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8 November 2011

Bankstown City Council
Upper Ground Floor, Civic Tower
66-72 Rickard Road
BANKSTOWN NSW 2200

Attention: Cherie Blackburn

RE: FINAL LETTER REPORT FOR THE DUCK RIVER FLOOD MITIGATION MODELLING

This letter report outlines the flood mitigation modelling and associated flood impact assessment of three options investigated in the Duck River catchment.

1 Introduction and Background

BMT WBM developed the Duck River model for Bankstown City Council (BCC) in 2007 and it was subsequently updated in 2009. This Duck River model extends to the Sydney Water Main (SWM) within the Bankstown Local Government Area (LGA). Flood modelling has indicated that properties immediately upstream of the Sydney Water Main are flood affected due to the flow constriction at the Sydney Water Main culverts and properties downstream of the Sefton Links Golf Course are flood affected.

The neighbouring Councils, Auburn and Parramatta City Councils (ACC and PCC), to the north (downstream) of BCC, have also undertaken flood studies of Duck River in their LGAs. In 2009, the three Councils jointly commissioned the Duck River Floodplain Risk Management Study. As part of this study, flood damages from various storm events have been calculated and extensive community consultation has been undertaken which has highlighted public interest in the existing flood risk upstream of the Sydney Water Main flow constriction and also in other areas of the catchment.

To address these issues and inform the Duck River Floodplain Risk Management Study, BCC commissioned BMT WBM to undertake hydraulic impact assessments of two potential options for managing flood risk and another potential option for improving water quality in the Duck River.

2 Methodology

The following three options have been assessed:

1 Widening of the culverts and channel underneath the SWM;

2 Construction of a detention basin on the grounds of the Sefton Golf Course; and

3 Widening and revegetating the existing channels traversing Band Hall Reserve.

The primary objective of the first two options is flood mitigation, while the third is improvement in water quality and other associated environmental benefits. This letter report focuses solely on the hydraulic assessment of all three options; other benefits or impacts are outside the scope of this project.

Option 1, the SWM culvert widening, utilised the following three hydraulic models:

- BMT WBM 2009 Duck River model, developed for BCC upstream of the SWM;
- WMA 2010 Duck River model, developed for PCC downstream of the SWM; and

- A combined model consisting of the two models joined together covering the entire BMT WBM model area and extending approximately 5.5km downstream of the SWM to the M4 Western Motorway in PCC.

The BMT WBM and WMA models form the main part of the assessment, and the combined model has been utilised to verify results of the assessment. This approach was undertaken to assess the potential affect of the adopted downstream boundary applied in the BMT WBM 2009 Duck River model. The downstream boundary was a stage-time hydrograph with different peak flood levels for various storm events. For more details on the selection of the downstream boundary refer to the *Duck River Stormwater Catchment Study 2007 Report including 2009 Addendum* (BMT WBM, 2010).

Options 2 and 3 were simulated utilising the 2009 Duck River model developed for BCC.

All three options have been assessed using the 100 Year Average Recurrence Interval (ARI) event. All model simulations utilised both the blocked and unblocked scenarios, as per BCC adopted blockage specifications (see Duck River Stormwater Catchment Study, 2007 Report including 2009 Addendum, prepared by BMT WBM for BCC, May 2010).

Details on the locality are outlined below; the results are presented in Section 3.

Widening of the Sydney Water Main Culverts (Option 1)

This flood mitigation option involved the widening of the culverts and channel from approximately 11.0m to 20.0m (an increase of approximately 9 metres) underneath the Sydney Water Main over a length of approximately 40m. Image 1 illustrates the locality with the existing channel and culvert under the SWM in the aerial photograph, and the widening of the culverts and channels to the east (indicated by the yellow polygons).

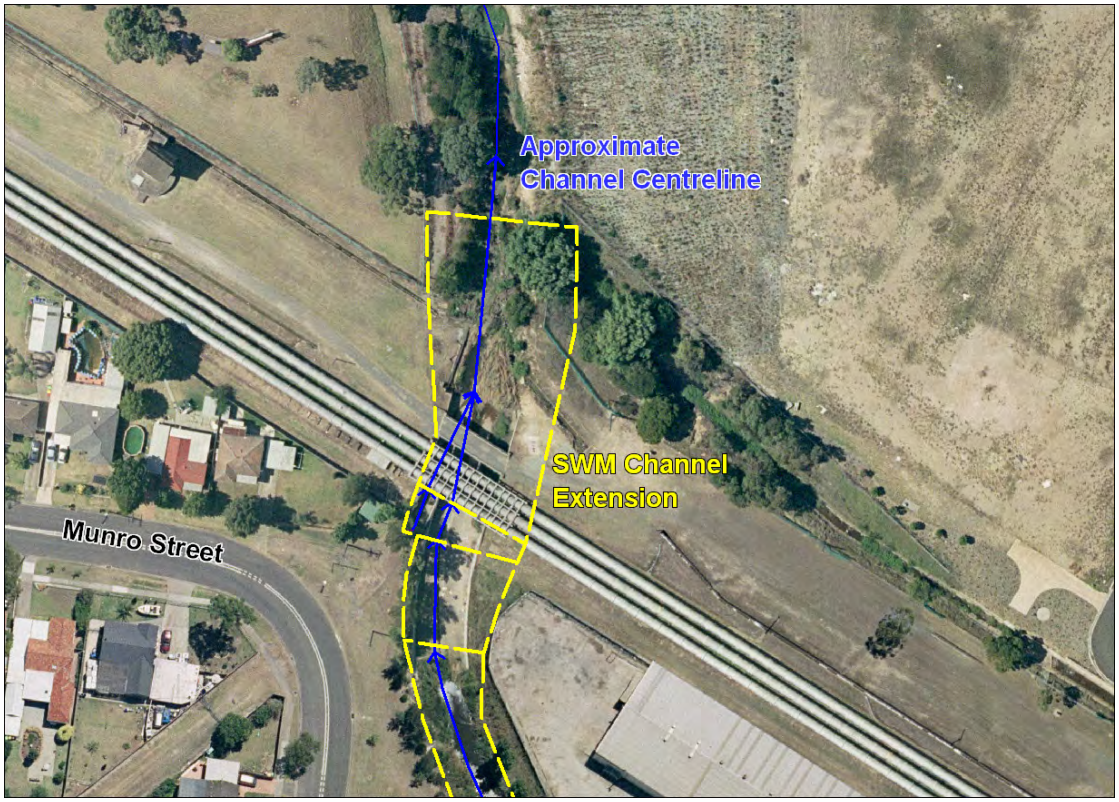


Image 1: Widening of the Sydney Water Main Culverts (Option 1)

Blockage Scenarios at Sydney Water Main Culverts

In addition to the modelling of the channel widening outlined above, an additional simulation was undertaken in May and June 2011 using the BMT WBM 2009 Duck River model. This additional simulation assessed the effects of blockage at the SWM (no widening of the culvert undertaken). To understand this additional simulation it is important to be aware of Council's blockage policy, in combination with the dimensions of the culvert structure underneath the SWM at the downstream end of the Duck River model; also outlined in Section 4 of the *Duck River 2009 Addendum Report* (BMT WBM, 2010).

Council's blockage policy includes a lateral blockage factor of 50% of structure openings with a diagonal span of less than 6 metres. Photos of the culvert structure underneath the SWM are provided in Image 2. With regards to the openings under the Sydney Water Main, Council have adopted the following blockage policy looking downstream for the Duck River Model:

- **Left hand opening unblocked:** Diagonal span less than 6 metres, however left unblocked as the potential for debris blockage was considered low due to the immediately adjacent fence, and the culvert is at the downstream end of a pipe and box culvert system.
- **Middle opening unblocked:** Diagonal span greater than 6 metres.
- **Right hand opening 50% blocked:** Diagonal span less than 6 metres.

TUFLOW modelling undertaken for Bankstown City Council catchments includes the modelling of the following two scenarios:

1 **'Blocked' scenario:** Council's blockage policy applied to all inlets and structures; and

2 **'Unblocked' scenario:** No blockage applied apart from at downstream boundary structure (i.e. for the Duck River TUFLOW model, at the Sydney Water Main crossing).

In 2009, a third fully unblocked scenario was also modelled to provide additional information on peak flood flows and levels at the Sydney Water Main crossing:

3 **'Fully unblocked' scenario:** No blockage applied at the Sydney Water Main crossing.

In May and June 2011 an additional fourth scenario was modelled to further assess the effects of blockage at the culverts underneath the SWM:

4 **'Blocked scenario, but with the right culvert underneath the SWM 0% blocked':** Council's blockage policy applied to all inlets and structures, but reduction of 50% blockage to 0% blockage to the right culvert underneath the SWM.

This fourth scenario provides additional information to evaluate a blockage prevention structure, which could be constructed at the SWM. Results for this additional modelling are also provided in Section 3.

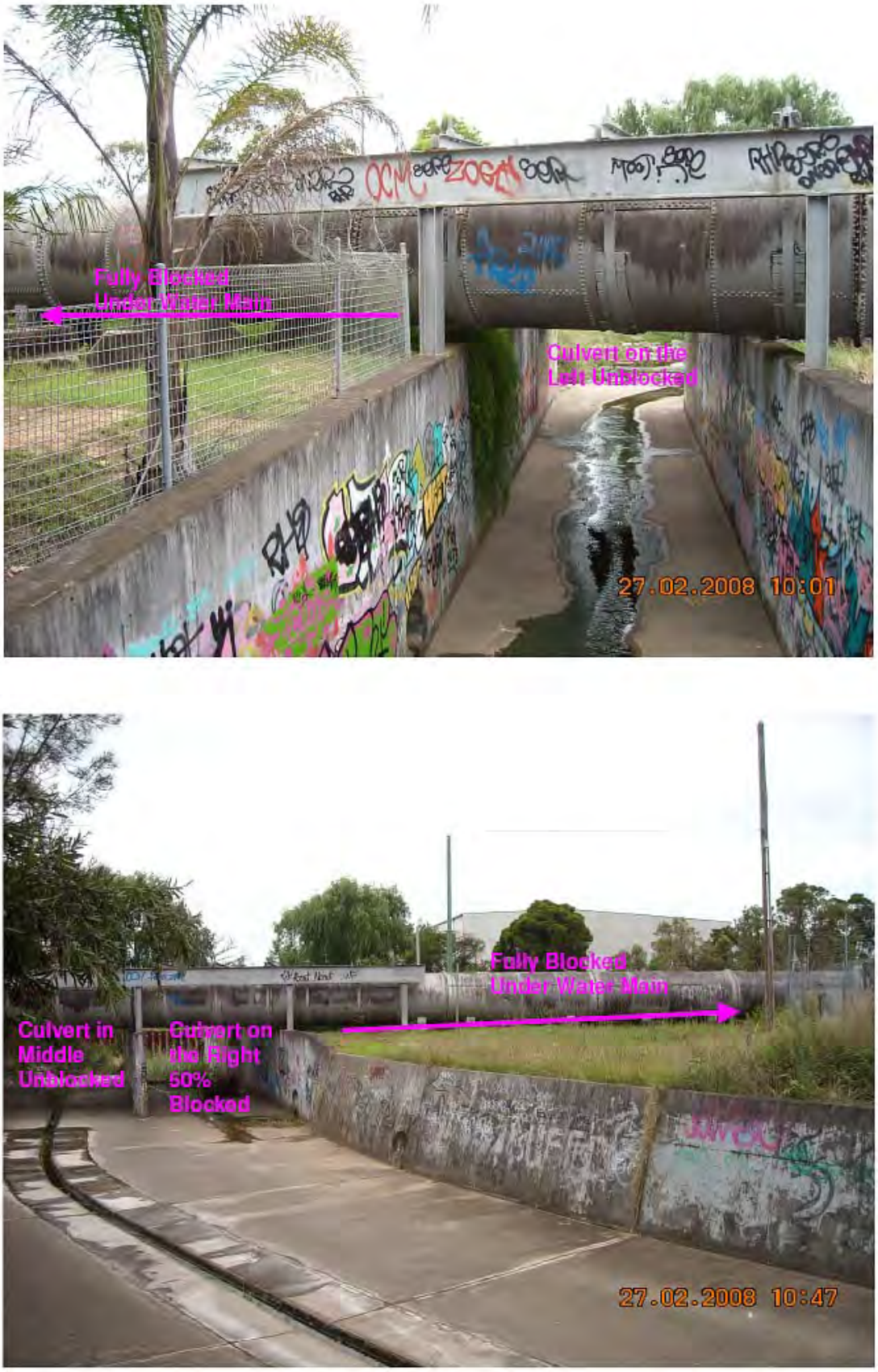


Image 2: Duck River at Sydney Water Main (Looking Downstream) Blockage Scenario

Sefton Golf Course Detention Levee (Option 2)

Image 3 shows the location of the proposed detention basin wall (illustrated as a bright green line) on the Sefton Golf Course. The proposed wall runs directly behind the row of houses on Rose Street, which back onto the course. For this assessment, the basin wall height has been set so that no overtopping of the basin wall will occur in the 100 year ARI event. A 5m x 2m inlet structure and 1200mm outlet pipe have been used to drain the detention area into the current trunk drainage network.

Image 3: Sefton Golf Course Detention Levee (Option 2)

Band Hall Reserve Channel Works (Option 3)

Option 3 involved the widening of the existing channel running along the western, eastern and northern side of the Band Hall Reserve. Image 4 illustrates the locality of the existing channel in the aerial photograph and the proposed widening of the channel along Band Hall Reserve, highlighted with the yellow polygons. Channel widths were increased from approximately 4.0m to approximately 9.0m at the top of the channel; a channel widening of approximately 5m. The base of the channel remained the same.

The increase in Manning's 'n' roughness within the northern, eastern and western channel was increased from 0.016 to 0.04 to reflect the proposed revegetation. Image 4 shows the labels of the modelled roughness values; the labels in black present the existing case, the green labels present the option 3 mitigation case.

This option has been identified by Council for the purposes of improving water quality and has been assessed to determine the impact of the channel widening and revegetation on flood risk.

Image 4: Band Hall Reserve Channel Widening (Option 3)

3 Results

For each option modelled, the flood levels from the existing scenario were compared to flood levels of the option modelled. Floor level inundation information provided by Council was also analysed (DR_W_Cadastre_region.TAB).

Widening of the Sydney Water Main Culverts (Option 1)

The model results are presented in Table 1 and indicate the following:

- The maximum decrease in peak flood levels upstream of the SWM is approximately 0.35m.
- Decreases in flood levels of 0.2m to 0.3m extend approximately 150m to 200m upstream of the SWM.
- The 100 year ARI flood extent in the vicinity of the SWM has been reduced by between 10m and 20m.
- The flood level difference immediately downstream of the SWM is below 0.05m.
- The peak flood levels are increased to slightly above 0.05m (but to less than 0.1m) from about 500m downstream of the SWM and extend to the Mona Street Bridge.
- Model results have shown that the largest increase in flood levels (of about 0.09m) is in the vicinity of the Wellington Road Bridge.

Table 1 shows the peak flood level impact (difference in peak flood levels) of Option 1 at key locations. The decreases in peak flood levels upstream of the SWM and increases in peak flow levels downstream of the SWM are illustrated in Figures 1, 2 and 3 respectively.

Table 1: Selected Results from the WMA Model

Location	Change in Peak Flood Level (m)
Upstream of Sydney Water Main	-0.05 to -0.35
Downstream of Sydney Water Main	0.04
Wellington Road	0.09
Upstream of Mona Street Bridge	0.06
Downstream of Mona Street Bridge	<0.02

It is noted that the increases in flood levels between Wellington Road and Mona Street Bridge are likely to have negligible affect on residents, as this part of the creek is located within park and open space reserves.

The Wellington Road Bridge was modelled with a road level of 9.45m. The WMA model results (WMA, 2010) indicate that upstream of Wellington Road the 100 year ARI event flood level is 9.6 mAHD. Therefore under existing conditions Wellington Road is already inundated in the 100 year ARI event. Under this option, it is estimated that the flood depth at Wellington Road would increase by approximately 0.1m in the 100 year ARI event.

The Mona Street Bridge was modelled with a road level of 6.9mAHD. Under both existing conditions and Option 1, modelling indicates this road will remain flood free in the 100 year ARI event.

Upstream of the SWM, it is estimated that under current conditions:

- Between 40 and 50 properties are affected by flooding in a 100 Year ARI event;
- Four of these properties are potentially inundated above floor level in a 20 year ARI event;
- Approximately 10 of these properties are potentially inundated above floor level in a 50 year ARI event; and
- Approximately 20 of these properties are potentially inundated above floor level in a 100 year ARI event.

It is expected that these properties would benefit under this option, with reduced levels of 0.1 to 0.3m, for the 100 Year ARI event. A cost-benefit analysis for this mitigation option, using flood damages estimates and constructions cost may be useful for further appraisal of this option.

As outlined in the methodology (Section 2), the separate BMT WBM and WMA models form the main part of the assessment, and the combined model was utilised to verify results of the assessment. The model results from the combined model also show downstream impacts of up to approximately 0.09m (same result as for the separate models), verifying the assessment based on the two separate models. This indicates that although the fixed water level boundary at the downstream of the Duck River model does influence flood levels in the area, similar downstream impacts are predicted under different boundary assumptions.

Blockage Scenarios at Sydney Water Main Culverts

The simulation of the blocked scenario with 0% blockage at right culvert of SWM resulted in a reduction of flood levels of 0.1m to 0.2m, upstream of the SMW.

The modelled peak flood levels and flows for the 100 year ARI event at the Sydney Water Main for the four blockage scenarios and for the Option 1 scenarios are summarised in Table 2 and the flow hydrographs are provided in Image 5.

Table 2: Peak Flood Levels and Flows at Sydney Water Main

Blockage Scenario	Details of Blockage Scenario	100 Year ARI Peak Flood Levels Upstream of SWM	100 Year ARI Peak Flow Downstream of SWM
Blocked	BCC's blockage policy applied to all inlets and structures	19.75 mAHD	121 m3/s
Unblocked	No blockage applied apart from at SWM	19.85 mAHD	128 m3/s
Fully unblocked	Unblocked scenario + no blockage applied at SWM	19.70 mAHD	129 m3/s
Blocked with 0% blockage at right culvert of SWM	BCC's blockage policy applied to all inlets and structures + blockage of right culvert underneath the SWM changed from 50% to 0%	19.75 mAHD	122 m3/s
Blocked and widening of culverts at SWM (Option 1)	BCC's blockage policy applied to all inlets and structures (including the SWM)	19.75 mAHD	121 m3/s
Unblocked and widening of culverts at SWM (Option 1)	No blockage applied apart from at SWM	19.85 mAHD	126 m3/s

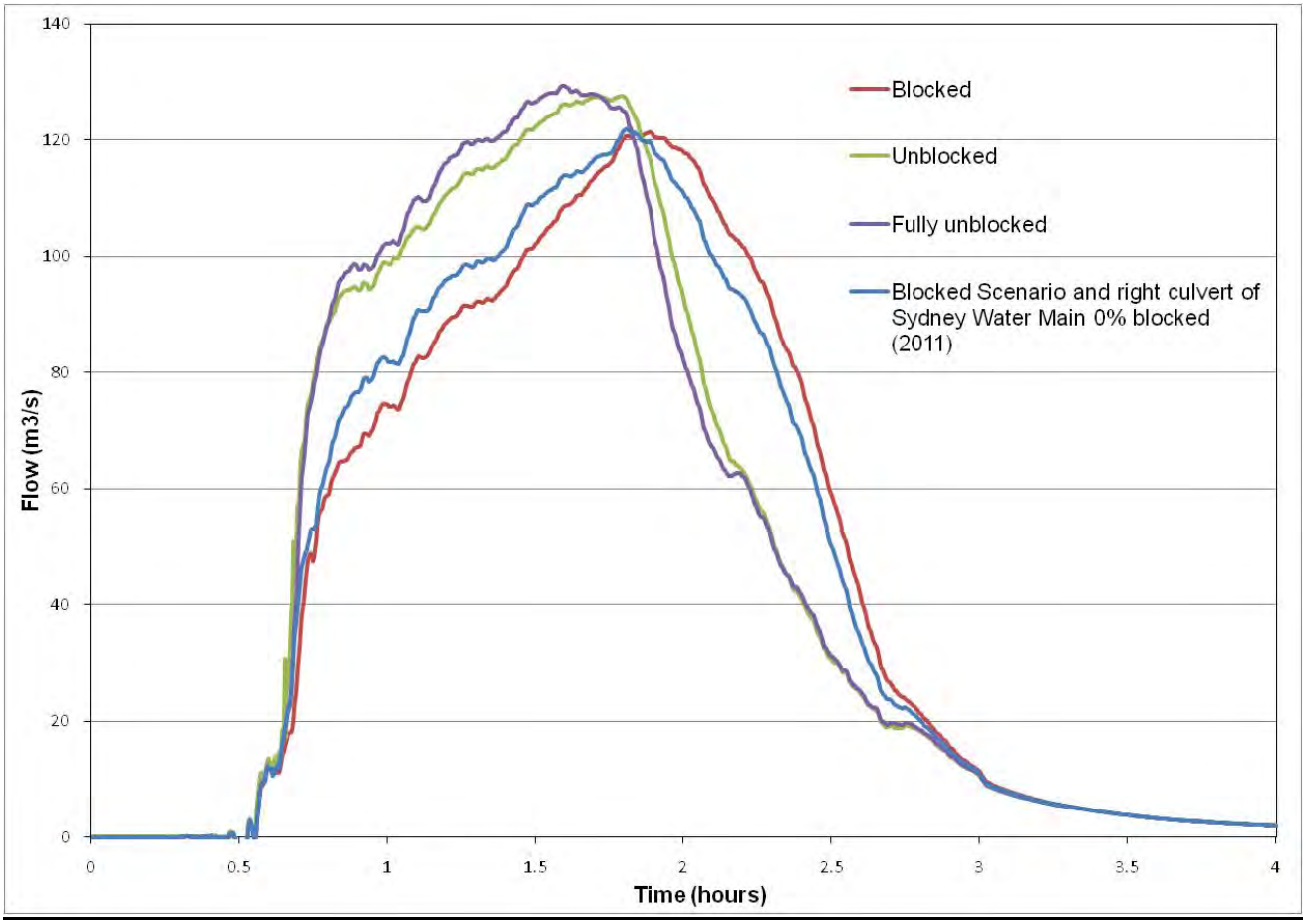


Image 5: Flow Hydrographs Downstream of the SWM for Four Blockage Scenarios

Sefton Golf Course Detention Levee (Option 2)

Under Option 2, the Sefton Golf Course detention basin, modelling indicates peak flood levels are reduced by between 0.05m and 0.20m between the retention basin and Maluga Passive Park, and by about 0.06m from Maluga Passive Park to Gascoigne Street. Downstream of these areas, flood levels are within 0.05m of those previously modelled. The flood level impact for Option 2 is presented in Figure 4 and Figure 5.

The reduction in peak flood level between the levee and Maluga Passive Park would benefit approximately 18 to 20 properties along Rose Street, Woods Road and Karraba Street. All of these properties currently experience flooding in the 100 Year ARI event. In addition, some of these are potentially affected by flooding above the floor level under current conditions. One house is first potentially affected by above floor level flooding in a 20 Year ARI event; another house potentially affected in a 50 Year ARI event and three potentially affected in a Probable Maximum Flood (PMF).

Flood level increases of up to 1m would occur within the Sefton Park golf course only, and would not affect any residential or industrial properties.

To contain the 100 year flood event, the detention basin wall would need to be between 0.7m and 2m high. Image 6 shows the detention basin wall, with selected locations being labelled with the wall height (and illustrated by yellow triangles).

A wall height of 1m to 2m behind the properties along Rose Street may be unacceptable by the residents. A lower wall height may provide reduced flood levels for events smaller than the 100 Year ARI event. If Council would like to investigate this option further it is recommended to simulate additional smaller storm events (i.e. the 5 and 20 year ARI events).

Image 6: Retention Basin Wall Heights Required To Contain The 100 Year ARI Flood

Band Hall Reserve Channel Works (Option 3)

Under Option 3, widening and revegetating the channels at Band Hall Reserve, modelling indicates increases of up to 0.4m in peak flood levels within the channel only. Residential and industrial properties in the vicinity will not be affected by increases in peak flood levels.

Decreases in flood levels ranging between 0.05m to 0.1m occur upstream of Ferrier Road. The modelling shows that two properties to the north of Ferrier Road, will benefit from peak flood level reductions of up to 0.2m. Currently, these two properties are affected by flooding above floor level in the PMF event. The flood level impact for Option 3 is presented in Figure 6 and Figure 7.

4 Conclusions

Hydraulic impact assessments of three options for providing flood mitigation or improving water quality have been investigated in the Duck River catchment:

1 Widening of the culverts and channel underneath the SWM;

2 Construction of a detention basin at Sefton Golf Course (utilised as a detention basin); and

3 Widening and revegetating the existing concrete lined channels around Band Hall Reserve to improve water quality.

Option 1 resulted in flood level reduction for a number of flood prone residential properties upstream of the SWM by up to 0.3m, but also resulted in flood level increases (with maximums of 0.1m) between Wellington Road and Mona Street. It is likely that residential properties in this area will not be affected by the increase in flood levels.

Option 2 resulted in beneficial outcomes with no exacerbation of existing flooding and with flood level reductions for a number of flood prone residential properties between the levee and Maluga Passive Park (west of Gascoigne Street).

A cost-benefit analysis of mitigation options 1 and 2, using flood damages estimates and construction costs may be useful for further appraisal of these options.

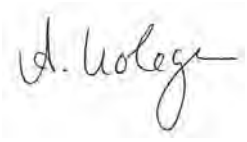
Options 3 resulted in no exacerbation of existing flooding, with the channel widening and revegetation expected to benefit water quality in the Duck River catchment.

The modelling of the different blockage scenarios applied in the Duck River model (BMT WBM, 2010) at the culverts underneath the SWM show that the resulting flood levels upstream of the SWM vary by up to 0.15m between the different blockage scenarios.

Please do not hesitate to contact either Anne Kolega or Sharon Wallace on (07) 3831 6744, should you have any questions.

Yours faithfully

BMT WBM Pty Ltd



Anne Kolega

Senior Flood Engineer

Enclosed:

- Figure 1: Peak Flood Level Impact, 100 Year ARI Event Widening of the Sydney Water Main Culvert in Bankstown.
- Figure 2 (Inset): Peak Flood Level Impact, 100 Year ARI Event Widening of the Sydney Water Main Culvert in Bankstown.
- Figure 3: Peak Flood Level Impact, 100 Year ARI Event Widening of the Sydney Water Main, Downstream of SWM
- Figure 4: Peak Flood Level Impact, 100 Year ARI Event Sefton Golf Course Detention Basin
- Figure 5 (Inset): Peak Flood Level Impact, 100 Year ARI Event Sefton Golf Course Detention Basin
- Figure 6: Peak Flood Level Impact, 100 Year ARI Event Band Hall Reserve Channel Widening and Revegetation
- Figure 7 (Inset): Peak Flood Level Impact, 100 Year ARI Event Band Hall Reserve Channel Widening and Revegetation

Title:

Peak Flood Level Impact, 100 Year ARI Event
Widening of Sydney Water Main Culvert in Bankstown

Figure: 1

Rev: A

N

0 400 800m

Approx. Scale

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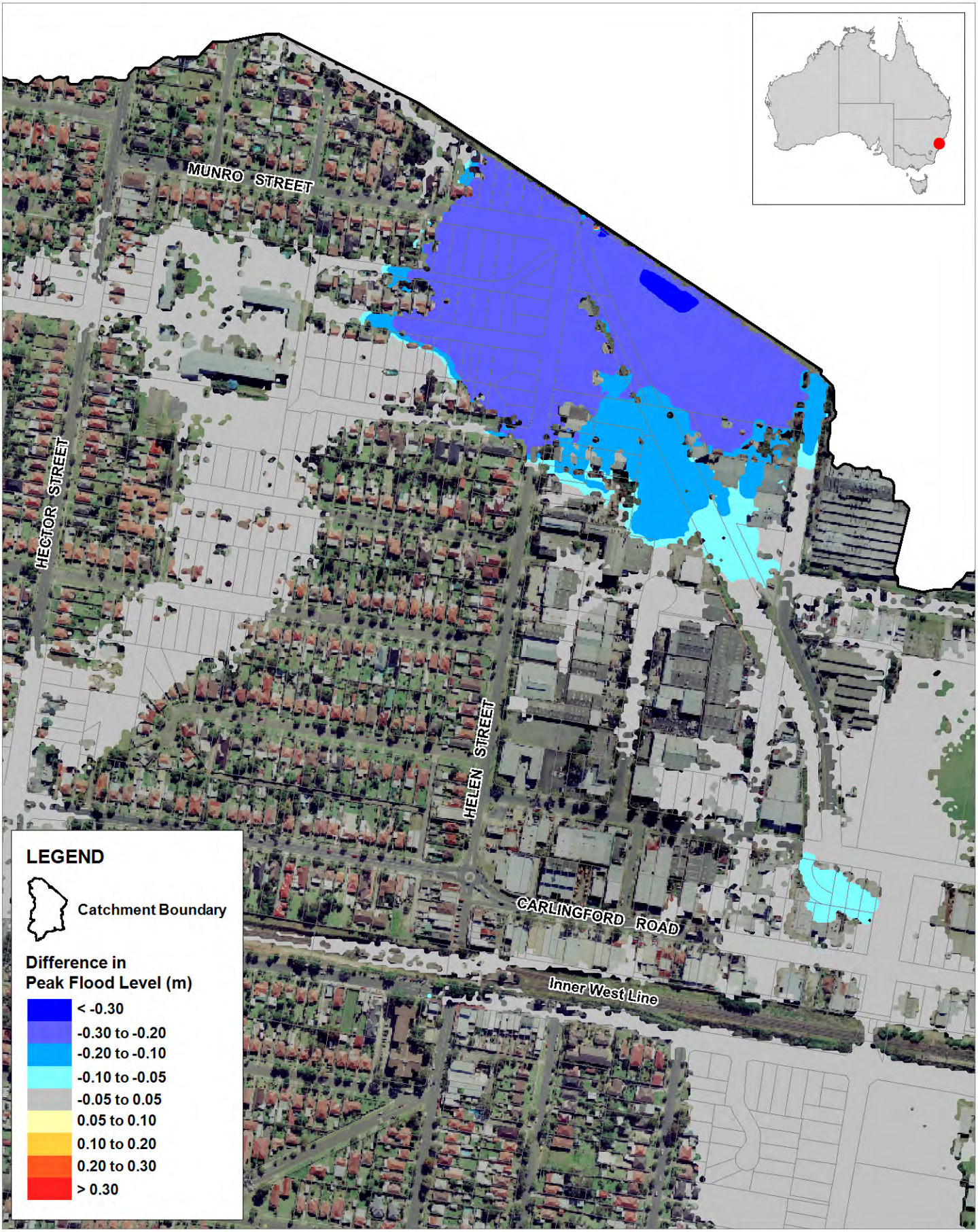

Title:

Peak Flood Level Impact, 100 Year ARI Event
Widening of Sydney Water Main Culvert in Bankstown

Figure: 2

Rev: A

N

0 100 200m

Approx. Scale

BMT WBM
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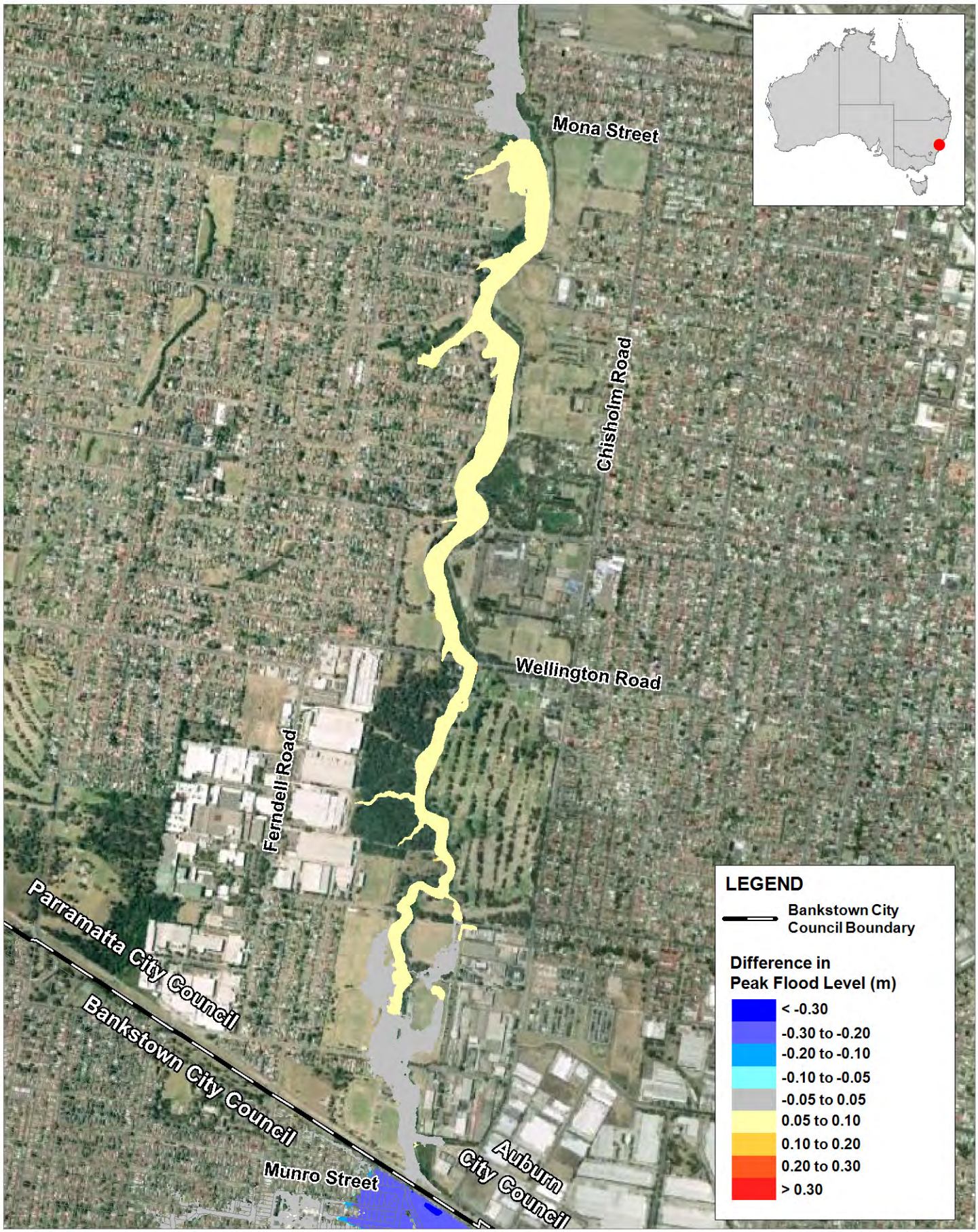

Title:

Peak Flood Level Impact, 100 Year ARI Event
Widening of Sydney Water Main, Downstream of SWM

Figure: 3

Rev: B

N

0 300 600m

Approx. Scale

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Title:

Peak Flood Level Impact, 100 Year ARI Event
Sefton Golf Course Detention Basin

Figure: 4

Rev: A

N

0 400 800m

Approx. Scale

BMT WBM
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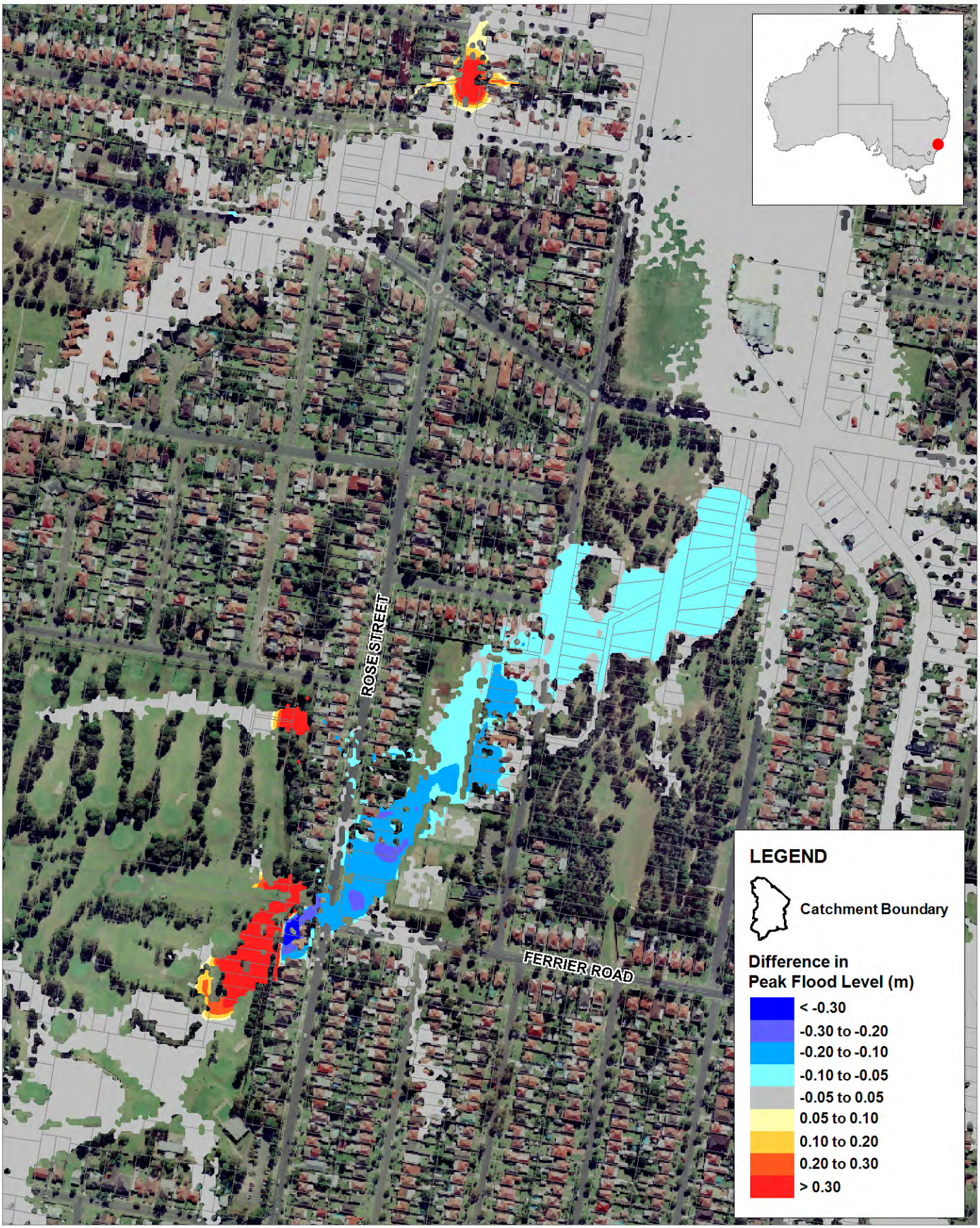

Title:

Peak Flood Level Impact, 100 Year ARI Event
Sefton Golf Course Detention Basin

Figure: 5

Rev: A

N

0 100 200m

Approx. Scale

BMT WBM
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Title:

Peak Flood Level Impact, 100 Year ARI Event
Band Hall Reserve Channel Widening and Revegetation

Figure: 6

Rev: A

N

0 400 800m

Approx. Scale

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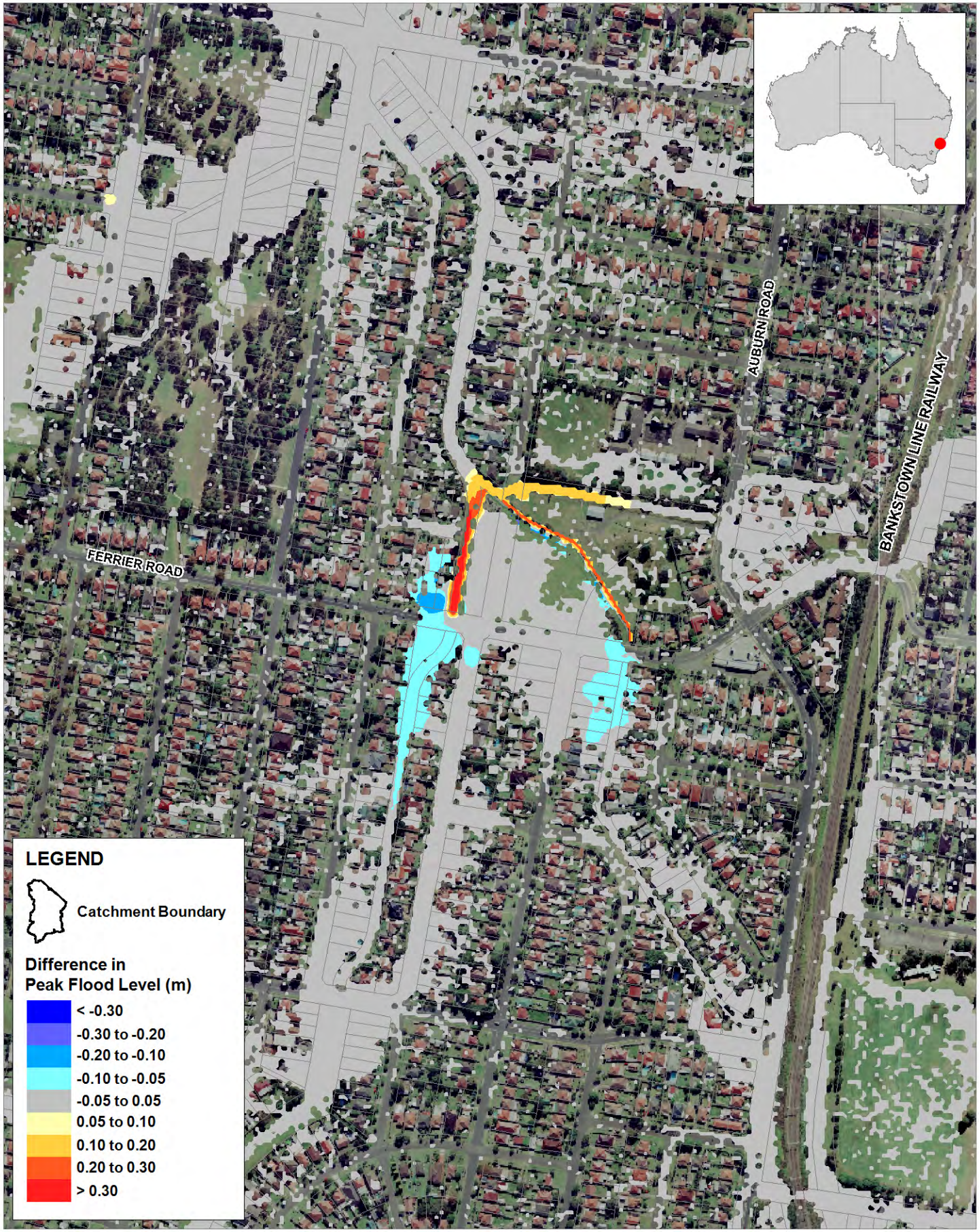

Title:

Peak Flood Level Impact, 100 Year ARI Event
Band Hall Reserve Channel Widening and Revegetation

Figure: 7

Rev: A

N

0 100 200m

Approx. Scale

BMT WBM
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