8. SENSITIVITY ANALYSIS

8.1 Climate Change

DECC (2007) recommends that climate change be considered in floodplain management. In particular, it recommends the consideration of three different rainfall scenarios and three different ocean level scenarios.

For the purposes of this study, two different scenarios were evaluated:

- Mid Range – Ocean level increase of 0.55m and 20% increase in rainfall
- High Range – Ocean level increase of 0.91m and 30% increase in rainfall.

These scenarios were evaluated utilising the 100 year ARI, 90 minute duration storm. This storm is generally critical for the proposed development area.

It is noted that the ocean level increase in the mid range scenario is the adopted level for the design events. Therefore, the mid-range sensitivity effectively assesses the impact of a 20% increase in rainfall.

The results of the climate change sensitivity runs are provided in Figure 8.1 and Figure 8.2.

Under the mid range scenario, peak water levels increase by between approximately 0.03 to 0.13m. Under the high range scenario, peak water levels increase by between approximately 0.04 to 0.36m (in the harbour area).

The climate change impacts are assessed between the design scenario with climate change and the design scenario under current conditions. No assessment has been undertaken on the impact of climate change on the existing site conditions. The assessment of climate change is focused on the adaptation of a design to the potential environmental changes that will occur in the future. As such, the existing site conditions under a climate change scenario were not assessed.

8.2 Hydraulic Roughness

A sensitivity analysis was undertaken on the assumed hydraulic roughness for the proposed development for the 100 year ARI design event. Two scenarios were analysed:

- 20% increase in hydraulic roughness
- 20% decrease in hydraulic roughness

The results of the hydraulic roughness sensitivity are shown in Figure 8.3 and Figure 8.4.

A reduction in hydraulic roughness of 20% results in a general reduction in peak water levels across the site, up to a maximum of approximately 0.25m. Localised increases are also observed as a result of hydraulically more efficient flowpaths, with a maximum of around 0.05m.

An increase in hydraulic roughness of 20% results in a general increase in the peak water levels across the site, up to a maximum of approximately 0.15m. The reduction in efficiency of the flowpaths also results in localised decreases, up to a maximum of approximately 0.10m.

It is noted that changes to the assumed roughness values to not alter the expected flooding in the existing Shellharbour Village

8.3 Culvert Blockage

A sensitivity analysis was undertaken on the potential impact of culvert blockage within the development for the 100 year ARI design event.

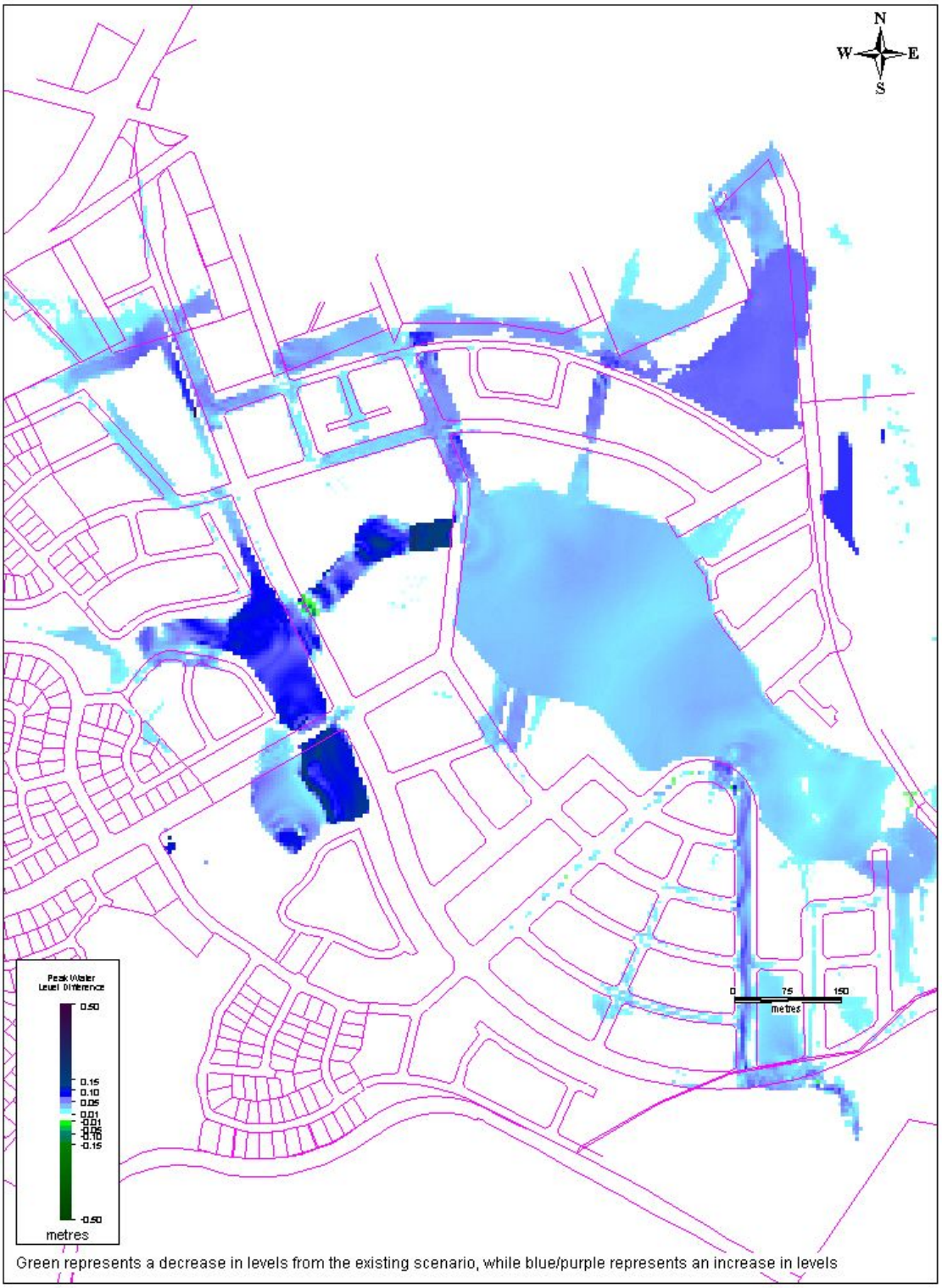
The existing pipe under the Ron Costello Oval area was assumed to be 100% blocked for the purposes of the analysis. However, given the relatively large dimensions of the proposed bridges and culverts within the proposed development, it was conservatively assumed that these were 50% blocked.

The results of the culvert blockage analysis are shown in Figure 8.5.

The culvert blockage scenario shows an increase in peak water levels upstream of the culverts within the study area, with increases generally less than 0.10m and a maximum increase of approximately 0.50m on the main western flowpath near the discharge point to the Boat Harbour. There is also the potential for culvert blockage to affect the existing Shellharbour Village, with a blockage in the two northern culverts resulting in an increase in peak water levels in this area of between 0.05 to 0.10m.

It is recommended that potential sources of debris be assessed and options be investigated to reduce the risk of blockage of these culverts. These options might include periodic cleaning of debris from local channels as well as trash racks or relatively large culvert dimensions.

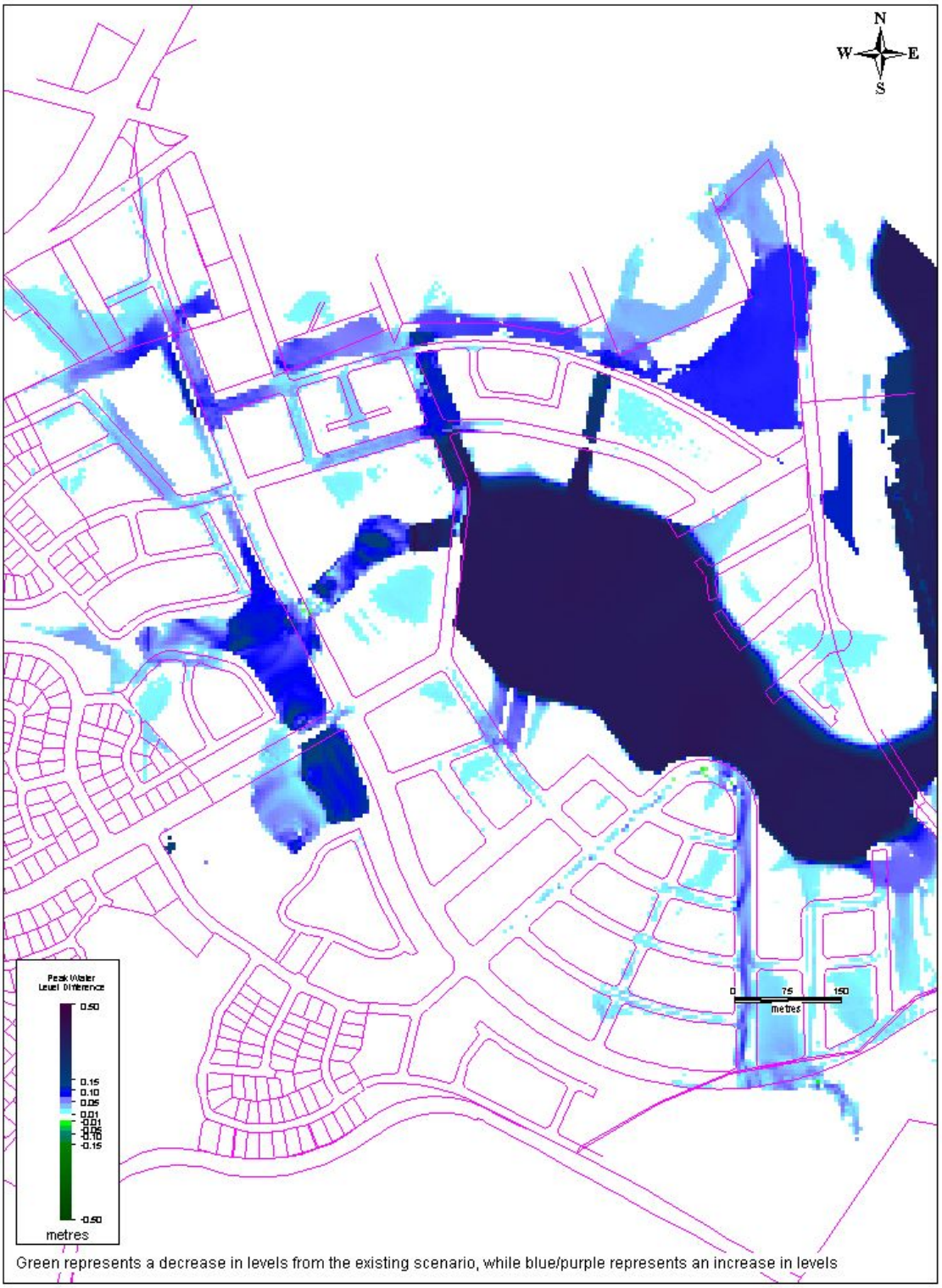
It should be noted that the increases in peak water levels in the Ron Costello Oval area would primarily be the result of the blockage of the pipes in this area, which are not part of the proposed development.



Blue represents an increase in peak water levels as a result of climate change

Figure 8.1 100 year ARI Climate Change Impacts on Developed Scenario - Mid Range

Mid Range = 20% increase in rainfall intensity, 0.55m increase in ocean level
Base Case = 0.55m increase in ocean level



Blue represents an increase in peak water levels as a result of climate change

Figure 8.2 100 year ARI Climate Change Impacts on Developed Scenario - High Range

High Range = 30% increase in rainfall intensity, 0.91m increase in ocean level
Base Case = 0.55m increase in ocean level

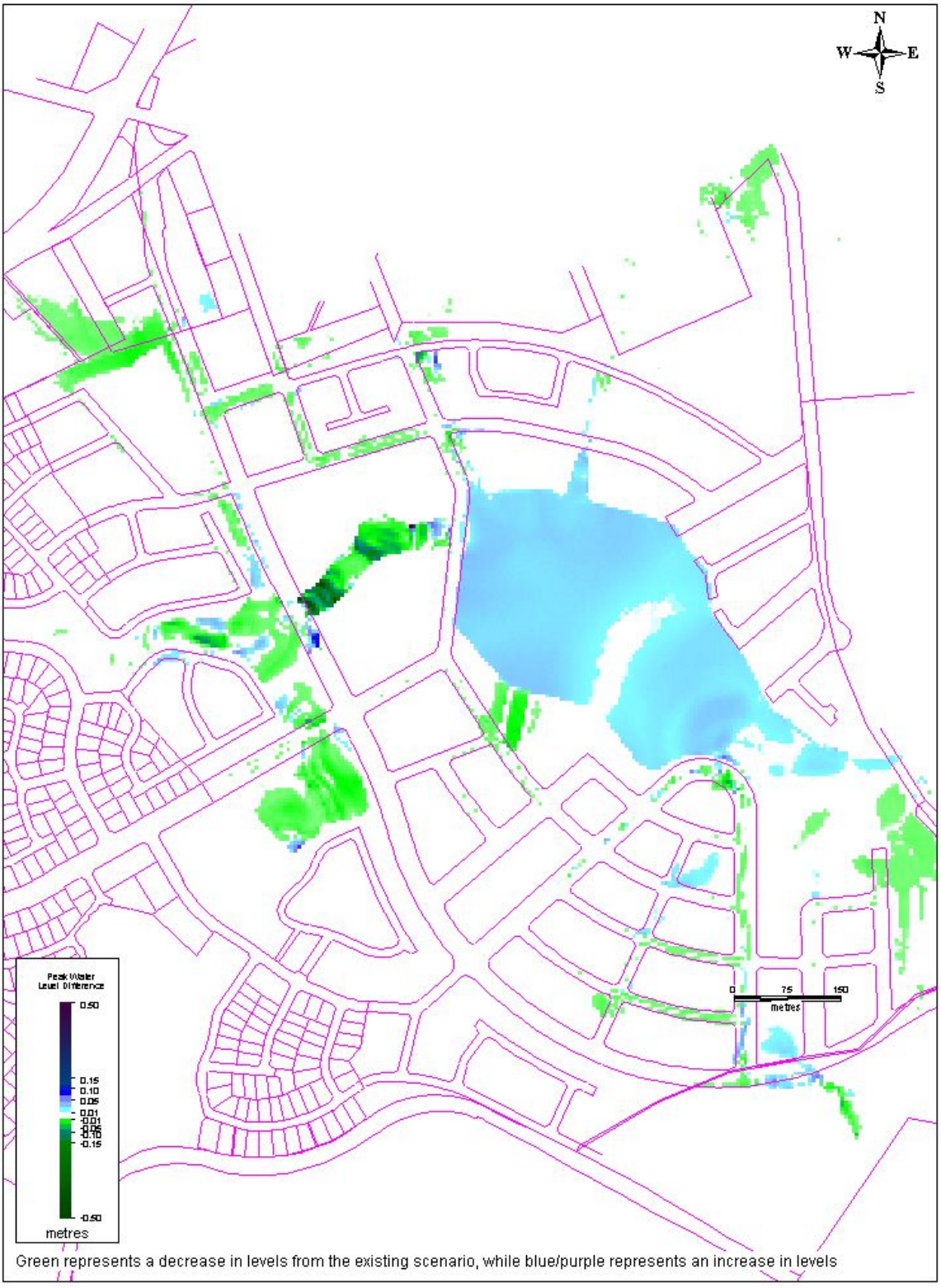


Figure 8.3 100 year ARI Sensitivity – 20% Reduction in Roughness

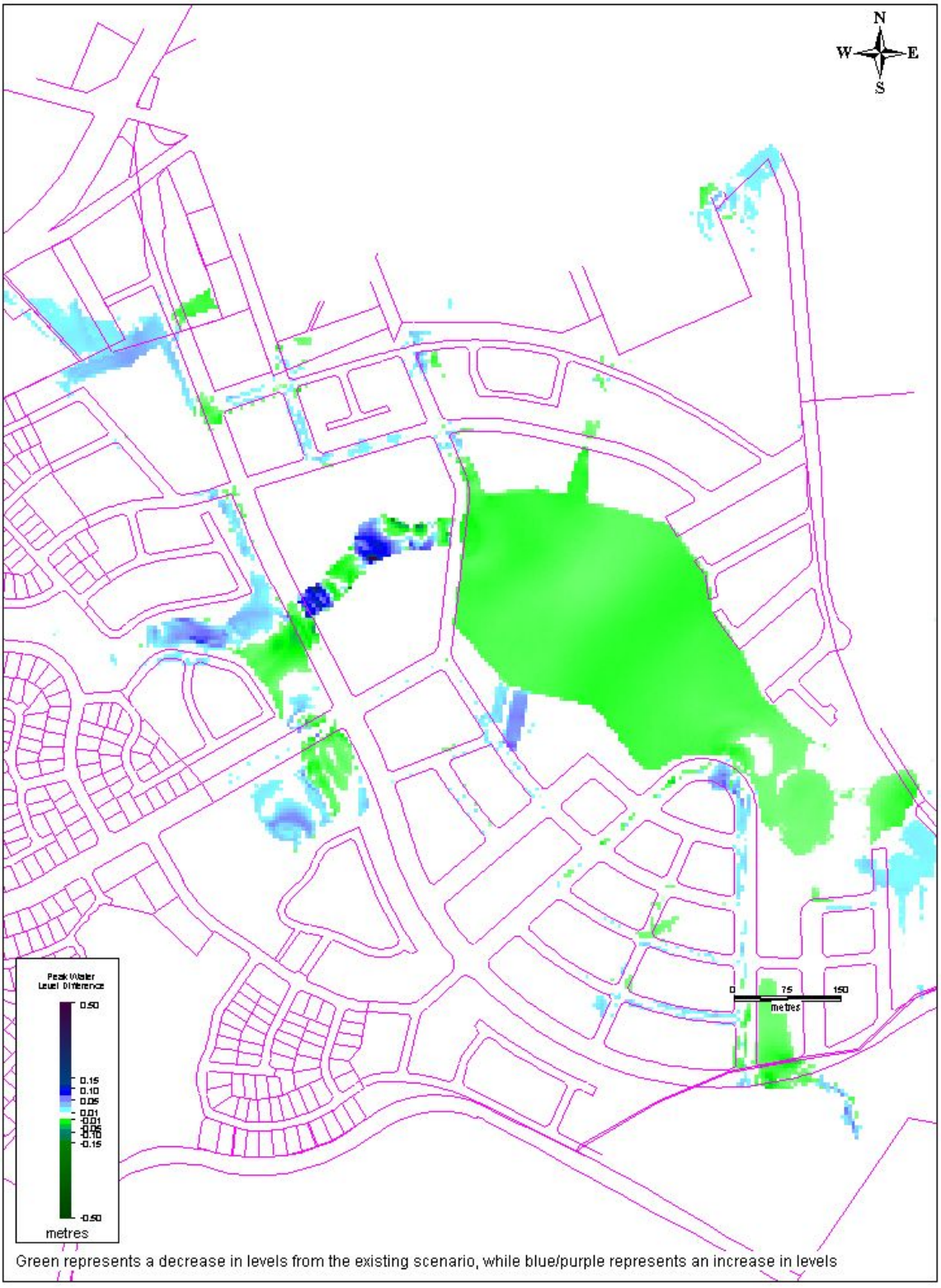


Figure 8.4 100 year Sensitivity - 20% Increase in Roughness

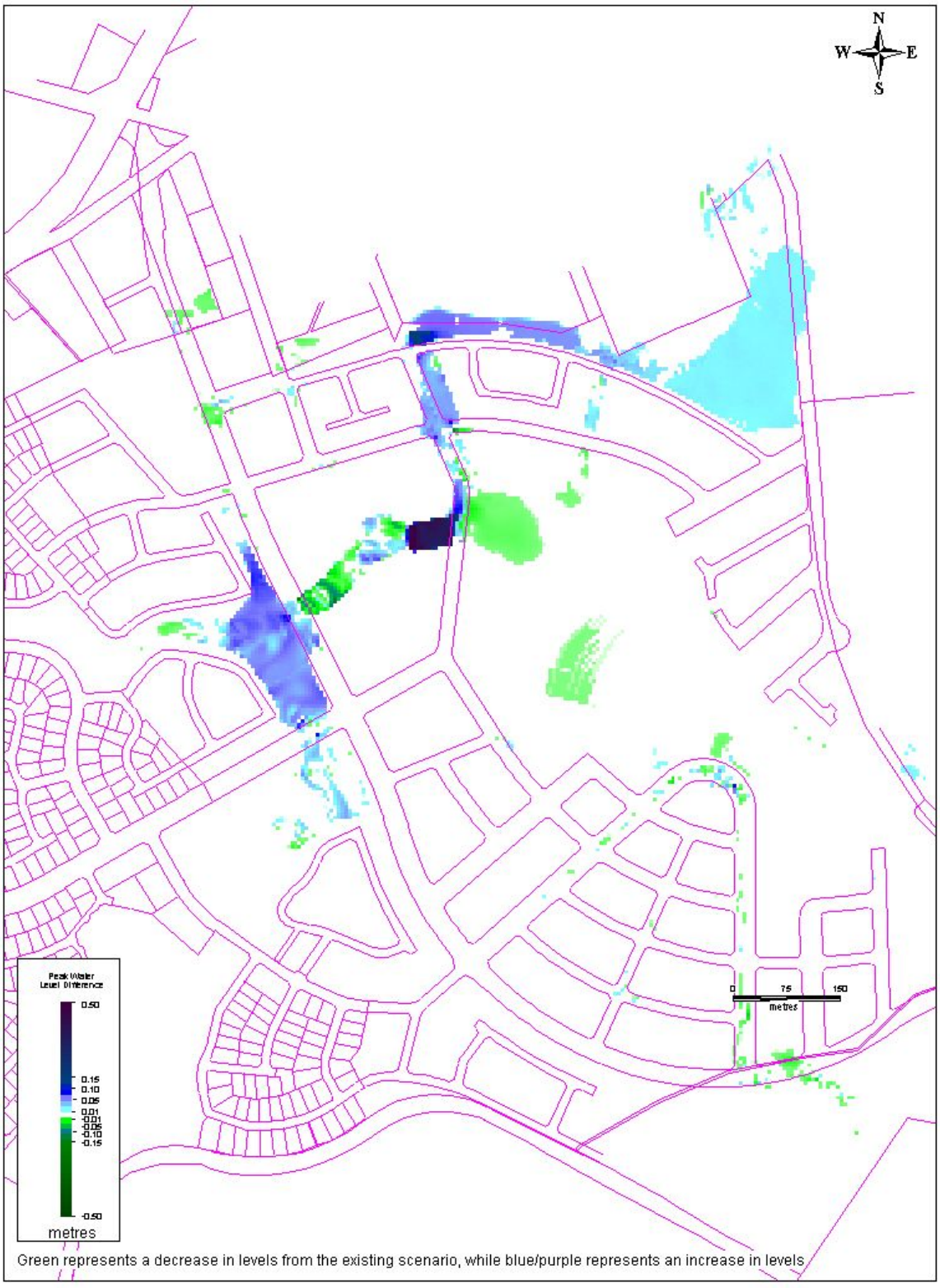


Figure 8.5 100 year ARI Sensitivity - Culvert Blockage

9. CONCLUSIONS

A flood analysis has been undertaken on the proposed development, as provided by Australand and Worley Parsons. This analysis was undertaken utilising a model that was developed for the study area as a part of a previous project (Cardno Lawson Treloar [1], 2005).

The results of the analysis suggest that the proposed development would impact on flood levels in the 100 year and 5 year events, in the vicinity of Ron Costello Oval. Whilst this impact is not considered significant, it could be addressed by either

- Reducing the invert of the north eastern flowpath, or;
- Providing a pipe, connecting upstream of the north eastern flowpath with the harbour.

Impacts in the PMF event are observed in the north west and south east of the proposed development. However, in both cases the impacts are within future development areas, and should be able to be managed as a part of the design process. It is noted that the proposed development would reduce the peak water levels in the existing Shellharbour Village.

An analysis of the provisional hazard in the study area shows that the high hazard, as defined by the Floodplain Development Manual (NSW Government, 2005), is primarily limited to the designated overland flow paths in the 5 year ARI and 100 year ARI design events. It is noted that the two northern flowpaths, which are intended for open space areas, should provide suitable grades to allow for adequate evacuation of these areas during a design flood event.

There is also an area of high provisional hazard in the 100 year ARI event along one of the roads in the southern portion of the proposed development. As discussed in the report, the hazard may be reduced by the inclusion of a stormwater network but the grades in this area would make it difficult to remove this area of high hazard completely. However, this area of high hazard is primarily contained with a central swale in the road, specifically designed for this purpose.

A sensitivity analysis for climate change, hydraulic roughness and culvert blockage has been undertaken. Peak water level increases, both within the development and within the existing Shellharbour Village, are generally between 0.03 to 0.23m. Maximum increases of approximately 0.36m occur as a result of climate change within the boatharbour waterway. Under a culvert blockage scenario, maximum increases of approximately 0.50m are observed on the main western flowpath near the discharge point to boatharbour. It is recommended to investigate options for debris control to minimise the risk of culvert blockage.

10. QUALIFICATIONS

- This report is subject to the same assumptions and qualifications as per Cardno Lawson Treloar [1] (2005).
- This report has been based upon design information supplied by both Worley Parsons and Australand (refer Section 3.2). The accuracy of the results are therefore dependent on the accuracy of the data supplied.
- The results of this report only apply to the design as stated. Any changes to the design will result in changes to the expected flood behaviour.

11. REFERENCES

BMD Consulting Pty Ltd (2004). *Shell Cove, Shellharbour Village, Stormwater Drainage Infrastructure Report*, November, prepared for Australand Pty Ltd.

Cardno Lawson Treloar (2006). *Shell Cove Boat Harbour Catchment Flood Study : PMF Analysis for Preliminary Design*, April, J2407/R2263/v1, prepared for Australand.

Cardno Lawson Treloar [1] (2005). *Shell Cove Boat Harbour Catchment Flood Study*, November, Issue No. 2, Final, J2407/R2208/v2, prepared for Australand.

Cardno Lawson Treloar [2] (2005). *Elliot Lake – Little Lake Flood Study*, July, Issue No. 4, LJ1959/R1974/V4, Final Draft, prepared for Shellharbour City Council.

Department of Environment & Climate Change [DECC] (2007). *Practical Considerations of Climate Change*, October.

Hanslow D, Davis G, You B & Zastawny J (2000). *Berm Height at Coastal Lagoon Entrances in NSW*, November, 10th Annual NSW Coastal Conference, Yamba.

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Appendix A

Revised Bowling Club Assessment

Revised Flood Assessment near Bowling Club

In May 2009, minor maintenance works were undertaken to drainage channels in the vicinity of an area to the south of the Shellharbour Bowling Club. A detailed survey was subsequently undertaken in this area reflecting the completed maintenance works and a more accurate ground survey in this location.

The ground survey (SCSTG8RV.DXF) was provided to Cardno Lawson and Treloar on 15 May 2009. The survey was incorporated into the existing model to assess the impacts of the updated information. The model was run for the 100 year 90 minute duration, which is the critical duration for this area.

Overall, there is a general reduction in peak water levels within the area (Figure A1). Reductions of up to 0.5m in peak water level are observed, generally as a result of the revised survey data. Some increases in peak water level are observed but these impacts are localised. The maximum increase in peak water level is 0.1m.

Generally, the changes to the 100 year flood extent are minimal. However, it is noted that the reductions in peak flood levels in the area have resulted in the Bowling Club property being excluded from the 100 year flood extent (refer Figure A2).

Revised extents and results for this area are provided in the following figures:

Figure A1 – 100 year 90 minute Peak Water Level Difference
Figure A2 – 100 year 90 minute Extent – post May 2009 Ground Survey
Figure A3 – 100 year 90 minute Peak Water Level – post May 2009 Ground Survey
Figure A4 – 100 year 90 minute Peak Depth – post May 2009 Ground Survey
Figure A5 – 100 year 90 minute Peak Velocity – post May 2009 Ground Survey

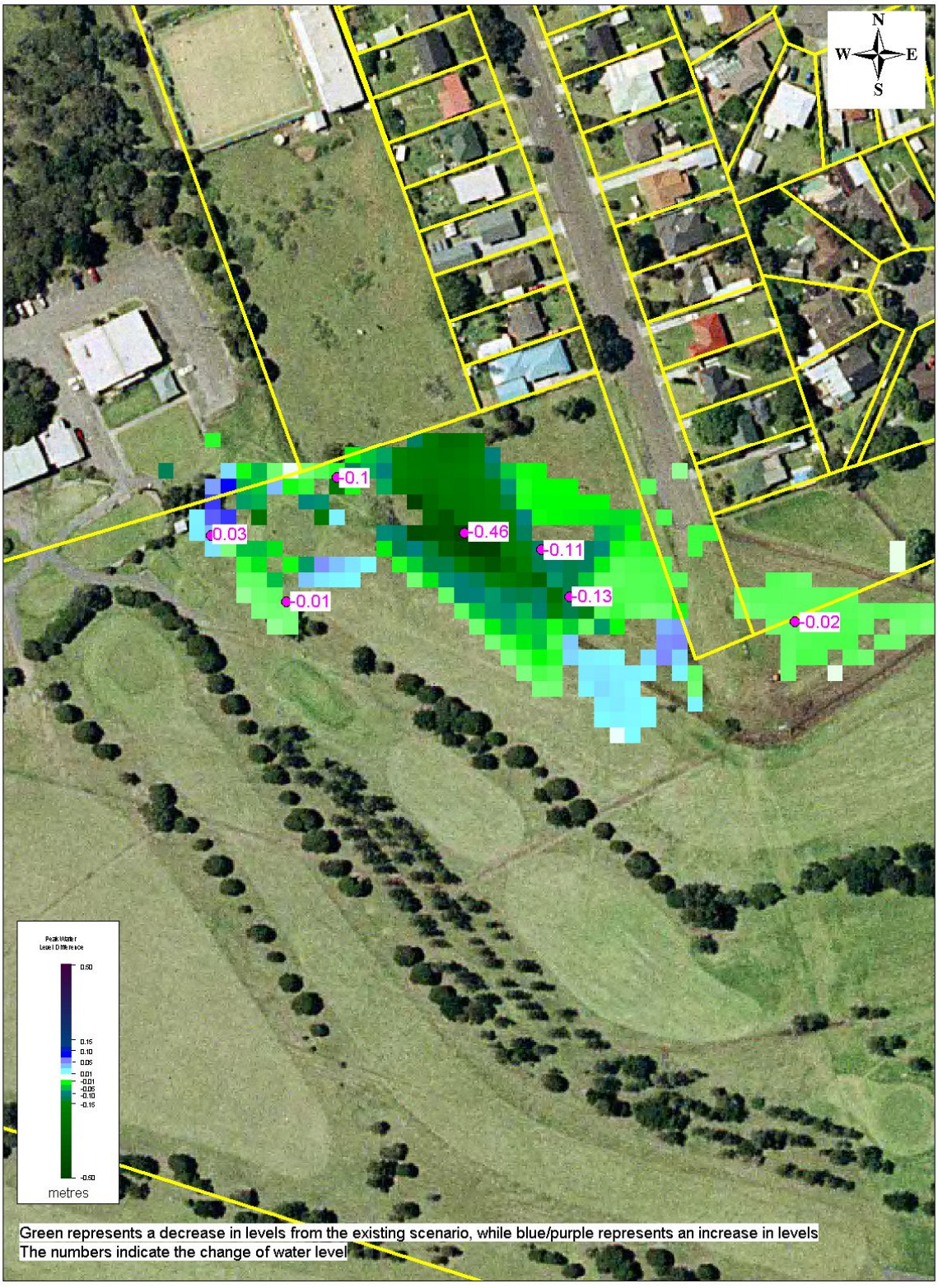

Figure A1. 100 year 90 minute Peak Water Level Difference – post May 2009 Ground Survey

Figure A2. 100 year 90 minute Extent – post May 2009 Ground Survey

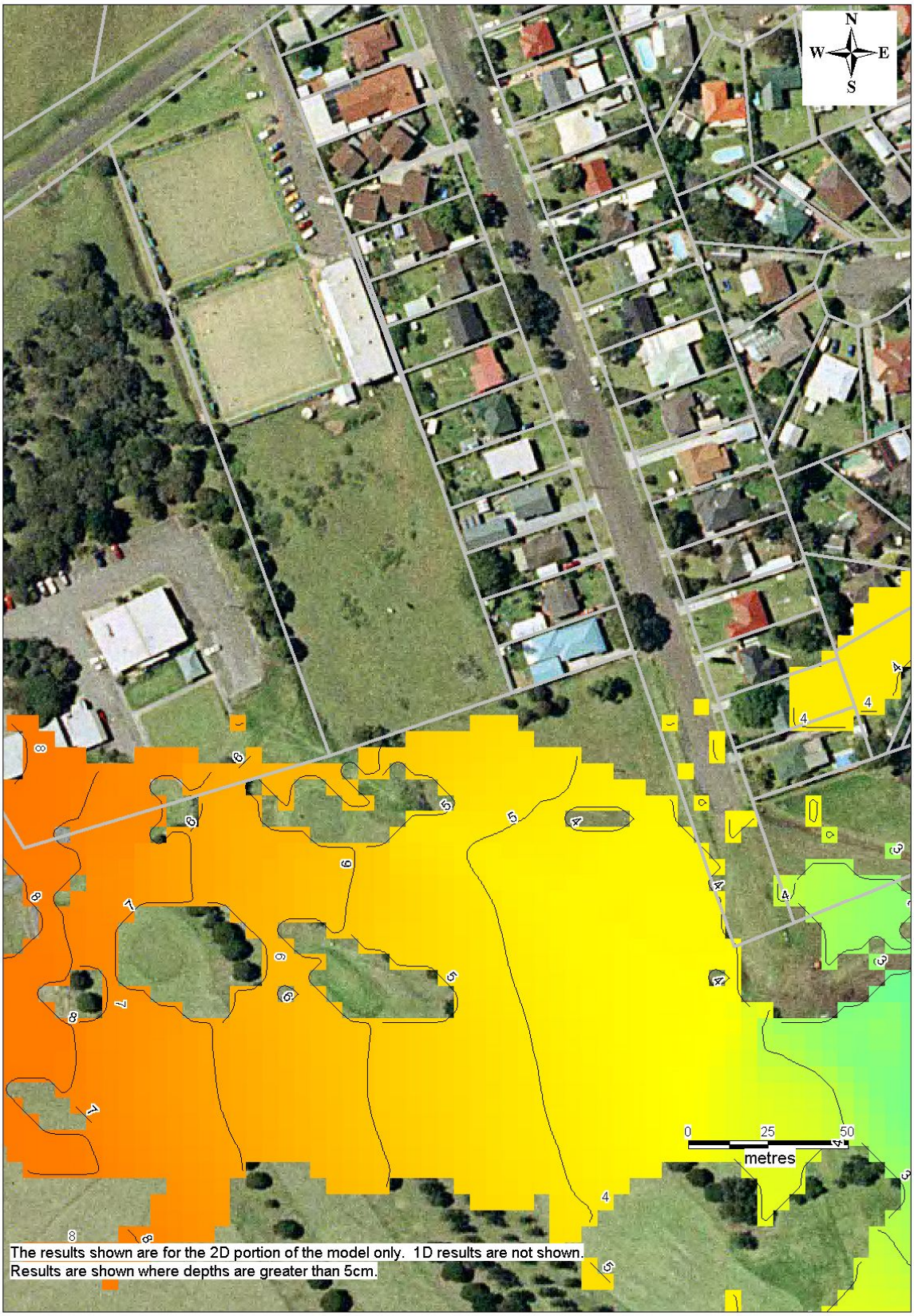

Figure A3 – 100 year 90 minute Peak Water Level – post May 2009 Ground Survey

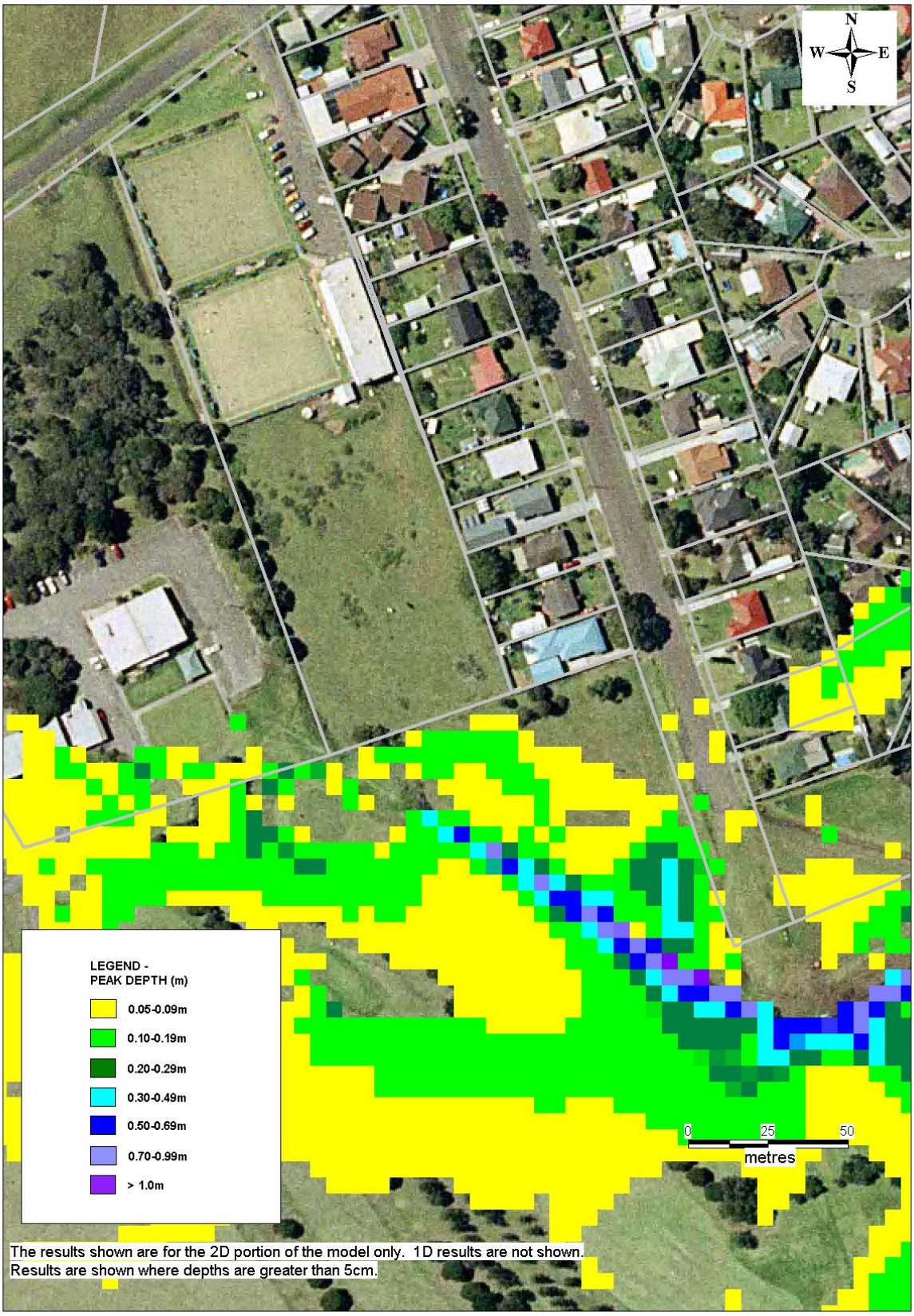

Figure A4 – 100 year 90 minute Peak Depth – post May 2009 Ground Survey

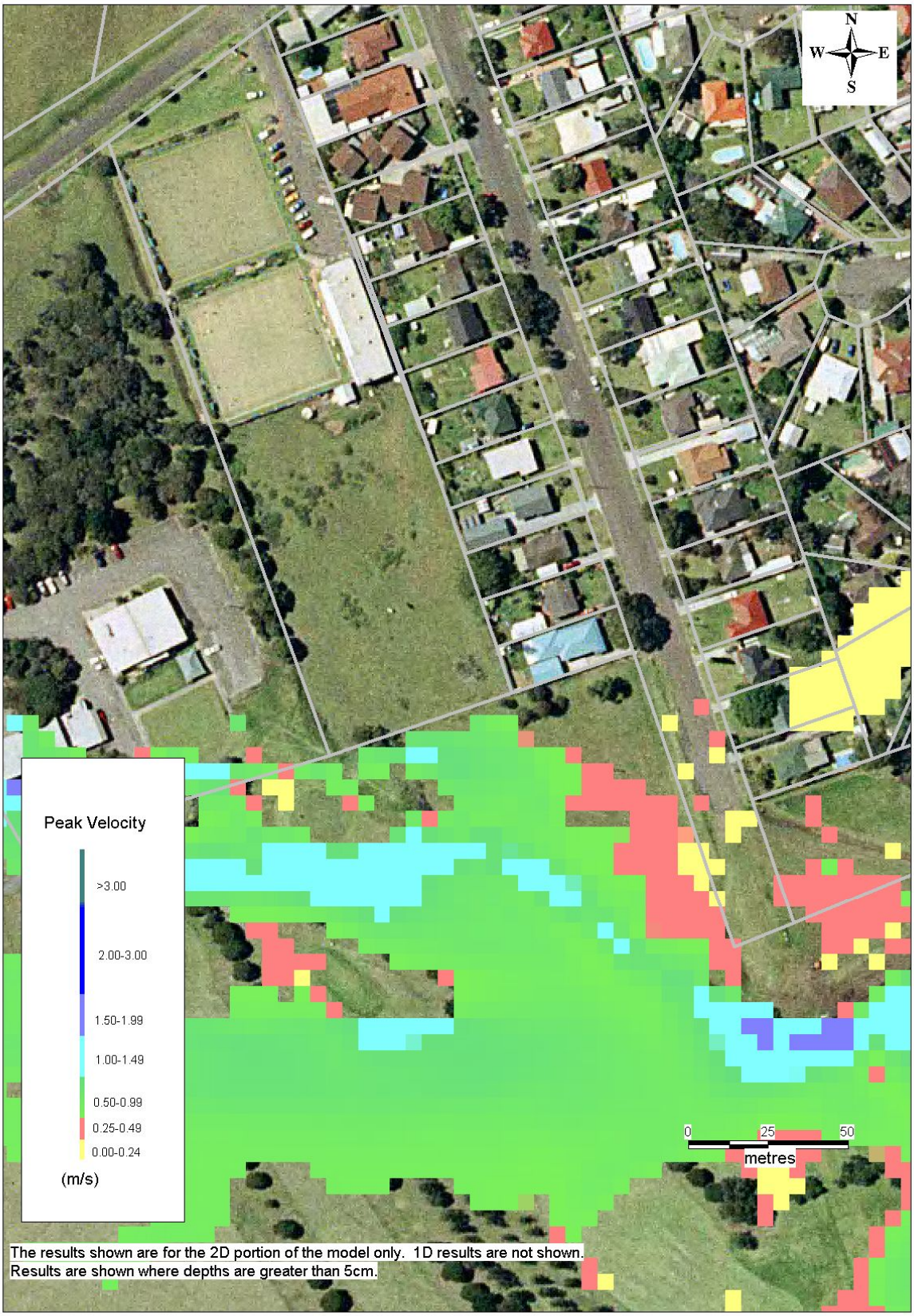

Figure A5 – 100 year 90 minute Peak Velocity – post May 2009 Ground Survey