

# The Risk of Flooding — What Are the People of the Hawkesbury–Nepean Willing to Accept?

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**Summary:** The designated flood (or flood standard) is the flood level selected for planning purposes and directly determines the area of land subjected to flood-related building and development controls. The level of the designated flood also directly determines by how much the local community will be exposed to the risk of flooding. Over the past 10–20 years, communities have become ‘comfortable’ with the 100 year average recurrence interval (ARI) flood as their designated flood. However, this has led to a ‘false sense of security’ that bigger floods are not possible. This is important in the Hawkesbury–Nepean valley, particularly at Windsor, where the probable maximum flood (PMF) would be more than 1 m higher than the 100 year flood and the 1867 flood, about a 300–400 year ARI flood, would have been about 2.4 m above the 100 year ARI flood level.

Calculations have shown that the adoption of a 100 year ARI flood as the designated flood in the Hawkesbury–Nepean valley would cause the average annual flood damage bill to increase by 2½ times within 50 years to \$100 million each year. However, if a PMF is adopted as the designated flood, there would be a minimal increase in future flood risk but large areas of land would be affected by planning and development controls.

This paper quantifies the possible future flood risks for a small pocket of the Hawkesbury–Nepean floodplain near Riverstone. It concludes that flood damage assessment and adoption of a particular designated flood, makes up only one component of a much larger equation of ‘non-flooding’ issues. Therefore, the issue of flood risk in the Hawkesbury–Nepean valley should ideally be tackled with a total catchment management approach, with cooperation among all Councils and the community.

## 1. DESIGNATED FLOOD VS. FLOOD RISK

The designated flood (or flood standard) is the flood level selected for planning purposes, and directly determines the area of land subjected to flood-related planning development and building controls (Reference 1). Future flood risks are directly dependent on these controls, and therefore generally under the jurisdiction of local councils.

Selection of the designated flood is one of the most critical decisions in floodplain management, and is not an easy one. The issues affecting the selection of a designated flood are numerous, with the implications often extending beyond the immediate floodplain area, or even the particular local government area. The selection of a designated flood should be based on an understanding of the flood behaviour, together with the balancing of the social, economic and environmental consequences of flooding, including the potential for property damage and the risk to human life.

Short-term gains will also need to be balanced against long-term problems, for example:

- ♦ If the designated flood is too low — people may be regularly exposed to the risks of flooding and large areas may be quite frequently inundated, with large

damage bills to the community as a result. As more and more development occurs, the risk will get higher and higher over time.

- ♦ If the designated flood is too high — large areas, that would be rarely flooded, may be subjected to unnecessarily restrictive development and building controls. This could mean a rethink on regional planning issues.

Over the past 10–20 years, communities have become ‘comfortable’ with the 100 year average recurrence interval (ARI) flood as their designated flood. However, this has led to a ‘false sense of security’ that bigger floods are not possible.

## 2. HOW IS ‘FLOOD RISK’ QUANTIFIED? — THE FLOOD DAMAGE ASSESSMENT

The assessment of flood damages is generally the method used to quantify flood risk in dollar terms. Flood damage assessment quantifies the potential cost of flooding to the community — it does not determine who pays for the effects of floods, rather, it treats the entire community in one overall cost.

## 2.1 Existing Flood Risk

The total potential damage bill for a particular sized flood is divided into a number of components. The definitions and methodologies used in estimating flood damage have been established by many previous investigations. **Figure 1** summarises the types of flood damages that are generally considered.

The flood damage assessment generally refers to the ‘existing flood risk’. Flood mitigation options are assessed by how well they could potentially reduce this risk. In the economic appraisal process, the ‘benefits’ of a particular option refer to the amount by which the predicted flood damage could be avoided.

## 2.2 Future Additional Flood Risk

What the flood damage assessment should also consider is the possible future flood risk from additional development in the floodplain. This future potential damage is dependent on how much development potential there is between a particular designated flood and the probable maximum flood (PMF) event.

It should be noted that the selection of a designated flood does not change anything in the past, only in the future. Regardless of the designated flood adopted (and assuming no flood mitigation measures are undertaken), the existing flood damage would not be reduced — only future flood damage, from additional development, can be prevented.

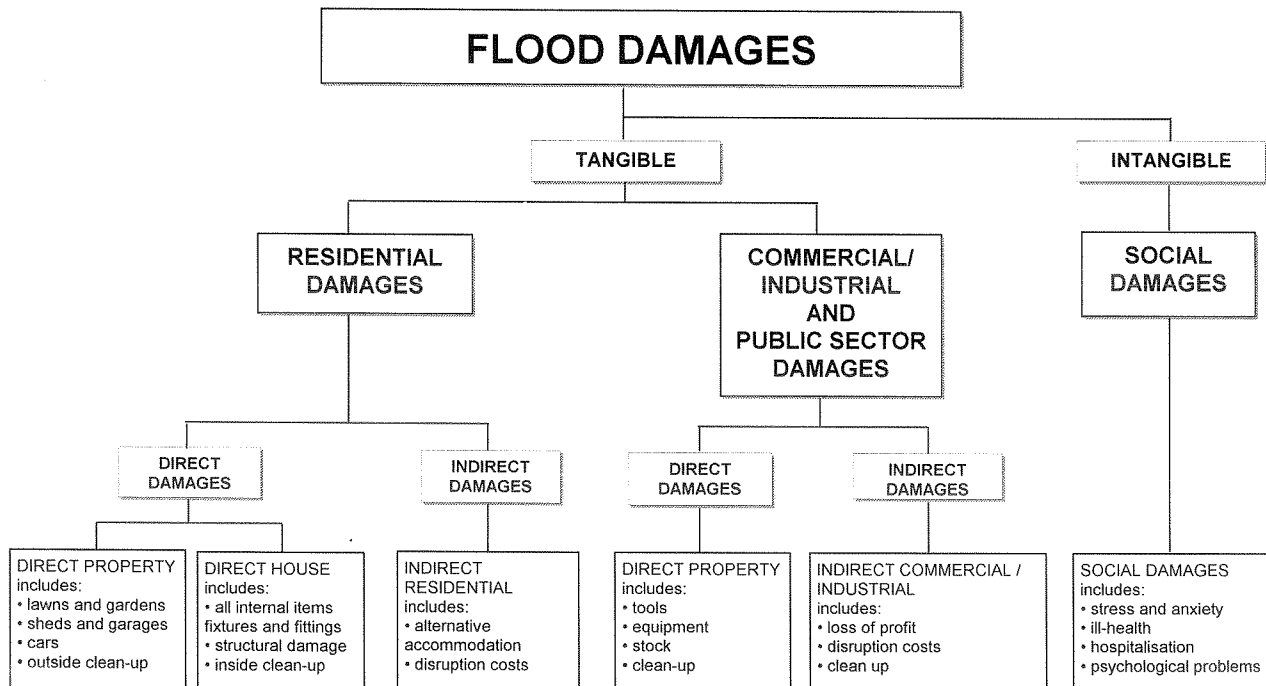
## 3. HOW HIGH COULD THE WATER GO? — FLOOD LEVELS AT WINDSOR

**Figure 2** shows a representation of the large differences in flood levels for different sized floods in the Hawkesbury River at Windsor. Key points from this figure are as follows:

- ♦ the probable maximum flood (PMF) level (which includes a failure of the Warragamba Dam wall) would be more than 11m higher than the 100 year ARI flood level. The extent of inundation for such a flood in the Windsor area is shown on **Figure 3**;
- ♦ the 1,000 year ARI flood level would be 4m higher than the 100 year ARI flood level;
- ♦ the 1867 flood, which is the largest flood in the Hawkesbury–Nepean Valley since European settlement, would have been 2.4m above the 100 year ARI flood level. It had a recurrence interval of 300–400 years.

## 4. WHAT IS THE EXISTING COST OF FLOODING IN THE HAWKESBURY –NEPEAN VALLEY?

**Table 1** summarises the existing flood risk for the entire Hawkesbury–Nepean valley. Based on this information (Reference 2), the damage bill in the valley for ‘another 1867 flood’ would be about \$1.5–\$2.5 billion.



**Figure 1:** Types of flood damage

Source: Reference 3

**TABLE 1: EXISTING FLOOD RISK IN THE HAWKESBURY-NEPEAN VALLEY**

FLOOD	NO. PROPERTIES INUNDATED		TOTAL POTENTIAL DAMAGE BILL*
	Residential*	Business*	
PMF	17,000	3,500	\$9.5 billion
1,000	12,000	2,700	\$3.5 billion
100	5,000	1,000	\$800 million
20	1,000	100	\$150 million
Average Annual Damage**	—	—	\$38 million

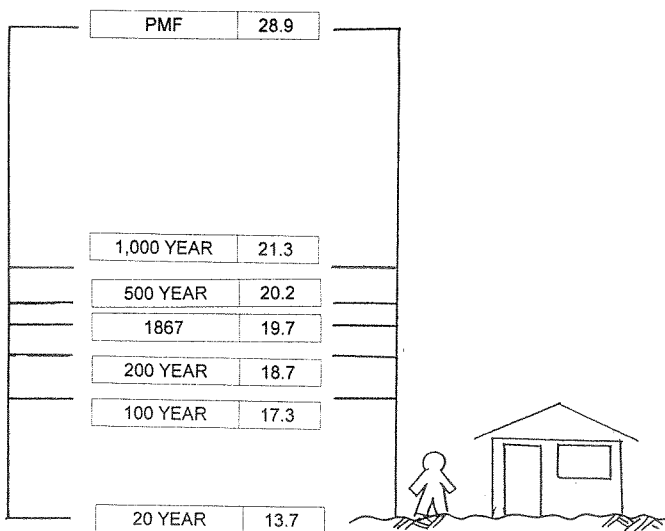
Source: Reference 2

Notes: \* Values have been rounded to provide an indication of magnitude for this paper.

\*\* Average annual damage — the cost of flood damage that could be expected each year by the community, on average.

**5. WHAT IS THE POSSIBLE FUTURE COST OF FLOODING IN THE HAWKESBURY –NEPEAN VALLEY?**

ERM Mitchell McCotter (2) suggests that, should a 100 year ARI designated flood be adopted for the valley, the average annual damage for the Hawkesbury–Nepean Valley would increase from \$38 million to \$100 million over the next 50 years — an increase of more than 2½ times. (Average annual flood damage is the theoretical amount that would need to put ‘in the bank’ by the community every year to pay for the effects of flooding.)



Assuming a typical location on the floodplain at about the 20 year flood level

Note: levels quoted in metres Australian Height Datum (mAHD)

**Figure 2: Flood levels at Windsor**

Source: Reference 2

**6. A CASE STUDY — THE EASTERN CREEK NORTH PRECINCT**

Eastern Creek is a large tributary of the Hawkesbury–Nepean catchment that flows into the Hawkesbury River near Windsor. As part of the Blacktown Floodplain Management Study (Reference 3) the lowermost reach of Eastern Creek within the Blacktown City local government area (generally north of the Castlereagh Freeway road reserve) has been called the ‘Eastern Creek North precinct’. Figure 3 shows that the Eastern Creek North precinct is only one very small pocket of Hawkesbury–Nepean floodplain.

The Eastern Creek North precinct would suffer backwater flooding from the Hawkesbury River in a 20 year ARI flood and larger, when flood levels are generally influenced by those at Windsor. Flood levels for events smaller than the 20 year ARI flood are more generally influenced by local catchment rainfall.

**6.1 Existing Flood Risk in Eastern Creek North**

Table 2 summarises the potential damage bill from flooding and the number of residential and business properties that would be inundated above floor level in the Eastern Creek North precinct for the 20, 100, 1,000 year ARI and PMF flood. The results show that the expected damage bill for a PMF would be about 20 times that of the 100 year ARI flood, while a 1,000 year ARI flood would be about 5–10 times as severe. Based on this analysis, the damage bill for ‘a 1867 flood’ would be about \$40–\$50 million.

**6.2 Possible Future Flood Risk in Eastern Creek North**

Because the PMF level would be more than 11m higher than the 100 year ARI flood in the Eastern Creek North precinct and because the Eastern Creek floodplain is quite flat, this results in a large area of land — up to about 1km wide in many places — being affected between the 100 year ARI flood and the PMF.

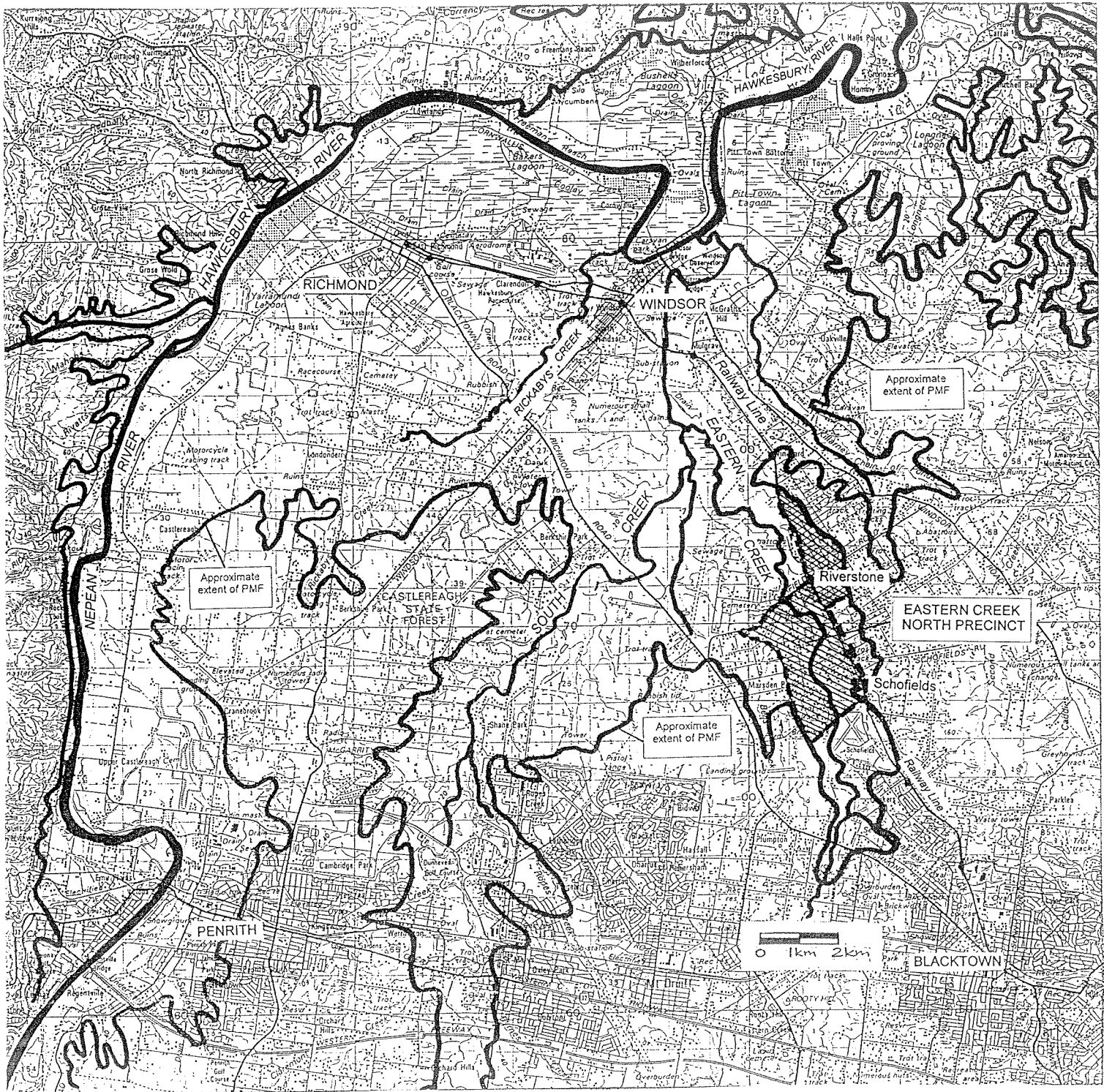
Don Fox Planning (4) has examined the potential for development over the next 20 years between the 100 year ARI flood and the PMF for the Eastern Creek North precinct, both within the current zonings and within planned future release areas. As part of this analysis it was assumed that Blacktown Council would not adopt a designated flood less than the existing 100 year ARI level.

The study found that most of the possible future development between the 100 year ARI flood and the PMF would be included in the large scale urban development strategy known as the Rouse Hill Urban Release Area (Sydney Regional Environmental Plan No. 19).

**6.3 Possible Future Flood Risk Vs. Designated Flood.**

Tables 3 and 4 shows the number of (residential and commercial /industrial properties flooded above ground level) both existing and future conditions for the following flood sizes:

- ♦ less than the 100 year ARI flood;
- ♦ between the 100 and 1,000 year ARI floods;
- ♦ between the 1,000 year ARI flood and the PMF.



Approximate extent of probable maximum flood event (Source: Reference 2)

Note that the flood extents shown are indicative only and the reader should refer to Reference 2 for more information

Figure 3: The Hawkesbury–Nepean Floodplain

**TABLE 2: EXISTING FLOOD RISK IN EASTERN CREEK NORTH PRECINCT**

FLOOD	RESIDENTIAL PROPERTIES		BUSINESS AND INFRASTRUCTURE PROPERTIES		SOCIAL DAMAGE	TOTAL POTENTIAL DAMAGE BILL*
	No. floors Inundated*	Potential Damage Bill*	No. Floors Inundated*	Potential Damage Bill*	Potential Damage Bill*	
PMF	1,440	\$70 million	120	\$170 million	\$10 million	\$250 million
1,000	660	\$30 million	60	\$70 million	\$6 million	\$110 million
100	180	\$6 million	30	\$5 million	\$2 million	\$13 million
20	20	\$0.6 million	<5	\$0.3 million	\$0.1 million	\$1.0 million
Average Annual Damage **	—	\$410,000	—	\$450,000	\$160,000	\$1.0 million
Present Value of Flood Damage***	—	\$4 million	—	\$5 million	\$2 million	\$11 million

Source: Reference 4

- Notes: \* Values have been rounded to provide an indication of magnitude for this paper.  
 \*\* Average annual damage — the cost of flood damage that could be expected each year by the community, on average.  
 \*\*\* Present value of flood damage — the equivalent value of flood damage if brought back to present day, assuming a discount rate of 7% over a period of 20 years.

**TABLE 3: POSSIBLE INCREASE IN FLOOD RISK IN EASTERN CREEK NORTH — RESIDENTIAL PROPERTIES**

FLOOD (ARI)	NO. OF FLOOD-AFFECTED RESIDENTIAL PROPERTIES			
	EXISTING	POSSIBLE FUTURE	INCREASE	
			NO.	%
<100 year	250	250	nil	0
100–1,000 year	410	450	40	10%
1,000 year-- PMF	770	960	190	25%

additional commercial/industrial properties (total of 110) that would be flood affected;

- ♦ in a PMF event there would be 230 additional residential (total of 1,660) and 85 additional commercial/industrial properties (total of 205) flood affected.

Using this possible future increase in development between the 100 year ARI and PMF level, the potential future flood risk was quantified using flood damage assessment methodology. As shown in **Figure 4**, three different designated floods were considered:

- ♦ 100 year ARI;
- ♦ 1,000 year ARI;
- ♦ PMF.

**TABLE 4: POSSIBLE INCREASE IN FLOOD RISK IN EASTERN CREEK NORTH — COMMERCIAL /INDUSTRIAL PROPERTIES**

FLOOD (ARI)	NO. OF FLOOD AFFECTED COMMERCIAL/INDUSTRIAL PROPERTIES			
	EXISTING	POSSIBLE FUTURE	INCREASE	
			No.	%
<100 year	30	30	nil	0
100–1,000 year	30	80	50	170%
1,000 year-- PMF	60	95	35	60%

If a 100 year ARI level was adopted as the designated flood for all future development, **Figure 4** shows that there would be a 12% increase over present levels in total flood damage to the community (including a 25% increase in commercial/industrial damage). This would equate to about \$150,000 every year.

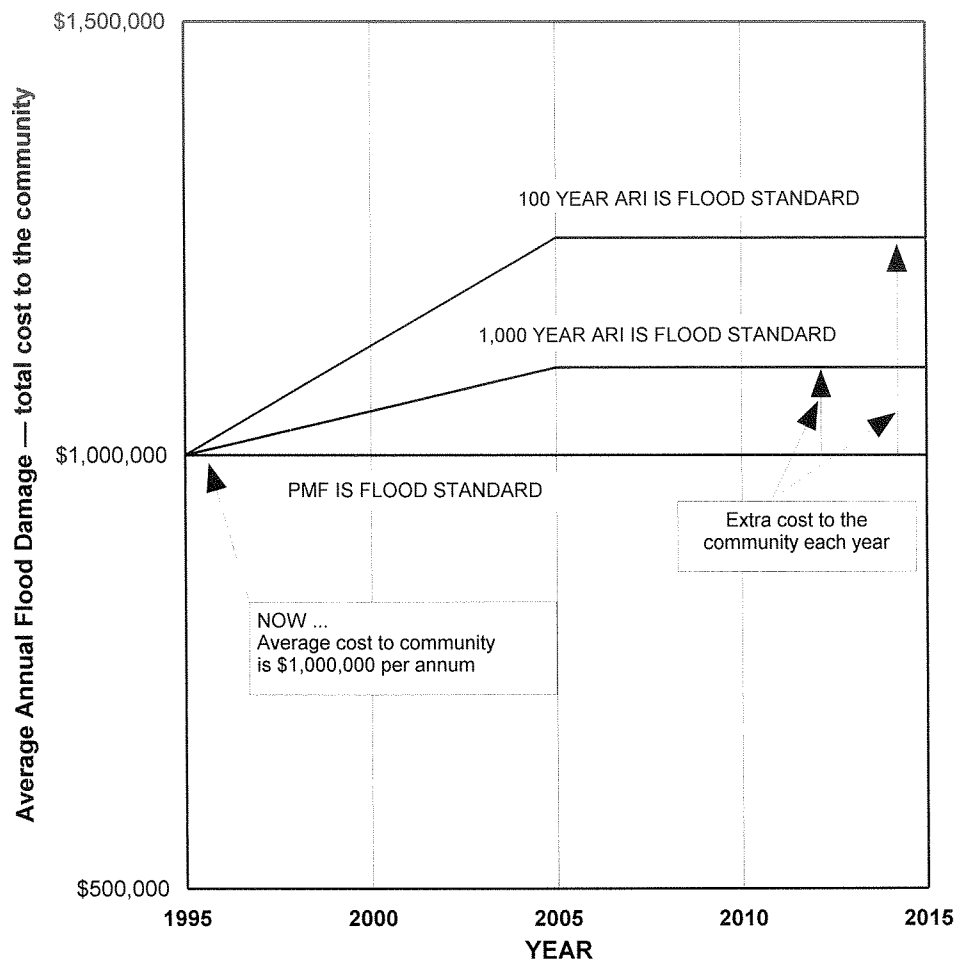
Similarly, if a 1,000 year ARI level was adopted as the designated flood for all future development, the results show that there would be a 2% increase over present levels (about \$40,000 every year) in total flood damage to the community.

**6.4 What If the Designated Flood Was Set at The PMF Level?**

If the PMF was adopted as the designated flood in the Eastern Creek North precinct, the flood damage analysis has shown that the flood risk to the community would not get any worse. It is also acknowledged that such a designated flood would result in significant environmental improvements to the riverine corridor. However, there are several foreseeable planning and social problems associated with such a decision.

Tables 3 and 4 shows, for example, that if a 100 year ARI designated flood was adopted:

- ♦ there would continue to be 250 residential and 30 commercial/industrial properties flood-affected in a 100 year ARI flood event;
- ♦ in a 1,000 year ARI flood event, there would be 40 additional residential properties (total of 700) and 50



THE NEXT 20 YEARS  
Most of the development will occur in Eastern Creek North precinct by 2005

**Figure 4:** Future Flood Damage in Eastern Creek North

As can be seen on **Figure 2**, the Eastern Creek floodplain is divided by the main Blacktown–Richmond Railway Line — a strategically vital transport link for the Rouse Hill Urban Release Area. The railway line and its immediate corridor are located at approximately the 100 year ARI flood extent. The extent of the PMF is about 1km away. Given the importance of the land surrounding the railway stations (particularly Riverstone), the consequences of precluding development in this vicinity may have significant impacts on the urban release area. The cost of moving the railway line or conversely, creating a link across the floodplain to the station, may far outweigh the avoided flood damages.

The impacts on infill development or adjacent development within existing zoning would also be high — would it really be practical to construct a house 11m higher than those nearby?

#### 6.5 What if the Designated Flood was between the 100 Year and the 1,000 Year Flood?

From only a flood damage perspective, the results showed that a designated flood somewhere between the 100 year ARI and 1,000 year ARI may be appropriate.

The flood damage analysis has shown that a designated flood somewhere between the 100 year and 1,000 year ARI flood may significantly reduce the future additional damages bill and may result in a more ‘acceptable’ increase in flood risk than if the 100 year ARI was adopted. One option may be to adopt the 1867 flood as the designated flood. This 300–400 year ARI flood would have the following advantages:

- ♦ it is a real event that is well documented and is (almost) in living memory;
- ♦ the level of the 1867 flood is about 2.4m above the 100 year ARI flood level — 2.4m represents one storey of a house, which would be much more visually acceptable if floor levels were based on this value.

#### 6.6 The Need to Consider the ‘Outer Floodplain Area’

Whatever the ultimately adopted designated flood (assuming it is below the PMF) it will also be important to consider the ‘Outer Floodplain Area’, that is, the area between the level of the designated flood and the PMF. Even if the 1867 (plus freeboard) was adopted for floor level control, the PMF would

still be 9m higher than the 1867 level. Although applying floor level controls in the 'Outer Floodplain Area' may not necessarily be appropriate, the following considerations could be applied to this area:

- ♦ the structural design of the building could take into account that total covering by water could occur;
- ♦ the use of flood-compatible building materials could be recommended in the Local Environmental Plan (LEP);
- ♦ all communities (residential and business) could be targeted for flood awareness programs and/or evacuation procedures;
- ♦ major and/or critical public infrastructure could be located outside the area (for example, railway lines, freeways, other important transport linkages, hospitals, community facilities used for evacuation of citizens and State Emergency Services' bases);
- ♦ other measures to ensure that properties in the outer floodplain area are not regarded as 'flood-free' — this could be in the form of appropriate notation on the property's Section 149 planning certificate.

## 7. WHAT ABOUT THE REST OF THE HAWKESBURY-NEPEAN VALLEY?

The flood damage assessment (Reference 4) and planning study (Reference 5), carried out as part of the Blacktown Floodplain Management Study (Reference 3), concluded it may be appropriate to adopt a designated flood greater than the 100 year ARI flood in areas under the influence of backwater flooding from the Hawkesbury River. However, such a decision is likely to impact upon other localities within the Hawkesbury-Nepean floodplain.

It should be noted that 'designated floods' (or 'planning levels') are already different in Blacktown and the adjacent areas near Windsor in the Hawkesbury Local Government area (in locations where the flood levels are essentially the same). The following planning levels are those used to show whether land has a 'flood affectation' on its Section 149 certificate:

- ♦ Blacktown City Council — 17.0m AHD
- ♦ Hawkesbury Council — 16.0m AHD

These differences already cause confusion in the community such as:

- ♦ most people do not understand that these are 'planning levels' and not (necessarily) flood levels;
- ♦ most people wonder why 'the flood level is 1m higher across the road' near the boundary between the two Council areas;
- ♦ most people have a 'false sense of security' that the 'planning level' is the biggest flood that could occur (in fact, it would be 11m-12m higher);

- ♦ in both cases, the 'planning levels' ignore the fact that bigger floods can and have occurred.

Conversely, considerable social (and political) impact is likely to occur if the 'planning level' in the Windsor area was lifted to the same as Blacktown, such as:

- ♦ additional construction costs associated with having higher building floor levels as well as the use of flood-compatible materials;
- ♦ additional development approval and supervision costs incurred by Council because of the extra area of land affected by flood-related controls;
- ♦ loss of economic growth in the region because of the loss of development potential of the land;
- ♦ the potential loss of property values for properties previously considered to be 'flood-free';

These impacts would intensify if a planning level such as the 1867, flood or even higher, was adopted throughout the Hawkesbury-Nepean Valley.

## 8. OUTRAGE NOW OR LATER? — SOME CONCLUDING COMMENTS

This paper has shown that the flood problem in the Hawkesbury-Nepean valley is extremely large, costing the community nearly \$40 million every year, on average. If current thinking on planning and development controls on flood-prone land is simply continued, this flood damage bill is likely to increase by 2½ times in the next 50 years.

Over the past 10-20 years, communities have become 'comfortable' with the 100 year ARI flood as their designated flood or planning level. However, this has led to a 'false sense of security' that bigger floods are not possible.

If a PMF was adopted as the designated flood, there would be minimal increase in future flood risk, but large areas of land would be affected by planning and development controls. There would also be serious implications for the Rouse Hill Urban Release Area as the strategically vital Blacktown-Richmond Railway line would be located up to 1km away from the limit of development.

The 1867 flood may be an appropriate designated flood. However, the area between the designated flood and the PMF (the Outer Floodplain Area) should still be considered in a planning sense. This could include appropriate notation on property certificates, flood awareness and evacuation programs, together with the preclusion of critical major infrastructure.

By quantifying the flood risk in dollar terms for a small pocket of the Hawkesbury-Nepean valley, it was shown that the flood damage assessment and adoption of a particular designated flood, is only one component of a much larger equation of 'non-flooding' issues.

The issue of flood risk in the Hawkesbury–Nepean Valley should ideally be tackled with a total catchment management approach, with cooperation among all Councils. Already different Councils are enforcing very different floor level standards for residential areas (they have actually adopted different 100 year flood levels) ... should people of neighbouring Councils be subjected to flood risks higher than their neighbours? On the other hand, should it have to cost more to build in a particular Council because of more stringent flood-related building conditions? Also, what are the consequences of advising people that they are ‘flood-affected’, when the Council has always said they are ‘flood-free’?

If the ‘rules’ for developing on flood-prone land were changed today, the community ‘outrage’ would probably be extreme. Yet would this outrage be worse, if things are allowed to continue as they are, and another ‘1867 flood’ struck the valley?

The selection of the designated flood, and the associated controls on development on the floodplain, are therefore important decisions that the community has to make.

However, for the community to make that decision they need to be aware and understand all the issues. The challenge for engineers and planners is to come to terms with all the issues and relay them (in understandable terms) to the decision makers and the community — only then is the community going to be in a position to make informed decisions about the level of flood risk they are willing to accept.

## 9. REFERENCES

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## 10. ACKNOWLEDGEMENTS

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