IS INUNDATION RESULTING FROM BASIN & DAM FAILURE, ‘FLOODING’?

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ABSTRACT

Many NSW Councils have detention basins which could fail in events more frequent than a probable maximum flood (PMF). The inundation which arises from failure of these basins is commonly not included in flood maps or considered in flood studies and floodplain risk management studies and plans prepared under the NSW Floodplain Development Manual. This paper reviews this past practice and asks:

- Is inundation resulting from basin and dam failure ‘flooding’ under the Manual?
- When maps of rare floods are prepared during flood studies, should basin and dam failure be included?
- Should floodplain risk management studies consider the risks posed by basin and dam failure and develop options to address these risks?
- Is this inundation risk a relevant consideration when assessing development applications?
- Should this information be included on certificates issued under Section 149(2) and Section 149(5) of the EP&A Act?
- What should be done when the failure frequency of a basin or dam is not known?

INTRODUCTION

Past Practice

In most NSW Local Government areas, 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 flood studies and floodplain risk management studies under the NSW Flood Program. In many cases, different officers within councils are responsible for each mapping program. Also, the development controls that are introduced to manage flood risks (and their notification on Section 149(2) and 149(5) certificates) usually do not consider the failure risks from basins and dams.

For instance, Fairfield City Council has approximately 20 detention basins and one major water supply dam that impacts its local government area and has recently been reviewing the manner in which it manages the rare but credible inundation risks arising from the failure of basins and dams. Like many other NSW councils, the inundation consequences of the failure
of these structures have not been considered as part of flood mapping programs. Enquiries made from counterparts overseas indicate this appears to be the approach worldwide. Dam failure is considered to be a residual risk and hence managed through strategies such as Dam Safety Emergency Plans rather than through land use planning. The Federal Emergency Management Agency (FEMA) in the US has no requirement on dam failure mapping but has indicated this may be included if desired by the local government. The Queensland State Planning Policy also advocates a similar approach where dam failure is not considered to be part of flood mapping. Recent development applications in hazardous areas below detention basins have prompted a rethink of Fairfield’s approach to the management of these risks and the better integration of these risk considerations within its existing flood risk management procedures and policies.

In common with Fairfield, most detention basins in urban areas across the State were designed in years past to safely convey a flood often with a magnitude around that of the 100 year event (as determined at the time of the design). Often there was little consideration of the consequences of events larger than this design flood, or of the possibility of outlet blockage in more frequent events. Subsequent reviews of the stability of detention basin structures using up-to-date hydrology may indicate that these structures could likely fail in events between the design flood frequency and the PMF. In the case of blockage or poor maintenance, failure in events more frequent than the design event may also occur.

Basin and Dam Guidelines
The ANCOLD guidelines [5] explain that no dam can be considered one hundred percent safe and require dam owners to assess the safety of a dam. They further explain that safety reviews could comprise of structural, hydraulic, hydrologic and geotechnical design aspects as well as information obtained from surveillance reports. A risk assessment would then be carried out to determine the urgency and extent of works required so that remedial works might be prioritised when dams no longer met an acceptable level of safety.

As explained in [4], the NSW Dam Safety Committee (DSC) prescribes all basins whose failure could cause loss of life. This risk to life is determined by assessing the incremental consequences of failure, through noting the difference between pre and post failure flood levels downstream of the basin at its potential failure flood level. The failure flood may be determined on the judgement of experienced dams engineers or through more detailed analysis such as a dam break study. It should be noted that this determination of risk to life is irrespective of the structural integrity of the dam itself. Once a dam is prescribed the dam owner has certain requirements to fulfil. They range from requirements imposed on the structural integrity of the spillway to on-going surveillance and reporting. These requirements are based on the category of prescription and the downstream risk to life. Detention basins act as dams during floods and are forming an increasingly important component of the DSC’s role.

Whilst the approach discussed in this paper is applicable to both water supply dams and detention basins, the focus is on failure of detention basins given the larger number of these structures in urban areas and their generally lower design standards.

Flood Risk Mapping
Many NSW councils have utilised a system of flood risk classification that is based on the probabilities and consequences of all floods that may occur, not just a singular event such as the 100 year flood. This approach is discussed in [6]. It often results in flood risks being classified into ‘high’, ‘medium’ and ‘low’ categories.
The consequences of basin failure, say during a 500 year event, may be significant and pose an additional safety risk to the general public located below the structure which would otherwise not have been apparent from traditional flood mapping alone. However during larger flood events, such as the probable maximum flood (PMF), the additional impact of detention basin failure may not in itself be significant as often detention basins are ‘outflanked’ by greater volumes of floodwater. See Figure 1(a), 1(b) and Figure 1(c).

Examination of the flood risks (i.e. probabilities and consequences) of the basin and dam failures indicates that in some cases the risks are as significant, or more significant, than those identified by flood mapping that concentrates only on the 100 year flood. Under these circumstances it is possible that areas below a basin which would previously have been classified as ‘medium’ or ‘low’ flood risk, should now be classified as ‘high’ flood risk once the probabilities and consequences of detention basin failure are included. See Figure 1(b) and Figure 2.

**Confusion Created by Separating Flooding and Basin Failure Inundation Risks**

From the community’s perspective, confusion will arise when the mapping of flood risks is carried out separately from those resulting from basin failure. The community cannot be expected to discern between the different sources of potential inundation that may arrive on their land.

In addition, Council planners who may need to apply development controls to manage these inundation risks, find it difficult to discern the difference between the inundation mechanisms.

**IS INUNDATION RESULTING FROM BASIN AND DAM FAILURE, ‘FLOODING’ UNDER THE NSW MANUAL?**
The term ‘flood’ is defined on Page 20 of the NSW Floodplain Development Manual [1] as follows:

“Relatively high streamflow which overtops the natural or artificial banks of any part of a stream, river, estuary, lake or dam and/or local overland flooding …”.

The definition of ‘flood’ and other definitions in the Manual recognise flooding as including the inundation of normally dry land occurring when water overtops the natural or artificial banks of a dam. Whilst the definitions in the Manual do not specifically reference the inundation that would result from the failure of a water supply dam or detention basin, it appears to the authors that this type of inundation would likely fall within the definition of ‘flood’. Therefore the consideration of inundation resulting from the failure of detention basins and water supply dams should be included with the normal activities that council flood engineers, planners and risk managers undertake under the auspices of the Manual.

**Exemption from Liability**

In NSW, Section 733 of the Local Government Act 1993 (LG Act) provides an exemption from liability for a council in respect of any advice furnished or anything done or omitted to be done in good faith by the council relating to the likelihood of any land being flooded or the nature or extent of any such flooding.

A council is, unless the contrary is proved, taken to have acted in good faith for the purposes of Section 733 if the advice was furnished, or the thing was done or omitted to be done substantially in accordance with the principles contained in the relevant manual. The relevant Manual for the purposes of Section 733 of the LG Act is currently the document in [1] together with the document published by the Department of Planning and the Department of Natural Resources titled “Guideline on Development Controls on Low Flood Risk Areas dated January 2007”.

If inundation resulting from basin and dam failure is ‘flooding’ under the Manual, it follows that the same exemption from liability would be available to councils as for other types of flood inundation.

**Are Such Failures a Relevant Consideration for Development Applications?**

When a Council determines the suitability of a site for a proposed development, it is necessary for the Council to specifically consider whether the site is subject to hazards including flooding and whether there are any risks to people or property from flooding. If such hazards and risks resulted from the failure of dams or detention basins, it would be relevant in the view of the authors, for Councils to consider those issues in determining the development application.

**January 2007 Guideline**

In NSW we have this most unusual situation resulting from the ‘Guideline’ released by the Minister for Planning in January 2007 [3]. This Guideline “confirms” that “unless there are exceptional circumstances Council should adopt the 100 year flood as the FPL for residential development”.

As the hazards and risks associated with the failure of detention basins and water supply dams may often be associated with floods rarer than the 100 year flood, it appears necessary for councils to apply for ‘exceptional circumstances’ status in order to apply development controls to manage these hazards and risks. Further, based on legal advice obtained by the Floodplain Management Authorities (FMA), it appears that if a council does not apply for exceptional circumstances, it may be assumed that it has already determined that there are no serious safety risks beyond a 100 year flood for which it needs to apply development controls. This
puts the onus back on councils to rigorously assess the hazards and risks beyond the 100 year flood and be proactive in requesting ‘exceptional circumstances’ status if required.

**PRACTICAL ISSUES ASSOCIATED WITH IMPLEMENTATION**

While there appears to be no legal impediment to including in a DCP or other policy a definition of ‘flood’ which includes inundation as a result of basin or dam failure, there may be potential for additional legal liability if it does. Councils will then be required to provide information to the public about flooding on the basis of the definition it adopts. The authors have identified some of the practical issues associated with adopting such a definition and have mapped a way forward, which is discussed below.

**Define the Failure Flood**

As discussed previously, flood extents downstream of a basin or dam will be impacted if failure occurs. If the floodplain risk management process is to include basin or dam failure, the first step would be to identify when failure occurs. Detailed information regarding this process is specified in [5]. These guidelines explain this will include (where relevant) a detailed study of hydraulic, hydrologic and geotechnical design aspects of the basin or dam, as well as gathering information from surveillance reports.

**Integration in Flood Studies and Floodplain Risk Management Studies**

Once a failure flood is determined it must then be converted to a failure flood probability so the failure can be included in the modelling of all events rarer than this. However, it must also be noted that poor maintenance and management of basins could lead to basin failure or overtopping in floods more frequent than the failure flood. Inundation resulting from a basin overtopping due to a clogged outlet in a 10 year or 50 year event could be more extreme than flooding from a 100 year event. There have been recent examples of this in Sydney.

In addition, as explained in [4], with increasing urbanisation it is not uncommon to find a series of cascading basins in many catchments. This document explains that the consequence of one basin failure cascading downstream into lower basins must also be considered. This adds an extra level of complexity to a flood study where a flood modeller is required to both analyse and investigate each basin individually and consider the systems collectively, making assumptions about the various combinations and permutations of upstream basin failures.

**Revise Flood Risk Mapping to include Basin Failure**

Figure 2 is an example of how basin failure can be integrated into flood risk mapping. The mapping is based on the assumption that failure occurs at the 500 year event. The left side of this graphic indicates the traditional approach where mapping only indicates the high, medium and low risk flood risk precincts. The right side of this graphic indicates how basin or dam failure might result in high risk floodplains even above the 100 year floodplain.

Councils such as Fairfield use flood risk maps as the basis for developing Section 149 flood notations as well as for setting development controls. The maps are relied on by land use planners, development engineers and town planners to inform their decision making process. Ensuring flood risk is calculated after consideration of all events including basin failure is vital to enabling the decision making process to consider all risks pertaining to flooding, whether it be for land use planning purposes, setting development controls or determining flood notations.

**Planning Controls and Section 149 Certificates**

It is obvious that basin failure may impact downstream development. During the failure flood, the downstream floodplain extent will likely be wider than the pre basin condition. In addition, all prescribed dams (and basins) are required to have a Dam Safety Emergency Plan (DSEP)
and a Disaster Plan. These plans identify emergency conditions which could endanger the integrity of the structure, prescribe procedures for response to these emergencies and provide for the timely evacuation of downstream communities.

Therefore communities downstream of a basin or dam can be affected not only by potential alterations to flood behaviour, but also by any requirements imposed on the communities as a consequence of the structure being prescribed.

From discussions conducted with planners, it appears the idea of restricting development downstream of a detention basin due to these affectations is not favoured. Many Sydney Councils are grappling with the pressures of development and struggle to meet the targets set by the Metro Strategy. The planning community would prefer that the basin owners meet the required safety standard without the imposition of additional constraints on development.

As explained in [4], the extent of existing and future development must be considered during the design of a basin. Future development downstream of a basin could significantly increase the consequences of basin failure and potentially increase the legal liability of the basin owner and the consent authority. In certain circumstances this could lead to a requirement to carry out rectification works to reduce the failure frequency of the basin. It follows then that in order to limit any increase in the consequences of basin failure, there must be responsible planning controls downstream of a basin. These controls can be included within an existing flood risk policy or through development of new policy that solely manages the risks relating to basin failure.

Once such policies are developed it is imperative that a Council informs the community. This information should be conveyed in a manner that does not cause undue alarm and with effective stakeholder consultation acknowledging failure is usually a low probability event.
Clause 7A of Schedule 4 of the *Environmental Planning and Assessment Regulation 2000* (Regulation) restricts a council to responding to the question set out in that clause when issuing a certificate under Section 149(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). In that regard it would seem that unless there is a provision contained in a current environmental planning instrument, development control plan or an adopted code or policy of the council that restricts the development of the land subject of the application for a Section 149(2) certificate because of the likelihood of that land being flooded as a result of a basin or dam failure, a negative response would be required to the questions posed in clause 7A.

In other words, if there are no provisions contained in a current environmental planning instrument, development control plan or an adopted code or policy of the Council that restrict the development of the land subject of the application for the Section 149(2) Certificate because of the likelihood of that land being flooded as a result of a basin or dam failure the Council is neither statutorily required or authorised to include information on a Section 149(2) certificate stating that the land is at risk of being flooded as a result of a dam failure.

However, if a council has reliable information to confirm that flooding of land as a result of a basin or dam failure where such failure is known to be reasonably possible in a particular flood event as a result of structural or spillway deficiencies in the basin or dam having been identified by or notified to the council, it has the discretion to include a notation to that effect on a certificate issued for the land under Section 149(5) of the EP&A Act.

There is a potential that such an approach may falsely imply that information held by the Council at the time of issue of the certificate as to the likelihood of that land being flooded as a result of a dam failure is complete and comprehensive and that all land in the local government area may be clearly classified as either liable or not liable to flooding as a result of a dam failure.

**CONCLUSIONS**

1. Inundation resulting from the failure of detention basins and water supply dams is likely to be considered to be ‘flooding’ under the NSW Floodplain Development Manual.
2. It is important to know what the failure flood probability of any structure is and to assess the consequences of such failures.
3. Include inundation failure from basins and dams when completing flood mapping as part of flood studies.
4. Include the consequences of dam and basin failure when mapping flood risks. Note that the most severe consequences of detention basin failure may often occur during flood events intermediate between the 100 year event and the PMF (or in more frequent events for poorly managed basins).
5. Once flood extent maps and flood risk maps have been prepared which include for the failure of dams and basins, it will be important to ensure that development controls and advices on Certificates issued under Sections 149(2) and 149(5) of the *EP&A Act* also take account of dam and basin failure.
6. Where it is appropriate for such controls to apply to residential land uses beyond the level of the 100 year plus 0.5m freeboard, it will be necessary to apply for ‘exceptional circumstances’ under the January 2007 Guidelines released by the NSW Minister for
Planning. It appears the onus is on a Council to identify if such risks exist in the area beyond the 100 year flood plus 0.5m, and then apply for ‘exceptional circumstances’ if necessary. Failure to make such an application, may imply that the council does not consider these risks to be significant.

TAKE-HOME MESSAGES

The inundation resulting from the failure of detention basins and water supply dams should be treated as ‘flooding’ under the *Floodplain Development Manual*. Consequently these risks should be mapped and managed in the same way as mainstream and overland flow flooding are mapped and managed under the *Manual*.

REFERENCES


