NSW Treasury

Technical Note: Flood Cost-Benefit Analysis Tool

TPG23-17: Disaster Cost-Benefit Framework

October 2023

The Flood Cost-Benefit Analysis Tool (the Tool) has been developed in partnership with the Department of Planning and Environment to make high quality analysis of flood mitigation initiatives faster and easier. This Technical Note provides details of the Tool's functions, parameters and inputs. It also provides a worked example and user manual. It should be read alongside the Disaster Cost-Benefit Framework (TPG23-17) and Flood Risk Management Measures Guideline MM01.

Acknowledgement of Country

We acknowledge that Aboriginal and Torres Strait Islander peoples are the First Peoples and Traditional Custodians of Australia, and the oldest continuing culture in human history. We pay respect to Elders past and present and commit to respecting the lands we walk on, and the communities we walk with.

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Document version number	Approval Date	Author	Approver	Description

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Definitions

Term	Definition
Actual-to-potential ratio	Ratio of actual flood damage to potential flood damage. Actual damage may be mitigated, for example by increasing warning time.
Annual exceedance probability (AEP)	The probability of a particular type of disaster of a given size or larger occurring in any twelve-month period.
Average annual damage (AAD)	The expected yearly damage cost arising from all occurrences of a given hazard.
Disaster	A serious disruption of the functioning of a community of a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.
Disaster resilience	The ability of a system, community or society exposed to disasters to resist, absorb, accommodate to and recover from the effects of a disaster in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.
Exposure	People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.
Hazard	A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.
Monte Carlo simulation	Monte Carlo analysis is a computerised simulation based on repeated random sampling from relevant probability distributions (assigned based on historical data or judgement) to produce multiple simulations.
Vulnerability	The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

1 Technical details

1.1 Overview

The Flood Cost-Benefit Analysis Tool (the Tool) was developed to assist with cost-benefit analysis (CBA) of flood resilience initiatives. The Tool can be used to:

- calculate average annual damage (AAD) based on a series of standard parameters
- estimate benefits including reduced mortality and injury, reduced mental health impacts, reduced clean-up costs and business disruption
- calculate a benefit-cost-ratio (BCR) and net present value (NPV)
- complete a sensitivity analysis
- complete a Monte Carlo simulation.

The Tool can also be used when undertaking a Floodplain Risk Management Study (FRMS), in line with the Flood Risk Management Manual (NSW Department of Planning and Environment, 2023a).

The Tool has been developed jointly by NSW Treasury and the NSW Department of Planning and Environment (DPE) and going forward will be managed and maintained by DPE. It is in Microsoft Excel (.xlsx format). Section 3 of Flood Risk Management Measures Guideline MM01 (NSW Department of Planning and Environment, 2023b) provides further information about the Tool. This Technical Note provides further details on aspects of the Tool developed by NSW Treasury as part of the Disaster Cost-Benefit Framework (TPG23-17).

Users should tailor application of the Tool to the context and consider the applicability of the standard parameters provided. In some cases, more detailed or tailored analysis will be appropriate.

Table 1 provides an overview of the structure of the Tool.

Table 1: Tool structure

Tab ^	Details
Info	• Introductory page including structure and a short description of each tab. • Lists limitations in terms of the maximum over-floor flood depth: — three metres for single storey residential properties — six metres for double storey residential properties — four metres for commercial properties.
Project Details	Background information about the project, including job-specific and client specific details and general QA, such as version control.
Inflation	The Tool is built in 2022 dollars and contains a calculator so that monetary figures can be inflated using Consumer Price Index (CPI) data.
NSW	Regional cost variation in different areas of New South Wales.
Inputs	• Various project-specific inputs required to calculate damage, set by default to an average or representative value. • See Section 1.2.6 for further details on the default parameters adopted.
Relocation	The cost of relocating as a result of overfloor flooding, in terms of weeks.

Tab ^	Details
Damage Curves	A summary of the default residential, commercial and public building damage curves.
BaseCase	• The main database requiring a user input; property ID, address, storeys, type (residential, commercial or public), floor level, ground level, size and the flood level for each modelled Annual Exceedance Probability (AEP). • Hazard classification (H1-H6) can also be entered to calculate the risk to life.
BaseCase_Calc	The final calculation and breakdown of floodplain damage (i.e. structural, internal, external, and risk to life) for the Base Case.
Outputs	• Summary graphs and tables that breakdown the overall flood damage and annual average damage into its four components. • A summary of the cost-benefit analysis.
Option[#]	Updated results for the Project Case (Option #), with the database linked to the BaseCase tab.
Option[#]_Calc	• The final calculation and breakdown of floodplain damage (i.e. structural, internal, external, and risk to life) for Option # (i.e. the Project Case). • The expenditure profile of the option is inserted here.
Agriculture_BC	Input of agricultural data (crops and livestock) and calculation of AAD.
Agriculture_PC	
Agriculture_CBA	• CBA of the agriculture component, which requires the insertion of an expenditure profile. • The results in this tab can also be combined with a selected 'property' flood resilience option, in order to produce an overall result.
MonteCarlo_Sim	The Monte Carlo method applied to the Base Case AAD result, in terms of 1,000 simulations.
MC_CBA	The Monte Carlo method applied to the CBA, in terms of 1,000 simulations, in order to determine the probability of returning a BCR greater than one.
Bespoke	Any additional items to be incorporated into the Tool, for both property and agricultural damage.

^ *Shaded tabs require a user input.*

1.2 Calculation of Average Annual Damage

The Tool calculates the AAD for a set of properties across a study area, broken down into four elements:

- *structural* damage
- *internal* (contents) damage
- *external* damage
- *intangibles*.

The AAD is calculated by applying the stage-damage curves across a property dataset, accounting for flood levels and inundation depth for each modelled AEP. The Tool calculates the present value of AAD across the assessment period, as recommended by the Disaster Cost-Benefit Framework.

1.2.1 Property damage

The Tool adopts default parameters in line with the Flood Risk Management Measures Guideline MM01. Key residential property parameters are provided in Table 2. Default figures represent the average property size across New South Wales and should be used only when more specific data is unavailable.

Table 2: Residential properties – default sizes and replacement values (2022 dollars)

Dwelling	Size	Floor Area (m^2)	Cost ($/$m^2$)	Total Cost
Detached dwellings – single storey	Small	90	2,280	$205,200
	Medium	180		$410,400
	Large	240		$547,200
	Default	220		$501,600
Detached dwellings – double storey	Small	90	2,620	$235,800
	Medium	180		$471,600
	Large	240		$628,800
	Default	220		$576,400
Multi-unit dwellings		100	2,730	$273,000
Townhouses		160	2,620	$419,200

Table 3 displays the cost per casualty (Office of Best Practice Regulation, 2022) applied in the Tool.

Table 3: Cost per casualty (2022 dollars)

Scale of Injury	Value of Statistical Life (VSL) 2022 dollars ($)
Fatality	5,300,000
Injury (moderate (emergency department) or minor)[1]	52,962

Residential damage curves

The default values create damage curves for residential single storey and double storey properties as set out in Figure 1 and Figure 2. The property size — small, medium, large and default — can be altered to suit the study area.

[1] Based on an assumed reduction weightage. See the heading "Injury, disease and disability" in (Office of Best Practice Regulation, 2022).

Figure 1: Damage curves – residential single storey

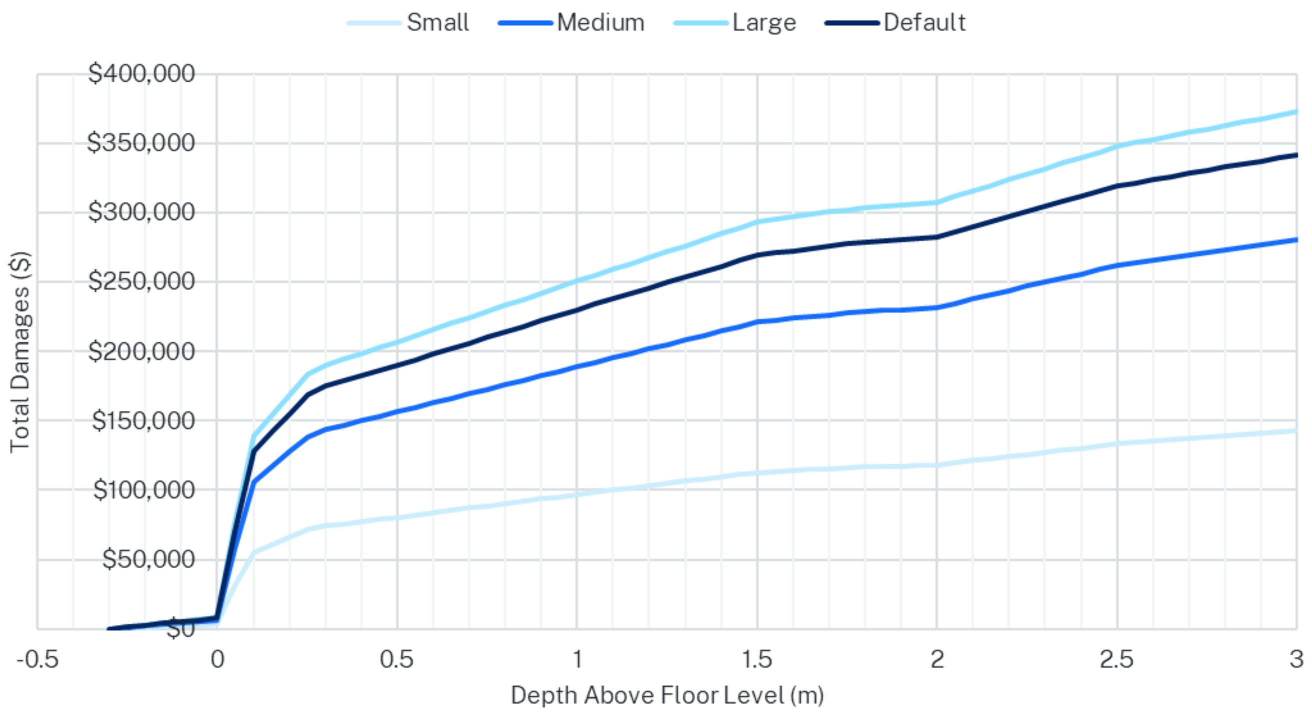
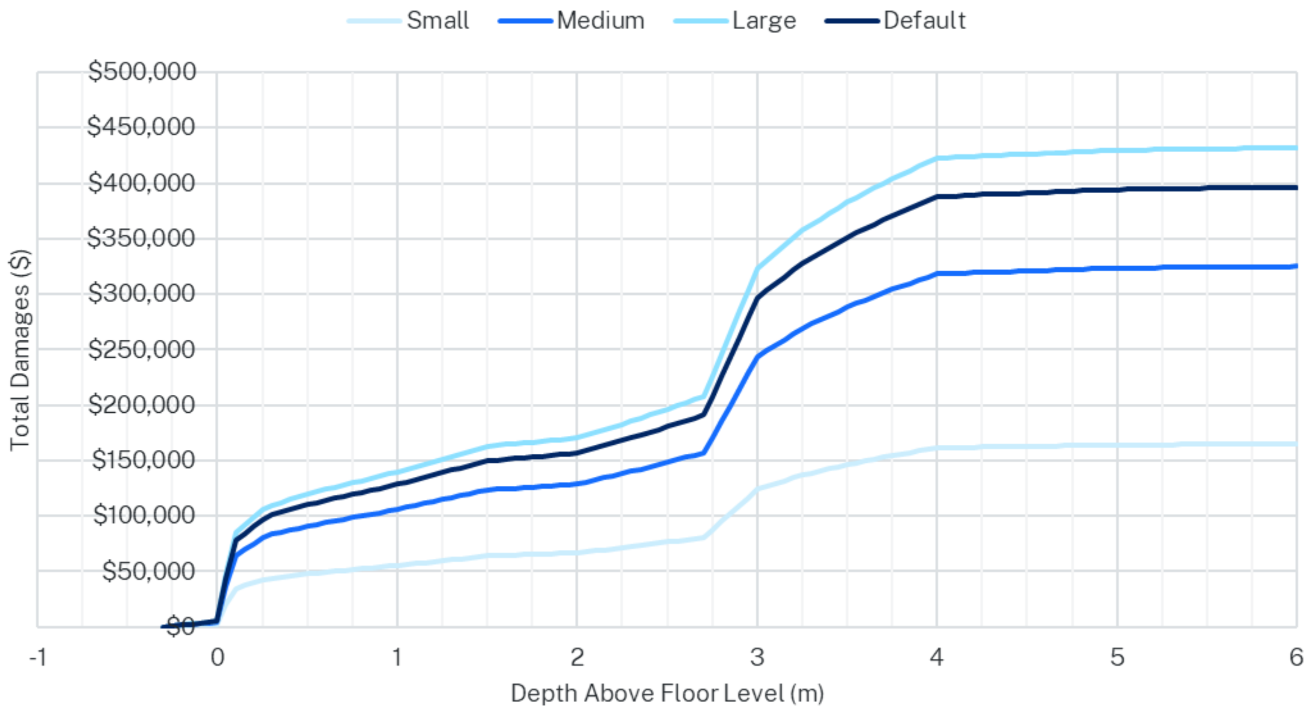


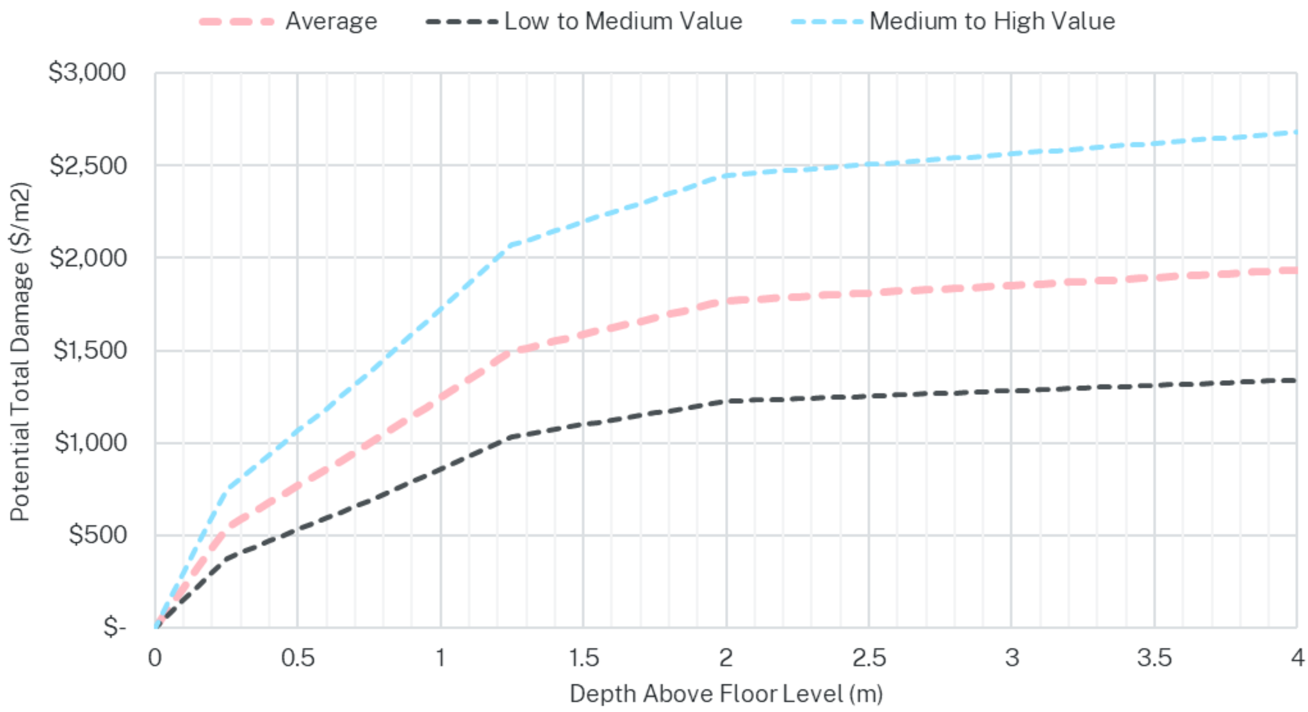
Figure 2: Damage curves – residential double storey



Commercial damage curves

The commercial damage curves depend on the use of the building and its contents. For example, low-to-medium corresponds to restaurants, offices, newsagencies and florists. Medium-to-high corresponds to chemists, electrical goods, bottle shops and electronics. The average curve is used when a particular use for a building is not known. Further guidance on which damage curve to select is provided in Flood Risk Management Measures Guideline MM01.

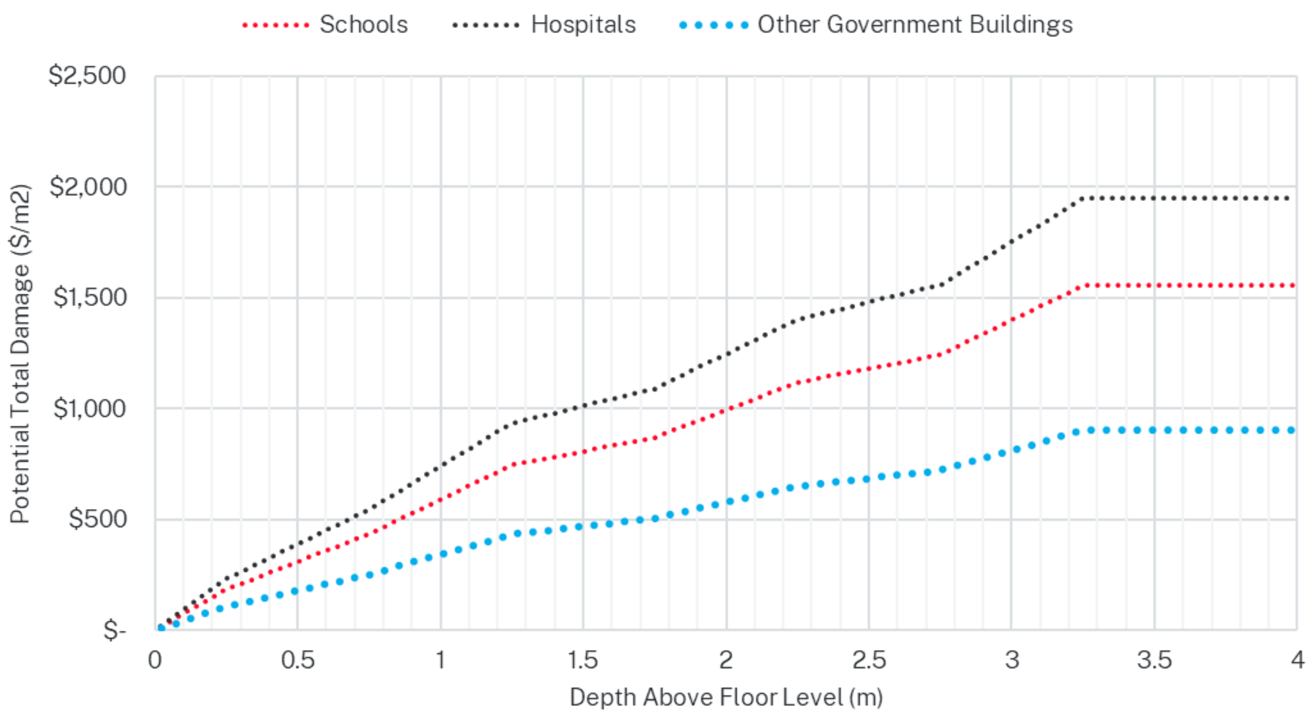
Figure 3: Damage curves – commercial properties



Public buildings damage curves

Curves in three categories — Schools, Hospitals and Other Government Buildings — are provided in Figure 4 on a dollar per square metre basis. Further details are provided in Section 1.2.3.

Figure 4: Damage curves – public buildings



1.2.2 Property inputs

The user needs to input the following data for each property:

- unique identifier (ID)

- address
- number of storeys
- ground and floor levels (mAHD[2]), often obtained through property survey
- number of ground floor units (if assessing a unit block)
- property size
- floor area (commercial properties only)
- modelled flood levels for selected AEPs
- modelled hazard rating for selected AEPs (if calculating risk to life).

These inputs are entered into the Base Case tab of the Tool, as well as any Options tabs. The flood model can reflect hydraulic modelling (i.e. design flood levels, with rainfall obtained from *BoM IFDs*), or actual data after an event (i.e. a validation flood model, used to estimate the total damage cost across a study area).

1.2.3 Public buildings and infrastructure

Public buildings

A sample of business cases and an online literature review was used to collect data on project costs, building floorspace and year of project completion. The data was used to estimate the average cost per square metre for each public building category, as displayed in the Table 4.

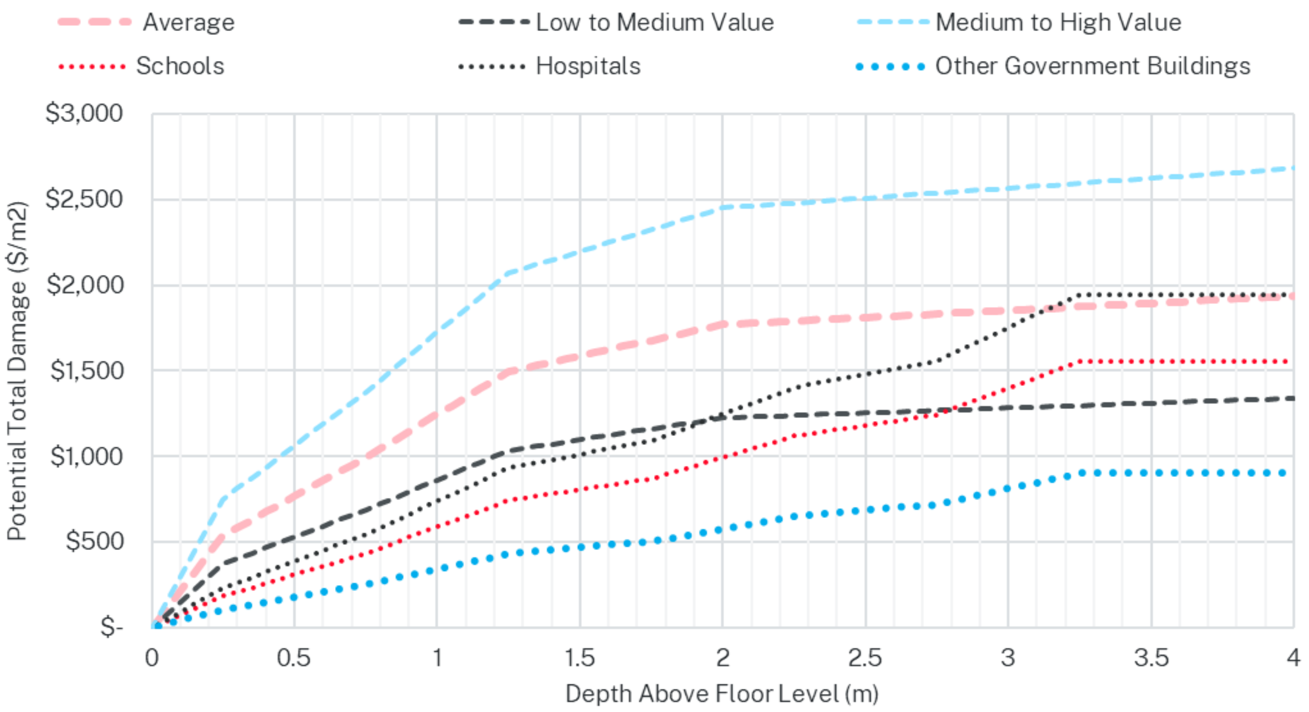
Table 4: Average cost of public buildings (2022 dollars)

Public building category	Average Cost ($/m^2)
Schools (including primary, secondary and tertiary, as well as childcare centres and universities)	$6,135
Hospitals	$7,686
Other public buildings (e.g. police stations, fire stations, courthouses, government offices, correctional facilities)	$3,561

Damage at each inundation depth was estimated by integrating the data into the public building stage damage curve function presented in Ke (2014) (see Figure 4). Figure 5 provides a comparison of all non-residential property damage curves (commercial and public buildings).

[2] Metres above Australian Height Datum (AHD), see https://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/ahdgm/ahd for more information (accessed 17 July 2023).

Figure 5: Damage curves – non-residential properties (2022 dollars)



The public building categories are consistent with the building classifications used in the National Exposure Information System (NEXIS) dataset. Data building exposure can be downloaded from the Australian Exposure Information Platform (AEIP).

Public infrastructure – roads

A road deterioration model that estimates the loss in a road's structural strength was used to estimate structural damage to roads following a flood. Sultana (2016) used pre-flood and post-flood data from the 2011 Brisbane floods to develop a model to predict the deterioration phase of roads impacted by river flooding. The model is denoted in the equation below, where SNC refers to modified structural strength of the road after a specific time period (days) following a flood.

$$SNC\ ratio = 1.032 - 0.034\ e^{\left(-\frac{time}{21.5}\right)}$$

The model estimates damage up to 42 days after a flood, as data from the Brisbane floods is not available for longer time periods. This time period reflects the rapid deterioration phase of pavement following a flood hence is considered a reasonable point to value post-flood road condition. Figure 6 displays the SNC ratio as a function of the number of days after a flood and Table 5 displays the road deterioration unit values.

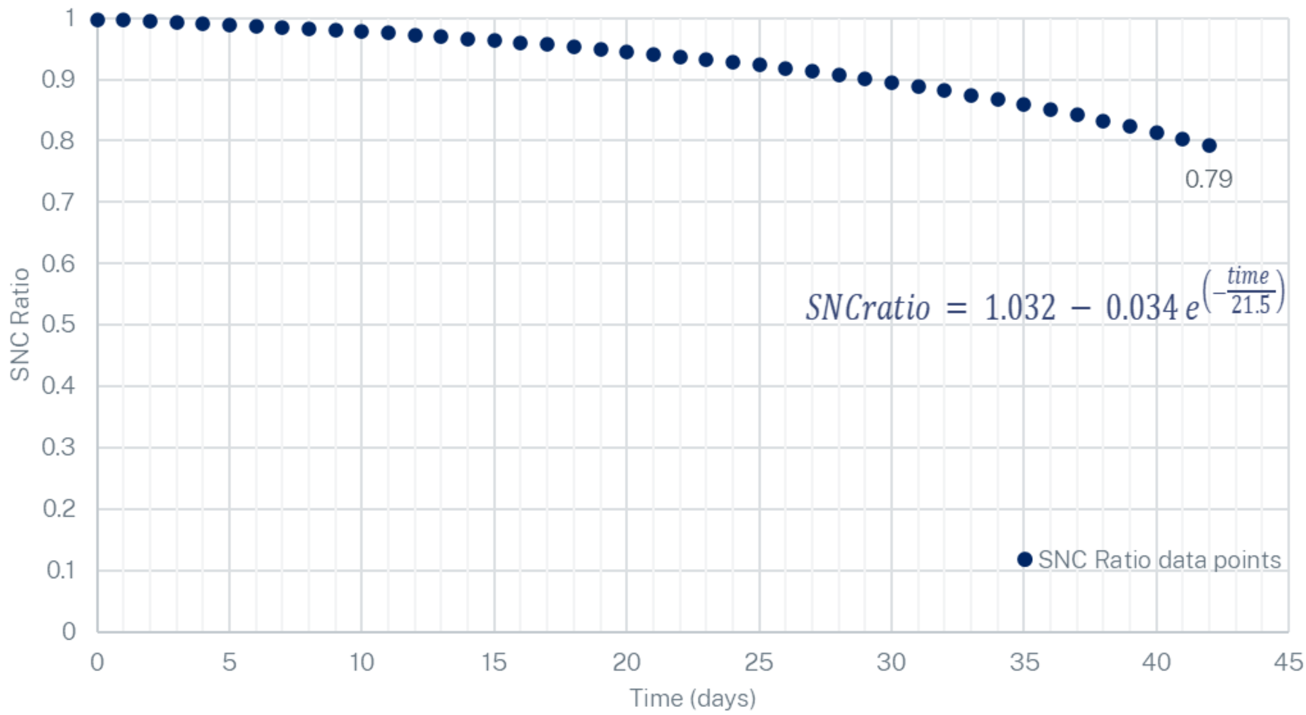
Table 5: Road deterioration unit values (2022 dollars)

Parameter	Value
Average construction cost Class 3 road pavement[3]	$35.87/m^2$
Initial road deterioration (pre-flood) assumption	25%
Post-flood road condition (42 days after flood), Sultana (2016) model	21%
Value of post-flood road deterioration[4]	**$5.65/m^2$**

[3] (Commonwealth Department of Infrastructure, Regional Development and Cities, 2018).

[4] 35.87 × (1 – 0.25) × 0.21 = 5.65

Figure 6: SNC ratio (modified structural number)



1.2.4 Agriculture values

The Australian Bureau of Statistics (ABS) collects data on the value of agriculture commodities produced and land use associated with each commodity produced in hectares. Data for both estimates is collected at the state and local government levels and published in Value of Agriculture Commodities Produced (2023).

Table 6 provides estimates of annual output her hectare, showing wide variation in value depending on agriculture profile. Estimates at the local government level are available through a drop-down menu in the Tool.

Table 6: Crops and livestock across New South Wales (2022 dollars, rounded)

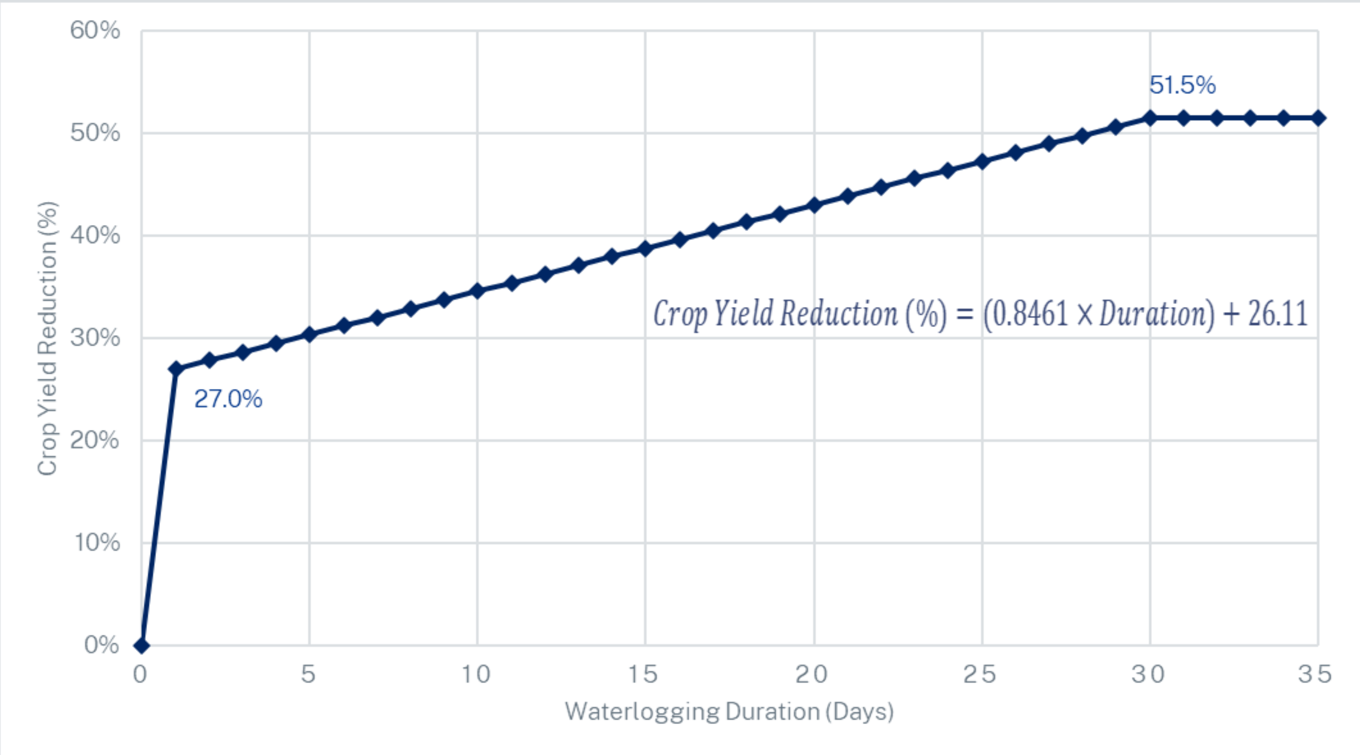
Agriculture Commodity	Total Annual Output ($M)	Total Area (km²)	Annual $/ha
Broadacre crops	8,187	82,212	996
Hay	535	3,374	1,584
Nurseries, cut flowers or cultivated turf	627	44	141,442
Fruit and nuts (excl. grapes)	1,266	597	21,216
Grapes	345	335	10,274
Vegetables	666	141	47,115
Total Crops (average)	**11,626**	**95,073**	**1,223**
Livestock	**7,299**	**405,806**	**180**

Practitioners should form an agriculture profile of the study area to assess how each commodity type may respond to floods. The Australian Exposure Information Platform provides a summary of the primary agriculture commodities produced for selected geographic regions.

Tian et.al (2021) conducted a meta-analysis of 2,419 observations from 115 global studies that evaluated the relationship between waterlogging and crop yields. Waterlogging refers to when free water overlays the soil surface of cropland. The analysis found that the longer the period of waterlogging, the more crop yield reduction, represented by the equation below and plotted in Figure 7.

$$Crop\ Yield\ Reduction\ (\%) = (0.8461 \times Duration) + 26.11$$

Figure 7: Observed yield reduction



This function is used to estimate crop damage at each AEP level, using flood duration and information on crop type and area. The meta-analysis did not include any observations for less than one day of waterlogging. As such, the crop yield reduction function has been linearly interpolated between zero and one day. Crop type and growth stage may have significant impacts on yield reduction. The meta-analysis incorporates a range of observations for different crops at different growth stages, however no further adjustments are made to account for crop type or growth stage.

This approach does not value losses to a farm's physical capital (machinery and structures) or cultivated biological resources (orchards, vineyards and productive livestock). The Bespoke tab in the Tool may be used where additional elements are expected to have a material impact on the damage assessment.

1.2.5 Mental health values

The UK Department of Environment measures direct mental health impacts from floods based on the cost of mental health treatment and associated work-based losses (Viavattene & Priest, 2020). Work based losses include increased absenteeism, decreased productivity and increased unemployment. In Australia, only three in five people aged 15-64 years with a mental or behavioural condition were employed, compared with around four in five people of the same age without a mental or behavioural condition (ABS, 2018).

Direct economic costs are estimated by multiplying the aggregate cost of mental health treatment and associated work-based losses by the increased prevalence of each mental health outcome during a flooding event (see Table 7). The approach is applied in the Disaster Loss Assessment Guidelines (2002).

Mental health can lead to broader costs, unquantified costs, including the emotional costs of reduced life expectancy, costs of diminished health and loss of lifetime earnings due to reduced participation in education.[5] Household social willingness to pay to avoid flooding at each AEP level is separately incorporated into the Tool. This is supplementary to the mental health values and accounts for social and wellbeing impacts of flooding such as stress (see Flood Risk Management Measures Guideline MM01 for further details).

Table 7: Method for estimating mental health economic impact

Method of Estimating Mental Health Economic Impact
$$\Big(\big((\text{Cost of treatment} + \text{absenteeism}) \times \text{\% mental disorders with consultation}\big) + \big(\text{presenteeism} \times \text{\% mental disorders with no consultation}\big)\big) \times \text{co} - \text{morbidity of conditions}\Big) \times \text{increased prevalence of mental disorder due to flooding}$$
Where: *Absenteeism* refers to time taken off work due to mental ill-health. Data from Cost-Benefit Analysis of Psychological Therapy (2007) is used to estimate additional days of sick leave (depression and PTSD 19 days and anxiety 9 days). *Presenteeism* refers to when somebody is able to work but not functioning as effectively. Estimated impacts of work presenteeism draws on an Australian study on the impacts of Depression in the workplace (2013) for each depression severity. *Co-morbidity* occurs when a person has more than one condition. This is estimated to occur in 30 per cent of mental health conditions (Viavattene & Priest, 2020). *Cost of treatment* refers to expenditure on mental healthcare. Costs for depression, anxiety and post-traumatic stress disaster (PTSD) is calculated using data on Government expenditure on mental-health services from the Australian Institute of Health and Welfare,[6] which is considered a reasonable proxy for treatment cost. The cost of treating each condition is estimated at $2,834 per person, per year. Individuals may also incur out of pocket costs, however these are not estimated. *Mental disorders with consultation* refers to whether there is at least one consultation with any health professional. Only 30 per cent of mental disorders had a consultation with a health professional (ABS, 2022c). *Increased prevalence of mental disorder due to flooding* refers to the increase in conditions with flooding compared to what would be expected without flooding (see Table 10).

The impact of work absenteeism and presenteeism is valued at the opportunity cost of labour, reflecting the value of foregone earnings, based on the ABS's estimate of median earnings in New South Wales. A weighted average value of labour has been calculated using the long-term average of the employment to population ratio. Table 8 outlines the method and results.

[5] The Commonwealth Productivity Commission's Inquiry Report on Mental Health (2020) Appendix H provides a detailed overview of the costs of mental health in Australia.

[6] Government expenditure includes recurrent expenditure by NSW Government and Australian Government's Medicare expenditure in New South Wales on mental-health specific services.

Table 8: Estimating opportunity cost of labour (2022 dollars)

Parameter	Value	Method and Source
Value of Employed Labour – Weekly ($) (ABS, 2022a)	1,250	ABS – earnings and working conditions
10 Year Average Employment to Population Ratio (%) (ABS, 2022b)	61.1	ABS – labour force
Weighted Value of Labour – Weekly ($)	763	$(Value\ of\ Employed\ Labour \times Average\ Employment\ Population\ Ratio)$

Prevalence of mental health conditions is directly related to the level at which an individual's house is inundated (Fernandez, et al., 2015). Public Health England (PHE) conducted a survey on flood experiences (depth of flood in their property, type of losses, evacuation, and disruption of services) and wellbeing (feelings, stressful experience, and physical health problems). Table 9 sets out the increased prevalence in mental health outcomes derived from the study.

Table 9: Increase in prevalence (percentage) of each outcome per depth band (based on PHE data, 2017)

Flood depth above floor level	Depression	Anxiety	PTSD
<30cm	0.162	0.204	0.250
30 to 100cm	0.285	0.319	0.386
>100cm	0.417	0.377	0.525

These estimates assume each household comprises two adults. Duration of a mental health conditions can vary from under a year to many years, so a conservative assumption of a two-year duration has been applied. The second year of mental health impacts is discounted at 5 per cent and added to the base year. This enables practitioners to account for the impact in a single appraisal period.

Table 10 specifies the mental health cost per flood event based on the method outlined in Table 7.

Table 10: Mental health cost per flood event, per household (2022 dollars)

Flood depth above floor level	Depression	Anxiety	PTSD	Total
<30cm	$1,549	$1,107	$2,674	$5,331
30 to 100cm	$2,726	$1,732	$4,129	$8,586
>100cm	$3,988	$2,046	$5,616	$11,651

1.2.6 Summary of standard parameters

Table 11 displays a summary of the standard parameters within the Tool. Values are presented in 2023 $AUD values. Parameters should be escalated with the Consumer Price Index using the Inflation tab in the Tool.

Table 11: Standard parameters used in the Tool

Parameter	Value
General Factors	
Actual-to-potential ratio	0.9
Regional uplift factor, reflecting regional variation in building costs	1.00, generally applicable to metropolitan areas. See Flood Risk Management Measures Guideline MM01 section 3.3 for alternative factors by region.
Infrastructure damage uplift (i.e damage to public infrastructure such as power lines and rail)	10% of total residential damage, assuming damage to public infrastructure is related to residential damage See Flood Risk Management Measures Guideline MM01 section 3.3 for details.
Emergency management uplift (i.e. cost of evacuations, rescue, supply of essential goods and services)	0% of total damage
Damage downscale for units and townhouses (typically incur less damage than detached dwellings)	30% reduction in damage compared to detached dwellings
Relocation cost	None provided, see Section 3.6.1 of the Framework for further details
Property sizes (floor area, m²)	
Detached dwelling (single and double storey)	• Small: 90 • Medium: 180 • Large: 240 • Default (average): 220
Unit or apartment	100
Townhouse	160
Non-residential buildings	• Average (default): 418 • Low-to-medium value: 186 • Medium-to-high value: 650 • School: 17,000 • Hospital: 28,000 • Other public (government) buildings: 2,200
Structural replacement value (per m²)	
Detached dwelling (single storey)	$2,280
Detached dwelling (double storey)	$2,620

Parameter	Value
Unit	$2,730
Townhouse	$2,620
Contents value (per m²)	
All residential properties	$550
External damage	
Residential properties only	$17,000, if over-ground flood depth exceeds 0.3 metres.
Road repair cost	$5.65 per m²
Indirect costs	
Residential clean-up	$4,500 per property, if affected by over-floor flooding.
Non-residential (clean-up cost and loss of trading)	30% of direct damage
Risk-to-life	
Fatality	$5.3 million
Injury	$52,962
Mental health impacts per household	
<30cm above floor level	$5,331
30 to 100cm above floor level	$8,586
>100cm above floor level	$11,651
Social willingness to pay[7]	
Event Probability (AEP)	*Cost per household per year*
PMF (Probable Maximum Flood)	$0
0.2%	$0
0.5%	$0
1%	$55
2%	$445
5%	$632
10%	$654
20%	$656
50%	$661
100%	$669

[7] Derived from Flood Risk Management Measures Guideline MM01, Table 21.

Parameter	Value
Agriculture commodity value (per ha, per year)	
Broadacre crops	$996
Hay	$1,584
Nurseries, cut flowers or cultivated turf	$141,442
Fruit and nuts (excl. grapes)	$21,216
Grapes	$10,274
Vegetables	$47,115
Total Crops (overall figure)	$1,223
Livestock	$180

1.3 Cost-benefit analysis

The Tool can conduct a CBA once the property data and flood modelling results are complete. In the Option[#]_Calc tab, the user needs to input:

- base year of analysis
- completion year of the works
- length of assessment period (typically 30 years)
- capital expenditure cost profile
- operating expenditure cost profile (i.e. maintenance costs)
- estimated residual value of the upgrade works at the end of the assessment period.

The following outputs are calculated by the Tool for the central social discount rate of five per cent and sensitivity analysis at three per cent and seven per cent:

- Present Value of Costs (base case and options)
- Present Value of Benefits (base case and options)
- Net Present Value
- Benefit-Cost Ratio.

1.4 Monte Carlo analysis

The Disaster Cost-Benefit Framework recommends that all disaster resilience CBAs include Monte Carlo analysis to improve understanding of uncertainty. The Tool includes a Monte Carlo analysis for the AAD calculation, with 1,000 random simulations that calculate the forecast damage attributed to flood events across the assessment period (also specified by the user, but typically 30 years).

The Tool outputs a series of statistics relating to AAD and present value of damage, including the minimum, maximum, mean, median and standard deviation. Histogram plots are also available to view within the Tool, which display the exponential impact of extreme weather events (i.e. significantly higher AAD in a fraction of the 1,000 simulations).

From a CBA perspective, the Monte Carlo component requires the same inputs as the Option[#]_Calc tab. It determines the number of simulations (out of 1,000) that result in a BCR greater than one.

1.5 Distributional analysis

The Tool undertakes a simple distributional analysis of the incremental impact of an option on households, producers and government. The Tool applies fixed percentages as set out in Table 12. Additional, project-specific distributional analysis may be required depending on the nature of the initiative and what groups it is likely to affect.

Table 12: Fixed allocation of impacts across stakeholder groups

Impact	Household	Producer	Government
Residential Property Damage	100%		
Residential Contents Damage	100%		
External Property Damage	100%		
Residential Clean-up Costs	100%		
Emergency Response			100%
Commercial Property Damage		100%	
Commercial Contents Damage		100%	
Non-Residential Indirect Costs		100%	
Commercial Vehicle Damage		100%	
Public Building Damage			100%
Road Damage			100%
Agriculture Damage		100%	
Mental Health Impacts[8]	61%		39%
Risk to Life	100%		
Social Willingness to Pay	100%		

[8] To account for mental health impacts in the distributional analysis, productivity impacts have been attributed to households and cost of treatment impacts have been attributed to government. These were calculated to be 61 per cent and 39 per cent of total mental health impacts respectively.

1.6 Other uses of the Tool

1.6.1 Climate change

The Tool can be used to calculate the AAD for climate change scenarios. As detailed in Section 1.2.2, water levels obtained from flood modelling results are an input to calculating the AAD across a set of properties within a study area.

Interim climate change factors (RCP 4.5, 6 and 8.5) for calendar years 2030 to 2090 can be obtained from the Australian Rainfall and Runoff (ARR) Data Hub (2022). The ARR Guidelines (2019) provide further guidance. The hydraulic flood model will need to be rerun with the application of these factors (e.g. a percentage increase in rainfall), after which the updated flood levels are input into the Tool. This will provide an updated estimate of AAD under a climate change scenario(s).

1.6.2 Calculating costs post-event

Post-event inundation data is often collected across a study area after a disaster, including the peak level of inundation across properties and the overall footprint of the flood. This data can be inserted into the Tool to estimate direct damage because of the disaster, assisting to calculate the overall economic cost. In this case AAD is not calculated as estimated future costs are not required.

1.7 Limitations of the Tool

Limitations of the Tool are summarised in Table 13.

Table 13: Limitations of the Tool

Item	Limitation
Base case	Do nothing scenarios are assumed, although an AAD growth rate can be applied if relevant.
Property dataset	The nature of each property within the Tool is identical in terms of age and flood resilient construction materials. In practice, replacement values will differ and properties with integrated flood resilient materials will be subject to less damage.
Cost categories	Some costs (e.g. transaction costs and evaluation costs) are not included.
Benefit categories	Some benefits (e.g. transport infrastructure, land value uplift as a result of the initiative, avoided emergency response costs) are not included.
Sensitivity analysis	Standard sensitivity testing has been incorporated into the Tool: • discount rate of 3% and 7% p.a. • ±20%; present value of costs and benefits. Project specific sensitivity testing should also be undertaken.
Distributional analysis	Standard distribution analysis is incorporated into the Tool for each option; household (consumer), producer and government. Project specific sensitivity testing may also be required.

Item	Limitation
Monte Carlo simulation	• Completely random distribution of AEP events over 30 years is assumed (however, there is no covariance between random variables) • 1,000 simulations are undertaken, meaning that for a 30 year assessment period, 30,000 floods will have been randomly assigned to the entire suite of simulations. Theoretically, this is enough to capture rare events (such as a 1 in 10,000 year event), although may not be enough to capture extremely rare events (such as a 1 in 50,000 year event)
Impact of climate change	Climate change has not explicitly been incorporated into the Tool. However, hydraulic modelling results of climate change scenarios can be input into the Tool.

2 Case study

The case study provides a worked example in using the Tool. It is based on a Floodplain Risk Management Study (FRMS) undertaken in 2021[9] as well as a dataset containing hydraulic modelling for 545 properties provided by DPE. The following AEP events are modelled:

- PMF[10]
- 0.2 per cent (500 years)
- 0.5 per cent (200 years)
- 1 per cent (100 years)
- 2 per cent (50 years)
- 5 per cent (20 years)
- 10 per cent (10 years)
- 20 per cent (5 years)
- 50 per cent (2 years)

The type of property (residential or commercial), as well as their ground level and floor level (mAHD) are also provided, enabling the calculation of overfloor and overground flooding depths and the corresponding flood damage in each AEP event.

CBA has been undertaken for the following options:

1. Levee – a 1.9km levee built around the township to withstand the 1 per cent AEP flood event.
2. House raising – raising the floor levels of all properties above the 2 per cent AEP flood level.
3. Warning time – increased warning time for the entire study area, allowing individuals to undertake actions that somewhat mitigate potential flood damage.
4. Agriculture – an extension of the levee in Option 1 to five kilometres to also cover agricultural land.

The costs[11] and benefits of each option are compared against the base case. The benefits include avoided damage and residual value, whereas the costs include capital expenditure (capex) and operating expenditure (maintenance). A sensitivity analysis has also been undertaken to assess the robustness of the results.

2.1 Background information and assumptions

The CBA is based on the following location-specific[12] factors:

- Actual to Potential Ratio – 0.9 (default)
- Regional Uplift Factor – 1.05 (Eastern land division, north of Newcastle)
- Infrastructure Damage Uplift – 10 per cent (default)
- Damage Downscale (Townhouse or Units) – 30 per cent (default)
- Relocation Cost – $0 per week (default)
- Warning Time – 2 hours (assumption)
- Base Year of Assessment – 2023
- Total Length of Assessment – 30 years.

Replacement values per square metre were selected in line with the default values:

- Detached Dwelling (Single Storey House) – $2,280 per sqm

[9] For privacy reasons, the location of this case study has been kept anonymous.

[10] The Tool denotes the PMF event as the 1-in-100,000 year event (0.001% AEP).

[11] Costings have been approximated for each option for the purposes of this case study.

[12] As the location of this case study is anonymous, it has adopted default values. This list does not account for inflation.

- Detached Dwelling (Double Storey House)[13] – $2,620 per sqm.

These values may be replaced by LGA-specific data. This would trigger removal of the Regional Uplift Factor.

Values have been inflated to the third quarter (March) of the 2022-23 financial year (CPI Sydney):

- December 2022 –130.9[14] (the baseline figures in the Tool have been indexed to this quarter)
- March 2023 –132.7[15] or an increase of 1.4 per cent.

2.2 The base case

The objective of the initiative is to reduce severity and impact of floods in the area.

For simplicity, the base case is assumed to be a do nothing scenario. In practice, pre-existing trends and exogenous factors (e.g. population growth and climate change) may impact the base case and should be considered and incorporated.

The AAD under the base case is calculated based on property survey data (floor and ground level), flood levels and hazard categories.

Damage categories include:

- structural[16] items of the building (e.g. foundation, walls and roof)
- internal building contents
- external elements (e.g. shed, garden and fence)
- intangibles (risk-to-life, mental health and social WTP to avoid intangible damage from a flood)
- damage to agricultural commodities.

Table 14 presents the number of properties affected by over-floor and over-ground flooding.

Table 14: Case study – base case results (total properties affected)

AEP	Over Floor Flooding	Over Ground Flooding
0.001%	452	481
0.2%	208	229
0.5%	142	159
1%	109	126
2%	75	107
5%	13	40
10%	5	10
20%	0	2
50%	0	0
100%	0	0

[13] The property dataset provided by DPE did not distinguish residential properties by property type, so the entire dataset as been set to 'detached dwelling single storey'.

[14] https://www.abs.gov.au/statistics/economy/price-indexes-and-inflation/consumer-price-index-australia/dec-quarter-2022

[15] https://www.abs.gov.au/statistics/economy/price-indexes-and-inflation/consumer-price-index-australia/mar-quarter-2023

[16] For non-residential properties, this category is inclusive of structural and internal components, due to an inability to delineate them.

AAD in the base case is calculated as $2.5 million (see Table 15).

Table 15: Case study – base case results (damage and AAD)

Base Case	AEP Event Damage					
AEP	Total	Structural	Internal	External	Intangibles	Agriculture
0.001%	$345,657,120	$237,896,983	$45,835,353	$7,265,325	$52,083,467	$2,575,992
0.2%	$184,995,591	$165,118,022	$13,396,517	$2,587,650	$2,466,050	$1,427,352
0.5%	$110,425,647	$100,296,314	$6,227,325	$1,373,445	$1,680,011	$848,553
1%	$59,319,247	$53,526,605	$3,067,469	$855,915	$1,329,922	$539,336
2%	$30,284,902	$28,502,110	$945,573	$378,195	$160,771	$298,254
5%	$3,515,084	$3,289,196	$54,292	$99,525	$4,685	$67,385
10%	$984,831	$936,727	$0	$39,810	$0	$8,294
20%	$0	$0	$0	$0	$0	$0
50%	$0	$0	$0	$0	$0	$0
100%	$0	$0	$0	$0	$0	$0
AAD	$2,520,325	$2,223,176	$148,029	$40,129	$86,145	$22,846
	AAD Contribution	*88.2%*	*5.9%*	*1.6%*	*3.4%*	*0.9%*

Agriculture base case

There are eight agricultural land uses across the study area, split into 25 segments. Table 16 displays the total area of agricultural land inundated across the modelled flood events. There is negligible inundation in the 20 per cent and 50 per cent AEP events.

Table 16: Agriculture – base case inundation

AEP	PMF	0.2%	0.5%	1%	2%	5%	10%
Inundated area (ha)	186.2	127.1	86.7	59.6	41.7	18.1	8.4

Each segment of land has been categorised into one of the agricultural commodities listed in Table 17. These damage costs along with the duration of inundation for each land segment in each AEP event is used to calculate AAD. **Error! Reference source not found.** presents the yield loss percentage applied.

Table 17: Agricultural commodities and damage cost (inflation-adjusted)

Agriculture Commodity	Annual Damage Cost $/ha
Broadacre Crops	$1,010
Hay	$1,606
Nurseries, Cut Flowers, or Cultivated Turf	$143,387
Fruits and Nuts	$21,508
Grapes	$10,415
Vegetables	$47,763
Crops – Total	$1,240
Livestock – Total	$182

Figure 8: Agriculture yield loss as a function of inundation duration

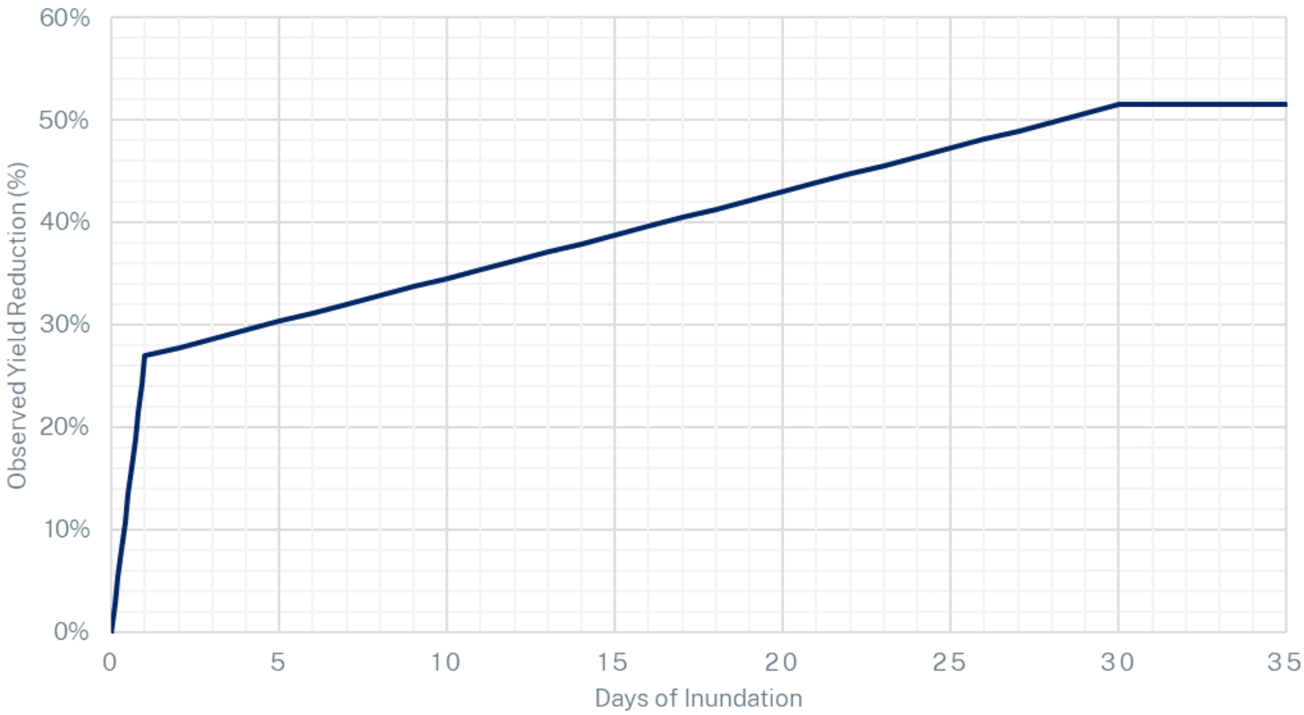


Table 18 presents agriculture damage under the base case for each AEP event, and a total AAD of approximately $23,000.

Table 18: Case study – base case agriculture results (damage and AAD)

AEP	AEP Event Damage	Contribution to AAD
0.001%	$2,575,992	$3,983
0.2%	$1,427,352	$3,414
0.5%	$848,553	$3,470
1%	$539,336	$4,188
2%	$298,254	$5,485
5%	$67,385	$1,892
10%	$8,294	$415
20%	$0	$0
50%	$0	$0
100%	$0	
	TOTAL AAD	$ 22,846

2.3 Options

A mix of real (anonymised) data and hypothetical data has been used to assess four[17] options. For simplicity, all options are scheduled to be completed in 2025, with the capital cost equally split across 2023 and 2024.

[17] Options 2 and 3 are hypothetical options that have been modelled within the Tool to demonstrate its usability. Option 1 is based on actual flood levels modelled in the data provided by DPE as a result of building

2.3.1 Option 1: Levee

Option 1 constructs a 1.9 kilometre levee around the township. The levee will protect properties up to the level of the 1 per cent AEP flood extent. Design of the levee was informed by flood and hazard modelling.

The levee costs $3 million to construct, an average cost of $1.6 million per kilometre. Average annual maintenance costs are $6,800 per kilometre or $12,920 per year. Additional maintenance costs of $20,000 apply every five years for inspections, audits and major repair works.

A residual value has been calculated as 40 per cent of the capital cost (see Section 2.4.1).

2.3.2 Option 2: House raising

Option 2 raises the floor level of residential properties[18] above the 1 per cent AEP flood level. Thirty-five properties are identified for raising at a cost of $50,000 each, or $1.75 million in total. No maintenance cost is expected. For simplicity, a residual value has not been estimated.

2.3.3 Option 3: Warning time

Option 3 implements a flood warning system, including a public address system (with messages, alert tones and sirens) and mobile phone notifications. This is assumed to result in:

- warning time increasing from two hours to 12 hours
- actual-to-potential ratio decreasing to 0.7 (previously 0.9, by default), as there is more time for residents to secure contents in the form of moving items upstairs (if available) or evacuating with valuable items.

The cost of implementing a new warning system is estimated at $1.6 million, with an annual maintenance cost of 20 per cent ($327,000) for testing and upkeep. As the system has a service life of 30 years, the residual value is zero.

2.3.4 Option 4: Levee extension (for agriculture)

Agricultural benefits occur from either a reduction in inundation area per AEP event, a reduction in the duration of inundation, or a combination of both.

Option 4 extends option 1 by extending the perimeter of the levee by 3.9 kilometres to protect agricultural land. This option will cost $8 million and have an annual maintenance cost of $34,000. In line with option 1, the periodic maintenance cost of $20,000 will be applied to the entire length of the levee (5km) for inspections, audits and major repair works.

2.4 Results

2.4.1 Central CBA estimate

The damage and AAD for all options, along with the base case, is presented in Table 19. AAD includes all benefit categories quantified in the Tool (property damage, risk-to-life, mental health, agriculture etc.).

the levee around the township. Option 4 is an extension of option 1 with hypothetical agricultural data, with details provided in Section Error! Reference source not found..

[18] Properties constructed from lightweight cladding are eligible for raising. Properties constructed from brick are not. For the purpose of this case study, all residential properties were assumed to be raisable.

Table 19: Project options and base case damage

AEP	Base Case	Option 1	Option 2	Option 3	Option 4
0.001%	$345,657,120	$345,657,120	$345,654,271	$296,775,877	$345,657,120
0.2%	$184,995,591	$184,949,156	$184,601,984	$150,200,425	$184,949,156
0.5%	$110,425,647	$110,379,212	$108,761,227	$88,946,976	$110,379,212
1%	$59,319,247	$11,221,007	$50,239,887	$47,773,527	$10,681,670
2%	$30,284,902	$3,894,373	$27,182,751	$24,184,083	$3,596,119
5%	$3,515,084	$969,430	$3,300,468	$2,807,390	$902,045
10%	$984,831	$332,529	$978,371	$778,105	$324,234
20%	$0	$0	$0	$0	$0
50%	$0	$0	$0	$0	$0
100%	$0	$0	$0	$0	$0
AAD	**$2,520,325**	**$1,478,327**	**$2,365,404**	**$2,046,538**	**$1,464,999**
less base case		***-$1,041,998***	***-$154,921***	***-$473,787***	***-$1,055,326***

The results of all options at the social discount rate of 5 per cent are displayed in Table 20. As the service life of a levee is 50 years, and the economic assessment period adopted in the case study is 30 years, a residual value of $1,216,000[19] can be claimed as a benefit in the final year of the assessment for option 1. This increases to $3.2 million for option 4. The other options do not have any residual value.

Table 20: Project option results (5 per cent p.a. discount rate)

Option	PV Costs	PV Benefits	NPV	BCR
1. Levee	$3,209,764	$15,523,261	$12,313,497	4.8
2. House raising	$1,708,333	$2,268,116	$559,783	1.3
3. Warning system	$6,383,492	$6,936,444	$552,952	1.1
4. Agriculture levee extension	$8,360,289	$16,155,575	$7,795,286	1.9

2.4.2 Sensitivity analysis

The results of the sensitivity analysis are presented in Table 21. Option 3 is sensitive to increased costs or reduced benefits, however other options are robust to sensitivity testing.

[19] Capital cost ($3,040,000) × service life remaining (20 years) ÷ service life (50 years) = 40% of the capital cost. The present value of this is $267,957.

Table 21: Sensitivity analysis – results

Test	Benefit-Cost Ratio				Net Present Value ($M)			
	Option 1	Option 2	Option 3	Option 4	Option 1	Option 2	Option 3	Option 4
Discount rate 3% p.a.	6.1	1.7	1.2	2.5	$17.0	$1.2	$1.2	$12.8
Discount rate 7% p.a.	3.9	1.1	1.0	1.5	$9.1	$0.1	$0.1	$4.5
PV Costs +20%	4.0	1.1	0.9	1.6	$11.7	$0.2	-$0.7	$6.1
PV Costs −20%	6.0	1.7	1.4	2.4	$13.0	$0.9	$1.8	$9.5
PV Benefits +20%	5.8	1.6	1.3	2.3	$15.4	$1.0	$1.9	$11.0
PV Benefits −20%	3.9	1.1	0.9	1.5	$9.2	$0.1	-$0.8	$4.6

Option-specific sensitivity tests were also undertaken for each proposed initiative (see Table 22).

Table 22: Sensitivity analysis – option-specific results

Option	Test	BCR	NPV ($M)
1. Levee	Construction cost of $2.5 million per km, instead of $1.6 million per km.	3.2	10.80
2. House raising	Threshold of 2% AEP instead of 1% AEP.	1.6	0.43
3. Warning system	Actual-to-potential ratio updated to 0.8 instead of 0.7 (base case remains at 0.9).	0.5	−2.88
4. Agriculture levee extension	Agricultural component of the levee only protects against the 5% AEP flood event.	1.9	7.65

Unquantified benefits

Some benefits were not quantified by the CBA and are not accounted for in the final results. These benefits vary across options, including:

- reduced pupil hours lost due to school closures
- avoided damage to public infrastructure and utilities
- avoided emergency response costs.

2.4.3 Distributional analysis

Tables 23 to 27 display analysis of the distribution of benefits to households, producers and government:

- Option 1 (levee): The majority of the incremental benefit is evident in the 1 per cent AEP event ($48 million), of which 54 per cent is attributed to producers. This suggests the majority of properties protected by the new levee are commercial in nature.

- Option 2 (house raising): The majority of the incremental benefit is evident in the 1 per cent AEP event ($9 million), of which 90 per cent is attributed to households. Producers do not benefit as non-residential buildings are out of scope.
- Option 3 (warning system): All groups benefit, with a split of 55 per cent producer, 38 per cent government and 7 per cent household.
- Option 4 (agricultural levee extension): Similar to option 1, however larger benefits to producers as a result of protection provided to agricultural commodities.

Table 23: Distributional analysis – incremental benefit of option 1 (levee)

AEP %	Total Damage Difference			
	Household	Producer	Government	Total
0.001	$0	$0	$0	$0
0.2	$42,213	$0	$4,221	$46,435
0.5	$42,213	$0	$4,221	$46,435
1	$1,521,239	$26,115,112	$20,461,888	$48,098,240
2	$979,683	$15,311,064	$10,099,783	$26,390,529
5	$4,758	$2,541,558	-$662	$2,545,654
10	-$97,057	$759,518	-$10,159	$652,302
20	$0	$0	$0	$0
50	$0	$0	$0	$0
100	$0	$0	$0	$0
AAD	**$24,188**	**$660,711**	**$354,699**	**$1,039,598**

Table 24: Distributional analysis – incremental benefit of option 2 (house raising)

AEP	Total Damage Difference			
	Household	Producer	Government	Total
0.001%	$2,590	$0	$259	$2,848
0.2%	$357,824	$0	$35,782	$393,607
0.5%	$1,492,814	$0	$171,605	$1,664,419
1%	$8,134,651	$0	$944,709	$9,079,360
2%	$2,785,998	$0	$316,153	$3,102,151
5%	$193,457	$0	$21,159	$214,616
10%	$5,873	$0	$587	$6,460
20%	$0	$0	$0	$0
50%	$0	$0	$0	$0
100%	$0	$0	$0	$0
AAD	**$131,775**	**$0**	**$15,075**	**$146,850**

Table 25: Distributional analysis – incremental benefit of option 3 (warning system)

AEP	Total Damage Difference			
	Household	Producer	Government	Total
0.001%	$12,828,832	$16,933,370	$19,119,041	$48,881,243
0.2%	$2,781,634	$14,288,710	$17,724,821	$34,795,165
0.5%	$1,333,105	$10,784,680	$9,360,885	$21,478,671
1%	$694,751	$6,273,384	$4,577,585	$11,545,720
2%	$195,853	$3,665,175	$2,239,791	$6,100,819
5%	$10,968	$695,628	$1,097	$707,693
10%	$0	$206,726	$0	$206,726
20%	$0	$0	$0	$0
50%	$0	$0	$0	$0
100%	$0	$0	$0	$0
AAD	**$34,604**	**$259,321**	**$179,862**	**$473,787**

Table 26: Distributional analysis – incremental benefit of option 4 (agriculture levee extension)

AEP	Total Damage Difference			
	Household	Producer	Government	Total
0.001%	$0	$0	$0	$0
0.2%	$42,213	$0	$4,221	$46,435
0.5%	$42,213	$0	$4,221	$46,435
1%	$1,521,239	$26,654,449	$20,461,888	$48,637,577
2%	$979,683	$15,609,318	$10,099,783	$26,688,783
5%	$4,758	$2,608,943	-$662	$2,613,039
10%	-$97,057	$767,812	-$10,159	$660,597
20%	$0	$0	$0	$0
50%	$0	$0	$0	$0
100%	$0	$0	$0	$0
AAD	**$24,188**	**$674,038**	**$354,699**	**$1,052,925**

2.4.4 Monte Carlo simulation

Monte Carlo analysis was applied to all options across 1,000 simulations. Using a random distribution of AEP events across each simulation over 30 years, the number of simulations with a positive NPV (BCR greater than one) was calculated for each option, as shown in Figure 9 to Figure 12:

- 77 per cent of simulations for option 1 (levee) have a positive NPV
- 47 per cent of simulations for option 2 (house raising) have a positive NPV
- 35.7 per cent of simulations for option 3 (warning system) have a positive NPV
- 63.5 per cent of simulations for option 4 (agricultural levee extension) have a positive NPV.

Figure 9: Monte Carlo simulation output – option 1 (levee)

	Average Annual Damage Avoided	Benefit Cost Ratio	Net Present Value	Number of Damage Events
Minimum:	$822	0.1	-$2,917,962	1
Maximum:	$4,782,879	27.6	$85,399,685	15
Range:	$4,782,057	27.5	$88,317,647	14
Median:	$765,451	3.4	$7,582,955	6.0
Mean:	$960,157	4.7	$11,782,452	6.0
Standard Deviation:	$851,788	4.5	$14,358,402	2.2
Kurtosis:	1.29	2.4	2.38	
Skewness:	1.18	1.5	1.49	
	BCR < 1	23.00%	*230 / 1000*	
	BCR >= 1	77.00%	*770 / 1000*	

Figure 10: Monte Carlo simulation output – option 2 (house raising)

	Average Annual Damage Avoided	Benefit Cost Ratio	Net Present Value	Number of Damage Events
Minimum:	$0	0.0	-$1,708,333	0
Maximum:	$805,757	8.9	$13,574,093	15
Range:	$805,757	8.9	$15,282,427	15
Median:	$99,331	0.9	-$178,353	6.0
Mean:	$141,793	1.3	$494,360	6.2
Standard Deviation:	$138,360	1.3	$2,305,514	2.3
Kurtosis:	1.64	3.6	3.64	
Skewness:	1.28	1.7	1.67	
	BCR < 1	53.00%	*530 / 1000*	
	BCR >= 1	47.00%	*470 / 1000*	

Figure 11: Monte Carlo simulation output – option 3 (warning system)

	Average Annual Damage Avoided	Benefit Cost Ratio	Net Present Value	Number of Damage Events
Minimum:	$0	0.0	-$6,383,492	0
Maximum:	$3,071,779	7.8	$43,319,078	15
Range:	$3,071,779	7.8	$49,702,570	15
Median:	$273,589	0.6	-$2,378,016	6.0
Mean:	$451,999	1.1	$377,076	6.1
Standard Deviation:	$484,868	1.2	$7,637,439	2.2
Kurtosis:	2.22	3.8	3.83	
Skewness:	1.52	1.8	1.84	
	BCR < 1	64.30%	*643 / 1000*	
	BCR >= 1	35.70%	*357 / 1000*	

Figure 12: Monte Carlo simulation output – option 4 (agricultural levee extension)

	Average Annual Damage Avoided	Benefit Cost Ratio	Net Present Value	Number of Damage Events
Minimum:	$0	0.1	-$7,708,130	0
Maximum:	$4,622,696	9.4	$70,760,658	14
Range:	$4,622,696	9.3	$78,468,788	14
Median:	$886,291	1.6	$4,704,134	6.0
Mean:	$1,007,690	1.9	$7,761,881	6.0
Standard Deviation:	$824,819	1.6	$13,780,141	2.3
Kurtosis:	0.57	1.3	1.34	
Skewness:	0.89	1.2	1.17	
	BCR < 1	36.50%	*365 / 1000*	
	BCR >= 1	63.50%	*635 / 1000*	

Figure 13 displays a histogram of the distribution of NPV results for option 4. Histograms can help visualise the potential for options to become feasible under certain circumstances, such as high consequence, low probability events. This is evident in Figure 14, which shows that option 2 has a positive NPV in 470 simulations out of 1,000 and an NPV of over $50 million in a handful of scenarios.

Figure 13: Monte Carlo output – NPV histogram for option 4 (agricultural levee extension)

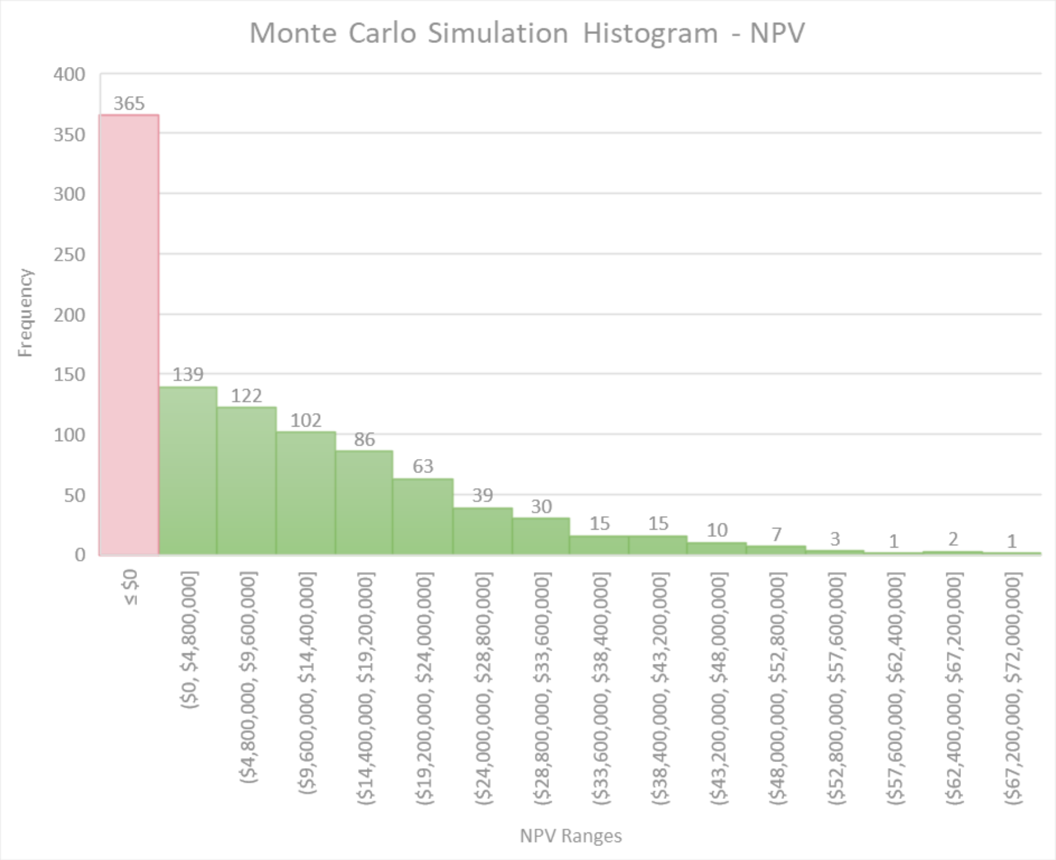
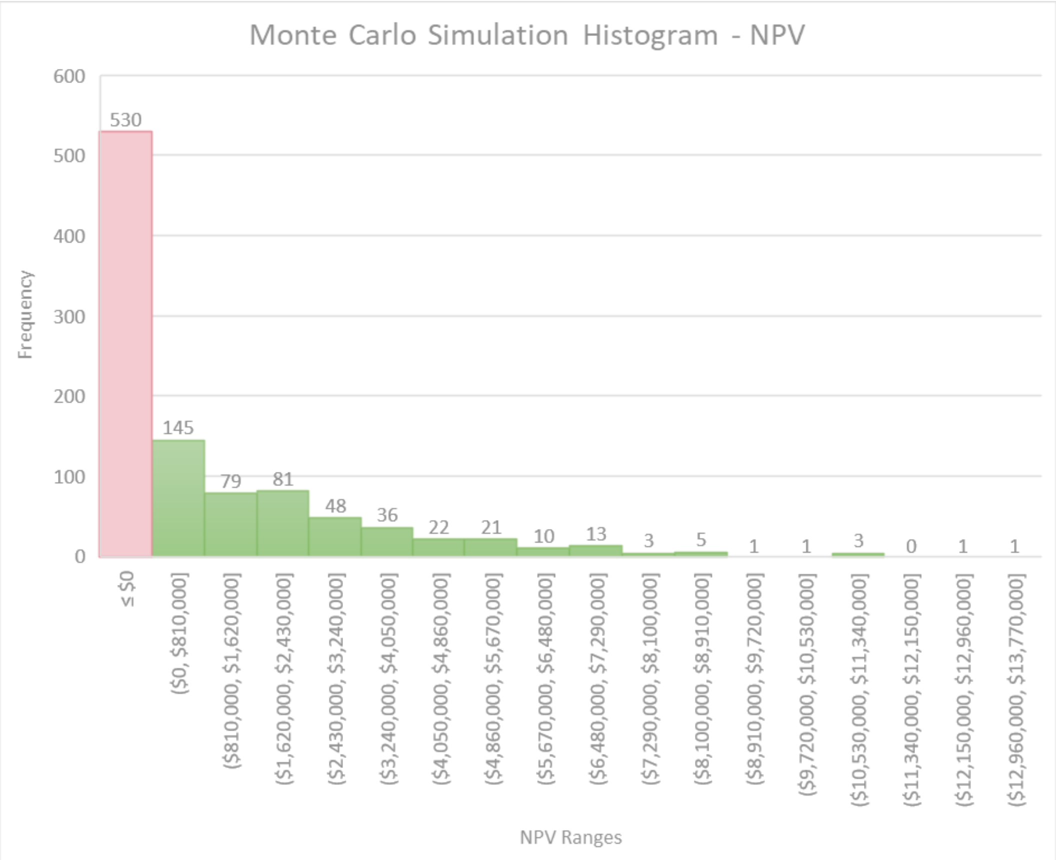


Figure 14: Monte Carlo output – NPV histogram for option 2 (house raising)



2.5 Findings and conclusion

Option 1 (levee) performs the strongest based on average BCR and NPV and Monte Carlo simulation results. It will protect the township against the 1 per cent AEP flood event. It provides the best value for money, with a BCR of 4.8, an NPV of $12.3 million, and a 77 per cent probability that the BCR will be greater than one. Producers capture most benefits, signifying that most properties protected are commercial.

Option 2 (house raising) has a BCR and NPV of 1.3 and $0.6 million, respectively. It protects eligible residential properties against the 1 per cent AEP flood event. The probability of the BCR being greater than one, however, is only 47 per cent. Benefits are primarily attributed to households, and a small proportion to Government due to reduced public infrastructure damage and reduced mental health impacts.

Option 3 (warning time) has a BCR and NPV of 1.1 and $0.6 million, respectively. While the average BCR and NPV results suggest the project may be economically feasible, the probability of the BCR being greater than one is only 36 per cent.

Option 4 (agricultural levee extension) has a BCR of 1.9 and NPV of $7.8 million. The additional cost of the levee extension, however, exceeds the additional benefits from protecting agricultural land, suggesting that the levee extension is not economically feasible.

2.5.1 Preferred option

Option 1 (levee) is the preferred option to meet the objective of reducing the severity and impact of floods in the area. It has the highest BCR and NPV and the highest probability of being economically feasible, suggesting that it is likely to provide the greatest overall benefit to the NSW community.

3 Local Government Area specific data

3.1 Properties – National Exposure Information System

Geoscience Australia has developed the National Exposure Information System (NEXIS) dataset which aims to capture exposure information for physical infrastructure assets and populations to enable users to understand the things at risk. This dataset is useful for deriving the value of infrastructure assets for a given project area.

Table 27[20] provides a summary of the structural and contents value across New South Wales, delineated to a Local Government Area (LGA) level. As an input to the Tool, and subsequently the stage-damage curves, data from Table 27 can be used for a given study area, as opposed to the standard parameters (2022 dollars, and subject to indexation in line with CPI), which are listed below:

- Detached single storey – $2,280 per m^2
- Detached double storey – $2,620 per m^2
- Multi-Unit – $2,730 per m^2
- Townhouse – $2,620 per m^2
- Contents value – $550 per m^2, for all property types.

If LGA-specific data is used, the regional uplift factor within the Tool needs to be set to 1.00. The values should be inserted into the Inputs tab. Further information is provided in Section 4.3 and Figure 21.

Table 27: NEXIS estimates – structural and contents value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Structural Value ($/m^2)				Contents Value ($/m^2)
	Detached Single Storey	Detached Double Storey	Multi-Unit	Townhouse	
Albury (C)	$1,839	$2,115	$2,207	$2,115	$223
Armidale Regional (A)	$2,274	$2,615	$2,729	$2,615	$387
Ballina (A)	$2,059	$2,368	$2,471	$2,368	$289
Balranald (A)	$2,389	$2,748	$2,867	$2,748	$350
Bathurst Regional (A)	$1,790	$2,058	$2,148	$2,058	$228
Bayside (A)	$2,546	$2,928	$3,056	$2,928	$455
Bega Valley (A)	$1,969	$2,265	$2,363	$2,265	$272
Bellingen (A)	$1,958	$2,252	$2,350	$2,252	$352
Berrigan (A)	$2,065	$2,375	$2,478	$2,375	$379
Blacktown (C)	$1,828	$2,102	$2,194	$2,102	$328

[20] ABS classifications: A-Area and C-City (for each LGA)

Table 27: NEXIS estimates – structural and contents value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Structural Value ($/m²)				Contents Value ($/m²)
	Detached Single Storey	Detached Double Storey	Multi-Unit	Townhouse	
Bland (A)	$1,985	$2,283	$2,382	$2,283	$341
Blayney (A)	$2,000	$2,300	$2,400	$2,300	$351
Blue Mountains (C)	$1,586	$1,824	$1,903	$1,824	$235
Bogan (A)	$2,335	$2,686	$2,802	$2,686	$347
Bourke (A)	$2,348	$2,700	$2,818	$2,700	$354
Brewarrina (A)	$2,338	$2,688	$2,805	$2,688	$319
Broken Hill (C)	$2,603	$2,994	$3,124	$2,994	$480
Burwood (A)	$2,454	$2,822	$2,944	$2,822	$417
Byron (A)	$2,035	$2,340	$2,442	$2,340	$299
Cabonne (A)	$1,930	$2,220	$2,316	$2,220	$297
Camden (A)	$1,725	$1,984	$2,070	$1,984	$305
Campbelltown (C)	$1,819	$2,092	$2,183	$2,092	$312
Canada Bay (A)	$2,542	$2,923	$3,050	$2,923	$451
Canterbury-Bankstown (A)	$2,069	$2,380	$2,483	$2,380	$362
Carrathool (A)	$1,997	$2,296	$2,396	$2,296	$328
Central Coast (C)	$1,815	$2,088	$2,178	$2,088	$300
Central Darling (A)	$2,368	$2,723	$2,841	$2,723	$332
Cessnock (C)	$2,071	$2,382	$2,485	$2,382	$428
Clarence Valley (A)	$2,001	$2,301	$2,401	$2,301	$324
Cobar (A)	$2,426	$2,790	$2,911	$2,790	$386
Coffs Harbour (C)	$1,873	$2,154	$2,248	$2,154	$244
Coolamon (A)	$1,967	$2,262	$2,360	$2,262	$328
Coonamble (A)	$2,333	$2,683	$2,799	$2,683	$326
Cootamundra-Gundagai Regional (A)	$2,034	$2,340	$2,441	$2,340	$372
Cowra (A)	$2,029	$2,333	$2,434	$2,333	$366

Table 27: NEXIS estimates – structural and contents value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Structural Value ($/m²)				Contents Value ($/m²)
	Detached Single Storey	Detached Double Storey	Multi-Unit	Townhouse	
Cumberland (A)	$2,115	$2,432	$2,538	$2,432	$366
Dubbo Regional (A)	$2,139	$2,460	$2,567	$2,460	$241
Dungog (A)	$1,869	$2,149	$2,242	$2,149	$301
Edward River (A)	$2,098	$2,412	$2,517	$2,412	$394
Eurobodalla (A)	$2,168	$2,493	$2,601	$2,493	$384
Fairfield (C)	$1,866	$2,145	$2,239	$2,145	$319
Federation (A)	$2,102	$2,417	$2,522	$2,417	$375
Forbes (A)	$2,034	$2,339	$2,440	$2,339	$368
Georges River (A)	$2,129	$2,448	$2,554	$2,448	$358
Gilgandra (A)	$2,326	$2,674	$2,791	$2,674	$337
Glen Innes Severn (A)	$2,134	$2,455	$2,561	$2,455	$345
Goulburn Mulwaree (A)	$2,058	$2,367	$2,469	$2,367	$389
Greater Hume Shire (A)	$1,960	$2,254	$2,352	$2,254	$328
Griffith (C)	$2,141	$2,462	$2,569	$2,462	$417
Gunnedah (A)	$2,183	$2,511	$2,620	$2,511	$366
Gwydir (A)	$2,086	$2,399	$2,503	$2,399	$299
Hawkesbury (C)	$1,822	$2,095	$2,186	$2,095	$338
Hay (A)	$2,506	$2,882	$3,007	$2,882	$387
Hilltops (A)	$1,991	$2,290	$2,390	$2,290	$340
Hornsby (A)	$1,786	$2,054	$2,144	$2,054	$267
Hunters Hill (A)	$1,840	$2,116	$2,208	$2,116	$290
Inner West (A)	$2,823	$3,246	$3,388	$3,246	$611
Inverell (A)	$2,155	$2,479	$2,586	$2,479	$361
Junee (A)	$2,024	$2,327	$2,428	$2,327	$374
Kempsey (A)	$2,052	$2,360	$2,463	$2,360	$392

Table 27: NEXIS estimates – structural and contents value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Structural Value ($/m²)				Contents Value ($/m²)
	Detached Single Storey	Detached Double Storey	Multi-Unit	Townhouse	
Kiama (A)	$2,297	$2,642	$2,757	$2,642	$458
Ku-ring-gai (A)	$1,661	$1,910	$1,993	$1,910	$236
Kyogle (A)	$2,134	$2,454	$2,561	$2,454	$323
Lachlan (A)	$1,995	$2,294	$2,394	$2,294	$347
Lake Macquarie (C)	$1,730	$1,989	$2,076	$1,989	$252
Lane Cove (A)	$2,366	$2,721	$2,840	$2,721	$361
Leeton (A)	$2,084	$2,397	$2,501	$2,397	$378
Lismore (C)	$1,999	$2,299	$2,399	$2,299	$234
Lithgow (C)	$2,061	$2,370	$2,473	$2,370	$401
Liverpool (C)	$1,894	$2,178	$2,273	$2,178	$334
Liverpool Plains (A)	$2,111	$2,427	$2,533	$2,427	$339
Lockhart (A)	$1,935	$2,225	$2,322	$2,225	$310
Maitland (C)	$1,753	$2,017	$2,104	$2,017	$232
Mid-Coast (A)	$2,041	$2,347	$2,449	$2,347	$337
Mid-Western Regional (A)	$2,004	$2,305	$2,405	$2,305	$347
Moree Plains (A)	$2,416	$2,778	$2,899	$2,778	$351
Mosman (A)	$2,431	$2,796	$2,917	$2,796	$405
Murray River (A)	$2,053	$2,361	$2,464	$2,361	$345
Murrumbidgee (A)	$1,974	$2,271	$2,369	$2,271	$335
Muswellbrook (A)	$2,261	$2,600	$2,713	$2,600	$417
Nambucca Valley (A)	$1,901	$2,186	$2,281	$2,186	$301
Narrabri (A)	$2,384	$2,742	$2,861	$2,742	$364
Narrandera (A)	$2,056	$2,364	$2,467	$2,364	$369
Narromine (A)	$2,300	$2,646	$2,761	$2,646	$333
Newcastle (C)	$1,948	$2,240	$2,338	$2,240	$301

Table 27: NEXIS estimates – structural and contents value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Structural Value ($/m²)				Contents Value ($/m²)
	Detached Single Storey	Detached Double Storey	Multi-Unit	Townhouse	
North Sydney (A)	$4,181	$4,809	$5,018	$4,809	$672
Northern Beaches (A)	$1,965	$2,260	$2,358	$2,260	$310
Oberon (A)	$1,944	$2,236	$2,333	$2,236	$307
Orange (C)	$1,779	$2,046	$2,135	$2,046	$225
Parkes (A)	$2,074	$2,385	$2,489	$2,385	$390
Parramatta (C)	$2,187	$2,515	$2,625	$2,515	$344
Penrith (C)	$1,828	$2,102	$2,194	$2,102	$302
Port Macquarie-Hastings (A)	$1,998	$2,298	$2,398	$2,298	$298
Port Stephens (A)	$2,015	$2,317	$2,418	$2,317	$324
Queanbeyan-Palerang Regional (A)	$1,971	$2,267	$2,365	$2,267	$270
Randwick (C)	$2,855	$3,283	$3,426	$3,283	$506
Richmond Valley (A)	$2,194	$2,523	$2,633	$2,523	$340
Ryde (C)	$2,139	$2,460	$2,567	$2,460	$341
Shellharbour (C)	$2,025	$2,329	$2,430	$2,329	$271
Shoalhaven (C)	$2,042	$2,348	$2,450	$2,348	$348
Singleton (A)	$1,987	$2,286	$2,385	$2,286	$360
Snowy Monaro Regional (A)	$2,055	$2,363	$2,466	$2,363	$326
Snowy Valleys (A)	$2,034	$2,339	$2,441	$2,339	$368
Strathfield (A)	$2,378	$2,735	$2,854	$2,735	$365
Sutherland Shire (A)	$1,903	$2,189	$2,284	$2,189	$302
Sydney (C)	$6,522	$7,500	$7,826	$7,500	$1,137
Tamworth Regional (A)	$1,991	$2,290	$2,389	$2,290	$257
Temora (A)	$2,016	$2,318	$2,419	$2,318	$365
Tenterfield (A)	$2,063	$2,372	$2,475	$2,372	$307

Table 27: NEXIS estimates – structural and contents value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Structural Value ($/m²)				Contents Value ($/m²)
	Detached Single Storey	Detached Double Storey	Multi-Unit	Townhouse	
The Hills Shire (A)	$1,718	$1,975	$2,061	$1,975	$282
Tweed (A)	$2,041	$2,347	$2,450	$2,347	$263
Upper Hunter Shire (A)	$2,141	$2,462	$2,569	$2,462	$338
Upper Lachlan Shire (A)	$1,942	$2,233	$2,330	$2,233	$301
Uralla (A)	$2,060	$2,369	$2,472	$2,369	$308
Wagga Wagga (C)	$1,830	$2,105	$2,197	$2,105	$237
Walcha (A)	$2,073	$2,384	$2,488	$2,384	$297
Walgett (A)	$2,341	$2,692	$2,809	$2,692	$340
Warren (A)	$2,366	$2,720	$2,839	$2,720	$349
Warrumbungle Shire (A)	$2,257	$2,595	$2,708	$2,595	$319
Waverley (A)	$3,427	$3,941	$4,113	$3,941	$638
Weddin (A)	$1,963	$2,257	$2,355	$2,257	$322
Wentworth (A)	$2,379	$2,736	$2,855	$2,736	$329
Willoughby (C)	$2,166	$2,491	$2,599	$2,491	$351
Wingecarribee (A)	$2,015	$2,318	$2,418	$2,318	$353
Wollondilly (A)	$1,858	$2,137	$2,230	$2,137	$404
Wollongong (C)	$1,864	$2,144	$2,237	$2,144	$260
Woollahra (A)	$2,817	$3,240	$3,380	$3,240	$511
Yass Valley (A)	$1,933	$2,223	$2,320	$2,223	$310
Unincorporated NSW	$2,287	$2,630	$2,745	$2,630	$286

3.2 Agriculture – Australian Bureau of Statistics

This section provides additional agriculture estimates at the local government level across New South Wales. Data displayed in Table 28[21] applies a consistent approach to the New South Wales level estimates outlined in Section 1.2.4.

Local Government Areas (LGA) with a metropolitan classification and categories that have less than 10 hectares of agricultural land have been excluded due to data quality concerns. The Australian Classification of Local Governments and Office of Local Government group numbers have been applied to classify each LGA into large rural, metropolitan, metropolitan fringe, regional town or city and rural.

Table 28: ABS estimates – crops and livestock value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Broadacre crops	Hay	Nurseries, cut flowers or cultivated turf	Fruit and nuts (excl. grapes)	Vegetables	*Total Crops*	*Total Livestock*
Albury	$1,049	$1,549	-	-	-	-	*$1,643*
Armidale Regional	$401	$1,277	$170,853	$31,782	-	*$193,071*	*$3,984*
Ballina	$1,087	$1,788	$257,505	$12,751	-	*$14,495*	*$12,362*
Balranald	$310	$485	-	$7,001	$20,946	*$28,289*	*$1,171*
Bathurst Regional	$250	$1,911	$74,890	$8,504	-	*$16,029*	*$2,751*
Bega Valley	$71	$1,765	$252,737	-	-	*$12,134*	*$9,430*
Bellingen	$771	$1,507	-	$70,030	-	*$19,573*	*$15,896*
Berrigan	$1,183	$1,405	-	$31,727	$8,887	*$34,724*	*$1,640*
Bland	$934	$1,267	-	$19,743	$8,311	*$19,528*	*$913*
Blue Mountains	-	$3,460	$491,208	$21,012	-	-	*$184,817*

[21] Agricultural commodity process can be highly variable, and the ABS can be consulted for up-to-date prices. See https://www.abs.gov.au/statistics/industry/agriculture/value-agricultural-commodities-produced-australia/latest-release for more information.

Table 28: ABS estimates – crops and livestock value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Broadacre crops	Hay	Nurseries, cut flowers or cultivated turf	Fruit and nuts (excl. grapes)	Vegetables	*Total Crops*	*Total Livestock*
Bogan	$1,080	$1,295	-	-	-	-	*$922*
Byron	$443	-	$323,119	$9,066	-	*$42,453*	*$13,159*
Cabonne	$784	$1,933	-	$71,999	$1,986	*$22,561*	*$1,598*
Camden	$49	$5,112	$183,276	$60,846	-	*$66,569*	*$47,237*
Campbelltown	-	$9,736	-	-	-	-	*$70,974*
Carrathool	$1,301	$1,173	$248,940	$21,001	$8,416	*$19,559*	*$1,764*
Central Coast	-	$653	$159,714	$13,873	-	*$60,500*	*$47,209*
Central Darling	$443	$1,198	-	$22,322	-	*$928*	*$307*
Clarence Valley	$1,643	$1,413	$108,806	$34,426	-	*$13,124*	*$4,350*
Cobar	$559	$695	-	-	-	-	*$247*
Coffs Harbour	$98	$1,480	$263,223	$101,175	-	*$130,514*	*$95,446*
Coolamon	$1,071	$1,568	$83,892	-	$3,114	*$36,593*	*$1,168*
Cowra	$882	$2,395	$182,683	$1,411	$4,544	*$33,312*	*$2,114*
Dubbo Regional	$716	$1,458	$64,061	$5,096	$825	*$6,046*	*$691*
Dungog	$61	$2,821	-	$1,038	-	*$8,805*	*$3,879*
Edward River	$881	$1,286	$258,711	$22,942	$12,071	*$108,783*	*$1,060*

Table 28: ABS estimates – crops and livestock value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Broadacre crops	Hay	Nurseries, cut flowers or cultivated turf	Fruit and nuts (excl. grapes)	Vegetables	*Total Crops*	*Total Livestock*
Eurobodalla	$165	$1,747	$72,046	-	-	-	*$17,923*
Federation	$1,135	$1,773	$420,626	$5,273	-	-	*$1,229*
Forbes	$926	$2,610	-	$1,455	-	*$28,437*	*$1,035*
Gilgandra	$817	$1,216	-	-	-	*$67,065*	*$789*
Glen Innes Severn	$356	$1,671	-	-	-	*$31,024*	*$870*
Goulburn Mulwaree	$377	$1,823	-	$1,363	-	*$35,288*	*$1,386*
Greater Hume Shire	$1,119	$1,710	-	$82,321	$502	-	*$1,514*
Griffith	$1,351	$1,178	$252,613	$24,513	$8,911	*$19,527*	*$2,338*
Gwydir	$832	$890	-	$13,184	-	-	*$711*
Hawkesbury	$21	$1,206	$65,057	$17,838	-	*$89,092*	*$77,802*
Hay	$2,863	$1,733	-	-	-	*$26,449*	*$1,538*
Hilltops	$1,090	$1,728	-	$17,497	$3,312	-	*$1,401*
Hornsby	-	-	$285,419	$24,519	-	*$31,520*	*$119,469*
Inverell	$613	$777	-	$29,714	$241	-	*$550*
Junee	$1,127	$1,486	-	$84	$2,689	-	*$1,300*
Kempsey	$44	$2,558	$177,703	$31,747	-	*$302,511*	*$14,183*

Table 28: ABS estimates – crops and livestock value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Broadacre crops	Hay	Nurseries, cut flowers or cultivated turf	Fruit and nuts (excl. grapes)	Vegetables	*Total Crops*	*Total Livestock*
Kiama	$39	$764	-	-	$1,711	-	*$2,470*
Kyogle	$863	$2,038	$141,834	$34,796	-	-	*$2,401*
Lachlan	$793	$1,657	-	-	-	*$23,612*	*$579*
Lake Macquarie	-	-	$190,562	-	-	-	*$51,867*
Leeton	$1,157	$2,042	-	$32,390	$7,971	*$19,526*	*$4,357*
Lismore	$984	$1,854	$469,616	$9,505	-	*$39,158*	*$5,949*
Liverpool Plains	$1,632	$1,973	-	$14,570	$1,596	-	*$1,613*
Lockhart	$1,081	$1,597	$84,234	$4,225	$3,106	*$36,587*	*$1,221*
Maitland	$509	$2,452	$59,430	-	$1,922	*$7,969*	*$16,777*
Mid-Coast	$110	$1,725	$100,467	$10,816	-	*$20,642*	*$2,651*
Mid-Western Regional	$382	$1,997	-	$4,343	$1,552	-	*$678*
Murray River	$832	$1,234	$234,791	$15,443	$17,193	*$105,364*	*$1,065*
Murrumbidgee	$1,233	$1,343	$281,740	$22,710	$8,458	*$27,122*	*$1,708*
Nambucca Valley	-	$3,069	$111,530	$28,179	-	*$70,812*	*$18,920*
Narrandera	$954	$1,118	$265,591	$6,786	$8,416	*$19,567*	*$1,068*
Narromine	$1,206	$1,511	$337,930	$22,168	-	*$21,713*	*$1,162*

Table 28: ABS estimates – crops and livestock value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Broadacre crops	Hay	Nurseries, cut flowers or cultivated turf	Fruit and nuts (excl. grapes)	Vegetables	*Total Crops*	*Total Livestock*
Oberon	$254	$1,346	-	-	-	*$41,903*	*$1,124*
Orange	$411	$981	-	$56,731	$2,007	-	*$3,448*
Parkes	$896	$1,535	-	$3,743	-	-	*$821*
Penrith	$199	$1,222	$112,196	$33,199	-	*$64,547*	*$49,072*
Port Macquarie-Hastings	$103	$816	-	$14,720	$817	-	*$1,932*
Port Stephens	$9	$2,878	-	$1,470	-	-	*$2,259*
Queanbeyan-Palerang Regional	$312	$2,306	-	$1,674	-	*$59,851*	*$1,634*
Richmond Valley	$1,285	$2,116	$151,417	$15,082	-	*$67,029*	*$1,827*
Shellharbour	-	$1,493	-	-	-	-	*$3,485*
Shoalhaven	$147	$1,245	$60,368	$9,711	$1,231	-	*$5,247*
Singleton	$122	$2,879	-	$1,855	$1,962	*$28,829*	*$2,429*
Snowy Monaro Regional	$287	$1,706	-	$2,777	$103	*$44,328*	*$1,078*
Tamworth Regional	$445	$1,623	$59,499	-	$12	-	*$624*
Tenterfield	$611	$2,065	$237,624	$13,239	-	*$25,386*	*$4,812*
The Hills Shire	$2	$3,473	$245,442	$13,063	-	*$47,866*	*$115,546*
Tweed	$3,361	$1,385	$204,812	$19,159	-	*$40,222*	*$12,647*

Table 28: ABS estimates – crops and livestock value for each LGA in New South Wales (2022 dollars)

NSW Local Government Area	Broadacre crops	Hay	Nurseries, cut flowers or cultivated turf	Fruit and nuts (excl. grapes)	Vegetables	*Total Crops*	*Total Livestock*
Upper Hunter Shire	$456	$3,388	-	$2,998	$24	-	*$670*
Upper Lachlan Shire	$432	$1,909	-	$1,558	$2,092	*$57,444*	*$1,436*
Uralla	$410	$1,046	-	$38,522	$38	-	*$625*
Wagga Wagga	$1,072	$1,605	$70,305	$3,960	$2,923	*$36,592*	*$1,237*
Warren	$988	$1,117	-	$20,098	$63	*$37,447*	*$895*
Weddin	$996	$1,627	-	$1,166	-	*$30,272*	*$1,082*
Wentworth	$299	$524	$124,149	$14,111	$21,339	*$45,879*	*$1,944*
Wingecarribee	$653	$1,369	$193,207	$3,001	$1,147	*$24,911*	*$6,900*
Wollondilly	$144	$1,717	$186,299	$21,373	-	*$30,867*	*$25,680*
Wollongong	-	$924	-	$36,558	-	-	*$71,448*
Yass Valley	$523	$1,538	-	$39,904	$2,209	*$171,378*	*$1,335*
Unincorporated NSW	$443	$1,198	-	$22,322	$11,646	*$927*	*$308*

If the LGA-specific dollar values in Table 28 are to be used in the Tool, as opposed to the default values, they are inserted into the Inputs tab. Further information is provided in Section 4.3 and Figure 24.

4 User manual

This user manual provides guidance to assist application of the Tool. It is not intended to be exhaustive and is complemented by the Flood Risk Management Measures Guideline MM01.

An outline of all user inputs is provided in Table 29 and is followed by further details on each of the steps. Screenshots from application to the case study are provided to aid understanding.

Columns or rows should not be inserted into the Tool, as this disrupts the structure of the Tool and can lead to incorrect calculations.

Table 29: Flood CBA Tool steps and inputs

Step and Tab	User Input
1. Project Details	• Administrative information about the project • Version history and version control
2. Inflation	Latest available figures from the Australian Bureau of Statistics (ABS) and their associated calendar year and quarter.
3. Inputs	• AEP events modelled • Base year of analysis (e.g. 2023) • Various project-specific inputs required to calculate damage (standard parameters will be applied if left unchanged)
4. BaseCase 5. Option[#]	• Property data (including ground level and floor level) • Flood levels for each AEP event modelled • Hazard categories (H1-H6) for each AEP event modelled
6. Option[#]_Calc	• Project completion year • Cost profile (capital expenditure and operating expenditure, e.g., maintenance) • Residual value
7. Agriculture	• Land parcel data and associated agricultural commodity • Agricultural area inundated • Duration of inundation
8. MonteCarlo_Sim	Optional user-defined scenarios (2-5)
9. MC_CBA	• Project completion year • Capital and recurrent costs • Residual value • Optional user-defined scenarios (2-5)
10. Bespoke	Additional project-specific values and outputs that can feed into the results of the CBA.

4.1 Project Details

The Project Details tab contains administrative details about the project, as well as a table for version control (Figure 15). It does not impact the results.

Figure 15: Project Details tab layout

Project Name:	**Disaster Cost Benefit Framework - Flood CBA Tool Case Study**
Job Number:	N/A
Date:	02-June-2023
Client:	N/A
Client Reference:	N/A
Details:	A case study consisting of a mix of real and hypothetical data to illustrate the use of this tool.
Current Spreadsheet Version:	2

Version History				
Version	**Effective Date**	**Prepared by:**	**Reviewed by:**	**Description / Updates / Changes**
0	13-Mar-23	**AS**	**TSY**	Initial setup
1	26-Apr-23	**AS**	**TSY**	QA check
2	02-Jun-23	**AS**		Final
[Insert, as appropriate]				

4.2 Inflation

The Inflation tab (Figure 16) ensures all dollar values, including the overall damage results, are in current prices. The latest data needs to be input using the ABS series ID and hyperlinks provided for Consumer Price Index (CPI). The corresponding calendar year and quarter (1, 2, 3 or 4) also need to be inputted. All dollar figures within the Tool are indexed to the December 2022 quarter by default (i.e. if no inflation is applied). The inflation calculator also provides reverse compatibility (i.e. deflates prices), up to the year 1970.

Figure 16: Inflation tab layout

Inflation: Consumer Price Index (CPI)

This converts the dollar values used within this spreadsheet to a different calendar year.

Update cell F8 with the quarter at the time of the study. No other cells need to be changed.

	Calendar Year	Quarter	CPI Level	Inflation Rate
Baseline dollar values:	2022	4	130.9	1.38%
Analysis dollar values:	2023	1	132.7	

CPI Sydney level at the end of every calendar year since 1970

Dec-2019	**117.1**	Dec-2009	**94.4**	Dec-1999	**69.7**	Dec-1989	**55.4**	Dec-1979	**24.7**
Dec-2018	**115.2**	Dec-2008	**92.4**	Dec-1998	**68.4**	Dec-1988	**51.6**	Dec-1978	**22.4**
Dec-2017	**113.3**	Dec-2007	**89.1**	Dec-1997	**67.1**	Dec-1987	**47.2**	Dec-1977	**20.7**
Dec-2016	**110.9**	Dec-2006	**87.0**	Dec-1996	**67.2**	Dec-1986	**44.1**	Dec-1976	**19.1**
Dec-2015	**108.9**	Dec-2005	**84.3**	Dec-1995	**66.1**	Dec-1985	**40.2**	Dec-1975	**16.9**
Dec-2014	**106.8**	Dec-2004	**82.3**	Dec-1994	**62.4**	Dec-1984	**37.1**	Dec-1974	**14.9**
Dec-2013	**105.0**	Dec-2003	**80.2**	Dec-1993	**60.8**	Dec-1983	**36.2**	Dec-1973	**12.8**
Dec-2012	**102.3**	Dec-2002	**78.4**	Dec-1992	**60.0**	Dec-1982	**33.7**	Dec-1972	**11.3**
Dec-2011	**99.8**	Dec-2001	**76.3**	Dec-1991	**59.8**	Dec-1981	**30.1**	Dec-1971	**10.8**
Dec-2010	**96.7**	Dec-2000	**73.8**	Dec-1990	**58.9**	Dec-1980	**27.1**	Dec-1970	**9.9**

Please input the latest annual CPI Sydney values from the ABS (quarter and annual)

Source: 6401.0 - Consumer Price Index, Australia

https://www.abs.gov.au/statistics/economy/price-indexes-and-inflation/consumer-price-index-australia/latest-release

Current Year: 2023

End of Year	CPI Level	Quarter	CPI Level
Dec-2020	**118.0**	Mar-2023	**132.7**
Dec-2021	**121.6**	Jun-2023	
Dec-2022	**130.9**	Sep-2023	
Dec-2023		Dec-2023	
Dec-2024			
Dec-2025			
Dec-2026			

Next Release 26/07/2023

The dollar values of the case study have been indexed to the March 2023 quarter.

4.3 Inputs

The first user input is the range of AEPs that have been assessed in the hydraulic flood model for a project. Up to nine AEPs can be input alongside the Probable Maximum Flood (PMF), as displayed in Figure 17.

Figure 17: Inputs tab – AEPs assessed, and road area inundated

Flood Events Assessed			
Please input up to nine flood event AEPs (without any gaps) to be assessed alongside the Probable Maximum Flood (PMF). Any surplus event rows or columns can be hidden throughout the spreadsheet but should not be deleted.	*#*	**AEP**	**ARI**
	1	0.001%	PMF
	2	0.2%	500
	3	0.5%	200
	4	1%	100
	5	2%	50
Note:	*6*	5%	20
*- **AEP** : Annual Exceedance Probability*	*7*	10%	10
*- **ARI** : Average Recurrence Interval*	*8*	20%	5
	9	50%	2
Please set unused AEPs to 100%.	*10*	100%	1

The parameters defined in the Inputs tab impact the overall stage-damage curves and results output. Default values have been provided for each parameter, in line with the Framework. Flood Risk Management Measures Guideline MM01 (NSW Department of Planning and Environment, 2023b) has also been heavily consulted in the production of the Tool.

The following figures[22] display the default values attributed to each parameter in the Inputs tab, within the context of the case study:

- Figure 18: Inputs tab – general factors
- Figure 19: Inputs tab – AAD calculation parameters (years and discount rates)
- Figure 20: Inputs tab – property sizes in terms of floor area
- Figure 21: Inputs tab – structural, internal and external damage (unit values)
  - The LGA-specific values presented in Table 27 can be used to replace the default structural and internal dollar values.
- Figure 22: Inputs tab – indirect damage parameters
- Figure 23: Inputs tab – risk-to-life methodology, including:
  - speed of onset
  - primary nature of area
  - warning system
  - warning time
  - education level
  - people vulnerability factor, derived from disability proportion and residents aged over 75.
- Figure 24: Inputs tab – agriculture.

Figure 18: Inputs tab – general factors

Actual to Potential Ratio	0.9	*0.9 recommended, as per the accompanying report*
Regional Uplift Factor	1.05	*Default 1.00. Please see guidance in "NSW" tab*
Infrastructure Damages Uplift	10%	***10%** of res. damages, or **5%** if road area is known*
Emergency Management Uplift	0%	*Applied to the total damages, 0% by default*
Damage Downscale (Townhouse or Units)	30%	*30% reduction in structural damage*
Road repair cost	$5.65	*per square metre*
Relocation Cost	$0	*per week ($0 by default)*

[22] Each dollar value displayed in this set of figures is indexed to December 2022.

Figure 19: Inputs tab – AAD calculation parameters (years and discount rates)

Base Year of Assessment	2023		
Total Length of Assessment	30	years	
AAD Fixed Annual Growth Rate:	0%	p.a.	*(Recommended to keep at zero percent p.a.)*
Discount Rate: Primary	**5%**	p.a.	*based on NSW Treasury Guidelines*
Discount Rate Sensitivity: Lower	3%	p.a.	*based on NSW Treasury Guidelines*
Discount Rate Sensitivity: Higher	7%	p.a.	*based on NSW Treasury Guidelines*

Figure 20: Inputs tab – property sizes in terms of floor area

Property sizes (floor area, m^2)

Typical Size (m^2)	**Small**	**Medium**	**Large**	**Recommended Default**	**Unit**	**Townhouse**
Detached Dwelling (Single Storey House)	90	180	240	220	100	160
Detached Dwelling (Double Storey House)	90	180	240	220	100	160

Typical Size (m^2)	**Average**	**Low to Medium**	**Medium to High**	**Schools**	**Hospitals**	**Other Public Buildings**
Non-residential buildings	418	186	650	17,000	28,000	2,200

Figure 21: Inputs tab – structural, internal and external damage (unit values)

Structural

Replacement Value per m^2	**Small**	**Medium**	**Large**	**Default**	**Unit**	**Townhouse**
Detached Dwelling (Single Storey House)	$2,280	$2,280	$2,280	$2,280	$2,730	$2,620
Detached Dwelling (Double Storey House)	$2,620	$2,620	$2,620	$2,620	$2,730	$2,620

Internal / Contents - Residential properties

Average contents ($)	$550	*per square metre, for residential properties*

External

External Damages Depth Threshold (metres)	0.30	*0.3 metres by default*
External Damages	$17,000	*Constantly applied to residential properties*

Figure 22: Inputs tab – indirect damage parameters

Indirect

Residential Clean-up Costs	$4,500	*Per property, applied if overfloor flooding exists*
Non-residential Indirect Costs	30%	*of direct damages; cleanup costs + loss of trading*

Figure 23: Inputs tab – risk-to-life methodology

Risk-to-Life

Estimated Cost per Fatality	$ 5,300,000	*Taken from the Office of Best Practice Regulation (Australian Government)*
Estimated Cost per Injury	$ 52,962	
N[z] (average people per household)	2.1	*Obtained from ABS*

Hazard Rating (HR) *Ranges from 0 to 4, based on Hazard Classification (H1-H6)*

Hazard Category	1	2	3	4	5	6
Hazard Rating (HR)	0	0	0.3	0.8	2.8	4.0

	Value	Options	1	2	3
Speed of Onset	1	*{1,2,3}*	Rate of rise is very gradual (many hours)	Rate of rise around and hour or so	Rate of rise less than 1 hour
Primary Nature of Area	2	*{1,2,3}*	Multi-Storey apartments	Detached residential dwellings	Caravan parks, schools, campsite

Effective Warning Time (hours)	2

	Value	Options	0	0.5	1
P1	0.5	*{0,0.5,1}*	No effective warning system.	Warning system in place, will reach 40% of flood affected population.	Warning system in place, will reach 80% of flood affected population.
P2	0	*{0,1}*	0 – 2 hour warning time		> 2 hours warning
P3	0	*{0,1}*	No education program or understanding of flood warnings		Well educated community on flood warnings and actions to undertake

Flood Warning Factor	3.0	*3 − (P1 × (P2 + P3)) [calculated from above]*
Area Vulnerability (AV)	6.00	*Speed of onset + Primary nature of area + flood warning factor*
People Vulnerability (PV)	36%	*{% residents suffering any disability [17.7%] + % aged 75+}, obtained from ABS census data for a particular area*

Figure 24: Inputs tab – agriculture

Agriculture

The estimated damage to agriculture, including crops and livestock output.

Agriculture Commodity	$ per Hectare
Broadacre Crops	**$996**
Hay	**$1,584**
Nurseries, Cut Flowers, or Cultivated Turf	**$141,442**
Fruits and Nuts (excl. grapes)	**$21,216**
Grapes	**$10,274**
Vegetables	**$47,115**
Crops – Total	**$1,223**
Livestock – Total	**$180**

The figures provided here can be adjusted to suit a particular region or area (such as SA4 or LGA). Appropriate justification needs to be provided if deviating from these default values.

4.3.1 Bespoke elements

The Tool contains a separate tab for bespoke elements which may be used for project-specific items not covered by the Inputs tab. A non-exhaustive list of these items includes:

- emergency costs
- vehicle damage
- additional clean-up costs (e.g. asbestos)
- capital equipment (e.g. machinery)
- other infrastructure
- agricultural fencing (including external and internal).

The damage incurred by all bespoke items needs to be estimated for each AEP and added into the Tool for a final AAD calculation.

4.4 Base Case (Properties)

The BaseCase tab holds the largest amount of information in the Tool and uses the Inputs tab to calculate flood damage on a per-property basis. Columns A to AE require a user input from Row 19 onwards, with one row representing one property. There is also an option to insert the road area inundated (if known) in each AEP, in cell range L11:U11.

Table 30, as well as the snapshot in Figure 26 summarises the inputs required. After Column AE, this tab does not require any other inputs.

Table 30: BaseCase tab – user inputs

Column and Title		User Input
A	*ID*	Unique identifier for the property.
B–C	*Address and Suburb*	Property address and suburb.
D	*Notes*	Any general information about the property (e.g. building material).
E	*Storeys*	The number of storeys, noting that any property with more than one storey will be treated as a two storey property in the Tool.
F	*Floor Level*	The surveyed[23] floor level (mAHD) for the property.
G	*Ground Level*	The surveyed ground level (mAHD) for the property, which can be obtained through property survey or LiDAR.
H	*Type*	Property classification, as per the table in cell range B8:I12 (see Figure 25).
I	*Ground Floor Units*	The number of units on the ground floor of multi-unit buildings, otherwise set by default to one.
J	*Size*	The qualitative size of the property, set to small, medium, large, default, units or townhouse.

[23] If property survey is not available, this can be estimated by using assumptions

Column and Title		User Input
K	*Area (m²)*	The floor area (m²) of the property, particularly important for commercial buildings as the overall damage is a function of the area.
L–U	*Flood Levels*	The flood level at each property for each AEP, determined by sampling the property points with flood modelling results.
V–AE	*Hazard Category (H1-H6)*	The hazard category at each property for each AEP, determined by sampling the property points with flood modelling results.

Figure 25: BaseCase tab – property types

Property Types (Codes for column H)							
Occupied Residential		**Commercial**		**Area (m²)**	**Public Buildings**		**Area (m²)**
Single storey	*1*	Default Average	*5*	418	School	*8*	17,000
Double storey	*2*	Low to Medium	*6*	186	Hospital	*9*	28,000
Multi-Unit	*3*	Medium to High	*7*	650	Other	*10*	2,200
Townhouse	*4*						

Figure 26: BaseCase tab – property inputs

Property Data

Input property data (columns A to K), flood levels (column L to U), and hazard categories if available (columns V to AE). This will feed into the calculation of flood damages.

To extend the formulas down for the complete dataset, please highlight and drag down the last row in this worksheet for enough to include all properties prior to adding property data and levels.

Base Case or Option Number & Description: **Base Case - Existing**

Actual to Potential Ratio: 0.9 *Downscales the internal damages.*

Effective Warning Time: 2 *hours*

Speed of Onset	1	*{1,2,3}*
Primary Nature of Area	2	*{1,2,3}*
Warning system - P1	0.5	*{0,0.5,1}*
Warning time - P2	0	*{0,1}*
Education - P3	0	*{0,1}*
Flood Warning Factor	3.0	*3 − (P1 × (P2 + P3)) [calculated from above]*

Please see the Inputs tab (row 82 to 89) for calculation details

Property Types (Codes for column H)							
Occupied Residential		Commercial		Area (m²)	Public Buildings		Area (m²)
Single storey	*1*	Default Average	*5*	418	School	*8*	17,000
Double storey	*2*	Low to Medium	*6*	186	Hospital	*9*	28,000
Multi-Unit	*3*	Medium to High	*7*	650	Other	*10*	2,200
Townhouse	*4*						

Floods Assessed										
AEP	0.001%	0.2%	0.5%	1%	2%	5%	10%	20%	50%	100%
ARI	PMF	500	200	100	50	20	10	5	2	1
Road area inundated (m²)										

Res. Lookup	*4*	*5*	*6*	*7*	*8*	*9*
Res. Size	Small	Medium	Large	Default	Units	Townhouse
Area (m²)	90	180	240	220.0	100	160

Hazard category (H1-H6) input that feeds into the Risk to Life calculation. These columns (or particular AEPs) can be left blank and hidden if not required, or if Hazard data is unavailable.

Total number of properties: 545

ID	Address	Suburb	Notes (E.g. foundation or material (or leave blank))	Storeys	Floor Level (m AHD)	Ground Level (m AHD)	*Type (cells B8 - I12)*	*Ground Floor Units* (Number of ground floor units, if applicable, otherwise = 1)	*Size (cells K14 - Q15)* (Use the default size if no data is available.)	Area (m²) (Enter values if known)
45	-	-	-		93.03	92.75	5	1	Default	418
46	-	-	-		92.83	92.74	5	1	Default	418
47	-	-	-		92.86	92.67	5	1	Default	418
48	-	-	-		92.81	92.73	5	1	Default	418
49	-	-	-		92.81	92.68	5	1	Default	418
50	-	-	-		92.82	92.56	8	1	Default	17,000
51	-	-	-		92.85	92.41	5	1	Default	418
52	-	-	-		92.76	92.35	5	1	Default	418
53	-	-	-		92.62	92.23	5	1	Default	418
54	-	-	-		93.81	93.41	5	1	Default	418
55	-	-	-		93.45	93.14	1	1	Default	220
56	-	-	-		93.45	93.14	1	1	Default	220
57	-	-	-		93.33	93.02	5	1	Default	418
58	-	-	-		93.39	93.24	5	1	Default	418
59	-	-	-		93.48	92.99	5	1	Default	418
60	-	-	-		93.21	92.94	5	1	Default	418
61	-	-	-		92.50	92.33	5	1	Default	418

ID	Flood Level at Property (m AHD) for each AEP Flood: PMF	0.2%	0.5%	1%	2%	5%	10%	20%	50%	100%
45	101.67	96.49	94.64	93.63	93.22	0.00	0.00	0.00	0.00	0.00
46	101.67	96.49	94.64	93.64	93.22	0.00	0.00	0.00	0.00	0.00
47	101.67	96.48	94.64	93.63	93.20	0.00	0.00	0.00	0.00	0.00
48	101.67	96.49	94.64	93.64	93.21	0.00	0.00	0.00	0.00	0.00
49	101.67	96.48	94.63	93.62	93.18	0.00	0.00	0.00	0.00	0.00
50	101.67	96.48	94.64	93.62	93.18	0.00	0.00	0.00	0.00	0.00
51	101.66	96.48	94.64	93.62	93.18	92.51	0.00	0.00	0.00	0.00
52	101.66	96.48	94.63	93.57	93.12	92.48	0.00	0.00	0.00	0.00
53	101.66	96.48	94.62	93.53	93.08	92.45	0.00	0.00	0.00	0.00
54	101.67	96.50	94.70	93.95	93.59	0.00	0.00	0.00	0.00	0.00
55	101.67	96.51	94.77	94.19	93.84	93.28	0.00	0.00	0.00	0.00
56	101.67	96.51	94.77	94.19	93.84	93.28	0.00	0.00	0.00	0.00
57	101.67	96.52	94.80	94.23	93.86	93.27	0.00	0.00	0.00	0.00
58	101.67	96.50	94.74	94.09	93.73	0.00	0.00	0.00	0.00	0.00
59	101.67	96.50	94.71	93.98	93.63	0.00	0.00	0.00	0.00	0.00
60	101.67	96.50	94.70	93.93	93.55	0.00	0.00	0.00	0.00	0.00
61	101.67	96.52	94.81	94.25	93.86	93.27	92.97	0.00	0.00	0.00

ID	Hazard Category (H1 - H6): PMF	0.2%	0.5%	1%	2%	5%	10%	20%	50%	100%
45	6	3	3	3	2	0	0	0	0	0
46	6	3	3	3	2	0	0	0	0	0
47	6	3	3	3	2	0	0	0	0	0
48	6	3	3	3	2	0	0	0	0	0
49	6	3	3	3	3	0	0	0	0	0
50	6	3	3	3	3	0	0	0	0	0
51	6	4	4	4	3	1	0	0	0	0
52	6	3	3	3	3	1	0	0	0	0
53	6	4	4	4	3	1	0	0	0	0
54	6	3	3	3	1	0	0	0	0	0
55	6	4	4	4	3	1	0	0	0	0
56	6	4	4	4	3	1	0	0	0	0
57	6	4	4	4	3	1	0	0	0	0
58	6	3	3	3	2	0	0	0	0	0
59	6	3	3	3	3	0	0	0	0	0
60	6	3	3	3	3	0	0	0	0	0
61	6	4	4	4	4	3	3	0	0	0

Prior to pasting in any data, the final row in the BaseCase tab should be 'dragged down' as far as need be (i.e. the total number of properties), so that pre-filled cell formulas are appropriately applied to all properties within the dataset.

4.4.1 Results

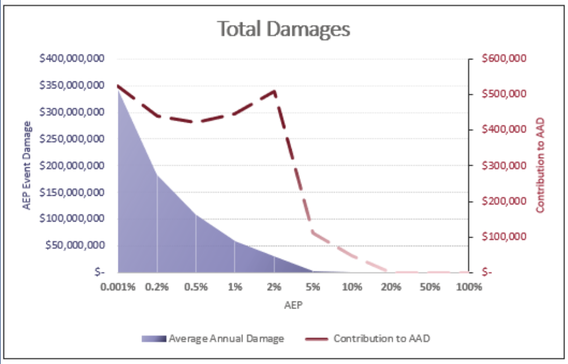
The results of the Base Case property analysis are presented in the BaseCase_Calc tab, delineated by structural, external, internal and intangibles. The overall result is derived from the sum of each category and displayed in Figure 27. Additional charts and tables associated with the base case are presented in the Outputs tab (Figure 28).

Figure 27: BaseCase_Calc tab – overall result

Annual Average Damage (AAD) Calculation

The AAD is defined as the area under the damage probability curve.

Annual Exceedence Probability	AEP Event Damage	Contribution to AAD	Number of Properties	Notes
0.001%	$343,081,128	$524,016	481	
0.2%	$183,568,239	$439,718	229	
0.5%	$109,577,094	$420,893	159	
1%	$58,779,911	$444,948	126	
2%	$29,986,648	$507,831	107	
5%	$3,447,699	$111,247	40	
10%	$976,537	$48,827	10	
20%	$0	$0	2	
50%	$0	$0	0	
100%	$0		0	
TOTAL AAD		$ 2,497,479		



^ The contribution to AAD and Total AAD include intangible social impacts. These are not included in the AEP event damage values as this only includes intangible risk to life damages, amongst the other categories (structural, internal, external).

Discount Rates based on NSW Treasury Guidelines.

Year	AAD	Discount Rates 3%	Discount Rates 5%	Discount Rates 7%	Year	AAD	Discount Rates 3%	Discount Rates 5%	Discount Rates 7%
1	$2,497,479	$2,424,737	$2,378,551	$2,334,092	26	$2,497,479	$1,158,068	$702,393	$430,055
2	$2,497,479	$2,354,113	$2,265,287	$2,181,395	27	$2,497,479	$1,124,338	$668,946	$401,920
3	$2,497,479	$2,285,547	$2,157,416	$2,038,687	28	$2,497,479	$1,091,590	$637,091	$375,626
4	$2,497,479	$2,218,978	$2,054,682	$1,905,315	29	$2,497,479	$1,059,796	$606,753	$351,053
5	$2,497,479	$2,154,347	$1,956,840	$1,780,668	30	$2,497,479	$1,028,928	$577,860	$328,087
6	$2,497,479	$2,091,599	$1,863,657	$1,664,176	~~31~~	-	$0	$0	$0
7	$2,497,479	$2,030,679	$1,774,912	$1,555,304	~~32~~	-	$0	$0	$0
8	$2,497,479	$1,971,533	$1,690,392	$1,453,555	~~33~~	-	$0	$0	$0
9	$2,497,479	$1,914,110	$1,609,897	$1,358,463	~~34~~	-	$0	$0	$0
10	$2,497,479	$1,858,359	$1,533,235	$1,269,592	~~35~~	-	$0	$0	$0
11	$2,497,479	$1,804,232	$1,460,224	$1,186,534	~~36~~	-	$0	$0	$0
12	$2,497,479	$1,751,681	$1,390,690	$1,108,910	~~37~~	-	$0	$0	$0
13	$2,497,479	$1,700,662	$1,324,466	$1,036,365	~~38~~	-	$0	$0	$0
14	$2,497,479	$1,651,128	$1,261,397	$968,565	~~39~~	-	$0	$0	$0
15	$2,497,479	$1,603,037	$1,201,330	$905,201	~~40~~	-	$0	$0	$0
16	$2,497,479	$1,556,346	$1,144,124	$845,982	~~41~~	-	$0	$0	$0
17	$2,497,479	$1,511,016	$1,089,642	$790,638	~~42~~	-	$0	$0	$0
18	$2,497,479	$1,467,006	$1,037,754	$738,914	~~43~~	-	$0	$0	$0
19	$2,497,479	$1,424,277	$988,337	$690,574	~~44~~	-	$0	$0	$0
20	$2,497,479	$1,382,793	$941,274	$645,396	~~45~~	-	$0	$0	$0
21	$2,497,479	$1,342,518	$896,451	$603,174	~~46~~	-	$0	$0	$0
22	$2,497,479	$1,303,415	$853,763	$563,714	~~47~~	-	$0	$0	$0
23	$2,497,479	$1,265,452	$813,107	$526,835	~~48~~	-	$0	$0	$0
24	$2,497,479	$1,228,594	$774,388	$492,370	~~49~~	-	$0	$0	$0
25	$2,497,479	$1,192,810	$737,512	$460,158	~~50~~	-	$0	$0	$0
						TOTAL NPV of AAD	$48,951,688	$38,392,371	$30,991,318

Total Length of Assessment:	30	*years*	*(selected by user in the "Inputs" tab)*
AAD Fixed Annual Growth Rate:	0%		*(selected by user in the "Inputs" tab)*

Total Damages

	AAD	NPV: Total Damages 3%	NPV: Total Damages 5%	NPV: Total Damages 7%
Base Case - Existing	**$2,497,479**	**$48,951,688**	**$38,392,371**	**$30,991,318**
Structural Damages	*$2,223,176*	*$43,575,237*	*$34,175,669*	*$27,587,486*
Internal Damages	*$148,029*	*$2,901,433*	*$2,275,568*	*$1,836,897*
External Damages	*$40,129*	*$786,546*	*$616,881*	*$497,962*
Intangibles	*$86,145*	*$1,688,473*	*$1,324,254*	*$1,068,972*

Figure 28: Outputs tab – overall result and charts

AEP	AEP Event Damage - Total	Structural	Internal	External	Intangibles
0.001%	$343,081,128	$237,896,983	$45,835,353	$7,265,325	$52,083,467
0.2%	$183,568,239	$165,118,022	$13,396,517	$2,587,650	$2,466,050
0.5%	$109,577,094	$100,296,314	$6,227,325	$1,373,445	$1,680,011
1%	$58,779,911	$53,526,605	$3,067,469	$855,915	$1,329,922
2%	$29,986,648	$28,502,110	$945,573	$378,195	$160,771
5%	$3,447,699	$3,289,196	$54,292	$99,525	$4,685
10%	$976,537	$936,727	$0	$39,810	$0
20%	$0	$0	$0	$0	$0
50%	$0	$0	$0	$0	$0
100%	$0	$0	$0	$0	$0
AAD	$2,497,479	$2,223,176	$148,029	$40,129	$86,145

AEP	Contribution to AAD - Total	Structural	Internal	External	Intangibles
0.001%	$524,016	$401,000	$58,936	$9,804	$54,277
0.2%	$439,718	$398,122	$29,436	$5,942	$6,219
0.5%	$420,893	$384,557	$23,237	$5,573	$7,525
1%	$444,948	$410,144	$20,065	$6,171	$8,569
2%	$507,831	$476,870	$14,998	$7,166	$8,798
5%	$111,247	$105,648	$1,357	$3,483	$758
10%	$48,827	$46,836	$0	$1,991	$0
20%	$0	$0	$0	$0	$0
50%	$0	$0	$0	$0	$0
100%	$0	$0	$0	$0	$0
AAD	$ 2,497,479	$ 2,223,176	$ 148,029	$ 40,129	$ 86,145

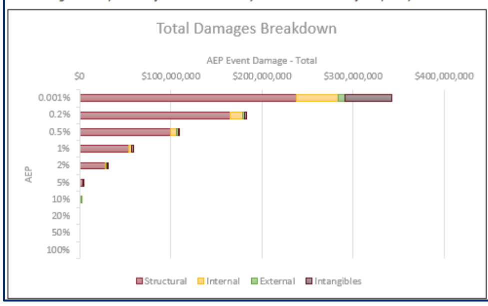
Damages	AAD	NPV: 5%	Proportion (%)
Total	**$2,497,479**	**$38,392,371**	*100%*
Structural	*$2,223,176*	*$34,175,669*	*89.0%*
Internal	*$148,029*	*$2,275,568*	*5.9%*
External	*$40,129*	*$616,881*	*1.6%*
Intangibles	*$86,145*	*$1,324,254*	*3.4%*

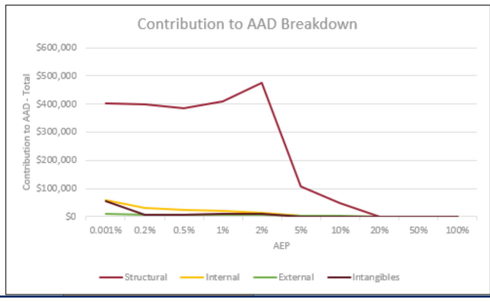
Note that total damages Include infrastructure uplift

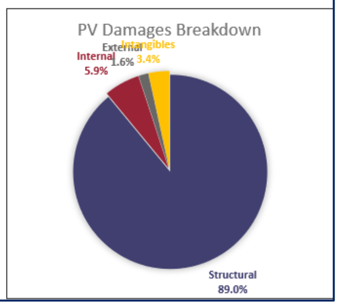
Non-residential damages are attributed to the Structural column

The Internal column only consists of residential damages

The intangible component of this bar chart only considers Risk-to-Life impacts, and not Social WTP.







4.5 Option(s)

The Option[#] tab(s) links to the BaseCase tab from a property perspective, and each unique identifier can be used to compare damage results. The final row in each Option[#] tab will also need to be 'dragged down', similar to the BaseCase tab, to ensure all properties are accounted for.

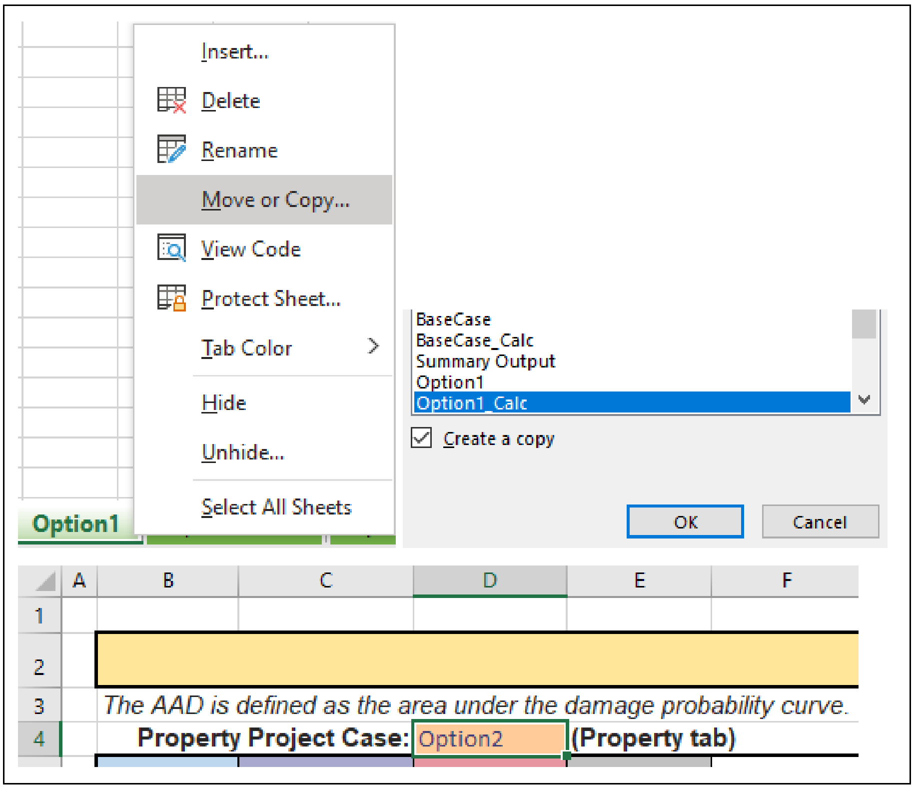
In order to assess multiple options within the Tool, the following steps need to be undertaken:

1. Create a copy of the Option1 tab and rename it to Option2.

1. Create a copy of the Option1_Calc tab and rename it to Option2_Calc.
2. Within the Option2_Calc tab, update cell D4 to 'Option2'.

Screenshots of these steps are provided in Figure 29, and the same steps can be followed to create more options. Alternatively, a new Tool workbook (.xlsx) can be created for each option.

Figure 29: Creating more options within the Tool



The inputs in the Option tab(s) depend upon the nature of the option. Inputs for the four case study options are:

- Levee:
  - The flood levels in Columns L–U need to be updated (i.e. flood levels at each property will change for particular AEPs if a levee is built around a township).
- House raising:
  - Column D (Notes) is used to earmark the building material of residential properties, otherwise denoted as 'non-residential'
  - an IF statement is applied to Column F (Floor Level) to calculate the updated floor level of the raised properties. If a property is ineligible for raising, the floor level will remain the same as the base case
  - the flood levels and hazard categories in each AEP remain unchanged as they are not affected by house raising. Raised properties, however, will have a smaller depth of inundation of overfloor flooding, as shown in Columns DD-DM. Flood depth above ground level will also remain unchanged.
- Warning time:
  - the warning time factor in cell Z10 has been updated to 1
  - the actual-to-potential ratio is cell P6 has been updated to 0.7.
- Agriculture levee extension:
  - see Section 4.6 for full details.

The actual-to-potential ratio in cell P6 can also be updated for each option, if relevant, along with the road area inundated in cell range L11:U11.

4.5.1 Intangibles

The cell range W4:AD12 replicates the information specified in the Inputs tab for the risk-to-life methodology (Figure 30). The inputs in these cells may be option-specific (such as an improved warning system, greater warning time or a higher standard of community awareness and education), so these cells can be tweaked for each option.

Figure 30: Option[#] tab – risk-to-life methodology inputs

Effective Warning Time	2	*hours*
Speed of Onset	1	*{1,2,3}*
Primary Nature of Area	2	*{1,2,3}*
Warning system - P1	0.5	*{0,0.5,1}*
Warning time - P2	0	*{0,1}*
Education - P3	0	*{0,1}*
Flood Warning Factor	3.0	*3 – (P1 × (P2 + P3))*

4.5.2 Cost-benefit analysis

The Option[#]_Calc tab contains a CBA of the option versus the base case. The inputs required are displayed in Figure 31. The costings specified need to manually be converted to an expenditure profile below cell M62.

Figure 31: Option[#]_Calc tab – CBA inputs

Base Year	2023	
Completion	2025	*Note that project benefits are not realised until this year*
Assessment Period (Y)	30	
Final year	2054	
Discount Rate (p.a.)	5%	
Total Capital Cost	$3,040,000	*Need to insert expenditure profile below cell M62,*
Recurrent Cost	$12,920	*incremental to the Base Case.*
Residual Value	$1,216,000	

Results

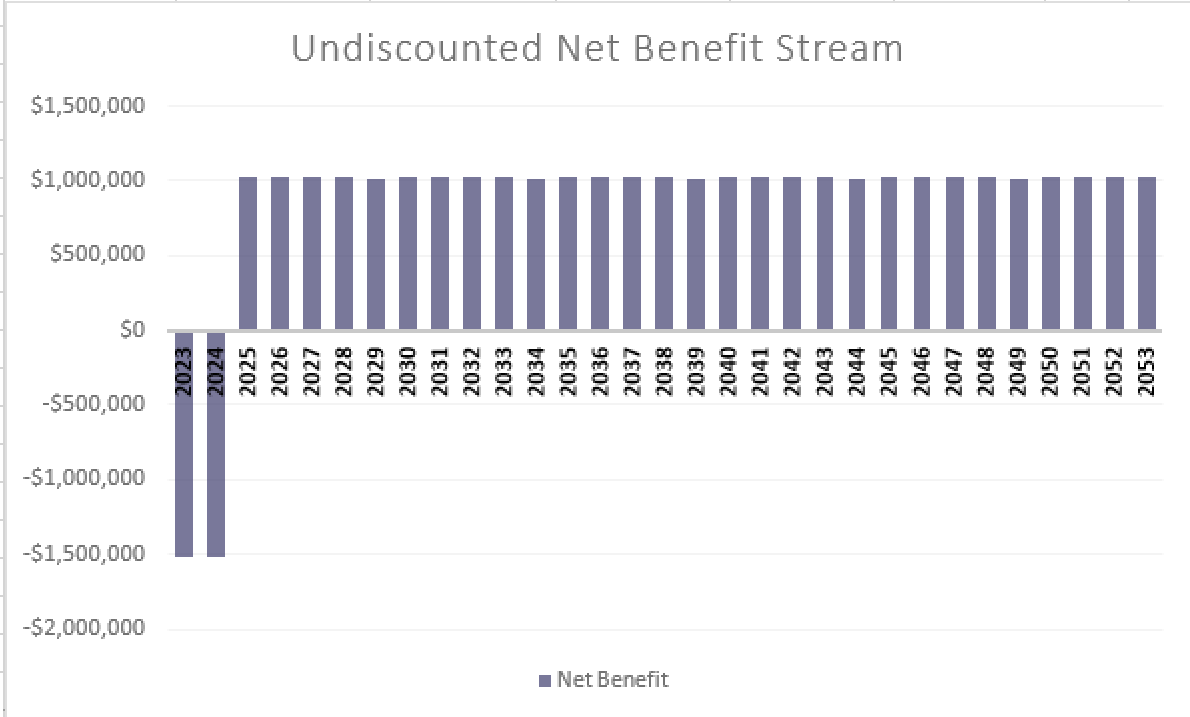
The results of the CBA are presented for the 5 per cent social discount rate, along with a sensitivity analysis (Figure 32). The user is encouraged to incorporate project-specific sensitivity tests, using the 'paste values' function in Microsoft Excel.

Figure 32: Option[#]_Calc tab – CBA results and sensitivity analysis

CBA Results Summary

Metric	5%	Sensitivity discount rates: 3%	7%
Present Value of Costs	$3,209,764	$3,313,276	$3,130,730
Present Value of Benefits	$15,523,261	$20,315,150	$12,233,592
Net Present Value	$12,313,497	$17,001,874	$9,102,862
Benefit Cost Ratio	4.84	6.13	3.91

Adjust x-axis to the number of years in the assessment period



Sensitivity Analysis (primary discount rate)

Test	BCR	NPV
PV Costs +20%	4.03	$11,671,544
PV Costs −20%	6.05	$12,955,450
PV Benefits +20%	5.80	$15,418,149
PV Benefits −20%	3.87	$9,208,844

This CBA method only uses the AAD estimates calculated from the Base Case and Option. The Monte Carlo method has also been used to conduct a CBA, which accounts for the timing of flood events, with details provided in Section 4.7.3.

Results for all options

The Outputs tab (Columns V–AO) contain multiple tables and charts that compare the results of all options (up to seven) to the base case. A snapshot of this tab is displayed in Figure 33. The key metrics compared across all options are:

- total damage in each AEP event
- contribution of each AEP event to the AAD
- AAD difference for all options, relative to the base case

- present value of costs
- present value of benefits
- net present value
- benefit-cost ratio
- internal rate of return
- sensitivity analysis results.

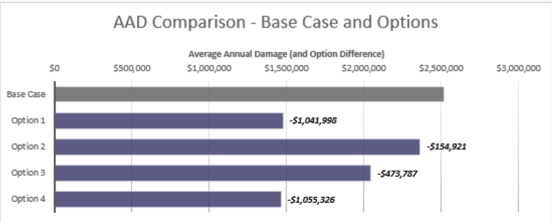
Figure 33: Outputs tab – CBA results comparison across all options

Project Case vs Base Case

Total Damages

Insert tab name:		Option1_Calc	Option2_Calc	Option3_Calc	Option4_Calc			
AEP	Base Case	Option 1	Option 2	Option 3	Option 4			*Agriculture Base Case*
0.001%	$345,657,120	$345,657,120	$345,654,271	$296,775,877	$345,657,120	--	--	*$2,575,992*
0.2%	$184,995,591	$184,949,156	$184,601,984	$150,200,425	$184,949,156	--	--	*$1,427,352*
0.5%	$110,425,647	$110,379,212	$108,761,227	$88,946,976	$110,379,212	--	--	*$848,553*
1%	$59,319,247	$11,221,007	$50,239,887	$47,773,527	$10,681,670	--	--	*$539,336*
2%	$30,284,902	$3,894,373	$27,182,751	$24,184,083	$3,596,119	--	--	*$298,254*
5%	$3,515,084	$969,430	$3,300,468	$2,807,390	$902,045	--	--	*$67,385*
10%	$984,831	$332,529	$978,371	$778,105	$324,234	--	--	*$8,294*
20%	$0	$0	$0	$0	$0	--	--	*$0*
50%	$0	$0	$0	$0	$0	--	--	*$0*
100%	$0	$0	$0	$0	$0	--	--	*$0*
AAD	$2,520,325	$1,478,327	$2,365,404	$2,046,538	$1,464,999	--	--	*$22,846*
Reduction		-$1,041,998	-$154,921	-$473,787	-$1,055,326	--	--	
Reduction %		41.3%	6.1%	18.8%	41.9%	--	--	

Depending on the nature of the option, the Agriculture Base Case may need to be added to results.



Contribution to AAD - Total

AEP	Base Case	Option 1	Option 2	Option 3	Option 4	0	0	*Agriculture Base Case*
0.001%	$527,999	$523,970	$523,622	$440,758	$527,953	--	--	*$3,983*
0.2%	$443,132	$439,579	$436,631	$355,307	$442,993	--	--	*$3,414*
0.5%	$424,362	$300,531	$394,033	$338,332	$302,652	--	--	*$3,470*
1%	$449,136	$72,337	$382,925	$356,715	$72,337	--	--	*$4,188*
2%	$513,315	$71,533	$451,764	$405,703	$71,533	--	--	*$5,485*
5%	$113,139	$30,657	$105,079	$88,386	$30,657	--	--	*$1,892*
10%	$49,242	$16,875	$48,504	$38,491	$16,875	--	--	*$415*
20%	$0	$0	$0	$0	$0	--	--	*$0*
50%	$0	$0	$0	$0	$0	--	--	*$0*
100%	$0	$0	$0	$0	$0	--	--	*$0*
AAD	$2,497,479	$1,455,480	$2,342,557	$2,023,692	$1,464,999	--	--	*$22,846*
Reduction		-$1,041,998	-$154,921	-$473,787	-$1,032,480	--	--	
Reduction %		41.7%	6.2%	19.0%	41.3%	--	--	

CBA Results (primary discount rate)

Tab	Option	PV Costs	PV Benefits	NPV	BCR
Option1_Calc	**Option 1**	$3,209,764	$15,523,261	$12,313,497	4.8
Option2_Calc	**Option 2**	$1,708,333	$2,268,116	$559,783	1.3
Option3_Calc	**Option 3**	$6,383,492	$6,936,444	$552,952	1.1
Option4_Calc	**Option 4**	$8,360,289	$16,155,575	$7,795,286	1.9
0	0	--	--	--	--
0	0	--	--	--	--

Sensitivity Analysis Results (primary discount rate)

	Benefit-Cost Ratio					
Test	Option 1	Option 2	Option 3	Option 4	0	0
Discount Rate 3% p.a.	6.1	1.7	1.2	2.5	--	--
Discount Rate 7% p.a.	3.9	1.1	1.0	1.5	--	--
PV Costs +20%	4.0	1.1	0.9	1.6	--	--
PV Costs −20%	6.0	1.7	1.4	2.4	--	--
PV Benefits +20%	5.8	1.6	1.3	2.3	--	--
PV Benefits −20%	3.9	1.1	0.9	1.5	--	--

	Net Present Value					
Test	Option 1	Option 2	Option 3	Option 4	0	0
Discount Rate 3% p.a.	$17,001,874	$1,223,572	$1,182,100	$12,760,156	--	--
Discount Rate 7% p.a.	$9,102,862	$103,903	$120,804	$4,458,780	--	--
PV Costs +20%	$11,671,544	$218,116	-$723,746	$6,123,228	--	--
PV Costs −20%	$12,955,450	$901,450	$1,829,650	$9,467,344	--	--
PV Benefits +20%	$15,418,149	$1,013,406	$1,940,241	$11,026,401	--	--
PV Benefits −20%	$9,208,844	$106,160	-$834,337	$4,564,171	--	--

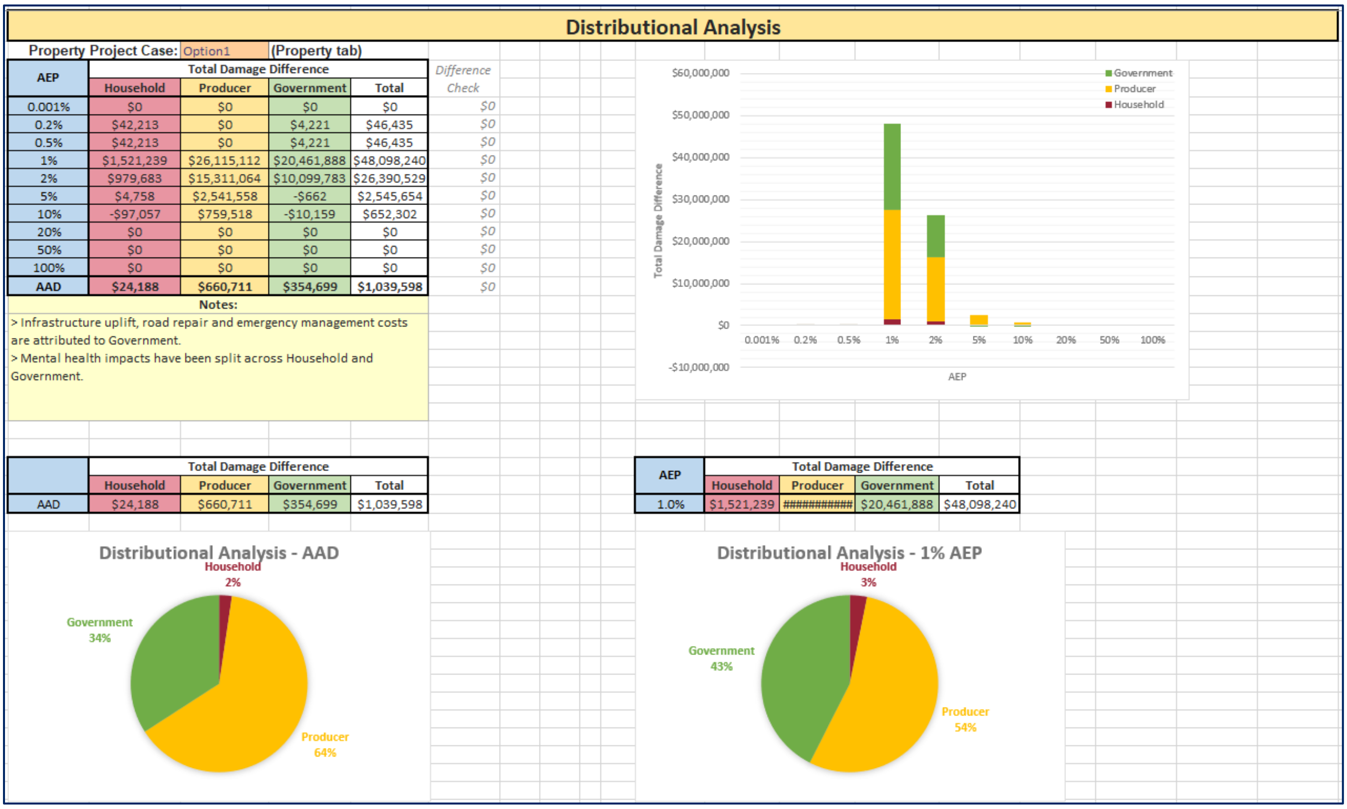
4.5.3 Distributional analysis

A distributional analysis is located in the Option[#]_Calc tab, below Row 165, and attributes the incremental benefit of an option (relative to the base case) to three groups:

- household
- producer
- government.

Figure 34 displays an example of the distribution analysis from the case study. Charts are included in the Tool to assist in visualising the output.

Figure 34: Option[#]_Calc tab – distributional analysis results


Distributional Analysis

Property Project Case: Option1 (Property tab)

AEP	Total Damage Difference				Difference Check
	Household	Producer	Government	Total	
0.001%	$0	$0	$0	$0	$0
0.2%	$42,213	$0	$4,221	$46,435	$0
0.5%	$42,213	$0	$4,221	$46,435	$0
1%	$1,521,239	$26,115,112	$20,461,888	$48,098,240	$0
2%	$979,683	$15,311,064	$10,099,783	$26,390,529	$0
5%	$4,758	$2,541,558	-$662	$2,545,654	$0
10%	-$97,057	$759,518	-$10,159	$652,302	$0
20%	$0	$0	$0	$0	$0
50%	$0	$0	$0	$0	$0
100%	$0	$0	$0	$0	$0
AAD	$24,188	$660,711	$354,699	$1,039,598	$0

Notes:

> Infrastructure uplift, road repair and emergency management costs are attributed to Government.

> Mental health impacts have been split across Household and Government.

	Total Damage Difference			
	Household	Producer	Government	Total
AAD	$24,188	$660,711	$354,699	$1,039,598

AEP	Total Damage Difference			
	Household	Producer	Government	Total
1.0%	$1,521,239	###########	$20,461,888	$48,098,240

The distributional analysis does not account for agriculture, with more information provided in Section 4.6.6.

4.6 Agriculture

4.6.1 Base Case

The Agriculture_BC tab of the Tool enables the user to calculate the AAD attributable to crops and livestock, if applicable. In many cases, this tab will not be used, nor feed into the overall final result. If it is to be used, **the switch in cell AC5 needs to be turned on** (i.e. set to 1).

It is recommended that large land parcels are split into multiple segments, based on:

- type of agriculture commodity
- average ground level (mAHD), as different segments may be inundated for different durations.

Each segment should be assigned its own row, and a unique ID number. Furthermore, similar to the tabs with property data, the final row should be 'dragged down' far enough to ensure all formulas are being appropriately calculated, before entering in the agricultural data.

4.6.2 Inputs

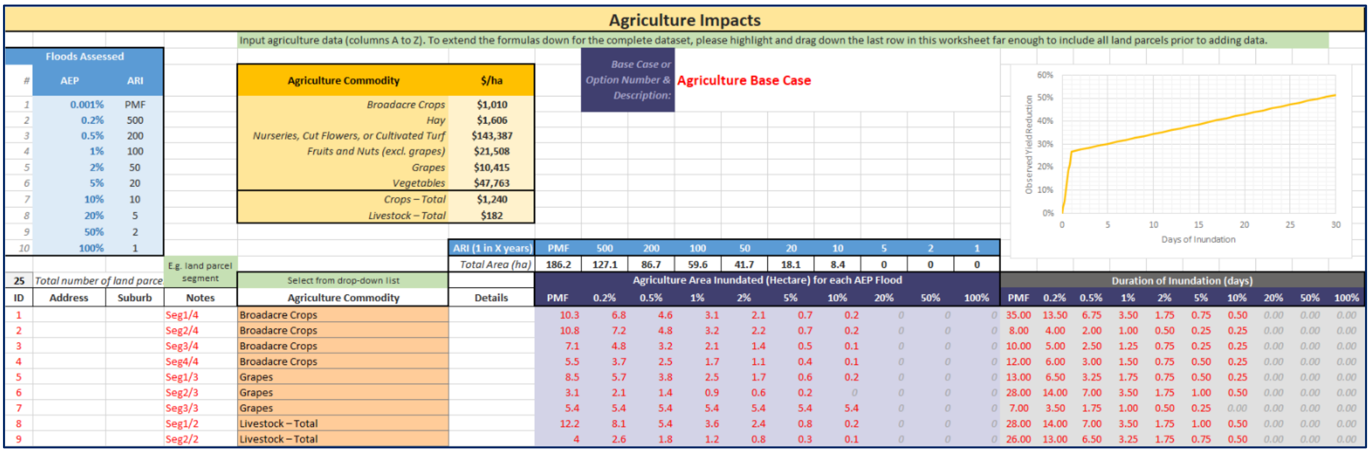
Columns A to Z require a user input from Row 19 onwards, with one row representing one land parcel segment. Table 31, as well as the snapshot in Figure 35, summarises the inputs required. After Column Z, this tab does not require any other inputs.

Table 31: Agriculture_BC tab – user inputs

Column and Title		User Input
A	*ID*	Unique identifier for the property.

Column and Title		User Input
B–C	*Address and Suburb*	Property address and suburb.
D	*Notes*	Any general information about the land parcel.
E	*Agriculture Commodity*	• The type of commodity, selected from a drop-down list • If the specific commodity is not available for selection, 'crops – total' should be selected
F	*Details*	Any further information about the commodity or land parcel.
G–P	*Area Inundated*	The total area (hectares) inundated in each AEP event.
Q–Z	*Duration of Inundation*	The time (days) for which the respective land parcel segment is inundated for in each AEP, obtained through a time-series output from the hydraulic flood model. This can be rounded to the nearest 15 minutes (0.25 hours).

Figure 35: Agriculture_BC tab – land parcel inputs



Agriculture Impacts

Input agriculture data (columns A to Z). To extend the formulas down for the complete dataset, please highlight and drag down the last row in this worksheet far enough to include all land parcels prior to adding data.

Floods Assessed

#	AEP	ARI
1	0.001%	PMF
2	0.2%	500
3	0.5%	200
4	1%	100
5	2%	50
6	5%	20
7	10%	10
8	20%	5
9	50%	2
10	100%	1

Agriculture Commodity	$/ha
Broadacre Crops	$1,010
Hay	$1,606
Nurseries, Cut Flowers, or Cultivated Turf	$143,387
Fruits and Nuts (excl. grapes)	$21,508
Grapes	$10,415
Vegetables	$47,763
Crops – Total	$1,240
Livestock – Total	$182

Base Case or Option Number & Description: Agriculture Base Case

ARI (1 in X years)	PMF	500	200	100	50	20	10	5	2	1
Total Area (ha)	186.2	127.1	86.7	59.6	41.7	18.1	8.4	0	0	0

25 *Total number of land parce*

			E.g. land parcel segment	Select from drop-down list		Agriculture Area Inundated (Hectare) for each AEP Flood									
ID	Address	Suburb	Notes	Agriculture Commodity	Details	PMF	0.2%	0.5%	1%	2%	5%	10%	20%	50%	100%
1			Seg1/4	Broadacre Crops		10.3	6.8	4.6	3.1	2.1	0.7	0.2	0	0	0
2			Seg2/4	Broadacre Crops		10.8	7.2	4.8	3.2	2.2	0.7	0.2	0	0	0
3			Seg3/4	Broadacre Crops		7.1	4.8	3.2	2.1	1.4	0.5	0.1	0	0	0
4			Seg4/4	Broadacre Crops		5.5	3.7	2.5	1.7	1.1	0.4	0.1	0	0	0
5			Seg1/3	Grapes		8.5	5.7	3.8	2.5	1.7	0.6	0.2	0	0	0
6			Seg2/3	Grapes		3.1	2.1	1.4	0.9	0.6	0.2	0	0	0	0
7			Seg3/3	Grapes		5.4	5.4	5.4	5.4	5.4	5.4	5.4	0	0	0
8			Seg1/2	Livestock – Total		12.2	8.1	5.4	3.6	2.4	0.8	0.2	0	0	0
9			Seg2/2	Livestock – Total		4	2.6	1.8	1.2	0.8	0.3	0.1	0	0	0

	Duration of Inundation (days)									
ID	PMF	0.2%	0.5%	1%	2%	5%	10%	20%	50%	100%
1	35.00	13.50	6.75	3.50	1.75	0.75	0.50	0.00	0.00	0.00
2	8.00	4.00	2.00	1.00	0.50	0.25	0.25	0.00	0.00	0.00
3	10.00	5.00	2.50	1.25	0.75	0.25	0.25	0.00	0.00	0.00
4	12.00	6.00	3.00	1.50	0.75	0.50	0.25	0.00	0.00	0.00
5	13.00	6.50	3.25	1.75	0.75	0.50	0.25	0.00	0.00	0.00
6	28.00	14.00	7.00	3.50	1.75	1.00	0.50	0.00	0.00	0.00
7	7.00	3.50	1.75	1.00	0.50	0.25	0.00	0.00	0.00	0.00
8	28.00	14.00	7.00	3.50	1.75	1.00	0.50	0.00	0.00	0.00
9	26.00	13.00	6.50	3.25	1.75	0.75	0.50	0.00	0.00	0.00

4.6.3 Results

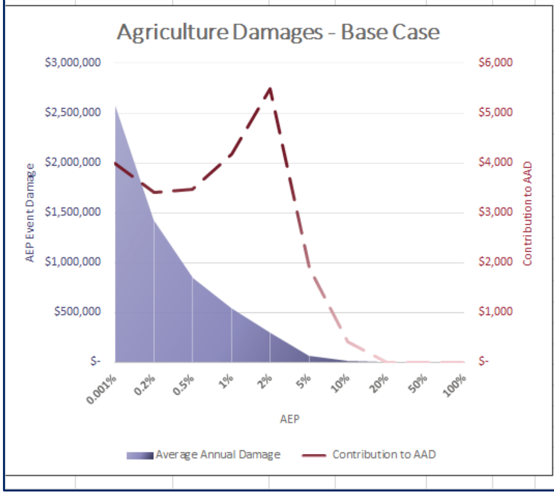
The total damage in each AEP event, as well as the calculation of AAD attributed to agriculture, is presented in cell range AR5:AX16. The adjacent cell range on the right of this consists of the present value calculation of the AAD, across the assessment period. Figure 36 displays a screenshot of the outputs, AAD calculation and its present value.

Figure 36: Agriculture_BC tab – AAD output

Annual Average Damage (AAD) Calculation - Agriculture Damages

The AAD is defined as the area under the damage probability curve.

AEP	AEP Event Damage	Contribution to AAD		Notes
0.001%	$2,575,992	$3,983		
0.2%	$1,427,352	$3,414		
0.5%	$848,553	$3,470		
1%	$539,336	$4,188		
2%	$298,254	$5,485		
5%	$67,385	$1,892		
10%	$8,294	$415		
20%	$0	$0		
50%	$0	$0		
100%	$0			
TOTAL AAD	$ 22,846			



Discount Rates based on NSW Treasury Guidelines.

		Discount Rates					Discount Rates		
Year	AAD	3%	5%	7%	Year	AAD	3%	5%	7%
1	$22,846	$22,181	$21,758	$21,352	26	$22,846	$10,594	$6,425	$3,934
2	$22,846	$21,535	$20,722	$19,955	27	$22,846	$10,285	$6,119	$3,677
3	$22,846	$20,907	$19,735	$18,649	28	$22,846	$9,986	$5,828	$3,436
4	$22,846	$20,298	$18,796	$17,429	29	$22,846	$9,695	$5,550	$3,211
5	$22,846	$19,707	$17,901	$16,289	30	$22,846	$9,412	$5,286	$3,001
6	$22,846	$19,133	$17,048	$15,223	~~31~~	-	$0	$0	$0
7	$22,846	$18,576	$16,236	$14,227	~~32~~	-	$0	$0	$0
8	$22,846	$18,035	$15,463	$13,297	~~33~~	-	$0	$0	$0
9	$22,846	$17,510	$14,727	$12,427	~~34~~	-	$0	$0	$0
10	$22,846	$17,000	$14,026	$11,614	~~35~~	-	$0	$0	$0
11	$22,846	$16,505	$13,358	$10,854	~~36~~	-	$0	$0	$0
12	$22,846	$16,024	$12,722	$10,144	~~37~~	-	$0	$0	$0
13	$22,846	$15,557	$12,116	$9,480	~~38~~	-	$0	$0	$0
14	$22,846	$15,104	$11,539	$8,860	~~39~~	-	$0	$0	$0
15	$22,846	$14,664	$10,989	$8,280	~~40~~	-	$0	$0	$0
16	$22,846	$14,237	$10,466	$7,739	~~41~~	-	$0	$0	$0
17	$22,846	$13,822	$9,968	$7,232	~~42~~	-	$0	$0	$0
18	$22,846	$13,420	$9,493	$6,759	~~43~~	-	$0	$0	$0
19	$22,846	$13,029	$9,041	$6,317	~~44~~	-	$0	$0	$0
20	$22,846	$12,649	$8,610	$5,904	~~45~~	-	$0	$0	$0
21	$22,846	$12,281	$8,200	$5,518	~~46~~	-	$0	$0	$0
22	$22,846	$11,923	$7,810	$5,157	~~47~~	-	$0	$0	$0
23	$22,846	$11,576	$7,438	$4,819	~~48~~	-	$0	$0	$0
24	$22,846	$11,239	$7,084	$4,504	~~49~~	-	$0	$0	$0
25	$22,846	$10,911	$6,747	$4,209	~~50~~	-	$0	$0	$0
					TOTAL NPV of AAD		$447,794	$351,201	$283,499

Total Length of Assessment: 30 *years*
AAD Fixed Annual Growth Rate: 0%

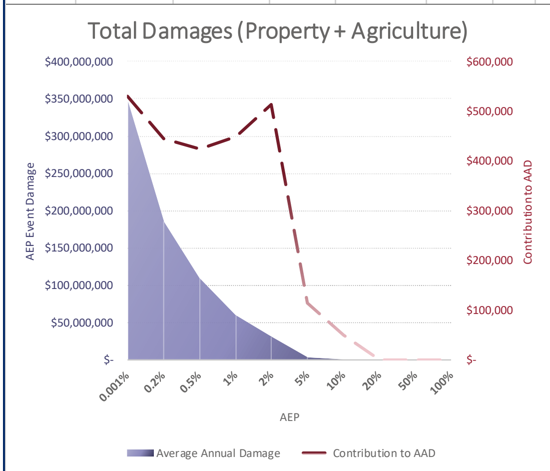
Agriculture Damages - Base Case		NPV: Agriculture Damages - Base Case		
	AAD	3%	5%	7%
Agriculture Damages - Base Case	$22,846	$447,794	$351,201	$283,499

Overall result (property + agriculture)

The overall result of the flood damage calculation, which combines the AAD from properties (Figure 27) and agriculture (Figure 36), is presented in Columns BM–CE in the Agriculture_BC tab (Figure 37).

Figure 37: Agriculture_BC tab – overall result

Annual Average Damage (AAD) Calculation - Total Damages (Property + Agriculture)			
The AAD is defined as the area under the damage probability curve.			
AEP	AEP Event Damage	Contribution to AAD	Notes
0.001%	$346,879,754	$529,575	
0.2%	$185,356,735	$443,926	
0.5%	$110,594,211	$424,990	
1%	$59,401,595	$449,664	
2%	$30,308,105	$513,680	
5%	$3,516,179	$113,166	
10%	$984,831	$49,242	
20%	$0	$0	
50%	$0	$0	
100%	$0	$0	
TOTAL AAD	$ 2,524,242		



Discount Rates based on NSW Treasury Guidelines.

Year	AAD	Discount Rates 3%	5%	7%	Year	AAD	Discount Rates 3%	5%	7%
1	$2,524,242	$2,450,721	$2,404,040	$2,359,105	26	$2,524,242	$1,170,478	$709,920	$434,663
2	$2,524,242	$2,379,340	$2,289,562	$2,204,771	27	$2,524,242	$1,136,386	$676,114	$406,227
3	$2,524,242	$2,310,039	$2,180,535	$2,060,534	28	$2,524,242	$1,103,288	$643,918	$379,652
4	$2,524,242	$2,242,757	$2,076,700	$1,925,732	29	$2,524,242	$1,071,153	$613,255	$354,815
5	$2,524,242	$2,177,434	$1,977,810	$1,799,750	30	$2,524,242	$1,039,954	$584,053	$331,602
6	$2,524,242	$2,114,013	$1,883,628	$1,682,009	31	-	$0	$0	$0
7	$2,524,242	$2,052,440	$1,793,932	$1,571,971	32	-	$0	$0	$0
8	$2,524,242	$1,992,660	$1,708,507	$1,469,132	33	-	$0	$0	$0
9	$2,524,242	$1,934,622	$1,627,149	$1,373,021	34	-	$0	$0	$0
10	$2,524,242	$1,878,273	$1,549,666	$1,283,197	35	-	$0	$0	$0
11	$2,524,242	$1,823,566	$1,475,872	$1,199,249	36	-	$0	$0	$0
12	$2,524,242	$1,770,453	$1,405,593	$1,120,794	37	-	$0	$0	$0
13	$2,524,242	$1,718,886	$1,338,660	$1,047,471	38	-	$0	$0	$0
14	$2,524,242	$1,668,822	$1,274,914	$978,945	39	-	$0	$0	$0
15	$2,524,242	$1,620,215	$1,214,204	$914,902	40	-	$0	$0	$0
16	$2,524,242	$1,573,024	$1,156,384	$855,048	41	-	$0	$0	$0
17	$2,524,242	$1,527,208	$1,101,319	$799,110	42	-	$0	$0	$0
18	$2,524,242	$1,482,726	$1,048,875	$746,832	43	-	$0	$0	$0
19	$2,524,242	$1,439,540	$998,928	$697,974	44	-	$0	$0	$0
20	$2,524,242	$1,397,612	$951,360	$652,312	45	-	$0	$0	$0
21	$2,524,242	$1,356,905	$906,058	$609,638	46	-	$0	$0	$0
22	$2,524,242	$1,317,383	$862,912	$569,755	47	-	$0	$0	$0
23	$2,524,242	$1,279,013	$821,821	$532,481	48	-	$0	$0	$0
24	$2,524,242	$1,241,760	$782,687	$497,646	49	-	$0	$0	$0
25	$2,524,242	$1,205,592	$745,416	$465,090	50	-	$0	$0	$0
					TOTAL NPV of AAD		$49,476,263	$38,803,791	$31,323,427

Total Length of Assessment:	30	*years*
AAD Fixed Annual Growth Rate:	0%	

Total Damages (Property + Agriculture)		NPV: Total Damages (Property + Agriculture)		
	AAD	3%	5%	7%
Total Damages (Property + Agriculture)	$2,524,242	$49,476,263	$38,803,791	$31,323,427

4.6.4 Project Case

The Agriculture_PC tab is a replication of the Agriculture_BC tab, with updated information depending on the nature of the project. The factors most likely to change are the agriculture area inundated per AEP event and the corresponding duration of inundation. If multiple agriculture options are assessed, the Agriculture_PC tab can be duplicated and renamed appropriately.

Agricultural flood mitigation can be undertaken using a number of options, such as improved drainage systems, building levees and embankments, contour farming and raising the ground level of farmland. For the case study in Section 2, a levee was extended to protect the agricultural land within the study area against a 1 per cent AEP flood level height, as shown in Figure 38.

Figure 38: Agriculture Project Case – data input

			E.g. land parcel segment		*Total Area (ha)*	186	127	87	0	0	0	0	0	0	0										
25	*Total number of land parcels*			Select from drop-down list		Agriculture Area Inundated (Hectare) for each AEP Flood										Duration of Inundation (days)									
ID	Address	Suburb	Notes	Agriculture Commodity	Details	PMF	0.2%	0.5%	1%	2%	5%	10%	20%	50%	100%	PMF	0.2%	0.5%	1%	2%	5%	10%	20%	50%	100%
1	0	0	Seg1/4	Broadacre Crops	0	10.3	6.8	4.6	0	0	0	0	0	0	0	35.00	13.50	6.75	0	0	0.00	0.00	0.00	0.00	0.00
2	0	0	Seg2/4	Broadacre Crops	0	10.8	7.2	4.8	0	0	0	0	0	0	0	8.00	4.00	2.00	0	0	0.00	0.00	0.00	0.00	0.00
3	0	0	Seg3/4	Broadacre Crops	0	7.1	4.8	3.2	0	0	0	0	0	0	0	10.00	5.00	2.50	0	0	0.00	0.00	0.00	0.00	0.00
4	0	0	Seg4/4	Broadacre Crops	0	5.5	3.7	2.5	0	0	0	0	0	0	0	12.00	6.00	3.00	0	0	0.00	0.00	0.00	0.00	0.00
5	0	0	Seg1/3	Grapes	0	8.5	5.7	3.8	0	0	0	0	0	0	0	13.00	6.50	3.25	0	0	0.00	0.00	0.00	0.00	0.00
6	0	0	Seg2/3	Grapes	0	3.1	2.1	1.4	0	0	0	0	0	0	0	28.00	14.00	7.00	0	0	0.00	0.00	0.00	0.00	0.00
7	0	0	Seg3/3	Grapes	0	5.4	5.4	5.4	0	0	0	0	0	0	0	7.00	3.50	1.75	0	0	0.00	0.00	0.00	0.00	0.00
8	0	0	Seg1/2	Livestock – Total	0	12.2	8.1	5.4	0	0	0	0	0	0	0	28.00	14.00	7.00	0	0	0.00	0.00	0.00	0.00	0.00
9	0	0	Seg2/2	Livestock – Total	0	4	2.6	1.8	0	0	0	0	0	0	0	26.00	13.00	6.50	0	0	0.00	0.00	0.00	0.00	0.00
10	0	0	Seg1/4	Hay	0	9.6	6.4	4.3	0	0	0	0	0	0	0	22.00	11.00	5.50	0	0	0.00	0.00	0.00	0.00	0.00
11	0	0	Seg2/4	Hay	0	10.8	7.2	4.8	0	0	0	0	0	0	0	13.00	6.50	3.25	0	0	0.00	0.00	0.00	0.00	0.00
12	0	0	Seg3/4	Hay	0	11.3	7.5	5	0	0	0	0	0	0	0	6.00	3.00	1.50	0	0	0.00	0.00	0.00	0.00	0.00
13	0	0	Seg4/4	Hay	0	12.2	8.1	5.4	0	0	0	0	0	0	0	14.00	7.00	3.50	0	0	0.00	0.00	0.00	0.00	0.00
14	0	0	Seg1/3	Vegetables	0	7.2	4.8	3.2	0	0	0	0	0	0	0	12.00	6.00	3.00	0	0	0.00	0.00	0.00	0.00	0.00
15	0	0	Seg2/3	Vegetables	0	7.9	5.3	3.5	0	0	0	0	0	0	0	7.00	3.50	1.75	0	0	0.00	0.00	0.00	0.00	0.00
16	0	0	Seg3/3	Vegetables	0	10.2	6.8	4.5	0	0	0	0	0	0	0	18.00	9.00	4.50	0	0	0.00	0.00	0.00	0.00	0.00
17	0	0	Seg1/2	Crops – Total	0	1.7	1.1	0.8	0	0	0	0	0	0	0	21.00	10.50	5.25	0	0	0.00	0.00	0.00	0.00	0.00
18	0	0	Seg2/2	Crops – Total	0	5.6	3.8	2.5	0	0	0	0	0	0	0	23.00	11.50	5.75	0	0	0.00	0.00	0.00	0.00	0.00
19	0	0	Seg1/4	Nurseries, Cut Flowers, or Cultivated Turf	0	7.5	5	3.3	0	0	0	0	0	0	0	10.00	5.00	2.50	0	0	0.00	0.00	0.00	0.00	0.00
20	0	0	Seg2/4	Nurseries, Cut Flowers, or Cultivated Turf	0	8.1	5.4	3.6	0	0	0	0	0	0	0	20.00	10.00	5.00	0	0	0.00	0.00	0.00	0.00	0.00
21	0	0	Seg3/4	Nurseries, Cut Flowers, or Cultivated Turf	0	6.5	4.4	2.9	0	0	0	0	0	0	0	12.00	6.00	3.00	0	0	0.00	0.00	0.00	0.00	0.00
22	0	0	Seg4/4	Nurseries, Cut Flowers, or Cultivated Turf	0	10.3	6.9	4.6	0	0	0	0	0	0	0	25.00	12.50	6.25	0	0	0.00	0.00	0.00	0.00	0.00
23	0	0	Seg1/3	Fruits and Nuts (excl. grapes)	0	4	2.6	2	0	0	0	0	0	0	0	26.00	13.00	6.50	0	0	0.00	0.00	0.00	0.00	0.00
24	0	0	Seg2/3	Fruits and Nuts (excl. grapes)	0	3	2.4	1.6	0	0	0	0	0	0	0	26.00	13.00	6.50	0	0	0.00	0.00	0.00	0.00	0.00
25	0	0	Seg3/3	Fruits and Nuts (excl. grapes)	0	3.4	3	1.8	0	0	0	0	0	0	0	26.00	13.00	6.50	0	0	0.00	0.00	0.00	0.00	0.00

A results comparison summary is provided in cell range AS45:AW56 in the Agriculture_PC tab (Figure 39). Similar to the base case, the combined result of the agriculture project case and a selected property option is displayed in Columns BM–CE (Figure 40). The name of the property option's calculation tab is entered into cell BO3.

Figure 39: Agriculture_PC tab – Project Case vs Base Case

AEP	Agricultural Damage: Project Case vs Base Case			
	Base Case	ject Case: Levee	Difference ($)	Difference (%)
0.001%	$2,575,992	$2,575,992	$0	0.0%
0.2%	$1,427,352	$1,427,352	$0	0.0%
0.5%	$848,553	$848,553	$0	0.0%
1%	$539,336	$0	$539,336	100.0%
2%	$298,254	$0	$298,254	100.0%
5%	$67,385	$0	$67,385	100.0%
10%	$8,294	$0	$8,294	100.0%
20%	$0	$0	$0	--
50%	$0	$0	$0	--
100%	$0	$0	$0	--
AAD	$22,846	$9,519	$13,328	58.3%

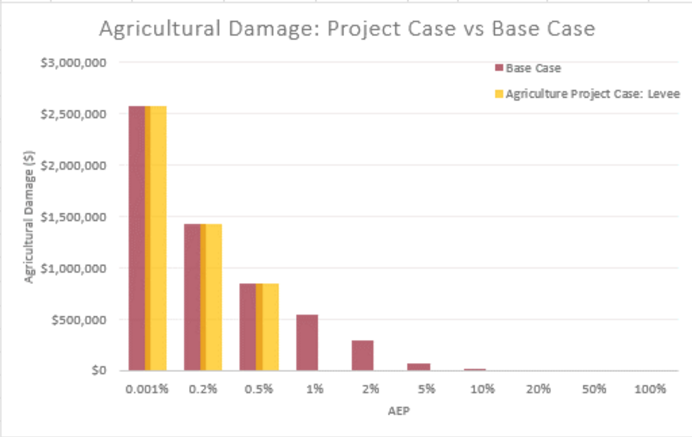
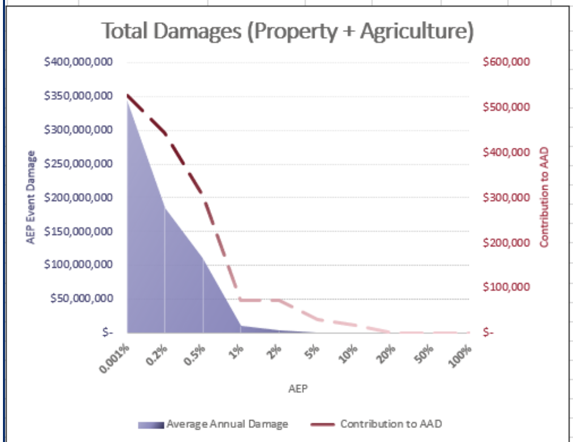


Figure 40: Agriculture_PC tab – overall result

Annual Average Damage (AAD) Calculation - Total Damages (Property + Agriculture)

Property Project Case: Option1_Calc

AEP	AEP Event Damage	Contribution to AAD		Notes
0.001%	$345,657,120	$527,953		
0.2%	$184,949,156	$442,993		
0.5%	$110,379,212	$302,652		
1%	$10,681,670	$72,337		
2%	$3,596,119	$71,533		
5%	$902,045	$30,657		
10%	$324,234	$16,875		
20%	$0	$0		
50%	$0	$0		
100%	$0			
TOTAL AAD	$ 1,464,999			



Discount Rates based on NSW Treasury Guidelines.

Year	AAD	Discount Rates 3%	5%	7%	Year	AAD	Discount Rates 3%	5%	7%
1	$1,464,999	$1,422,329	$1,395,237	$1,369,158	26	$1,464,999	$679,312	$412,017	$252,266
2	$1,464,999	$1,380,902	$1,328,797	$1,279,587	27	$1,464,999	$659,527	$392,398	$235,763
3	$1,464,999	$1,340,682	$1,265,521	$1,195,876	28	$1,464,999	$640,317	$373,712	$220,339
4	$1,464,999	$1,301,633	$1,205,258	$1,117,641	29	$1,464,999	$621,667	$355,916	$205,924
5	$1,464,999	$1,263,721	$1,147,865	$1,044,524	30	$1,464,999	$603,560	$338,968	$192,453
6	$1,464,999	$1,226,914	$1,093,205	$976,191	~~31~~	-	$0	$0	$0
7	$1,464,999	$1,191,178	$1,041,147	$912,328	~~32~~	-	$0	$0	$0
8	$1,464,999	$1,156,484	$991,569	$852,643	~~33~~	-	$0	$0	$0
9	$1,464,999	$1,122,800	$944,351	$796,862	~~34~~	-	$0	$0	$0
10	$1,464,999	$1,090,097	$899,382	$744,731	~~35~~	-	$0	$0	$0
11	$1,464,999	$1,058,346	$856,555	$696,010	~~36~~	-	$0	$0	$0
12	$1,464,999	$1,027,521	$815,766	$650,477	~~37~~	-	$0	$0	$0
13	$1,464,999	$997,593	$776,920	$607,923	~~38~~	-	$0	$0	$0
14	$1,464,999	$968,537	$739,924	$568,152	~~39~~	-	$0	$0	$0
15	$1,464,999	$940,327	$704,690	$530,983	~~40~~	-	$0	$0	$0
16	$1,464,999	$912,939	$671,133	$496,246	~~41~~	-	$0	$0	$0
17	$1,464,999	$886,349	$639,174	$463,781	~~42~~	-	$0	$0	$0
18	$1,464,999	$860,533	$608,737	$433,440	~~43~~	-	$0	$0	$0
19	$1,464,999	$835,468	$579,750	$405,084	~~44~~	-	$0	$0	$0
20	$1,464,999	$811,134	$552,143	$378,584	~~45~~	-	$0	$0	$0
21	$1,464,999	$787,509	$525,850	$353,816	~~46~~	-	$0	$0	$0
22	$1,464,999	$764,572	$500,810	$330,670	~~47~~	-	$0	$0	$0
23	$1,464,999	$742,303	$476,962	$309,037	~~48~~	-	$0	$0	$0
24	$1,464,999	$720,682	$454,249	$288,820	~~49~~	-	$0	$0	$0
25	$1,464,999	$699,692	$432,618	$269,925	~~50~~	-	$0	$0	$0
						TOTAL NPV of AAD	$28,714,628	###########	$18,179,233

Total Length of Assessment: 30 *years*
AAD Fixed Annual Growth Rate: 0%

Total Damages (Property + Agriculture)	AAD	NPV: Total Damages (Property + Agriculture) 3%	5%	7%
Total Damages (Property + Agriculture)	$1,464,999	$28,714,628	###########	$18,179,233

4.6.5 Cost-benefit analysis

The Agriculture_CBA tab contains two CBAs: for an agriculture option in isolation and an agriculture option combined with a selected property option.

Agriculture CBA

Columns B–T contain a CBA for the agriculture option in isolation. The setup is identical to the property CBA detailed in Section 4.5.2. Figure 41 displays a snapshot of the agriculture CBA undertaken for the case study. As this option, however, is packaged with option 1 (levee), the results cannot be interpreted in isolation.

Figure 41: Agriculture_CBA tab – cost-benefit analysis of agriculture only

Agriculture Damages - Cost-Benefit Analysis

Base Year	2023	
Completion	2025	*Note that project benefits are not realised until this year*
Assessment Period (Y)	30	
Final year	2054	
Discount Rate (p.a.)	5%	

Description: An extension of the levee in Option 1 to cover the agricultural land in the study area.

Total Capital Cost	$4,960,000	*Need to insert expenditure profile below cell M19*
Recurrent Cost	$21,080	
Residual Value	$1,984,000	

	AAD	Base Case	Project Case	Difference	
Year 0	Total	$22,846	$9,519	$13,328	58%

Working out space

Levee service life	50	years		
Length of levee	3.1	km		
Cost of construction	$1,600,000	per km		
Cost of maintenance	$6,800	per km per yea	$20,000	periodic (5 years)

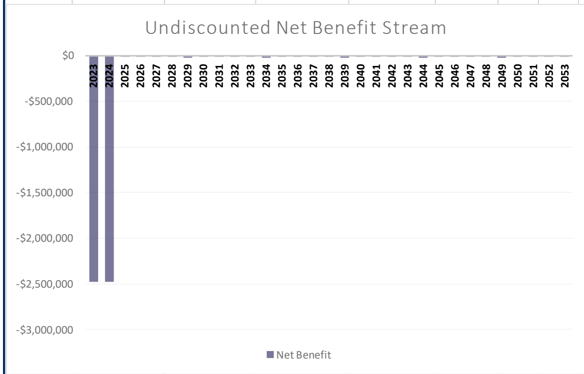
Discount Rate (p.a.)	Project Cost	Base Case AAD	Project Case AAD	Residual Value	Total Benefit	Net Benefit
3%	$5,360,596	$434,752	$181,134	$793,574	$1,047,192	-$4,313,404
5%	$5,203,516	$334,477	$139,356	$437,193	$632,314	-$4,571,202
7%	$5,082,560	$264,952	$110,389	$243,582	$398,145	-$4,684,415

CBA Results Summary

Sensitivity discount rates

Metric	BCR	3%	7%
Present Value of Costs	$5,203,516	$5,360,596	$5,082,560
Present Value of Benefits	$632,314	$1,047,192	$398,145
Net Present Value	-$4,571,202	-$4,313,404	-$4,684,415
Benefit Cost Ratio	0.12	0.20	0.08

Adjust x-axis to the number of years in the assessment period



Sensitivity Analysis (primary discount rate)

Metric	BCR	NPV
PV Costs +40%	0.09	-$6,652,608
PV Costs +20%	0.10	-$5,611,905
PV Costs −20%	0.15	-$3,530,498
PV Benefits +20%	0.15	-$4,444,739
PV Benefits −20%	0.10	-$4,697,664
PV Benefits −40%	0.07	-$4,824,127

	Year	Project Cost	Base Case AAD	Project Case AAD	Residual Value	Total Benefit	Net Benefit
1	2023	$2,480,000	$0	$0	$0	$0	-$2,480,000
2	2024	$2,480,000	$0	$0	$0	$0	-$2,480,000
3	2025	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
4	2026	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
5	2027	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
6	2028	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
7	2029	$41,080	$22,846	$9,519	$0	$13,328	-$27,752
8	2030	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
9	2031	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
10	2032	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
11	2033	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
12	2034	$41,080	$22,846	$9,519	$0	$13,328	-$27,752
13	2035	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
14	2036	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
15	2037	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
16	2038	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
17	2039	$41,080	$22,846	$9,519	$0	$13,328	-$27,752
18	2040	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
19	2041	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
20	2042	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
21	2043	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
22	2044	$41,080	$22,846	$9,519	$0	$13,328	-$27,752
23	2045	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
24	2046	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
25	2047	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
26	2048	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
27	2049	$41,080	$22,846	$9,519	$0	$13,328	-$27,752
28	2050	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
29	2051	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
30	2052	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
31	2053	$21,080	$22,846	$9,519	$0	$13,328	-$7,752
32	2054	$41,080	$22,846	$9,519	$1,984,000	$1,997,328	$1,956,248
33							
34							
35							
36							
37							
38							
39							

Agriculture and Property CBA

Columns W–AO contain a CBA for the agriculture option combined with a selected property option (in cell BO3 of the Agriculture_PC tab). The user inputs for this CBA are similar to the agriculture-only CBA, however cost and residual value should only be presented once for both options to ensure there is no double counting.

Figure 42: Agriculture_CBA tab – cost-benefit analysis of agriculture and property combination

Agriculture + Property Damages - Cost-Benefit Analysis

Property Project Case:	Option1_Calc	
Base Year	2023	
Completion	2025	*Note that project benefits are not realised until this year*
Assessment Period (Y)	30	
Final year	2054	
Discount Rate (p.a.)	5%	
Total Capital Cost	$8,000,000	*Agriculture + Property option*
Recurrent Cost	$34,000	*Need to insert expenditure profile below cell M19*
Residual Value	$3,200,000	

Description: 5 kilometre levee around a segment of the township, built to withstand the 1% AEP flood event. It has a design life of 50 years.

	AAD	Base Case	Project Case	Difference	
Year 0	Total	$2,520,325	$1,464,999	$1,055,326	42%

Discount Rate (p.a.)	Project Cost	Base Case AAD	Project Case AAD	Residual Value	Total Benefit	Net Benefit
3%	$8,602,186	$47,960,662	$27,878,279	$1,279,959	#########	$12,760,156
5%	$8,360,289	$36,898,640	$21,448,215	$705,150	#########	$7,795,286
7%	$8,172,957	$29,228,800	$16,989,938	$392,874	#########	$4,458,780

Working out space

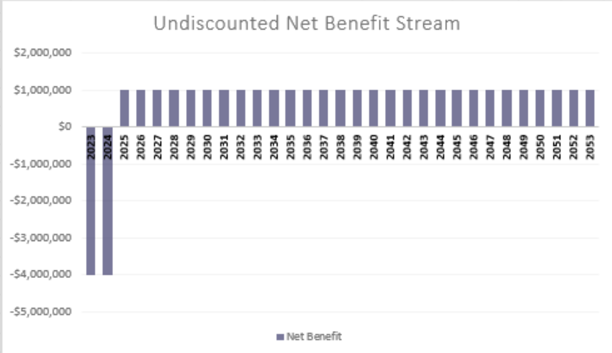
Levee service life	50	years		
Length of levee	5	km		
Cost of construction	$1,600,000	per km		
Cost of maintenance	$6,800	per km per yea	$20,000	periodic (5 years)

CBA Results Summary

Sensitivity discount rates

Metric	BCR	3%	7%
Present Value of Costs	$8,360,289	$8,602,186	$8,172,957
Present Value of Benefits	$16,155,575	$21,362,342	$12,631,736
Net Present Value	$7,795,286	$12,760,156	$4,458,780
Benefit Cost Ratio	1.93	2.48	1.55

Adjust x-axis to the number of years in the assessment period



	Year	Project Cost	Base Case AAD	Project Case AAD	Residual Value	Total Benefit	Net Benefit
1	2023	$4,000,000	$0	$0	$0	$0	-$4,000,000
2	2024	$4,000,000	$0	$0	$0	$0	-$4,000,000
3	2025	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
4	2026	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
5	2027	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
6	2028	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
7	2029	$54,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,001,326
8	2030	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
9	2031	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
10	2032	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
11	2033	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
12	2034	$54,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,001,326
13	2035	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
14	2036	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
15	2037	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
16	2038	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
17	2039	$54,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,001,326
18	2040	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
19	2041	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
20	2042	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
21	2043	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
22	2044	$54,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,001,326
23	2045	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
24	2046	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
25	2047	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
26	2048	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
27	2049	$54,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,001,326
28	2050	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
29	2051	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
30	2052	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
31	2053	$34,000	$2,520,325	$1,464,999	$0	$1,055,326	$1,021,326
32	2054	$54,000	$2,520,325	$1,464,999	$3,200,000	$4,255,326	$4,201,326
33	2055	$34,000					
34	2056	$34,000					
35	2057	$34,000					
36	2058	$34,000					
37	2059	$54,000					
38	2060	$34,000					

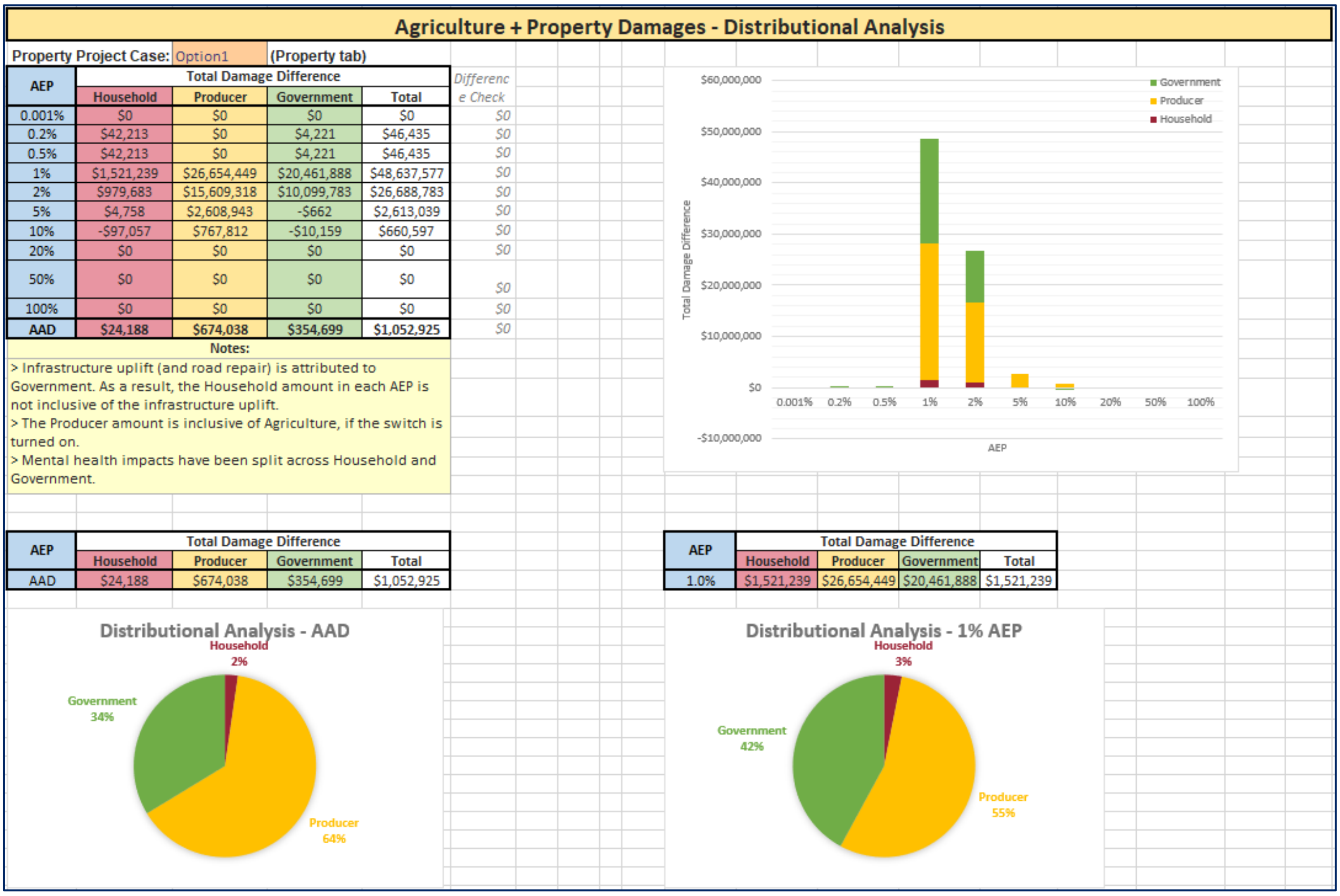
Sensitivity Analysis (primary discount rate)

Metric	BCR	NPV
PV Costs +40%	1.38	$4,451,170
PV Costs +20%	1.61	$6,123,228
PV Costs −20%	2.42	$9,467,344
PV Benefits +20%	2.32	$11,026,401
PV Benefits −20%	1.55	$4,564,171
PV Benefits −40%	1.16	$1,333,056

4.6.6 Distributional analysis

The Agriculture_CBA tab contains a distributional analysis that extends what is already presented in each individual Option[#]_Calc tab (see Section 4.5.3). The property tab of the selected option needs to be entered into cell AT3, and a combined property and agriculture distributional analysis is undertaken in Columns AR–BJ, based on the total incremental difference between the project case and base case. All agricultural impacts are attributed to the producer group. A snapshot of the combined distributional analysis for the case study (option 4 – agriculture levee extension, which includes option 1) is displayed in Figure 43.

Figure 43: Agriculture_CBA tab – combined distributional analysis



Agriculture + Property Damages - Distributional Analysis

Property Project Case: Option1 (Property tab)

AEP	Total Damage Difference				Difference Check
	Household	Producer	Government	Total	
0.001%	$0	$0	$0	$0	$0
0.2%	$42,213	$0	$4,221	$46,435	$0
0.5%	$42,213	$0	$4,221	$46,435	$0
1%	$1,521,239	$26,654,449	$20,461,888	$48,637,577	$0
2%	$979,683	$15,609,318	$10,099,783	$26,688,783	$0
5%	$4,758	$2,608,943	-$662	$2,613,039	$0
10%	-$97,057	$767,812	-$10,159	$660,597	$0
20%	$0	$0	$0	$0	$0
50%	$0	$0	$0	$0	$0
100%	$0	$0	$0	$0	$0
AAD	$24,188	$674,038	$354,699	$1,052,925	$0

Notes:
> Infrastructure uplift (and road repair) is attributed to Government. As a result, the Household amount in each AEP is not inclusive of the infrastructure uplift.
> The Producer amount is inclusive of Agriculture, if the switch is turned on.
> Mental health impacts have been split across Household and Government.

AEP	Total Damage Difference			
	Household	Producer	Government	Total
AAD	$24,188	$674,038	$354,699	$1,052,925

AEP	Total Damage Difference			
	Household	Producer	Government	Total
1.0%	$1,521,239	$26,654,449	$20,461,888	$1,521,239

4.7 Monte Carlo simulation

The MonteCarlo_Sim tab displays a set of outputs that relate to the Base Case AAD results, based on 1,000 flood event simulations across the assessment period timeframe (e.g. 30 years). The results are based on a series of linear interpolations between the AEP flood damage data points calculated in the BaseCase_Calc tab. The Monte Carlo simulation focuses on the total damage amount, but this can be adjusted by selecting from the drop-down list in cell C5.

Up to four additional scenarios can be incorporated into the Monte Carlo output using a switch contained in cell N4. In this case, rather than each of the 1,000 simulations looking up the point estimate results previously calculated in the Tool, they look up one of five scenarios. Scenario 1 is fixed at the point estimate calculated by the Tool, whereas scenarios 2-5 can be used to modify certain assumptions or inputs within the tool (using the ‘paste values’ function in Excel). Alternatively, they can be used to increase or decrease damage associated with each AEP event. An example of this is displayed in Figure 44, where the five scenarios are:

1. Point estimate from BaseCase_Calc tab
2. Damage +10 per cent
3. Damage –10 per cent
4. Damage +20 per cent
5. Damage –20 per cent.

If no sensitivity analysis is incorporated into the Monte Carlo, the switch in cell N4 can be left at zero. Alternatively, all five scenarios can be set to the point estimate determined from the BaseCase_Calc tab (i.e. the results displayed in cell range C5:C16).

Figure 44: MonteCarlo_Sim tab – five scenarios

	Base Case - Scenarios (1-5)					
Switch:	1	1	2	3	4	5
	Change in forecasted damage	0%	10%	-10%	20%	-20%
	0.001%	$346,879,754	$381,567,729	$312,191,778	$416,255,704	$277,503,803
	0.2%	$185,356,735	$203,892,409	$166,821,062	$222,428,082	$148,285,388
	0.5%	$110,594,211	$121,653,632	$99,534,789	$132,713,053	$88,475,368
	1%	$59,392,365	$65,331,602	$53,453,129	$71,270,838	$47,513,892
	2%	$30,298,859	$33,328,745	$27,268,973	$36,358,631	$24,239,087
	5%	$3,510,817	$3,861,898	$3,159,735	$4,212,980	$2,808,653
	10%	$984,868	$1,083,354	$886,381	$1,181,841	$787,894
	20%	$0	$0	$0	$0	$0
	50%	$0	$0	$0	$0	$0
	100%	$0	$0	$0	$0	$0
	AAD (excl. WTP)	$ 2,515,705	$ 2,767,275	$ 2,264,134	$ 3,018,846	$ 2,012,564

The four additional columns (2-5) can be updated to project-specific scenarios, using the 'paste values' function in Excel.

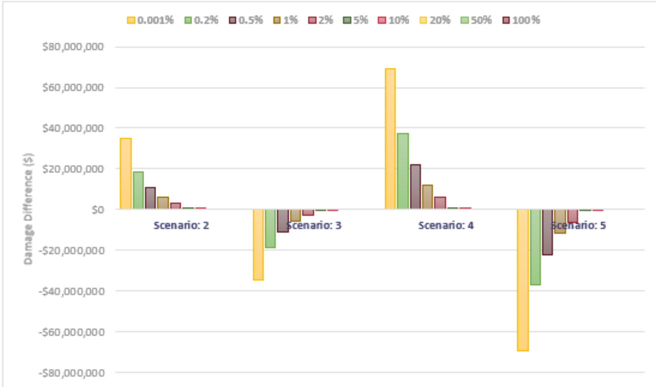


Figure 45 shows a snapshot of the Monte Carlo simulations, and displays the following outputs:

- scenarios one to five, derived from Figure 44
- average annual damage
- present value of damage
- number of damage events
- worst flood event (AEP).

Figure 45: MonteCarlo_Sim tab – snapshot of simulations and their associated outputs

	Simulation #:	1		2		3		4		5	
	Scenario (1-5)	1		4		3		1		2	
	Average Annual Damage	$2,116,795		$245,440		$7,213,748		$647,046		$648,650	
	Present Value of Damage	$16,252,270		$3,913,484		$106,092,739		$9,881,383		$9,161,821	
	Number of Damage Events	4		4		11		7		4	
	Worst Flood Event (AEP)	1.00%		5.41%		0.20%		4.60%		3.55%	
	Year	Simulation: 1	Damage	Simulation: 2	Damage	Simulation: 3	Damage	Simulation: 4	Damage	Simulation: 5	Damage
1	2023	74.03%	$0	78.63%	$0	32.52%	$0	59.56%	$0	39.50%	$0
2	2024	46.07%	$0	69.35%	$0	45.09%	$0	5.01%	$3,458,772	66.11%	$0
3	2025	39.29%	$0	79.73%	$0	66.18%	$0	53.57%	$0	47.20%	$0
4	2026	31.46%	$0	18.85%	$139,866	19.23%	$67,700	67.66%	$0	79.31%	$0
5	2027	71.59%	$0	34.26%	$0	7.06%	$2,192,669	57.28%	$0	86.80%	$0
6	2028	85.58%	$0	68.87%	$0	14.65%	$467,675	80.83%	$0	33.70%	$0
7	2029	43.26%	$0	11.64%	$1,014,858	3.05%	$18,604,860	6.18%	$2,872,721	60.94%	$0
8	2030	95.58%	$0	26.61%	$0	86.09%	$0	6.02%	$2,956,259	70.45%	$0
9	2031	84.12%	$0	73.82%	$0	76.04%	$0	96.97%	$0	40.30%	$0
10	2032	74.81%	$0	43.77%	$0	45.17%	$0	47.00%	$0	75.34%	$0
11	2033	27.36%	$0	5.41%	$4,075,023	66.05%	$0	83.99%	$0	70.75%	$0
12	2034	18.83%	$114,055	84.16%	$0	80.94%	$0	46.17%	$0	46.52%	$0
13	2035	41.52%	$0	94.52%	$0	8.35%	$1,612,679	67.21%	$0	53.57%	$0
14	2036	34.91%	$0	63.68%	$0	85.58%	$0	51.18%	$0	51.08%	$0
15	2037	9.21%	$1,366,093	78.72%	$0	0.20%	$166,899,621	24.89%	$0	3.55%	$17,837,500
16	2038	46.73%	$0	66.83%	$0	90.10%	$0	35.32%	$0	94.46%	$0
17	2039	68.46%	$0	92.79%	$0	11.99%	$700,006	11.78%	$798,277	41.23%	$0
18	2040	41.20%	$0	75.72%	$0	42.65%	$0	89.71%	$0	15.25%	$507,980
19	2041	78.28%	$0	64.71%	$0	16.27%	$326,369	89.58%	$0	61.95%	$0
20	2042	5.01%	$3,458,289	46.04%	$0	2.62%	$21,965,443	43.30%	$0	21.66%	$0
21	2043	50.19%	$0	38.82%	$0	78.71%	$0	90.52%	$0	17.78%	$237,062
22	2044	48.44%	$0	86.31%	$0	72.83%	$0	66.38%	$0	59.83%	$0
23	2045	97.23%	$0	8.52%	$2,133,459	26.93%	$0	8.75%	$1,594,883	11.79%	$876,953
24	2046	49.59%	$0	26.69%	$0	43.24%	$0	25.41%	$0	70.93%	$0
25	2047	38.51%	$0	42.72%	$0	70.47%	$0	12.68%	$711,555	53.67%	$0
26	2048	73.54%	$0	47.95%	$0	48.26%	$0	22.03%	$0	77.63%	$0
27	2049	85.66%	$0	76.63%	$0	51.66%	$0	61.24%	$0	60.61%	$0
28	2050	71.46%	$0	93.40%	$0	6.56%	$2,417,419	90.68%	$0	59.64%	$0
29	2051	1.00%	$58,565,420	54.01%	$0	9.37%	$1,157,986	88.56%	$0	27.88%	$0
30	2052	54.50%	$0	39.62%	$0	99.01%	$0	4.60%	$7,018,901	85.57%	$0

4.7.1 Outputs

The MonteCarlo_Sim tab also contains a series of outputs:

- Histograms (Figure 46), which display the distribution of AAD and the present value of damage across the 1,000 simulations.

- Distribution plots (Figure 47), which display the random distribution of floods for the following key simulations:
  - — minimum AAD
  - — maximum AAD
  - — minimum PV Damage
  - — maximum PV Damage.

Figure 46: MonteCarlo_Sim tab – histogram outputs (AAD and PV of damage)

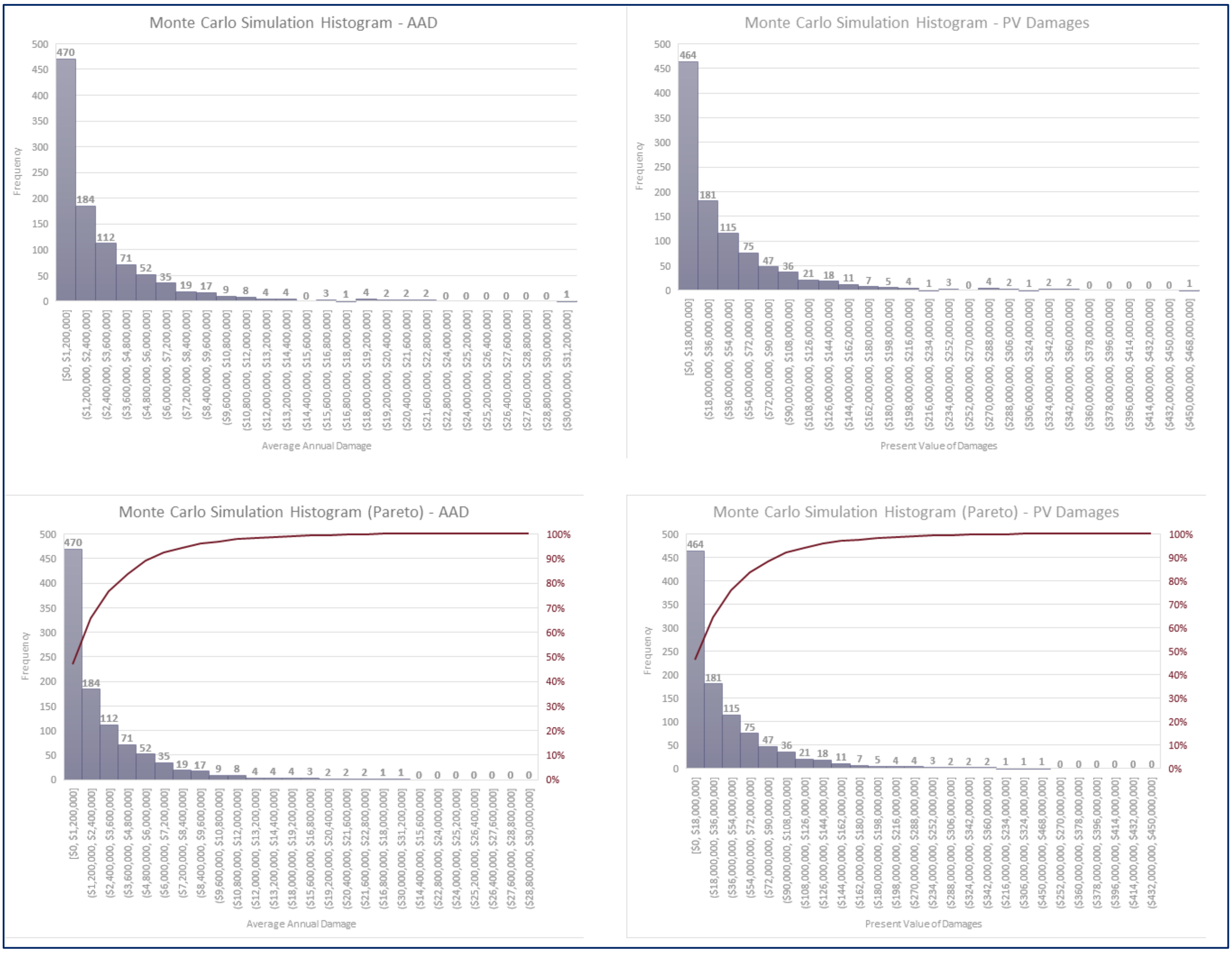
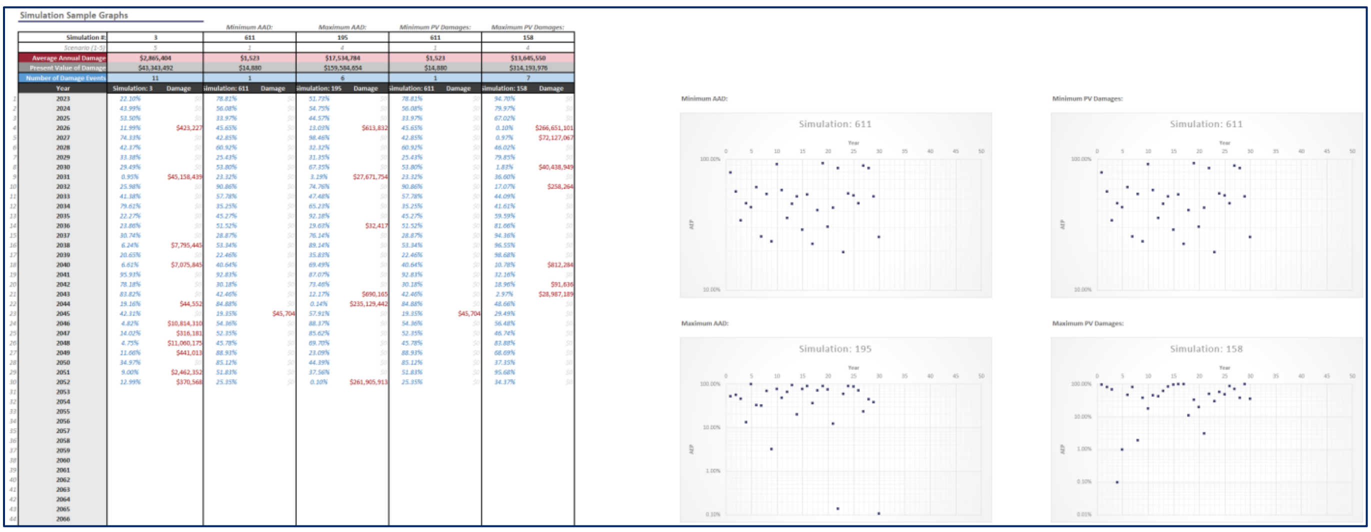


Figure 47: MonteCarlo_Sim tab – key simulations



4.7.2 Results

The summary results of the Monte Carlo simulations are presented in cell range B32:D40 (Table 32). Eight key metrics are outputted for the AAD and present value of damage, as defined in Table 33.

Table 32: MonteCarlo_Sim tab – results

	AAD	Damage PV
Minimum	$0	$0
Maximum	$30,075,090	$462,327,842
Range	$30,075,090	$462,327,842
Mean	**$2,557,330**	**$39,312,430**
Median	$1,311,589	$20,162,334
Standard Deviation	$3,380,439	$51,965,630
Skewness	2.93	2.93
Kurtosis	12.20	12.20

Table 33: Monte Carlo Sim tab – result metric definitions

Metric	Definition
Minimum	The lowest value in the dataset.
Maximum	The highest value in the dataset.
Range	The difference between the maximum and minimum.
Mean	The average value in the dataset.
Median	The middle value in an ordered dataset.
Standard Deviation	A measure of disbursement in a dataset, calculated by averaging the difference between each element and the mean of the dataset.
Skewness	A measure of symmetry; a positive value means that the distribution is skewed right (i.e. right tail longer than the left).
Kurtosis	A measure of whether the dataset has a heavy or light tail relative to a normal distribution (which has a kurtosis of 3) – the higher the number of outliers (i.e. heavier tail), the greater the kurtosis.

4.7.3 Cost-benefit analysis

The MC_CBA tab conducts a simple CBA of an option relative to the base case. The name of the option calculation tab being assessed against the base case needs to be entered in cell C17. A series of inputs already entered by the user throughout the Tool are replicated in cell range B32:C36, as shown in Figure 48. The MC_CBA tab can also be duplicated to conduct another CBA with a different option.

Figure 48: MC_CBA tab – user input summary

Base Year	2023	
Completion	2025	*Note that project benefits are not realised until this year*
Assessment Period (Y)	30	
Final year	2054	
Discount Rate (p.a.)	5%	

As stated in Section 4.4.1, flood modelling needs to be undertaken for each option. The MC_CBA tab, however, contains a retrospective solution that allows the calculation of a BCR by estimating an overall percentage reduction in damage. This is controlled through cell D18 (set to 'Reduction'), and damage reduction percentages are specified by the user in cell range F16:L16. This component is only provided for testing purposes and should not be used in the final CBA.

Figure 49 summarises the retrospective reduction capability. Project cost inputs are required, detailed in the following subsection.

Figure 49: MC_CBA tab – retrospective reduction capability

Base Case	
Annual Exceedance Probability	**Total**
0.001%	$346,879,754
0.2%	$185,356,735
0.5%	$110,594,211
1%	$59,401,595
2%	$30,308,105
5%	$3,516,179
10%	$984,831
20%	$0
50%	$0
100%	$0

	Base Case	AEP Event Damage					
	Annual Exceedance Probability	**Total**	**Structural**	**Internal**	**External**	**Intangibles**	**Agriculture**
1	0.001%	$346,879,754	$237,896,983	$45,835,353	$7,265,325	$53,306,101	$2,575,992
2	0.2%	$185,356,735	$165,118,022	$13,396,517	$2,587,650	$2,827,194	$1,427,352
3	0.5%	$110,594,211	$100,296,314	$6,227,325	$1,373,445	$1,848,575	$848,553
4	1%	$59,401,595	$53,526,605	$3,067,469	$855,915	$1,412,270	$539,336
5	2%	$30,308,105	$28,502,110	$945,573	$378,195	$183,974	$298,254
6	5%	$3,516,179	$3,289,196	$54,292	$99,525	$5,781	$67,385
7	10%	$984,831	$936,727	$0	$39,810	$0	$8,294
8	20%	$0	$0	$0	$0	$0	$0
9	50%	$0	$0	$0	$0	$0	$0
10	100%	$0	$0	$0	$0	$0	$0
	Damage Reduction % (compared with BC):	10%	10%	10%	10%	10%	10%

Property Project Case:	Option1_Calc	*Please enter*
Project Case		Reduction
Annual Exceedance Probability	**Total**	***Damage Change %***
0.001%	$312,191,778	*-10.0%*
0.2%	$166,821,062	*-10.0%*
0.5%	$99,534,789	*-10.0%*
1%	$53,461,436	*-10.0%*
2%	$27,277,295	*-10.0%*
5%	$3,164,561	*-10.0%*
10%	$886,348	*-10.0%*
20%	$0	-
50%	$0	-
100%	$0	-

	Project Case	AEP Event Damage - obtained from *reduction above*					
	Annual Exceedance Probability	**Total**	**Structural**	**Internal**	**External**	**Intangibles**	**Agriculture**
1	0.001%	$312,191,778	$214,107,285	$41,251,818	$6,538,792	$47,975,491	$2,318,392
2	0.2%	$166,821,062	$148,606,220	$12,056,865	$2,328,885	$2,544,475	$1,284,617
3	0.5%	$99,534,789	$90,266,682	$5,604,592	$1,236,101	$1,663,717	$763,697
4	1%	$53,461,436	$48,173,944	$2,760,722	$770,324	$1,271,043	$485,403
5	2%	$27,277,295	$25,651,899	$851,015	$340,376	$165,577	$268,429
6	5%	$3,164,561	$2,960,277	$48,863	$89,573	$5,203	$60,646
7	10%	$886,348	$843,054	$0	$35,829	$0	$7,465
8	20%	$0	$0	$0	$0	$0	$0
9	50%	$0	$0	$0	$0	$0	$0
10	100%	$0	$0	$0	$0	$0	$0

Costs

The CBA component requires two cost inputs: the total capital cost and ongoing operational (i.e. maintenance cost) of each option. These costs are respectively entered in cells C39 and C40. Based on these values, an expenditure profile needs to be entered in Column C, below cell C62, and a segment of this is displayed in Figure 50. Note that this profile may already be defined in the Option[#]_Calc tab (and Agriculture_CBA tab if Agriculture is switched on) defined in cell C17.

Figure 50: MC_CBA tab – project costings and expenditure profile

Total Capital Cost	$3,040,000
Recurrent Cost	$12,920

		Present Value
		$3,209,764
		Project Cost
	1	$1,520,000
	2	$1,520,000
OPEN	3	$12,920
	4	$12,920
	5	$12,920
	6	$12,920
	7	$32,920
	8	$12,920
	9	$12,920
	10	$12,920
	11	$12,920
	12	$32,920
	13	$12,920
	14	$12,920

Benefits

The CBA component of the Tool focuses on avoided damage and residual value.

Avoided damage

To estimate avoided damage results from flood modelling of the mitigation option(s) must be inserted into the Option[#] tab, as detailed in Section 4.4.1. It is important to ensure that cell D18 is set to ‘Modelling’ and the results displayed in table range N18:T29 are linked to the correct option (defined in cell C17).

Like the Base Case (Section 4.6), 1,000 Monte Carlo simulations are undertaken that incorporate random flood events in each year of the economic assessment period (Figure 51). The year of opening (i.e. project completion), as defined in Figure 48, is highlighted purple across all simulations and this is the first year in which avoided damage benefits can be realised.

Each CBA simulation can also look up a user-defined scenario randomly, in line with the base case approach, and these scenarios are specified in cell range X5:AB29 (example displayed in Figure 52). By default, however, this functionality is switched off within the tool. If used, each individual CBA simulation looks up the same scenario, as the project case versus base case comparison needs to be like-for-like.

Figure 51: MC_CBA tab – snapshot of simulations and their associated outputs

		Simulation #:	1					2					3				
		Damage Events	10					7					6				
		Average Annual Damage Avoided	$284,065					$1,008,361					$428,642				
		NPV:	-$468,813					$15,394,965					$146,339				
	Present Value	BCR:	0.90					4.05					1.02				
	$5,033,412	Present Value:	1	$20,395,581	$16,316,465	$4,039,934	-$468,813	1	$99,518,558	$79,614,846	$19,903,712	$15,394,965	5	$24,144,067	$19,315,254	$4,655,085	$146,339
	Project Cost	Year	Simulation: 1	BC Damage	PC Damage	Avoided	Net Benefit	Simulation: 2	BC Damage	PC Damage	Avoided	Net Benefit	Simulation: 3	BC Damage	PC Damage	Avoided	Net Benefit
1	$2,500,000	2023	77.71%	$0	$0	$0	-$2,500,000	65.09%	$0	$0		-$2,500,000	15.14%	$256,653	$205,323		-$2,500,000
2	$1,250,000	2024	17.08%	$205,706	$164,565	$0	-$1,250,000	27.26%	$0	$0		-$1,250,000	13.77%	$329,211	$263,368		-$1,250,000
3	$1,250,000	2025	38.01%	$0	$0	$0	-$1,250,000	33.31%	$0	$0		-$1,250,000	13.77%	$329,046	$263,237		-$1,250,000
4	$15,000	2026	57.36%	$0	$0	$0	-$15,000	1.51%	$40,742,500	$32,594,000	$8,148,500	$8,133,500	68.83%	$0	$0	$0	-$15,000
5	$15,000	2027	24.74%	$0	$0	$0	-$15,000	11.19%	$620,903	$496,722	$124,181	$109,181	88.33%	$0	$0	$0	-$15,000
6	$15,000	2028	88.58%	$0	$0	$0	-$15,000	47.02%	$0	$0	$0	-$15,000	16.09%	$206,529	$165,223	$41,306	$26,306
7	$15,000	2029	8.33%	$5,014,718	$4,011,775	$1,002,944	$987,944	88.80%	$0	$0	$0	-$15,000	94.97%	$0	$0	$0	-$15,000
8	$15,000	2030	25.75%	$0	$0	$0	-$15,000	32.94%	$0	$0	$0	-$15,000	54.81%	$0	$0	$0	-$15,000
9	$15,000	2031	56.08%	$0	$0	$0	-$15,000	50.14%	$0	$0	$0	-$15,000	32.55%	$0	$0	$0	-$15,000
10	$15,000	2032	18.98%	$72,029	$57,623	$14,406	-$594	36.67%	$0	$0	$0	-$15,000	99.20%	$0	$0	$0	-$15,000
11	$15,000	2033	96.65%	$0	$0	$0	-$15,000	0.87%	$68,870,299	$55,096,239	$13,774,060	$13,759,060	65.36%	$0	$0	$0	-$15,000
12	$15,000	2034	11.98%	$564,877	$451,902	$112,975	$97,975	58.14%	$0	$0	$0	-$15,000	25.21%	$0	$0	$0	-$15,000
13	$15,000	2035	44.66%	$0	$0	$0	-$15,000	48.57%	$0	$0	$0	-$15,000	31.10%	$0	$0	$0	-$15,000
14	$15,000	2036	91.10%	$0	$0	$0	-$15,000	82.08%	$0	$0	$0	-$15,000	92.39%	$0	$0	$0	-$15,000
15	$15,000	2037	6.62%	$9,402,546	$7,522,037	$1,880,509	$1,865,509	53.45%	$0	$0	$0	-$15,000	80.39%	$0	$0	$0	-$15,000
16	$15,000	2038	90.33%	$0	$0	$0	-$15,000	31.55%	$0	$0	$0	-$15,000	5.63%	$8,973,277	$7,178,622	$1,794,655	$1,779,655
17	$15,000	2039	36.84%	$0	$0	$0	-$15,000	33.71%	$0	$0	$0	-$15,000	27.07%	$0	$0	$0	-$15,000
18	$15,000	2040	97.10%	$0	$0	$0	-$15,000	76.86%	$0	$0	$0	-$15,000	90.21%	$0	$0	$0	-$15,000
19	$15,000	2041	3.92%	$18,685,230	$14,948,184	$3,737,046	$3,722,046	1.35%	$44,941,230	$35,952,984	$8,988,246	$8,973,246	96.81%	$0	$0	$0	-$15,000
20	$15,000	2042	79.45%	$0	$0	$0	-$15,000	12.47%	$530,569	$424,455	$106,114	$91,114	39.02%	$0	$0	$0	-$15,000
21	$15,000	2043	81.41%	$0	$0	$0	-$15,000	14.15%	$412,425	$329,940	$82,485	$67,485	1.32%	$34,305,638	$27,444,510	$6,861,128	$6,846,128
22	$15,000	2044	44.75%	$0	$0	$0	-$15,000	63.28%	$0	$0	$0	-$15,000	52.27%	$0	$0	$0	-$15,000
23	$15,000	2045	16.86%	$221,212	$176,969	$44,242	$29,242	28.45%	$0	$0	$0	-$15,000	47.42%	$0	$0	$0	-$15,000
24	$15,000	2046	28.71%	$0	$0	$0	-$15,000	99.20%	$0	$0	$0	-$15,000	89.43%	$0	$0	$0	-$15,000
25	$15,000	2047	12.79%	$508,063	$406,451	$101,613	$86,613	62.13%	$0	$0	$0	-$15,000	48.92%	$0	$0	$0	-$15,000
26	$15,000	2048	15.42%	$323,092	$258,474	$64,618	$49,618	55.75%	$0	$0	$0	-$15,000	52.37%	$0	$0	$0	-$15,000
27	$15,000	2049	15.77%	$298,050	$238,440	$59,610	$44,610	32.38%	$0	$0	$0	-$15,000	47.17%	$0	$0	$0	-$15,000
28	$15,000	2050	5.70%	$11,780,903	$9,424,723	$2,356,181	$2,341,181	40.62%	$0	$0	$0	-$15,000	94.69%	$0	$0	$0	-$15,000
29	$15,000	2051	59.03%	$0	$0	$0	-$15,000	47.24%	$0	$0	$0	-$15,000	50.46%	$0	$0	$0	-$15,000
30	$15,000	2052	22.40%	$0	$0	$0	-$15,000	6.29%	$10,261,667	$8,209,334	$2,052,333	$2,037,333	7.94%	$4,505,171	$3,604,137	$901,034	$886,034
31	$15,000	2053	91.09%	$0	$0	$0	-$15,000	46.96%	$0	$0	$0	-$15,000	18.26%	$91,782	$73,426	$18,356	$3,356
32	$15,000	2054	88.00%	$0	$0	$0	-$15,000	82.49%	$0	$0	$0	-$15,000	29.85%	$0	$0	$0	-$15,000
33	$15,000	2055	60.42%	$0	$0	$0	$2,485,000	96.36%	$0	$0	$0	$2,485,000	1.91%	$22,643,574	$18,114,859	$4,528,715	$7,013,715

Figure 52: MC_CBA tab – five scenarios (example)

	Base Case					
Switch:	1	*1*	*2*	*3*	*4*	*5*
	Change in forecasted damage	0%	10%	-10%	25%	-25%
	0.001%	$276,871,555	$304,558,710	$249,184,399	$346,089,443	$207,653,666
	0.2%	$146,017,368	$160,619,105	$131,415,632	$182,521,711	$109,513,026
	0.5%	$108,653,886	$119,519,274	$97,788,497	$135,817,357	$81,490,414
	1%	$54,334,183	$59,767,602	$48,900,765	$67,917,729	$40,750,637
	2%	$27,756,147	$30,531,762	$24,980,532	$34,695,184	$20,817,110
	5%	$13,572,907	$14,930,197	$12,215,616	$16,966,133	$10,179,680
	10%	$704,731	$775,204	$634,258	$880,913	$528,548
	20%	$0	$0	$0	$0	$0
	50%	$0	$0	$0	$0	$0
	100%	$0	$0	$0	$0	$0

The four additional columns (2-5) can be updated to project-specific scenarios, using the 'paste values' function in Excel.

	Project Case					
Switch:	1	*1*	*2*	*3*	*4*	*5*
	Change in forecasted damage	0%	10%	-10%	25%	-25%
	0.001%	$221,497,244	$243,646,968	$199,347,519	$276,871,555	$166,122,933
	0.2%	$116,813,895	$128,495,284	$105,132,505	$146,017,368	$87,610,421
	0.5%	$86,923,108	$95,615,419	$78,230,798	$108,653,886	$65,192,331
	1%	$43,467,347	$47,814,081	$39,120,612	$54,334,183	$32,600,510
	2%	$22,204,917	$24,425,409	$19,984,426	$27,756,147	$16,653,688
	5%	$10,858,325	$11,944,158	$9,772,493	$13,572,907	$8,143,744
	10%	$563,785	$620,163	$507,406	$704,731	$422,838
	20%	$0	$0	$0	$0	$0
	50%	$0	$0	$0	$0	$0
	100%	$0	$0	$0	$0	$0

Residual value

The estimated asset value at the end of the economic assessment period is the residual value. Within the CBA, it can be claimed as a benefit in the final year of the assessment period, discounted to present day. An example of the calculation of residual value is presented below:

- Mitigation option: constructing a levee around a township
- Capital cost: $5,000,000
- Service life (with regular maintenance) is 60 years
- Economic assessment period is 30 years
- Residual value (attributed to year 30) = 5,000,000 × 30 ÷ 60 ≈ $2.5m (undiscounted).

Within the MC_CBA tab, the undiscounted residual value is entered in cell C42 (Figure 53). This cell may already be populated using the respective Option[#]_Calc tab (and Agriculture_CBA tab if Agriculture is switched on).

Figure 53: MC_CBA tab – residual value

Residual Value	$1,216,000	*Included in the Net Benefit below*
Present Value:	$267,957	*Included in the BCR calculation below*

Results

The results of the CBA are presented in cell range N5:R15, as displayed in Figure 54.[24] Histograms have also been provided which display the distribution of results (Figure 55).

Figure 54: MC_CBA tab – results of the cost-benefit analysis

Summary Statistics	Average Annual Damage Avoided	Benefit Cost Ratio	Net Present Value	Number of Damage Events
Minimum:	$0	0.1	-$2,941,807	0
Maximum:	$5,315,908	27.9	$86,301,478	13
Range:	$5,315,908	27.8	$89,243,286	13
Median:	$821,432	3.7	$8,683,199	6.0
Mean:	$982,361	4.9	$12,461,626	6.0
Standard Deviation:	$863,342	4.5	$14,343,046	2.1
Kurtosis:	1.92	2.0	2.03	
Skewness:	1.24	1.3	1.34	
	BCR < 1	21.90%	*219 / 1000*	
	BCR >= 1	78.10%	*781 / 1000*	

[24] The terms presented in this figure are defined in Table 33.

Figure 55: MC_CBA tab – histogram outputs (NPV and BCR)

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