Appendix B

Feasibility Assessment Methodology

Contact Information

Rhelm Pty Ltd
ABN : 55 616 964 517
50 Yeo Street
Neutral Bay NSW 2089
Australia

Lead Author:
Duncan Turner
contact@rhelm.com.au

Rhelm

Table of Contents

Figures

Tables

1 Introduction

1.1 Overview

This document provides an overview of the methodology that has been adopted for the feasibility assessment of Planned Retreat at representative locations across Australia. It uses a combination of IAG's internal databases for residential damages, together with available literature and guidance on flood damages, and compares these against strategic level cost estimates for the Planned Relocation measures of property Buy-backs and Community Relocation at four (4) representative locations.

The feasibility assessment components are:

- **Cost-benefit analysis** - the present value of costs and economic benefits over a 50-year period, using a discount rate of 5%[1]
- **Risk to life** – the potential loss of life (PLL) per year in each location compared to the accepted threshold[2]
- **Affordability** – the average annual damage amounts[3] compared to the median annual average household income in each location[4]. This represents the potential costs associated with either insurance, or repairs where the property owner does not have sufficient insurance.

The key purpose of the feasibility assessment is to:

- To support the main discussion paper document and complement the case study component of this project to provide a holistic policy and economic assessment of Planned Relocation.
- Provide an understanding of the order-of-magnitude of economic costs and benefits of Planned Relocation at different flood prone locations across Australia.
- To discuss complementary measures for the feasibility of Planned Relocation such as risk to life and affordability of damages.

1.2 Representative Area Location Selection

The case study locations have been selected to assess Planned Relocation costs and benefits in a range of flood risk scenarios. The locations were selected as having relatively high flood risk, based on available information from IAG and other flood related data.

For the purposes of this analysis, no alternative mitigation measures were considered for these areas. The assessment assumes that Planned Relocation is one viable option to be considered in a portfolio of hazard mitigation options and does not evaluate Planned Relocation over other natural hazard mitigation options.

For sensitivity reasons, the four representative locations have not been identified and are reported as:

- **Mid North Coast NSW** - A township located on the east coast of NSW, on a large riverine floodplain.

[1] The NSW Treasury (2023) NSW Government Guide to Cost-Benefit Analysis recommends a social discount rate of 5%, with sensitivity testing at 3% and 7%.

[2] Typical threshold for loss of life adopted, including for dam safety (e.g. NSW Government, 2019). PLL estimated using draft methodology as outlined in NSW Government (2022)

[3] Based on IAG data for each location

[4] Based on Australian Bureau of Statistics Census 2021 information

- **Central Victoria** - A township located in Central Victoria, in a low-lying area on the banks of a major waterway.
- **North-east Queensland** - A township located in North-East Queensland, at the confluence of two rivers.
- **Northern NSW** – A coastal suburb located on an estuary, at risk of sea level rise and coastal inundation.

The key demographic factors of each location are summarised in Figure 1-Figure 4.

Representative Area 1 – Mid North Coast, NSW	
Total properties considered for Retreat (approx.)	400
Study area average annualised damage per dwelling	$30,000
Population (estimated)	1000
Proportion of Properties affected in 1 in 20 AEP	100%
Average Annual Household Income	$60,000
% of NSW Average Income	65%
SEIFA IRSD Index[5]	1.0

Figure 1 Representative Area 1 – Mid North Coast

Representative Area 2 – Central Victoria	
Total properties considered for Retreat	68
Study area average annualised damage per dwelling	$5,000
Population (estimated)	170
Proportion of Properties affected in 1 in 20 AEP	88%
Average Annual Household Income	$60,000
% of Victoria Average Income	65%
SEIFA IRSD Index	1.0

Figure 2 Representative Area 2 - Central Victoria

[5] Socio-Economic Indexes for Areas (SEIFA) is an Australian Bureau of Statistics (ABS) product using Census information to rank Australian locations according to relative socio-economic advantage and disadvantage on a scale of 1 (disadvantaged) to 5 (advantaged).

Representative Area 3 – North-East Queensland	
Total properties considered for Retreat	27
Study area average annualised damage per dwelling	$20,000
Population (estimated)	70
Proportion of Properties affected in 1 in 20 AEP	100%
Average Annual Household Income	$55,000
% of Queensland Average Income	60%
SEIFA IRSD Index	2.0

Figure 3 Representative Area 3 - Representative Area 3 - North-East Queensland

Representative Area 4 – North Coast, NSW	
Total properties considered for Retreat	105
Study area average annualised damage per dwelling	$11,500
Population (estimated)	250
Proportion of Properties affected in 1 in 20 AEP	90%
Average Annual Household Income	$65,000
% of NSW Average Income	85%
SEIFA IRSD Index	3.0

Figure 4 Representative Area 4 - North Coast, NSW

1.3 Terminology

The economic impacts of flooding are typically estimated through ‘damages’, representing the economic loss at different magnitude flood events.

Benefits from flood mitigation are then typically measured as the reduction in damages that would be achieved because of a mitigation measure.

In referring to damages, there are three key categories that are typically referred to:

- **Tangible Damages – Direct**: these represent the direct cost/impact on the property and building being inundated by floodwaters, and the clean-up costs associated with the removal of debris. For example, the damage to the contents of a house or structural damage to a building.
- **Tangible Damages – Indirect**: these represent the ‘knock-on’ costs/impacts as a result of direct damages. They can include relocation and evacuation costs, loss of wages or sales for a business following a flood etc. These are typically associated with properties that are impacted by flooding. However, properties adjacent to the flooding can also be impacted (for example, a commercial property impacted by a reduction in customers as a result of surrounding flood impacts).

* **Intangible Damages:** these represent the social and environmental costs beyond those identified above. They can be both direct or indirect and may include mental health issues, risk to life, impacts to the environment and community, etc. They are typically difficult to quantify and estimating their potential reduction because of a mitigation measure can be highly challenging.

In the context of Planned Relocation as a mitigation measure, depending on the scale of the program that is implemented, there may also be benefits that are additional to the reduction or avoidance of costs. These include:

* **Intangible Benefits:** these represent social and economic benefits that do not have a market value such as amenity values accruing to the community from returning vacated land to the local community through public spaces or improved connectivity to riverside areas; or benefits accruing to society more broadly from returning vacated land to the environment through remediated riparian land.

Figure 5 provides a graphical illustration of the types of tangible and intangible damages associated with a flood event.

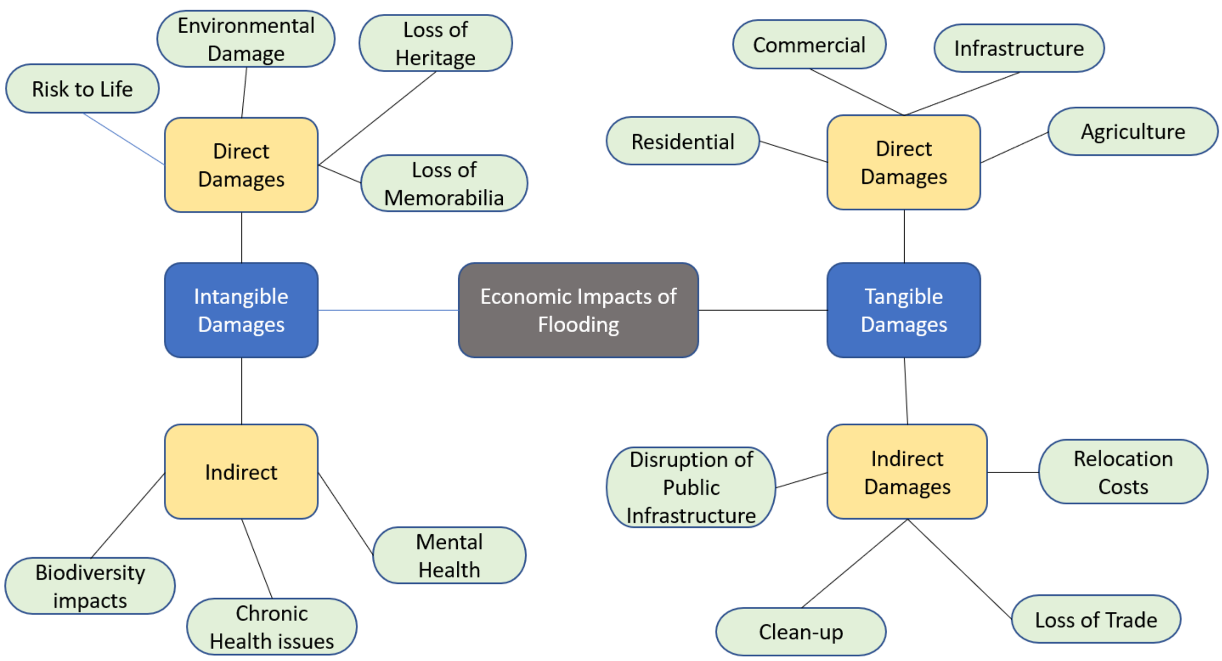

Figure 5 Intangible and tangible damages associated with a flood event (Source: revised version of figure published by Deloitte (2015))

2 Cost Benefit Analysis

2.1 Key Economic Assumptions

The following key economic assessment parameters were adopted in the analysis:

- Economic Assessment Period – 50 years. This period starts from the commencement of the construction of the proposed mitigation measure. Government agencies typically prescribe a 30-year assessment period. However as Planned Relocation will provide benefits in perpetuity, and most new dwellings would have an expected service life of at least 50 years, a 50-year assessment period has been adopted in this analysis.
- Base year of 2022/23.
- Discount Rate – 5%.

The 5% discount rate is commonly adopted as the core discount rate across most jurisdictions in Australia. Discount rates of 3% and 7% are applied in the sensitivity analysis.

The benefits identified within this report are based on a literature review of flood studies and economic impact assessments, both in Australia and internationally. Where possible, Rhelm has identified values associated with recent flood events in Australia.

2.2 Costs

The costs of two Planned Relocation options were investigated:

- **Property buy-back** (Buy-back) – a scheme based on the purchase of high-risk properties (determined by flood risk ratings)
- **Community Relocation** – a scheme based on the purchase and sub-division of vacant land and construction of new houses away from the floodplain for community resettlement.

The type of costs of the two schemes can be divided into four categories:

- **Property related costs** – the purchase of at-risk properties (Buy-back) and the cost of demolition (Buy-back, relocation)
- **Relocation costs** – the purchase and sub-division of land for resettlement[6] and construction of new housing stock (relocation)
- **Reclaimed land related costs** – costs related to the remediation of vacated land. For this assessment, it was assumed that the vacated land would be converted to public space (e.g. parkland)
- **Transaction costs** – the administrative costs related to the scheme. Transaction costs were not included in this analysis as they are likely to be transfer costs where resources are reallocated from one use to another, and hence are not considered an incremental cost to society.

The costs of Planned Relocation were found to be highly variable depending on the design of the scheme (Buy-back or Community Relocation); the location of the scheme due to the ranges in house and land prices across Australia; and size of the scheme where larger schemes (particularly Community

[6] For the purposes of this assessment, it was assumed that where the number of properties for the Community Relocation was small, that it would be undertaken as a part of a much larger subdivision (at least 100 – 200 lots) and therefore there would be lower subdivision costs.

Relocation) had economies of scale. To illustrate the spectrum of costs, **Figure 6** provides an indication of the range of subdivision costs based on the total number of lots in the subdivision.

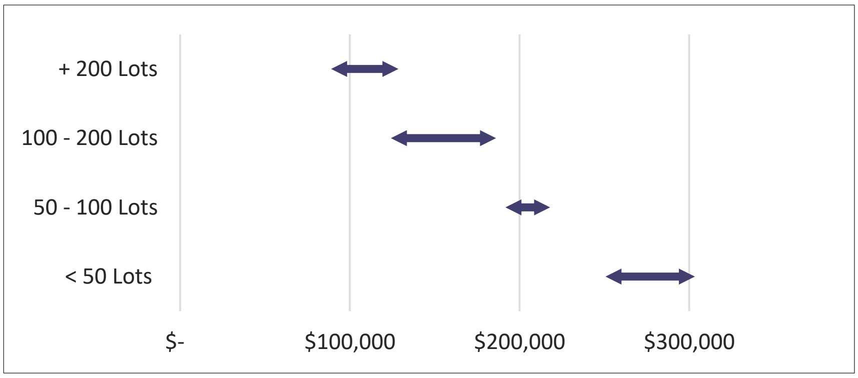

Figure 6 Sub-division costs per lot[7] (source: Enspire Solutions)

2.2.1 Property Related Cost Estimates

Property related costs include the purchase of at-risk properties and the cost of demolition of those properties once purchased.

Case-study research found that, typically, previous Planned Relocation schemes purchased at-risk properties at pre-disaster market prices. As such, for inclusion in the economic assessment, an average property price for each representative area was calculated based on publicly available information on recent property sales within the immediate location.

The average prices adopted for each location are shown in **Table 1** below.

Table 1 Average property price ($2022)

Representative Area	Range	Adopted average
Mid-North Coast NSW	$350,000 - $550,000	$410,000
Central Victoria	$300,000 - $500,000	$420,000
North-East Qld	$200,000 - $385,000	$285,000
Northern NSW	$1,000,000 - $2,500,000	$1,500,000

Source: Domain.com and Realestate.com

The relatively higher property price range in Northern NSW is reflective of the coastal estuary location, compared to the flood-plain location of the first three areas. The range of market prices provides an indication of the wide range of costs potentially facing Planned Relocation policy makers in various locations.

The costs of property demolition were obtained from stakeholder consultation and review of publicly available information on previous Planned Relocation schemes. Demolition costs were found to be highly variable depending on the scheme, for example demolition of houses known to have asbestos

[7] Costs are based on sub-division projects completed in Sydney, NSW.

were double the cost of houses that did not contain asbestos[8]. The low to high range of costs adopted in this analysis is shown in **Table 2.** The core analysis used mid-range costs, where high and low costs were adopted for sensitivity testing.

Table 2 Demolition costs

	Low	Mid	High
Demolition costs	$10,000	$25,000	$40,000

Source: Stakeholder consultation

2.2.2 Relocation Costs

Relocation costs include the purchase and sub-division of land for resettlement and construction of new housing stock. For the purposes of this assessment, it was assumed that where the number of properties for the Community Relocation was small, that it would be undertaken as a part of a much larger subdivision (at least 100 – 200 lots). This assumption was based on stakeholder interviews and case-study reviews which reported that Planned Relocation schemes have tended to create additional improved lots for sale on the open market (see **Appendix A**). This is done to achieve economy of scale and as a means offsetting the initial costs of the scheme.

In some reported case-studies, the land used for Planned Relocation schemes was already owned by the local government authority. This analysis assumed that land would be purchased on the open market, as land in existing local government authority ownership would have a market value which represents the opportunity cost of its use for a Planned Relocation scheme. The costs adopted in the analysis are based on publicly available information on rural land prices.

Sub-division costs were obtained from civil engineering and construction project management firm Enspire Solutions. The costs supplied were fully costed estimates based on actual projects completed in Sydney, NSW and included costs such as water and sewer connections, and electrical and communications connections. Sub-division costs are highly variable depending on the scale of the project.

House construction costs adopted in the analysis were based on information on the cost of package home construction sourced from the Rawlinsons Construction Cost Guide 2022 - Edition 30. The low to high range of relocation costs adopted in this analysis are shown in **Table 3** . The core analysis used mid-range costs were high and low costs were adopted for sensitivity testing.

Table 3 Relocation costs

	Low	Mid	High
Land purchase/m^2	$10	$50	$60
Sub-division/lot	$125,000	$155,000	$185,000
House construction/m^2	$1,460	$1,530	$1,600

[8] The ACT Government report that cost of average cost of demolition of a 'Mr Fluffy' house was $89,946 where interviewed stakeholders reported average demolition costs of non-asbestos houses was between $15,000 - $30,000.

2.2.3 Vacated Land Related Cost Estimates

Vacated land related costs are the costs of remediating vacated properties. This cost has been quantified in the analysis as surrendered land will have an opportunity cost to society, whereby it can be repurposed to satisfy alternative community or private needs. Repurposed land will also provide benefits and therefore the cost should be quantified in the CBA to allow for estimation of the net benefit. This assessment assumed that all vacated land would be converted to passive open space (e.g. parkland) due to the land being flood prone.

The parameter values adopted for estimating remediation costs were obtained from the NSW Department of Planning and Environment (DPE 2022) *Interim Framework for Valuing Green Infrastructure and Public Spaces* (March version). DPE (2022) state that, generally, cost estimates will be specific to the individual projects but where such site-specific costs are not available benchmark costs can be used. The DPE (2022) passive open space benchmark costs adopted in this analysis are show in **Table 4**.

Table 4 Open space parameter cost (per Sqm)

	Amount	Frequency	Description
Capital costs	$175	One off	Embellishment cost of regional open space, not including land acquisition or management costs
Maintenance costs	$0.96	Year	Annual cost of maintenance

Source: DPE (2022) Interim Framework for Valuing Green Infrastructure and Public Spaces Table 4.1

2.2.4 Transaction Costs

Transaction costs are the administrative costs related to the scheme. Transaction costs were not included in this analysis as they are likely to be transfer costs where resources are reallocated from one use to another, and hence are not considered an incremental cost to a given scheme (i.e., the movement of staff from one purpose to another does not create an incremental cost).

The exception to this assumption will be where agencies are created for the specific purpose of implementing a planned relocation scheme, creating new resource requirements. However, the costs and benefits of creating such an agency should be considered in isolation.

2.3 Natural Hazard Damages

A key component of the economic analysis of Planned Retreat was the quantification of tangible and intangible damages. This is because the primary benefit of Planned Relocation, and indeed any natural hazard mitigation scheme, is likely to be future avoidance or minimising of damages costs. This section discusses the available methodologies and the adopted approach.

2.3.1 Tangible damages

Residential damages

IAG provided key summarised information from their risk modelling for the study areas, as per Section 2 of the main report. This information was provided at an Australian Bureau of Statistics (ABS) Mesh Block scale.

In addition to direct damages, it is understood that the AAD provided also incorporates indirect damages, such as clean-up and relocation costs.

Given that these estimates are inclusive of both direct and indirect damages, no modifications were undertaken to these estimates for the purposes of this assessment.

It is noted that the loss functions adopted by IAG in deriving these estimates were not provided and that IAG damage curves are based on IAG's claims experience remediating flood-damaged properties. The reliability of the AAD estimates is also entirely reliant on the underlying quality of the flood information held by IAG. IAG's flood information consists of a combination of government-sourced and other flood risk datasets.

Clean up costs

While both the residential damages incorporate an allowance for clean-up, this focuses on the individual properties, and not to the environment, public spaces and public infrastructure. In the March 2021 Hawkesbury-Nepean flood, for example, in addition to significant clean-up of individual properties, significant debris was washed down the river system and large amounts of that debris accumulated along the foreshore in specific locations as well as out to the ocean before being deposited on beaches and was required to be cleaned up by various councils. Hawkesbury City Council reported around 4,700 tonnes from March to July 2021 of flood debris clean-up, although this was focused more on affected residential dwellings[5]. Central Coast Council identified that 710 tonnes of flood related debris were cleaned off beaches in their LGA following the Hawkesbury River flood[6].

With increasing costs of disposal, together with the potential contamination of this material (including from asbestos) the disposal costs can be relatively high, together with the effort required for the clean-up itself.

In 2022, the Southeast Queensland flood resulted in significant mud and silt being deposited that was cleaned up by volunteers and public authorities. Estimates from the Southeast Queensland flood were that the clean-up and rehabilitation of the environment, public assets and spaces was roughly 2% of the total residential damages of the flood (Deloitte, 2022).

For the purposes of this analysis, a similar 2% has been assumed. This 2% has been applied to the total residential and commercial damages.

Climate change

Three climate change scenarios were provided by IAG with their residential risk modelling:

- 0 degree warming, assumed to be representative of 2020 conditions.
- Two degrees of warming. Based on advice from IAG, this scenario has a horizon of around 2040 to 2060, based on RCP4.5 and RCP8.5 (refer **Figure 7**). For this project, 2050 was adopted as representative.
- Three degrees of warming. Similar to the above, this is representative of 2065 or later, depending on the RCP adopted. For this project, it was assumed to be representative of 2100.

The stated degrees of warming relate to pre-industrial conditions, for example, two-degrees warming vs preindustrial conditions.

The assumptions behind the methodology for estimating the residential damages and AAD that was undertaken by IAG for these scenarios is summarised in Dyer et al (2019). Further discussion on IAG's investigation of climate change influences in general are provided in Bruyere et al (2020).

For the economic assessment, a linear change in AAD was assumed between these periods for the residential data provided by IAG.

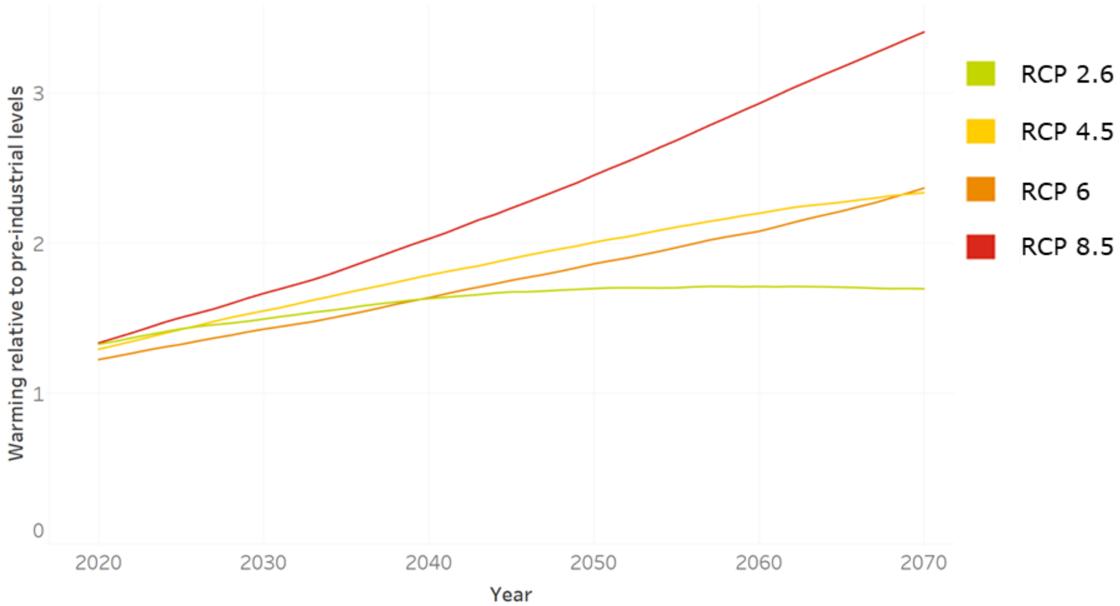

Figure 7 Climate change scenarios

2.3.2 Intangible damages

Intangible damages incorporate impacts to individuals and the overall community that typically do not have a market or dollar value. For example, these may include flood-induced anxiety, depression and/or post-traumatic stress disorder (PTSD), living disruptions and loss of community. There are a variety of economic methods that can be used to estimate the monetary value of some of these impacts, such as Willingness to Pay methodologies. However, these are typically only undertaken in very large projects. In other cases, these methods are used to derive reference values that can be adapted for wider use. Due to the nature of intangible damages, it is difficult to estimate them to a high degree of accuracy.

Where intangibles are incorporated within an assessment, one of the most common ways this is done is through an uplift factor, where the intangibles are estimated as a proportion of the tangible damages.

The studies undertaken by Deloitte (2016) suggests that the average intangible-to-tangible ratio is 1.2. However, it is noted that this is based on three separate types of disaster (earthquake, fire and flood), and all of which were relatively large in scale for Australia (e.g., Brisbane flood).

Deloitte (2021) updated this analysis to estimate the proportion of intangible damages. This was based on an analysis of three historical events:

- The South-east Queensland floods (Queensland, 2010–11)
- The Black Saturday bushfires (Victoria, 2009)
- The ‘Pasha Bulker Storm’, an East Coast Low event (Newcastle, New South Wales, 2007).

In the revised estimate, they incorporated a reduction in the multiplier for smaller (or more frequent events). While not explicitly reported, a review of the results would suggest that the intangible damages are roughly 75% of the tangible damages.

BMT WBM (2018) for the Brisbane River Flood Study reviewed the Deloitte (2016) analysis and incorporated an adjustment to the intangible damage uplift factor. This adjustment was based on an analysis of indirect damages from flooding in Katherine (Northern Territory) and assumed that intangible damages would follow a similar trend to indirect damages. The proposed BMT WBM (2018) uplift factors are summarised in **Table 5**. For the Brisbane River Flood Study, these factors resulted in intangibles being approximately 55% of the tangible damages. However, this uplift would vary from floodplain to floodplain, given the variability in the values in **Table 5.**

For the IAG residential database, individual damages for different events were not available, and only a summarised AAD value. However, the number of dwellings impacted for each AEP range can be estimated based on the information provided. This can be used to estimate an approximate intangibles uplift factor for the AAD.

Table 5 Uplift Factors for Intangibles as identified in BMT WBM (2018)

AEP	Intangibles uplift factor
5%	0.00
2%	0.72
1%	1.20
PMF	4.56

Risk to life

One component of intangible damages relates to the potential loss of life and injury for people as a result of the flood.

Estimating the value of the loss of life in a flood, requires two key components:

- An estimated Value of a Statistical Life (VSL), representing the economic value of a typical person
- An estimate of the likely loss of life in a floodplain in any given flood event.

Transport for NSW (2020) provides a detailed review of the available literature for VSL and based on this review they adopted Willingness to Pay values to void casualties and fatalities associated with transport related accidents. These are summarised in **Table 6**. These are recommended for use in all Transport for NSW economic assessments.

In the absence of more detailed assessments in the flood sector, these are likely to represent the best estimates for Australian conditions.

Table 6 Cost per Casualty (TfNSW, 2020)

Source	VSL (2019 AUD)
Fatality	$7,752,786
Serious Injury (requiring hospitalisation)	$495,874
Moderate (emergency department) or minor injury	$77,472

The probability of loss of life/injury occurring varies in terms of:

- The likelihood, magnitude and nature of the flood event
- The characteristics of population at risk, including amongst others:
  - Number of individuals
  - Demographics
  - Flood awareness and education
  - Accessibility and evacuation planning.

WRL (2016) undertook a literature review of loss of life estimation methods. These are primarily divided into empirical methods and agent-based modelling, with the empirical methods having the largest literature base. A detailed review of the different methods is provided in WRL (2016).

WRL (2016) found that the different methods tended to result in relatively large variance in the loss of life estimates. Priest (2009) in a review of applicability of UK methods to Europe noted that there is a tendency with most of the loss of life models to use catastrophic and extreme flood events (or dam break) for the establishment of the models. This can lead to some bias in the models.

Four potential loss of life models were reviewed as a part of this project:

- Jonkman (2008) – this method builds on previous work by Jonkman (2007) and uses data from hurricane Katrina in New Orleans. It proposed mortality functions for both breach zones (i.e., behind levee failure locations) and remaining areas. The remaining areas correlates the mortality rate with flood depth. It is understood that the mortality rate applies to the non-evacuated population
- Asselman and Jonkman (2003) – this method relates mortality for non-breach zones (i.e., behind a levee) with flood depth. The method was based on flooding from the 1953 floods in the Netherlands. As with Jonkman (2008), it is understood that this applies to the non-evacuated population.
- Graham (1999) – this method was derived for dam breach. However, WRL (2016) identified that it performed relatively well for floodplains as well. It relates several key factors such as warning time, flood severity and the relative understanding of flooding in the community and provides broad ranges of mortality.
- Wade et al. (2005) – this method, out of the UK (and is suggested in the UK MCM (2013) as well), was derived and is applied to studies in the UK. Unlike the above methods, it incorporates factors for vulnerable people (e.g., disabled and elderly), the type of flooding (warning times, rate of rise etc) and flood hazard (related to depth and velocity). This method was derived more

specifically for floodplains and has been assessed across a range of floods. It also has the advantage of providing an estimate of the injuries rather than mortality alone.

To provide a comparison between the methods, they were estimated against the typical flood hazard zones within the AIDR (2017). These are shown in **Figure 8**. Mid-range values for each of the hazard categories were adopted, and conservative estimates (such as longer warning times) were assumed for each of the methods.

A comparison of the different methods is provided in **Figure 9.** Asselman and Jonkman (2003) and Jonkman (2008) both provide high mortality estimates, but as noted it is understood that the population at risk should be estimated on the remaining population (those who did not evacuate). Wade et al (2005) and Graham (1999) show some agreement at low levels of flood hazard, but Graham (1999) increases significantly for high hazard flows.

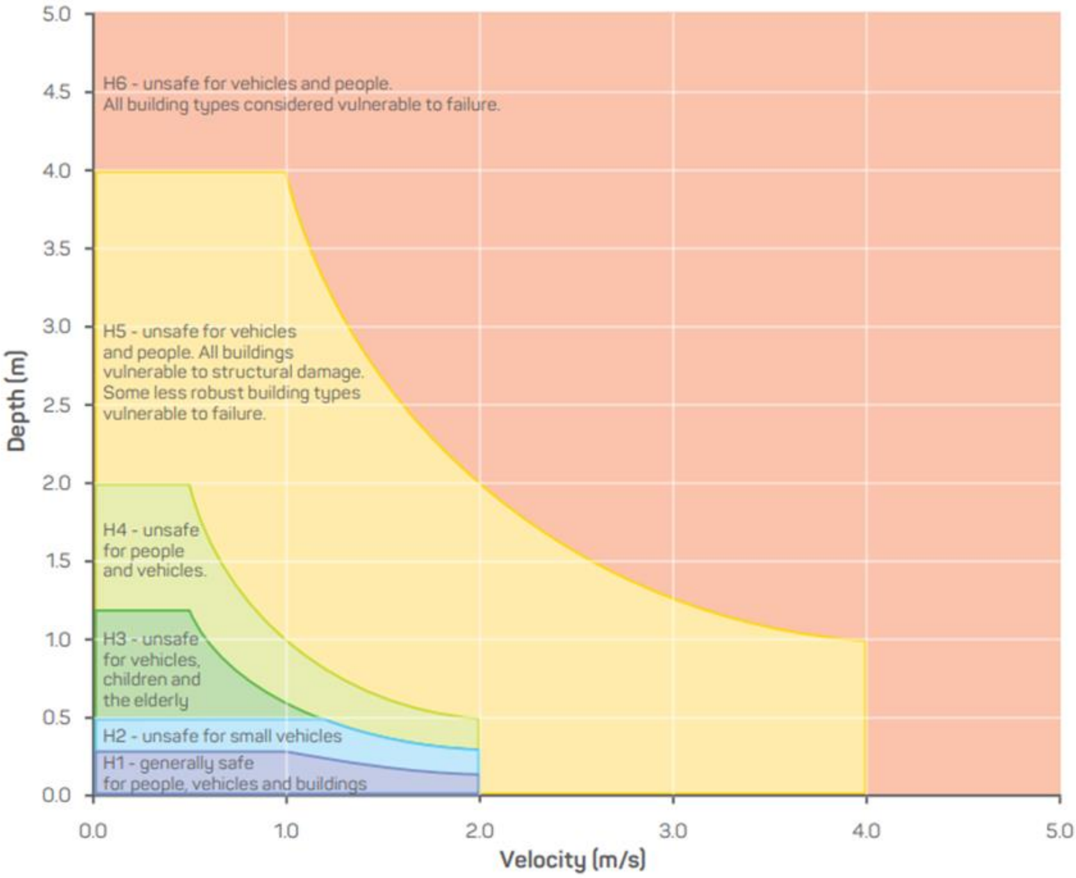

Figure 8 Flood hazard

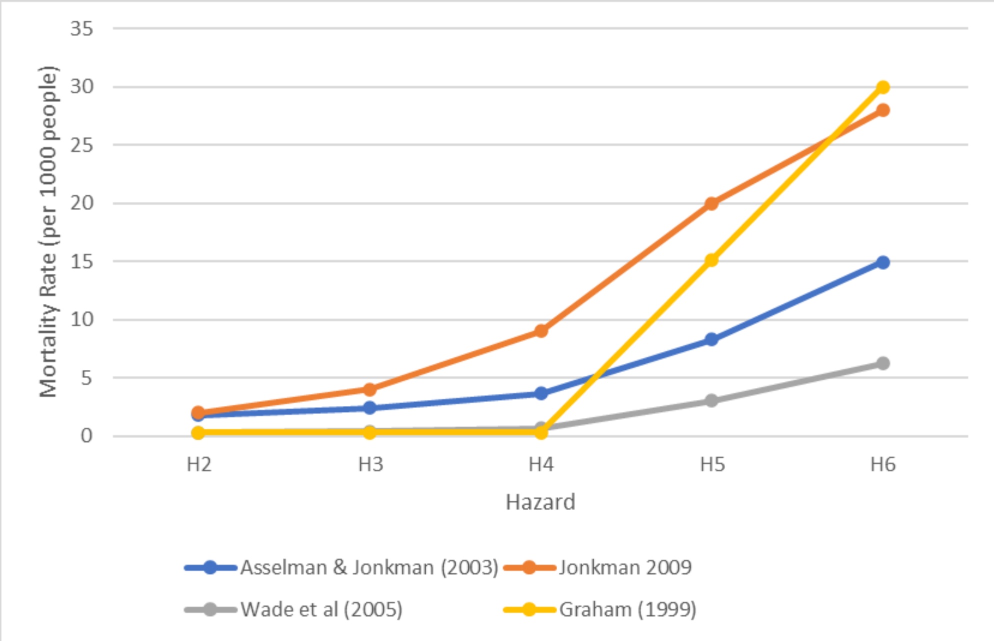

Figure 9 Comparison of Risk to Life Methods

Thomson et al (2021), in undertaking a review for NSW DPIE in the preparation of updated NSW guidelines, suggested the adoption of the Wade et al (2005) methodology. Given that this method would appear to provide a conservative estimate of the risk to life, as well as estimating injuries, this method has been adopted for this project.

Information available for each study area varies. The following approach was adopted:

- Estimate the approximate average flood hazard for each mesh block, based on either flood hazard mapping or depths, depending on availability of mapping, for the 1 in 100 AEP and 1 in 20 AEP. In some cases, such as Representative Area 4, flood depth information was relatively coarse and conservative methods were applied.
- Estimate the population at risk, adopting a population of 2.6 per household and estimating the number of households (based on the dwellings in the IAG database) impacted by flooding in the 1 in 100 AEP and 1 in 20 AEP.
- Assume that there is no loss of life or injuries in events more frequent than a 1 in 20 AEP.
- Estimate the annual average value of lost life and injury assuming a linear increase in loss of life between 1 in 20 AEP and 1 in 100 AEP and assume no increase beyond that.

Other intangibles

DEFRA (2004) undertook a research project into intangible damages from flood events in the UK. This involved national level willingness-to-pay surveys to recently flooded and ‘at-risk’ properties and focused on the intangible health impacts following the flood event. The results of the national survey confirmed “that flooding caused physical effects in the short term and psychological effects in the short and longer terms. Psychological effects included memory of the stress from flooding and damage, and the stress of recovering after an event, including that arising from settling claims with insurers and dealing with builders and repairers”.

The research identified that the value of avoiding these intangible damages was roughly £200 per year per household (in 2004). There was no clear relationship between different types of households etc and this overall weighted value.

Using this information, and the survey results, the research established relationships between the value of avoiding impacts and the reduction in likelihood of being flooded.

To adapt this for Australian assessments, the following was undertaken:

- Conversion of all values into 2022/23 values, and conversion from UK pounds to Australian Dollars.
- Conversion of this information to reflect the willingness to pay to avoid overfloor flooding at different recurrence intervals.

The estimated damages per household per year is provided in Table 7. This shows the annual cost per household per year based on the threshold at which overfloor flooding occurs.

More recent work by Joseph et al (2015), also in the UK, undertook willingness-to-pay surveys as well, and focused on experience from flooding in the 2007 floods in the UK. Their survey was also more expansive, taking into consideration both health related as well as other intangibles at the household level. They estimated that the willingness-to-pay for households was approximately £650 per year per household in 2015. They also estimated the WTP to reduce psychological effects of flooding, which was approximately £260 per year per household, and not dissimilar to the DEFRA (2004) estimate. This suggests that the total willingness to pay was roughly 2.6 times just the health impacts.

Applying this ratio, the values in **Table 7** were adjusted to account for these wider intangible damages. These have been adopted in this study. It is noted that over floor flooding is not necessarily known, so instead the dwellings affected in each range of AEP event have been adopted as a proxy.

Table 7. Intangible Damage Estimate based on threshold event where over floor flooding occurs – 2020 AUD values

Event ARI (years)	Event Probability (AEP)	Cost per Household per Year (based on Defra (2004))	Cost per Household per Year (adjusted based on Joseph et al (2015))
150	0.67%	$0	$0
125	0.8%	$8	$20
100	1%	$49	$123
75	1.33%	$175	$439
50	2%	$391	$981
30	3.33%	$520	$1,304
20	5%	$555	$1,392
10	10%	$574	$1,439
1	100%	$587	$1,472

Adopted approach

Our estimate from the above explicit techniques for estimating intangibles suggests a lower estimate compared with the BMT WBM (2018) or the Deloitte (2021) studies.

Given the overall uncertainties, three intangible estimates have been provided in this study:

- Low Estimate – this estimate is based on explicit estimates as shown in the above sections.
- Mid-Level Estimate – based on the factors provided in the Brisbane River Flood Study (BMT WBM, 2018) and approximating the uplift factor based on the dwellings.
- High Estimate – based on the Deloitte (2021) estimate, adopting a 75% uplift factor.

Given that it is potentially conservative, the low-level estimate method has been used for cost benefit analysis of the mitigation options for each Representative Area. The high-level estimate has been used for comparative purposes when estimating the high-range damages for each of the Representative Area, to provide an understanding of the potential range and uncertainty associated with the intangible damages. This is discussed further in **Section 2.5**

2.4 Economic Benefits

The economic benefits of Planned Relocation and are discussed in this section. A summary of the value of the benefits is provided in **Table 8** and **Table 9.**

Table 8 Community Relocation - present value of economic benefits ($M)

Community Relocation	Mid-NSW Coast	Central Victoria	North-East Queensland	North Coast, NSW	North Coast, NSW (delayed)
AAD - Residential	202.8	6.2	9.0	21.4	15.1
Public Infrastructure	47.6	1.3	2.1	4.7	3.4
Housing stock value	27.9	4.7	1.9	7.3	6.8
Intangibles	16.3	3.4	2.0	3.4	2.4
Clean up	4.2	0.1	0.4	0.8	0.6
Emergency response	4.5	0.8	0.3	1.2	0.9
Public space	1.9	0.7	0.3	5.4	4.9
Total	**305.3**	**17.3**	**15.9**	**44.3**	**34.1**

Table 9 Buy-back - present value of economic benefits ($M)

Buy-back	Mid-NSW Coast	Central Victoria	North-East Queensland	North Coast, NSW	North Coast, NSW (delayed)
AAD - Residential	219.7	6.7	9.5	22.9	16.8
Public Infrastructure	48.9	1.4	2.1	4.7	3.4
Intangibles	16.7	3.5	2.0	3.4	2.5
Clean up	4.4	0.1	0.4	0.8	0.6
Emergency response	4.7	0.8	0.3	1.2	0.9
Public space	1.9	0.7	0.3	5.4	4.9
Total	**296.3**	**13.3**	**14.5**	**38.4**	**29.1**

2.4.1 Avoided tangible damages

Avoided tangible damages relate to the avoided direct and indirect tangible damages discussed in **Section 2.3.1**.

The avoided tangible damages incorporated in the cost-benefit analysis include:

- **Avoided residential property damage** – the avoided damage costs to residential buildings.
- **Avoided public infrastructure damage** – infrastructure flood damage includes damage to public infrastructure such as roads, bridges and utilities (water, electricity etc), as well as parks and other recreation areas.
- **Avoided public clean-up costs** – the avoided costs of cleaning up flood related debris from public spaces.
- **Avoided emergency response costs** – the costs avoided incurred by emergency services in evacuating people from flood impacted areas.

2.4.2 Avoided intangible damages

Avoided intangible damages relate to the avoided direct and indirect intangible damages discussed in **Section 2.3.2.**

Avoided intangibles incorporated in the cost-benefit analysis include:

- **Risk to life** – the value of avoided risk to life
- **flood-induced mental health issues** – the value of avoided mental health issues such a flood induced anxiety and depression **(refer to Section 2.3.2)**

2.4.3 Public space benefits

The repurposing of vacated land can provide benefits to society through improved health outcomes (use values), amenity outcomes (existence values) or environmental outcomes (improved biodiversity or capture of greenhouse gas emissions).

This cost-benefit analysis assumes all vacated land is used as passive open space such as community parkland. This is because land located in high-risk flood zones is likely to be repurposed for uses with a high flood tolerance, such a minimally developed public space such as parkland or community sporting fields.

The DPE (2022) parameters for valuing new urban parks were adopted in the cost benefit analysis. The (DPE) 2022 recommended parameters relate changes in public space to a one-off change in property values. When applying the DPE (2022) parameters, the size of the one-off change will depend on the change in open space within the defined 'catchment'. A 0.3% percent increase per percentage point increase of parkland within the catchment is then applied to the value of property within the defined catchment area . The size of the catchment to which the property value uplift applies is dependent on the size of the park. For example, a local park (defined as being 0.5 hectares to 5 hectares in size) will have a catchment of all properties within a 200 metre radius, whereas a district park (defined as 5 hectares to 25 hectares in size) will have a catchment of all properties within a 1,600 metre radius.

As an example, if a new local park led to the share of parkland increasing by five percentage points (i.e. 5% to 10%) then the value of the one-off property value uplift is calculated by multiplying five by 0.3% to give an uplift value of 1.5%. The uplift value of 1.5% is applied to all properties within a 200 metre radius.

2.4.4 Housing stock benefits

The housing stock benefit relates to the increase in value of the newly constructed housing stock, compared to the depreciated value of the existing housing stock. This benefit has been incorporated into the cost-benefit analysis as the incremental value of the construction of the new house accrues to the property owner.

The benefit is considered a net benefit as the cost of construction is included in the cost-benefit analysis and the housing stock benefit has been calculated as being net of the (pre-natural hazard event) residual value of the existing surrendered house.

The housing stock benefit was calculated using a straight-line depreciation method and adopting the following parameters:

- Average lifespan of house – 100 years
- Average age of house – 25 years
- Average construction cost of a 3-bedroom 1 bathroom house - $1,460 per Sqm (Refer **Section 2.2.2**)

Adopting these parameters resulted in a renewal value of $80,300 per house. For each Representative Area, this value was multiplied by the number of houses relocated.

2.4.5 Unquantified benefits

There are a number of benefits (including dis-benefits) of Planned Relocation that have not been quantified in this analysis.

Notable unquantified benefits (and disbenefits) of Planned Relocation include:

- **Home-owner and community sense of place** or attachment to place (including cultural) – residents and the community may possess a deep sense of attachment to a place for a range of cultural, sentimental, or other reasons. Relocating residents out of communities, or relocating entire communities, may results in a loss or transfer of sense of place. Community Relocation has the advantage of keeping communities together, where Buy-backs may dislocate communities, and this has not been incorporated into the analysis.
- **Loss of local tax base** – relocation of residents or community out of region can lead to a loss of taxes and rates to the local government authority. While the loss of local tax base was considered a transfer cost in this analysis (one region's loss may be another region's gain) and not incorporated, a Planned Relocation scheme proponent may want to consider the impacts if assessing on a regional scale.
- **Impacts on the housing market –** this economic analysis assumed that houses could be readily bought on the open market. Housing market limitations were not considered. In a constrained housing market, a significant number of homeowners participating in a house Buy-back scheme could place upward pressure on housing prices. Similarly, not being able to find a replacement home could create intangible costs such as stress and anxiety. This analysis considered market impacts to be a transfer costs as the benefit of increased prices will accrue to the seller. The intangible costs associated with searching for a new home were considered to be second round costs and not considered in this analysis.

2.5 Cost benefit analysis results

The relative costs and benefits of Panned Relocation, in comparison to the Base Case, were compared through a Cost Benefit Analysis (CBA). A positive NPV and a benefit cost ratio (BCR) of greater than one support a claim for Planned Relocation to be considered as economically feasible in each Representative Area.

To account for the range of costs and parameter values discussed in previous sections, core analysis results were calculated for low, medium, and high range scenarios at a discount rate of 5 percent. Alternative discount rates of 3 percent and 7 percent were applied to the medium scenario in the sensitivity analysis.

- **Low** – the low scenario incorporates the high-range costs estimates and low-range benefit estimates.
- **Medium** – the medium scenario incorporates mid-range cost estimates and mid-range benefit estimates.
- **High** – the high scenario incorporates mid-range cost estimates and high-range benefit estimates. The high scenario adopted mid-range cost estimates, as opposed to low-range cost estimates, to provide a conservative estimate.

As discussed in Section 2.3.2, given the overall uncertainties in estimating intangible damages, this study reviewed a range of methods for incorporating avoided intangible damages within the cost benefit analysis. In order to maintain a conservative approach to quantifying the benefits of Planned Relocation, the low-range estimate method was adopted in the Low and Medium scenarios. The high range approach to estimating intangibles was adopted in the High scenario to offer a comparative range in potential benefit values.

It is noted that this cost-benefit analysis aims to show the indicative costs and benefits of a Planned Relocation scheme in the studied areas, and the results should be interpreted accordingly. The cost and benefit values adopted involve a level of generalisation. Planned Retreat policy makers should conduct bespoke assessments based on location specific conditions.

2.5.1 The Base Case

The Base Case was assumed to be a ‘do-minimum’ scenario where residential and public infrastructure damage is continually repaired after each natural hazard event, and the damage costs continue to be borne by society. Therefore, all costs and benefits in the Project Case were incremental.

2.5.2 The Project Case

The Project Case the implementation of two possible Planned Relocation schemes:

- **Buy-back** – a scheme based on the purchase of high-risk properties (determined by flood risk ratings)
- **Community Relocation** – a scheme based on the purchase and sub-division of vacant land and construction of new houses away from the floodplain for community resettlement.

2.5.3 Results

The CBA results for each Representative Area are summarised in and **Table 10** and **Table 11** discussed in detail in the following sections.

Table 10 CBA results for Community Relocation scheme

Community relocation	Low	Medium	High
Mid-NSW Coast	1.0	1.1	1.7
Central Victoria	0.4	0.5	0.5
North-East Queensland	1.0	1.1	1.4
North Coast, NSW (delayed)	0.8	0.8	1.0

Table 11 CBA results for Buy-back scheme

Buy-back	Low	Medium	High
Mid-NSW Coast	1.4	1.7	2.5
Central Victoria	0.4	0.4	0.5
North-East Queensland	1.3	1.6	2.1
North Coast, NSW (delayed)	0.2	0.2	0.3

2.5.3.1 Representative Area 1 (Mid-Coast, NSW)

Representative Area 1 is a township located on the east coast of NSW, on a large riverine floodplain. Extensive flooding of the community, even in relatively frequent floods (e.g. 1 in 10 AEP). Due to low lying nature of the area, most properties inundated to a similar extent. The representative case study considered the Planned Relocation of the entire town.

The CBA results for Representative Area 1 are shown in **Table 12** and **Table 13.** It can be observed in **Table 12** and **Table 13** that the Community Relocation and Buy-back schemes are economically viable under all scenarios. The marginal-to-viable results for Representative Area 1 are largely driven by the high avoided AAD/household per household ($30,000) which is sufficient to offset the high costs of the Community Relocation and Buy-back Scheme.

Table 12 CBA results for Community Relocation - Mid-Coast, NSW ($M)

Discount Rate	Low	Medium	High
Present Value of Costs	$304.5	$266.6	$266.6
Present Value of Benefits	$303.7	$305.3	$441.9
Net Present Value	$127.4	$38.7	$244.8
Benefit-Cost Ratio	1.0	1.1	1.7

Table 13 results for Buy-back - Mid-Coast, NSW ($M)

Discount Rate	Low	Medium	High
Present Value of Costs	$207.6	$176.4	$176.4
Present Value of Benefits	$296.0	$296.3	$435.3
Net Present Value	$149.3	$119.9	$322.1
Benefit-Cost Ratio	1.4	1.7	2.5

2.5.3.2 *Representative Area 2 (Central Victoria)*

A township located in Central Victoria, in a low-lying area on the banks of a major waterway. Extensive flooding of the community, even in relatively frequent floods (e.g. 1 in 10 AEP). Due to topography of township, properties are impacted to a varying extent. The representative case study considered the Planned Relocation of the two worst affected ABS Mesh Blocks within the township.

The CBA results for Representative Area 2 are shown in **Table 14** and **Table 15.** It can be observed in the **Table 14** and **Table 15** that in Representative Area 2, both Community Relocation and Buy-back were found to have a BCR of less than one and are not considered economically viable. The results are due to the relatively low avoided AAD/household ($5,000) not being sufficient to offset the high costs of property Buy-back or new house construction. This suggests that alternative flood mitigation schemes such as house raising or retrofitting may be more appropriate in this location.

Table 14 CBA results for Community Relocation - Central Victoria ($M)

Discount Rate	Low	Medium	High
Present Value of Costs	$40.3	$36.4	$36.4
Present Value of Benefits	$16.9	$17.3	$18.4
Net Present Value	-$16.6	-$19.1	-$21.2
Benefit-Cost Ratio	0.4	0.5	0.5

Table 15 CBA results for Buy-back - Central Victoria ($M)

Discount Rate	Low	Medium	High
Present Value of Costs	$36.8	$30.6	$30.6
Present Value of Benefits	$13.2	$13.3	$14.2
Net Present Value	-$12.6	-$17.3	-$6.1
Benefit-Cost Ratio	0.4	0.4	0.5

2.5.3.3 *Representative Area 3 (North-East Queensland)*

A township located in North-East Queensland, at the confluence of two rivers. Extensive flooding of the community, even in relatively frequent floods (e.g. 1 in 10 AEP). Due to topography of township, properties are impacted to a varying extent. The representative case study considered the Planned Relocation of the worst affected area within the township.

The CBA results for Representative Area 3 are shown in **Table 16** and **Table 17.** It can be observed in **Table 16** and **Table 17** that both schemes are marginally economically viable in low scenario and economically viable in the high scenario.

Table 16 CBA results for Community Relocation - North-East Qld ($M)

Discount Rate	Low	Medium	High
Present Value of Costs	$16.1	$14.2	$14.2
Present Value of Benefits	$15.8	$15.9	$20.6
Net Present Value	$3.7	$1.7	$5.2
Benefit-Cost Ratio	1.0	1.1	1.4

Table 17 CBA results for Buy-back - North-East Qld ($M)

Discount Rate	Low	Medium	High
Present Value of Costs	$10.9	$9.2	$9.2
Present Value of Benefits	$14.5	$14.5	$19.1
Net Present Value	$6.9	$5.4	$12.6
Benefit-Cost Ratio	1.3	1.6	2.1

2.5.3.4 Representative Area 4 (North Coast, NSW)

A coastal suburb situated on an estuary, at risk of catchment and coastal flooding. It is particularly susceptible to sea level rise as a result of climate change, resulting in higher change in flood affectation in the future compared with the other representative areas. Due to low lying coastal nature of the suburb and proximity to shoreline, all properties are inundated to a similar extent. The representative case study considers the Planned Relocation of the worst affected area.

The CBA results for Representative Area 4 are shown for the imp **Table 18** and **Table 19.**

It can be observed in **Table 18** and **Table 19** are currently not economically viable. The results suggest that Community Relocation (**Table 18**) is marginal and may become viable with further investigation, whereas Buy-back is not economically viable. The results are due to the average house prices ($1.5 million) in the Representative Area, relative to the cost of sub-division and new house construction.

Table 18 CBA results for Community Relocation - North Coast, NSW ($M)

Discount Rate	Low	Medium	High
Present Value of Costs	$70.9	$62.0	$62.0
Present Value of Benefits	$44.3	$44.3	$56.6
Net Present Value	-$7.1	-$17.7	-$8.3
Benefit-Cost Ratio	0.6	0.7	0.9

Table 19 CBA results for Buy-back - North Coast, NSW ($M)

Discount Rate	Low	Medium	High
Present Value of Costs	$184.6	$158.8	$158.8
Present Value of Benefits	$38.4	$38.4	$50.0
Net Present Value	-$96.1	-$120.4	-$47.0
Benefit-Cost Ratio	0.2	0.2	0.3

Due to the susceptibility of Representative Area 4 to the impacts of climate change, and the intensifying of those impacts over time (such as through increased AAD), an alternative scenario was assessed where a Planned Relocation scheme would be implemented in 2030. The results for the delay to 2030 scenario are shown in **Table 20** and **Table 21**. It can be seen in **Table 20** that Community Relocation becomes marginally economically viable in the high range scenario when delaying until 2030, the Buy-back scheme (**Table 21**) remains unviable due to high average house prices.

Table 20 CBA results for Community Relocation (delay to 2030) - North Coast, NSW

Discount Rate	Low	Medium	High
Present Value of Costs	$42.5	$42.5	$42.5
Present Value of Benefits	$31.9	$32.1	$40.5
Net Present Value	-$4.0	-$10.4	-$1.9
Benefit-Cost Ratio	0.8	0.8	1.0

Table 21 CBA results for Buy-back (delay to 2030) - North Coast, NSW

Discount Rate	Low	Medium	High
Present Value of Costs	$131.2	$112.9	$112.9
Present Value of Benefits	$27.7	$27.7	$35.9
Net Present Value	-$67.9	-$85.2	-$95.3
Benefit-Cost Ratio	0.2	0.2	0.3

2.5.3.5 Sensitivity Analysis

A sensitivity analysis was conducted to test the sensitivity of the medium scenario results to the alternative discount rates of 3 percent and 7 percent. The results of the sensitivity analysis are shown in **Table 22** and **Table** 23, the core results at 5 percent are shown in the centre column. **Table 22** indicates that Community Relocation is economically viable at all the case study locations at a discount rate of 3 percent, except for Central Victoria. For the Buy-back scheme, **Table** 23 shows that lowering the discount rate to 3 percent does not improve the economic viability in locations that did not have a positive BCR at 5 percent. This is due to the high cost of property Buy-backs in those locations, particularly the North Coast of NSW.

Table 22 Sensitivity test - Community Relocation ($M)

Community Relocation	3%	5%	7%
Representative Area 1 (Mid-Coast, NSW)			
Present Value of Costs	$275.2	$266.6	$258.60
Present Value of Benefits	$435.5	$305.3	$227.42
Net Present Value	$160.3	$38.7	-$31.18
Benefit-Cost Ratio	1.6	1.1	0.9
Representative Area 2 (Central Victoria)			
Present Value of Costs	$38.0	$36.4	$34.9
Present Value of Benefits	$23.2	$17.3	$13.6
Net Present Value	-$14.8	-$19.1	-$21.3
Benefit-Cost Ratio	0.6	0.5	0.4
Representative Area 3 (Northeast Qld)			
Present Value of Costs	$14.9	$14.2	$13.6
Present Value of Benefits	$23.1	$15.9	$11.8
Net Present Value	$8.2	$1.7	-$1.8
Benefit-Cost Ratio	1.5	1.1	0.9
Representative Area 4 (North Coast, NSW)			

Community Relocation	3%	5%	7%
Present Value of Costs	$65.1	$62.0	$59.2
Present Value of Benefits	$61.8	$44.3	$34.1
Net Present Value	-$3.4	-$17.7	-$25.1
Benefit-Cost Ratio	0.9	0.7	0.6
Representative Area 4 (North Coast, NSW - delay to 2030)			
Present Value of Costs	$51.8	$42.5	$35.0
Present Value of Benefits	$51.1	$32.1	$21.7
Net Present Value	-$0.72	-$10.4	-$13.4
Benefit-Cost Ratio	1.0	0.8	0.6

Table 23 Sensitivity test - Buy-back ($M)

Buy-back	3%	5%	7%
Representative Area 1 (Mid-Coast, NSW)			
Present Value of Costs	$179.5	$176.4	$173.6
Present Value of Benefits	$425.2	$296.3	$219.6
Net Present Value	$245.6	$119.9	$46.0
Benefit-Cost Ratio	2.4	1.7	1.3
Representative Area 2 (Central Victoria)			
Present Value of Costs	$31.1	$30.6	$30.1
Present Value of Benefits	$19.0	$13.3	$9.8
Net Present Value	-$12.1	-$17.3	-$20.2
Benefit-Cost Ratio	0.6	0.4	0.3
Representative Area 3 (Northeast Qld)			
Present Value of Costs	$9.4	$9.2	$9.0
Present Value of Benefits	$21.0	$14.5	$10.8
Net Present Value	$11.5	$5.4	$1.8
Benefit-Cost Ratio	2.2	1.6	1.2
Representative Area 4 (North Coast, NSW)			
Present Value of Costs	$161.3	$158.8	$156.6
Present Value of Benefits	$53.9	$38.4	$29.1
Net Present Value	-$107.5	-$120.4	-$127.4
Benefit-Cost Ratio	0.3	0.2	0.2
Representative Area 4 (North Coast, NSW - delay to 2030)			
Present Value of Costs	$131.2	$112.9	$97.5
Present Value of Benefits	$44.3	$27.7	$18.4
Net Present Value	-$86.9	-$85.2	-$79.1
Benefit-Cost Ratio	0.3	0.2	0.2

3 Risk to life

An economic assessment is a useful tool for assessing the net cost to society of a particular Planned Relocation scheme, however it is not the role of an economic assessment to define the tolerable level of a given risk. As such, Planned Relocation policy makers may also adopt risk to life criteria to assist in deciding when a given risk poses an unacceptable threat to human safety.

This analysis adopted the methodology for calculating risk to life is defined in **Section 2.3.2**. The potential risk to life for each location was calculated for the 1 in 100 AEP[9] and compared to the acceptable threshold for loss of life of 1 in 10,000 (0.010%) that is typically used by the NSW Government for dam safety assessments and other hazard mitigation guidelines.

The results of the risk to life evaluation are shown in **Figure 10.**

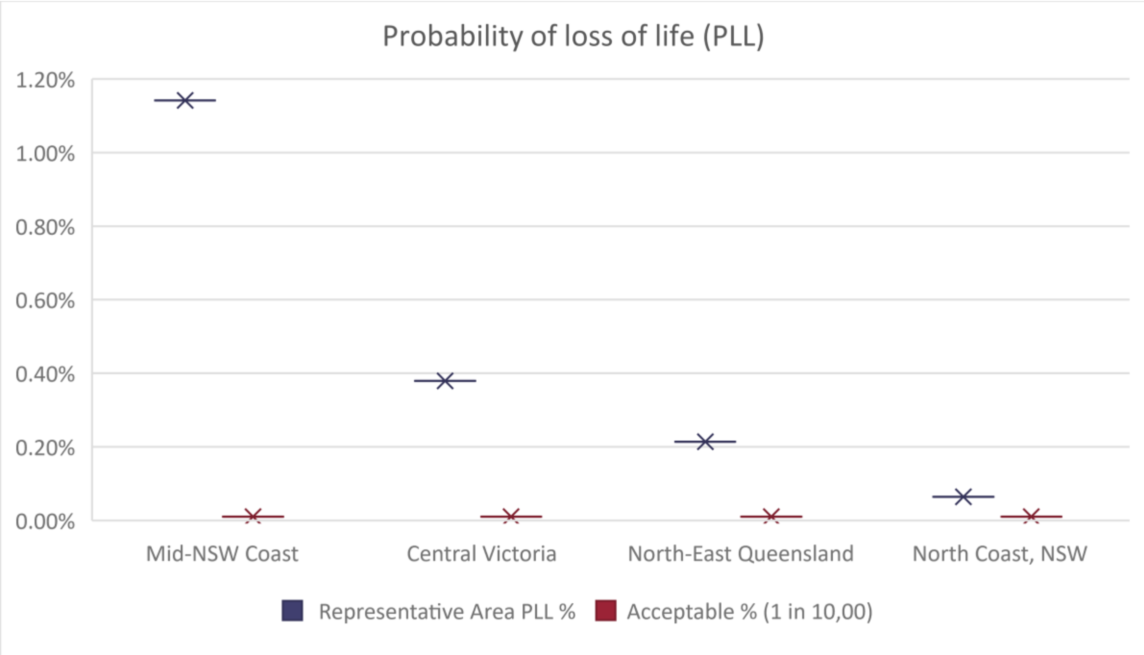

Figure 10 Probability of Loss of Life

Figure 10 shows that the risk to life, or probability of loss of life (PLL), is above the acceptable threshold in all the studied locations. The exceedance of the acceptable threshold varies significantly across the locations. Typically, densely populated low-lying areas that flood relatively frequently, such as the Representative Area 1 (Mid-NSW Coast) present the greatest risk to life.

[9] The potential risk to life was calculated for the 1 in 100 AEP, and expressed as a chance per year of a loss of life.

4 Affordability

The purpose of the affordability analysis is to incorporate socio-economic considerations that are not considered by the cost benefit analysis or risk to life analysis.

The feasibility assessment compared the average annual damage (AAD) amounts[10] to the median annual average household income in each location[11]. This represents the potential costs associated with either insurance, or repairs where the property owner does not have sufficient insurance. The results of the are shown in **Figure 11**.

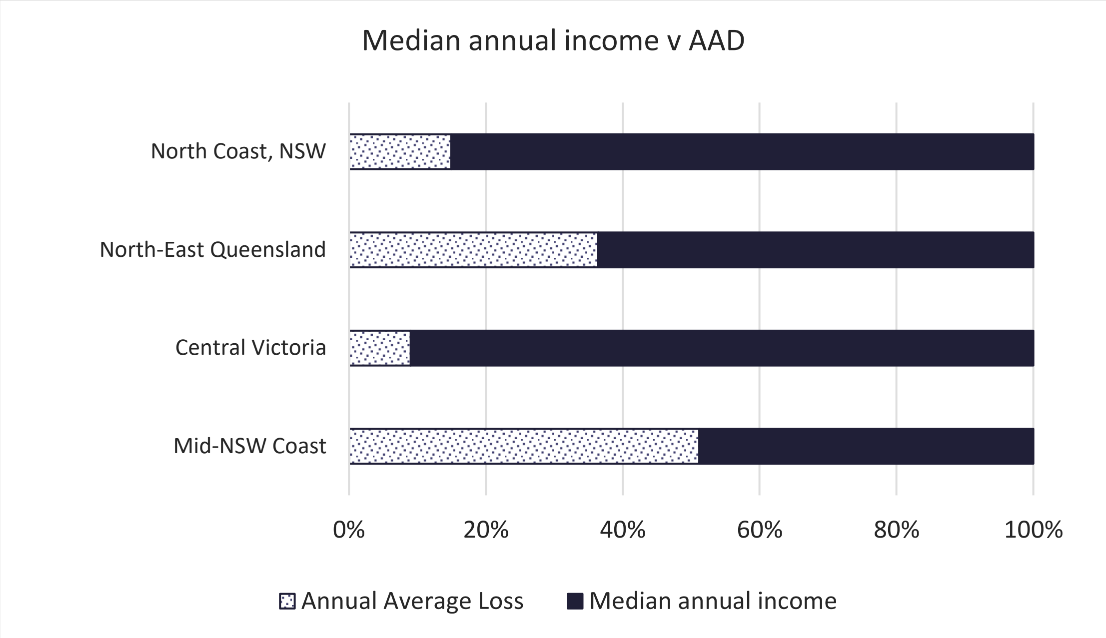

Figure 11 Affordability assessment

The results in **Figure 11** were compared with Australian Bureau of Statistics (ABS) Socio-Economic Indexes for Areas (SEIFA) scores to incorporate broader indicators (than just income) of socio-economic advantage and disadvantage into the analysis. For example, an area with high retirees may have a low median income but a high store of wealth and focusing on income alone may give a false impression of low affordability.

The ABS SEIFA is a set of four indexes that have created from Census information. Each index incorporates a slightly different aspect of socio-economic conditions in a given geographic area, and ranks the area in terms of their relative socio-economic advantage and disadvantage. A score of one (1) indicates the area is the most disadvantaged. Where a score of five (5) indicates either the area with the highest lack of disadvantage or greatest advantage, depending on the index used.

[10] Based on IAG data for each location

[11] Based on Australian Bureau of Statistics Census 2021 information

This analysis incorporated the Index of Relative Socio-economic Disadvantage (IRSD) which includes measures of disadvantage only (it does not include off-setting measures of advantage such as high-income households). A low IRSD score indicates relatively greater disadvantage, such as

- many households with low incomes
- many people with no qualifications
- many people with low skilled occupations.

The IRSD has been used, in favour of alternative SEIFA indexes, as the ABS states that it is recommended in situations where the user 'wants a broad measure of disadvantage, rather than a specific measure (such as low income)[12]'.

The SEIFA IRSD scores for each Representative Area are shown in **Figure 12.**

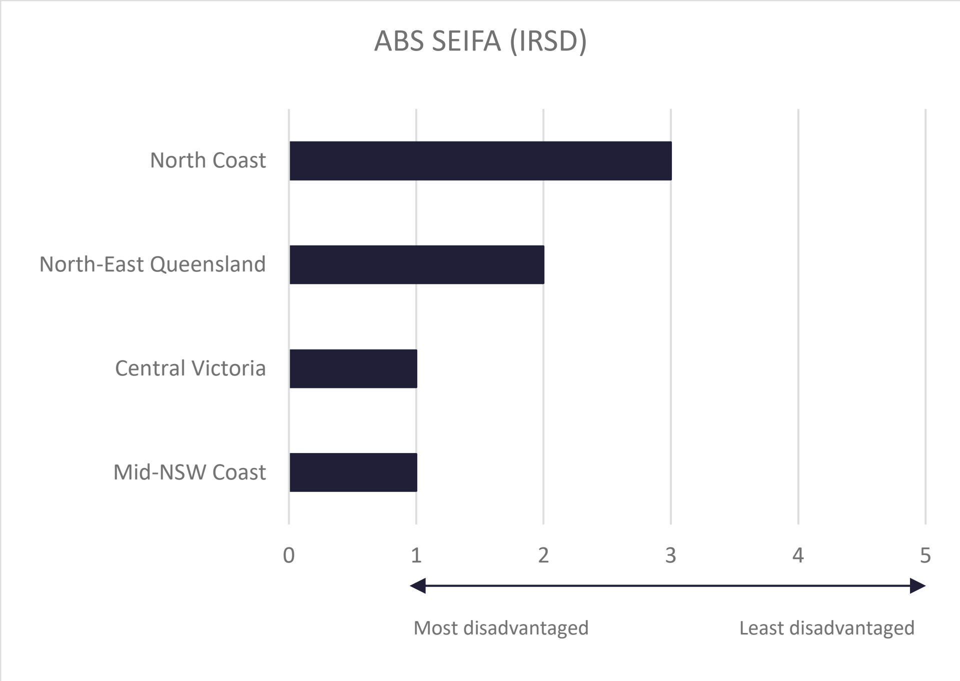

Figure 12 ABS SEIFA (IRSD) Scores

Combining the AAD as a share of median annual income in **Figure 11** with the ABS SEIFA **Figure 12,** the following observations can be made:

- **Representative Area 1 (Mid-NSW Coast)** – this location has the highest percentage share of AAD as a proportion of median annual income (around 50%) and a SEIFA index score of 1 (most disadvantaged). This suggests that affordability is low for recovery after a flood event, or for adequate level of flood protection insurance.
- **Representative Area 2 (Central Victoria) -** The average annual damages for a household for the area represents around 10% of the median household income, suggesting that affordability of repairs or insurance is higher than the other representative areas considered in this paper. However, the SEIFA score of 1 (most disadvantaged) indicates that homeowners may have low

[12] www.abs.gov.au/ausstats/abs@.nsf

accumulated wealth stores to draw on for repairs or insurance, or that their wealth is held in the flood-impacted property.

- **Representative Area 3 (North-East Qld)** - The average annual damages for a household for the area represent nearly 40% of the median household income and the SEIFA index score is 2, suggesting that affordability is relatively low for recovery following a flood event, or for insurance.
- **Representative Area 4** (**North Coast NSW**) - The average annual damages for a household for the area represent nearly 15% of the median household income and the SEIFA score is 3, indicating that for this location affordability of insurance or repairs post event may be higher.

Rhelm

5 Feasibility Assessment Summary

The key outcomes of the Planned Relocation Feasibility Assessment can be summarised as:

- The economic feasibility of Planned Relocation is highly dependent on the scale of the scheme and the annualised damage per dwelling in the location being assessed.
- In three of the four locations, the Buy-back scheme represented a relatively more cost-effective option than the Community Relocation scheme. This is due to the relatively higher cost of land sub-division and house construction than the purchase of the equivalent number of properties.
- The economic analysis did not attempt to quantify the economic benefit of keeping communities together (e.g. place based values) and doing so may increase the economic feasibility of Community Relocation schemes relative to Buy-back schemes. Similarly, housing supply limitations were not considered in the Buy-back schemes.
- Both schemes were generally viable for two of the representative areas (North Qld and Mid North Coast, NSW). These two locations had higher annualised average damages and impacts than the Victorian and North Coast, NSW examples. Generally, it would suggest that Planned Relocation is viable in situations where the flood risk and potential damage to property is high.
- Representative Area 4 (North Coast, NSW) was selected as a case study area due to its susceptibility to future sea level rise, and resulting flood affection, due to the forecast impacts of climate change. The results show that while planned relocation may not be economically viable at present, a Community Relocation scheme does become economically viable when delaying the scheme commencement until 2030. This is due to the increase in forecast average annual damages as flooding becomes more frequent and severe in future years.
- In all representative areas the possible loss of life was well above the typical acceptable threshold of 1 in 10,000. Depending on the priorities of Planned Relocation policy makers, this may be a key consideration.
- The affordability assessment provided a range of results, with AAD being equal to between 10% - 50% of median household income. In Representative Area 1 in particular the AAD was nearly 50% of the household income, suggesting very low affordability in that area for insurance or capacity for recovery from a flood event.

6 References

Australian Institute for Disaster Resilience [AIDR] (2017). *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*. Handbook 7: Australian Disaster Resilience Handbook Collection. East Melbourne.

BMT WBM (2018). *Technical Evidence Report – Brisbane River Strategic Floodplain Management Plan*, prepared for State of Queensland, October, Version 5.

Bruyere C, Buckley B, Prein A, Holland G, Leplastrier M, Henderson D, Chan P, Done J and Dyer A (2020). *Severe Weather in a Changing Climate*, 2nd Edition, September, IAG, NCAR and NSF.

Chamber of Commerce & Industry Queensland (2011). *Impact of the Queensland Floods on Business*, CCIQ Survey, February.

DEFRA (2004). *The Appraisal of Human Related Intangible Impacts of Flooding*, R&D Technical Report FD2005/TR, August, London.

Deloitte Access Economics [DAE] (2016). *The Economic Cost of Social Impact of Natural Resources*, March, Australian Business Roundtable for Disaster Resilience and Safer Communities.

Department of Environment and Climate Change [DECC] (2007) *Floodplain Risk Management Guideline - Residential Flood Damages*, Revision 1, October.

Dyer A, Buckley B, Conway P, Leplastrier M (2019). *Regional Sensitivity of Australian Flood Risk to Climate Drivers*, 2019 Floodplain Management Authorities National Conference.

Graham W J (1999). *A Procedure for Estimating Loss of Life Caused by Dam Failure*, United States Department of the Interior – Bureau of Reclamation, September.

Jonkman S, Maaskant B, Boyd E and Levitan M (2008). *Loss of Life Caused by Flooding of the New Orleans After Hurricane Katrina: A Preliminary Analysis of the Relationship between Flood Characteristics and Mortality*, 4th International Symposium on Flood Defence, Canada, May.

Joseph R, Proverbs D, & Lamond J (2015). *Assessing the Value of Intangible Benefits of Property Level Flood Risk Adaptation (PLFRA) Measures*, Natural Hazards.

Mason M, Phillips E, Okada T & O'Brien J (2012). *Analysis of Damage to Buildings Following the 2010-2011 Eastern Australia Floods*, National Climate Change Adaptation Research Facility [NCCARF], Gold Coast.

NRM (2002). *Guidance on the Assessment of Tangible Flood Damages*, Natural Resources and Mines, Queensland Government, Qld.

Penning-Rowsell E, Priest S, Parker D, Morris J, Tunstall S, Viavattene C, Chatterton J, Owen D, [MCM] (2013). *Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal*. Flood Hazard Research Centre and Environmental Agency, published by Routledge, Oxon.

Priest S (2009). Building Models to Estimate Loss of Life for Flood Events, FLOODsite Project Report Contract GOCE-CT-2004-505420.

Rawlinsons Construction Guide 2022 – Edition 30, (2022). Published by Rawlinsons Cost Management [online] at: https://www.rawlhouse.com.au.

Read Sturgess and Associates (2000). *Rapid Appraisal Method (RAM) for Floodplain Management*, prepared for Department of Natural Resources and Environment, Victoria.

Transport for New South Wales [TfNSW] (2020). *Economic Parameter Values*, Version 2.0. NSW State Government, June.

Wade S, Ramsbottom D, Floyd P, Penning-Rowsell E & Surendran S (2005). *Risks to People: Developing New Approaches for Flood Hazard and Vulnerability Mapping*, Proceedings of the 40th Defra Flood and Coastal Management Conference.

Water Research Laboratory [WRL] (2016). *Approaches for Estimating Flood Fatalities Relevant to Floodplain Management*, WRL Technical Report 2015/09, September.

Rhelm Pty Ltd
ABN 55 616 964 517
ACN 616 964 517

Head Office
Level 1, 50 Yeo Street
Neutral Bay NSW 2089
contact@rhelm.com.au
+61 2 9098 6998
www.rhelm.com.au