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25 March 2009

Tweed Shire Council
PO Box 816
Murwillumbah
NSW 2484

Attention: Danny Rose / Ian Dinham

Dear Danny and Ian

RE: NDMP 06/07, TWEED VALLEY FLOOD STUDY UPDATE, CLIMATE CHANGE

Please find enclosed a summary of the methodology and results of the climate change investigations undertaken for the Tweed Valley as part of the Flood Study Update.

Background

Modelling was undertaken to assess the potential impact of climate change on the 100 year ARI design flood event for the Tweed catchment. This modelling was undertaken using the WBNM hydrologic and TUFLOW hydraulic models developed for the 2009 update of the *Tweed Valley Flood Study* (BMT WBM, 2009). The 100 year ARI design flood adopted in the Flood Study was based on two combinations of catchment and coastal flooding:

Dominant Event	Rainfall Event	Storm Surge Event
Catchment flooding	100 year ARI	20 year ARI
Coastal flooding	5 year ARI	100 year ARI

Catchment flooding dominates (i.e. produces higher peak flood levels) along the Tweed River floodplain downstream to Shallow Bay, as well as the Cobaki / Piggabeen floodplains down to Terranora Creek. The storm surge flood dominates along the lower Tweed River floodplain from Shallow Bay to the mouth, and the Terranora Creek floodplain from the lower Bilambil / Duroby floodplains down to Tweed Heads.

Stormwater flooding (i.e. from localised short-duration, high-intensity storm events) was not assessed as part of the catchment Flood Study.

Climate Change Scenarios

Two climate change scenarios were selected for assessment based on DECC guidelines outlined in *Floodplain Risk Management Guideline: Practical Consideration of Climate Change* (October 2007) and *Draft Sea Level Rise Policy Statement* (currently out for consultation):

- **Medium level impacts:** A 20% increase in rainfall intensity and a 55 cm increase in sea level; and
- **High level impacts:** A 30% increase in rainfall intensity and a 91 cm increase in sea level.

These increases in rainfall intensity and sea level were applied to the Tweed Valley 100 year ARI design flood event as follows:

Climate Change Scenario	Dominant Event	Rainfall Event	Storm Surge Event
Medium level impacts	Catchment flooding	100 year ARI + 20%	20 year ARI
	Coastal flooding	5 year ARI	100 year ARI + 55 cm
High level impacts	Catchment flooding	100 year ARI + 30%	20 year ARI
	Coastal flooding	5 year ARI	100 year ARI + 91 cm

Note that the 100 year ARI storm surge level adopted for the Flood Study was 2.6 mAHD based on DIPNR's *Floodplain Management Guideline No. 5 Ocean Boundary Conditions*. This included a 0.3 metre allowance for the potential effects of climate change. The increase in sea level for these climate change scenarios (i.e. 55 cm and 91 cm for the medium and high scenarios respectively) was therefore applied to a 100 year ARI storm surge of 2.3 mAHD, so as not to duplicate the allowance for potential climate change effects. It should be noted in the subsequent results discussion therefore, that the medium and high climate change scenarios are compared with the baseline 100 year ARI design flood from the Flood Study, but that the baseline includes a low climate change allowance for sea level rise.

Results

Table 1 shows a comparison of the baseline 100 year ARI design flood levels with the two (medium and high) climate change scenarios (as well as the PMF for comparison) at the reporting locations shown in Figure 2.

The 100 year ARI design flood levels for the high climate change scenario are mapped in Figure 1. These levels (together with those for the medium scenario) have also been provided electronically in MapInfo GIS format.

Figure 2 shows a map of the change in 100 year ARI design flood levels as a result of the high climate change scenario. Design flood levels in the 100 year ARI design event are broadly:

- Approximately 0.5 metre higher at Letitia;
- 0.5 to 1 metre higher along the Tweed River from Murwillumbah to the river mouth (apart from around Letitia), along Terranora Creek and at the broadwaters;
- 1 to 1.5 metres higher along the Tweed River from Byangum to Murwillumbah and in the Condong Creek floodplain; and
- More than 2.5 metres higher in the Murwillumbah town centre (behind the levee).

Lower Tweed

In general, the 91 cm increase in sea level in the high climate change scenario results in a corresponding increase in flood levels in the lower Tweed area where coastal flooding is the dominant event. This increase is attenuated somewhat as the flood propagates inland (from the ocean / river mouth) such as in the Letitia area where the increase in the 100 year ARI design flood level is approximately 0.5 metre. Further upstream however, catchment flooding becomes the dominant event and the 30% increase in rainfall results in larger increases in flood levels.

Murwillumbah

There is a natural constriction in the floodplain at Murwillumbah formed by the reservoir hill to the north and the ridgelines following Tweed Valley Way and Wardrop Valley Road heading south. Flow in the Tweed River is further constrained in Murwillumbah by levees on both banks.

As a result of this constriction, the effect of the increase in rainfall intensity on 100 year ARI flood levels is more pronounced upstream of Murwillumbah (see Figure 2). Levels in the Condong Creek floodplain (on the southern bank between Murwillumbah and Condong), which are largely influenced by breakout from the Tweed River upstream of Murwillumbah, are also similarly affected.

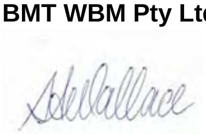
The 100 year ARI design flood level in the Tweed River at Murwillumbah increases by approximately 1.1 metres due to the 30% increase in rainfall intensity associated with the high climate change scenario. However, this translates to a much greater increase in levels in town (behind the levee) which are controlled by the depth and duration of levee overtopping.

Overtopping into town first occurs at the Murwillumbah Bridge when levels in the river reach approximately 6.8 mAHD. In the baseline 100 year ARI event, the levee is overtopped for approximately **3 hours** with a peak depth of approximately **0.1 metre** over the levee. This limits inundation depths in most areas behind the levee to less than 0.5 metre, apart from some deeper localised ponding in Knox Park and at the Commercial Road / Wharf Street intersection.

In the high climate change scenario, with a 30% increase in the 100 year ARI rainfall intensity, the levee is overtopped for approximately **8 hours** with a peak depth of approximately **1.2 metres** over the levee. As a result, the basin behind the levee is completely inundated, with depths through town of between 4 and 5 metres; an increase of more than 4 metres in the 100 year ARI design flood level in most areas.

I trust these investigations and results quantify the possible effects of the two medium and high level climate change impacts scenarios assessed. More detailed considerations of these effects and the implications on floodplain management and planning will be undertaken as part of the Floodplain Risk Management Study.

Yours faithfully
BMT WBM Pty Ltd



Sharon Wallace
Senior Flood Engineer

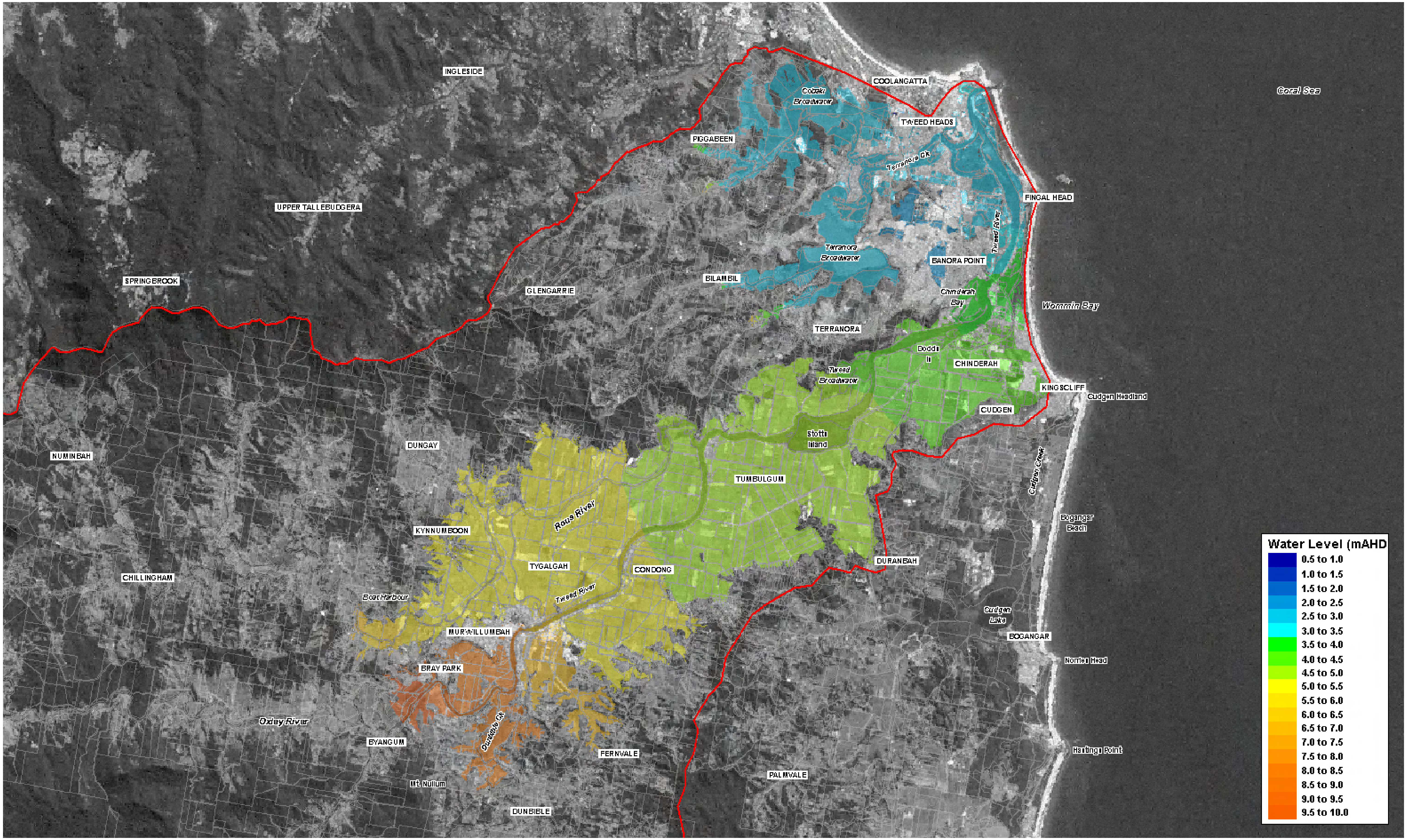
cc Toong Chin, DECC

enc Table 1 Peak Design Flood Levels at Selected Locations
Figure 1 100 Year ARI Design Flood Levels, High Climate Change Scenario
Figure 1 Change in 100 Year ARI Design Flood Levels, High Climate Change Scenario

Table 1 Peak Design Flood Levels at Selected Locations

Location	Flood Level (mAHD)			
	100 year ARI	Med Impacts	High Impacts	PMF
Lower Tweed				
Rivermouth	2.60	2.85	3.21	2.60
Terranora Ck Junction	2.39	2.59	2.88	5.98
Letitia 2A Gauge	2.39	2.59	2.87	6.18
Tweed Heads West 3	2.36	2.56	2.85	6.27
Ukerebagh Channel	2.37	2.57	2.86	6.28
Dry Dock Gauge	2.30	2.53	2.82	6.28
Tweed Heads West 2	2.31	2.54	2.83	6.28
Tweed Heads West 1	2.28	2.52	2.81	6.28
Cobaki Gauge	2.29	2.53	2.82	6.28
Terranora Gauge	2.32	2.55	2.84	6.28
Mid Tweed				
Barneys Pt Bridge	2.92	3.53	3.83	8.10
Barneys Pt Gauge	2.92	3.53	3.83	8.10
Chinderah Gauge	3.01	3.64	3.95	8.25
D/S Stotts Island*	3.57	4.21	4.53	8.87
Tumbulgum	3.82	4.45	4.76	9.09
Rous				
Dulguigan	4.50	4.96	5.24	9.42
Kynnumboon	4.16	4.74	5.05	9.32
North Arm	6.05	6.41	6.57	9.50
Upper Tweed				
Condong	4.27	4.80	5.09	9.31
Murwillumbah Bridge	6.91	7.63	8.03	12.11
Hartigan St	7.14	7.89	8.30	12.49
Bray Park	8.78	9.61	10.01	14.02
Byangum	9.81	10.67	11.04	14.80

* Averaged level across line



LEGEND

Tweed Catchment Boundary

Cadastre

Title:

High Climate Change Scenario
100 Year ARI Design Flood Levels

Figure: **1**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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0 3 6km

Approx. Scale

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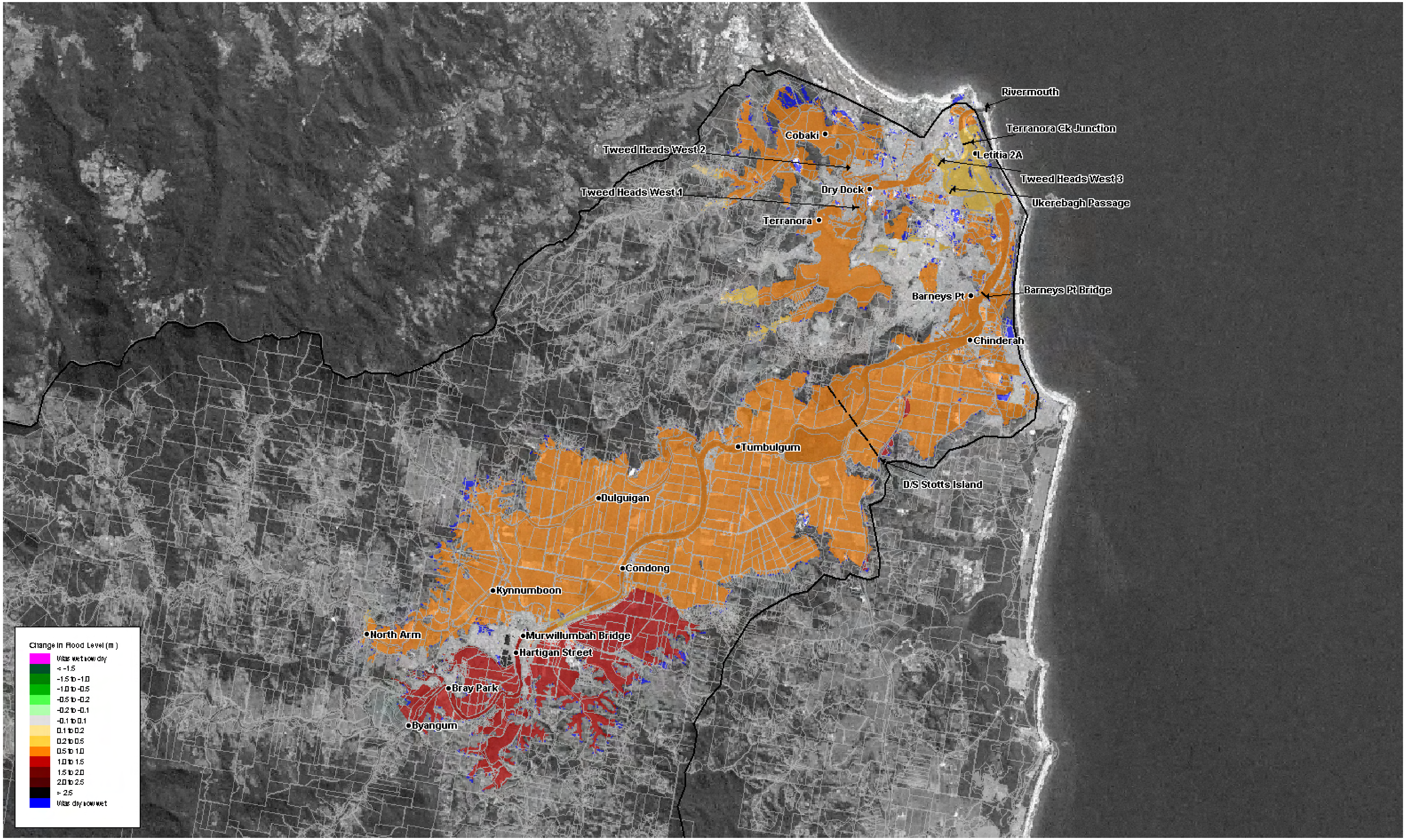

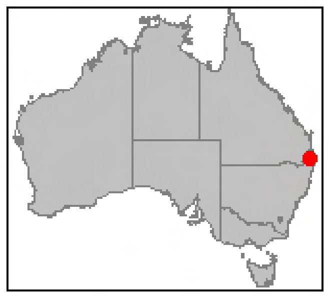

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Tweed Catchment Boundary

Reporting Location

Reporting Location

Title:

Change in Q100 Design Flood Levels (Due to High Level Climate Change Impacts)

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Approx. Scale

Figure: 2

Rev: A

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