

PLANNING MAPS AND FLOOD MAPS, KEY ELEMENTS OF FLOODPLAIN MANAGEMENT AND EFFECTIVE PERMANENT OR EMERGENCY FLOOD PROTECTION OF PROPERTY

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The obvious solution to prevent flood loss to properties is to avoid building in flood-prone areas. Unfortunately, this is not always possible and an arbitrary level of acceptable risk is commonly used for floodplain management. This is typically based on the so-called 100-year flood water level in best cases obtained from complex hydrological and hydraulic models. Flood modelling is a dynamic process and can result in changes of the level of risk to a specific property over time. Regardless, flood behaviour is complex and never influenced by our studies and statistically derived flood levels. However, flood behaviour can be influenced by mitigating features identified by such studies. In such situations, physical protection of a property or emergency response becomes critical in mitigating flood loss. The key is to fully understand the exposure to the site.

This paper will explain the benefits of including all relevant flood data in the final flood study or similar product for maintaining its availability and transparency. The paper is targeting potential floodplain risk management committee members (New South Wales) or equivalent (other states) and is hoped to resonate with planning and development council staff, as well as emergency management agencies. The paper is also a plea for a higher level of coordination, at the 'design stage' of a study, between various agencies involved in emergency response during floods, which will inadvertently lead to a document useful to more stakeholders.

Availability of flood data

Mapping of the flood risk in Australia is the responsibility of disparate local governments and a number of different bodies. Mapping of the flood risk is far from being universally available and given the variety of organisations commissioning the work, the complexity of the flood information varies significantly. Even when data is available, in many cases authorities are reluctant or unwilling to release it, though it appears that in the past few months this is gradually changing for the best. However, in a majority of the cases, the only information made available is an estimated flood level for the so-called 100-year event and occasionally for the probable maximum flood (PMF), sometimes with a general flood extent map. Such information is probably sufficient for planning purposes as long as a predetermined level of residual risk has been accepted by the community.

Flood risk management

Flood is one of the most confusing hazards for the general public, including some of the risk managers of private and public organisations. This is understandable considering the complexity of the flood hazard, the confusions around the flood definitions, maps and zones (FM Global, 2005, p. 9). It is not uncommon for the

general public to believe that there is no risk of flooding to a specific property being located outside an official flood zone for which flood-related development controls apply.

Ideally, building in flood-prone areas should be avoided but this is impractical and not economically feasible considering that flood-prone land is generally defined as land susceptible to flooding by the PMF event, although some authorities may argue differently. As a result, in many cases a level of residual risk will remain present even if new properties are built above council-approved flood planning levels (FPLs), generally based on a combination of flood levels for a certain annual exceedance probability (AEP), or historical flood event, and some freeboard. In recent times, flood levels associated with the 1% AEP (meaning that there is a 1% chance for these levels to be exceeded in any one year) and 0.3 or 0.5 m freeboard, appear to be commonly used. However, for commercially and industrial properties in some regions, a higher probability is accepted by local authorities and inadvertently by owners.

Moreover, there are still areas with flood information that is outdated due to local development and additional flood mitigation features completed. Additional development in an area will change the flood behaviour, increasing or not the flood risk. Completion of a flood mitigation project, on the other hand, like increasing the conveyance capacity of a storm-water drain or modifying a bridge, may actually decrease the flood risk, leading to situations whereby maps become possibly conservative.

Even properties located outside flood map areas can be drastically affected by floods. Vital utilities such as water, sewer treatment and power supplies or transportation routes closed temporarily will result in business interruption for commercial and industrial properties and severe inconvenience for residential properties.

Depending on the criticality of the assets, means of temporary emergency protection should be considered where cost effective, and flood emergency response plans should be developed to further mitigate the flood risk. The need to develop flood emergency plans is also recognised by CSIRO (2000, p. xv), which recommends assessing the flood behaviour for a range of flood events up to and including PMF:

“Preparation of a flood emergency plan encompassing flood warning, defense, evacuation, clean-up and recovery arrangements is the most effective way to address the residual flood risks associated with floods.”

Complex disaster plans are prepared by state organisations that include emergency operations and are not the subject of this paper. At property level, flood emergency response plans can mitigate the flood risk. Floodplain development manual, the management of flood-liable land, produced by Department of Infrastructure, Planning and Natural Resources (DIPNR) in 2005 (pp. N6-N7) refers to such plans as ‘private flood plans’ and highlights the fact that such plans depend “explicitly on a thorough understanding of the risk and of the roles and responsibilities of the participants”. With regard to the information available, Perry (2011, p. 5) states that:

“Near real-time flood modelling used for emergency management is far more complex and data hungry than the modelling used for non-emergency management activities such environmental analysis and land use planning.”

Typically management of properties, unlike state emergency services, does not have access or expertise to employ real-time flood modelling to protect their assets but would certainly benefit from outputs of such models prepared in advance.

Relevance of flood data

Flooding is governed by nature, often unpredictable and difficult to avoid. While flood emergency response (private) plans can fail, our experience shows that overall their impact on reducing the potential damage and disruption to business if the flooding occurs should not be underestimated. And, as also stated in the CSIRO report (2000, p. xvi):

“Flood maps that show the extent, depth, velocity and hazard of flooding for nominated flood events are an important tool for the preparation of floodplain management plans and flood emergency plans.”

Development of information for a range of flood events including the 1% AEP, 0.2% AEP and PMF is of paramount importance for development of meaningful flood emergency response plans.

Flood extent

The first step in assessing the flood risk is visually identifying the location of the property of interest on a flood extent map. Unfortunately, in some instances only maps and/or basic information for properties within a zone to which (flood) controls apply are available to be used rightly or wrongly as flood maps.

Understanding the flood extent provides the first indication of likely level of risk to the property and continuity of activity on the premises. A flood level obtained from a certificate for a property or even a two-dimensional (planning) map provides some hints, but for a meaningful analysis one should look at the ‘big picture’. The quality and availability of maps varies from council to council (or any other governmental organisation responsible for the data). There are flood maps providing a large amount of useful information in one document including: flood extent and flood levels for a multitude of flood annual reoccurrence intervals (from 20- to 500-year ARI), topographic data (the smaller the interval the more valuable), 50% and 95% values for flood levels, information on the (tidal) boundary condition, and various other supporting information. Such maps provide a clear snapshot summarising the findings of complex hydrological and hydraulic studies.

The map can be used to assess the likely ingress/egress capabilities, and if the property of interest is within an area likely to be flood-affected or in the immediate vicinity, the predicted flood levels with existing yard and floor levels, as well as any low-level possible water ingress points into basements (including cable penetrations and tunnels, etc) should be compared. It also provides good information to the property manager of the likely flood water levels band (5% to 95% confidence interval).

Such maps may allow for identification of critical services that might be directly affected by flooding which might result in prolonged loss of services. An example is a local transformer yard supplying electricity to the area. This could have an effect on properties not directly affected by flood water to various degrees from losing the food in a household fridge to losing the food or pharmaceutical products in an industrial freezer or controlled ambient cool room. Emergency and contingency plans can be made for such events to mitigate the risk.

Flood levees, where present, can be useful flood mitigation features but they do not eliminate the risk. A well-designed and maintained levee will reduce the likelihood of flooding but not the consequences. Therefore, it is important to understand possible levee failure scenarios and tailor flood emergency response plans accordingly. Figure 1 shows the levee bank failure flood-extent scenario and estimated flood water levels. This map provides a clear representation of the hazard.

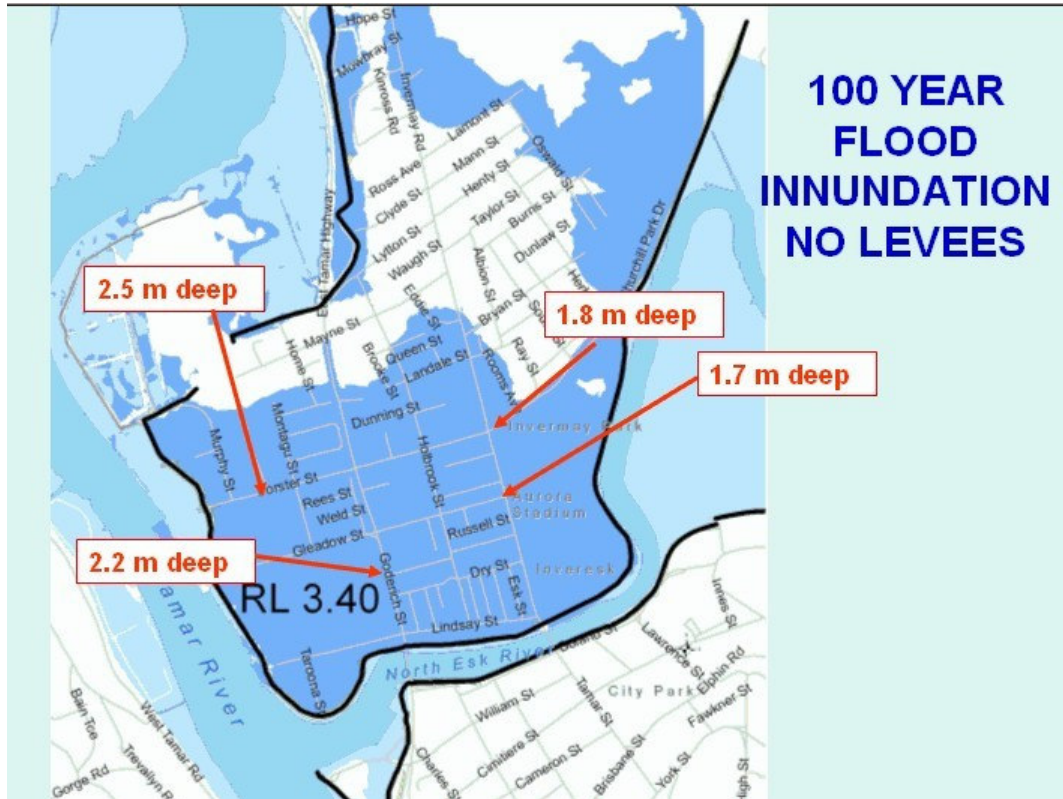


Figure 1: 100-year flood inundation map if no levees
 (Source: <http://www.launceston.tas.gov.au/lcc/index.php?c=174&langID=1>)

Such maps are valuable tools for educating the public and possibly developing contingency plans.

Flood water depth

Various flood water depths and flood behaviour will generate various degrees of damage to buildings (and their contents) depending on their adequacy to resist flood-related loads and conditions, including hydrostatic loads, hydrodynamic loads, breaking wave action, debris impact, debris jams, rapid rise and draw-down of flood water, prolonged inundation, soil liquefaction, soil consolidation and subsistence, sediment deposition, mud slides, and wave-induced and flood-related erosion and scour.

All appropriate load combinations when analysing flood loads for actions, including overturning sliding, undermining (erosion and scour), and uplift (buoyant forces) need to be considered. The estimated water level is critical in determining these loads.

Understanding the predicted flood water depth will help determine possible emergency actions to mitigate the risk. Depending on the water depth and the characteristics of the building, damage could be mitigated by preventing water ingress into the buildings (or at least some of them that would be suitable) by using emergency flood protection like barriers, sandbags or alternatives. If the building is not suitable to be temporarily flood-proofed, relocating contents within the building or to other elevated buildings above the anticipated flood water levels is likely to reduce the loss.

For a flood emergency response plan to be effective, the predicted water level on site needs to be referenced back to the location for which predictions are made by the Bureau of Meteorology or the relevant local authorities.

A flood map reach in data will help make rough, educated decisions about likely flood levels along the flood plain and on the premises for various events. During recent events, some councils produced and made available on the Internet maps indicating the likely extent of the flood for that particular event. Figure 2 shows one of the several likely flood extents for December 29, 2010 mapped by the Rockhampton Regional Council based on Bureau of Meteorology predictions. Such maps are of great value and can help in activating various stages of (private) flood emergency plans, if one was prepared in advance.

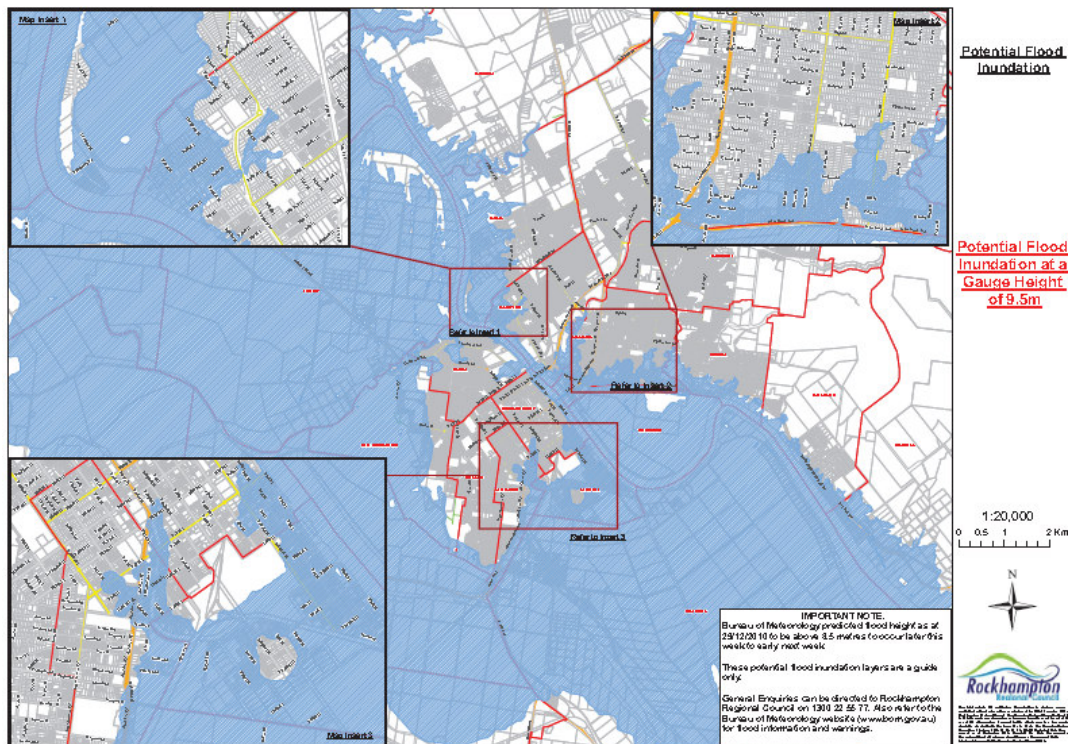


Figure 2: Potential flood inundation at a gauge height of 9.5 m, Rockhampton Regional Council

(Source:

[http://www.rockhamptonregion.qld.gov.au/Council_Services/News and Announcements/Latest News/Be Prepared - Rockhampton Flood Maps Available Here](http://www.rockhamptonregion.qld.gov.au/Council_Services/News_and_Announcements/Latest_News/Be_Prepared_-_Rockhampton_Flood_Maps_Available_Here))

Flood water velocity

High-velocity flood water will affect buildings, structures and landscaping, utilising materials with low-erosion threshold. High or even moderate velocity flows (typically in excess of 2 m per second) can undermine raised land in the absence of adequately designed erosion protection. Even low-velocity rainwater can easily dislodge some landscaping materials, such as woodchips and pine needles, etc. which can obstruct or clog drainage systems, catch basins, culverts or divert overland flow patterns resulting in localised flooding.

Emergency flood protection should be suitable for the predicted velocities as well as the water depth.

Of great value are also flood maps showing velocity vectors that not only indicate velocities but also the likely direction of the flow, particularly valuable for complex floodplains.

Flood duration

Damage inflicted by longer-duration floods is often much worse than anticipated. Because of the long exposure time, water has time to soak the contents and building components, resulting in damages to larger areas. Lack of access immediately after the flood has receded will further increase the level of damage.

Buildings or structures on raised land above predetermined flood levels can be affected unless they utilise fill material that is stable when exposed to flood action, including rapid rise and draw-down, prolonged inundation, scour and erosion.

Geotechnical properties used for the foundation design, like bearing and frictional resistance, active and passive pressure and settlement, should be based on possibly diminished structural capacities that are associated flood level and flood water action.

Understanding the likely flood duration can help tailor the (private) flood emergency response plan. The most useful form of conveying the information is the hydrograph, a graph showing for a particular location the variation with time of water level (stage hydrograph) during the course of floods for various reoccurrence intervals. Such a graph also provides information about the likely warning time to be expected.

Flood warning time

The longer the warning time available, the higher the chances of mitigating the flood risk. It is important to understand how much time would be available to activate a (private) flood emergency plan, along with how fast the water will rise and how long it will last. A reliable and meaningful method of flood warning is important, although in the case of flash flooding and small streams there may be very little warning time. In such situations, permanent physical changes to the property may be justified to permanently reduce the impact of such flood.

Even small actions can make a considerable difference in mitigating flood loss or prevent it completely. In addition to a reliable method of warning, to be effective the

plan should have clear authorisation for site personnel to act, as it most likely will involve shutting down critical operations, and a well-trained team with adequate equipment and emergency actions tailored to the amount of expected warning time can make a credible defence effort.

Foreseeable improvement in availability of flood data

Floodplain management in Australia: best practice principle and guidelines, SCARM Report 73 produced by CSIRO in 2000 and Floodplain development manual, the management of flood liable land, produced by Department of Infrastructure, Planning and Natural Resources in 2005, are two of the notable publications providing best-practice principles and guidance for the management of the floodplain risk. Unfortunately, availability of relevant flood data continues to be minimal.

The 2010 and 2011 flood events have once again highlighted limitations of the current understanding of the flood risk for the affected areas and triggered high-level reviews of the flood risk nation-wide. Inquiries, debates, consultations and workshops, several reports and comments on reports have looked into the flood risk with the ultimate goal to mitigate the hardship and loss associated with floods. Many organisations need to bring their contribution to progress towards achieving this goal. A report prepared by Perry (2011, Appendix C) lists 20 of the many agencies and organisations that have a role in this process.

For some time a movement has been initiated towards development of a national best-practice manual and, at the time this paper is written, it appears that progress is being made. Attempts are being made to develop an agreed methodology to map areas at risk of flooding not only from riverine and overland flow, but also coastal inundation, which typically includes the combined effects of tide, storm surge and wave action. Such a document should be able to facilitate a consistent approach throughout Australia to future modeling and mapping.

Conclusion – What can be done to help mitigate the residual flood risk?

Fortunately, floods are considered one of the most manageable of all natural disasters.

Facilities with well-organised (private) flood emergency response plans have, according to FM Global loss history (2005, p. 12), reduced their property damage by nearly 70% and have been able to resume operations far sooner than facilities with inadequate or no flood plans in place.

To successfully mitigate the flood risk, a (private) flood emergency response plan should benefit from a reliable method of warning and be developed in advance based on meaningful information for a series of flood events including lower probability events like 1% and 0.2 % AEP and, if possible PMF, including:

- Flood extent maps
- Flood levels/depth maps
- Velocity maps
- Stage hydrographs
- Flood levee failure scenario extent, depth and velocity maps

Supporting information and details like boundary conditions, sensitivity analyses, and levee and retention basin characteristics, will help ensure that the data is correctly interpreted.

Such data is generated and forms the basis of flood studies, therefore most of the information should already be available and indeed can be found in some of the studies. However, in many situations important data is not included in the final documents and is difficult and time consuming to retrieve.

Therefore, it is of great importance to carefully determine in conceptual stages the scope and output of the flood study. It should be remembered that flood maps and flood data are very important and useful products of the floodplain management process.

Transparent quality flood data is an important factor in educating and offering the opportunity to interested parties to mitigate flood risks. In this manner, not only will the livelihood and employment of the community be restored through the protection of residential and commercial assets but also the ability for authorities to maintain essential services. These factors will no doubt play a valuable role in the flood recovery.

While this paper has focused on inland flood risks, the same principles apply to coastal flood risks.

References

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