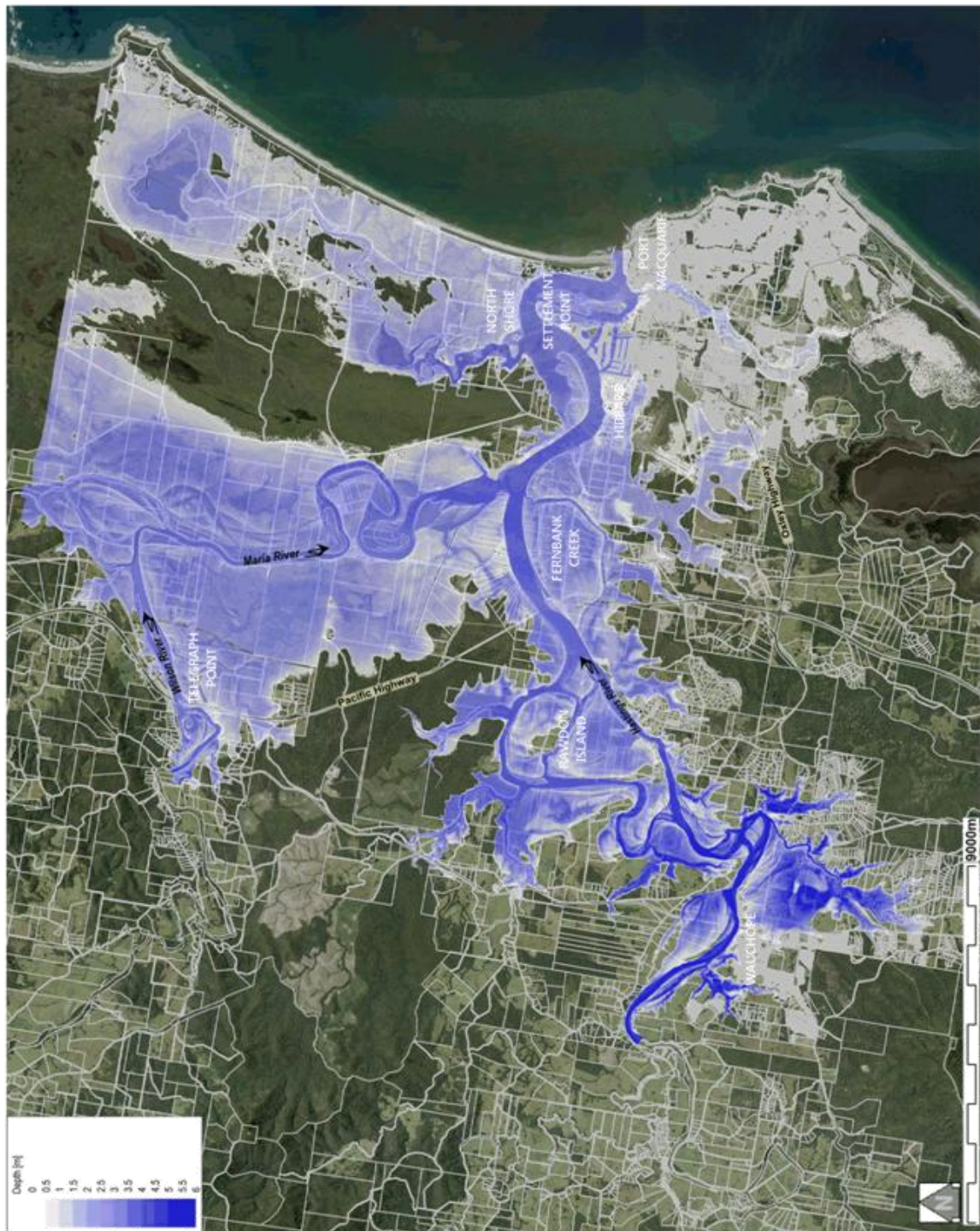
Port Macquarie Hastings Council
Hastings River Climate Change Assessment

Appendix A

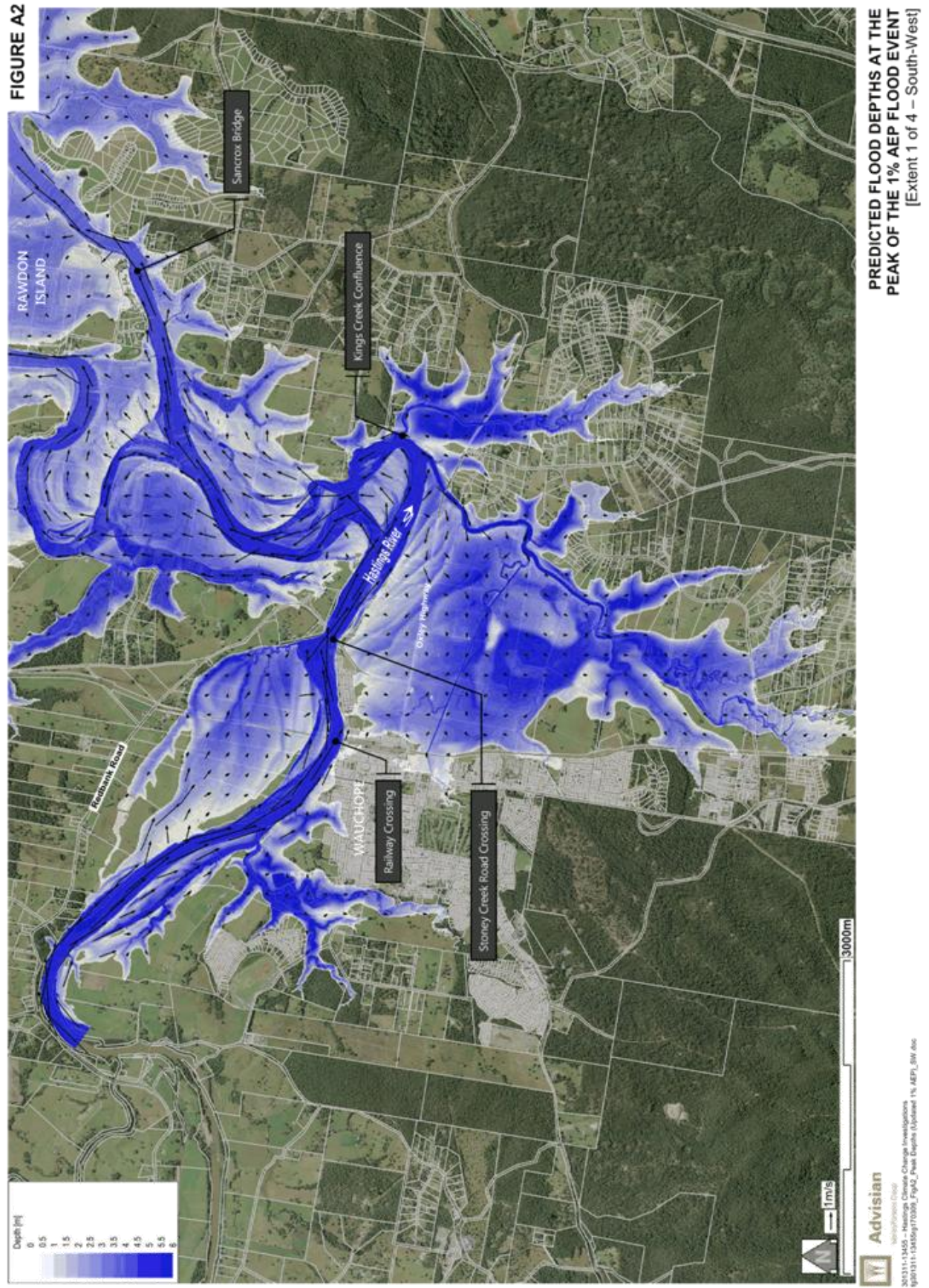
Flood Behaviour Plots for the Updated 1% AEP Flood (Depths, Velocities, Hazards and Hydraulic Categories)

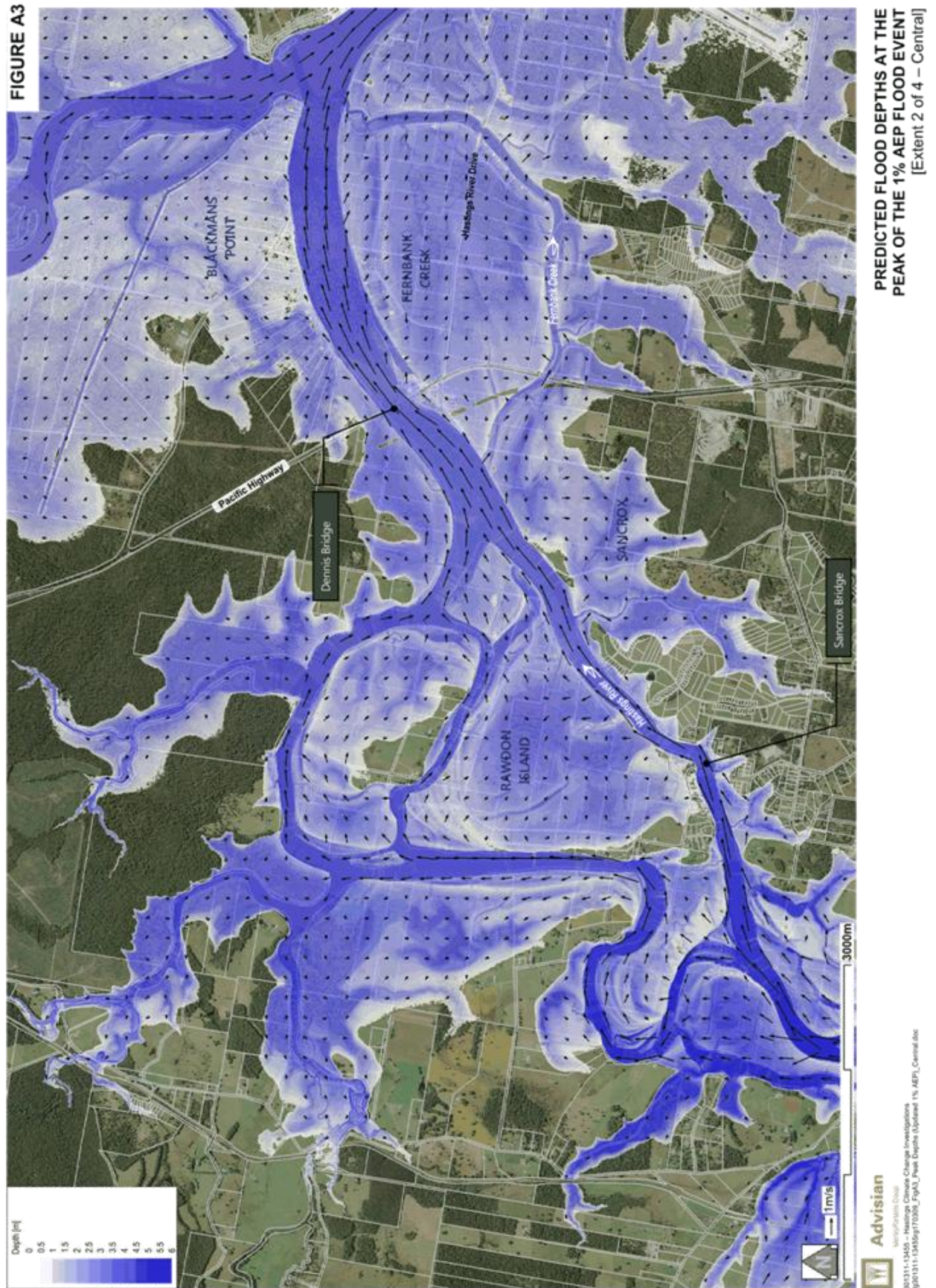


FIGURE A1



PREDICTED FLOOD DEPTHS AT THE
PEAK OF THE 1% AEP FLOOD EVENT
(Based on Updated RMA-2 Model)





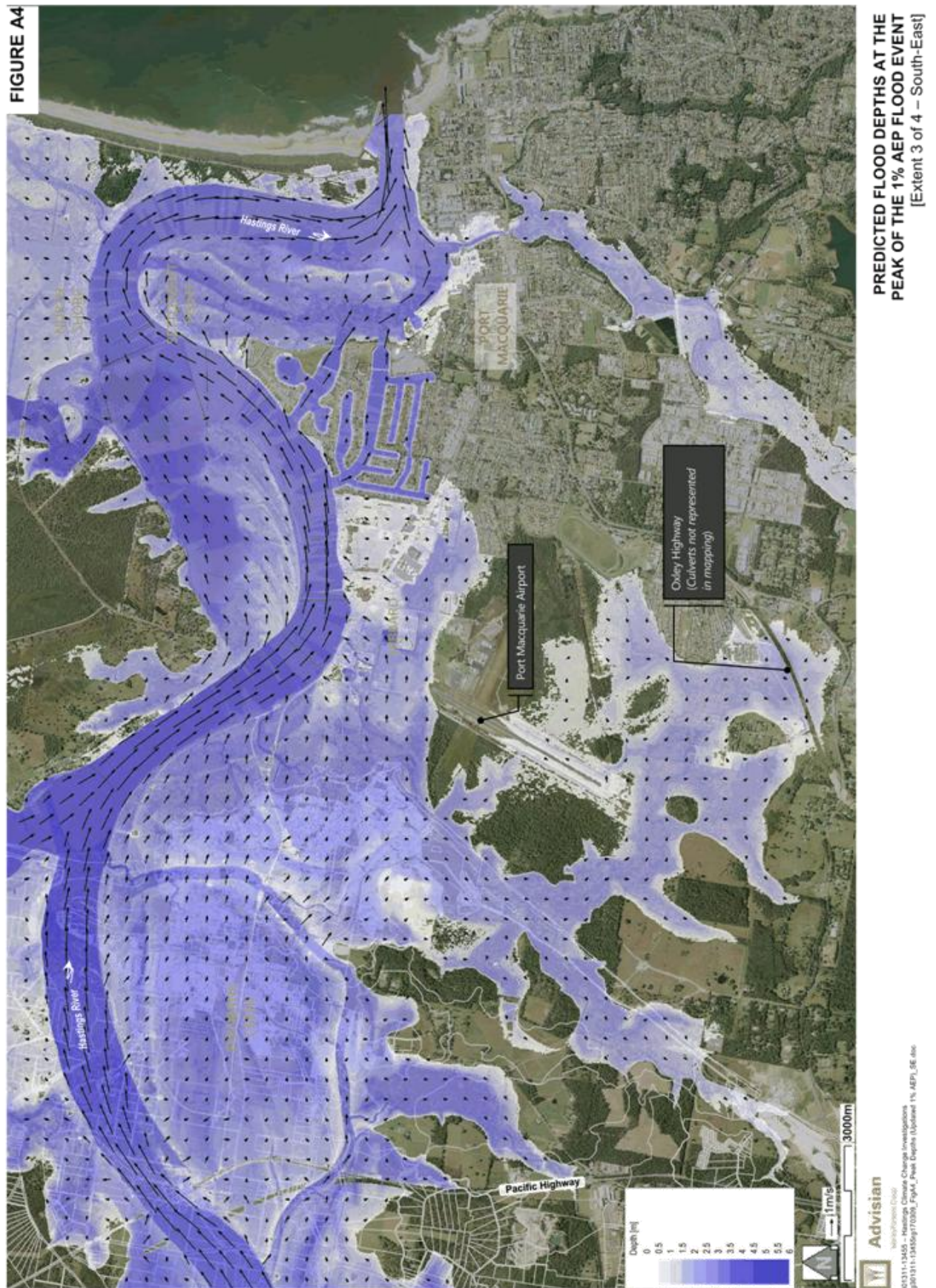
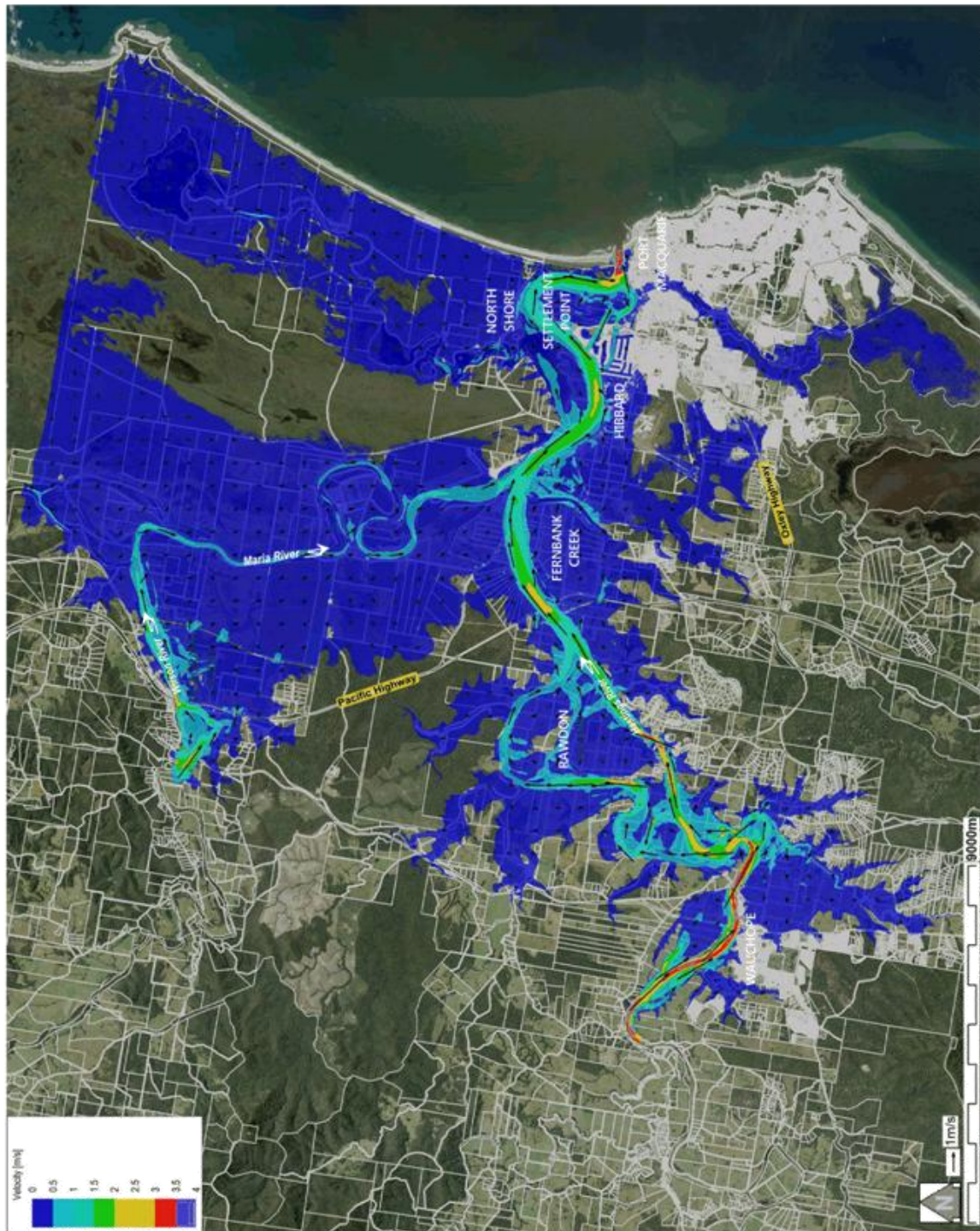


FIGURE A5

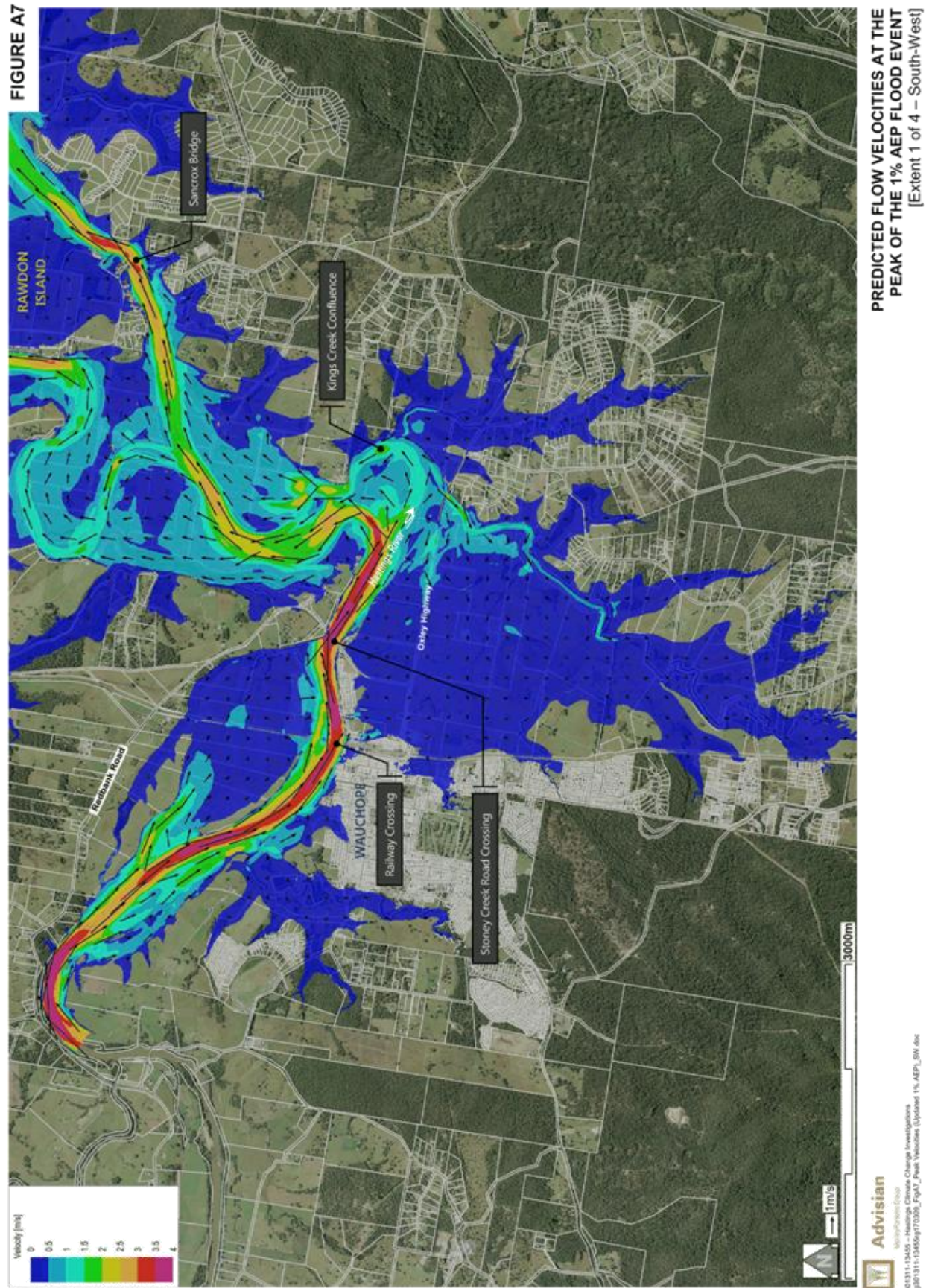


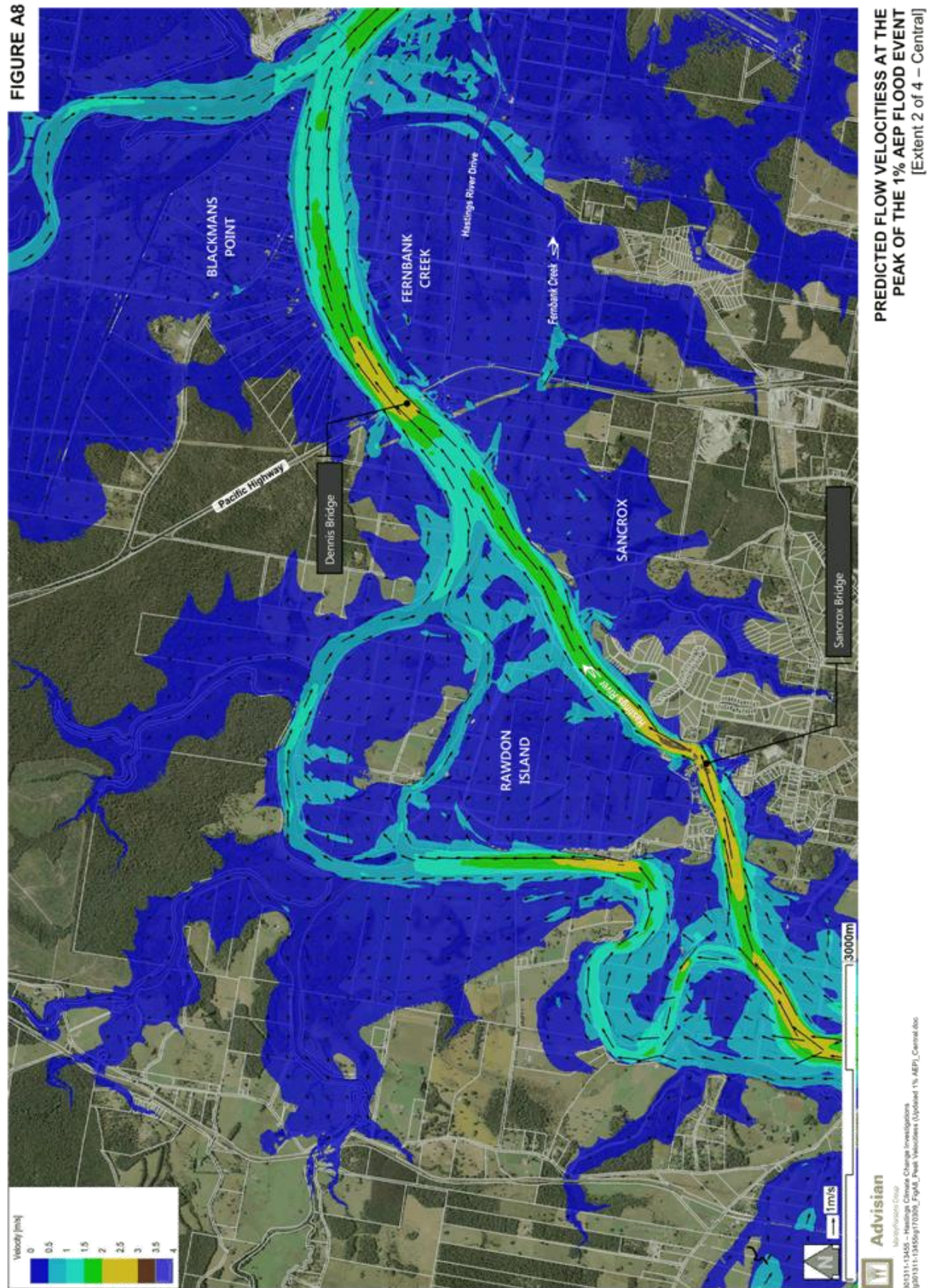
PREDICTED FLOOD DEPTHS AT THE
PEAK OF THE 1% AEP FLOOD EVENT
[Extent 4 of 4 - North-West]

FIGURE A6



PREDICTED FLOW VELOCITIES AT THE
PEAK OF THE 1% AEP FLOOD EVENT
(Based on Updated RMA-2 Model)





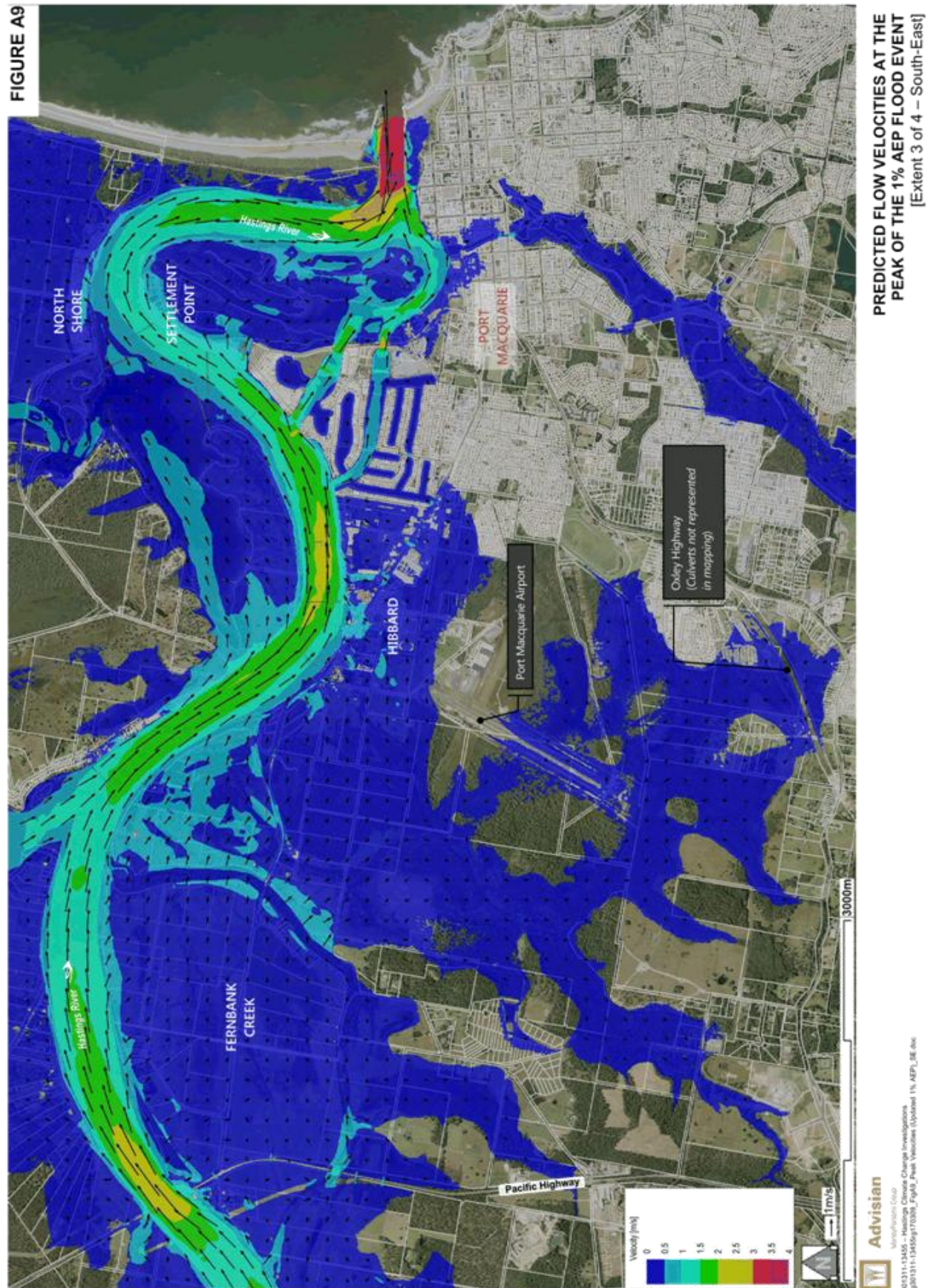


FIGURE A10

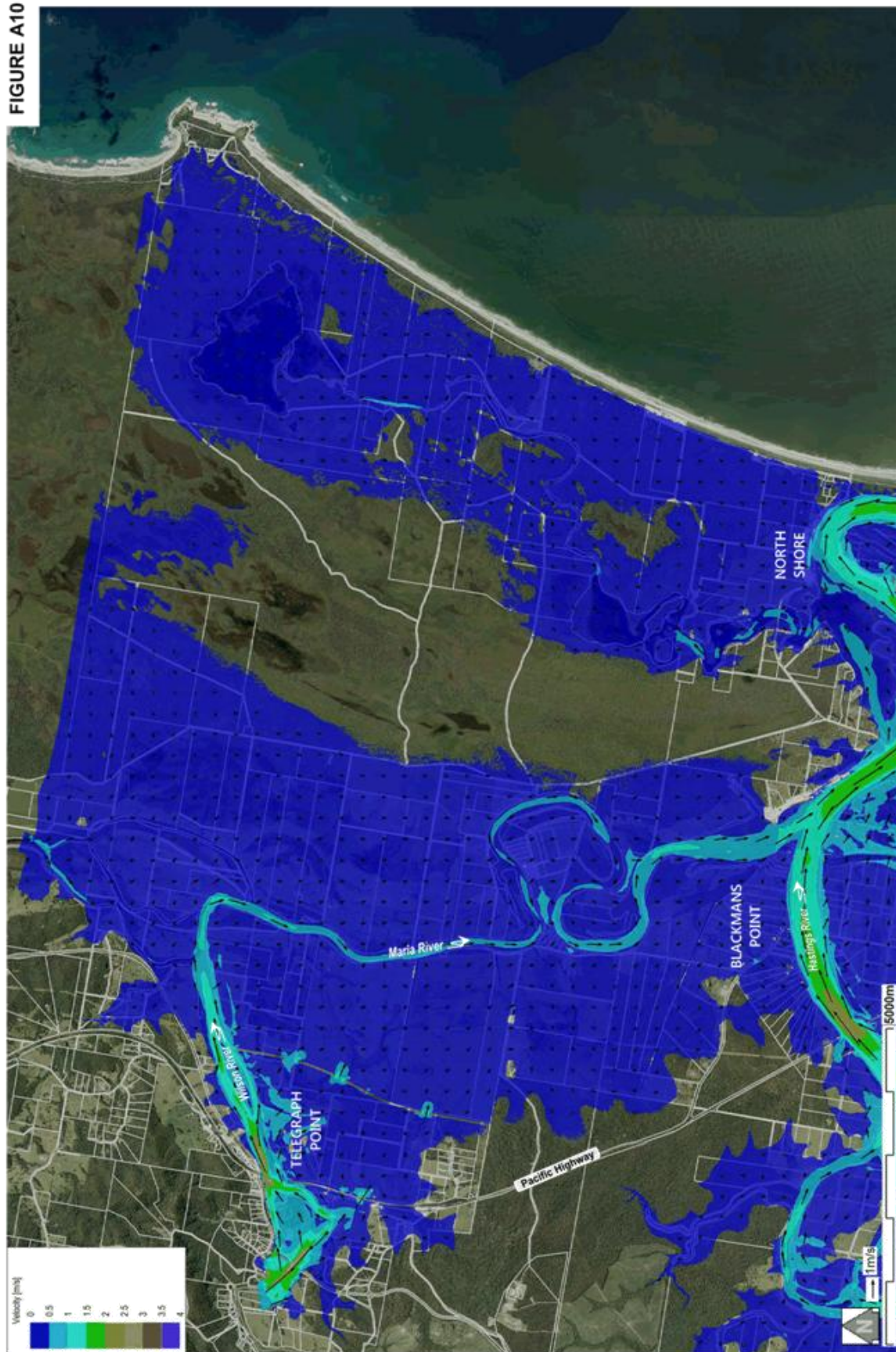
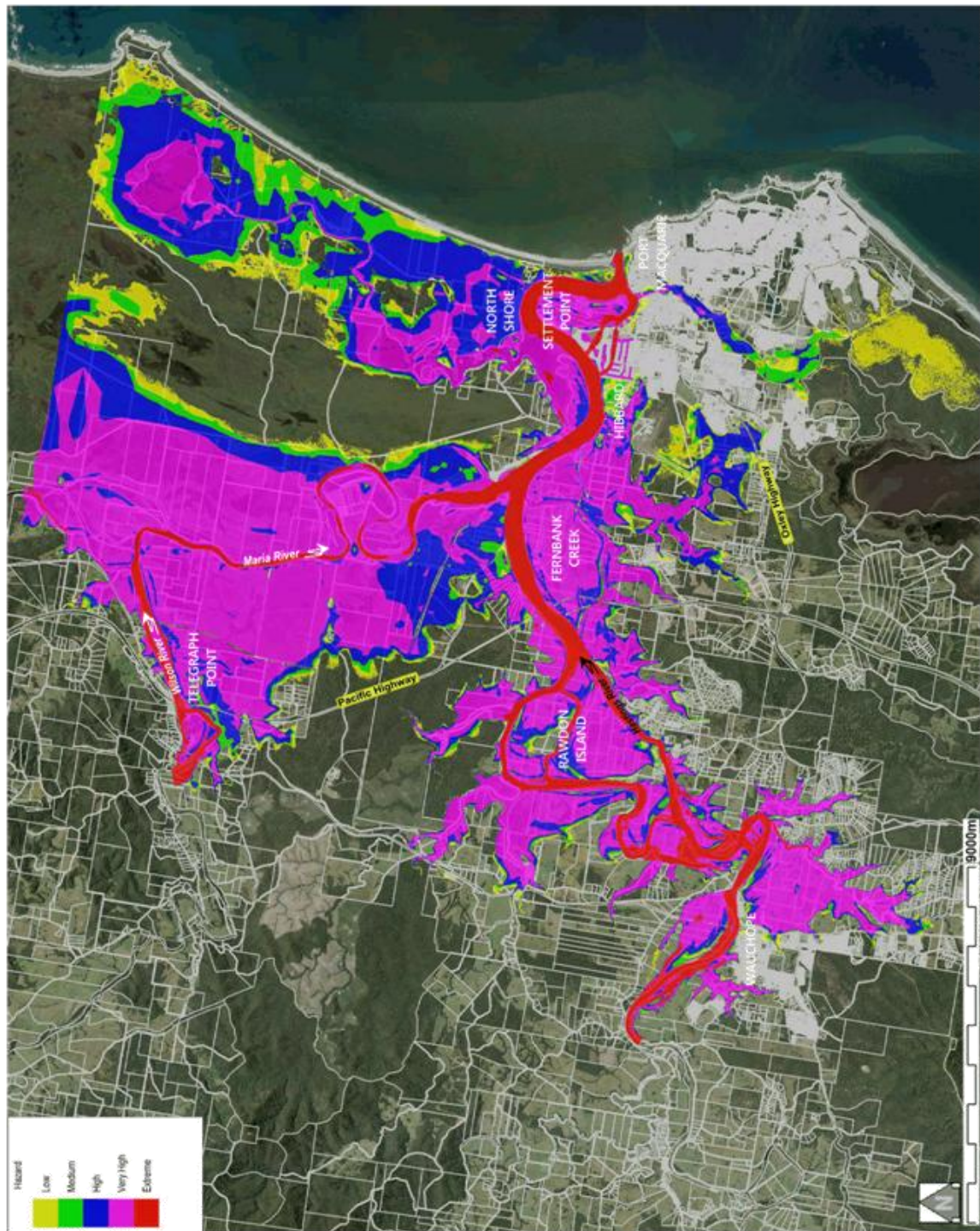
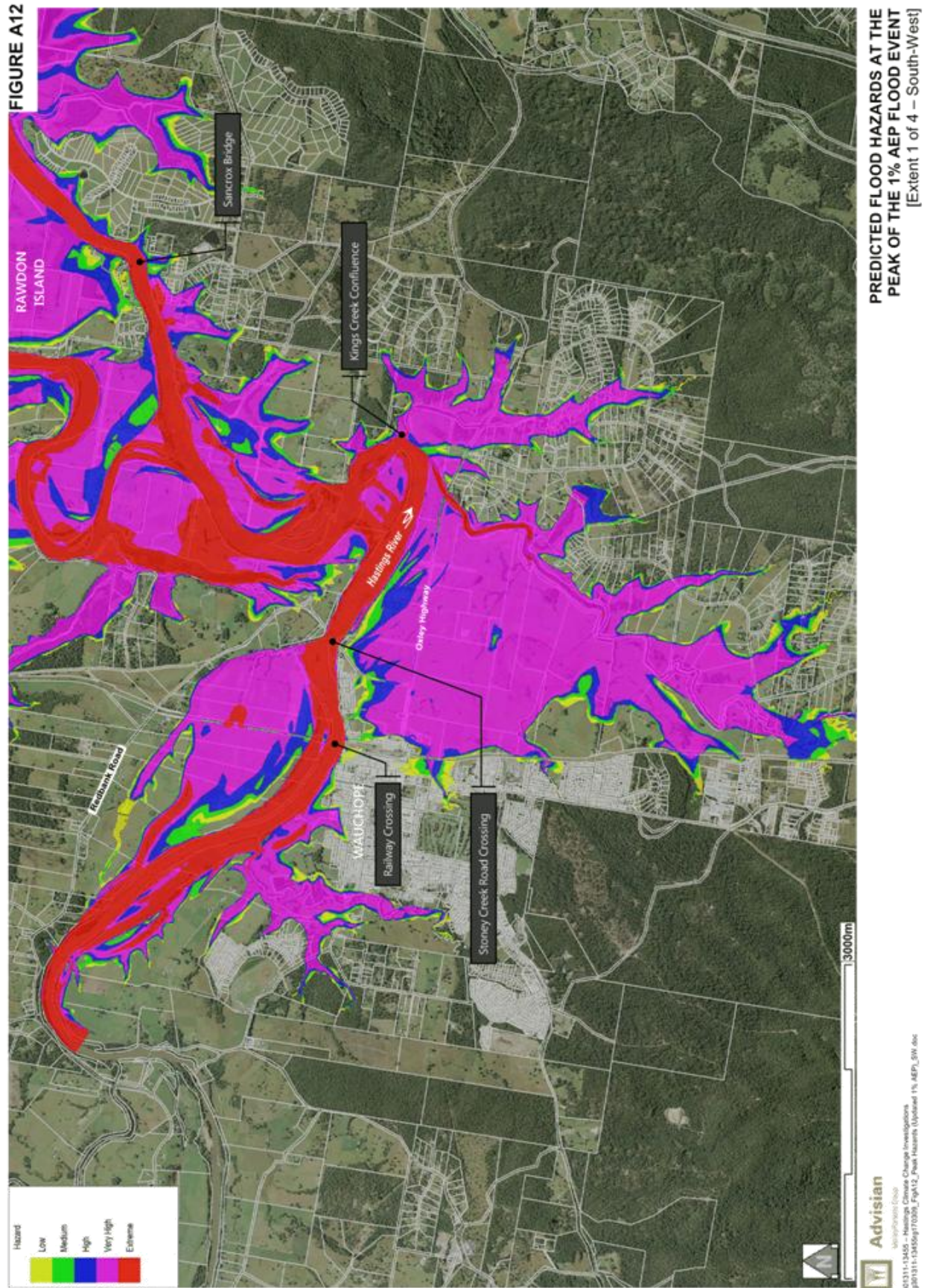
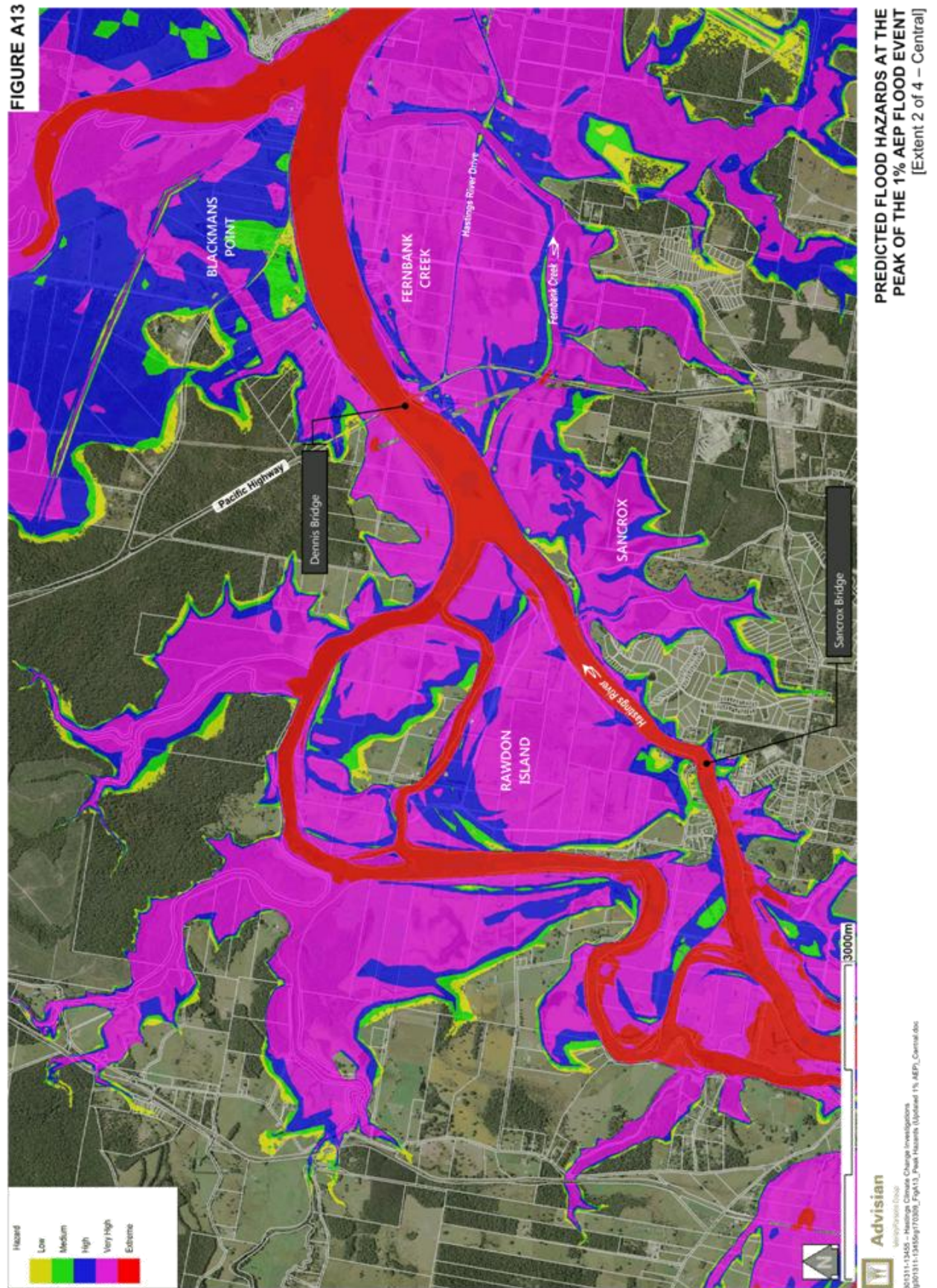
PREDICTED FLOW VELOCITIES AT THE
PEAK OF THE 1% AEP FLOOD EVENT
[Extent 4 of 4 – North-West]

FIGURE A11



PREDICTED FLOOD HAZARDS AT THE
PEAK OF THE 1% AEP FLOOD EVENT
(Based on Updated RMA-2 Model)





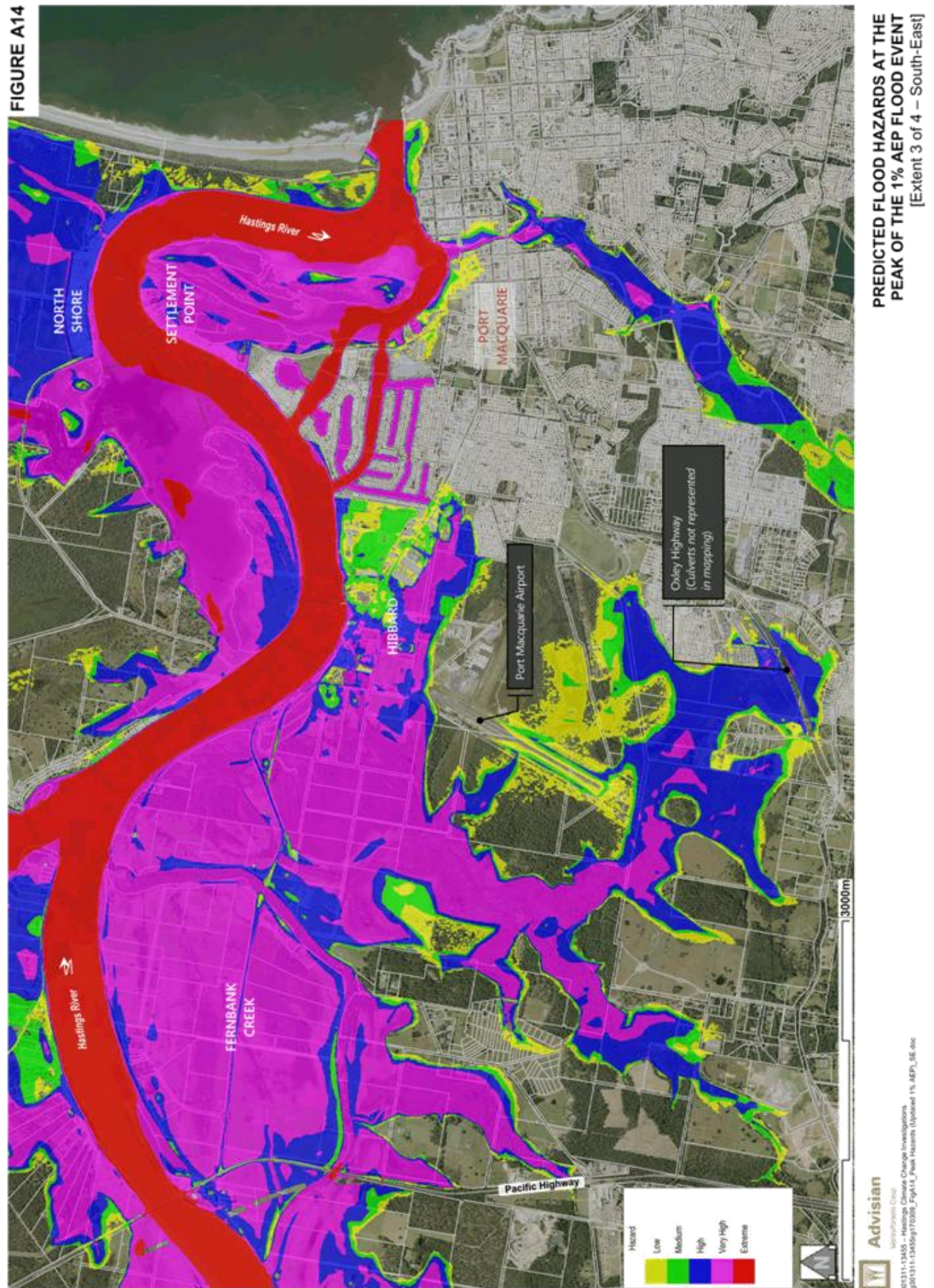
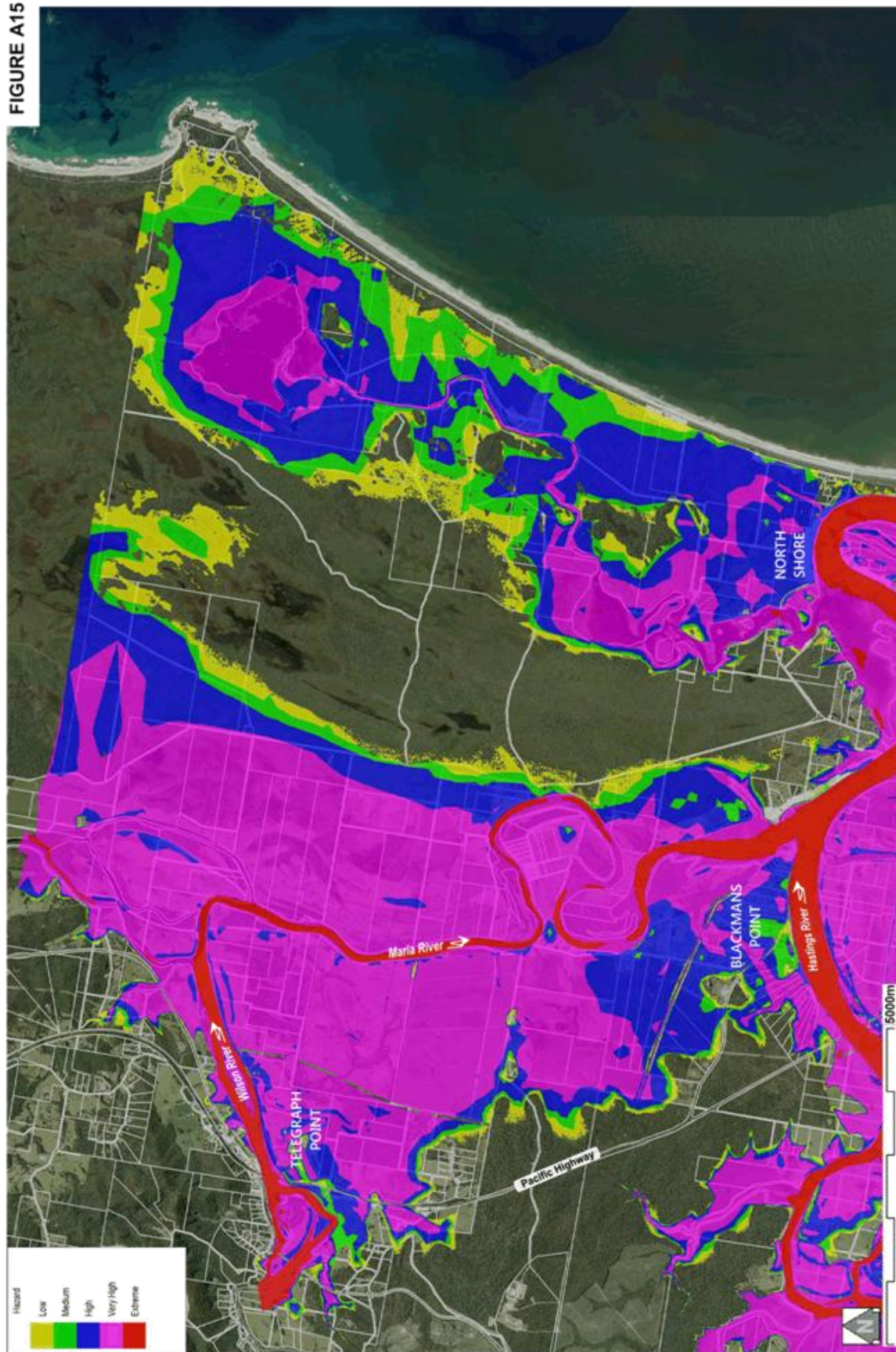
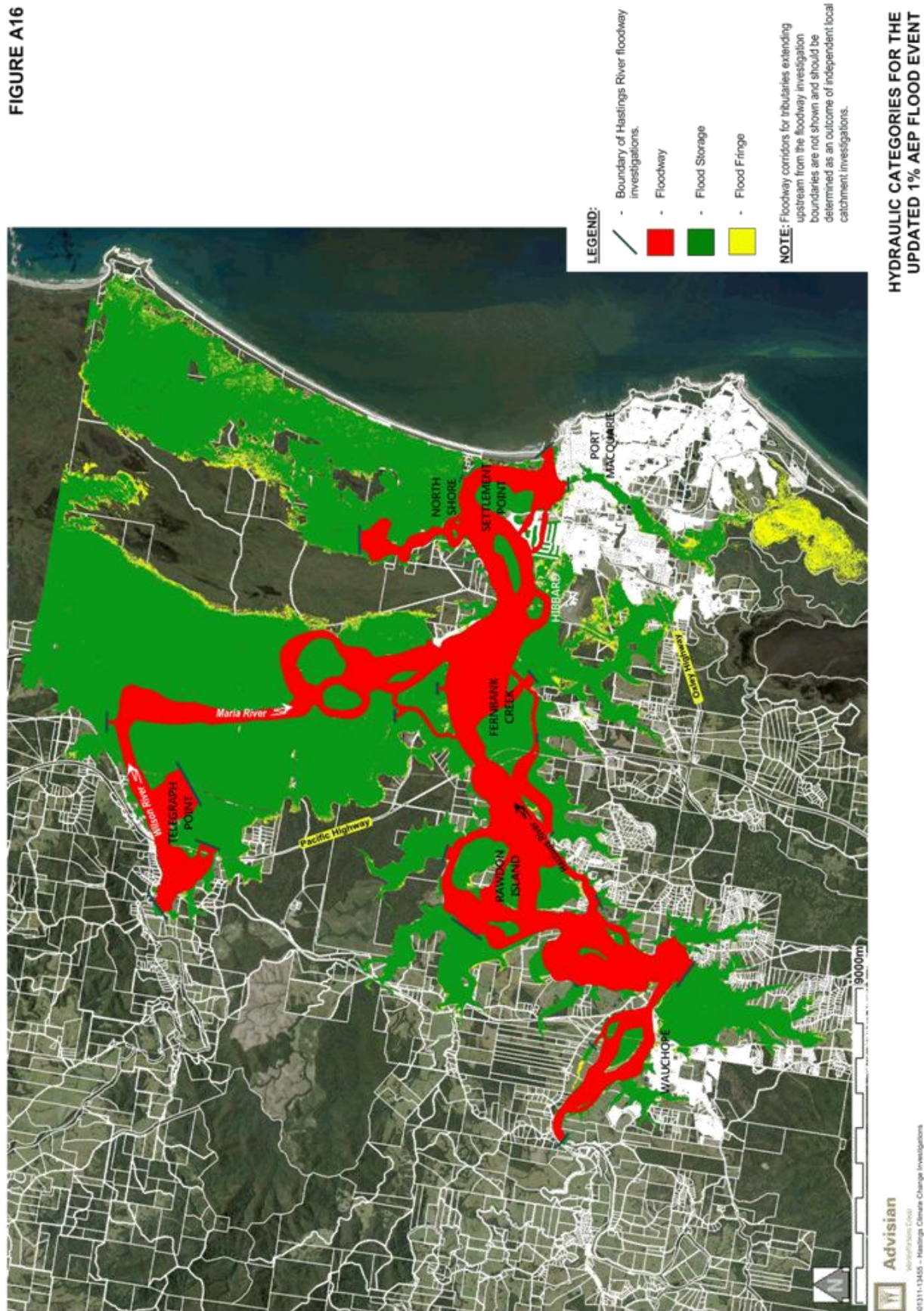


FIGURE A15



PREDICTED FLOOD HAZARDS AT THE
PEAK OF THE 1% AEP FLOOD EVENT
[Extent 4 of 4 – North-West]

FIGURE A16



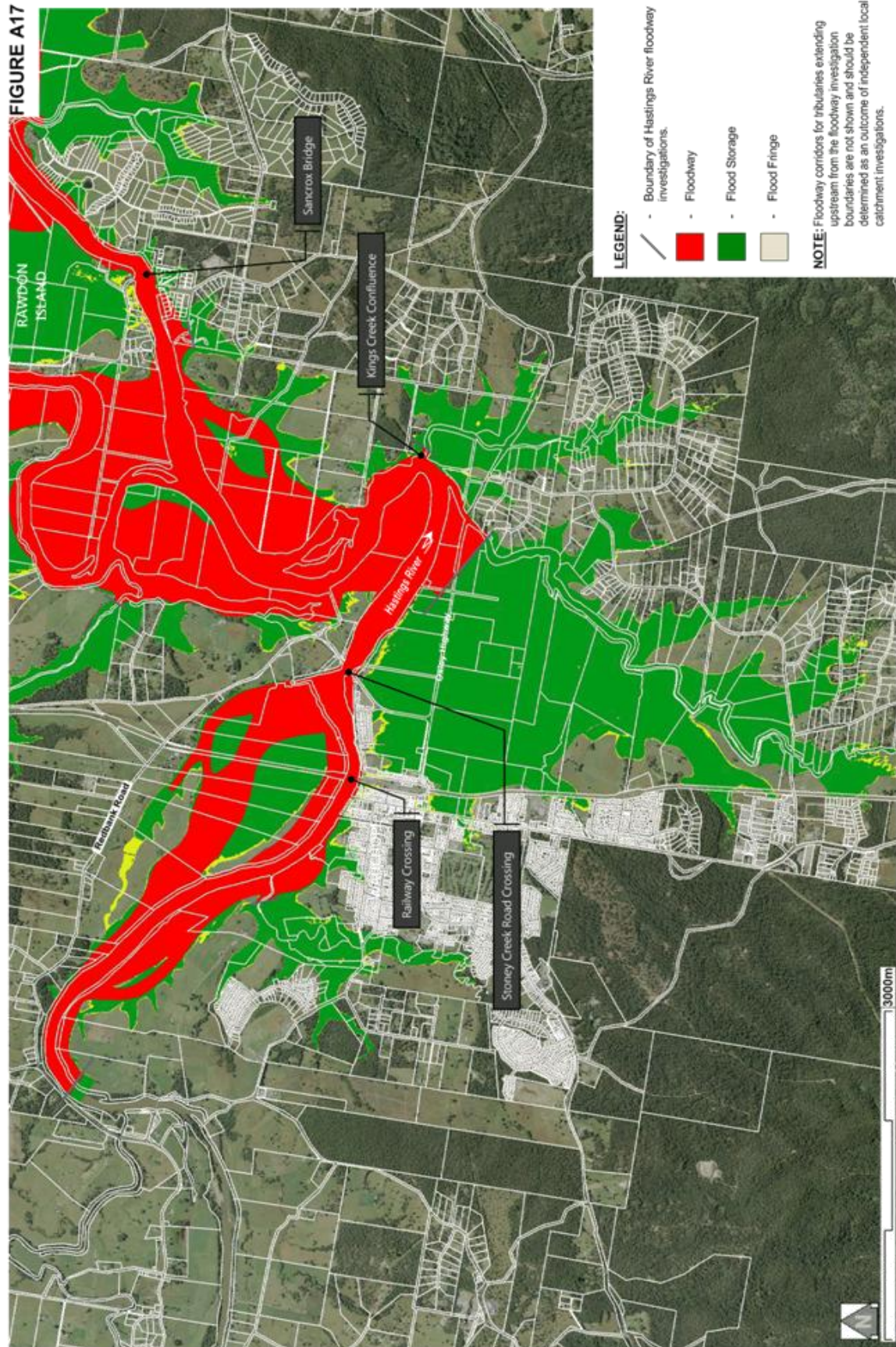
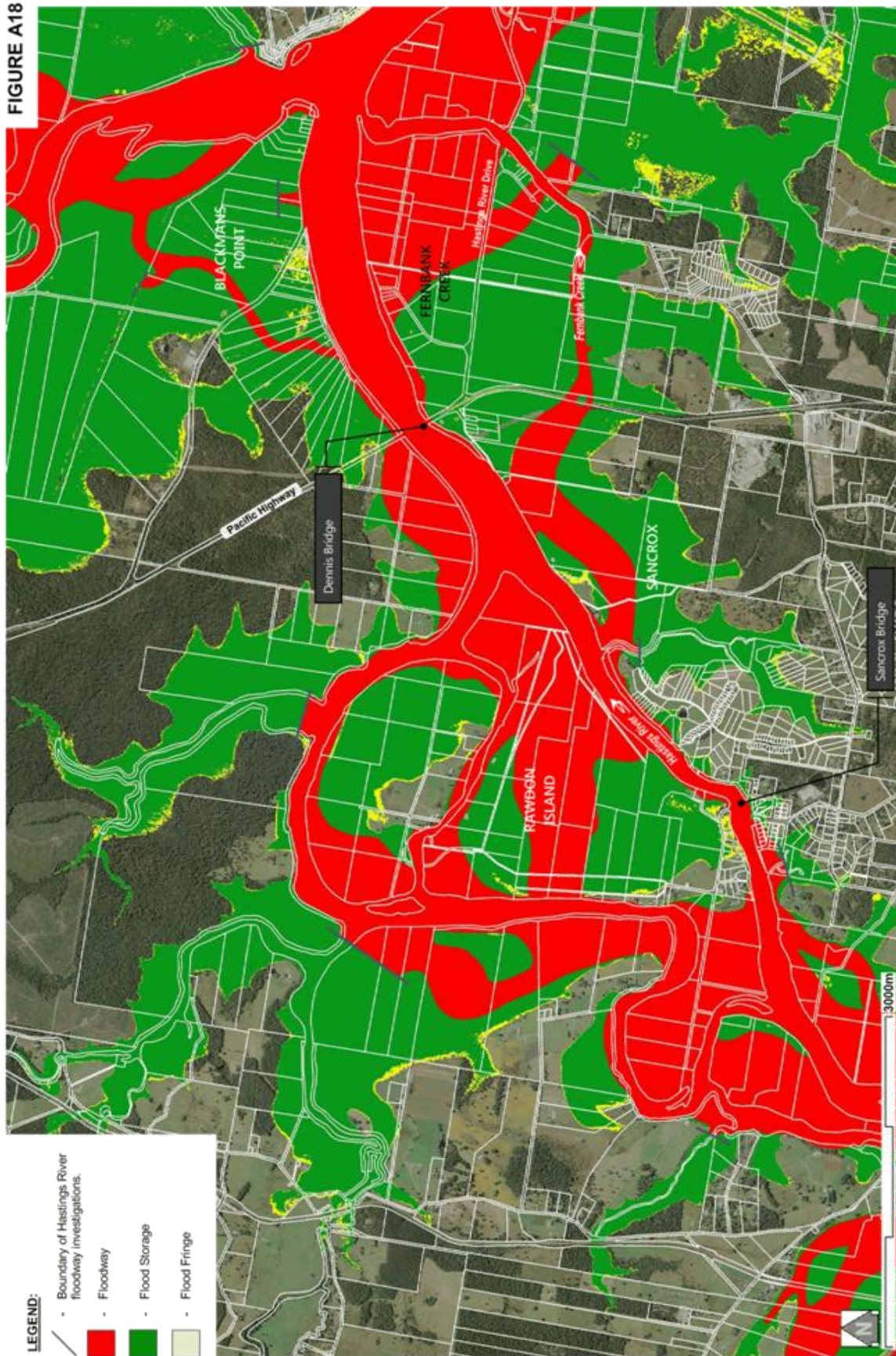
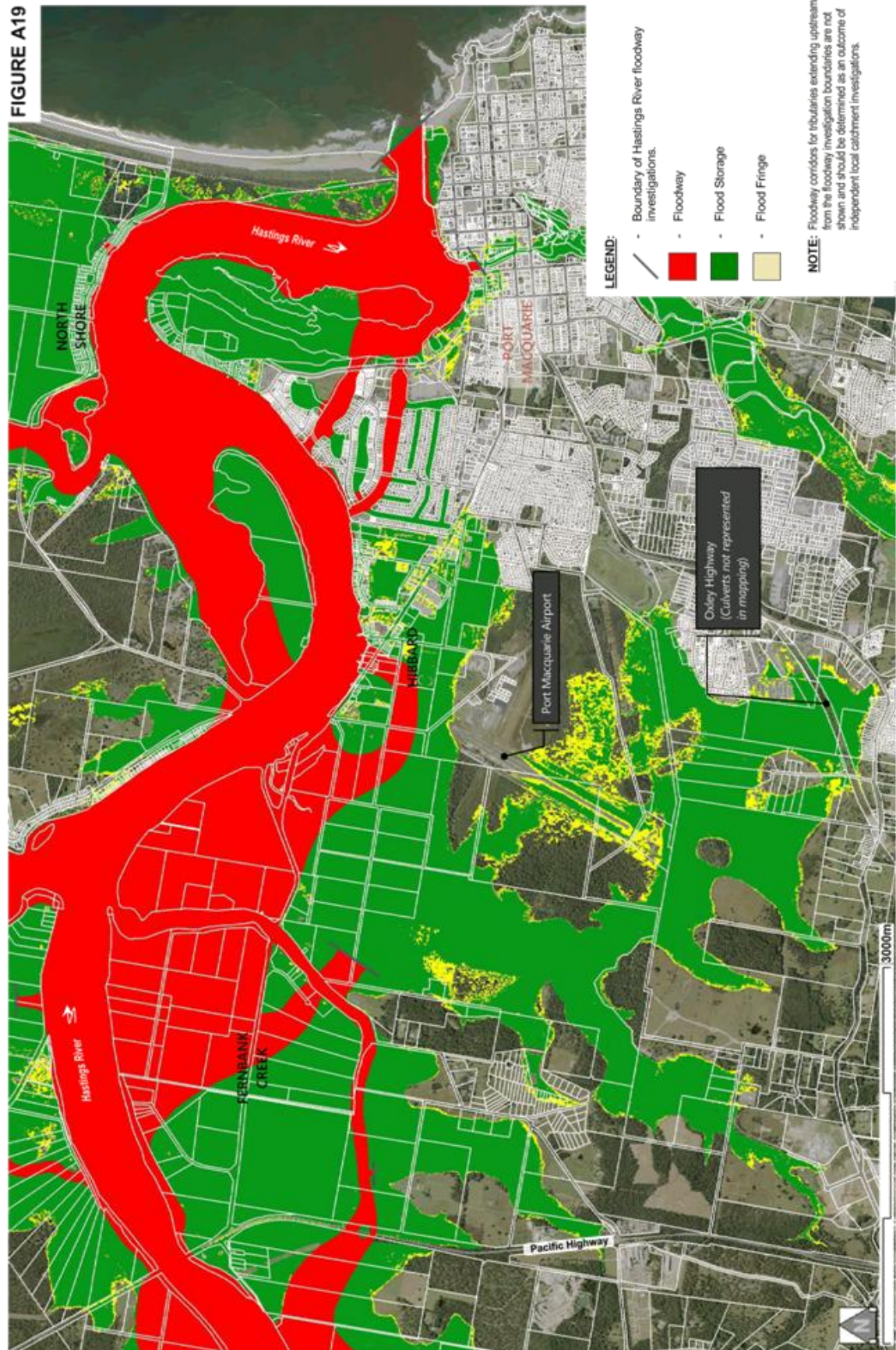


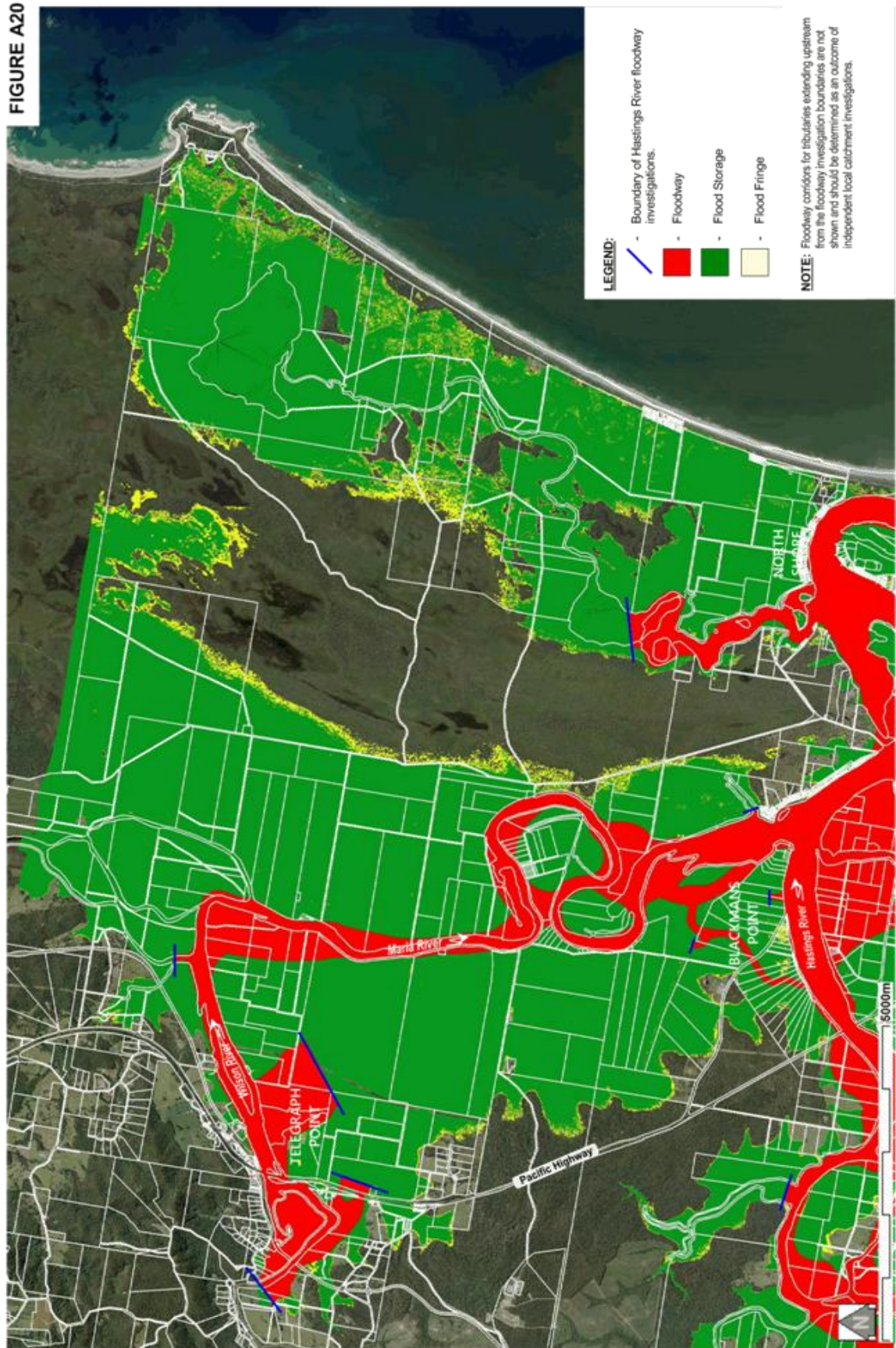
FIGURE A18

HYDRAULIC CATEGORIES FOR THE
UPDATED 1% AEP FLOOD EVENT
[Extent 2 of 4 – Central]



**HYDRAULIC CATEGORIES FOR THE
UPDATED 1% AEP FLOOD EVENT**
[Extent 3 of 4 - South-East]

FIGURE A20



**HYDRAULIC CATEGORIES FOR THE
UPDATED 1% AEP FLOOD EVENT**
[Extent 4 of 4 – North-West]



Advisian
WorleyParsons Group

Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

Appendix B

RMA-2 Boundary Conditions

Inflow Hydrographs and Ocean Boundary Conditions



FIGURE B1

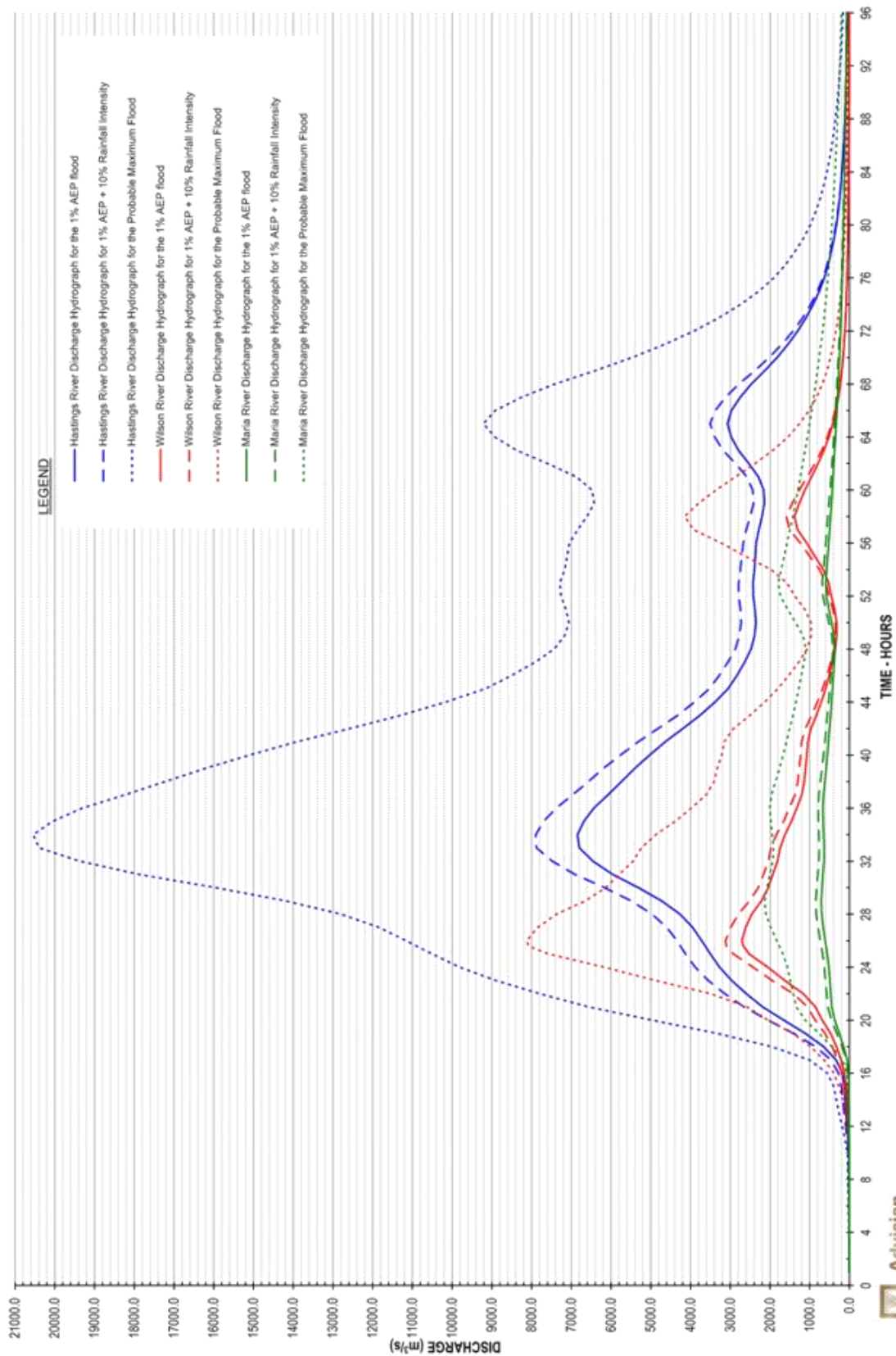
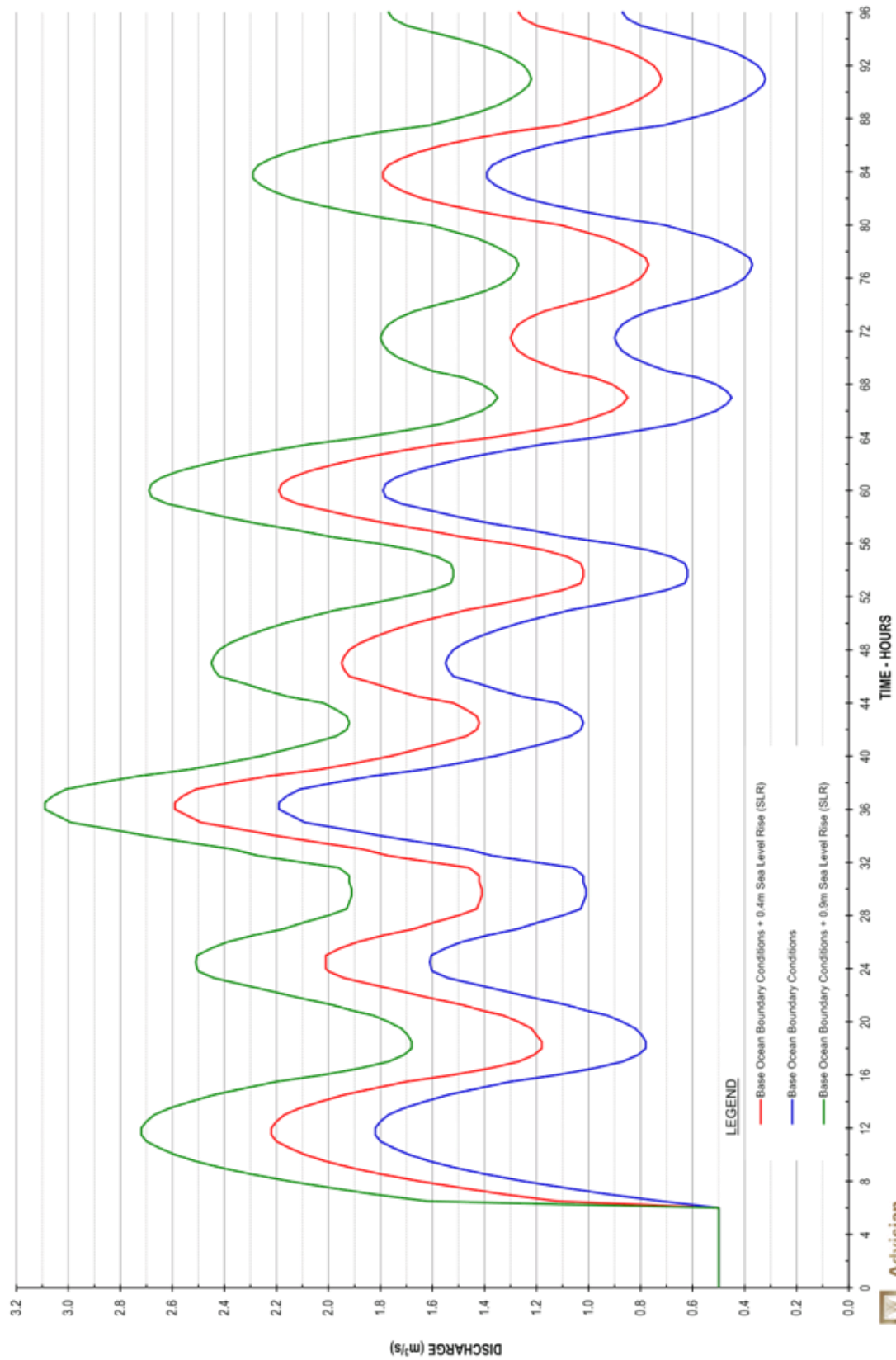


FIGURE B2

TIDAL BOUNDARY CONDITIONS ADOPTED
FOR THE CLIMATE CHANGE INVESTIGATIONS



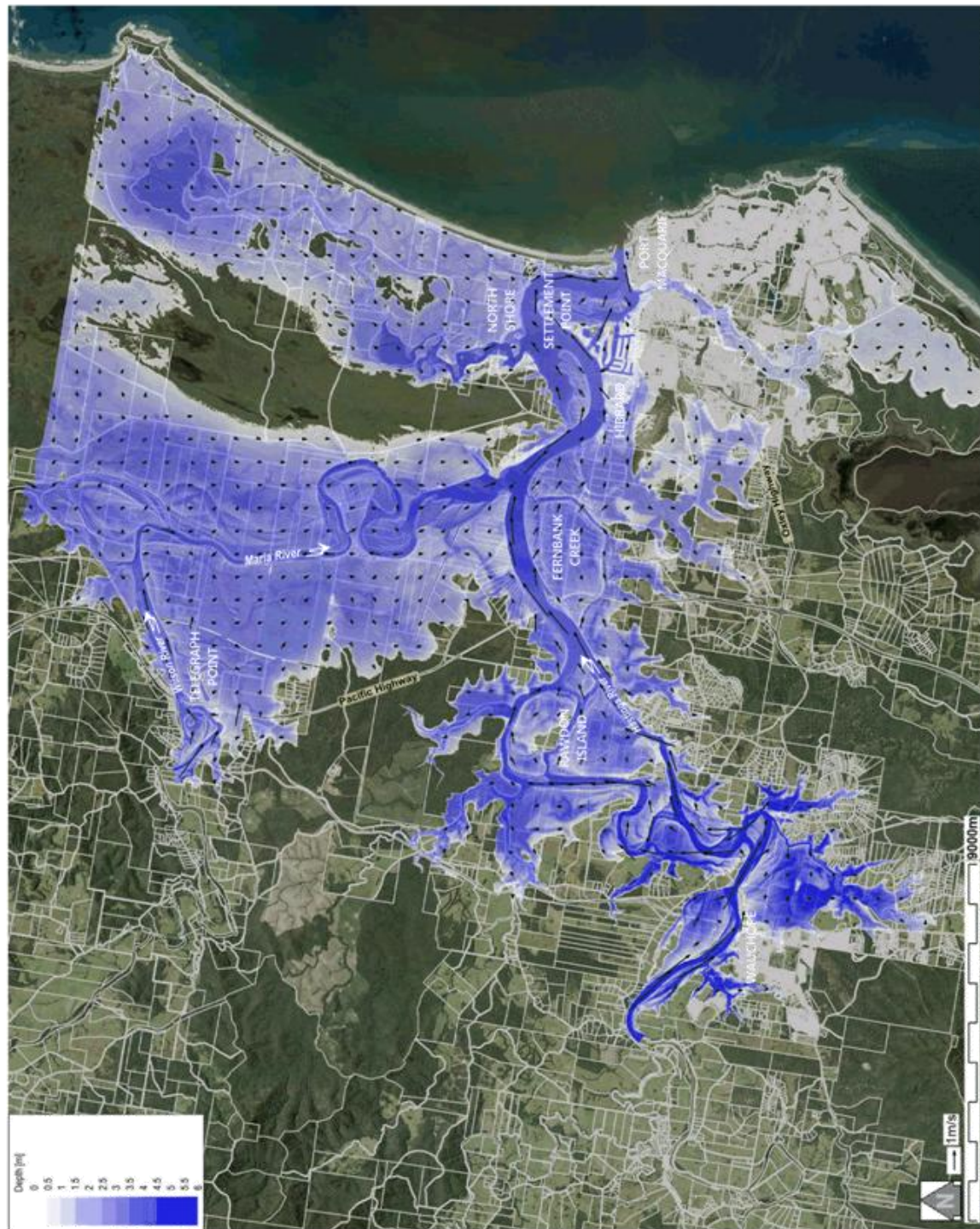
Port Macquarie Hastings Council
Hastings River Flood Study Climate Change
Assessment

Appendix C

Flood Behaviour Plots for Climate Change Scenario 1 (Depths, Velocities, Hazards and Hydraulic Categories)



FIGURE C1

PREDICTED FLOOD DEPTHS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 1
(Based on Updated RMA-2 Model)

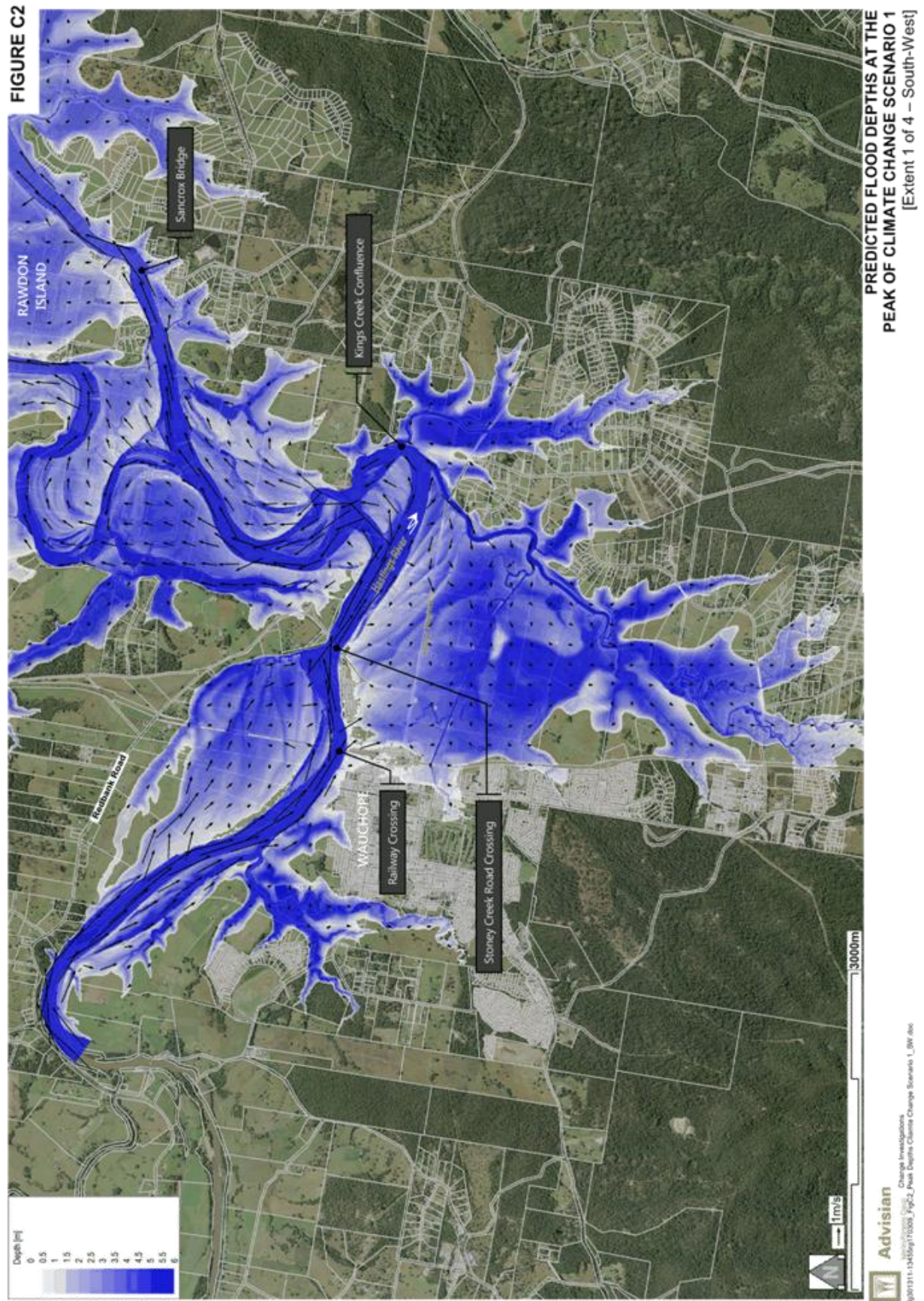
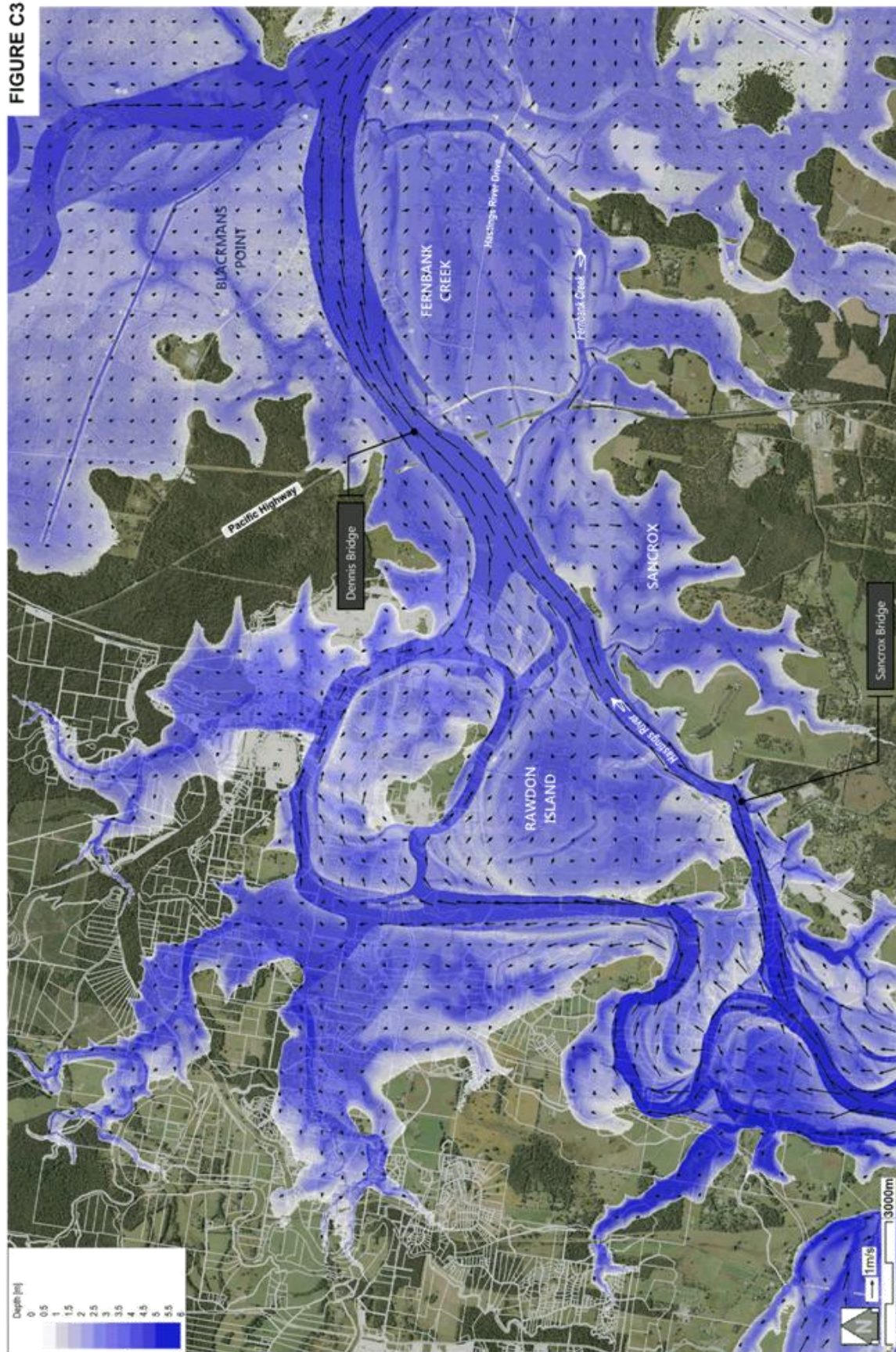


FIGURE C3



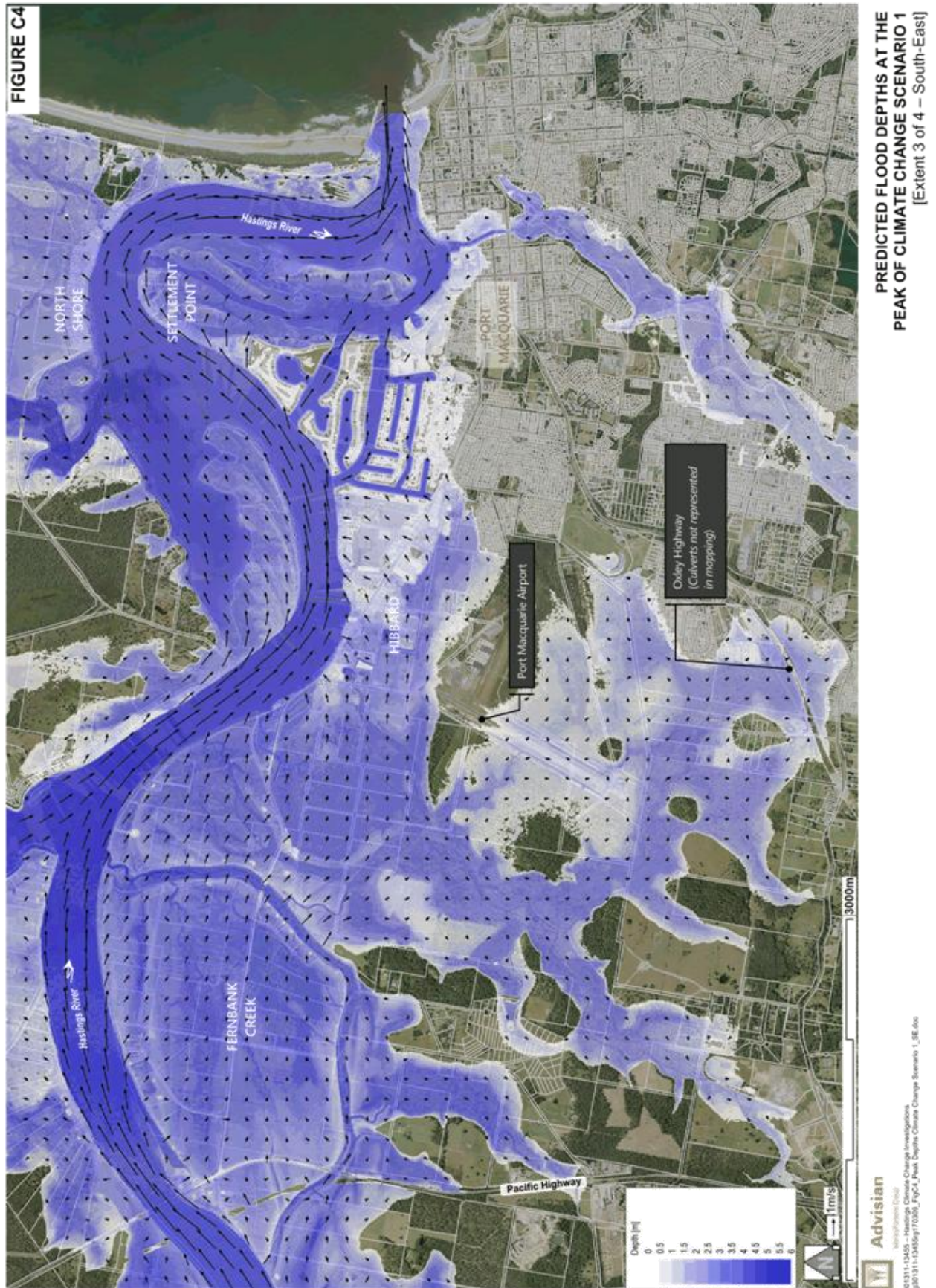


FIGURE C5

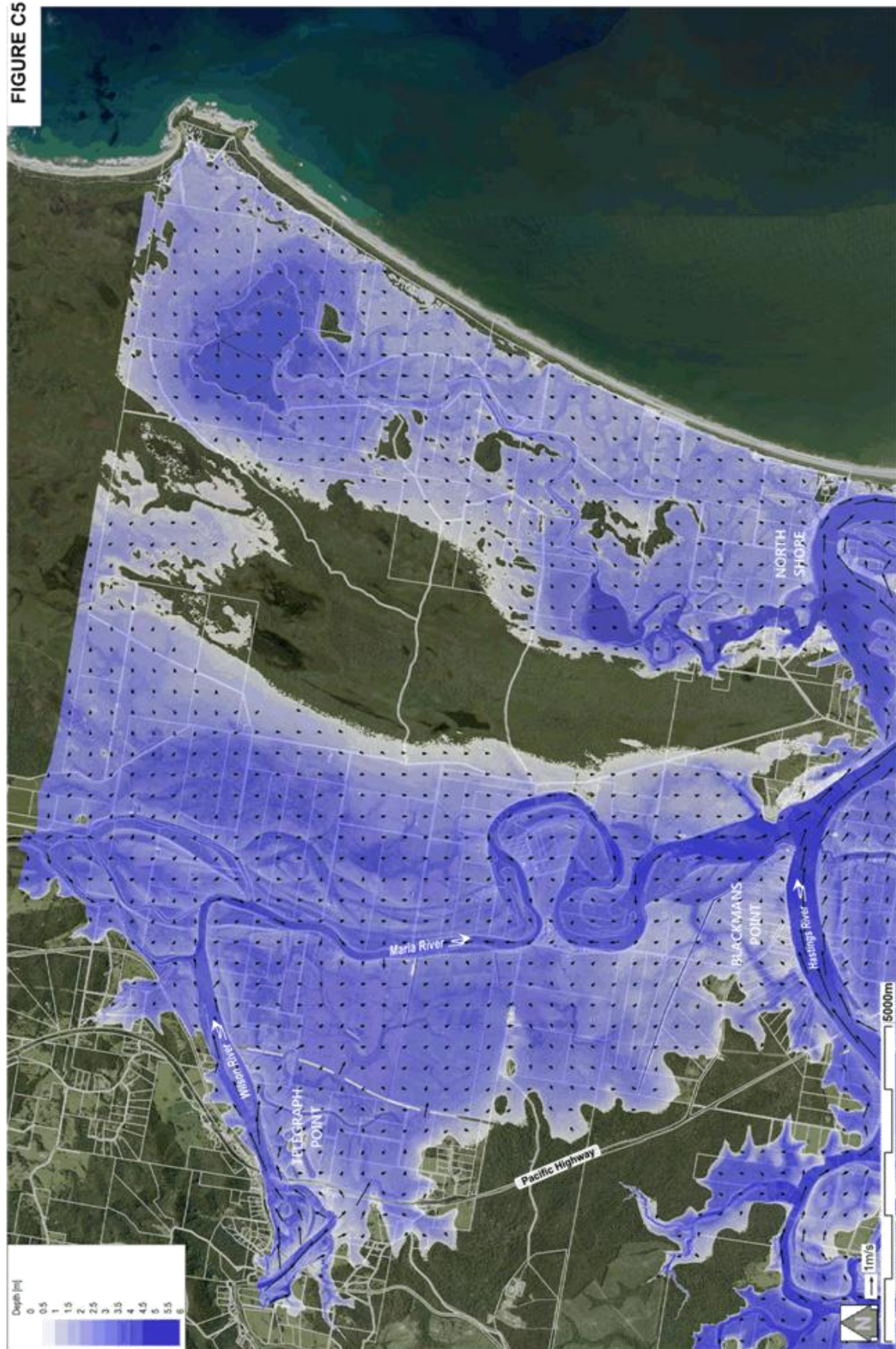
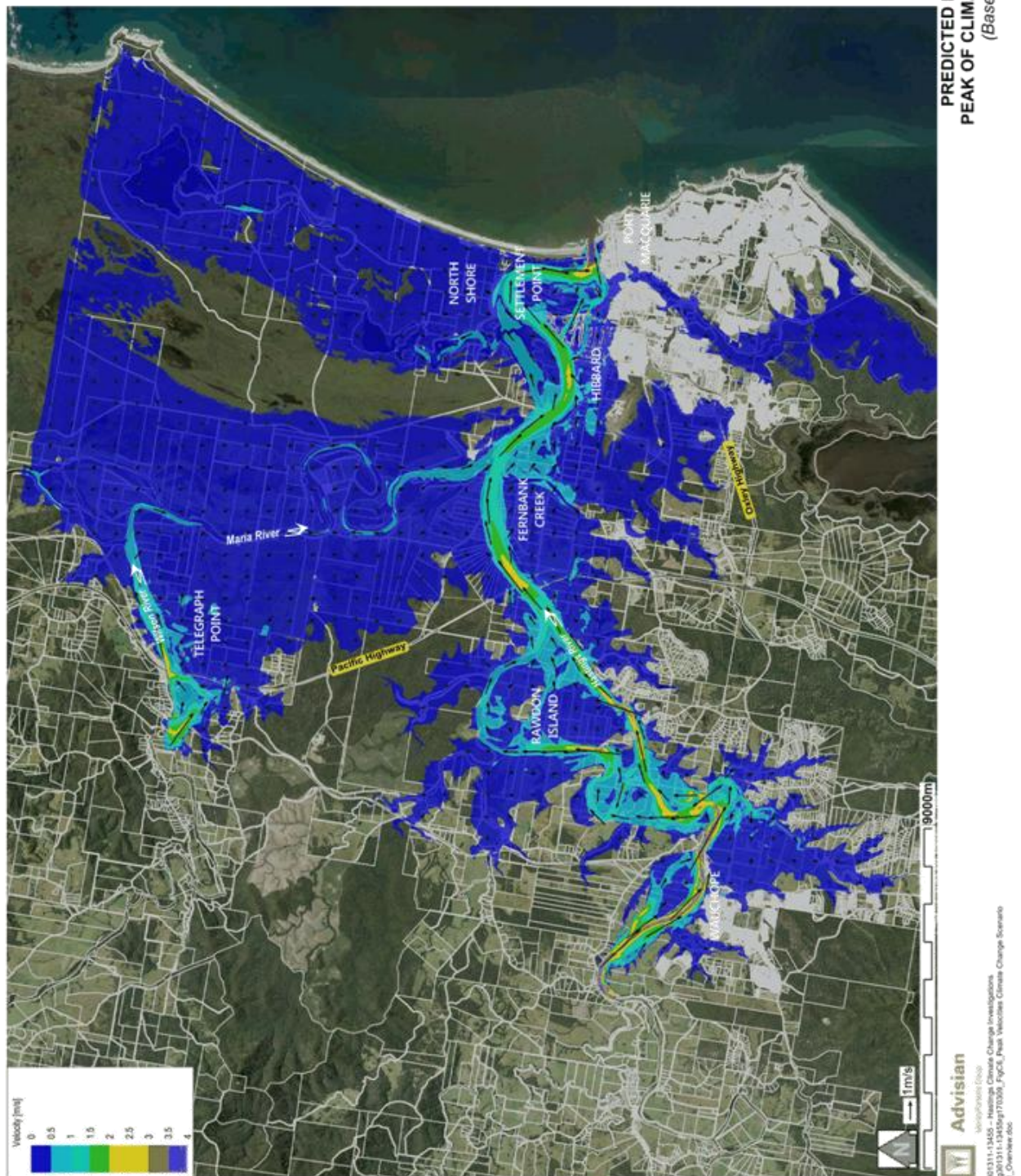
PREDICTED FLOOD DEPTHS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 1
[Extent 4 of 4 - North-West]

FIGURE C6



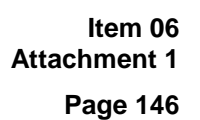


FIGURE C8

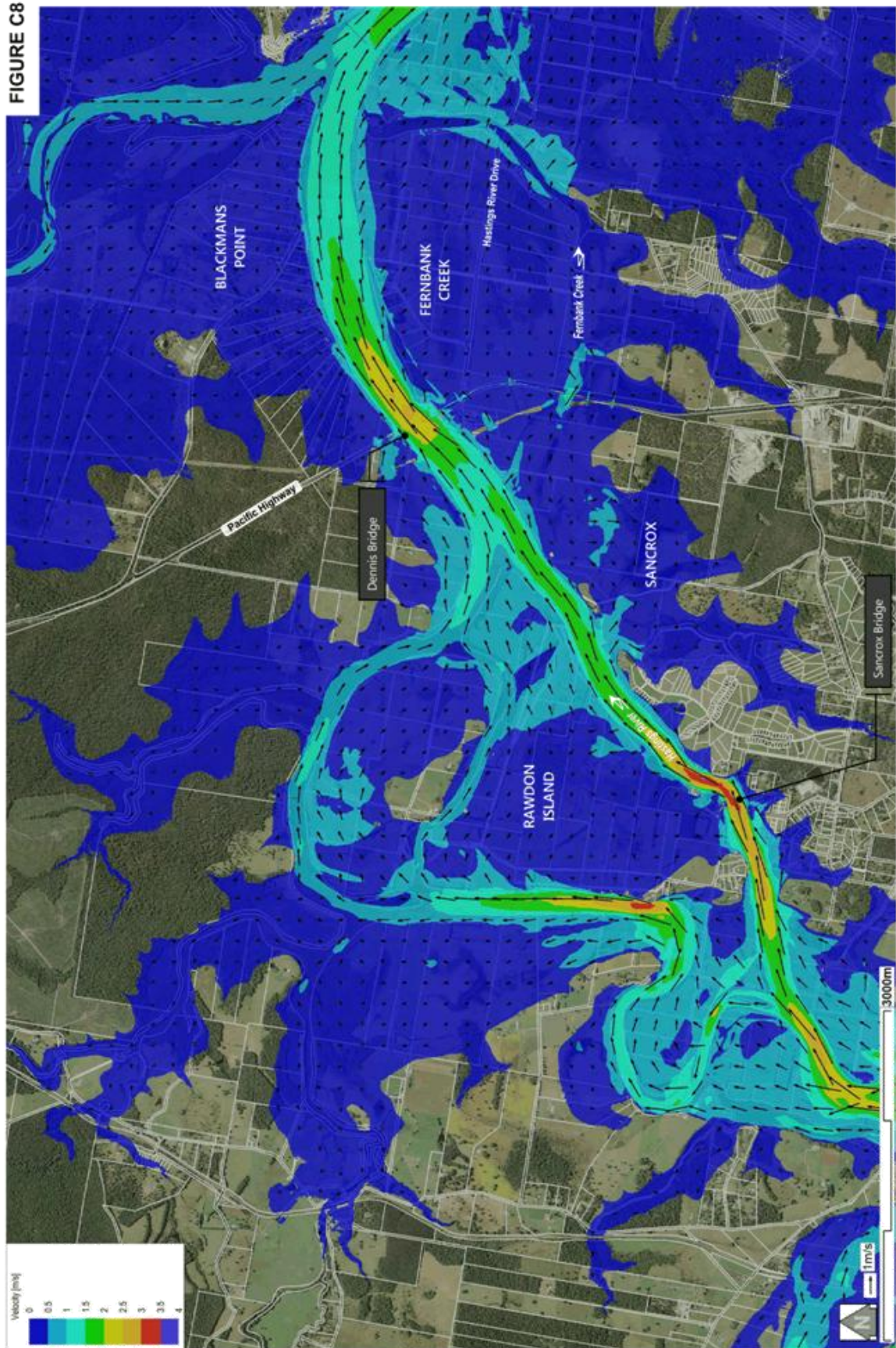
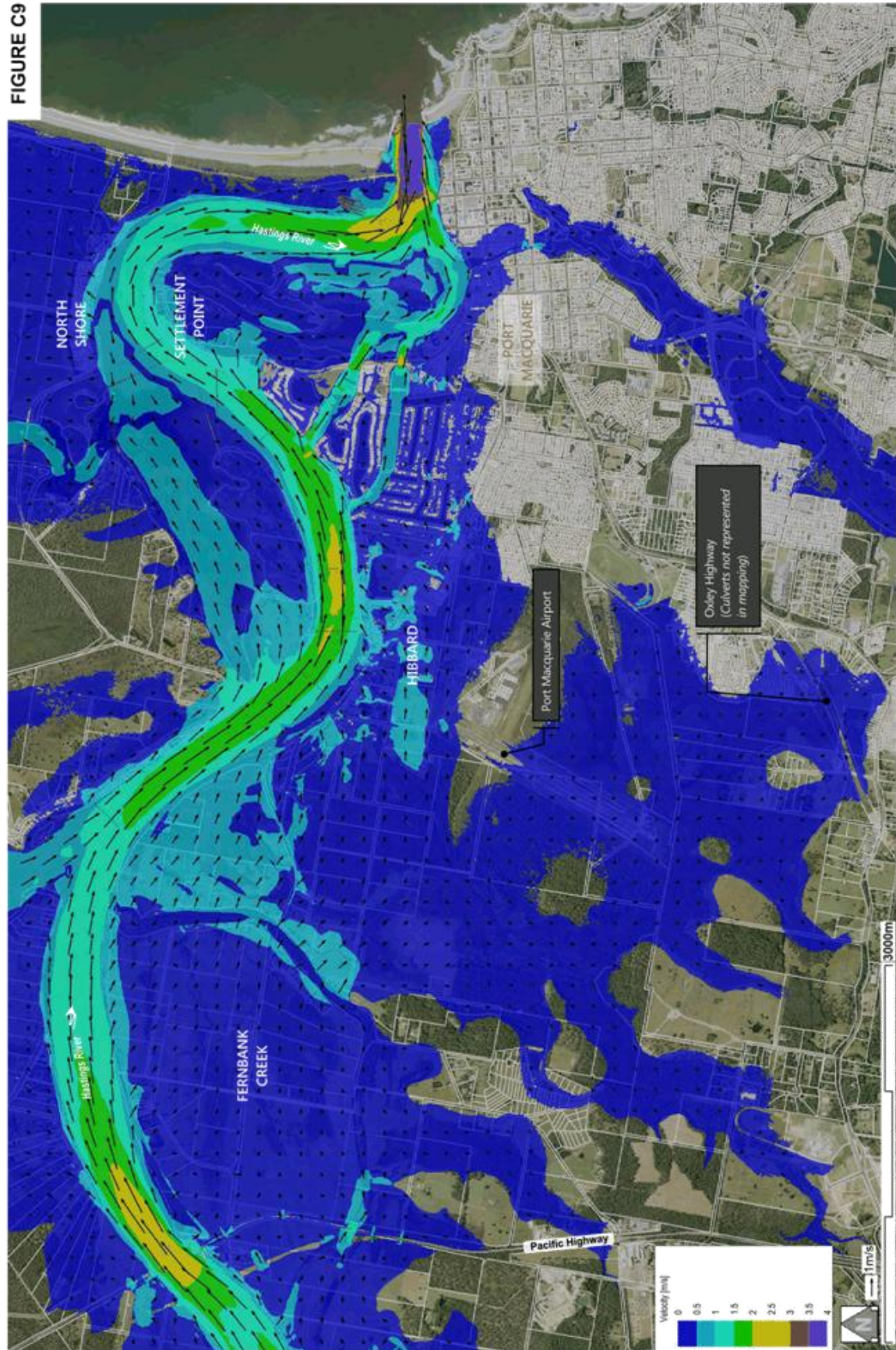
PREDICTED FLOW VELOCITIES AT THE
PEAK OF CLIMATE CHANGE SCENARIO 1
[Extent 2 of 4 - Central]

FIGURE C9

PREDICTED FLOW VELOCITIES AT THE
PEAK OF CLIMATE CHANGE SCENARIO 1
[Extent 3 of 4 – South-East]

Advisian
Marine & Coastal Group

30/03/17-13455 - Hastings Climate Change Investigations
19/03/17-13455-1710300_FigC9_Peak Velocities Climate Change Scenario
1_Ext 3 of 4

FIGURE C10

PREDICTED FLOW VELOCITIES AT THE
PEAK OF CLIMATE CHANGE SCENARIO 1
[Extent 4 of 4 – North-West]

FIGURE C11

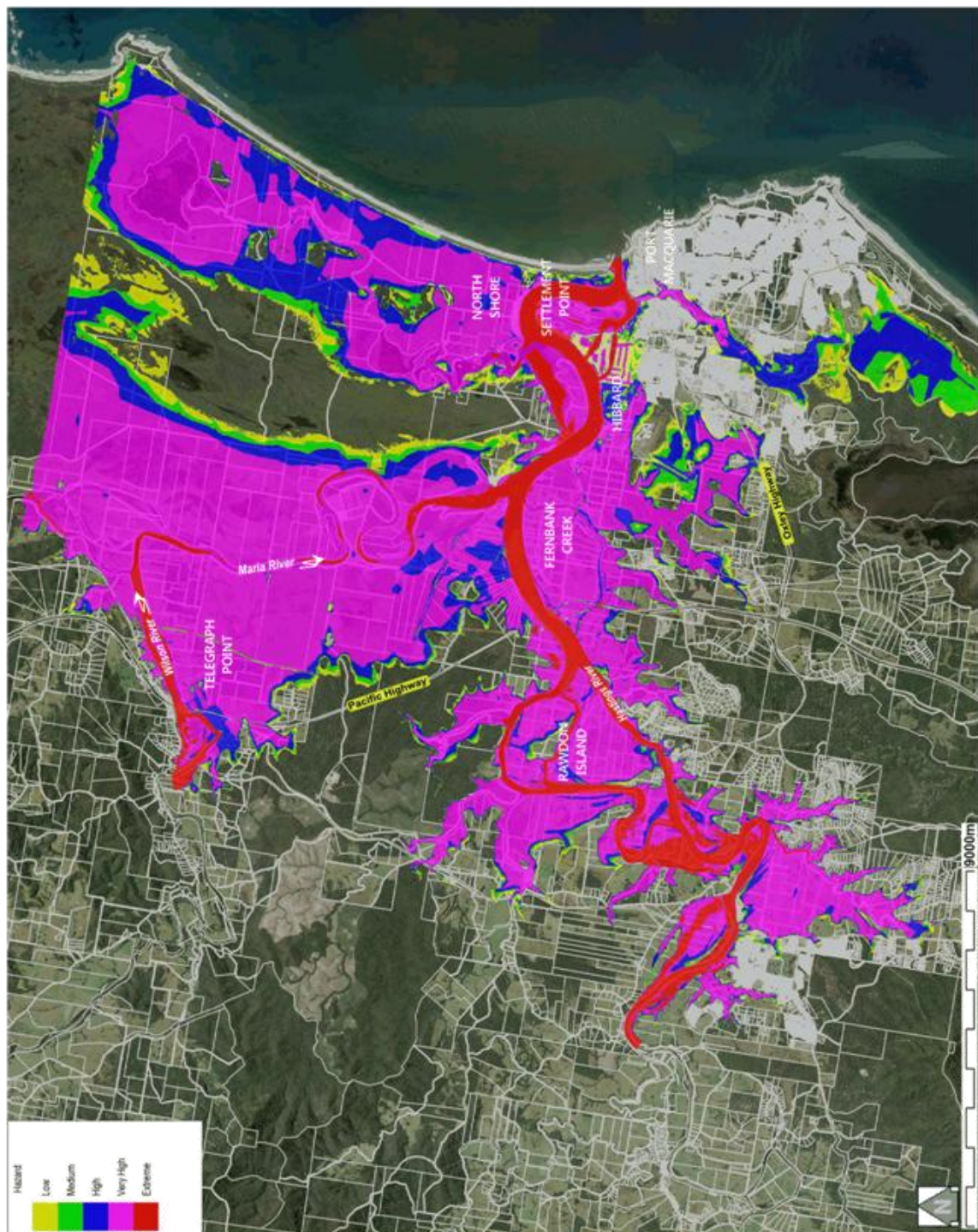
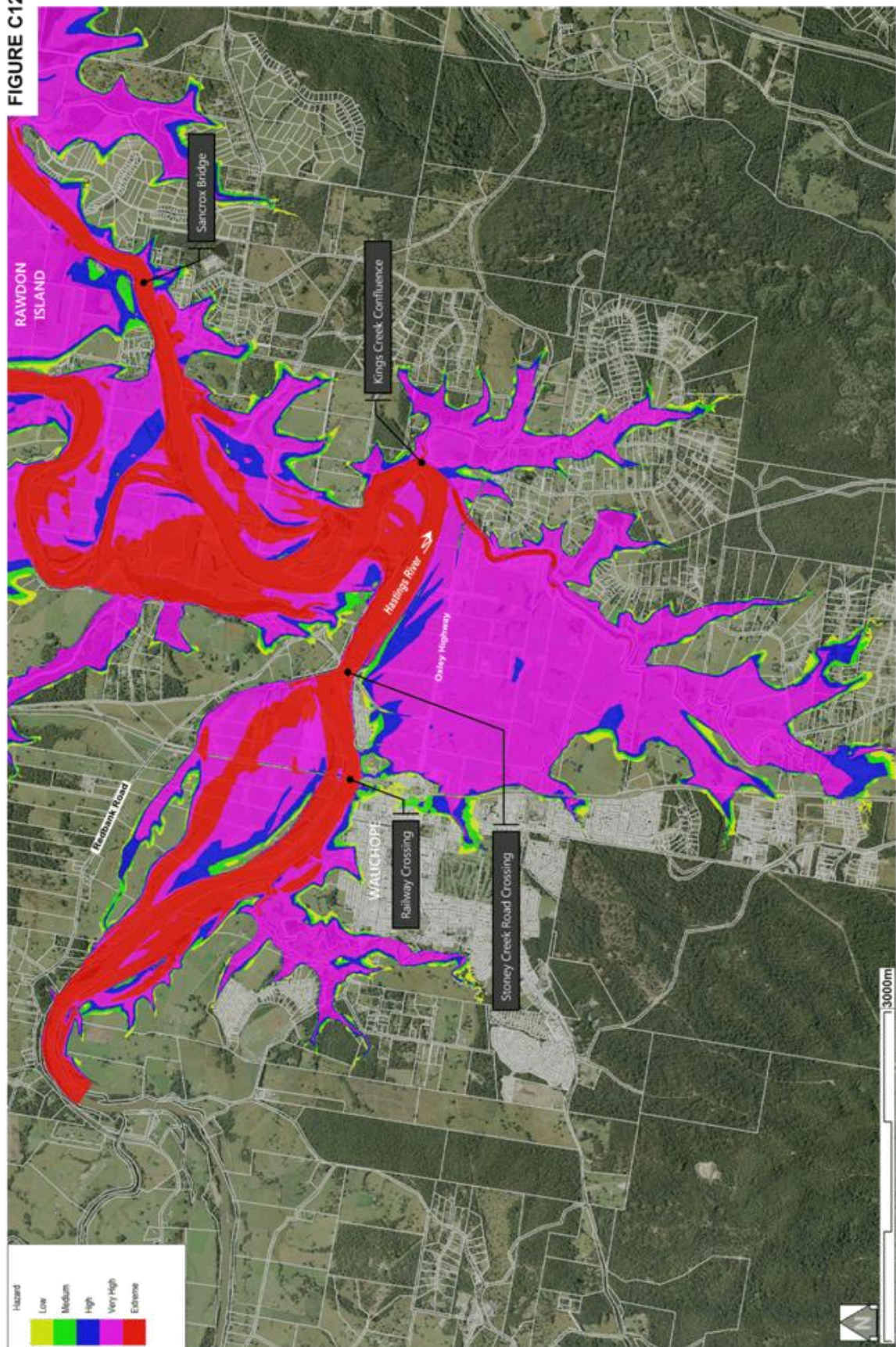
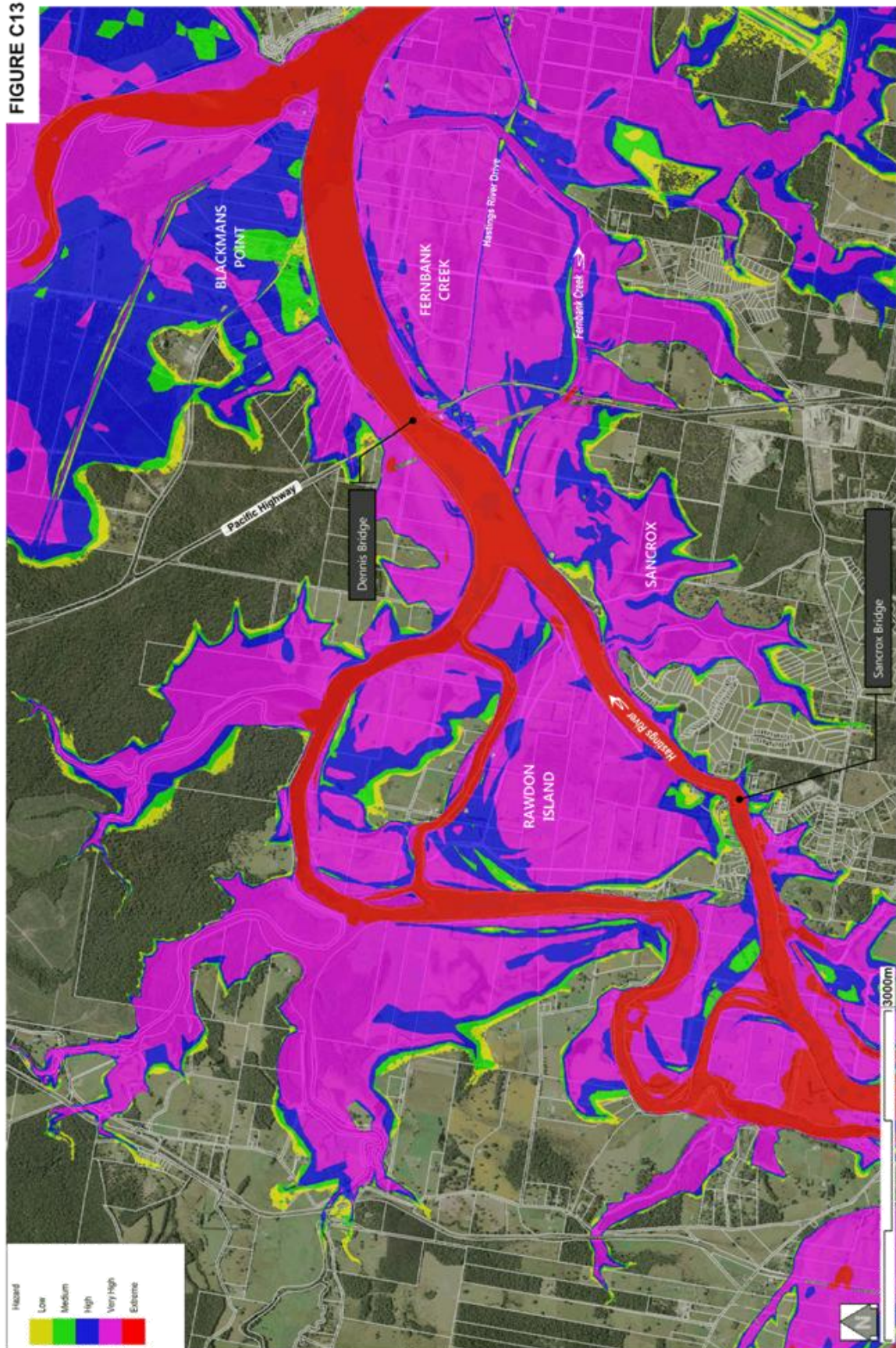


FIGURE C12



PREDICTED FLOOD HAZARDS AT THE
PEAK OF THE CLIMATE CHANGE SCENARIO 1
[Extent 1 of 4 – South-West]

FIGURE C13

PREDICTED FLOOD HAZARDS AT THE
PEAK OF THE CLIMATE CHANGE SCENARIO 1
[Extent 2 of 4 - Central]

Advisian
 30/03/17 13:45 - Hastings Climate Change Investigations
 19/03/17 13:45 - Hastings Climate Change Investigations
 19/03/17 13:45 - Hastings Climate Change Investigations

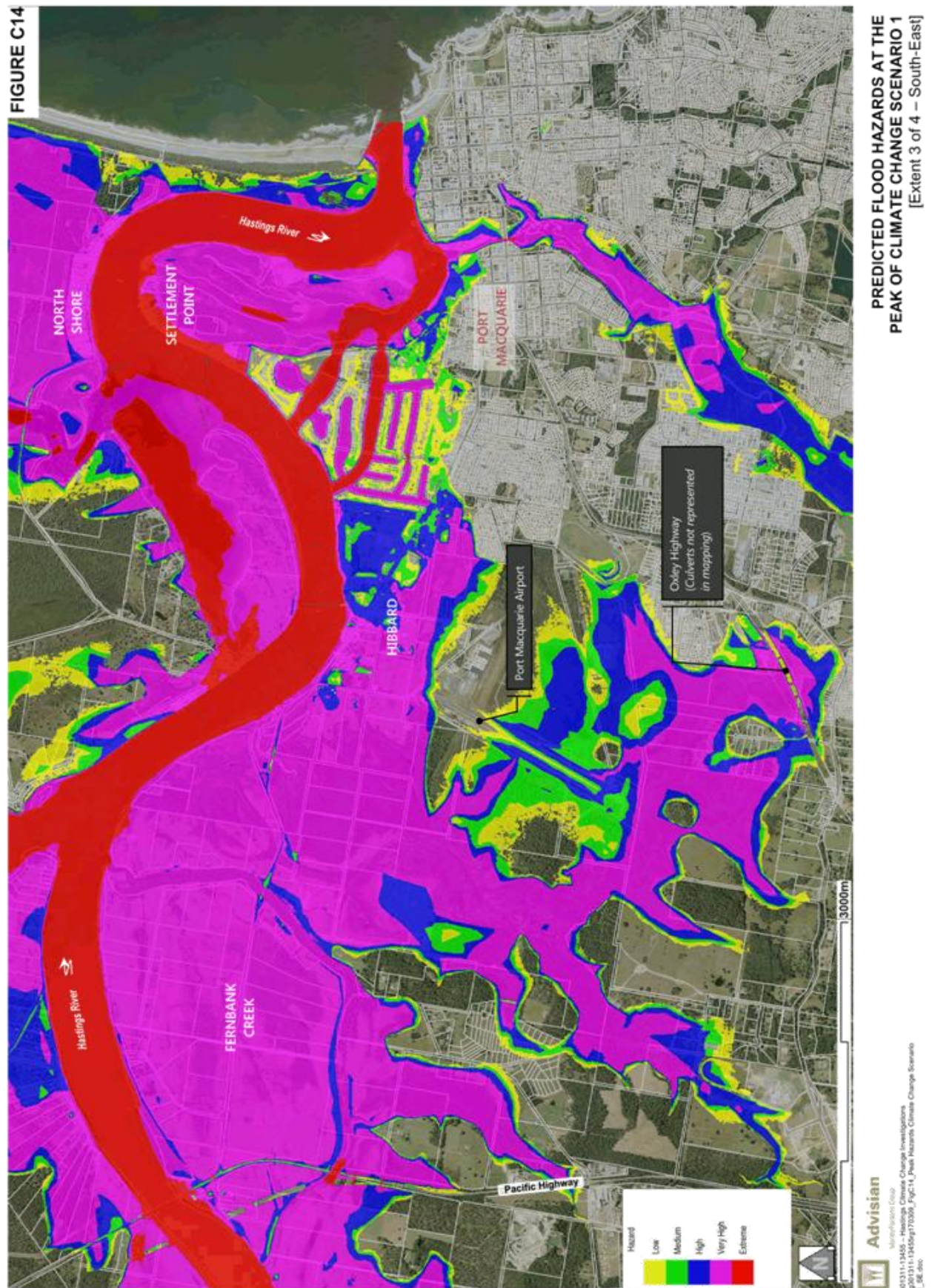


FIGURE C15

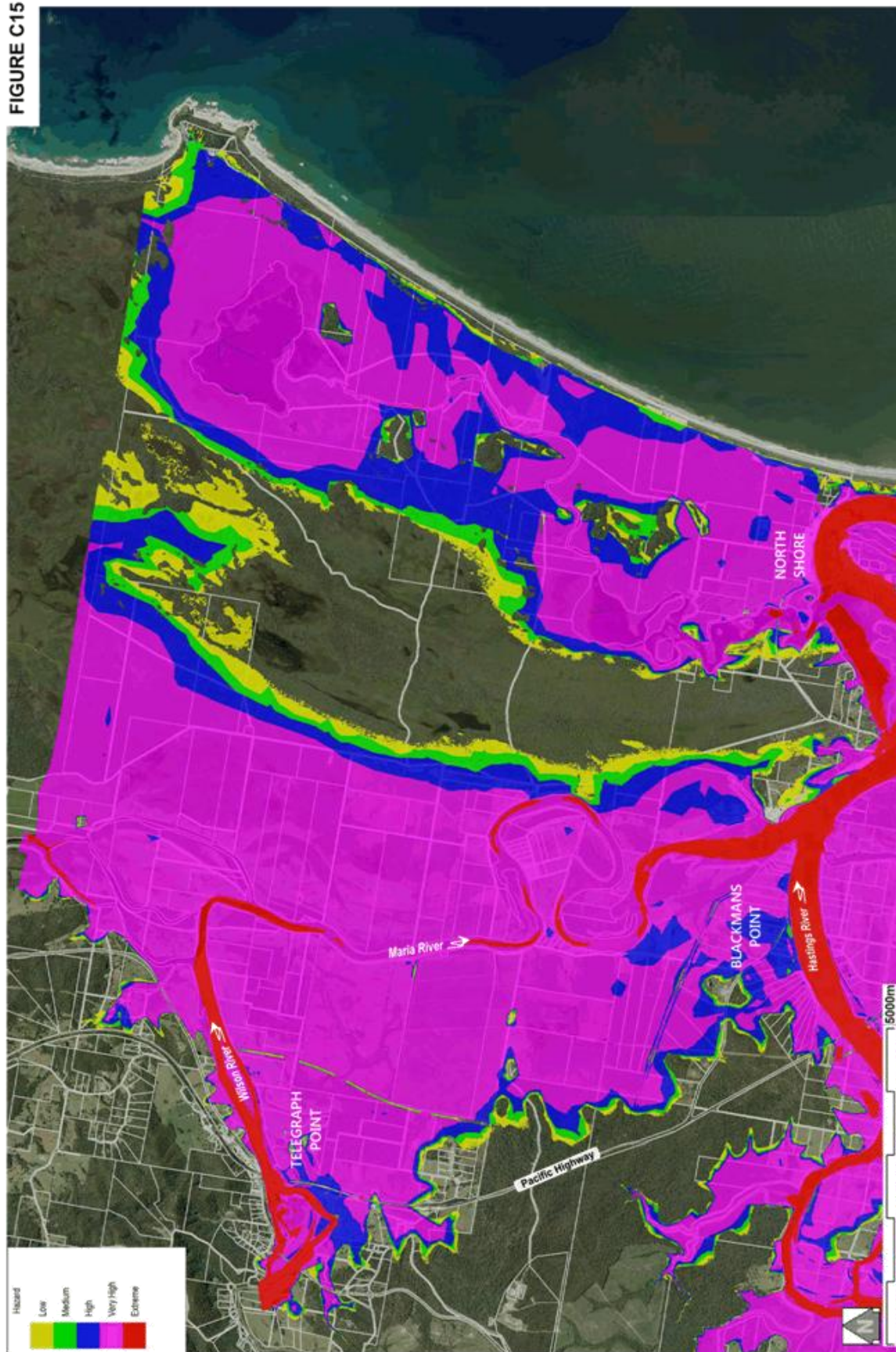
PREDICTED FLOOD HAZARDS AT THE
PEAK OF CLIMATE CHANGE SCENARIO 1
[Extent 4 of 4 - North-West]

FIGURE C16

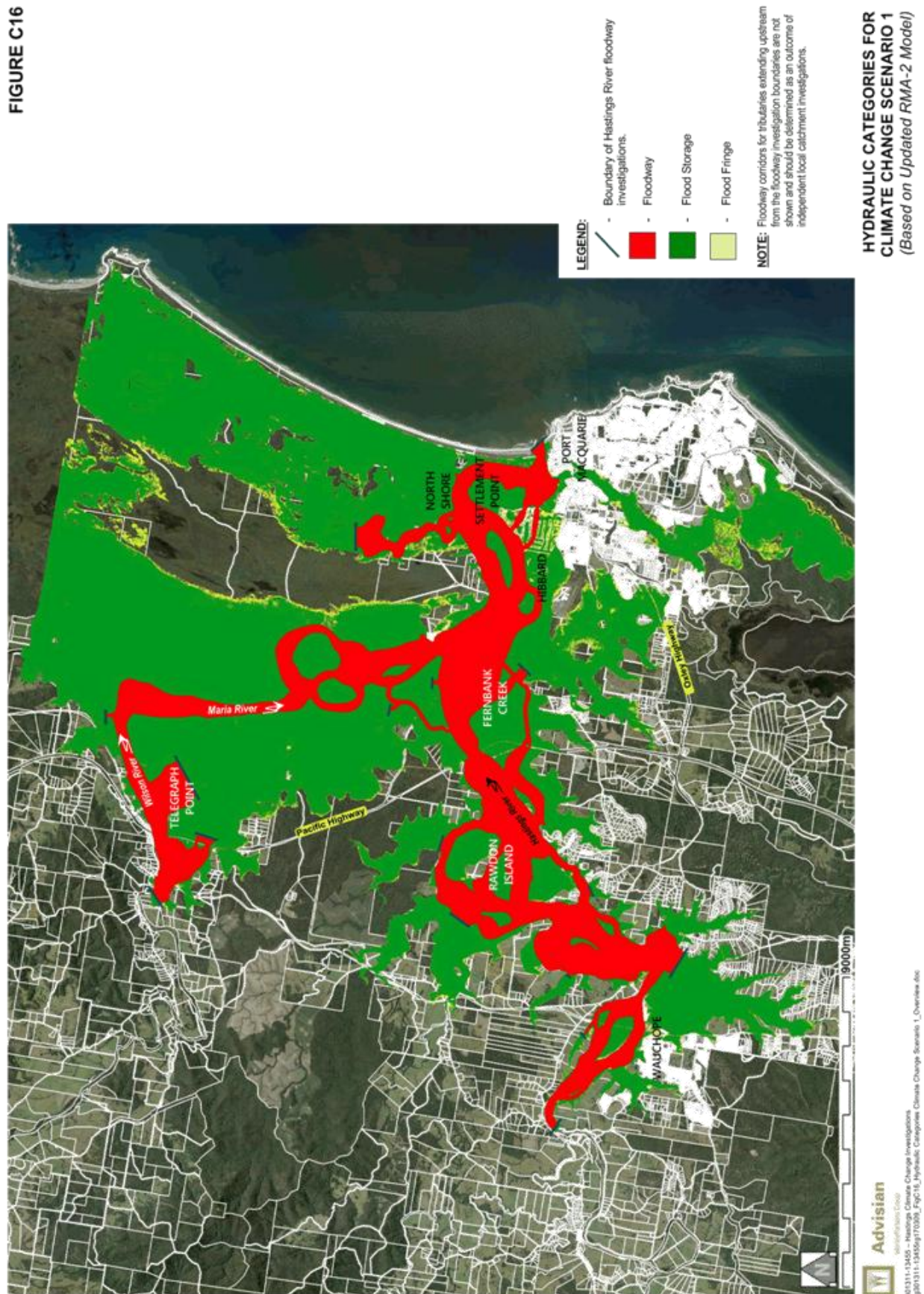


FIGURE C17

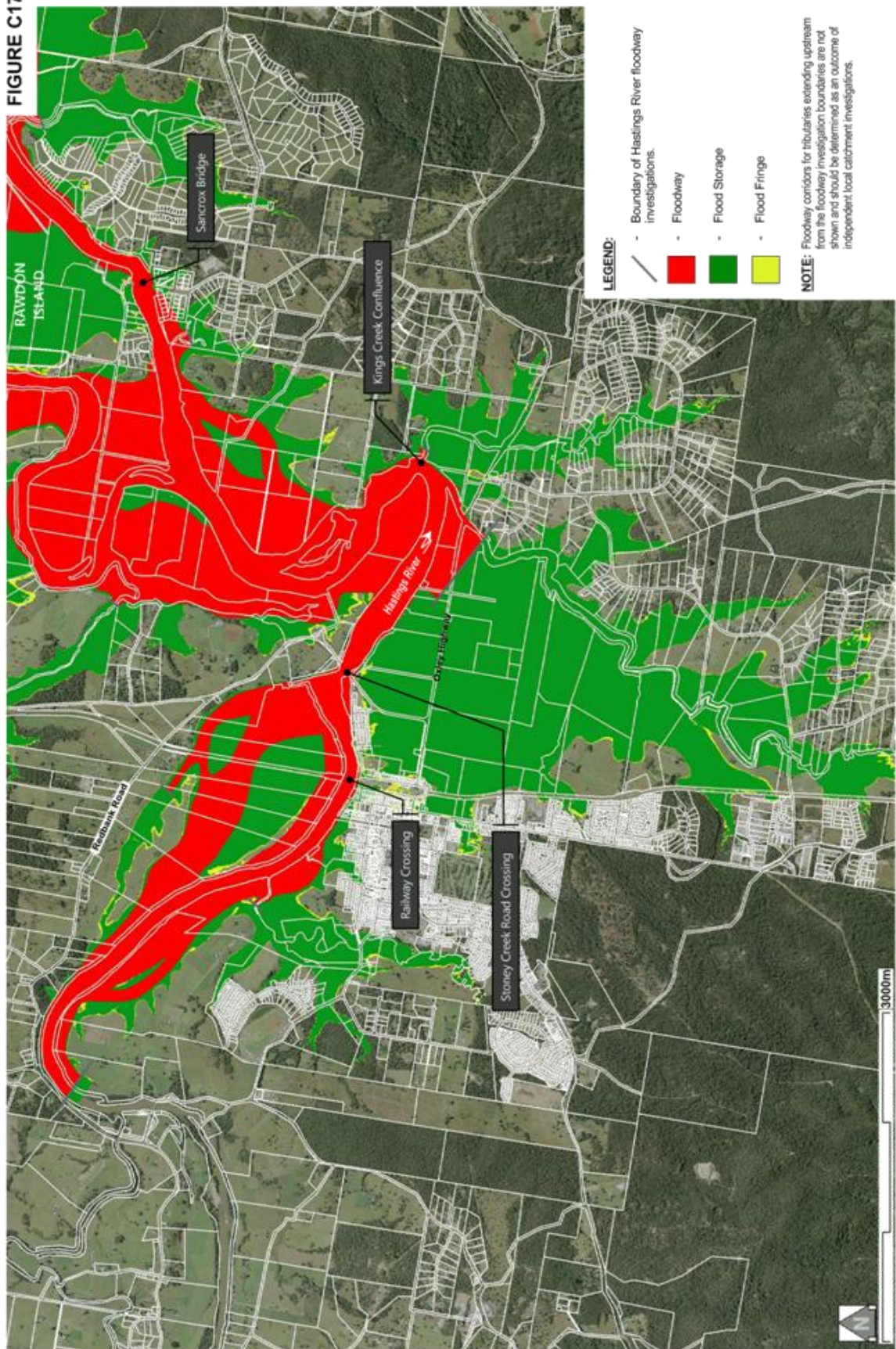


FIGURE C18

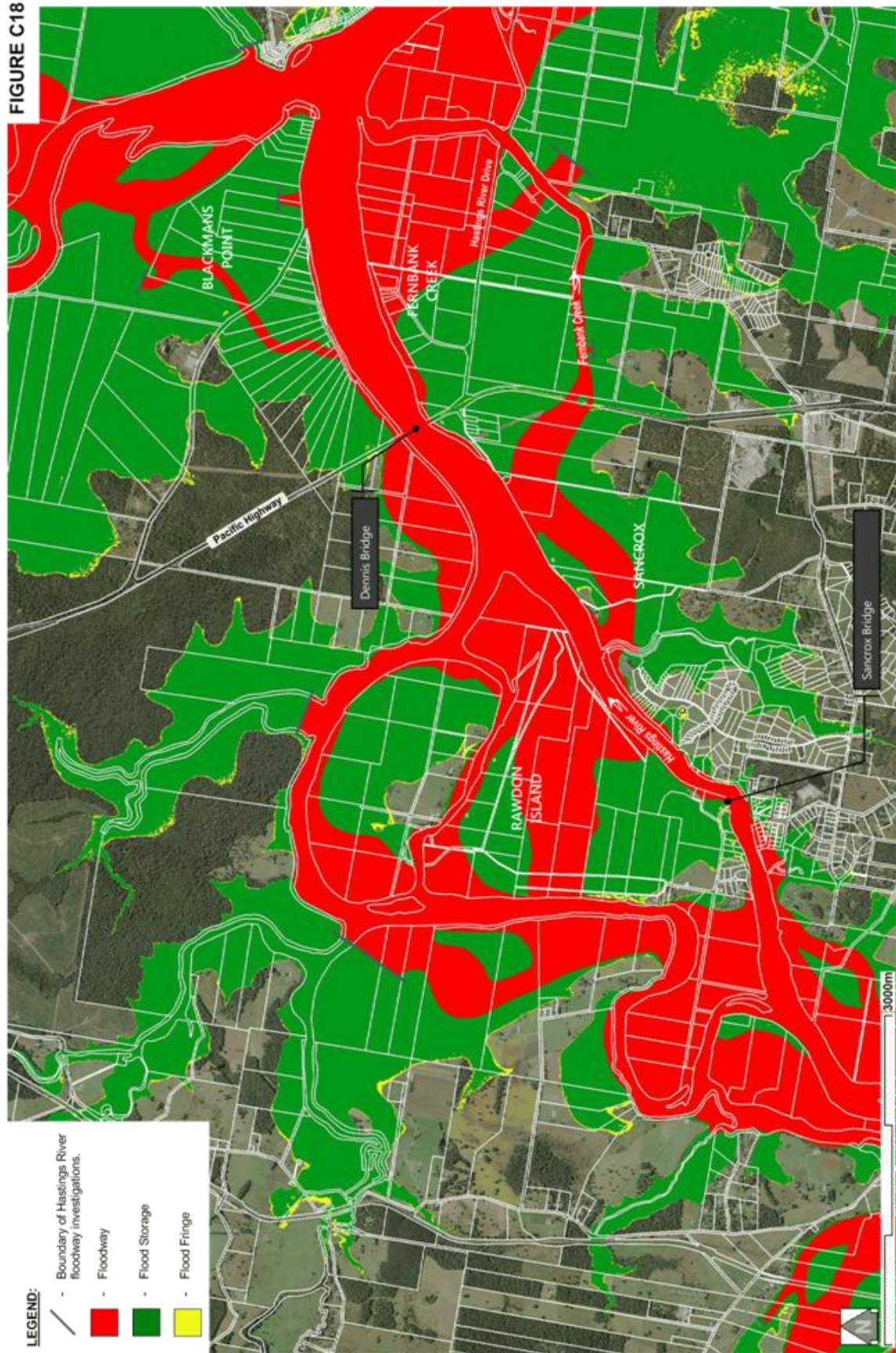
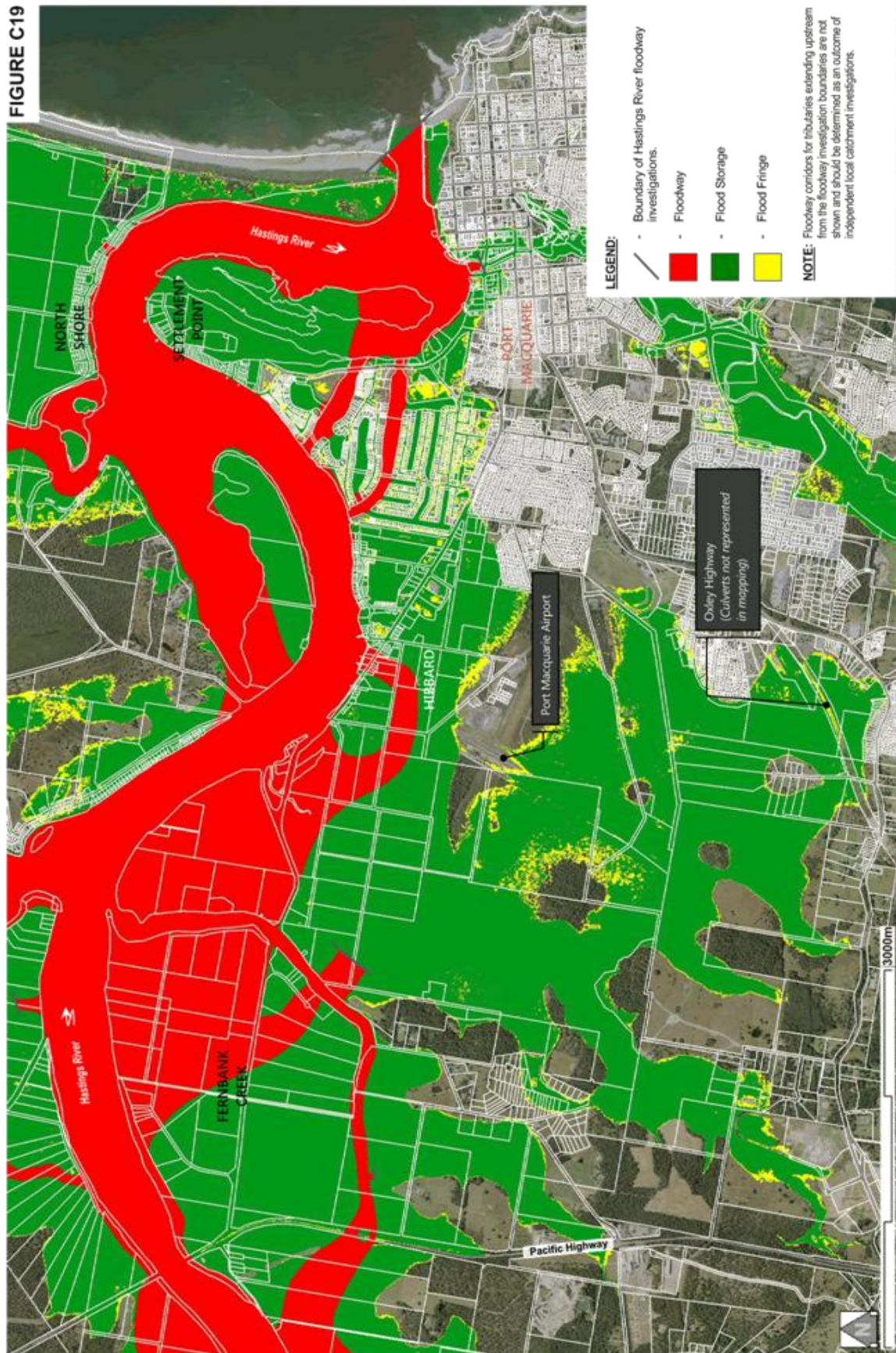


FIGURE C19

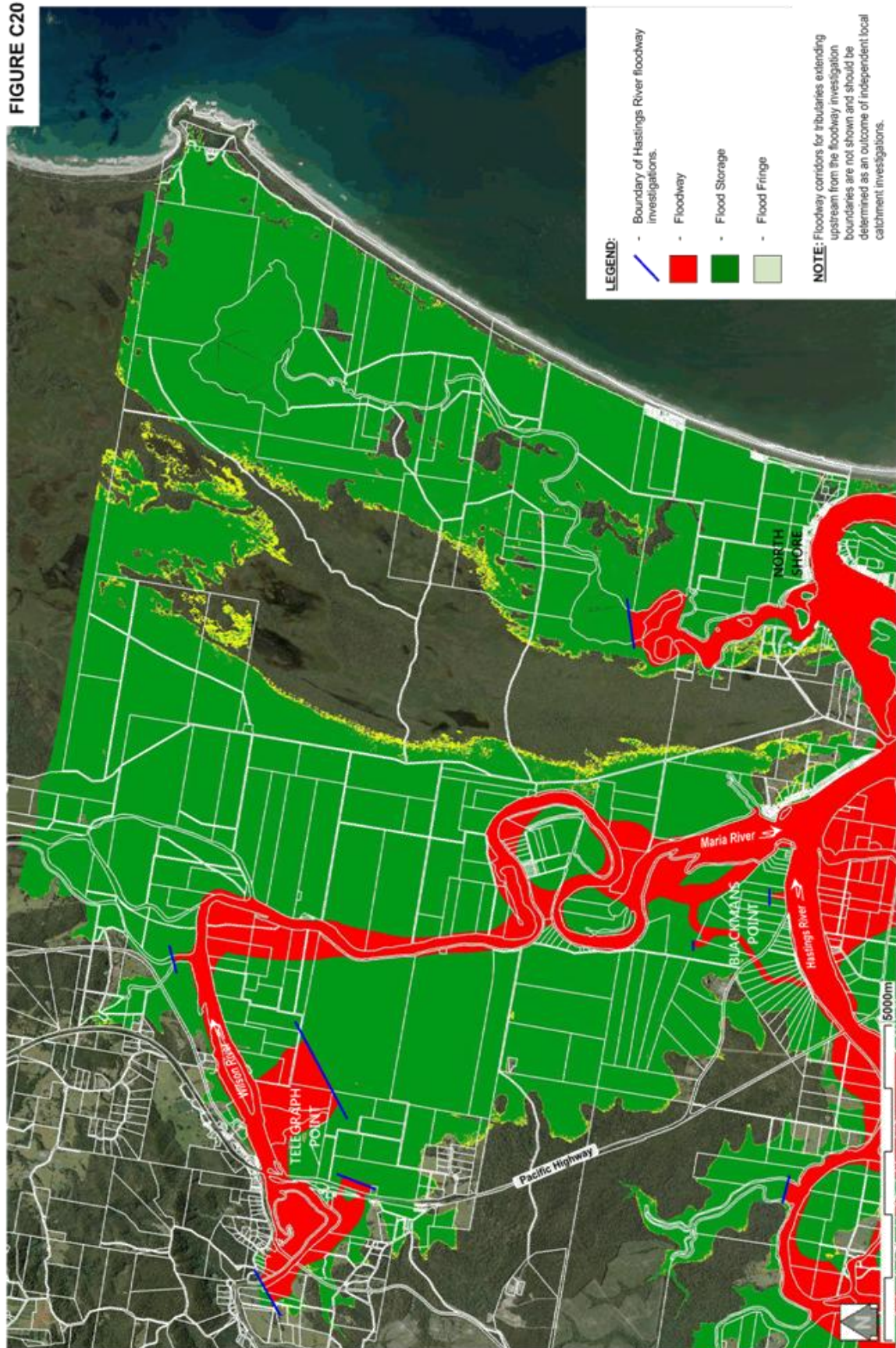


HYDRAULIC CATEGORIES FOR
CLIMATE CHANGE SCENARIO 1
[Extent 3 of 4 – South-East]

Advisian
Infrastructure Group

301311-13455 - Hastings Climate Change Investigations
9/01/11-13/05/17 0009_FigC19_Hydraulic Categories Climate Change Scenario 1_06.doc

FIGURE C20



Item: 07

**Subject: IMPLEMENTATION UPDATE ON FLOODPLAIN RISK, ESTUARY AND
COASTAL ZONE MANAGEMENT PLAN PROJECTS**

Presented by: Development and Environment Services, Matt Rogers

RECOMMENDATION

That the Committee note the status of action for each Coast, Estuary and Floodplain Risk Management Plan.

Discussion

This report details the current status of actions listed in current Coast, Estuary and Floodplain Risk Management Plans.

Floodplain Risk Management Plans

Port Macquarie-Hastings Council (PMHC) currently has Floodplain Risk Management Plans for the Hastings River and the Camden Haven River.

PMHC and relevant stakeholders have been working progressively to undertake the actions proposed in the Plans.

As noted in the Floodplain Sub-Committee Meeting held on 3 December 2014 and on 24 November 2016, many of the actions of the Camden Haven River Management Plan have been completed. Work has commenced more recently on the actions in the Hastings River Flood Risk Management Plan given its finalisation in May 2014. See attached Action Plan for details.

The outstanding actions from each Plan, as well as any ongoing management actions, will be progressively considered for incorporation into Council's annual Operational Plans as funding allows. Some items have been completed since the last report to the committee on 24 November 2016. See attachment for details.

Items which have had a change in status have been highlighted for ease of reference.

Estuary Management Plans:

PMHC currently has Estuary Management Plans for the Hastings River, Lake Cathie/Lake Innes and Camden Haven River estuaries.

As noted in the Coast & Estuary Sub-Committee Meeting held on 24 April 2014 and on 24 November 2016, most of the actions in each Plan have been completed.

Remaining items and ongoing management actions will be considered for incorporation into Council's ongoing Operational Plans as funding allows.

Attached is a summary of the outstanding action items together with the corresponding status for the Committee's information. Again, some items have been completed since the last report to the committee on 24 November 2016.

Items which have had a change in status have been highlighted for ease of reference.

Coastal Zone Management Plans

Coastal Zone Management Plans have been prepared for Town Beach and for Lake Cathie.

At this point in time, key actions from the Town Beach Coastal Zone Management Plan have been implemented and ongoing management actions will be considered for incorporation into Council's annual Operational Plans as funding permits.

The Lake Cathie Coastal Zone Management was certified by the Minister for Planning in November 2016 and is the subject of a separate report in this agenda. Council has commenced a number of actions including stormwater outlet reconstruction, land-use planning responses, stormwater network redirection detailed design and the design of the revetment along Illaroo Road.

Attached is a summary of the outstanding action items from each of the plans mentioned above, together with the corresponding status for the Committee's information. Some items have been completed since the last report to the committee on 24 November 2016.

Items which have had a change in status have been highlighted for ease of reference.

Attachments

1 [View](#). Management Plan Implementation Update Summary Table

Coast, Estuary and Floodplain Management Plan Action Status

Action Number	Specific Plan Catchment/Management Area	Coast/Estuary/Floodplain	Key Issues	Management Action Required	Sub Tasks	Status Comment
5	Camden Haven	Estuary Management	WATER QUALITY	Develop Stormwater Catchment Action Plans for all urban and rural sub-catchments draining directly to the estuary (in accordance with the Hastings Stormwater Management Plan).		Commenced - 1 sub catchment completed.
49	Camden Haven	Estuary Management	WATER QUALITY	Maintain existing foreshore vegetation around Queens Lake		Commenced - weed and vertebrate pest control works underway. Working in partnership with Queens Lake Landcare Group.
43	Camden Haven	Estuary Management	ENVIRONMENTAL MANAGEMENT	Prepare a 'Significant Bushland Overlay' for Council's GIS based on the mapping of priority conservation areas within the Vegetation Management Plan.		Completed mapping, to be presented in Biodiversity Strategy report.
4	Camden Haven	Estuary Management	WATER QUALITY	Determine and adopt target values for water quality parameters for different reaches of the estuary consistent with the Interim Environmental Objectives of the NSW Water Reforms.		2nd round of Ecohealth Monitoring is currently being finalised for completion in December. Regional specific targets to be developed by UNE
40	Camden Haven	Estuary Management	RECREATION	Support local Landcare Groups to retain or reinstate riparian vegetation along river and creek corridors to provide a 30 metre wide strip along each bank.		Ongoing
54	Camden Haven	Estuary Management	WATER QUALITY	Identify and map derelict oyster leases and those that are not in production		Ongoing
7	Camden Haven	Estuary Management	WATER QUALITY	Identify, prioritise, design and construct stormwater management mechanisms (eg., Gross Pollutant Traps and constructed wetlands) at key locations within the drainage system so that better control of catchment runoff to the estuary can be effected.		Ongoing - as stormwater upgrade works proceed
16	Camden Haven	Estuary Management	WATER QUALITY	Undertake specific actions to prevent future threats to estuary water quality		Ongoing - managed through the rezoning and development assessment processes
12	Camden Haven	Estuary Management	WATER QUALITY	Establish an estuary wide water quality monitoring program		Ongoing - SoE process
13	Camden Haven	Estuary Management	WATER QUALITY	Undertake water quality monitoring program		Ongoing - SoE process
48	Camden Haven	Estuary Management	WATER QUALITY	Monitor seagrass growth throughout the estuary		Ongoing - SoE process
8	Camden Haven	Estuary Management	WATER QUALITY	Establish a stormwater quality monitoring program.		Ongoing - SoE process
42	Camden Haven	Estuary Management	WATER QUALITY	Pursue gains for the environment through negotiated conditions on any new developments.		Ongoing and supported through DA process.
26	Camden Haven	Estuary Management	BANK EROSION	Identify areas where stock access should be restricted on individual properties to either: a) prohibit livestock access to creeks by fencing, with watering afforded by pumping to off-channel farm dams, or to, b) control livestock access so that watering only occurs at selected and rotated watering points.		Ongoing - Council opportunistically engages with landholders who show a willingness to co-operate.
25	Camden Haven	Estuary Management	BANK EROSION	Develop vegetated buffer strips along major creek lines such as Stingray Creek, Stewarts River and the upper reaches of the Camden Haven River.		Ongoing - Council opportunistically engages with landholders who show a willingness to co-operate.
44	Camden Haven	Estuary Management	RECREATION	Throughout the rural hinterland (ie., Kew, Kendall, Heron's Creek Catchment) encourage conservation of valued terrestrial vegetation through voluntary conservation agreements and retain existing riparian vegetation. Target areas should include: - land adjoining the eastern perimeter of Queens Lake - extensive forested areas and existing riparian vegetation around Heron's creek - large tract of undisturbed old growth forest adjacent to Dooragan National Park		Ongoing - Council opportunistically engages with landholders who show a willingness to co-operate.
50	Camden Haven	Estuary Management	ENVIRONMENTAL MANAGEMENT	Encourage the establishment of native vegetation on private property by providing tube stock to foreshore property owners.		Ongoing - Council opportunistically engages with landholders who show a willingness to co-operate.
17	Camden Haven	Estuary Management	WATER QUALITY	Enforce erosion and sediment controls for development and activities which have the potential to impact on the estuary.		Ongoing through the DA process

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Page 1 of 9

Coast, Estuary and Floodplain Management Plan Action Status

Action Number	Specific Plan Catchment/Management Area	Coast/Estuary/Floodplain Management	Key Issues	Management Action Required	Sub Tasks	Status Comment
15	Camden Haven	Estuary Management	FISHERY	Promote use of existing boat effluent pump out facilities.		Ongoing through Waterways
33	Camden Haven	Estuary Management	FISHERY	Verify the extent of the reported reduction in fish stocks.		Fisheries advice required
36	Camden Haven	Estuary Management	FISHERY	Develop strategies to halt the decline in fish stocks		Fisheries advice required
6	Camden Haven	Estuary Management	WATER QUALITY	Develop a community education program for responsible stormwater runoff management within the urban areas adjacent to the estuary.		Yet to commence
41	Camden Haven	Estuary Management	ENVIRONMENTAL MANAGEMENT	Justify and recommend that wetland areas identified as regionally significant be rezoned to "Environmental Protection" under Hastings LEP 2000, or be incorporated within SEPP 14.		Ongoing through individual rezoning application phase.
46	Camden Haven	Estuary Management	ENVIRONMENTAL MANAGEMENT	Justify and support the rezoning to "Environmental Protection" of the following within land that drains to the estuary: (a) Priority 1 and 2 status vegetation identified and mapped in the draft Hastings Vegetation Management Plan that fall within a 500 metre wide band that is parallel to and extends around the perimeter of the estuary shoreline; (b) Native vegetation that exists within a 250 metre wide band along either side of the banks of all estuary tributaries where that vegetation is considered to be of value.		Ongoing through individual rezoning application phase.
5	Camden Haven	Floodplain Management		Emergency Management Measures		Commenced - Camden Haven Flood Plan Complete - New Hastings SES Flood Plan expected to be complete in 2015. SES to confirm current status. Flood Action Plans to be included as part of the flood awareness and education program in 15/16.
7	Camden Haven	Floodplain Management		Voluntary House Raising		Yet to commence - Audit undertaken in 2007 showed project of high cost and mixed interest from owners. Pilot scheme was suggested to gauge likely issues. The pilot has not been commenced at this time.
4.3.1	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Enhance foreshore habitat of Kooloonbung Creek between Gordon and William streets		Commenced - planning and environmental approvals obtained
4.1.4	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Strategic planning to protect high value conservation areas		Mapping completed as part of Biodiversity Strategy. Protection of high value conservation undertaken as part of any individual rezoning process.
	Hastings	Estuary Management	Salvinia control in Upper Maria River	Eradicate Salvinia from upper Maria River and Connection Creek and undertake annual inspections of target farm dams		Ongoing
	Hastings	Estuary Management	Control Upper estuary vine weeds	Control invasive vines weeds in the upper Hastings estuary		Ongoing
	Hastings	Estuary Management	Fish Stock Monitoring	Seek opportunities to develop fish stock monitoring.		Ongoing
	Hastings	Estuary Management	Significance/Protected Area Mapping	Continue working on Biodiversity Strategy to highlight key environmental assets (including wetlands and riparian) necessary for protection.		Ongoing
	Hastings	Estuary Management	Estuary Sedimentation	Determine significant sediment sources and educate where appropriate.		Ongoing
1.2.2	Hastings	Estuary Management	Acid Sulphate soils	Initiate regulatory and enforcement action to unlawful ASS management activities		Ongoing
2.5.5	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Provide opportunities for direct community participation in review of the plan		Ongoing
4.2.2	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Council and DUAP to Monitor and enforce compliance with SEPP 14 & SEPP 26		Ongoing

Page 2 of 9

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Coast, Estuary and Floodplain Management Plan Action Status

Action Number	Specific Plan Catchment/Management Area	Coast/Estuary/Flood	Key Issues	Management Action Required	Sub Tasks	Status Comment
4.2.1	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Council to ensure compliance with development consent conditions for habitat conservation		ongoing
4.3.5	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Maintain existing rock wall protection		ongoing
4.3.6	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Prepare plans for strategic retreat of ancillary buildings and infrastructure		Ongoing
4.2.3	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Council to Monitor and enforce compliance with tree preservation policy		ongoing
4.3.3	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Review management plans for foreshore reserves		ongoing
5.1.4	Hastings	Estuary Management	Manage Interactions of Recreational Users	Complete open space, community, cultural and recreational facilities study		ongoing
2.2.1	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Monitoring and enforcement of soil and water management and habitat protection provisions of development consent		ongoing
2.2.2	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Audit Planning decisions to ensure consistent response to issues affecting the health of the estuary		ongoing
2.3.1	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Stormwater management for Koodoobung Creek		ongoing
4.3.2	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Support Landcare groups or landowners to carry out riparian zone rehabilitation		Ongoing
3.2.1	Hastings	Estuary Management	Sedimentary Processes and Dredging Management	Council, DLWC, NSW Fisheries and EPA use regulatory powers strategically to enhance environmental outcomes		ongoing
2.4.5	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Establish and maintain tourism databases		ongoing
3.0	Hastings	Estuary Management		Implement urban stormwater measures, Wauchope and lower priority areas of Port Macquarie		ongoing
7.0	Hastings	Estuary Management		Continue to negotiate landholder agreements for drain operation, maintenance, restoration of high conservation land		ongoing
3.3.1	Hastings	Estuary Management	Sedimentary Processes and Dredging Management	Prepare statutory documentation for urgent navigation dredging (REF) and confirm funding options		Ongoing - as part of specific proposals
5.2.1	Hastings	Estuary Management	Manage Interactions of Recreational Users	Maintain and enforce no wash zones in narrow channel areas (Maria River and Limeburners Creek)		Ongoing - RMS
1.4.3	Hastings	Estuary Management	Acid Sulphate soils	Collate information on performance indicators such as fish kills, water quality etc		Ongoing - SoE process
2.4.1	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Establish monitoring programs for core indicators of estuary health		Ongoing - SoE process
4.4.1	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Establish assessment and monitoring protocol for riparian vegetation to be reported in SoE		Ongoing - SoE process
2.5.1	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Report on core suite of sustainability indicators		Ongoing - SoE process
2.4.6	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Maintain integrate socio-economic databases with environmental databases		Ongoing - SoE process

Page 3 of 9

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Coast, Estuary and Floodplain Management Plan Action Status

Action Number	Specific Plan Catchment/Management Area	Coast/Estuary/Floodplain	Key Issues	Management Action Required	Sub Tasks	Status Comment
2.4.1	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Maintain 3 yearly ecological and sediment monitoring of Koodoobung Creek		Ongoing - SoE process
1.4.2	Hastings	Estuary Management	Acid Sulphate soils	Initiate ecological monitoring program		Ongoing - SoE process
3.4.2	Hastings	Estuary Management	Sedimentary Processes and Dredging Management	Extend river Styles assessment to the estuary		Ongoing - SoE process
4.4.3	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Conduct community surveys on usage/ satisfaction with foreshore park facilities		Ongoing - through existing community engagement processes
2.5.4	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Provide direct and well publicised Council contact on environmental matters via estuary education		ongoing (NRO) position
2.3.5	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Maximise opportunities for sustainable reuse of sewage effluent		ongoing and fully funded through the delivery of recycled waste water (purple pipe) for new developments such as Area 13.
2.5.2	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Continue to promote and fund Urban Landcare		ongoing and funded through Environmental Levy
3.4.1	Hastings	Estuary Management	Sedimentary Processes and Dredging Management	Establish an ongoing program of channel survey to monitor rates of shoaling at key locations, bed form and refine maintenance dredging program		ongoing Dept of Lands
4.1.6	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Focus riparian vegetation protection measures in Maria River and Lineburners Creek		ongoing requires Landholder willingness
2.3.3	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Septic safe program - Onsite sewerage management plan		ongoing through provision of rural village sewer programme and OSMS inspections
2.5.3	Hastings	Estuary Management	Sustainable Urban Growth and waterway use	Involve local aboriginal community in ongoing estuary management activities		ongoing through representation on the Committee and other estuary related matters
8.0	Hastings	Estuary Management		Ongoing monitoring and reporting of sustainability indicators for the estuary		Ongoing through the Regional State of the Environment reporting
4.1.1	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Establish voluntary conservation agreements with landholders		ongoing where suitable
5.4.1	Hastings	Estuary Management	Manage Interactions of Recreational Users	Provide baseline data on recreational fishing effort and catches		Fisheries advice required
5.5.1	Hastings	Estuary Management	Manage Interactions of Recreational Users	Provide clear information and Guidance to visitors and residents on issues such as recreational boating, swimming areas, water conservation etc		Yet to commence
5.1.2	Hastings	Estuary Management	Manage Interactions of Recreational Users	Implement ongoing projects under HIMS-T system		Yet to commence
4.3.4	Hastings	Estuary Management	Habitat rehabilitation & Riparian Zone Management	Fund Blackmans Point Landcare to continue installation of log walls		Yet to commence - currently under investigation by Dept of Lands
7	Hastings	Floodplain Management		Commission a Climate Change Assessment Study to investigate and quantify the implications of climate change on existing flood predictions to Year 2100	1. Prepare Brief defining climate change scenarios to be investigated 2. Engage consultant to undertake associated modelling 3. Undertake investigations and compare results to Design Levels adopted in Hastings FRMS (2011) 4. Adopt revised Flood Levels (as appropriate) 5. Determine and map Updated Flood Planning Area (as required)	Commenced - Refer to report item in agenda for details.

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Page 4 of 9

Coast, Estuary and Floodplain Management Plan Action Status

Specific Plan Catchment/Management Area		Coast/Estuary/Floodplain Management Area	Key Issues	Management Action Required	Sub Tasks	Status Comment
2	Hastings	Floodplain Management		Construct Settlement Point Flood Protection Levee	<ol style="list-style-type: none"> 1. Review results of Supplementary Study into climate change impacts on Design Flood Characteristics and determine short, medium and long term implications for Settlement Point. Establish projected timescale for levee that acknowledges community based safety requirements. 2. Undertake local scale stakeholder consultation to educate local community on implications of climate change on design flood characteristics and associated risk to life. 3. Prepare REF/EIA for Settlement Point Levee. Develop preliminary concept design that recognises staggered impacts of climate change. 4. Apply for funding under the floodplain management grants program 5. Develop formal concept design incorporating additional stakeholder / community consultation 6. Undertake Detail Design 7. Undertake staged construction as per climate change impact 	Community consultation and preliminary design programmed for 2017/18 subject to grant funding. Grant funding application to be submitted when floodplain grant funding round opens later this year.
4	Hastings	Floodplain Management		Update Port Macquarie-Hastings LEP 2011 to reflect latest standard clauses for the management of flood prone land	<ol style="list-style-type: none"> 1. Develop recommended changes in wording for flood related clauses within Port Macquarie - Hastings LEP 2011 2. Submit recommended clause changes to Council's Planning Department for consideration 3. Workshop with Council's Dept of Planning (as required) 4. Submit final recommended clause changes to Council for acceptance 5. Following Council acceptance, forward to NSW Dept of Planning 6. Infrastructure for adoption and incorporation into LEP 2011 6. Public notification of changes & incorporation of community feedback. 	Yet to be scheduled - to be reviewed with Council's Strategic Planning Section once Hastings River Climate Change Mapping & Weights Creek Flood Study Projects completed.
10	Hastings	Floodplain Management		Investigate options for properties / dwellings that fall within the floodway corridors for house raising	<ol style="list-style-type: none"> 1. Identify relevant floodway areas: <ul style="list-style-type: none"> - Oaks Crescent - Blackmans Point - Ferribank Creek 2. Engage consultant to investigate feasibility and cost for house raising works 3. Consult with residents and landowners to gauge their support for house raising 4. OEH guidelines confirm that grant funding for house raising is not available where the development falls within a floodway. However it is dependent on the individual circumstances of the site and each proposal would be assessed on a case by case basis. 	Yet to be scheduled
19	Hastings	Floodplain Management		Develop and initiate flood education and awareness program for vulnerable groups and flood affected communities	<ol style="list-style-type: none"> 1. Vulnerable Groups to include: <ul style="list-style-type: none"> - Heritage Christian School at Hibbard - Wauchope High School - St Josephs Primary School and Regional High School 2. Priority flood affected communities to target: <ul style="list-style-type: none"> - Settlement Point - Hibbard - Ferribank - Blackmans Point 	Yet to be scheduled - 2016-17 Grant funding application not successful - not proposed to submit grant funding application in 2017/18 due to volume of other flood projects currently underway.

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Page 5 of 9

Coast, Estuary and Floodplain Management Plan Action Status

Specific Plan Catchment/Management Area	Coast/Estuary/Flood	Key Issues	Management Action Required	Sub Tasks	Status Comment
1	Hastings	Floodplain Management	Construct North Shore Flood Protection Levee	<ol style="list-style-type: none"> 1. Review results of Supplementary Study into climate change impacts on Design Flood Characteristics and determine short, medium and long term implications for North Shore. Establish projected timescale for levee that acknowledges community based safety requirements. 2. Undertake local scale stakeholder consultation to educate local community on implications of climate change on design flood characteristics and associated risk to life. 3. Prepare REF/EIA for North Shore Levee. Develop preliminary concept design that recognises staggered impacts of climate change. 4. Apply for funding under the floodplain management grants program 5. Develop formal concept design incorporating additional stakeholder / community consultation 6. Undertake Detail Design 7. Undertake staged construction as per climate change impact 	Yet to be scheduled. Due to the inconclusive response from residents construction of a ring levee at North Shore may depend on community acceptance or a future change in flood policy.
13	Hastings	Floodplain Management	Raise Settlement Point Road between the ferry wharf and Park Street	<ol style="list-style-type: none"> 1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design 4. Undertake construction works 	Community consultation and preliminary design programmed for 2017/18 subject to grant funding. Grant funding application to be submitted when floodplain grant funding round opens later this year.
14	Hastings	Floodplain Management	Raise Hastings River Drive from west of Boundary Road to Tuffins Lane	<ol style="list-style-type: none"> 1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design 4. Undertake construction works 	Yet to commence - Road works to be progressively undertaken in conjunction with Council capital works program. Current priority is HRD from Hughes Place to Boundary Street and Boundary Street from HRD Intersection to Airport.
15	Hastings	Floodplain Management	Raise Hastings River Drive between Fernbank Creek bridge and the existing Pacific Highway	<ol style="list-style-type: none"> 1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design 	Yet to commence - Road works to be progressively undertaken in conjunction with Council capital works program. Current priority is HRD from Port Home Zone to Boundary Street and Boundary Street from HRD Intersection to Airport.
16	Hastings	Floodplain Management	Raise Fernbank Creek Road	<ol style="list-style-type: none"> 1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design 4. Undertake construction works 	Yet to commence - Road works to be progressively undertaken in conjunction with Council capital works program. Current priority is HRD from Port Home Zone to Boundary Street and Boundary Street from HRD Intersection to Airport.
18	Hastings	Floodplain Management	Raise short section of Shoreline Drive (near Riverside Drive intersection) (interim emergency response measure)	<ol style="list-style-type: none"> 1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design 4. Undertake construction works 	Yet to commence - Road works to be progressively undertaken in conjunction with Council capital works program. Current priority is HRD from Port Home Zone to Boundary Street and Boundary Street from HRD Intersection to Airport.
17	Hastings	Floodplain Management	Raise Shoreline Drive and North Shore Drive (subject to construction of North Shore and Settlement Point Levees)	<ol style="list-style-type: none"> 1. Prepare REF/EIA for road raising 2. Apply for funding under the floodplain management grants program 3. Prepare concept & detail design 4. Undertake construction works 	Yet to commence - Road works to be progressively undertaken in conjunction with Council capital works program. Current priority is HRD from Port Home Zone to Boundary Street and Boundary Street from HRD Intersection to Airport.
5	Lake Cathie	Coastal Management	Ongoing Beach Nourishment		Ongoing
7.4	Lake Cathie	Coastal Management	Batter back any storm erosion escarpment that forms at Foreshore Reserve (or in other locations) to ensure public safety and maintain park amenity.		Ongoing
9.2	Lake Cathie	Coastal Management	Continue to monitor and rehabilitate informal beach access tracks		Ongoing
9.3	Lake Cathie	Coastal Management	Reduce erosion escarpments at the base of beach accessways and carry out any necessary repairs following storm erosion		Ongoing

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Page 6 of 9

Coast, Estuary and Floodplain Management Plan Action Status

Action Number	Specific Plan Catchment/Management Area	Coast/Estuary/Flood Management Area	Key Issues	Management Action Required	Sub Tasks	Status Comment
6	Lake Cathie	Coastal Management	Stormwater Management	Continue to upgrade the stormwater outlets to the beach e.g. placement of rock at outlets to reduce beach scour.		Ongoing, subject to funding availability. Grant funding application successful for Middle Hock & Chepana Street outlet works. Design & construction works to be commenced within coming FY.
7.1	Lake Cathie	Coastal Management	Foreshore Management	Continue to control/ remove bitou bush along with regeneration/ revegetation with locally indigenous vegetation species.		Ongoing, subject to funding availability.
8.1	Lake Cathie	Coastal Management	Reserve Improvements	Prepare masterplan for foreshore reserves (Aqua Reserve, Foreshore Reserve and Johnathon Dixon Reserve), incorporating the following improvements: - additional lighting at Johnathon Dixon Reserve and in the vicinity of the Foreshore Reserve barbeque facilities - upgrade Johnathon Dixon Reserve to relieve pressure on Foreshore Reserve by providing shade, shelter and play areas.		To be undertaken 2016/17 to support community driven improvement of these resources
2.2	Lake Cathie	Coastal Management	Development Controls	Upgrades should allow for revetment end effects. Review area subject to controls following construction of the revetment and when the hazard lines are reviewed. Note that the 50 year impact line would move over time due to shoreline recession (and possibly affect additional properties, e.g. along Chepana Street).		Yet to be scheduled
3.5	Lake Cathie	Coastal Management	Revetment	Call tenders and construct revetment.		Yet to be scheduled
3.6	Lake Cathie	Coastal Management	Revetment	Finalise private/ public cost-sharing arrangements including private payment plans.		Funding model proposed to be undertaken in 2016/17 & 17/18 FY, subject to grant funding.
3.7	Lake Cathie	Coastal Management	Revetment	Carry out post-storm assessments to identify revetment maintenance requirements and actions to address exacerbated erosion in front of, and at the ends of, the revetment.		Yet to be scheduled
4.1	Lake Cathie	Coastal Management	Contingency Measures	Develop a Servicing Strategy in consultation with other service providers in the event that access and services to Illaroo Road properties are threatened by coastal erosion, prior to construction of a revetment.		Yet to be scheduled
4.2	Lake Cathie	Coastal Management	Contingency Measures	Designate Aqua Crescent/ Bundella Avenue and Illaroo as a one-way loop in a Local Area Traffic Management Plan in the event that damage to the road reserve occurs as a result of erosion events and the road pavement width needs to be reduced to maintain safe access, prior to the construction of a revetment.		Yet to be scheduled
17.3	Lake Cathie	Estuary Management	Lower Lake Cathie Creek (North)	Linking pathways		Commenced
17.4	Lake Cathie	Estuary Management	Lower Lake Cathie Creek (North)	additional seating		Commenced
5	Lake Cathie	Estuary Management	Shoaling in the lower estuary	Monitor shoaling and initiate entrance closure if required		Ongoing
10	Lake Cathie	Estuary Management	Water Quality	Continue and expand WQ monitoring		Ongoing
17.8	Lake Cathie	Estuary Management	Lower Lake Cathie Creek (North)	water quality monitoring		Ongoing
17.27	Lake Cathie	Estuary Management	Lake Innes and Lake Cathie	vehicle and bike barriers		Ongoing
13	Lake Cathie	Estuary Management	Water Quality	Construct water quality control structures		Ongoing - as stormwater upgrade works proceed
6	Lake Cathie	Estuary Management	Shoaling in the lower estuary	Undertake EIS and dredge lower estuary		Ongoing - SOEE Completed in 2013 to cover repeated dredging works. Currently waiting entrance closure to allow dredging to occur.
11	Lake Cathie	Estuary Management	Water Quality	Investigate pollution impacts and establish nutrient budgets		Ongoing - incorporated in Ecohealth Programme

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Page 7 of 9

Coast, Estuary and Floodplain Management Plan Action Status

Action Number	Specific Plan Catchment/Management Area	Coast/Estuary/Flood	Key Issues	Management Action Required	Sub Tasks	Status Comment
24	Lake Cathie	Estuary Management	Sedimentation	Construct sediment control structures		Ongoing as necessary
1	Lake Cathie	Estuary Management	Lake Cathie Entrance Opening	Implement combined entrance opening strategy (when to open)		Opening strategy identified opening at 1.6m. Ongoing as required
17.22	Lake Cathie	Estuary Management	Upper Cathie Creek	creek pathway		National Parks and Wildlife Service advice required
17.26	Lake Cathie	Estuary Management	Lake Innes and Lake Cathie	linking pathways		National Parks and Wildlife Service advice required
	LGA Wide	Estuary Management	Undertake coastal improvements as per coastal zone management plans	Undertake coastal improvements as per coastal zone management plans		Commenced and ongoing.
	LGA Wide	Estuary Management	Monitoring and reporting of waterway health	Undertake regional State of the Environment / Ecohealth monitoring and reporting		Ongoing
	LGA Wide	Estuary Management	Coastal floodplain Habitat improvements	Control invasive weeds and feral animals on public management bushland and participating private land to improve the coastal vegetation habitat on the floodplain		Ongoing
	LGA Wide	Estuary Management	Abandoned Oyster lease Clean up	continue to remove abandoned oyster infrastructure from estuaries		Ongoing
	LGA Wide	Estuary Management	Environmental Improvements to Stormwater	Undertake environmental upgrade works as per stormwater management plan		Ongoing - as Stormwater works are implemented
	LGA Wide	Estuary Management	Implement recreational users infrastructure plan	as per plan		Ongoing and in accordance with Recreation Plan
	LGA Wide	Estuary Management	Comprehensive coastal zone management plan	complete a LGA-wide coastal zone management plans		Yet to be scheduled
14	Town Beach	Coastal Management		Provide formalised stairway access from Gool Point to the back beach area, on north and south faces of Gool Point		Commenced - Stairs on southern face complete. Northern yet to be scheduled.
10	Town Beach	Coastal Management		Install additional seating, tables and lighting in the northern reserve, in the same general style as that in the southern reserve		Ongoing
16	Town Beach	Coastal Management		Upgrade pathways in Rotary Park and enhance landscaping to improve connectivity between the park, beach and adjacent accommodation		Ongoing
1A	Town Beach	Coastal Management		Maintain Southern Breakwall of the Hastings River entrance, to replace dislodged rock and protect the wall core and raise crest height to 4.6 mAHOD		Ongoing
1B	Town Beach	Coastal Management		Ongoing maintenance of Southern Breakwall		Ongoing
2	Town Beach	Coastal Management		Remove displaced rock from the surf zone to reduce safety hazards to swimmers and surfers		Ongoing
22	Town Beach	Coastal Management		Continue to remove weeds from coastal bluff grassland vegetation communities, replacing weeds with local coastal shrub and ground cover species		Ongoing
27	Town Beach	Coastal Management		Review safety of all pathways, stairways, elevated walkways and lookout fencing around Flagstaff Hill.		Ongoing
28	Town Beach	Coastal Management		Ensure that any further development of facilities in the woodland areas at Flagstaff Hill and beyond does not detract from the natural landscape character of this area.		Ongoing
7	Town Beach	Coastal Management		Construct a rotunda adjacent to the children's playground area		Yet to be scheduled
17	Town Beach	Coastal Management		Prepare Traffic Management Plan that includes investigation of the closure of the southern end of Stewart Street and installation of traffic calming devices to minimise potential conflicts with pedestrians		Yet to be scheduled
18	Town Beach	Coastal Management		Implement Traffic Management Plan		Yet to be scheduled

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Page 8 of 9

Coast, Estuary and Floodplain Management Plan Action Status

Action Number	Specific Plan Catchment/Management Area	Coast/Estuary/Flood Management	Key Issues	Management Action Required	Sub Tasks	Status Comment
19	Town Beach	Coastal Management		Improve lighting along all pathways, using efficient lighting fixtures		Yet to be scheduled
23	Town Beach	Coastal Management		Wherever possible, introduce shade trees into car parking areas		Yet to be scheduled

Page 5 of 9

NOTE: YELLOW HIGHLIGHTING DENOTES CHANGE TO STATUS SINCE LAST COMMITTEE MEETING WAS HELD

Item: 08

**Subject: LAKE CATHIE COASTAL MANAGEMENT DEVELOPMENT CONTROL
PLAN PROVISIONS**

Presented by: Development and Environment Services, Matt Rogers

RECOMMENDATION

That the report be noted.

Discussion

At the Coast, Estuary and Floodplain Advisory (CEF&A) committee meeting held on 24 November 2016 the draft Lake Cathie Coastal Management Development Control Plan provisions were considered by committee members with the following recommendation being made:

That it be a recommendation to Council that the Lake Cathie Coastal Management Development Control Plan (DCP) provisions be placed on public exhibition for a period of 28 days.

On 15 December 2016, Council resolved to publicly exhibit the draft Coastal Management Development Control Plan provisions for Lake Cathie (draft coastal DCP) after considering the recommendation from the CEF&A committee.

The draft coastal DCP was publicly exhibited on 21 December 2016 and closed on 20 February 2017.

The purpose of this report is to inform Committee members of the results of the community engagement and Council's decision on the DCP.

Eleven (11) submissions were received during the exhibition period. A key issue raised in submissions was the prescriptive nature of the requirements or relocatable homes.

Following consideration of the submissions, several changes were proposed to the exhibited draft coastal DCP. The proposed changes fall into three (3) main categories:

- General formatting - revision of the documents format to meet current DCP numbering and other editing requirements.
- Clarification - further reduction of duplication with other provisions.
- Removal of building specifications - the draft Development Control Plan chapter contained six (6) detailed building specifications that have been removed. A certificate from a structural engineer as to the adequacy of the relocatable structure is now included and the requirement for a relocation management plan has been further clarified.

After a detailed review of the submissions it was recommended that Council proceed to adopt the draft coastal DCP chapter as altered in response to the issues raised in the submissions.

At the Council Meeting held on 15 March 2017, Council resolved as follows:

That Council:

1. *Adopt the additional provisions to Chapter 2.4 Hazard Management of Port Macquarie-Hastings Development Control Plan (DCP) 2013, as described in this report.*
2. *Repeal the Lake Cathie Interim Planning Controls (25 July 2012).*
3. *Publish a public notice of this decision and forward a copy of the approved Development Control Plan to the Director General of the Department of Planning within 28 days.*

Chapter 2.4 Hazard Management of Port Macquarie-Hastings Development Control Plan (DCP) 2013, is attached for the information of members.

Attachments

- 1 [View](#). Lake Cathie Coastal Hazard DCP 2017

Draft
Addition to Chapter 2.4 Hazard Management of
Port Macquarie-Hastings Development Control Plan 2011

To be inserted at the end of section 2.4.3:

Coastal Hazard Management

Clause 7.6 **Coastline hazards**, in *Port Macquarie-Hastings Local Environmental Plan 2011*, contains provisions that must be considered prior to the grant of development consent on land mapped as subject to **Coastal Erosion Risk**.

The following DCP provisions are intended to assist in the consideration and interpretation of Coastal Hazard lines for areas covered by the **Lake Cathie Coastal Zone Management Plan** (2016).

A diagram of the development zone provisions relating to the 2050 planning horizon are shown on Figure 2.4.1. The key coastal hazard lines for Lake Cathie are shown on Figures 2.4.2, 2.4.3 & 2.4.4 and are defined as:

- 2050 Zone of Reduced Foundation Capacity (2050 ZRFC) - shown by dashed purple line, and
- 2050 Zone of Slope Adjustment (2050 ZSA) - shown by solid purple line.

These define the coastal hazard area into:

- A** landward of the 2050 ZRFC - no restrictions
- B** between the 2050 ZRFC and 2050 ZSA - restrictions
- C** seaward of the 2050 ZSA - restrictions

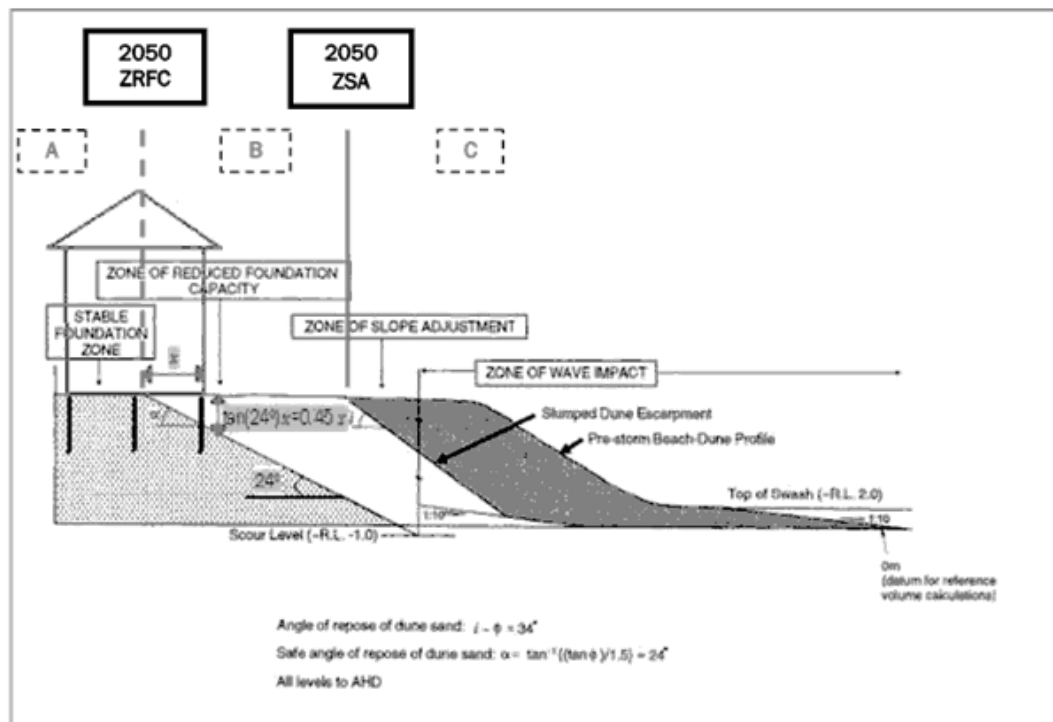


Figure 2.4-1 2050 Hazard Zones and Stable Foundation Zone calculation guidelines

Lake Cathie Coastal Hazard Management

2.4.3.7 Objective

To assist in the consideration of coastline hazards, as required by clause 7.6 of LEP 2011, relating to:

- avoiding significant adverse impacts from coastal hazards,
- enabling evacuation of coastal risk areas in an emergency,
- ensuring uses are compatible with coastal risks.

To facilitate adaptive planning for natural hazard and risk of coastline erosion.

To ensure new development or redevelopment of existing properties avoids significant adverse impacts from coastal hazards.

To ensure land use that reduces exposure to risks from coastal hazards, including through siting, design, construction and operation decisions.

To ensure uses are compatible with coastal risks.

To mitigate current and future risk from coastal hazards by taking into account the effects of coastal processes and climate change.

Development Provisions

- a) Development shall not proceed unless it can be demonstrated that the provisions of each applicable development zone can be met.

Table 2.4-1 2050 Development zone provisions

ZONE A	No coastal hazard development restrictions apply. Normal relevant planning controls apply.
ZONE B	The following controls apply for properties behind the 2050 zone of slope adjustment and forward of the 2050 zone of reduced foundation capacity. 1. Development to existing dwellings be limited to a one off maximum 10% increase in

Lake Cathie Coastal Hazard Management	
	<p>Gross Floor Area (refer to PM-H LEP 2011 definition), calculated from the ground floor footprint only, unless provided with foundation footings extending into the stable foundation zone or the development is undertaken as relocatable structures.</p> <p>2. Refer to Figure 2.4.1 for engineering calculation requirements.</p>
ZONE C	<p>The following controls apply for properties forward of the 2050 zone of slope adjustment.</p> <p>1. Development to existing dwellings be limited to a maximum 10% increase in Gross Floor Area (calculated from the ground floor footprint only) or be undertaken as relocatable structures.</p> <p>2. Ancillary development (decks/patios, carports, detached garages outbuildings and structures (including pools) must be undertaken as relocatable structures).</p> <p>3. Refer to Figure 2.4.1 for engineering calculation requirements.</p>
<p>2.4.3.8 Objective</p> <p>To enable removal of relocatable structures in coastal risk areas in an emergency.</p> <p>To adopt coastal management strategies that reduce exposure to coastal hazards.</p> <p>To improve the resilience of coastal development and communities by improving adaptive capacity and reducing reliance on emergency responses.</p>	
<p>Development Provisions</p> <p>a) Relocatable structures must be designed and constructed so that they can be quickly and easily removed from the site by road vehicle.</p> <p>b) Relocatable structures must be modular in construction and installation. Each relocatable structure module must be single storey.</p> <p>c) Confirmation must be provided that the relocatable structures can be legally transported on NSW public roads in accordance with applicable regulations and legislation, notably the Heavy Vehicle National Law and Regulations (NSW). Specific details on escort vehicles requirements, road closure notices and traffic management permits shall be provided in the Relocation Management Plan.</p> <p>d) A certificate is to be provided from a structural engineer as to the adequacy of the relocatable structure and its capacity to be easily dismantled and readily removed.</p> <p>e) Plans and specifications accompanying the structural engineering certificate for the building must be provided which demonstrate that the building can be easily dismantled, prepared for removal and that removal is practical and achievable.</p> <p>f) Removal of the building must be undertaken using the existing NSW public road network.</p>	
<p>Trigger Points</p> <p>g) For sites with direct frontage to Illaroo Road, relocation of the building must be initiated once the erosion escarpment reaches the seaward edge of the existing formed road surface (i.e. the sealed bitumen edge) directly seaward of the site frontage, or if the erosion escarpment reaches such a point on the last available relocation route that would inhibit relocation of buildings offsite.</p> <p>h) For sites located on a corner block (i.e. corner of Illaroo Road and Kywong Street, Kalang Street or Bundella Avenue), relocation of the building must be initiated once the erosion escarpment is within 10m of the relocatable building.</p> <p>i) The erosion escarpment distance is to be measured from the closest point of the site, or for corner sites, the closest point of the relocatable building.</p> <p>j) All approvals will include a condition of consent requiring the removal of structures if the above trigger points occur.</p> <p>k) Refer to Figure 2.4.5 for evacuation trigger point and removal route information.</p>	
<p>Relocation Management Plan</p> <p>l) The proposed removal route and destination shall be identified and detailed on a Relocation Management Plan.</p> <p>m) The Relocation Management Plan shall detail the following matters (Note: this list is not considered to</p>	

Lake Cathie Coastal Hazard Management

be exhaustive):

- The removal route for the relocatable structure
- The final or temporary destination for the relocatable structure
- Dimensions of the relocatable structure modules
- Any requirements of the Roads and Maritime Services (RMS) and National Heavy Vehicle Regulator (NHVR)
- Method of relocating/removing the structure modules
- Proposed timeframe for relocating/removing the structure modules
- Any impacts to services (eg. water mains, power poles, etc)
- How ancillary structures/developments/infrastructure/vegetation (eg. decks, patios, detached garages/sheds, fences, water tanks trees and the like) will be managed during relocating/removing the structure modules. Temporary storage areas for ancillary items requiring relocation/removal to enable relocation/removal of the structure modules shall be identified on the Relocation Management Plan.
- Compliance with all Development Provisions in Chapter 2.4.

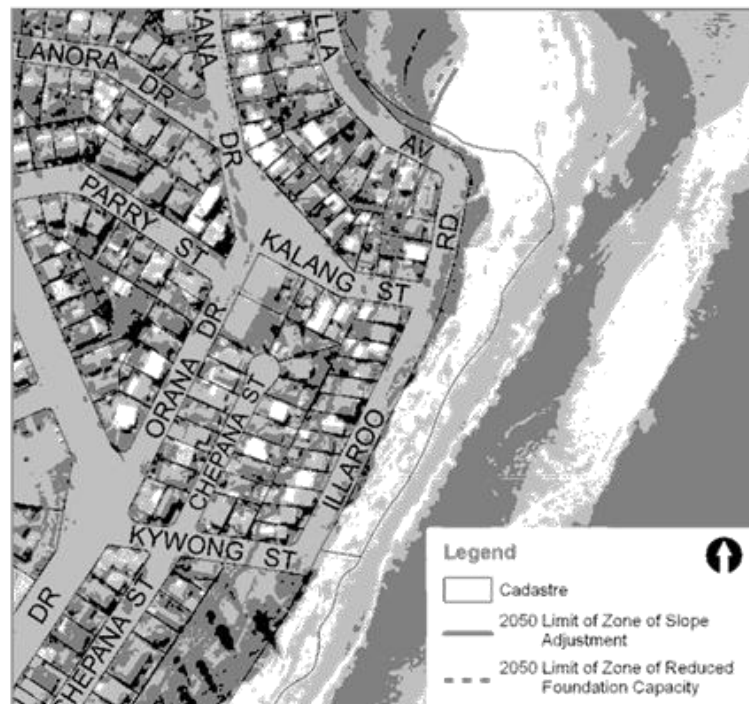


Figure 2.4-2 2050 Hazard Lines: Lake Cathie (Illaroo Road)



Figure 2.4-4 2050 Hazard Lines: Lake Cathie (Chepana Street - North)



Figure 2.4-3 2050 Hazard Lines: Lake Cathie (Chepana Street - South)

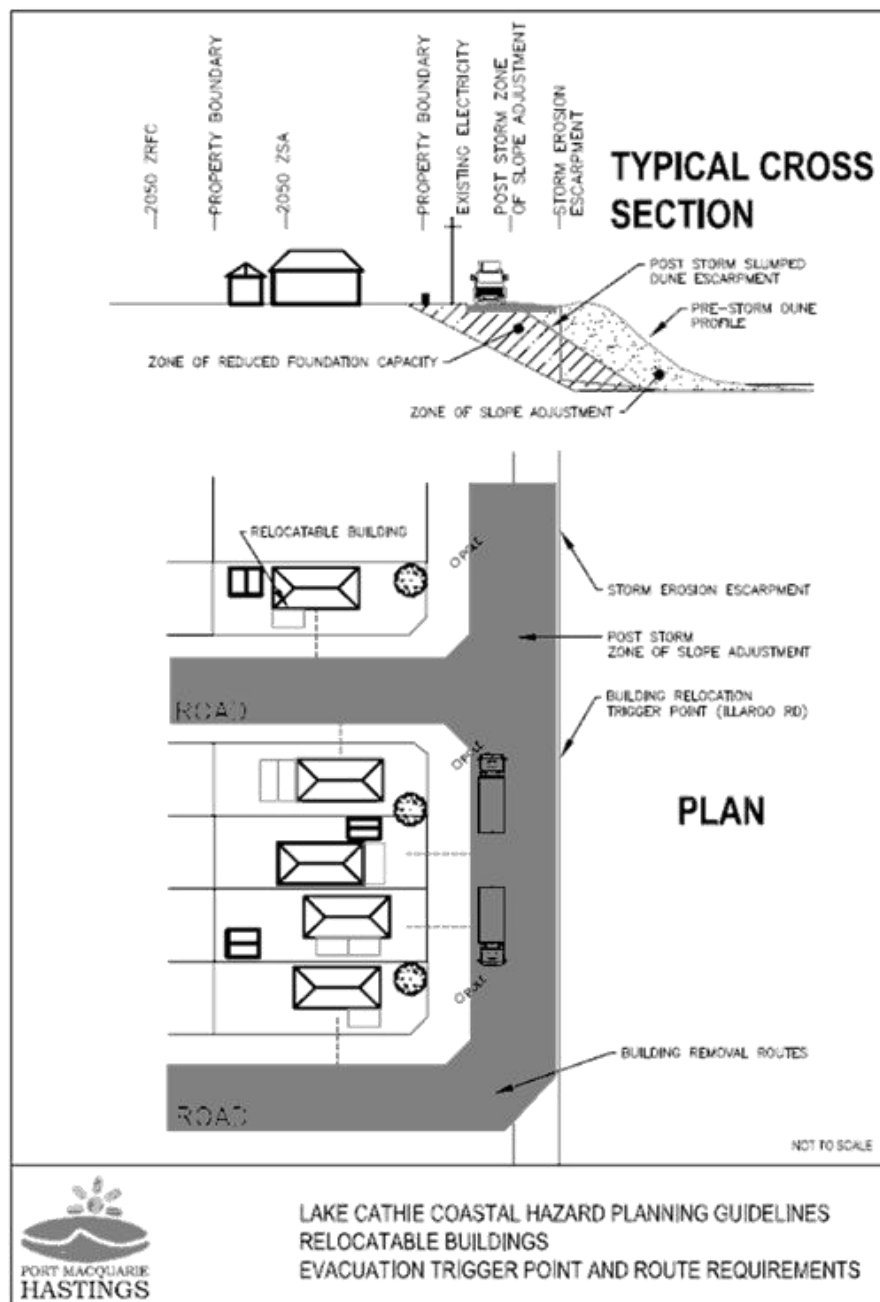


Figure 2.4-5 Relocatable buildings evacuation trigger point and route requirements

Item: 09

**Subject: UPDATE OF BIODIVERSITY STRATEGY AND ECOHEALTH
MONITORING**

Presented by: Development and Environment Services, Matt Rogers

RECOMMENDATION

That the report be noted.

Discussion

The Biodiversity Strategy has been developed over the past 2 years in consultation with a Community and Expert Panel with the assistance of the NSW Office of Environment and Heritage and the University of Melbourne.

The Strategy is now in a draft form and is with a professional editor and is expected to go on public exhibition for 60 days commencing in May.

A draft copy of this Strategy will be distributed to committee members at the commencement of this exhibition period.

In partnership NSW Office of Environment and Heritage and the University of New England (UNE), the Ecohealth Monitoring Project has completed 4 years of monitoring for all major freshwater systems and estuaries in the LGA. Due to ill health of the principle researcher at UNE, the completion of the Ecohealth report has been delayed. The report is expected to be completed by the end of March and Council will distribute a copy to committee members once received.

Attachments

Nil