



# Appendix J: Emergency Management Considerations for Raising North Wagga Levee

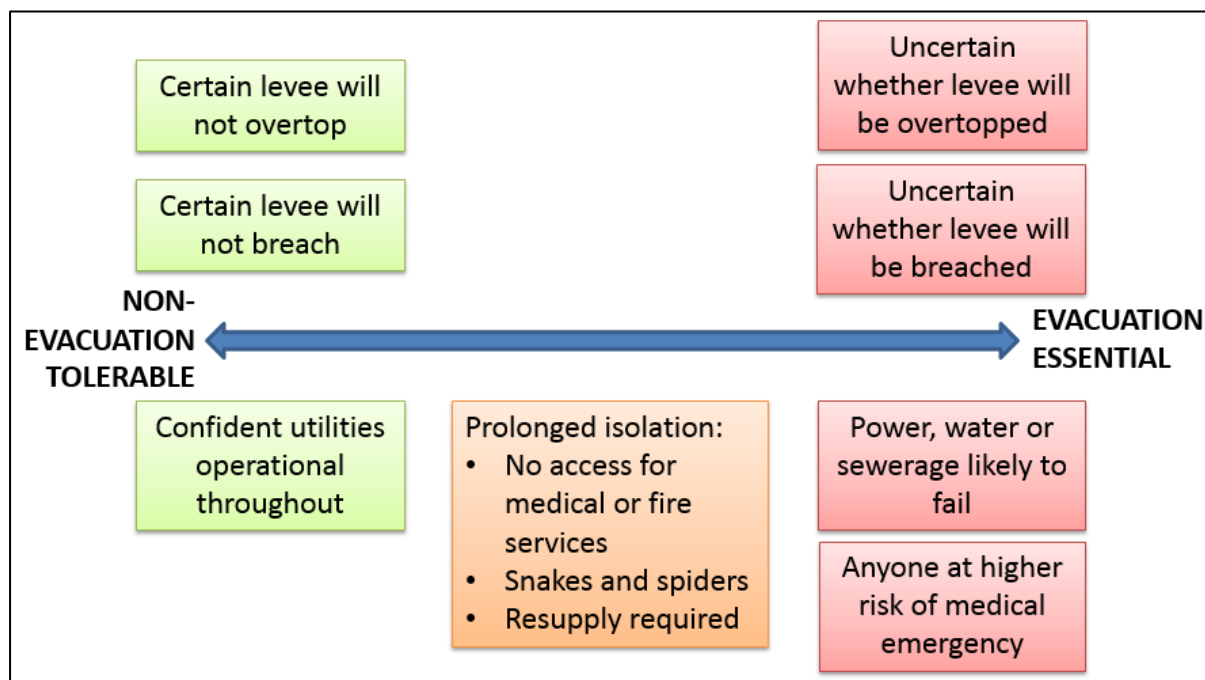
## J1. Introduction

One of the primary concerns with raising the North Wagga levee is the implications this could have for compliance with Evacuation Orders. The NSW SES, the State’s combat agency for flooding, has expressed the concern that a higher levee – particularly a levee excluding floods up to and including the 1% AEP event (plus freeboard) – might cause residents behind the levee to increasingly reject Evacuation Orders, thereby adding to the risk to life for that rare event when the levee is overtopped or breached.

## J2. Evacuation Compliance in Recent Australian Floods

From an Emergency Management Services organisation perspective, the factors that determine whether evacuation from a levee-protected flood island is considered essential, or whether non-evacuation is tolerable, are summarised in Diagram 1. Only if there is certainty that a levee will not overtop or breach, and confidence that utilities shall remain serviceable throughout the event, is it considered tolerable to remain in the ‘protected’ area. If there is a chance that the levee could overtop, or that essential services are likely to fail, evacuation is considered essential. Prolonged isolation is at best considered undesirable due to the associated risks.

Diagram 1: Factors influencing need for evacuation from levee-protected community

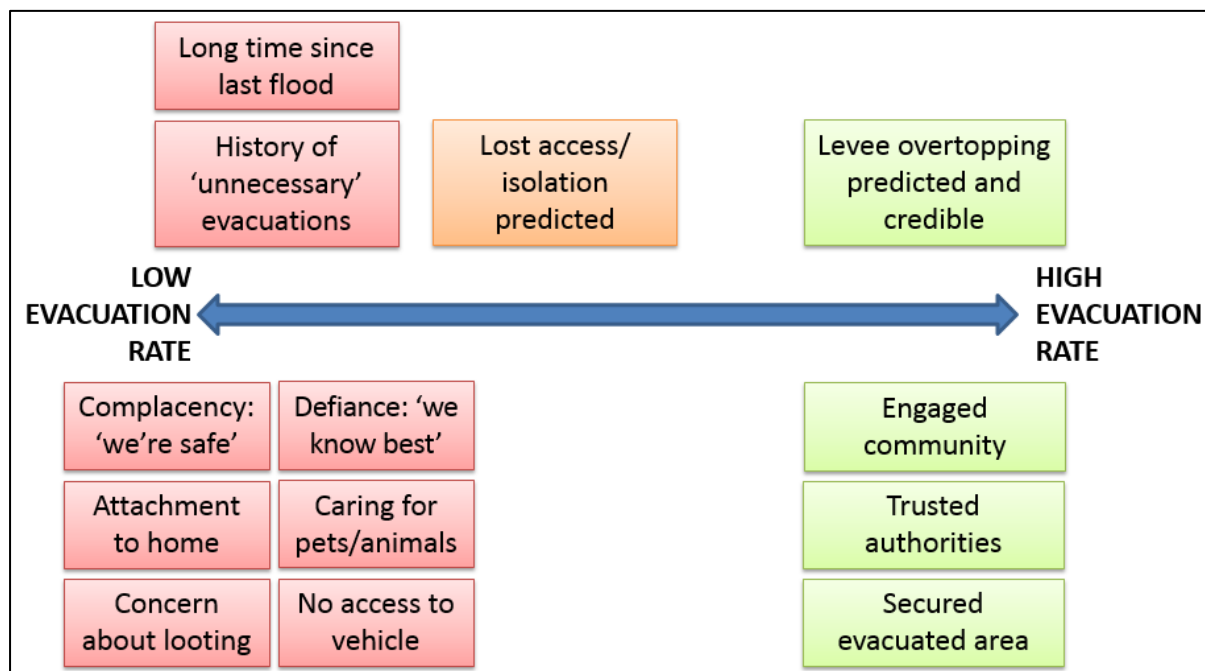


Rates of evacuation compliance for some previous Australian floods where Evacuation Orders were issued are estimated in Table 1. This shows that evacuation compliance rates vary substantially. From the literature, and from interviews at Wagga Wagga, various factors are at play in shaping people's evacuation decisions. These are summarised in Diagram 2. High rates of evacuation have been observed where predictions of levee overtopping were judged to be credible, which relates to the degree of trust with which the emergency services' issuing the Evacuation Order are trusted by the community, and the quality of their engagement with the community. There also needs to be confidence that the Police will provide security for the evacuated areas. On the other hand, if a long time has elapsed since the previous flood, or there has been a history of evacuations that later proved to be 'unnecessary', or the community holds complacent or defiant attitudes, there may be a poor response to Evacuation Orders.

Table 1: Evacuation compliance in recent Australian floods

Flood	Evacuation rate	Source
<b>Grafton, 2001</b>	13%	Pfister, N. 2002, 'Community response to flood warnings: the case of an evacuation from Grafton, March 2001', <i>Australian Journal of Emergency Management</i> 17(2), 19-29.
<b>Grafton, 2009</b>	32%	Molino Stewart, 2010, <i>May 2009 East Coast Low Flood Warning Community Feedback</i> , report prepared for NSW SES.
<b>Maitland, 2007</b>	76%	Gissing, A. et al., 2008, 'How do you improve community response to warnings?', FMA conference.
<b>North Wagga, 2010</b>	~80%	This study
<b>North Wagga, 2012</b>	~97%	This study
<b>Gumly Gumly, 2012</b>	<50%	This study
<b>Wagga central, 2012</b>	~95%	This study
<b>Hay, 2012</b>	<30%	Keys, C. 2015, 'Flood evacuation: never fun, sometimes necessary, always problematic', <i>Risk Frontiers Briefing Note</i> No. 306.

Diagram 2: Factors influencing evacuation compliance



But these factors are not all equal. In the case of North Wagga, a good evacuation rate was achieved in December 2010, despite the most recent flood to threaten to overtop the North Wagga levee occurring some 19 years previously in 1991. And in March 2012, a good evacuation rate was again achieved (see Diagram 3), despite the apparent 'false alarm' of December 2010.<sup>1</sup> It seems that the certainty, clarity and force of the Evacuation Order – that the levees would definitely be overtopped, that 'your houses will be inundated' and that 'you have five hours to get out' – delivered by a trusted SES official at a community meeting and reinforced by the volume of uniformed officials moving about North Wagga, were decisive factors in prompting this high evacuation rate. Most houses in the village were subsequently flooded over floor (see Diagram 4).

<sup>1</sup> But interviewees did describe how the 2010 flood may have influenced some people in 2012 not lifting property as high as they might have done.



Diagram 3: Spatial pattern of evacuation, North Wagga, March 2012

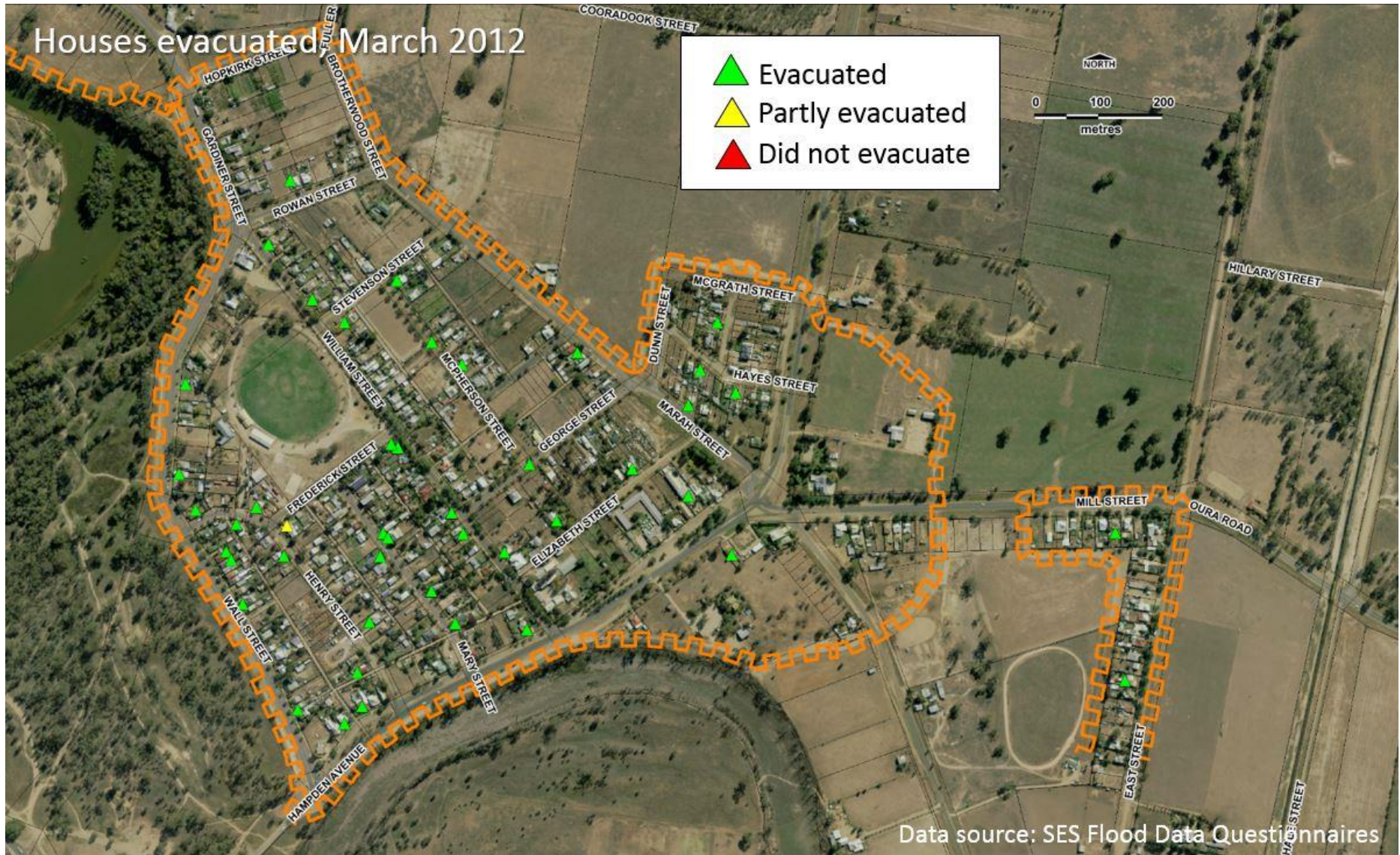
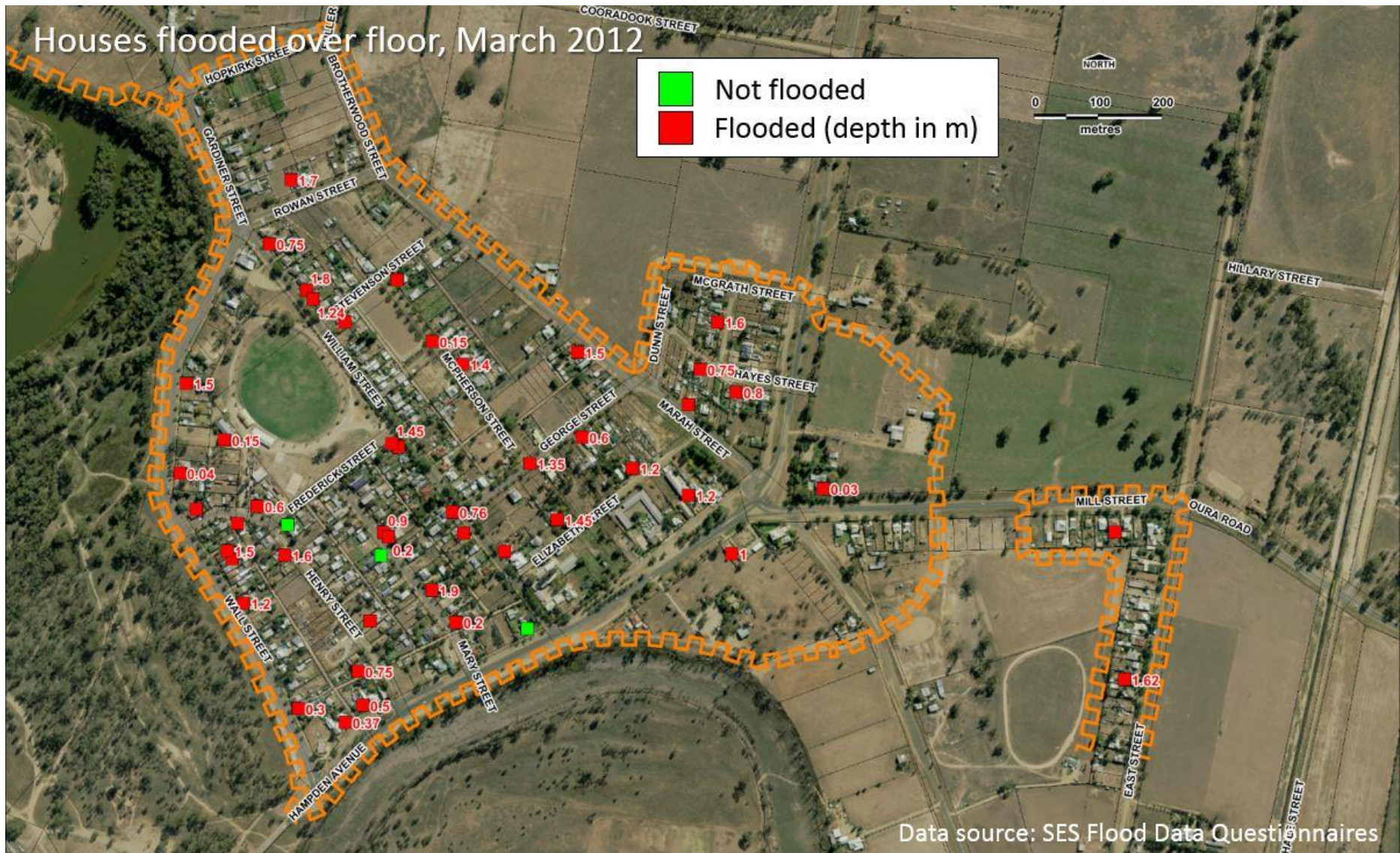




Diagram 4: Spatial pattern of house flooding, North Wagga, March 2012



### Increased Catastrophe Potential with a Higher Levee

If a 1% AEP levee is built, the concern is that the average experience of levee overtopping will become less frequent, leading to an increased perception of safety from all floods, with an increased reluctance to evacuate in future floods and an increased likelihood of poor compliance with Evacuation Orders. In the event of a big flood (e.g. 0.2% AEP event) overtopping or breaching the levee, there could be serious loss of life (Diagram 5). In such an event, water levels would rise very rapidly (Chart 1), making it difficult for rescuers.

Diagram 5 shows how a higher levee could also lead to greater isolation risks, not only with an increasing reluctance to evacuate but also due to the increased period of isolation associated with larger floods of longer durations, plus the increased danger of resupply across a more hazardous river.

However, it is noted that a similar effect could result from the gradual development of houses built to floor levels 0.5m above the 1% AEP flood level (in accordance with Council's DCP), or from a voluntary house raising scheme that sources funds to promote this as a floodplain management measure.

Diagram 5: Potential for reduced evacuation with higher levee

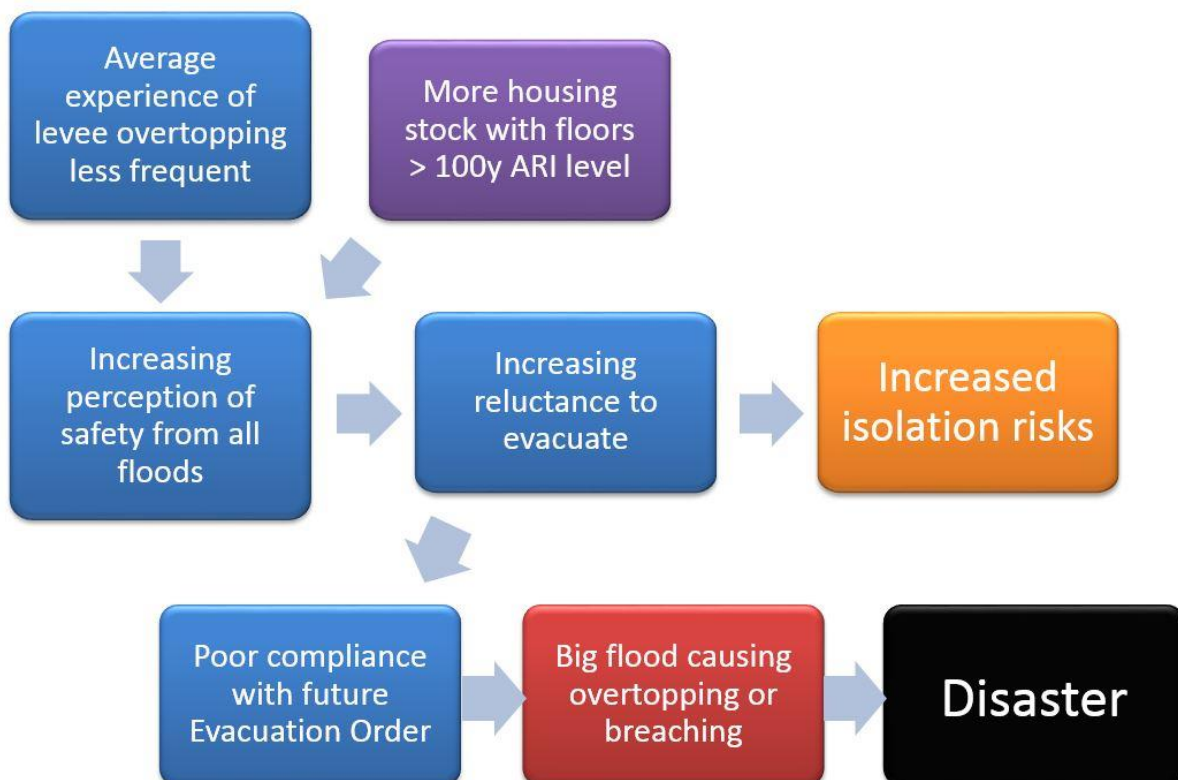
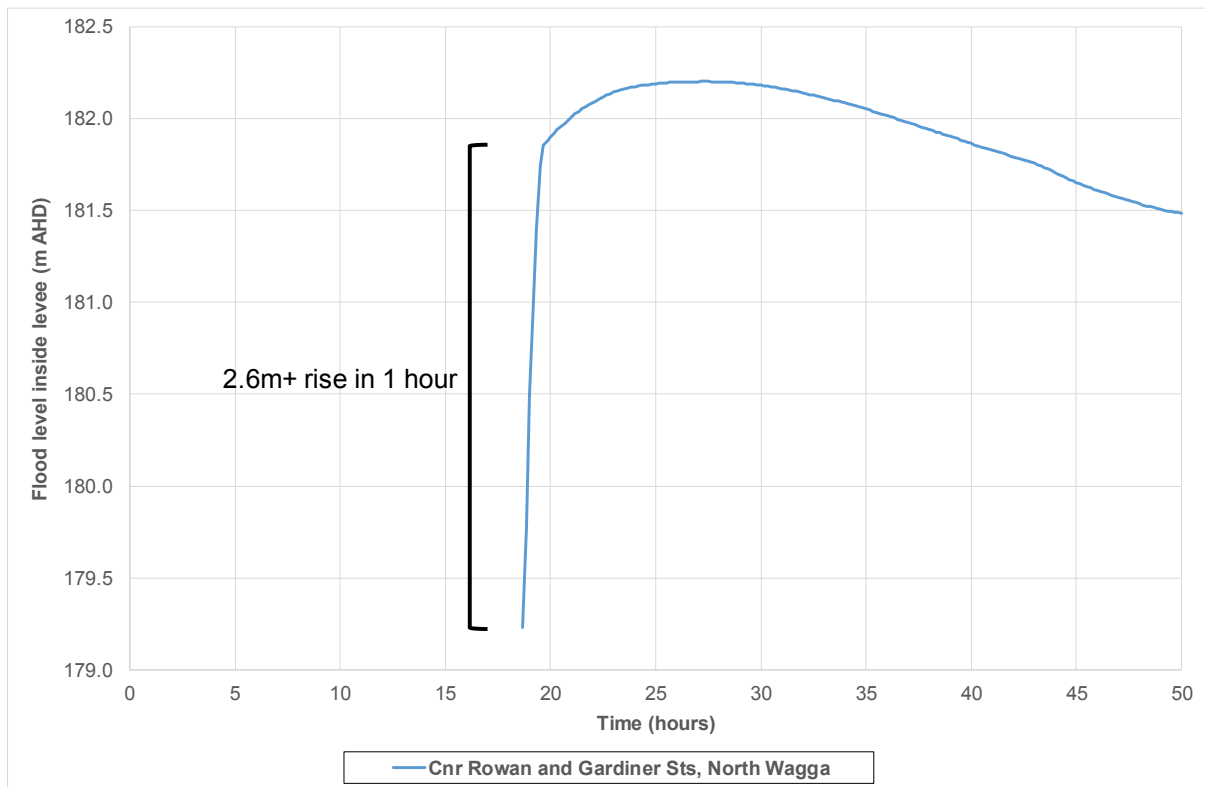




Chart 1: Rate of rise when a 1% AEP North Wagga levee is overtopped in a 0.2% AEP event



### Mitigating the Increased Catastrophe Potential

A variety of options are available to mitigate the increased catastrophe potential associated with a higher levee. These include:

- 1) Flood education. It is clear that ongoing education of flood prone communities will be required. Messages people need to receive include these:
  - Levees don't keep out all floods
  - Levees do overtop (e.g. Nyngan 1990; North Wagga 2012)
  - Flood prediction is not an exact science
  - Freeboard cannot be relied upon for evacuation decisions
  - Don't gamble your family's life
  - Isolation can be unpleasant and unsafe

It is noted however that an actual flood is the best teacher, and with a 1% AEP flood levee, the average experience of such floods will become less frequent.

- 2) Flood Evacuation Orders. The high evacuation rates from both North Wagga and Wagga CBD in March 2012 have been attributed to the clarity and force of the Evacuation Orders, and the role of Army, Police and other personnel in banging on doors to get people out. A similar direct engagement method could be deployed again when the Murrumbidgee is predicted to overtop the levee.



- 3) Higher access road. It has been suggested that having a raised access road will offset the increased risk of people failing to evacuate in a timely fashion, since this would allow additional time for evacuation, acting as a safety buffer. It would also help to mitigate isolation risks. But the SES view is that it might only encourage people to delay their evacuations, this eroding the very purpose for which it would be built. In addition, such a road would be costly to construct, particularly since bridging may be required to avoid creating an adverse hydraulic impact upstream.

### **Summary**

In the multi-criteria assessment table prepared to compare different options, the impact of a 1% AEP levee on the SES and on risk to life is considered negative. The likelihood is that despite precautions it would be *more* difficult to evacuate people than with a lower levee, leading to increased isolation risks during floods that cut access but do not overtop or breach the levees, and increased risk to life in the rarer events that do overtop or breach the levees.

In and of itself, these issues are not necessarily so insurmountable that they would disqualify a 1% AEP levee on emergency management grounds. Raising houses to be above the 1% AEP flood – either through a formal voluntary house raising scheme or through the gradual replacement of housing stock – could lead to similar issues.

But a 1% AEP levee would put a lot of weight on the SES and Council to maintain community and agency readiness as well as mechanisms to evacuate a community whose experience of increased protection from floods will in all likelihood mean increased resistance to evacuation.