Appendix C

APPENDIX C: FLOOD DAMAGES ASSESSMENT

C.1. Quantification of Damages

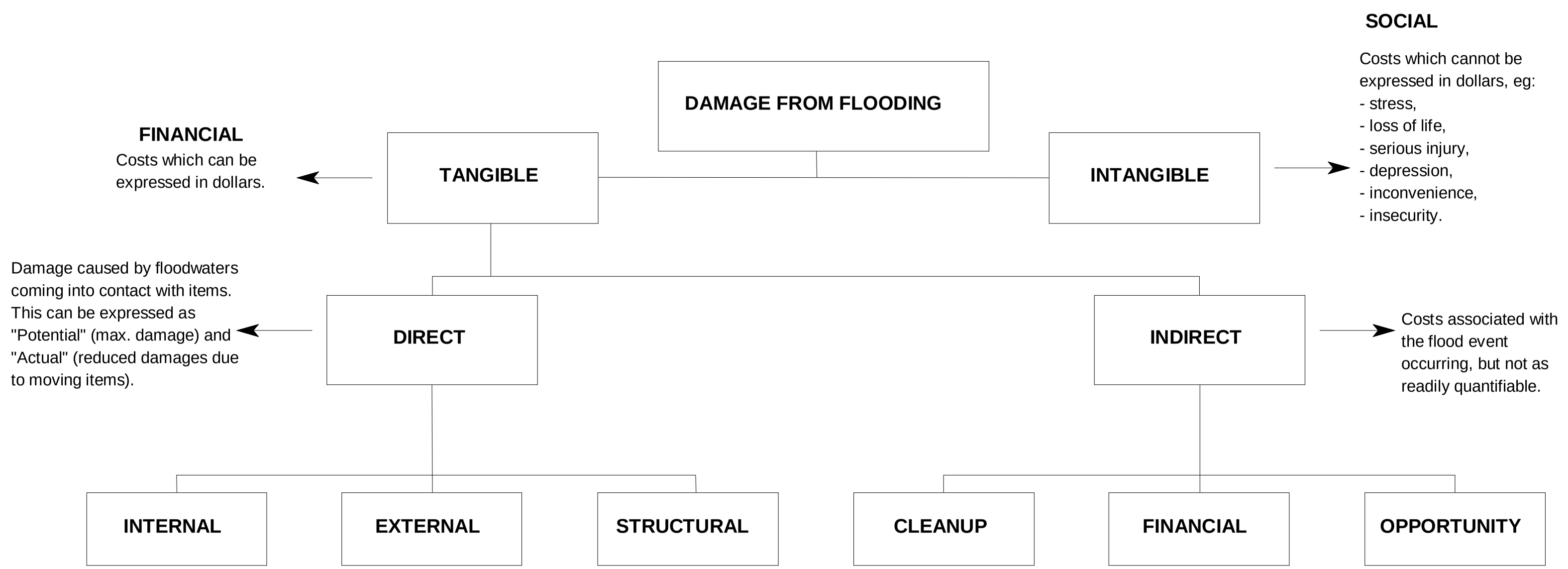
The quantification of flood damages is an important part of the floodplain risk management process. Flood damages can be defined as actual or potential, where actual damage refers to the damage incurred during known flood events, and potential damage is an estimation of the damage that could occur. Calculating potential flood damages gives a potential value of damage per property per design flood event, and an overall average annual damages value which is the average cost to property owners per year owing to flood damages. By quantifying flood damage for a range of design events, appropriate cost effective management measures can be analysed in terms of their benefits (reduction in damages) versus the cost of implementation. The cost of damage and the degree of disruption to the community caused by flooding depends upon many factors including;

- The magnitude (depth, velocity and duration) of the flood;
- Land use and susceptibility to damages;
- Awareness of the community to flooding;
- Effective warning time;
- The availability of an evacuation plan or damage minimisation program;
- Physical factors such as failure of services (sewerage), flood borne debris; and
- The types of asset and infrastructure affected.

The estimation of flood damages tends to focus on the physical impact of damages on the human environment and can be defined as being tangible or intangible. Tangible damages are those for which a monetary value can be easily assigned, while intangible damages are those to which a monetary value cannot easily be attributed. Types of flood damages are shown on Diagram C1 overleaf.

Floor level survey was undertaken by CMS in 2015 for 69 properties which were determined to experience flooding. The floor levels of the remaining properties within the PMF extent were estimated by WMAwater with the use of ALS data in combination with visual inspection of property floor level heights above ground, and validated against floor levels captured by survey. The floor levels have been used in the approximation of flood damages in Section 8.

Diagram C1: Flood Damage Categories



	INTERNAL	EXTERNAL	STRUCTURAL	CLEANUP	FINANCIAL	OPPORTUNITY
RESIDENTIAL	Contents of Buildings: Clothes, Carpets, Furniture, Valuables, Fittings, Appliances	External Items: Vehicles, Laundries, Caravans, Sheds, Tools, Gardens, Fences	Physical Damage to Buildings: Gyprock, Cupboards, Scour of Footings, Houses becoming buoyant (floating off footings)	Clean Carpets, Walls, Clothes; Re-instate Furniture; Remove Mud and Debris	Loss of wages, Living costs (temporary accommodation and food), Time to repair/replace damaged items	Not Applicable
RURAL	Contents of Buildings: Clothes, Carpets, Furniture, Valuables, Fittings, Appliances	External Items: Vehicles, Sheds (stables/barns), Machinery, Tools, Fences, Feed storage, Saddles, Crops &/or Stock, Irrigation Systems	Physical Damage to Structures: Damage to Homestead, Sheds, Access tracks, Protection levees	Clean Homestead and Out-buildings; Remove Debris; Dispose of affected crops &/or stock	Loss of Farm Production and Income, Re-instatement of Pastures, Supplementary feeding of stock (by hand or outside agistment), Stock movement/ transport, Living costs (temporary accommodation and food)	Sowing or harvesting of Crops, Sale of Stock (at depreciated value or dependent on market influences)
COMMERCIAL	Contents of Buildings: Products, Stock, Fittings, Tools, Machinery, Raw Materials	External Items: Vehicles, Machinery, Display, Raw Materials/Stockpiles, Fences	Physical Damage to Buildings	Dispose of damaged products, stock, materials; Cleaning and Re-instatement	Loss of Productivity and Income, Bank Interest Charges	Loss of existing &/or Potential Trade
PUBLIC AUTHORITIES	Contents of Public Buildings and Facilities	Public Property and Facilities: Parks, Signs, Machinery, Equipment	Physical Damage to Infrastructure: Electricity, Water, Telephone, Gas, Road & Rail Transport Links	Remove Mud & Debris from Facilities, Public & Private Property Repairs (temporary & permanent)	Disruption of Services, Community Service Relief Grants	Provision of Public Service

C.2. Identifying Flood Affected Properties

The damages assessment does not only look at potential costs due to flooding but also identifies when properties are likely to become flood affected by either flooding on the property or by over floor flooding.

C.3. Tangible Flood Damages

Tangible flood damages are comprised of two basic categories; direct and indirect damages (Diagram C1). Direct damages are caused by floodwaters wetting goods and possessions resulting in cost of replacement or repair, or in a reduction of their value. Direct damages are further classified as either internal (damage to the contents of a building including carpets, furniture), structural (referring to the structural fabric of a building such as foundations, walls, floors, windows) or external (damage to all items outside the building such as cars, garages). Indirect damages are the additional financial losses caused by the flood for example the cost of temporary accommodation, loss of wages by employees etc.

Given the variability of flooding and property and content values, the total likely damages figure in any given flood event is useful to get a feel for the magnitude of the flood problem, however it is of little value for absolute economic evaluation. However, considering damages estimates is useful when studying the economic effectiveness of proposed mitigation options. Understanding the total damages prevented over the life of the option in relation to current damages, or to an alternative option, can assist in the decision making process.

C.4. Expressing Flood Damages

Average Annual Damages (AAD) is equal to the damage caused by all floods over a period of time divided by the number of years in that period, and represents the equivalent average damages that would be experienced by the community on an annual basis. This means that the smaller floods, which occur more frequently, are given a greater weighting than the rare catastrophic floods. Total potential damage refers to the total damage estimated for a given flood event. Average damage per property is the total damage estimated for a particular flood event divided by the number of properties flood affected in this event; either by flooding on the yard and/or above floor level of a building.

C.5. Calculating Tangible Flood Damages

The flood damages assessment was undertaken for existing development in accordance with current OEH guidelines and the Floodplain Development Manual (Reference 1). Potential flood damages were calculated with the use of height-damage curves which relate the depth of water above the floor with tangible damages. The height-damage curves were established in accordance with OEH guidelines.

For residential damages the values used are based on the recommendations in the guidance with a post late 2001 adjustment factor applied to increase damage values

according to changes in Average Weekly Earnings (AWE) since 2001. Separate curves were established for non-residential damages.

Structural damages vary on whether the property is slab/low set or high set. For the purpose of this study, any property with a floor level of 0.5 m or more above ground level was assumed to be high set.

In calculating AAD, it was assumed that there would be no flood damages in events smaller than the 5-year ARI event.

Commercial and industrial damages are typically higher than residential damages, and as such a multiplier was applied to the total damage per property for each event by adjusting the typical building size value within the curve development calculations. Other factors, including the clean-up costs and external damages, were adjusted to reflect the differences between commercial and residential properties.

To adjust the residential damage curve to be applicable to non-residential development, the average contents damages for a business was estimated to be $150,000 and the clean-up costs have been estimated at $4,000. This was done to take into account the higher costs that businesses would incur compared to residential dwellings when flooded above floor level. The commercial damages curves were also amended to reduce the bench height based on the assumption that many commercial premises would have stock from floor level. External damage was set at $1,250 as per residential properties. The parameters assumed in the stage-damages curves are presented in Table C1, and the resultant curves are shown in Diagram C2 and C3. The Rock and Lockhart FRMS&P investigated a range of methods for the assessment of commercial damages in consultation with OEH, the preferred method is that which has been adopted for this study. The adopted values for the residential damages assessment are listed below.

Table C1 Stage-Damage Curve Parameters

Floodplain Specific Damage Equations								
Components								
Structural								
Single Storey Slab/Low Set		**$**	**22,707**	**+**	**$**	**8,402**	**x**	**AFD**	**m**
	Validity Limits		AFD	>		0.00	m		
Single Storey High Set		**$**	**28,611**	**+**	**$**	**12,857**	**x**	**AFD**	**m**
	Validity Limits		AFD	>		0.00	m		
Contents								
AFD <= TTBH (Typical Table/Bench Height)		**$**	**34,500**	**+**	**$**	**34,500**	**x**	**AFD**	**m**
	Validity Limits - (DRF negated above TTBH)		AFD	>		0	<	0.90	m
AFD > TTBH		**$**	**34,500**	**+**	**$**	**34,500**	**x**	**AFD**	**m**
	Validity Limits - (DRF only operates below TTBH)		AFD	>		0.91	< =	2	m
AFD > 2m		**$**	**103,500**						
Additional Costs - Total		**$**	**26,128**						
Made up of:									

External Damage	$	15,410						
Clean Up Costs	$	9,200						
Additional accommodation costs /Loss of Rent	$	1,518						

Total Equations

Single Storey Slab/Low Set

								eqn
Flooding above floor depth (AFD) <=		-0.10	Plus water level above ground level					1
	$	15,410						
Flooding above floor depth (AFD) between		-0.10	and	0.01	m			2
	$	38,117	+	$ 8,402	x	AFD		
Flooding above floor depth (AFD) between		0.01	and	0.90	m			3
	$	83,335	+	$ 42,902	x	AFD		
Flooding above floor depth (AFD) between		0.90	and	2.00	m			4
	$	83,335	+	$ 42,902	x	AFD		
Flooding above floor >		2.00	m					5
	$	152,335	+	$ 8,402	x	AFD		

Single Storey High Set

Flooding above floor depth (AFD) <=		0.00						6
	$	15,410						
Flooding above floor depth (AFD) between		0.00	and	-0.10				7
	$	44,021	+	$ 12,857	x	AFD		
Flooding above floor depth (AFD) between		-0.10	and	0.90	m			8
	$	89,239	+	$ 47,357	x	AFD		
Flooding above floor depth (AFD) between		0.90	and	2.00	m			9
	$	89,239	+	$ 47,357	x	AFD		
Flooding above floor >		2.00	m					10
	$	158,239	+	$ 12,857	x	AFD		

2 Storey Houses

Flooding above floor depth (AFD) <=		-0.10						11
	$	15,410						
Flooding above floor depth (AFD) between		-0.10	and	0.01				12
	$	31,305	+	$ 5,881	x	AFD		
Flooding above floor depth (AFD) between		0.01	and	0.90	m			13
	$	62,958	+	$ 30,031	x	AFD		
Flooding above floor depth (AFD) between		0.90	and	2.00	m			14
	$	62,958	+	$ 30,031	x	AFD		
		2.00	m	2.60	m			15
	$	111,258	+	$ 5,881	x	AFD		
Flooding above floor >		2.60	m					16
	$	172,874	+	$ 9,662	x	AFD		

Diagram C2: Flood Damages Curves – Residential Property

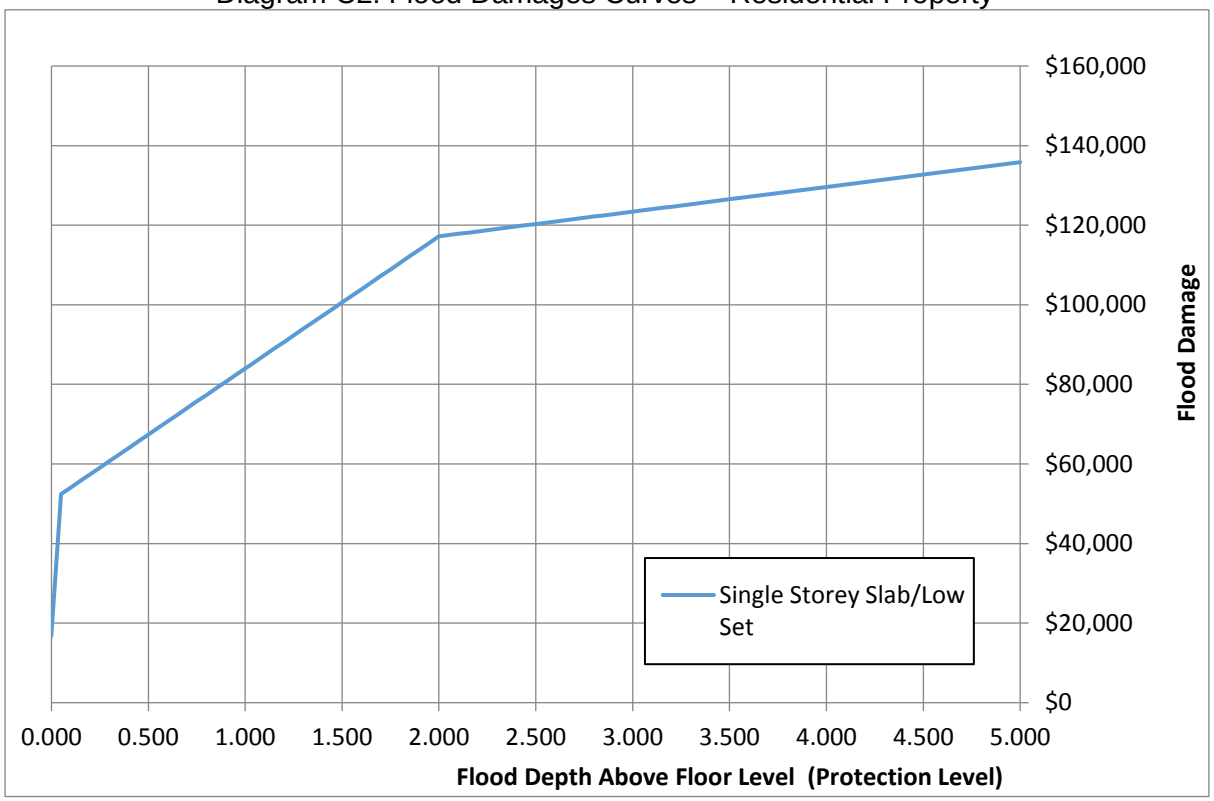
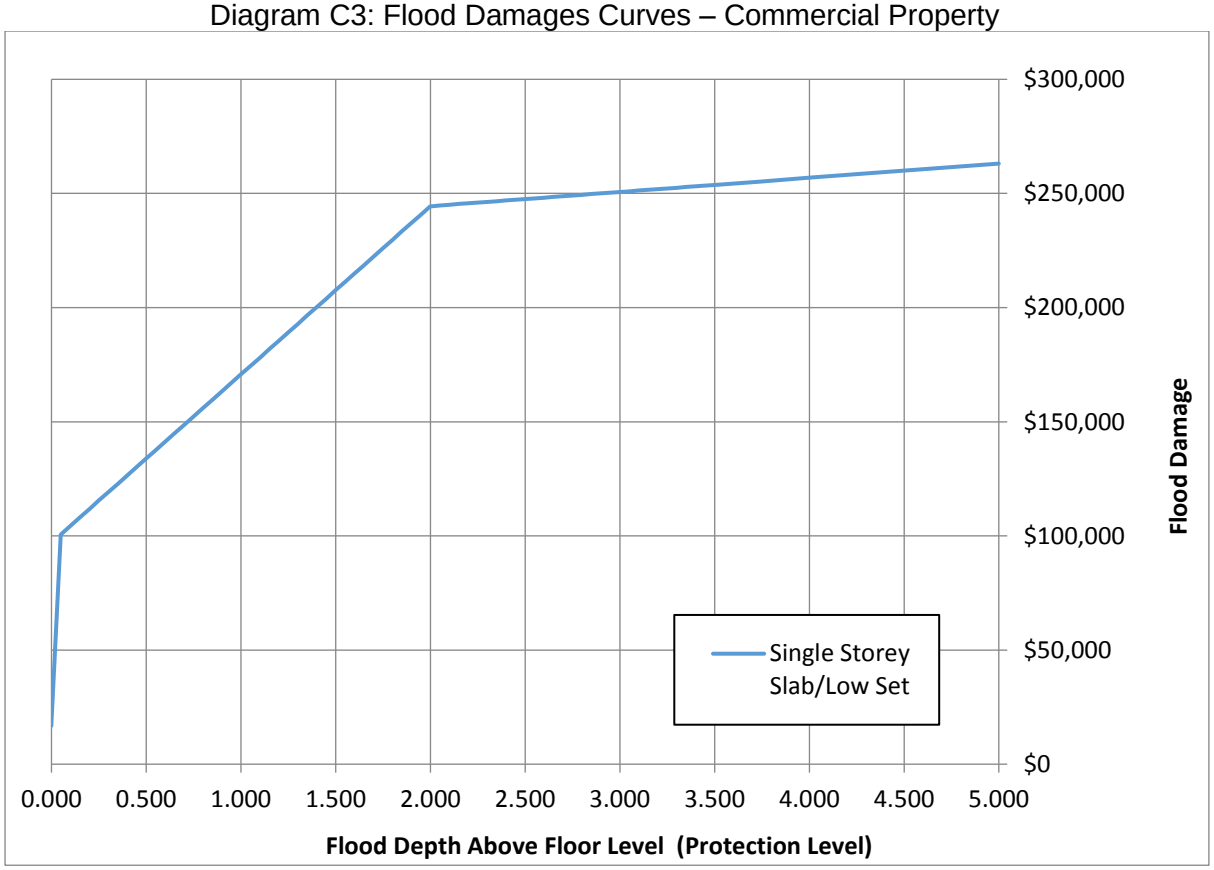


Diagram C3: Flood Damages Curves – Commercial Property



The OEH guidelines suggest a protection level be applied when calculating damages. This effectively reduces the floor level by the given amount (usually 0.5 m). This level of protection is considered overly conservative and has not been applied in this instance. Incorporating this 0.5 m 'level of protection' would lead to Council financing flood management measures that provide little benefit.

C.6. Intangible Flood Damages

The intangible damages associated with flooding, by their nature, are inherently more difficult to estimate in monetary terms. In addition to the tangible damages discussed above, additional costs/damages are incurred by residents affected by flooding, such as stress, risk/loss to life, injury, loss of sentimental items etc. It is not possible to put a monetary value on the intangible damages as they are likely to vary dramatically between each flood (from a negligible amount to several hundred times greater than the tangible damages) and depend on a range of factors such as the size of flood, the individuals affected, and community preparedness. However, it is still important that the consideration of intangible damages is included when considering the impacts of flooding on a community.

Post flood damages surveys have linked flooding to stress, ill-health and trauma for residents. For example the loss of memorabilia, pets, insurance papers and other items without fixed costs and of sentimental value may cause stress and subsequent ill-health. In addition flooding may affect personal relationships and lead to stress in domestic and work situations. In addition to the stress caused during an event (from concern over property damage, risk to life for the individuals or their family, clean up etc.) many residents who have experienced a major flood are fearful of the occurrence of another flood event and the associated damage. The extent of the stress depends on the individual and although the majority of flood victims recover, these effects can lead to a reduction in quality of life for the flood victims.

During any flood event there is the potential for injury as well as loss of life due to causes such as drowning, floating debris or illness from polluted water. Generally, the higher the flood velocities and depths the higher the risk. The Manly Lagoon study area generally is classified as high hazard for areas along the main waterway, however the hazard farther from the main channel is generally catergorised as low hazard.

C.7. Benefit/Cost Analyses for Management Options

To assess the full monetary benefits, including taking into account costs of construction and maintenance, Net Present Value (NPV) calculations were used and a Cost-Benefit (B/C) ratio established. The B/C approach is used to quantify the economic worth of each option enabling the ranking against other options. A B/C ratio is the benefits expressed in monetary terms, i.e. the reduction in AAD, compared to the actual likely cost of achieving those benefits, i.e. construction and maintenance costs.

The AAD per annum in today's monetary terms was assumed to apply for each year of the NPV damage calculation and was established for each year based on a discount rate of 7% as per the recommendation in the Residential Flood Damages FRM Guidelines. A construction cost was estimated and, using the NPV of the AAD assuming lifetime of 50-years, the B/C ratio was established for each of the options.