Appendix E

E. Appendix E: Hydraulic Categorisation – Floodway Definition

Introduction

The Culcairn hydraulic categorisation maps for the 5% and 1% AEP events and the PMF are presented in Figure 8 to Figure 10 respectively. The floodway was determined for the 1% AEP events with the same methodology then applied to the 5% AEP and PMF events.

Hydraulic categorisation is the process by which flood behaviour for a given design event is classified into areas of flood storage, flood fringe and floodway. The NSW Floodplain Development Manual 2005 (Reference 1) provides definitions for all three categories, however these are descriptive definitions and aren't suitable for directly calculating/assessing the categories. The definitions as per Reference 1 are provided below for clarity.

> *Floodway*– areas in the floodplain where significant discharge occurs. Often aligned with natural channels. Floodways are areas that even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
>
> *Flood Storage* – those parts of the floodplain important for the temporary storage of floodwaters during a flood. Extent and behaviour of flood storage areas may vary greatly for different events and so a range should be examined.
>
> *Flood Fringe* – remaining areas of land in the floodplain after flood storage and floodway have been defined. (NSW FDM, 2005)

Three further definitions that are suitable for directly calculating/assessing the floodway extent and that are widely used to describe the characteristics of the floodway are described below:

1. The extent which comprises a significant proportion of flow in a flow path (80 to 90% is often used as the portion of flow within the floodway); and
2. The extent which if partially blocked causes impacts in excess of 0.1 m to occur upstream of the partial blockage.
3. The Floodplain Risk Management Guidelines (2007) (Reference 18) advise that the minimum width of a floodway is required to be at least as wide as the main channel as determined from the top of bank.

These three definitions have been used to assist in determining the floodway extent at Culcairn.

Defining the floodway is a critical component of the flood risk management work carried out under the NSW Floodplain risk management program. This relates to the fact that the defined floodway extent will typically not be available for further residential development. As such it is imperative that the floodway definition is appropriate and not conservative.

Approach

Generally speaking there is no definitive method and defining a floodway is often an iterative process. In the context of 2D and 1D/2D models, the output used in the mapping tends to be in

a raster format. A raster presents flood modelling outputs for each grid cell in a gridded format for the given study area. The velocity depth (VD) product for each cell can, and has in previous studies, been used to define the floodway. For example the Howells et al (Howells) method utilises the VD product and the velocity (V) when assessing hydraulic categories.

The Howells method differentiates the floodway from other hydraulic categories by selecting a VD criteria that exceed a specific threshold. Some subjectivity still exists within the methodology and different regions often require different V and VD criteria to produce suitable results. Testing varying V and VD criteria, to some degree, is comparable to a calibration exercise where the VD product to be used as a threshold for defining floodway is modified until such a time as a suitable floodway is obtained.

Given that the VD product can provide a base for defining the floodway extent for raster results, the next issue with floodway definition is defining what the VD product should be "calibrated" to, to achieve a reasonable floodway definition. In other words, what VD product will define a floodway extent which will satisfy the three floodway definitions mentioned above.

Methodology

In the 2012 paper by Thomas et al., the two previously mentioned floodway definitions were investigated and a remarkable correlation was observed between the 80% - 90% flow criteria and a 0.1 m afflux.

The proposed approach builds on the criteria proposed by Howells et al. in their 2004 paper using various VD and V parameters to estimate the floodway and then verifies results using encroachment analysis similar to that found in Thomas et al. (2012).

In the encroachment analysis all areas not defined as floodway via the Howells method have been totally excluded from the modelling domain and the subsequent impact on flood levels is examined. In other words the encroachment run undertaken as a check, conservatively assumes that all areas outside the floodway are blocked and should development occur outside the floodway zone defined herein the impact is likely to be less than 0.1 m

A summary of VD and V values investigated (VDV criteria) is listed below:

a. VD > 0.25 m^2/s and V>0.25 m/s; or V>1.0 m/s;
b. VD > 0.20 m^2/s and V>0.20 m/s; or V>1.0 m/s;
c. VD > 0.15 m^2/s and V>0.15 m/s; or V>1.0 m/s;

In addition to the Howells method, other methods are also utilised to define the Culcairn floodway and further add to the robustness of results. The top of the main channel bank has been adopted as the minimum floodway width, satisfying the guidelines discussed above. Also, the percentage of flow conveyed in the floodway is investigated to see if it fits the 80% - 90% criteria, as previously mentioned.

The remainder of the floodplain outside the defined Floodway becomes either Flood Storage or Flood Fringe.

In the past, the 20Y ARI flood extent has been used to define the 1% AEP floodway. As a

supplementary test, this approach has also been considered in this investigation by comparing the 20Y ARI flood extent (trimmed to remove depths greater than 0.1 m) to the VD and V criteria listed above.

Results

Appendix Figure E 1 displays the afflux associated with the encroachment analysis testing for Culcairn. Regions displayed in red satisfy VDV criteria (b), mentioned previously. This defined floodway was found on encroachment analysis testing to produce an afflux of approximately 0.1 m in the Culcairn township area. In Billabong Creek and the anabranch proximate to Culcairn, VDV criteria (a) was used to produce an afflux of approximately 0.1 m. Using the criteria postulated above, the 2nd floodway definition is satisfied.

In some areas the afflux produced is below 0.1 m. The width of the floodway in these regions could not be decreased without excluding the top of the channel bank and therefore not meeting the guidelines previously outlined. By extending the defined floodway to at least as wide as the main channel (as determined from the top of bank) the 3rd floodway definition is satisfied.

The 20Y ARI flood extent is approximately the same as the floodway defined by the Howells method and accordingly produced a similar afflux. The Howells method extent and the top of bank are more robust than using the 20Y ARI extent and are therefore more appropriate for hydraulic categorisation in Culcairn.

A number of cross sections that measure flow in the model are also displayed in Appendix Figure E 1. For each cross section, the flow distribution (%) both within and outside of the floodway are displayed. It can be seen that the percentage of flow contained within the defined floodway is within 80% – 90% thus satisfying the 1st floodway definition. This adds further robustness to the floodway results.

Conclusions

Defining a floodway is a non-precise process. The goal is to produce floodway extents that match flow behaviour so that the areas which need to be retained for flow are identified whilst other parts of the flood extent can be developed as appropriate. While the allocation of floodway is likely to be a contentious issue that would merit a precise definition, the fact remains that a one size fits all approach still eludes the practitioner. The method presented defines a reasonable floodway extent using VD and V criteria and then confirms the suitability of the defined floodway extent by using afflux testing. The percentage of flow within the floodway was also investigated to see if the 1st floodway definition is satisfied.

The method used in defining the floodway is based on the Howells method but the VD and V thresholds are adjusted according to an encroachment analysis until the 2nd floodway definition is satisfied. When all areas outside the defined floodway are blocked and the resulting afflux is in the region of 0.1 m it can be argued that any development outside this floodway will result in an afflux less than 0.1 m which satisfies our 2nd floodway definition. Additionally, as previously mentioned, the top of bank for the main channel was set as the minimum width of the floodway extent, thus satisfying the 3rd floodway definition.

FIGURE E1
CULCAIRN HYDRAULIC CATEGORISATION INVESTIGATION

Hamilton St
Hopetoun St
Melrose St
Melrose St
Federal St
Douglas St
Kirndeen St
McBean St
Railway Pde
Victoria St
Munro St
Federal St
Henty St
Balfour St
Balfour St
Culcairn - Holbrook Rd
Culcairn Rd
Fraser St
Gordon St
Wattle St
Cummings Rd
Olympic Hwy

0.4%
2.72 %
95.73 %
0.34 %
0.8%
90.4%
0.5%
8%
0.3 %

N

Billabong Creek Top of Bank
Flow Distribution Lines
Encroachment Region V*D>0.25

Impact (m)

No longer Flooded
< -0.1
-0.1 - -0.05
-0.05 - -0.01
-0.01 - 0.01
0.01 - 0.05
0.05 - 0.15
0.15 - 0.25
> 0.25
Newly Flooded

0 0.25 0.5 1 1.5 2 km

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