Introduction

Wollongong City Council’s Transport and Stormwater Services section is responsible for asset management as well as floodplain risk management. The asset management and floodplain risk management functions are separately managed in different units. This paper will focus on demonstrating the importance of integrating these two functions when managing existing flood detentions basins and planning for new ones.

Asset management

Overview of asset management

Asset management is a key function of Council and is strongly driven by the vision and community goals endorsed in the Wollongong 2022 Community Strategic Plan which forms part of the New South Wales Integrated Planning and Reporting Framework for Councils. Council’s Revised Resource Strategy 2012-2022 identified that while Council’s financial position was considered sound in the short to medium term, depreciation of assets outstripped funding for renewal with the gap at approximately $21M annually.

Council manages over $4.1 billion of assets. These assets consist of:

<table>
<thead>
<tr>
<th>Asset Category</th>
<th>Replacement Cost ($’000)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure Assets</td>
<td>$3,362,181</td>
</tr>
<tr>
<td>Transport</td>
<td>$1,817,883</td>
</tr>
<tr>
<td>Stormwater</td>
<td>$922,902</td>
</tr>
<tr>
<td>Buildings</td>
<td>$524,651</td>
</tr>
<tr>
<td>Recreation</td>
<td>$69,027</td>
</tr>
<tr>
<td>Other*</td>
<td>$27,719</td>
</tr>
<tr>
<td>Non Infrastructure Assets</td>
<td>$74,090</td>
</tr>
<tr>
<td>Buildings</td>
<td>$581</td>
</tr>
<tr>
<td>Recreation</td>
<td>$26,168</td>
</tr>
<tr>
<td>Other*</td>
<td>$47,341</td>
</tr>
<tr>
<td>Non Depreciable Assets</td>
<td>$671,292</td>
</tr>
<tr>
<td>Transport</td>
<td>$26,278</td>
</tr>
<tr>
<td>Recreation</td>
<td>$87,543</td>
</tr>
<tr>
<td>Other*</td>
<td>$577,471</td>
</tr>
<tr>
<td>Grand Total</td>
<td>$4,107,563</td>
</tr>
</tbody>
</table>

Table 1: Wollongong City Council’s assets replacement cost

Council strategic asset management plan identifies that best practice in Asset Management requires the consideration and provision of funding for operational, maintenance, renewal and disposal needs. Existing and new assets need to be
carefully managed, planned and prioritised to consider efficiencies, condition, function, risk, and level of service.

**Asset management and detention basins**

Council currently owns 96 detention basins. The majority of these have been constructed by developers as part of subdivision developments in the 1970s to 1990s. Only a few were designed and built by Council in response to a floodplain risk management process.

Of the 96 basins, 11 were classified as ‘prescribed basins’ in accordance with the NSW Dams Safety Act 2015 and are currently overseen by the NSW Dam Safety Committee. Put simply, a prescribed dam is considered to be a dangerous dam.

The cost of monitoring, inspecting and managing risks of prescribed basins in accordance with the guidelines and requirements of the NSW Dam Safety Committee is significant. This results in increased lifecycle costs.

The dam breach and consequence category assessments for these 11 dams were recently developed or updated. This process resulted in 2 detention basins no longer being classified as prescribed basins, as the revised consequence category was changed to *less than significant*. The remaining 9 prescribed dams have consequence categories ranging from *significant* to *high A*. The consequence categories of prescribed dams are mainly determined by two factors; the Population at Risk and Loss of Life (LoL). The Total PAR is the total population occupying the full extent of the dambreak affected zone (including that area affected by natural flooding prior to dambreak) immediately prior to the onset of flooding. LoL is an index that estimates the severity of a dam failure in terms of the likely loss of people’s life.

The table below compares the estimated average annual lifecycle cost per basin for prescribed and non-prescribed basins in Wollongong Local Government Area (LGA). It also highlights the gap between the desired and allocated resources to manage these assets.

<table>
<thead>
<tr>
<th>Item</th>
<th>Prescribed basins</th>
<th>Non-Prescribed basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of detention basins Council owns</td>
<td>9</td>
<td>87</td>
</tr>
<tr>
<td>Required spending (on average basin/year over 50 year life-cycle includes operational, maintenance, renewal &amp; upgrade)</td>
<td>$34,844</td>
<td>$18,844</td>
</tr>
<tr>
<td>Current scheduled maintenance expenditure (basin/year)</td>
<td>$14,022</td>
<td>$0*</td>
</tr>
</tbody>
</table>

*Only reactive maintenance if and when required.

**Table 2: Average Lifecycle cost of detention basins-Wollongong LGA**

The lifecycle costs can vary greatly between basins, based on their location and the nature and size of contributing catchments.
Many basins in Wollongong LGA are located at the toe of the escarpments and are particularly prone to sediment, rock and boulders deposition. Those basins require more resources for on-going maintenance. As an example, in recent years, the Foothills Road detention basin at Mount Ousley required approximately 2,330m³ of deposited materials to be removed to restore basin design volumes, this represented an overall cost of approximately $600,000. It is estimated that similar operations may need to reoccur every 20 to 30 years if basin design volumes are to be maintained.

Detention basins and risks

Detention basins are providing flood mitigation benefits for downstream properties but also present safety risk to the community. The main risks are:

- risk of drowning by sudden rise of flood waters and excessive water depth within the basin itself, noting most Wollongong catchments are prone to flash flooding and the basins would respond very quickly to the rainfall event
- risk of drowning by being trapped against the outlet structure due to hydraulic pressure
- dam breach risk

Those risks are generally mitigated by restricting access to the asset, or providing risk signage, designing outlet structures to facilitate egress and implementing works and emergency management procedures recommended by the NSW Dam Safety Committee to reduce likelihood and impacts of dam breach. For example, at Barina Park, the DSC required the construction of a spillway which in turn requires the purchase of 5 additional properties, the total scheme is evaluated at approximately $3.5 million (refer Appendix 1).

If we were to plot the safety risks presented by detention basins on Council’s enterprise wide risk management ranking tool, the likelihood of dam breach risk would be unlikely to rare but with generally catastrophic consequences, the risk of drowning would have a higher likelihood (possible) with also catastrophic consequences. The safety risks would therefore range between M5 and E15.
Wollongong City Council has been highly proactive in developing floodplain risk management plans under the NSW Flood program and in accordance with the NSW Floodplain Development Manual. Council has 7 adopted floodplain risk management studies and plans which cover the key flood risk areas in the LGA. These flood risk management plans do not consider the risk of dam failure. As noted by DeSilva et al (2010), in most NSW LGAs, the mapping of flood extents and flood risks resulting from the failure of detention basins and water supply dams is carried out separately from the mapping carried out as part of the flood studies and floodplain risk management studies under the NSW Flood Program.

In addition, the flood studies and floodplain risk management studies and plans generally model the existing catchment conditions (including existing detention basins) as the base case on which further flood risk mitigation efforts are explored. Therefore the plans are generally silent about the performance of existing basins and the flood benefits they provide.

Two of the floodplain risk management plans adopted by Council recommend 4 new detention basins at an approximate capital cost of $8 million.

Three of the proposed detention basins are currently under further investigation / concept design. A review of the plans highlights that recommendations for these new basins are based on a cost benefit analysis that fails to take into consideration the significant lifecycle costs of such structures, with sometimes maintenance costs not
considered at all, or estimated at $5,000 which is in stark contrast to the actual costs indicated in Table 2 above. The cost benefit analysis was also limited to the reduction in flood damages to residential and commercial properties and did not consider the potential benefit related to risk to life.

In addition, the plans when assessing the social, environmental and economic benefits and dis-benefits of each recommended flood mitigation options consistently acknowledge the positive social impacts of such structures in terms of reducing flood affectation of downstream properties, but fail to recognise the negative social impacts posed by the risks of potential dam breach such as potential loss of life as well as future risks associated with new developments set at lower flood planning level downstream of the basin.

**Detention basins and flood risk mitigation**

The flood risk mitigation benefits provided by the prescribed detention basins vary greatly between basins with most having small capacities as shown in the table below.

<table>
<thead>
<tr>
<th>Basin</th>
<th>catchment area (ha)</th>
<th>basin capacity (Ml)</th>
<th>Dam Crest Flood (ARI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gunyah Park</td>
<td>0.14</td>
<td>3.7</td>
<td>1</td>
</tr>
<tr>
<td>Nyrang Park (upper)</td>
<td>0.22</td>
<td>8.1</td>
<td>1</td>
</tr>
<tr>
<td>Nyrang Park Lower</td>
<td>1.45</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Wollongong High School</td>
<td>3.4</td>
<td>94.1</td>
<td>5</td>
</tr>
<tr>
<td>Brokers Road</td>
<td>2</td>
<td>64.6</td>
<td>500</td>
</tr>
<tr>
<td>Foothills Estate Basin 1</td>
<td>0.44</td>
<td>21</td>
<td>PMF</td>
</tr>
<tr>
<td>Foothills Estate Basin 3</td>
<td>0.24</td>
<td>20.7</td>
<td>PMF</td>
</tr>
<tr>
<td>Foothills Road Basin</td>
<td>0.79</td>
<td>16.7</td>
<td>50-100</td>
</tr>
<tr>
<td>Dapto Heights Basin</td>
<td>0.19</td>
<td>46</td>
<td>PMF</td>
</tr>
<tr>
<td>Gannet Ave</td>
<td>0.11</td>
<td>5.4</td>
<td>5</td>
</tr>
<tr>
<td>Barina Park</td>
<td>0.52</td>
<td>3.95</td>
<td>2</td>
</tr>
</tbody>
</table>

**Table 3: Detention basins-key parameters and DCF**

Generally, for basins with a Dam Crest Flood less than a 20%AEP (5 year ARI), the flood mitigation benefits are very limited in floods such as the 1%AEP or PMF as the volume of floodwaters captured by the basin only represents a very small portion of the total flood volume.

According to Council's enterprise wide risk management ranking tool, the maximum benefit for any flood event would be likely to be insignificant. Therefore the risk managed by the asset would rank between L1 to M5 and it could be satisfactory to accept the risk provided residual risk levels are understood. Council's risk ranking matrix does not require any level of treatment.
Integrating Asset and Floodplain Risk Management

As can be seen by the brief overviews provided above relating to asset management and floodplain risk management, there does not seem to be much integration of these two functions where it relates to the management of detention basins. As a result, the asset manager generally does not question the service level (flood risk protection) provided by the asset and the floodplain risk manager does not generally recognise the maintenance burden and whole lifecycle cost as well as safety risks presented by the structure itself.

The flood risk management process however provides an opportunity to integrate these two functions.

Comparing floodplain risk mitigation benefits to the risks presented by the assets

It is recommended that floodplain risk management studies examine the flood risk mitigation benefits provided by key existing detention basins (at least those that are currently prescribed). The flood risk mitigation benefits considered should not be limited to reduction in residential or commercial flood damages but also consider benefits in terms of risk to life.

The flood risk mitigation benefits could then be compared to the risks presented by the assets itself and informed by the dam breach assessment carried out by the asset manager. Council’s enterprise wide risk ranking matrix could be used as a first pass comparison tool.

For example, by comparing Figure 1 and Figure 2, it can be seen that in some instances the risks presented by the asset could be equal or greater to the flood risk...
mitigated by the asset. Therefore further consideration should be given to decommissioning this asset.

When a new detention basin is proposed by a floodplain risk management study the level of detail of the proposed structure is not sufficient enough to assess the safety risk presented by it, therefore it would be at the feasibility/concept design stage that further consideration of safety risks would be required.

The additional risks and life cycle costs of detention basins that are prescribed dams should also considered when specifying detention basins as part of the development process.

**Cost benefit analysis**

The cost benefit analysis undertaken in the floodplain risk management study should be informed by the asset manager and consider operational, maintenance, renewal and disposal costs. This is in accordance with Asset Management best practice.

For assets with high operational costs, such as detention basins, consideration of life cycle costs would impact the cost benefit assessment outcomes compared to the current practice where only capital costs are considered, however it gives a truer cost to the community of the asset and would help inform better and more economically sustainable decision making by Councils.

**Concept designs**

When the floodplain management process guided by the floodplain development manual has failed to integrate asset management considerations, there is an opportunity to address the gaps at the concept design stage.

It is recommended that technical briefs include the following requirements:

- Assessment of on-going maintenance cost which would include a preliminary assessment of sediment/debris loads and would also be informed by maintenance costs of existing basins
- Cost benefit analysis to include whole life cycle cost such as maintenance/renewal/upgrade/disposal
- Dam breach risk analysis
- Risk presented by the asset (including potential dam breach/drowning) to be compared to risk mitigated by the structures (including risk to life)
- Design optimisation to achieve the best balance between life cycle costs and economic and other benefits.
Conclusion

While this paper has focused on the need to integrate asset management and flood risk management for detention basins, similar recommendations could be derived for other assets with high lifecycle costs or risks of failure (e.g. levees).

There is generally a need for better integration at the Local Government and State Government scales between asset management and floodplain risk management. The functions between asset management and floodplain risk management are generally separated in Councils and so are the roles at the State Government scale (e.g. Office of Environment and Heritage and Dam Safety Committee).

The Floodplain Policy and Floodplain Development Manual need to consider the risks resulting from flood mitigation asset failure as flood risks so that both risks are managed concurrently under this process. Such integration would ensure that existing and future assets do not present a greater risk than they manage and also that adequate level of resources are allocated to ensure their level of service is maintained throughout their life.

The majority of Council’s 96 detention basins were constructed as part of urban development with only a few being designed and built by Council in response to a floodplain risk management process. Council’s Development Control Plans and engineering standards should be reviewed to require planning for detention basins and water cycle masterplans for future developments to consider all life cycle costs, with life cycle costs for these assets minimised and the construction of additional prescribed dams discouraged.

References

DeSilva, N., Bewsher, D., Himsley, N., SETON, A., Is inundation resulting from basin and dam failure, ‘Flooding’?, 50th Annual Floodplain Management Authorities Conference, Gosford, February 2010


Appendix A: Case study: Barina park, Basin

**Flood risk management**

This Basin is located in the catchment of Minnegang Creek a small tributary of Lake Illawarra. The catchment has a fast response to rainfall, due to its small size, steep terrain and urbanised nature, with a critical storm duration of two hours (KBR, 2004).

The floodplain risk management plan (KBR, 2004) identifies that the worst affected area is immediately downstream of the basin where there is no overland flow path to convey flows spilling over from the basin.

The floodplain risk management plan adopted by Council recommends the voluntary purchase of 6 properties downstream of the basin as well as the construction of a spillway to significantly reduce the threat to personal safety and flood damages; and facilitate the creation of a channel between the basin and the creek (refer figure 3).

The cost of the voluntary purchase scheme was evaluated at $1,512,000 and the spillway at $431,000 (KBR, 2004).

Council has been progressing the implementation of these options, however they are subject to the landowners agreeing to the sale of their property.

A design for the spillway and downstream channel by Worley Parsons (2010) is complete with the cost of implementation evaluated at $1.8 million. The design of the spillway caters up to the PMF event and the channel up to the 1%AEP. This design also indicated an additional property would be at high risk and would need to be purchased.

Two of the properties have been purchased to date.
**Asset Management**

**Dam breach risk**

The basin is a prescribed basin and as such required a dam breach and consequence category assessment. GHD (May 2017) assessed the dam breach risk for a range of floods including the Dam Crest Flood (approximately 2 year ARI) and the PMF. From this report it appeared that incremental consequences of the breach exist only up to the Dam Crest Flood. The consequence category was found to be ‘significant’. Based on guideline DSC3B, the acceptable flood capacity for a ‘significant’ consequence category dam is 1:10,000 AEP flood. Under the current DSC guideline, the dam would require the construction of a spillway and therefore purchase of the 7 houses located in the spillway’s flow path.

The cost of managing dam breach risk is evaluated at approximately $3.5 million.
Asset’s Risks

The risk to park users was recognised in the floodplain risk management plan which recommended the installation of warning signs to inform park users that the park is subject to flash flooding following heavy rainfall and that significant depths of water can accumulate behind the embankment.

The grated basin's outlet (see Figure 4) also represent a risk of people being held against the grate by hydraulic forces with no means of egress.

![Figure 4: Barina Park basin-looking upstream from dam crest](image)

Bringing it all together

Council has an asset which provides flood detention up to the 2 year ARI which represents risks to the community and has on going inspection and maintenance cost.

The floodplain risk management plan recommends the voluntary purchase of properties and the creation of a channel downstream of the basin, with a 1%AEP capacity, yet no consideration has been given to remove the basin and not provide any detention at all.

If the 7 houses at risk were purchased and a channel was built what would the basin be protecting? It seems that the flood risk management process fails to consider the ongoing burden associated with the maintenance of existing flood assets and little consideration is given to the disposal of existing assets.