Final

REGULATION IMPACT STATEMENT

For Decision

Proposals to address the risk of floods to new residential buildings

November 2012

The Office of the Australian Building Codes Board prepared this Regulation Impact Statement with the assistance of a consultant and in accordance with the requirements of *Best Practice Regulation: A Guide for Ministerial Councils and National Standard Setting Bodies,* endorsed by the Council of Australian Governments in 2007. Its purpose is to inform stakeholders and provide a basis for decision-making by the Board in its consideration of proposals to address the risk of floods to new residential buildings.

The Australian Building Codes Board

The Australian Building Codes Board (ABCB) is a joint initiative of all levels of government in Australia, together with the building industry. Its mission is to oversee issues relating to health, safety, amenity and sustainability in buildings. The ABCB promotes efficiency in the design, construction and performance of buildings through the National Construction Code, and the development of effective regulatory and non-regulatory approaches. The Board aims to establish effective and proportional codes, standards and regulatory systems that are consistent between States and Territories. For more information see www.abcb.gov.au

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Summary

Floods are a prominent natural hazard in Australia. The problem is that many home owners are unaware that they live in a flood hazard area until the flood is upon them. Others tend to assume that a new residential building has been constructed with survivability measures. The demand side of the market does not respond adequately to flood risks due to a lack of information about floods. On the supply side, builders who may be aware of flood risks will not voluntarily add flood survivability measures to their designs because their quotations will be uncompetitive in a price conscious market, where these measures are not expected to be valued by consumers.

Flood risks are managed under State and Territory planning regulations, as administered by local governments, where:

- approvals for new residential buildings are discouraged / disallowed in high risk areas – usually where the flood risk is higher than 1% Annual Exceedance Probability; and
- approvals for new residential buildings in other flood hazard areas are permitted where the minimum floor height of the habitable rooms is higher than the expected flood level.

The problem is that these planning actions by local governments – that do help in addressing flood risks – are insufficient to prevent buildings being structurally damaged during a flood event or to ensure the survival of utilities. Consequently residents still face life safety risks and a lack of amenity when they return to their homes.

The objective is to support health, safety and amenity outcomes for residents during a flood event, by addressing the structural robustness of buildings and the survival of utilities.

Four alternative choices are suggested to the ABCB Board:

- **Status Quo** – this is the default choice for decision makers if other options would impose a net cost on society.
- **Option 1a** - new NCC provisions to apply in flood hazard areas, as designated by each local government.
- **Option 1b** – new NCC provisions to apply in flood hazard areas, identified on a national flood map.
- **Option 2** – a handbook providing guidance on constructing residential buildings in flood hazard areas (as designated by each local government).

Option 1a would increase construction costs by $216 million (present value over 10 years), but the benefits of ensuring structural integrity and survival of amenities was estimated to be $352 million (present value over 10 years); a net benefit to society.

Option 1b would result in the same cost and benefits plus the additional cost in the first year of preparing a national flood map. An initial estimate for this is $11 million, although clearly this is a minimum and the actual cost could be much higher.

An alternative approach, suggested by stakeholders, notes that Geoscience Australia is developing an internet portal for local governments and other organisations to upload existing flood hazard information, which could be used as a national data source very much like a national map. However this approach does not deliver superior information than is

already known by local governments – the flood hazard areas in the database would be the same flood hazard areas designated by each local government.

The principal intangible and indirect benefits of Option 1 would be: the avoidance of injuries and fatalities during a flood event; the avoidance of damage to other resident's dwellings by preventing parts of buildings washing away; reduced emotional and physiological effects, household disruption and loss of memorabilia; enhanced resilience of the community after a flood event for residents and business; the benefit to insurers when national building provisions reduce risks of flood damage and more clearly define these risks; and a reduction in Government disaster relief payments after a flood event.

Option 1 would also have distributional impacts. While all residents in new buildings would incur costs to ensure structural robustness and the survival of utilities, only some residents would benefit from these measures – during a flood event within the 40 year physical life of the building. For many residents in flood hazard areas a flood event will not have occurred during this 40 year period, and hence these residents will not directly benefit from the flood protection measures. These distributional impacts are only observable in retrospect, after 40 years. From the perspective of today, looking to the future over the next 40 years, it is impossible to determine where the incidence of floods will occur. It is impossible to determine where residents need not bother with more robust structures, and where they should. However all residents will have the comfort of knowing that, should a predictable flood event occur, their homes will be sufficiently robust to withstand it.

Option 2 would deliver a similar ratio of benefits to costs as Option 1a, but at a much reduced scale. As an example (and purely as an example) if the handbook was applied to 10% of approved new residential buildings, the present value of costs would be $22 million and $35 million for benefits. In circumstances where Options 1a and 1b would result in very high costs, with a benefit cost ratio close to unity, Option 2 could appear an attractive and low cost option for decision makers.

Stakeholders generally supported the proposed NCC provisions and were evenly divided in their preferences between Options 1a and 1b. Two stakeholders, one from government and one from industry, were critical of the material presented in the Consultation RIS; see NSW and HIA sections in the Consultation chapter for stakeholder comments and ABCB responses.

Option 1b introduces a degree of complexity and uncertainty, in that a national flood map currently does not exist and would have to be developed de novo. There is no guarantee that this could be accomplished in a timely or cost-effective manner. Given these uncertainties concerning Option 1b, and the outcomes of the impact analysis where Option 1a would result in the highest net benefit to society, Option 1a is preferred.

Recommendation

It is recommended that the Board agree to adopt new NCC provisions to address the risk of floods to residential buildings, as described in Option 1a.

Contents

Glossary

ABCB	Australian Building Codes Board
ABS	Australian Bureau of Statistics
AEP	Annual Exceedance Probability
1% AEP	1% annual probability of a defined flood event
BCA	Building Code of Australia, a component of the NCC
Class ( ) building	Class of building defined in the NCC
COAG	Council of Australian Governments
DFE	Defined flood event
DFL	Defined flood level - associated with a DFE
DTS	Deemed-to-Satisfy Provisions in the NCC
Flood hazard area	An area determined by a relevant authority as subject to flood hazard
Freeboard	Height above the DFL to the finished floor level
Habitable room	A room used for normal domestic activities
Hydrodynamic action	The action caused by a fluid in motion
Hydrostatic action	The pressure exerted by a fluid at equilibrium due to the force of gravity
NCC	National Construction Code, comprising the BCA and PCA
NPV	Net Present Value
OBPR	Office of Best Practice Regulation
PCA	Plumbing Code of Australia, a component of the NCC
PV	Present Value
RIS	Regulation Impact Statement

1 Introduction

The purpose of this Regulation Impact Statement (RIS) is to present an analysis of proposals to address the risk of floods to new residential buildings in Australia, for the information of stakeholders and to provide a basis for decision-making on these proposals by the ABCB Board.

The ABCB previously published a Consultation RIS on its website and invited comments, information and data from stakeholders during a public consultation period. This RIS presents a summary of the stakeholder responses in chapter 8 and also incorporates pertinent responses into the regulatory analysis. The ABCB expresses its appreciation to these stakeholders for their contributions.

Scope

Flooding represents a very prominent and costly natural hazard across Australia. It involves substantial and broad ranging impacts on stakeholders, with the level of costs incurred influenced by multiple risk factors. Government and the community seek to respond to these risks (and reduce related costs) through a combination of behavioural, policy and regulatory measures. Specifically, the scope of this RIS is limited to consideration of options that:

- Focus on the mitigation of key life safety risks arising from damages caused to the overall structure and / or individual components of Class 1, 2, 3, 4, 9a and 9c buildings by flooding;
- Apply only in designated flood hazard areas, as defined by relevant State, Territory and Local Government authorities;
- Acknowledge the roles and responsibilities of local council planning officials in making assessments of land use and, in known flood hazard areas, of determining the minimum habitable floor heights of new residential buildings to mitigate flood risks;
- Impact only on new residential buildings in flood hazard areas; the stock of existing residential buildings will be unaffected by the options.

Within these parameters, this RIS evaluates options that address the risk of floods.

Stakeholders from government and insurance commented on the previous Consultation RIS, to suggest that the scope be broadened in two ways:

- ***That the scope be broadened from just residential buildings to cover all buildings, including commercial and industrial buildings.***
- ***That the scope extend from "new work" – essentially major re-builds – to also include (major) repairs and clean-up after the flood.***

To respond: the emphasis on the objectives of health, safety and amenity of residents during a flood event does focus this RIS on residential buildings. On the repair issue, if they are sufficiently major then they could qualify as "new work", and be subject to all provisions of the NCC. Minor repairs are covered by legislation of the State and Territo*ries *and outside scope of the NCC. Clean-up activity would also be outside scope of the NCC.

2 Background

The National Construction Code

The National Construction Code (NCC) is a performance based document that contains the technical provisions for the design and construction of buildings and other structures, covering such matters as structure, fire resistance, access and egress, services and equipment, and energy efficiency as well as certain aspects of health and amenity. The NCC is given the status of building / plumbing regulations by all States and Territories.

The NCC specifies 'Objectives' which are considered to reflect community expectations for the built environment. It also defines mandatory 'Performance Requirements', which state the level of performance a 'Building Solution' must meet to achieve the related NCC Objectives.

The NCC allows compliance with the Performance Requirements through the adoption of acceptable Building Solutions by:

- implementing Deemed-to-Satisfy (DTS) Provisions, which are technical provisions contained either in the NCC or in NCC referenced documents; and / or
- formulating an Alternative Solution that can be shown to be at least equivalent to the DTS Provisions or which can be demonstrated as complying with the Performance Requirements.

In the case of flooding, the relevant Performance Requirements are contained in the NCC, specifically in Building Code of Australia (BCA) Volume One Part B1 Structural Provisions and BCA Volume Two Part 2.1. These specify that a building or structure during construction and use, with appropriate degrees of reliability, must:

- Perform adequately under all reasonably expected design actions; and
- Withstand extreme or frequently repeated design actions; and
- Be designed to sustain local damage, with the structural system as a whole remaining stable and not being damaged to an extent disproportionate to the original local damage; and
- Avoid causing damage to other properties;

by resisting the actions to which it may reasonably be subjected.

While the BCA states that these actions could include, but are not limited to, the action of liquids, ground water and rainwater ponding, neither the NCC nor any referenced document contains technical standards for construction in flood hazard areas.

Flood Risk in Australia

There are many ways to describe or define a 'flood', with the simplest being "water where it is not wanted". Flooding is a temporary condition and involves the inundation of normally dry areas from the overflow of waters due to rapid accumulation or runoff from any source. While many factors can cause flooding, it is most commonly caused by heavy rainfall where natural watercourses do not have the capacity to convey excess water. Other causes are less common and are typically related to natural disasters (e.g. tropical cyclones, tsunamis, etc).

There are three common types of floods that affect Australia:

Slow-onset floods

Inland rivers in the vast flat areas of Western Australia, central/western New South Wales and Queensland can often flood. These floods may take days to build-up. They can last for one or more weeks and can even last for months on some occasions. The damage caused by floods in these areas can lead to major losses of livestock, cutting off rural towns and damaging crops, major roads and railways.

Rapid-onset floods

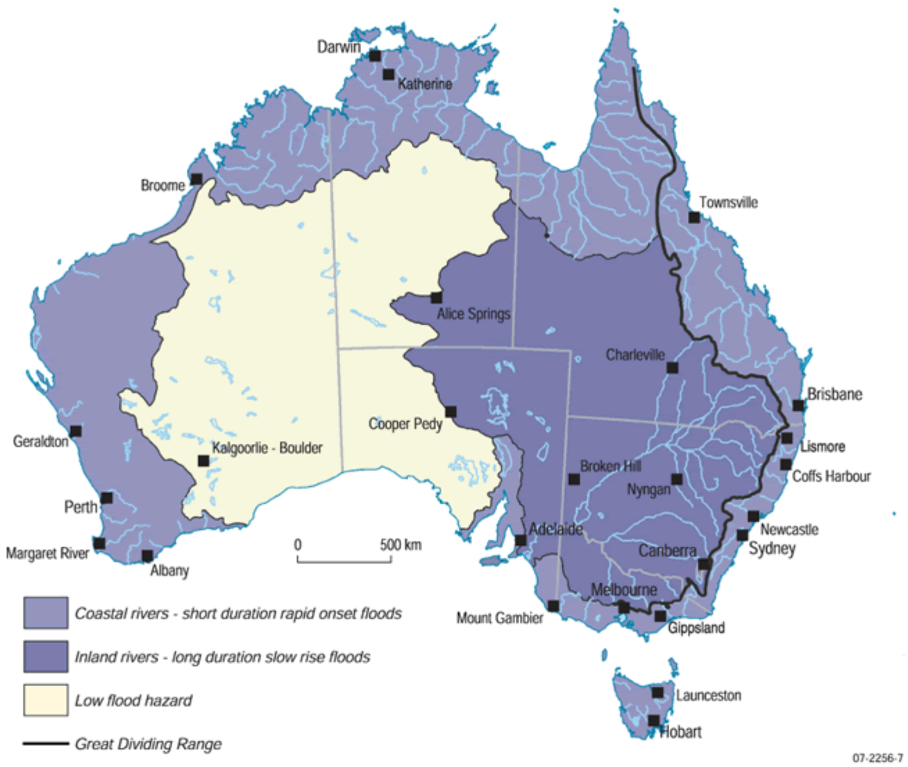
Rapid-onset flooding occurs more quickly than slow-onset floods. These floods can potentially be much more damaging and can pose a greater risk to loss of life and property. This is because there is generally much less time to take preventative action, and a faster, more dangerous flow of water. This type of flooding can affect most of our major towns and cities.

Flash floods

Flash flooding results from relatively short, intense bursts of rainfall, often from thunderstorms. It can occur in almost all parts of Australia and poses the greatest threat of loss of life. People are often swept away after entering floodwaters on foot or in vehicles. These floods can also result in significant property damage and major social disruption. They are a serious problem in urban areas where drainage systems are often unable to cope.

While flash flooding can occur in any location, the risk of onset flooding varies by geographic location, and is related to factors such as ground cover and topography. The figure below shows areas in Australia prone to particular types of onset flooding.

Figure 1: Geographic distribution of flood risk in Australia

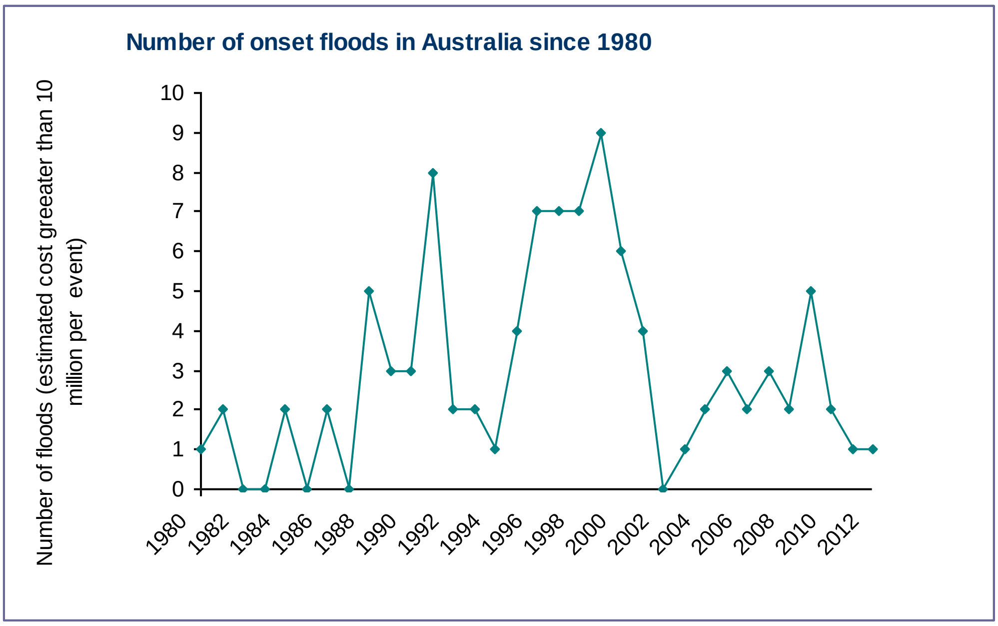


Source: Geoscience Australia website

As shown above, slow onset flooding is more likely to occur in the vicinity of inland river systems in central and western NSW, QLD, and parts of Victoria. In comparison, rapid onset flooding is more likely to occur around coastal and mountain areas along the east coast of Australia and in Tasmania. The prevalence of rivers draining to the coast in the densely populated south east Queensland suggests a significant risk of rapid onset flooding in that region.

Figure 2 below presents the number of onset flood events recorded in Australia each year since 1980. Note, this includes only major events, which are defined as those with a total estimated cost of greater than $10 million.

Figure 2: Number of onset floods from 1980 – 2011



Source: Derived from the EM-DAT and EMA Database (Australian Government Attorney-General's Department, Disasters database)

During this period, the average number of major flood events per year is three, with the greatest number of floods (nine) occurring in 1999. Each of these flood events involved substantial and broad ranging costs, which can be separated into the following categories:

- *Direct tangible costs* – *i*.e. costs stemming directly from the flood such as damage to infrastructure, agriculture, buildings, vehicles, death and injury, etc;
- *Indirect tangible costs* – i.e. costs incurred following the event such as loss of production, loss of income and increased insurance costs; and
- *Intangible costs* – i.e. other costs that are often emotional, such as loss, grief and isolation.

Evidence from the Queensland Floods Commission of Inquiry

The Queensland Floods Commission of Inquiry (QFCI) examined issues relating to the 2010/2011 floods in Queensland.

The QFCI describes the roles and responsibilities of local council planners in mitigating flood risks within their council region. It showed that council planners enforce requirements set out within their local council planning scheme, when an application for a new development is submitted. This involves making an assessment of land use and determining the minimum habitable floor height. For example, the Kolan Shire Planning Scheme, through the use of an infrastructure overlay map, identifies 12 properties in the town of Gin Gin as being located within a flood and drainage liability area. The scheme requires that development proposed on land identified in the overlay map provide 'an acceptable level of flood immunity'. One way in which an applicant can demonstrate compliance with this standard is by constructing the floor level of habitable rooms at not less than 300 millimetres above the level of a 1% Annual Exceedance Probability (AEP) flood.

Further evidence in the QFCI shows that community infrastructure, such as health centres and aged care facilities, does not require approval under a council planning scheme.[1] State Planning Policy (SPP) 1/03 acknowledges that it would be unrealistic to locate and design community infrastructure so as to withstand any conceivable flood. This practice is risky. As a consequence, an aged care facility in Yeronga became inundated by flood waters up to a metre above ground, causing evacuation and also preventing the return and use by residents up to two months after the flooding occurred.

A lack of flood mapping in Queensland also diminishes the effectiveness of council planning decisions.

The QFCI identifies a report commissioned by the Queensland Reconstruction Authority in conjunction with the Department of Local Government and Planning which reviewed 127 of Queensland's 137 planning schemes and established that 80 out of the 127 planning schemes reviewed contained no flood-related mapping. The reasoning behind the inadequate level of flood mapping is that the SPP 1/03 or any other piece of legislation is not required; and the costs, time and processes involved in undertaking a detailed flood study are impracticable for local councils. For example, the Bundaberg Regional Council argued that it is unable to determine the habitable floor level for residential buildings, because it does not have information about the 1% AEP flood level for the Kolan Shire. Thus, short of engaging a specialist engineer to determine a 1% AEP flood level, an applicant cannot demonstrate compliance with this provision of the council planning scheme.

Imperfect Individual and Industry Responses

The QFCI reported that "purchasers of property, in making the decision to purchase, did not turn their minds to the property's vulnerability to flood". This implies that many, and possibly most, prospective residents of new buildings would be unaware of the risks of flooding.

Queensland council flood maps depict areas that have a 1 per cent chance of becoming inundated by flood waters in any given year, by a "Q100" contour line. The QFCI discovered that many members of the public did not understand the term "Q100", nor what the Q100 line represented. Other members of the public misunderstood the meaning of Q100 and believed that floods would occur only once every hundred years.

The QFCI received evidence that showed that segments of the industry were aware of the benefits of using flood resistant materials and innovative design solutions; however the associated costs often discouraged developers from putting these methods into place. The developers avoided adding costs to projects as that would reduce their affordability.

[1] Note that health centres and aged care facilities are classified as 9a and 9c buildings respectively under the BCA and as residential buildings are within the scope of this RIS.

3 The Problem: the Risk of Floods

Floods are a prominent natural hazard in Australia. The problem is twofold.

- First, *lack of information about flood risks and imperfect industry responses*. Prospective residents lack sufficient information to understand and assess the flood risks to new buildings. And where purchasers do not perceive value from the inclusion of flood damage prevention measures in buildings or are not aware of their level of exposure to the risk of flood, there is little or no incentive for builders to include such features in construction. This is because purchasers are unlikely to choose to meet the additional costs that builders may incur to provide these protections.
- Second, *imperfect regulatory arrangements*. The risk of floods to prospective residents of new residential buildings is currently managed by local government planning officials, under State or Territory legislation, who make assessments of land use and may also determine the minimum floor height for habitable rooms in flood hazard areas. In many jurisdictions, planning officials are restricted by planning and/or building law from regulating building matters such as structural integrity and location of utilities. These building matters are vital to ensure the resilience of residential buildings in flood hazard areas during a flood event.

Lack of Information and Imperfect Industry Responses

Prospective residents, and especially owner-occupiers, have a clear interest in ensuring that new buildings are sufficiently robust to withstand an anticipated flood event, and by so doing enhance their health and safety during a flood event. Prospective residents can choose to implement protection measures to mitigate flood risks, where these are known and understood. Given this information, residents may be able to balance the risk of loss (including personal safety and health) against the cost of risk mitigation measures, and choose the level of exposure they are willing to accept.

In practice this is unlikely to occur because, to determine the risks associated with a particular building and the appropriate approach to mitigating those risks, prospective residents require information about the following:

- how risks are influenced by specific building, property and location characteristics; and
- how different modifications made to the design of various building components can effectively mitigate flood risks, minimise damage to the building structure and enhance personal health and safety during a flood event.

This information is highly technical, extensive and potentially difficult to comprehend. In practical terms, it may not be realistic to assume that residents would, as a matter of course, have the capacity to assemble, analyse and assess the range of information necessary to form a fully informed view of the building risks and the appropriate mitigation measures. Evidence from the QFCI shows that residents, in making the decision to purchase a property, did not turn their minds to the property's vulnerability to flood. Evidence from stakeholders is similar: "the general public do not know or understand what their flood risk is, or what resilience measures are required, or how to identify these".

Further, the benefits of preventing flood damage and injury normally do not accrue to the party that designs or constructs the building. Designers and builders have incentives to minimise building costs in order to attract purchasers and remain competitive in the building industry, yet decisions made during the building design and construction phases can significantly impact on the probability of these damages and injuries occurring when a flood event takes place. Without intervention, builders do not have incentives to voluntarily incorporate additional preventative measures in the design and construction of buildings, where owners are price driven and, due to insufficient information, unable to verify the benefits arising from an increase in building costs. Evidence from the QFCI showed that segments of industry were aware of the benefits of using flood resistant materials and design solutions; however developers were discouraged by the added costs that reduced the affordability of new buildings.

The previous Consultation RIS asked stakeholders a number of questions about whether the market does address the risk of floods, providing survivability measures without regulatory intervention. The emphatic answer from local governments and insurers was: no, it does not. Comments included the following:

> ***"The market does not respond to the risk of floods and is not interested in addressing the issue."***
>
> ***"The home owner would assume a new dwelling has been constructed with survivability measures."***
>
> ***"The general public do not know or understand what their flood risk is, or what resilience measures are required, or how to identify these."***
>
> ***"Many home owners are unaware that they live in a flood hazard area until the flood is upon them."***
>
> ***"Building Certifiers would not and should not be expected to conduct inspection of buildings potentially subject to flood inundation to determine flood survivability."***
>
> ***"The demand side of the market does not adequately respond to flood risks, due to a lack of information about flood risks. Governments have a duty of care to disseminate information about flood risks, including in land use planning and building standards."***

Nature of the Problem for Residents

The occupants of residential buildings face a number of life safety risks, which arise from the impact of flooding on the building structure (refer Table below).

Table 3-1: Relevant Life Safety Risks arising from Performance of Building Structure

Life Safety Risk	Structural Risk to Building
Injury or fatality from structural failure of a building due to the effects of water at rest or in motion	Erosion or scour undermining footings Failure of walls or columns resulting in collapse Striking action of flood debris
Health issues due to the loss of amenity from inundation	Saturated plasterboard, carpets, structural members, etc causing conditions for mould Inability of building components to remain dry Bacterial or other organisms causing illness

Life Safety Risk	Structural Risk to Building
Injury or illness caused by loss of utilities	Loss of phone or electrical network Backflow of sewerage or water lines
Injury, illness or fatalities from failure of a structure or auxiliary structure resulting in additional damage being caused to the same property or to another property	Breakaway of elements which may cause damage to other property compromising the structural integrity of that structure
Injury or illness caused by not being able to safely evacuate	Failure to ensure safe egress (e.g. balcony, verandah, etc) from building in the event of a flood

Consequences of Floods for Residents

Data collected from the National Flood Insurance Database (NFID) shows that there are 220,000 residential and commercial addresses located within the 100-year Average Recurrence Interval (ARI) flood zone or the 1% Annual Exceedance Probability (AEP). That is, new and existing buildings at these addresses face a one per cent risk of being affected by flooding in any given year.

The Insurance Council of Australia (ICA) reported that, as at 24 November 2011, a total of 58,463 residential and commercial claims were made, with 26,554 residential building claims alone (96.8 per cent within Queensland) made in relation to the 2010/2011 Queensland floods. The total insured losses covering the reserved and paid value of building costs, replacement items, cash settlements, accommodation, business interruption, rebuilding services etc of the Queensland flood disaster is estimated at $2.38 billion.

The ICA also reported that around 2900 properties are unliveable due to flooding until they can be repaired. In addition, another 1400 properties are liveable but will potentially require residents to vacate during repairs.

The QFCI Final Report states that in the 2010/2011 floods, which affected more than 78 per cent of Queensland, 33 people died while another 3 are still missing.

Imperfect Regulatory Arrangements

The current regulatory arrangements pertaining to construction in flood hazard areas comprise general Performance Requirements contained in the NCC and varying State and Territory based requirements contained in planning provisions and building regulations.

NCC Requirements

The NCC does not address flood risks specifically. Instead, the provisions are limited to general Performance Requirements that stipulate a building or structure should not collapse when subject to reasonable 'design actions'. While important considerations, these Performance Requirements apply to all new buildings and are not targeted to the specific risks posed by flooding. There are currently no technical standards provided for construction in flood hazard areas at a national level that would be available for each State and Territory to adopt and address flood risks through building provisions.

As such, the treatment of flood risk in the NCC differs from other natural hazards (e.g. earthquakes, bushfires, cyclones, etc), where technical standards are referenced in the NCC to ensure that appropriate and risk reflective levels of protection are incorporated in new buildings constructed in risk prone areas.

State and Territory Requirements

In the States and Territories, planning law allows local government planning officials to manage flood risks by assessing appropriate land use, and in designated flood hazard areas, determining the minimum building floor height. In many jurisdictions, local governments are prevented by planning and/or building law to include provisions in local planning instruments that are regulated by the building provisions, including the NCC. As a consequence, under the current regulatory arrangements there are critical omissions in the guidance for industry in building in flood hazard areas. These omissions include guidance on methods, materials and products for buildings in flood hazard areas, guidance on design, for example to require foundations to be appropriately compacted and protected from the impacts of floods, and ensuring that the structural integrity of the building is sufficient withstand flood events.

The building industry and its regulators, assessors and inspectors need to have a clearer understanding of the need to consider flood impacts in design, where necessary, and to be provided with advice and direction on how to appropriately consider and address this risk.

Evidence from the Queensland Floods Commission of Inquiry (QFCI) confirmed the roles and responsibilities of local council planners in mitigating flood risks within their council region: making assessments of land use and, in flood hazard areas, determining the minimum habitable level usually at 300mm above the level of a 1% AEP flood.

State and Territory Regulations

The general approach of the States and Territories in addressing the risk of floods is to require the minimum floor height of new residential buildings (in flood hazard areas) to be above the expected flood level.

- Five jurisdictions – QLD, VIC, WA, TAS and NT – specify in planning legislation that minimum floor levels are required for these buildings. Local governments provide planning approval on this basis in the four States and the NT government provides approvals directly.
- Two jurisdictions – NSW and SA – do not specifically require minimum floor levels in legislation. However local governments have the capacity to require this in their planning approval process for flood hazard areas, and most do.
- One jurisdiction – the ACT – does not, because it generally does not release land for construction in areas subject to flooding.

There are differences between the jurisdictions in their planning legislation, but these differences are a secondary order of importance compared with their common approach of setting minimum floor heights.

Responsibility for determining the location of flood hazard areas sits with planning authorities, in most cases. This determination is normally based on the 1% AEP, with authorities typically avoiding any risk exposure above this level. The following table provides a summary of the regulations for each jurisdiction.

Table 3-2: Summary of Current Regulatory Approach for each State / Territory

Jurisdiction	Building Regulations	Planning Regulations
NSW	Flood related planning requirements for local governments are set out in a Ministerial Direction issued under the *Environment Planning and Assessment Act 1979* that require provisions to be commensurate to the level of flood hazards.	Merit approach for all development decisions in floodplains (i.e. 1% AEP), with local governments responsible for managing flood risk and developing flood prone lands in accordance with Government policy.
VIC	N/A – there are no specific provisions in State legislation / regulations relating to the construction requirements for buildings in flood hazard areas.	Local governments define land considered to be liable to flooding. In those areas, either relevant planning schemes apply or (if not available) the report and consent of the relevant local government must be obtained for an application for a building permit.
QLD	Local governments are not able to include provisions in local planning instruments that are regulated by the building provisions, including the NCC.	Local governments designate natural hazard management areas within their jurisdiction (for flood, the 1% AEP normally applies), and can declare the level to which the floor levels of habitable rooms must be built.
WA	N/A – There are no specific provisions in State legislation / regulations relating to the construction requirements for buildings in flood hazard areas.	Local governments typically incorporate provisions into their Town Planning Schemes. Local governments have the power to not issue approvals in areas at risk of flooding and may consult with State authorities to determine specific requirements for construction in those areas.
SA	N/A – Building provisions are limited to those in the NCC, with no specific State building provision for flood prone areas.	The State Government's 'Better Development Plans' provide generalised policies for use in local government development plans throughout the State. This provides general policy on flooding, with local governments able to add more specific planning provisions which relate to their circumstances.
TAS	The *TAS Building Act 2000* and the *Building Regulations 2004* require that the floor level of habitable rooms must be 300mm above the prescribed designated flood level (1% AEP).	N/A – Local governments do not have their own building related controls.
NT	NT legislation / regulation defines flood hazard areas (1% AEP) and specifies requirements for those areas (e.g. floor level of habitable rooms 300mm above the flood level, adequate structural design to withstand flood).	N/A – Local governments have no powers to develop their own requirements for construction in those areas.
ACT	N/A – Territory Government controls and planning restrictions mean there are no flood prone areas currently available for construction.	N/A – new construction prohibited in flood prone areas (i.e. 1% AEP).

Table 3-3 below identifies five flood risk areas and summarises the extent to which existing provisions in each jurisdiction address these risks (refer Appendix A for further detail). This assessment is based on documented jurisdictional requirements. While the table illustrates the variability of regulations, it also shows that all jurisdictions (apart from the NT and ACT (by exclusion)) do not regulate to ensure the structural integrity in new residential buildings during a flood event.

Table 3-3: Alignment of State / Territory requirements with key risk areas

Risk Area	**NSW**	**VIC**	**QLD**	**WA**	**SA**	**TAS**	**NT**	**ACT**
Injury or fatality arising from structural failure due to the effects of water at rest or in motion	*No*	*No*	*No*	*No*	*No*	*No*	*Yes*	*
Health issues due to the loss of amenity from inundation	*No*	**Yes**	**Yes**	*No*	*No*	**Yes**	**Yes**	*
Injury or illness caused by loss of utilities	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*
Injury, illness or fatalities caused by failure of a structure or auxiliary structure resulting in additional damage to the property or another property	**Yes**	*No*	*No*	*No*	*No*	*No*	*No*	*
Injury or illness caused by not being able to safely evacuate	**Yes**	*No*	*No*	*No*	*No*	*No*	*No*	*

*Note that the ACT is an exception. It does not experience the problem of flooding because there are no designated flood hazard areas in its urbanised areas. The Government has ensured that land is not released for construction in flood hazard areas.

Conclusion

Floods are a prominent natural hazard in Australia. However flood risks are poorly understood by residents. In the words of one stakeholder: “the general public do not know or understand what their flood risk is, or what resilience measures are required, or how to identify these”. Some builders are aware of flood risks, but are reluctant to add flood survivability measures (unless directed by the client) due to the loss of competitiveness with price conscious buyers who are unaware of and do not value these measures. Overall the market does not manage the risks of floods in terms of the structural integrity of buildings and survival of utilities, that are important for residents’ health, safety and amenity during a flood event.

Management of flood risks to new residential buildings does occur - at the government level. This is through the planning controls of the States and Territories as exercised by local governments. Approval to build new residences is withheld in the most hazardous areas, generally with a flood risk greater than 1% AEP, and may be granted in 1% AEP flood hazard areas. The principal tool used by planners in these circumstances is to require the minimum floor height of the habitable rooms to be set at a predetermined height, above the anticipated flood level. However this planning approach does not ensure the structural integrity of buildings or the protection of utilities in new residential buildings during a flood event, which are vital to life safety, health and amenity of residents. This omission is evident in all Australian States and Territories (apart from the NT and ACT (by exclusion)).

In light of these considerations, there is a strong case for Government intervention and a review of the current regulatory arrangements to assess whether the risk of flood damage to buildings and with associated injuries, and its impact and costs on the community can be addressed more effectively and efficiently than the Status Quo.

4 Objectives

The ABCB's mission is to address the issues of health, safety, amenity and sustainability in the design, construction and performance of buildings. This will be achieved through the NCC and the development of effective regulatory systems and appropriate non-regulatory solutions.

Objectives of the ABCB

The objectives of the ABCB are to:

- develop codes and standards that accord with strategic priorities established by Ministers from time to time, having regard to societal needs and expectations;
- establish codes and standards that are the minimum necessary to efficiently achieve the relevant Mission objectives; and
- ensure that, in determining the area of regulation and the level of the requirements:
    - there is a rigorously tested rationale for the regulation;
    - the regulations are effective and proportional to the issues being addressed such that the regulation would generate benefits to society greater than the costs (that is, net benefits);
    - there is no regulatory or non-regulatory alternative (whether under the responsibility of the Board or not) that would generate higher net benefits; and
    - the competitive effects of the regulation have been considered and the regulation is no more restrictive than necessary in the public interest.

Objectives in addressing the Risk of Floods

The objectives in addressing flood risks are to support the achievement of key health, safety and amenity objectives:

- safeguarding people from injury caused by structural failure in the event of a flood;
- safeguarding people from loss of amenity caused by structural behaviour in the event of a flood;
- safeguarding people from illness or injury caused by utility failure in the event of a flood;
- protecting other property from physical damage caused by structural failure in the event of a flood; and
- safeguarding people from injury by facilitating egress in the event of flood.

Stakeholders from government and insurance, in commenting on the Consultation RIS, suggested that the objectives be broadened to include the protection of property.

To respond: this RIS accepts the mission and objectives of the ABCB as expressed in its Inter-Government Agreement of 2012. The priority is the health, safety and amenity of building occupants; protection of property is not mentioned.

5 Options

This chapter presents four alternative choices for decision makers in addressing the risk of floods in Australia:

- **Status Quo**
- **Option 1a**: New NCC Provisions, in flood hazard areas designated by local councils
- **Option 1b**: New NCC Provisions, in flood hazard areas identified in a national flood map
- **Option 2**: Handbook

Many (but not all) stakeholders explicitly supported Option 1, with their preferences evenly divided between the sub-options 1a and 1b.

Status Quo

The status quo is the default option for decision makers in considering proposals to address the problem, and achieve the objectives. Where the incremental impacts of Options 1 and 2 would result in more costs than benefits, the RIS would recommend the Status Quo.

The Status Quo will be regarded as a baseline, as a basis to determine the incremental impacts of Options 1 and 2.

Option 1: New NCC Provisions

This option would introduce new provisions into the NCC to address risks that floods pose for new residential buildings. The proposed provisions contain two principal parts:

- Performance Requirements under which industry may propose an "Alternative Solution" for a new residential building to resist the actions of flood. These Performance Requirements apply to any flood – flash floods or onset floods – and must be effective in resisting flood actions in the local topography.
- Deemed-to-Satisfy (DTS) standard, comprising a set of specific provisions on the construction requirements for new residential buildings in flood hazard areas, incorporated into the NCC as a new standard. Note that the DTS standard is limited to floods, also known as "rising water", where the rate of flow does not exceed 1.5 metres per second.

The structure of the proposed arrangements is consistent with the treatment of other natural hazards in the NCC (e.g. bushfires, cyclones and earthquakes), where the DTS standard is referenced in the NCC to assist the building industry and building owners to efficiently mitigate the risks posed by those hazards. Similar to other natural hazards, the proposed provisions will only apply where a new building is deemed to be at risk of flooding. Responsibility for designating a particular location as a flood hazard area will reside with the relevant State/Territory or Local Government authority having jurisdiction.

Performance Requirements

The Performance Requirements for the proposed provisions are as follows;

> "A building in a flood hazard area, to the degree necessary, must be designed, constructed, connected and anchored to resist flotation, collapse or significant permanent movement resulting from the action of hydrostatic, hydrodynamic,

erosion and scour, wind and other actions during the designed flood event or lesser event in accordance with the requirements of this standard."

To satisfy the above requirements, the proposed provisions include consideration of the following areas:

- flood actions;
- elevation requirements;
- foundation requirements;
- requirements for enclosures below the flood hazard level;
- requirements for structural connections;
- material requirements;
- flood proofing;
- requirements for utilities;
- requirements for egress; and
- impacts to other structures and properties.

These Performance Requirements allow the proposed provisions to be applied to the design of buildings in any area that may be affected by flooding, as determined by the authority having jurisdiction.

Deemed-to-Satisfy Standard

The proposed NCC provisions also provide a technical Deemed-to-Satisfy (DTS) standard designed to meet the above Performance Requirements for new construction in flood hazard areas. The technical standard will apply to the design and construction of Class 1, 2, 3, 4, 9a and 9c buildings, and is focused on reducing the risk of death or injury of building occupants as a result of the building being subjected to certain flood events.

The DTS standard is limited to situations were the maximum flow velocity is no greater than 1.5 metres per second. Where a flood flow velocity exceeds this value it becomes more difficult to develop appropriate DTS construction criteria because the higher hydrostatic and hydrodynamic actions, together with increased risk of scour and foundation damage, preclude the use of traditional construction methods. However, where the flood flow velocity exceeds 1.5 metres per second, the Performance Requirements still apply and competent practitioners (e.g. hydrologists and engineers) would be able to develop an appropriate design solution that meets the applicable Performance Requirements.

Table 5-1 below summarises the key elements of the proposed DTS standard to address each identified life safety risk. A full copy of the draft standard is included as Appendix D to this RIS.

Table 5-1: Deemed-to-Satisfy elements contained in the proposed provisions

Risk Area	DTS Standard
Injury or fatality to occupants from structural failure of a building due to the effects of water at rest or in motion.	Foundations and footings of structures must provide the required support to prevent flotation, collapse or permanent movement resulting from flood action. This is to be determined by a qualified engineer at the design stage. Compliance will require consideration of geotechnical

Risk Area	DTS Standard
	conditions, footing depth, piers, post, columns or pole; and adequate design for use of slabs-on-ground. This is to be determined by a qualified engineer at the design stage. Fill must be designed to ensure support under conditions of flooding. Strength of walls must be able to resist hydrostatic and hydrodynamic actions. Water resistant materials to be used for structural items such as bracing, columns, connections, fasteners, wall framing members, etc. Impacts from horizontal loads caused by debris action must be determined using a rational approach at the most critical location at or below the defined flood level.
Health issues due to the loss of amenity to the household from inundation	The finished floor level of any habitable room must be above the flood hazard level, which includes any required freeboard. Finished floor level on enclosed non-habitable rooms must be no more than 1.0m below the defined flood level.
Injury or illness caused by loss of utilities	Increase protection for utilities, including: • Utilities must not be placed below the flood hazard level unless they have been designed to cope with flood water inundation; • Buried systems protected from scour and erosion; and • Greater level of fixing of HVAC equipment. •
Injury, illness or fatalities by failure of a structure or auxiliary structure resulting in additionally damage being caused to the same property or to another property	Decks, patios, stairways, ramps, etc are to be structurally adequate to not reduce the structural capacity of the building they are attached to.
Injury or illness caused by not being able to safely evacuate	Egress from a balcony, verandah, deck, door, window or the like must be available to allow a person to be rescued by emergency services personnel.

The Consultation RIS asked whether there was any risk area able to be excluded from the proposed provisions. One stakeholder, an insurer, expressed strong opposition to any reduction in scope of the proposed DTS Standard or acceptance of risks.

Considerations in Developing the DTS Standard

- *Maximum velocity of flood waters* – the defined maximum velocity of flood waters (i.e. 1.5 metres per second) limits the scope of the proposed provisions. This limit was determined by an expert reference group, which sought to achieve a balance between providing coverage for the majority of flood events while recognising current typical construction practice. For flood velocities higher than 1.5 metres per second, the hydrostatic and hydrodynamic actions, together with potential problems of scour and foundation failure, are likely to require specialist treatment.

- *Level of freeboard* – the proposed standard leaves consideration of freeboard requirements within the jurisdiction of local governments. Freeboard is typically set at 300mm to 500mm.
- *Non-habitable rooms* – the proposed standard does not require waterproofing of materials in non-habitable rooms. While making all materials waterproof or water resistant was considered by the reference group, it was determined that only structural members such as columns, load-bearing walls and bracing would be required to be waterproof or water resistant to maintain structural integrity and life safety of occupants. Additional requirements for non-structural elements in this area might be uneconomical. In addition, it may still be necessary for water resistant wall linings to be removed to enable the wall cavity to be cleaned out or to allow the structural frame to dry out.

Several stakeholders provided detailed comments on the proposed DTS Standard. These comments have been taken into account in refining the DTS Standard.

Considerations in developing the NCC Provisions

This section describes other considerations relevant to the development of the proposed NCC provisions, including other potential policy options and the ability of other forms of regulation and / or non-regulatory measures to achieve the identified regulatory objectives.

Mandatory vs voluntary adoption of the proposed DTS standard for flood hazard areas

The proposed standard provides building solutions for buildings in flood hazard areas. One consideration was whether the standard should become mandatory when the authority having jurisdiction identifies a flood hazard area or whether it would be the role of planners (voluntary) to determine whether the building provisions provided by the proposed standard would apply to buildings in flood hazard areas, i.e. not all buildings in flood hazard areas would have to comply with the proposed provisions at the discretion of the planner.

It was thought that voluntary adoption of the proposed standard by planners may lead to the existing inconsistent, inadequate or incomplete solutions to address the problem identified.

National flood mapping

The preparation of a national flood map, to be included with the NCC provisions, was considered as a possibility but assessed as not feasible. The costs involved to develop and maintain a national flood map were assessed as very high, and the expertise and information required to develop these maps is likely to reside at the local level.

However, this possibility is presented as a sub-option (see below) and stakeholders were invited to provide feedback on the feasibility of this approach.

Exclusions within flood hazard areas

The proposed NCC provisions were designed and drafted to ensure the Performance Requirements are met. In considering this there were several identified limitations in drafting the proposed provisions, with consideration being made for alternative hazards which may occur in parallel or separately to flooding. The proposed Deemed-to-Satisfy provisions do not apply to areas within a flood hazard area which is also subject to landslip, mudslide, storm surge or coastal wave action.

This is due to the difficulty in determining how a building would behave in these situations, for instance mudslides and landslides are the result of geomorphic process by which soil, sand, and / or rock falls away due to gravity. In extreme cases mudslides may reach a velocity of 80km/hr. Storm surge refers to the rise of water associated with a storm, it is caused by high winds pushing on the ocean in addition to the level of the tide. Storm surge may raise the ocean's sea level to a point where it affects houses. This may also be evident in freshwater areas, where the combination of a high tide and increase in ocean sea level may cause rivers to burst their banks. Storm surge is particularly damaging due to coastal wave actions and the potentially significant lateral forces applied to a building.

The exclusions of mudslides, landslides, coastal wave actions and storm surge from the proposed Deemed-to-Satisfy provisions reflect the different, varied and uncertain technical requirements to ensure survivability of buildings subjected to these events. While the scope of the proposed provisions might be expanded to deal with these additional hazards, there would be additional costs and complexity associated with doing so, which would need to be considered against the associated benefits. At this point in time it was determined that these risks were better addressed on a case –by-case basis in accordance with the relevant NCC Performance Requirements.

Potential conflicts with other planning goals

The proposed Deemed-to-Satisfy provisions include a requirement to elevate the floor level of habitable rooms above the flood hazard level. In some locations this requirement may conflict with other planning controls such as height restrictions of a building, the visual amenity or locality issues.

While in these cases construction may not be permitted in a particular location, the need to either review the proposed provisions or planning controls to mitigate any negative implications arising from this conflict (e.g. reduced choice, diminished property value) should be considered in light of the costs or risks of doing so.

Protection against damages to non-habitable rooms

The proposed NCC provisions' primary objective is to ensure the life safety of building occupants in flood hazard areas is maintained. Whilst some elements of property protection may come as a result of this objective, property protection *per se* is not an objective of the NCC. It is considered that occupants would not seek shelter during a flood event in a non-habitable room such as a garage, bathroom, etc due to the nature of these rooms.

To protect non-habitable rooms against damage from flood waters would mean mandating that these rooms be placed above the defined flood level, and this would drastically limit design options.

Acceptance of one or more key risks

A relevant consideration might also be to reduce the scope of the proposed provisions to address one or more (but not all) of the identified risk areas. This approach implies acceptance of one or more of the identified life safety risks associated with construction in flood hazard areas such as:

- structural failure of building;

- floodwater inundation of building;
- loss of utilities due to flooding;
- impact of structural failure on other buildings; and / or
- inability to safely evacuate buildings.

However, it is important to recognise that the costs associated with mitigating a particular risk area cannot readily be isolated and avoided. For example, should decision-makers decide to accept the risks arising from a loss of amenity from inundation, this would require a different building solution (e.g. wall strengthening, roof bracing, etc) to address the risks arising from structural failure due to flooding.

Potential application of other forms of regulation

The COAG *Best Practice Regulation* guide identifies a spectrum of regulatory approaches with explicit government regulation (i.e. the proposed provisions) at one end of the spectrum and self-regulation at the other. Intermediate forms of regulation (quasi-regulation and co-regulation) are also identified.

The lack of alignment between those with responsibility for incorporating better preventative measures in new buildings in flood hazard areas and those who realise their benefits, mean it is unlikely that an intermediate form of regulation would achieve the Government's objectives. The risks associated with non-compliance include substantial risks to public health and safety, and economic impacts.

Potential for non-regulatory intervention

A range of alternative instruments that might be used as alternatives to regulatory intervention, include:

- information and education campaigns;
- standards including voluntary, non-regulatory, performance-based or prescriptive; and
- market-based instruments such as taxes and subsidies.

Non-regulatory interventions, on their own, appear to be inappropriate responses to ensure implementation of appropriate preventative measures for flood damage and flood injury because they would not provide the level of assurance of protection and minimisation of damages required by the public and the Government.

Sub-options for Option 1

Option 1 contains two sub-options:

- **Option 1a**: new NCC provisions to apply in flood hazard areas as designated by each local government.
- **Option 1b**: new NCC provisions to be applied according to a national flood map.

Option 1a would complement the current planning process where the new NCC provisions could ensure the structural integrity and protection of utilities of new residential buildings in designated flood hazard areas, in all States and Territories of Australia. The designation of each flood hazard area would continue to be made by local government. The relevant planning authorities in each jurisdiction would retain responsibility for defining a location as being at risk of flooding. This means flood mapping and any associated risk analysis is performed by State, Territory or Local Government authorities, who are considered to be best placed to identify areas at risk of flooding in their jurisdictions and manage the nature and extent of construction activity in those areas.

Option 1b would require the preparation of a national map of all 1% AEP flood hazard areas in Australia, and included with the new NCC provisions. Any new residential building proposed in a mapped flood hazard area that did not meet the Performance Requirements through an Alternative Solution, would be subject to the DTS standard. In essence, the DTS standard would be triggered by location of a property on the national flood map, not by local government designation of a flood hazard area. The advantage of using a national flood map is that this approach would support a nationally consistent application of the proposed NCC provisions.

Option 1b would be a major strategic decision and require agreement of all Australian Governments to the preparation of a national flood map. At present there has been no indication from any Government that a national map is needed or that flood risk in all its dimensions should be managed through the NCC. There are also practical considerations. Flood mapping is an extremely complex and detailed exercise reliant on detailed analysis of flood risk for individual addresses within a jurisdiction. The understanding of flood risk within each jurisdiction is constantly evolving, with existing maps subject to ongoing refinement and improvement. This exercise may be more effectively undertaken at the jurisdictional and local government level, with local knowledge of the flood hazards.

Overall, Option 1b has the potential to deliver the greatest benefit (where it most closely matches up with the risks) but the very high costs of developing and maintaining a national flood map offsets this. To the extent that local governments well understand their flood hazard areas, Option 1a can potentially deliver much of the benefit of Option 1b without the cost of full flood hazard mapping.

Stakeholders generally were evenly divided between support for the sub-options 1a and 1b. Some emphatic statements were made:

> ***"Responsibility for designating a particular location as a flood hazard area should reside with the relevant jurisdiction or local council. Flood hazard is best understood at the local level."***
>
> ***"The Council is acutely aware of the impact of flooding within its local government area and has taken responsible action to mitigate the impact of floods by the preparation of flood studies."***
>
> ***"Local government flood map data is generally disparate and inconsistent, where it exists, and is insufficient to rely upon when implementing the standard."***
>
> ***"Flood mapping is essential to improved development and planning, and ensuring flood risk exposure is minimised."***
>
> ***"Flood mapping would be a good idea, but the overall cost may make the scheme prohibitive."***
>
> ***"A national flood map is critical to providing uniformity in flood controls across Australia. Lack of a national flood map will result in an inconsistent approach within local government areas and between states."***

Stakeholders generally expected the cost of preparing a national flood map to be "substantial" or "prohibitive". One local government commented that the cost of a flood study for half a local government area stakeholder was around $100,000. The insurers suggested utilising the national flood hazard data base currently being assembled by

Geoscience Australia as the basis for identifying and designating flood hazard areas – an approach with minimal cost.

Option 2: Handbook

The ABCB has prepared a handbook to accompany the proposed NCC provisions. It could be developed to provide stand alone guidance for governments and the building industry on structural measures to address the risk of floods. The handbook could be expanded to indicate the intent of the Performance Requirements and include detailed guidance similar to the proposed DTS standard.

The handbook option is included in this RIS in response to stakeholder comments on the problem, that:

> ***"The demand side of the market does not adequately respond to flood risks, due to a lack of information about flood risk" and "Governments have a duty of care to disseminate information about flood risks".***

The handbook would provide helpful information for use by local governments and industry.

6 Unit Costs of the DTS Standard

This section presents the unit costs of the proposed DTS standard in Option 1. The incremental changes in building requirements, from the Status Quo to the proposed DTS standard, are costed for a representative sample of residential buildings.

Proposed New Requirements under the DTS Standard

The proposed DTS standard applies only to Class 1, 2, 3, 4, 9a and 9c buildings. In order to quantify the cost impact of the proposed arrangements for new buildings in these categories, a number of sample buildings have been identified as representative examples of construction activity within that BCA Class (defined in Table 6-1 below with designs included as Appendix C).

Table 6-1: Description of affected buildings

Class	Detail	Description of Sample Buildings
1	Single dwelling, including terrace or townhouse	**A**. Two storey, slab on ground bottom floor, timber upper floor, lightweight upper floor cladding, no integral garage (sourced from Geoscience Australia) **B**. One storey, slab on ground floor, masonry veneer construction (sourced from Geoscience Australia) **C**. Standard House, 3 bedroom, single storey, slab-on-ground (sourced from HIA) **D**. Standard House, 4 bedroom, two storey, slab-on-ground, garage (sourced from HIA)
2	Building containing two or more dwellings	Two storey, two single occupancy (2 bedroom) units built on top of one another, concrete slab, external staircase. Note, this design would be representative of a larger scale construction once impacts are converted into percentage terms (i.e. additional units)
3	Guest house, motel, backpacker accommodation etc	Five unit motel, single level, one bedroom and bathroom per unit plus office and kitchenette. Note, this design would be representative of a larger scale construction once impacts are converted into percentage terms (i.e. additional units)
4	Single dwelling in a Class 5, 6, 7, 8, or 9 building	n/a – construction within this BCA Class is expected to be minimal for flood hazard areas. Therefore, the cost impact was approximated based on averages for other building types rather than estimated at the individual building level.
9a	Health-care building, hospitals etc	n/a – construction within this BCA Class is expected to be minimal for flood hazard areas. Therefore, the cost impact was approximated based on averages for other building types rather than estimated at the individual building level.
9c	Aged care building	

Given the majority of Australian construction activity relates to BCA Class 1, the cost analysis focused on the impact of the proposed DTS standard on the construction costs of these buildings. Accordingly, four detailed designs (with accompanying specifications) were used as a basis for the Class 1 cost analysis (refer Appendix C).

In comparison, the analysis of cost impacts for Class 2 and Class 3 buildings was based on high-level designs, which although not representative of the diverse types of construction within these categories, sought to provide a reasonable basis for estimating a percentage cost impact to be applied across other buildings in that category. For example, while the Class 2 design incorporated four single occupancy units within a two storey building, the cost impact in percentage terms was assumed to be similar should additional single occupancy units of a similar size be incorporated in the building design. For each chosen design, the plans and specifications were used to determine the impact of the proposed provisions on standard construction practices.

Due to minimal construction activity being projected for Class 4, 9a and 9c buildings in flood hazard areas, a more high level approach was adopted for the cost analysis in these categories. Specifically, the average percentage cost increase quantified for other building types was applied to the construction in these categories, with areas of potential variation identified and described qualitatively.

The analysis identified the cost impact of the proposed provisions for each BCA Class, which represents the estimated increase in costs compared to a base case of no regulation.

The Consultation RIS asked whether the sample of Class 1 building (house) designs was representative of future construction activity in flood hazard areas. One local government responded that it had approved designs A, B and C.

Estimated Cost Impact of the Proposed DTS Standard

The costs associated with the proposed DTS standard were estimated by quantity surveyors based on the outcomes of an engineering analysis for each sample building. The outcome of this costing work is summarised below, with the detailed outputs provided in Appendix B.

Cost Impact by BCA Class

Table 6-2 below summarises the estimated change in construction costs for each affected BCA Class.

Table 6-2: Estimated change in future construction costs (2011/12 dollars)

Class	Design	Base Cost	Cost Impact	Cost Impact (%)
1	Design A*	$497,904	$14,895	3.0%
1	Design B	$546,480	$28,103	5.1%
1	Design C	$451,757	$27,404	6.1%
1	Design D	$689,779	$30,202	4.4%
	Average	*$546,480*	*$25,151*	*4.6%*
2		$427,469	$14,926	3.5%
3		$306,029	$20,757	6.8%
4		$434,000	$19,974	4.6%
9a		$1,653,000	$76,077	4.6%

9c		$2,617,000	$120,444	4.6%

* Note that Design A is a Queenslander style pole house so the cost impacts are significantly less.

The cost impacts for Class 4, 9a and 9c buildings were assumed to be equal to the weighted average percentage change identified for Classes 1, 2 and 3 buildings. The base costs for these buildings were approximated as the average value per approval in each BCA Class.

On average, it is estimated that the proposed provisions will involve a 4.6 per cent cost increase for the construction of new buildings in flood hazard areas (compared to a base case of no regulation).

In most cases, this additional cost relates to the requirement for the floors of habitable rooms to be above the flood hazard level (assumed to be one metre), which will mitigate the risk to health and safety of structural failure and health issues arising from inundation. The assessed increase in cost is lowest for *BCA Class 1 (Design A),* where the design does not incorporate habitable rooms below the assumed flood levels and more cost effective strengthening measures have been assumed (i.e. increased pier embedment in substructure and strengthening of lower walls).

One stakeholder commented on Table 6-2: "the base cost for estimating the change in future costs of new buildings to meet the draft Standard appears to be excessively high; the construction cost for houses is double what would be expected in Ipswich."

To respond: agree that the base costs for houses appear to be very high. However the costs expressed as percentages are quite moderate. In the Impact Analysis it is the percentage costs that are applied to the value of new housing, to allow for the broader housing market in flood hazard areas where the implied construction cost is much lower.

7 Impact Analysis

This section provides an assessment of the incremental costs and benefits of the Options 1 and 2, compared with the Status Quo baseline.

As discussed in the problem chapter, planning decisions in themselves do not ensure the structural integrity of residential buildings or the survival of utilities, key building outcomes that affect the health, safety and amenity of residents during and after a flood event. This chapter examines the efficiency of the options in achieving the objectives through ensuring structural integrity and survival of utilities.

Groups affected by the Options

The following stakeholder groups will be affected by the options:

- individuals, e.g. residents of new buildings in flood hazard areas;
- businesses, e.g. building practitioners and other businesses who operate in flood hazard areas; and
- government, e.g. regulators, Local and State Government planning authorities.

The nature of the expected impacts for each stakeholder group, is described below.

Individuals in Flood Hazard AreasThe impacts of the options on individuals in flood hazard areas include:

- potential changes to the costs associated with the design and construction of the building components impacted by the Standard;
- potential implications for the safety and well-being of building occupants through a reduction in the occurrence of flood related injuries in buildings; and
- potential reductions in building repair costs following a flood event.

Businesses in Flood Hazard Areas

The options are also likely to impact businesses operating in the design and building industry. This may include potential variations in demand for the design and construction of building components that meet the new requirements as a result of the proposed arrangements, and a requirement for building practitioners to become familiar with and implement the proposed provisions.

The options could also potentially provide benefits for businesses occupying new buildings by contributing to a reduction in the costs associated with flood related damages or injury, and reduced productivity losses arising from fewer disruptions to their business activities.

Government

The options may enable Governments to more effectively and efficiently meet their community objectives of reducing the extent of flood related damages, injuries or fatalities. They may also impact the activities of regulatory authorities in various State and Local Government jurisdictions, and potentially contribute to a reduction in the costs associated with emergency response and relief efforts as a result of flood events.

Distributional Impacts of Option 1

Flood hazard areas, where residential buildings are permitted to be built, typically have a design annual probability of a flood event of 1%. An equivalent statement of risk is to expect a flood event in 1 year, every 100 years. With the physical life of a dwelling about 40 years, the low flood risk implies that many new dwellings will not face a flood during their 40 year physical life. Hence, in retrospect after a 40 year period, the additional structural robustness of new dwellings under Option 1 will not be needed for many buildings.

Distributional impacts occur when flood events over a 40 year period occur in some areas but not in others. Residents in buildings that experience a 1% AEP flood event are protected by the more robust structural building requirements and hence while these residents bear the cost of the requirements, Option 1 has delivered health, safety and amenity outcomes to them. Residents in buildings that do not experience a 1% AEP flood event will have incurred the cost of implementing the more robust structural measures of Option 1, but these measures will not deliver any outcomes for these residents over the 40 year period.

The distributional impacts can only be observed in retrospect. From the perspective of today, looking out over the next 40 years, it is impossible to determine where the incidence of floods will occur. It is impossible to determine where residents need not bother with more robust structures, and where they should.

From the perspective of today, Option 1 provides residents with an assurance and comfort that new buildings can withstand a 1% AEP flood event and that, should such a flood event occur, residents can expect health, safety and amenity outcomes. This level of comfort is similar to that from insurance – in incurring an upfront expense but also knowing that the effect of a foreseeable natural hazard is contained. The difference with insurance is that, while insurance avoids financial loss after the event, Option 1 would deliver health, safety and amenity outcomes to residents during a flood event.

Note that Option 1 has the capacity to reduce insurance premiums. However this may take many years. One insurer wrote in their submission:

> ***"It will take some time for new building code provisions to impact on premiums. It is only when the general housing stock is built to a new standard that significant changes will occur."***

Possible Conflict of Option 1 with Planning Goals

A key risk management measure adopted by many local governments is to prescribe the minimum floor height of the habitable rooms to be above the expected flood level. In some areas local governments also prescribe the maximum roof height, for aesthetic reasons. These two planning requirements can come into conflict: where raising a new dwelling so that the floors would be above the expected flood level also would mean that the roof would exceed the permitted maximum height. Local governments would resolve this conflict. The most straightforward approach would be to insist on the maximum roof height of dwellings, and where this is not possible (for whatever reason) to disallow construction of the proposed building.

This conflict between two planning requirements would occur from time to time now, under the Status Quo. It does not involve structural requirements and hence does not have any implications for the impacts of Option 1.

Quantitative Impacts of Option 1

The quantitative impacts of Option 1 are assessed as the incremental costs and benefits estimated relative to the baseline of the Status Quo.

Estimated Costs of Option 1

The estimated construction activity for buildings Classes 1, 2, 3, 4, 9a and 9c in each State and Territory was based on ABS Building Approvals Data for all jurisdictions, and a breakdown of construction activity within each BCA Class obtained from the Victorian Building Commission. The breakdown in construction activity for each jurisdiction was assumed to be proportionate to the variation in Building Approvals between that State / Territory and Victoria.

As this approach relies on an assumed proportional breakdown across each BCA Class (based on Victorian data), the resulting estimates of annual building activity within each BCA Class should be considered as indicative. The development of robust estimates for all jurisdictions would require a census of councils and State and Territory Governments, which is beyond the scope of this RIS.

The estimated construction activity in flood hazard areas for the affected BCA Classes in each State and Territory is based on data sourced from the National Flood Information Database (NFID), which provided the number and types of addresses located within the boundaries of a 100 year flood event. This allowed the calculation of the proportion of addresses located in flood hazard areas within each jurisdiction, which was then assumed to also represent the proportion of estimated future construction expected to occur in flood hazard areas.

Table 7-1 and 7-2 below provide both the estimated number and the estimated value of building approvals per annum for each BCA Class in flood hazard areas.

Table 7-1: Construction by BCA Class in flood hazard areas (approvals per annum)

Class	NSW	VIC	QLD	SA	WA	TAS	NT	Total
1	935	526	572	130	126	2	19	2,310
2	20	11	12	3	3	0	0	49
3	2	1	1	0	0	0	0	4
4	1	1	1	0	0	0	0	3
9a	1	1	1	0	0	0	0	3
9c	1	0	0	0	0	0	0	1
Total	**960**	**540**	**587**	**133**	**129**	**2**	**19**	**2370**

Table 7-2: Construction by BCA Class in flood hazard areas ($ value per annum)

Class	NSW	VIC	QLD	SA	WA	TAS	NT	Total
1	$242,454,420	$120,631,141	$133,028,267	$24,374,784	$26,623,867	$342,011	$6,443,232	**$553,897,721**
2	$30,791,107	$15,319,854	$16,894,258	$3,095,537	$3,381,165	$43,435	$818,274	**$70,343,630**
3	$2,609,071	$1,298,121	$1,431,527	$262,299	$286,501	$3,680	$69,336	**$5,960,536**

Class	NSW	VIC	QLD	SA	WA	TAS	NT	Total
4	$462,865	$230,295	$253,962	$46,533	$50,827	$653	$12,301	**$1,057,436**
9a	$2,127,158	$1,058,349	$1,167,115	$213,851	$233,583	$3,001	$56,529	**$4,859,585**
9c	$1,852,720	$921,805	$1,016,538	$186,260	$203,447	$2,613	$49,236	**$4,232,621**
Total	**$280,297,341**	**$139,459,565**	**$153,791,667**	**$28,179,264**	**$30,779,390**	**$395,393**	**$7,448,908**	**$640,351,528**

As shown above, the majority of construction activity in flood hazard areas each year is expected to relate to BCA Class 1 buildings (87 per cent of construction value or 97 per cent of volume) and residential buildings in total (97 per cent of construction value or 99.5 per cent of volume). Accordingly, the detailed analysis has focused on the impact of the proposed Standard on residential construction, with impacts on other buildings considered at a higher level.

While the Class 2 impact analysis has focused on smaller scale construction, this was assumed to be more representative of future construction in flood hazard areas. Further, the assessed percentage cost impact was assumed to be representative of the cost impost for other types of construction within this category.

The Consultation RIS asked whether the approach taken to arrive at activity in flood hazard areas was reasonable. One stakeholder from industry commented: no foundation to assume that the risk profile of new residential land is likely to reflect the broader dwelling stock. State government development plans should have been consulted.

To respond: the composition of the population living in flood hazard areas would be similar to that of the broader community; hence the composition of new housing in flood hazard areas would also be similar new housing broadly across Australia.

The estimated increase in construction costs related to the proposed Standard was calculated based on annual building activity in flood hazard areas (estimated above), and the estimated cost impacts (in percentage terms) for a representative sample of affected buildings and applied to the broader housing market in flood hazard areas.

The estimated present values for the overall cost impact of the proposed Standard (and its component requirements) over the assumed life of the regulations (i.e. ten years) for each jurisdiction and building type is summarised in the table below.

Table 7-3: Present Values of Cost Impacts by Jurisdiction (2011 dollars)

Class	NSW	VIC	QLD	SA	WA	TAS	NT	Total
1	$83,807,223	$41,697,573	$45,982,785	$8,425,431	$9,202,853	$118,220	$2,227,179	$191,461,264
2	$8,079,953	$4,020,112	$4,433,255	$812,306	$887,258	$11,398	$214,725	$18,459,006
3	$1,329,908	$661,684	$729,685	$133,700	$146,037	$1,876	$35,342	$3,038,232
4	$159,995	$79,604	$87,785	$16,085	$17,569	$226	$4,252	$365,515
9a	$735,277	$365,831	$403,427	$73,920	$80,741	$1,037	$19,540	$1,679,773
9c	$640,415	$318,633	$351,378	$64,383	$70,324	$903	$17,019	$1,463,055
Total	**$94,752,770**	**$47,143,437**	**$51,988,315**	**$9,525,825**	**$10,404,781**	**$133,660**	**$2,518,057**	**$216,466,845**

The present value of the increase in annual construction costs under the proposed Standard (and its component requirements) is estimated to be in the order of $216 million. Around 90 per cent of the estimated cost increase relates to new construction in NSW, Victoria and Queensland, with NSW construction representing around 44 per cent of the total cost.

See Appendix B for a more detailed description of the approach and the assumptions underlying these calculations.

Additional Costs of the Sub-options

Option 1 is presented with two sub-options:

- **Option 1a**: new NCC provisions to apply in flood hazard areas as designated by each local government.
- **Option 1b**: new NCC provisions to be applied according to a national flood map.

Costs, in addition to those calculated above, may be incurred through the implementation method.

For Option 1a, many local governments have already designated flood hazard areas, so the additional cost of implementing the proposed NCC provisions only in these designated areas would be zero.

For Option 1b, the additional cost of implementing the proposed NCC provisions according to a national flood map, would be the costs of developing and maintaining a national flood map. Stakeholders generally considered that the cost of developing a national flood map would be very large. One local government helpfully indicated a cost of $100,000 for a flood study of half a local government area. With 564 local government areas in Australia, and noting from Table B-7 that a little less than 10% of residential addresses are within flood hazard areas, then an initial estimate for the cost of preparing a national flood map could be $11 million. This would be a minimum cost. Mapping a known flood risk area would be relatively straightforward, as undertaken by the council, compared with an exercise of identifying and assessing flood hazard areas from scratch.

An alternative approach, suggested by stakeholders, notes that Geoscience Australia is developing an internet portal for local governments and other organisations to upload existing flood hazard information, which could be used as a national data source very much like a national map. However this approach does not deliver superior information than is already known by local governments – the flood hazard areas in the database would be the same flood hazard areas designated by each local government.

Estimated Benefits of Option 1

The quantitative analysis considered the extent to which the proposed Standard might contribute to a reduction in future costs incurred as a result of flooding. Based on available research (e.g. BTE (2001)), these costs are estimated to be in the order of $300 million per annum across Australia. While the proposed Standard would also contribute to improved health, safety and amenity outcomes, these benefits have been considered qualitatively rather than in quantitative terms.

The benefits modelling utilised estimated repair costs for each of the sample buildings (refer Section 6) developed by Turner and Townsend Quantity Surveyors. This work provided an estimate of the costs associated with repairs to damage resulting from a flood event characterised by flood levels of around one metre. These repair costs were then adjusted to reflect the probability of a flood event of this magnitude occurring in any given year.

The full procedure for estimating benefits is set out in Attachment B. A number of simplifying assumptions were adopted for the analysis:

- the proportion of total properties within the 100-year ARI flood level affected by different levels of inundation (high-level estimate derived from data accessed from the NFID);
- application of a damage factor to calculate the variation in the estimated repair costs associated with different flood levels (based on damage estimates provided in Middlemann et al (2000) for different flood levels);
- the estimated repair costs for a one metre flood event (sourced from Turner and Townsend) were extrapolated to other flood depths based on the assumed 'damage factor' and the assumed proportion of affected properties; and
- the cost a household would reasonably expect to incur in a given year was estimated as one per cent of the estimated damage costs for each building.

Key estimating assumptions are contained in the following table.

Table 7-4: Assumptions to estimate benefits

Item	Value	Explanation
Useful dwelling life	30 yrs	Previous advice received from the government agencies in relation to similar analyses
Class 1 – expected annual cost	$1,762	Refer Table B-16
Class 2 – expected annual cost	$1,451	Refer Table B-16
Class 3 – expected annual cost	$2,157	Refer Table B-16
Class 4 – expected annual cost	$1,399	Estimated base construction cost (based on Building Commission data) multiplied by average annual damage percentage from Table B-16
Class 9a – expected annual cost	$5,327	
Class 9c – expected annual cost	$8,434	
Percentage of flood damage avoided by new NCC provisions	90%	Reflects building performance on implementation of the new NCC provisions, drawing a parallel with the performance of buildings during cyclones.

Overall, the total avoided construction repair costs in one year are estimated to be, in 2011 dollars, $3,777,181. The present value of total avoided construction repair costs, for a 10 year program, is $352,247,867.

Sensitivity Analysis

This section examines the sensitivity of the quantitative analysis to variations in key assumptions underpinning the aggregate gross impact analysis. Note that the estimated average increase in construction costs was 4.6%, and sensitivity will be tested from a lower bound of a 2% cost increase to an upper bound of a 6% cost increase. A real discount rate of 7% has been used in the quantitative analysis, and sensitivity will be tested from a lower bound of 3% to an upper bound of 11%. The outcomes of the sensitivity analysis are summarised in the table below, in present value terms, with the impact of each on the assessed level of quantitative costs and benefits provided.

Table 7-5: Outcomes of the Sensitivity Analysis (NPV, 2011 dollars)

Parameter	Costs	Benefits	Net Benefits
Construction Costs			
Lower bound 2% cost increase	$96,247,809	$352,247,867	$256,000,058
Upper bound 6% cost increase	$288,743,427	$352,247,867	$63,504,440
Alternative Discount Rates			
Lower bound 3% discount rate	$253,072,855	$722,749,273	$469,676,417
Upper bound 11% discount rate	$188,291,461	$238,515,247	$50,223,786
Benefits (avoided construction costs)			
Lower bound – 10% lower	216,466,845	317,023,080	$100,556,235
Upper bound – 10% higher	216,466,845	387,472,654	$171,005,809
Physical Life of a House			
Central case – 30 years	216,466,845	352,247,867	135,781,021
Alternative case - 40 years	216,466,845	380,225,984	163,759,139

As shown above, under all sensitivity scenarios the quantitative benefits estimated for the proposed Standard remain above the projected cost impacts.

Overall Impact of the Quantitative Analysis of Option 1

The preliminary quantitative analysis indicates a present value of total costs in the order of $216 million and the present value of total benefits approximately $352 million. This suggests a substantial and a positive net present value and a benefit–cost ratio above unity. In these terms, the proposed Standard would be expected to provide quantitative benefits to residents significantly in excess of the additional construction costs incurred.

Qualitative Impacts of Option 1

A range of impacts that are difficult to quantify in monetary terms, but nonetheless are significant for the impact analysis, are outlined in the following table.

Table 7-6: Qualitative Impacts of Option 1

Group	Impact	Assessment
BENEFITS		
Individuals	Avoidance of future damage costs to buildings as a result of flood events Avoidance of injuries or loss of life as a result of a defined flood event Avoidance of future intangible costs associated with flood events	To the extent that the proposed Standard aims to improve the survivability of a building in the event of a flood, as a result of incorporating the most recent knowledge of risks and construction measures to mitigate those risks, it should translate to a decrease in the costs incurred by householders, both individually and at the aggregate level. A potential reduction in the costs of injuries and fatalities in buildings to which the Standard has been applied. The proposed Standard may reduce intangible costs for which no market exists, such as emotional and physiological effects, household disruption and loss of memorabilia.
	Structural robustness of a resident's dwelling during a flood prevents parts of the building being washed away and damaging other residents' dwellings.	This is an indirect benefit, where some residents benefit from compliance by other residents with a structurally robust standard.
	Community resilience, where the low level of damage during a flood and the survival of utilities allows residents to return sooner to their homes after a flood event.	The community is less disrupted by a flood event if residents can return sooner to their homes without extended clean up, rebuilding and installation of utilities – and begin normal living activities.
Business	Potential reduction in disruption to productivity	Flood events are often associated with loss of production as a result of disruption to businesses and productive work. While the improvement in building resistance to flooding is unlikely to reduce resources diverted in the event of a flood, improved protection could lead to a potential reduction in lost time attributed to clean-up and recovery.

	Insurers benefit when standards eliminate ill-defined risks	Insurers offer a range of discrete, building insurance products. The range will not be continuous with respect to incremental shifts in risk and there will be regions of risk where insurance is not available. Under the current regulations the quality of residential buildings in 1% AEP areas will be variable between local government areas and between jurisdictions. This complicates the evaluation of risk and premium setting on a nation-wide basis and on a State or Territory wide basis. The proposed standard will provide an assurance of quality, and a basis for insurers to evaluate flood hazard risks and develop products capable of nation-wide marketing. Residents of new buildings in 1% AEP areas will also benefit from more readily available off-the-shelf insurance products.
Government	Potential reduction in disaster relief and assistance funding	The Governments of all States and Territories, as well as the Commonwealth, provide disaster relief and assistance in the event of floods. Such assistance is available to individuals as well as communities. If building survivability improves as a result of the proposed Standard, expenditure in these areas would be likely to decrease.
Individuals / Business	Potential reduction in future insurance premiums	To the extent that the proposed Standard may reduce potential losses, the price of risk reflected in insurance premiums borne by households and businesses should also reduce.
COSTS		
Individuals	Potential to impact on consumer choice to building on particular sites	The revised Standard might impact on the choice of house builders to build on particular sites due to an increase in costs, including individuals who purchased land with the intention to build. However, the proposed Standard does not preclude individuals from choosing less expensive alternatives as long as a compliant performance approach is used. To some extent, the implementation of the proposed Standard may actually create additional choice, with planning authorities more likely to approve construction in flood hazard areas given appropriate and risk reflective national building standards.
Business	Potential to delay or add costs to the building approval process in flood hazard areas	The proposed Standard contains additional requirements stipulating that flood actions are understood for defined flood events at the building site. There are potential costs associated with the use of specialists to clarify or approve building plans before construction commencement.

Government	Potential increase to regulatory costs associated with compliance monitoring	It is likely that enforcement of the proposed Standard would inflict an additional cost to building industry regulators, for compliance monitoring activities which might include site inspections of buildings where the Standard applies.

In summary the principal intangible and indirect benefits of Option 1 would be: the avoidance of injuries and fatalities during a flood event; the avoidance of damage to other resident's dwellings by preventing parts of the building washing away; reduce emotional and physiological effects, household disruption and loss of memorabilia; enhancing the resilience of the community after a flood event, for residents and business; the benefit to insurers when national building provisions reduce risks of flood damage and more clearly define these risks; and a reduction in Government disaster relief payments after a flood event.

Impacts of Option 2

The utilisation of a handbook by local governments and industry will depend on local circumstances. Where it is used, additional costs will be incurred and additional benefits will be generated, on an equivalent per building basis to Option 1. Hence the quantified impacts of Option 2 are based on the estimates for Option 1, adjusted by an assessment of the probable application of the handbook by industry and governments.

For example (and purely as an example) if governments and industry voluntarily applied the handbook to 10% of new residential buildings in flood affected areas: the impact of Option 2 would be:

- Additional costs (in present value terms) of $21.6 million.
- Additional benefits (in present value terms) of $35.2 million.

Business Compliance Costs

The COAG *Best Practice Regulation* guide requires consideration of the compliance burden imposed on businesses. This is the additional (incremental) cost incurred by businesses when complying with regulations.

Compliance costs include:

Notification costs – requirement to report certain events;

Education costs – keeping abreast of regulatory requirements;

Cost of gaining permission – to conduct certain activities;

Purchase costs – requirement to purchase materials or equipment;

Record keeping costs – keeping up-to-date records;

Enforcement costs – cooperating with audits or inspections;

Publication and documentation costs – producing documents for third parties; and

Procedural costs – costs incurred that are of a non-administrative nature (e.g. requirement to conduct fire drills).

Business, particularly the building industry, already incurs compliance costs under existing arrangements. We consider below the potential extent of any additional compliance costs under the options.

Assessment of Compliance Costs under Option 1

The proposed NCC provisions may involve minor changes in compliance costs as a result of the education and familiarisation of industry practitioners with the new requirements.

Education and familiarisation

The proposed Standard will impose some additional compliance costs on businesses in the short term as they undergo processes of familiarisation with and education in the new NCC requirements. Evidence from previous changes to the NCC indicates that while there is likely to be some level of transition costs, these impacts are likely to be contained to the first year of its implementation.

The building industry takes time and effort to become familiar with all updates to the NCC each year, such as attending the annual NCC seminars in each jurisdiction. Participants at the seminars will spend a half day each year familiarising themselves with all new NCC amendments. In addition to this practitioners will need to spend time in determining how any of the amendments may affect their business. It is difficult to provide an estimate as to these compliance costs. However the contribution of the proposed NCC provisions to address flood risks would be a minor part of the overall annual NCC update process – for example, 10 minutes on the subject in a half day seminar.

Based on this assessment, the proposed NCC provisions are unlikely to impose significant compliance costs on businesses, and only in the first year of implementation.

Stakeholders did not comment on possible compliance costs.

Assessment of Compliance Costs under Option 2

There would be a similar need for education and familiarisation as for Option 1. The channels of communication could change, from notification of new standards to publicity of the handbook, for example on the ABCB website as “What’s New” and similar publicity throughout the jurisdiction building commissions and their networks. The level of education and familiarity activity by government and industry people could be less than Option 1.

Assessment of Competition Impacts

The COAG *Best Practice Regulation* guide requires that the competition impacts of proposed regulation be considered when undertaking a RIS. A preliminary analysis can be conducted by working through the questions in the *Competition Assessment Checklist* set out in the guide. Where this preliminary analysis indicates that there could be an impact on competition, a competition assessment should be undertaken as part of the RIS.

The checklist questions are:

- Would the regulatory proposal restrict or reduce the number and range of suppliers?
- Would the regulatory proposal restrict or reduce the ability of suppliers to compete?
- Would the regulatory proposal alter suppliers’ incentives to compete vigorously?

Does the proposed Standard restrict or reduce the number and range of suppliers?

It is unlikely that the proposed Standard will affect or restrict the number and range of suppliers of the materials required to address the new requirements, or restrict or reduce the number of businesses operating in the design and construction industry.

The proposed Standard does not restrict the use of any particular material for the construction of the building components that are affected. While it may increase demand for structural reinforcements or fittings, it is unlikely that this requirement would restrict competition for suppliers.

Further, any additional costs of construction of the new preventative measures would most likely be passed on to the building purchaser and not be borne by the builder or developer.

Do the options being considered restrict or reduce the ability of suppliers to compete?

The proposed Standard does not restrict the use of any particular building material. The options only influence the design of the building components affected by the revisions. This is unlikely to have any adverse impact on the ability of suppliers of design and construction services to compete.

Do the options being considered impact incentives to compete vigorously?

The proposed Standard does not impact or alter suppliers’ or builders’ incentives to compete vigorously. There remains an incentive for practitioners to design the most cost effective solution to comply with the NCC Performance Requirements for the relevant building components.

Conclusion

Overall, it is unlikely that there will be any competition impacts associated with the proposed Standard. Furthermore, because the proposed Standard constitutes performance-based regulation, it provides flexibility to builders to meet the NCC Performance Requirements by proposing alternative building solutions.

One insurer commented: "we are not aware of nor envisage any material competition impacts arising from the proposed standard".

8 Consultation

Consultation is the cornerstone of the Australian Building Codes Board (ABCB) and their commitment to create a contemporary and relevant construction code that delivers good societal outcomes for health, safety, amenity and sustainability in the built environment.

The ABCB believes meaningful consultation can promote trust between industry, the community and government, providing transparency to allow stakeholders to see and judge the quality of government actions and regulatory decisions. Consultation also provides an opportunity for stakeholders to participate in the development of policy solutions and encourages broad ownership of solutions. Furthermore, an appropriate consultation process can lead to the revision and modification of preliminary recommendations before a final decision is made, thereby delivering a better outcome for all.

Stakeholders

Comments were received from thirteen stakeholders in response to the Consultation RIS, deriving from: insurance experts; State and Territory administrations, local governments; industry groups and individuals. The majority of submissions received were in support for a nationally accepted Standard for construction in flood hazard areas.

State and Local Government submissions were received from–

- New South Wales Building Administration
- Northern Territory Building Administration
- South Australian Building Administration
- Victorian Building Administration
- Ipswich City Council
- Lismore City Council
- Wyong Shire Council

Industry organisations included–

- Housing Industry Association (HIA)
- Plumbing Industry Commission (PIC)
- Suncorp Group
- Insurance Australia Group (IAG)
- Flood Management Association

One other individual stakeholder provided feedback.

Comments from Government agencies

Government agencies provided a range of comments, each a reflection of the different impacts the options would have based on the current level of requirements set by the individual States and Territories.

Northern Territory

The Northern Territory building administration suggested that Option 1a was the preferred option as Option 1b would appear to be unreasonably expensive and impractical. They consider that Option 1a acknowledges that local jurisdictions are best placed to identify areas at risk of flooding and successfully respond through planning and building controls, together with a national standard for flood resistant design and construction is an optimal outcome.

ABCB Response

Comments are noted.

New South Wales

The NSW building administration suggested that the impacts of the Standard in NSW are difficult to assess, given that greenfield urban release areas are typically filled to the defined flood level and the majority of local government authorities have building controls relating to development within flood planning areas, such as minimum floor levels and other design and construction requirements

NSW believe that a national flood map is paramount to providing a nationally uniform set of construction requirements in flood hazard area as the lack of an appropriate national flood map will cause issues amongst stakeholders as to where and when the provisions are to apply which will result in an inconsistent approach not only across states, but within individual local government areas. Despite support for a national flood map NSW request costs associated with option 1a and the development of a national flood map to be explored within the RIS.

NSW believe where appropriate flood mapping is not available, it will require proponents to prepare and obtain flood studies on an individual site by site basis and these studies may be time consuming and cost prohibitive, and as such will make the implementation of the Standard complex.

NSW are also concerned that the limitation to the proposed Standard to residential buildings is problematic and other building types may also be constructed in areas that are at risk of flooding and thus must also be constructed accordingly. This is on the basis that Local Governments within NSW apply minimum construction standards to non-residential buildings in flood prone areas. The application of the BCA provisions to only residential buildings may create confusion amongst industry and adoption of the Standard could mislead industry in NSW to believe protection of non-residential buildings is not required.

NSW also believe that property protection could be considered as there is community expectation that a building constructed in accordance with a national flood Standard would not be subject to significant damage as a result of a flood event.

ABCB Response

NSW give the clear impression that NSW regulations are sufficient to adequately address the risk of floods. Minimum floor levels are a common (and desirable) feature of planning regulation across jurisdictions. However this requirement does not itself ensure the structural integrity of a building nor the survival of utilities during a flood event. NSW does include some outcomes to be attained by a building during a flood event, but does not contain guidance on structural integrity or the survival of utilities.

The importance of a national flood map is noted and the desirability of additional costings is acknowledged, however NSW was unable to provide any information to help cost a national flood map.

Inclusion of property protection in the Standard is outside the scope of the NCC and the Objectives of the ABCB.

Local governments are currently able to designate flood hazard areas without a flood map. While this may not be as precise as a mapping exercise would determine, proponents are not required to obtain site specific flood studies.

The Standard acknowledges the current Deemed-to-Satisfy Provisions as being adequate for flood not exceeding 1.5m/s velocity. In this regard structural integrity of the building will not be impacted. Including protection for home contents is not consistent with the Objectives of the NCC.

South Australia

The South Australian building administration believe that mapping should be at the local government level where local knowledge can be best obtained. This is on the basis that it would be extremely difficult for a national flood map to capture all of the small rivers and streams that could be subject to flooding. Furthermore, they believe it should be at the discretion of individual jurisdictions to decide when and how to indicate certain areas as being a flood risk.

Concern is raised that the scope of the Handbook and Standard is inconsistent with the types of floods that cause the most fatalities. In this regard, they suggested that the limitation to slow onset floods is inappropriate as the majority of fatalities occur in fast moving floods.

SA also propose that the restriction to residential buildings ignores the potential risk for other buildings to become debris which ultimately become an impact risk for other residential buildings, and suggest there should be minimum requirements for all buildings located in a flood risk area. This is consistent with the view from New South Wales.

South Australia conclude by recommending the inclusion of greater detail on the requirements to reduce the impacts of debris and suggest this is a major issue in flood events.

ABCB Response

The preference for Local Government to determine Flood Hazard Areas is noted.

The scope of the DTS Standard is restricted to slow moving water as the predictability of the impacts rapid onset or flash flood would evoke is highly complex and as such an Alternative Solution approach is best fit.

The restriction of the Standard to residential buildings aligns with the Objectives of the ABCB under the IGA.

Useful references will be included in the Handbook as a reflection of concerns raised regarding debris.

Victoria

The Victorian building administration support the development of Performance Requirements and a 'Deemed-to-Satisfy' building solution for buildings constructed in flood hazard areas.

The Victorian building administration believe the proposed Standard will complement the current planning controls which restrict the location of buildings in flood hazard areas and flood related development controls to limit the residual risk of flooding in Victoria. They acknowledge there are gaps in the current data to support consistent mapping although suggest the proposal will trigger a review of flood mapping State wide in the near future.

Victoria also believe that current local governments are not in the position to confirm water velocity predictions on a site specific basis and note the costs associated with this are not covered by the RIS.

ABCB Response

It is anticipated that determination of water velocity within flood hazard areas will require minimal additional resources that are unlikely to significantly change costings associated with Option 1a.

Local Government

There was overall concern about the potential conflict between existing planning controls and the proposed construction requirements, though this was complimented by the general agreement that the proposed Standard would benefit those within flood hazard areas.

In terms of market responsiveness, a clear view was expressed that the market does not respond to the risk of floods and is not interested in addressing this issue.

There was general support for Option 1a with the introduction of the proposed Standard however concerns were expressed by one council that both Options 1a and 1b had significant cost implications and suggested that further analysis was required to determine the cost implications for Local Governments in terms of flood mapping if Option 1a was adopted.

Local council also expressed concern that the Standard and Handbook lacked the detail required in order to achieve compliance with the proposed requirements. They suggested that the Handbook could be improved to reference applicable information to the relevant parts to assist in compliance.

In regards to the proposed Standard, they offered the following recommendations:

- Expand the scope of the Standard beyond just structural collapse to help reduce high potential clean-up costs (i.e. specifying no wall cavities below the DFL) and therefore increasing financial sustainability.
- Reference the relevant specialised literature as specified within the Handbook.
- Reduce the maximum velocity of 1.5m/s to below 1m/s on the basis that wading by adults becomes dangerous when the velocity of shallow water exceeds 0.8m p.s
- Not having a specified measurement for the minimum height above the FHL will lead to a confusing situation by different height levels being applied though out the country. One council area may impose a 500mm above the FHL while the adjoining

council imposes no such requirement and therefore the owner builds to the FHL. This does not allow for any safety factor (i.e. freeboard) and floods do not always behave as expected and a person thinking that they have built to the FHL may find themselves inundated with flood waters.

- The base costs used in the RIS for estimating / highlighting the estimated change in future costs of new buildings to meet the draft Standard appears to be excessively high (e.g. the estimated base cost for Design A in Table 6.2 and Table B-10 of $451,757 being the construction cost of a highset 3 bed house is more than double what would be expected.

  ABCB Response

  The Handbook will provide greater detail in response to concerns raised regarding where to source relevant publications.

  If Option 1a is favoured, it is assumed that existing Local Government flood designations will be used and hence costs will be minimal. Those areas that do not have designated flood hazard areas would not be impacted by the proposed Standard.

  The scope of the Standard is consistent with the objectives of the NCC being *to safeguard people from injury and loss of amenity from structural failure*.

  The 1.5m/s velocity has been determined to be the maximum allowable velocity for a building constructed to current Deemed-to-Satisfy requirements.

  It is the responsibility of the authority having jurisdiction to determine the appropriate minimum finished floor height.

  A higher than expected base construction cost suggests costs generally may be too high.

Comments from Industry Organisations

The responses received from industry organisations in regards to the Consultation RIS varied and the broad variety of comments received can be seen to be a reflection of the different areas of the industry responding.

Insurance industry

The insurance industry suggested that the scope of the Standard be expanded to include property protection, repairs, and over all clean up post flood events.

The insurers advocated that the Geo-Science Australia national flood data base be used to identify flood hazard areas as an approach to adopting option 1b.

Insurers commented on insurance affordability and the potential increase for those who are at significant risk of flooding and it will take some time for new building code provisions to impact on premiums. They suggest it is only when the general building stock is built to a new standard that significant changes will occur.

There was a suggestion of a tiered approach to flood mitigation. This being:

- Restrictions should be in place in unacceptable flood risk areas to prohibit development in these areas.
- In areas of low hazard flood risk, the building codes and controls that minimise the impacts to building should be implemented and enforced.

- Where planning, zoning and building codes cannot effectively eliminate the risk to individual homes, Governments should consider building flood mitigation infrastructure such as flood detention basins, storm water culverts, back flow devices and levees subject to a cost-benefit analysis.

It was stated that the proposed Standard is flawed as it focuses too narrowly on the health and safety objectives of the NCC. These objectives should be augmented, and the NCC objectives realigned, to cost-effectively protect property itself.

They also noted that destructive floods in Australia mostly involve low velocity and large depths – hence depth of flooding should also be included in the proposed Standard.

Insurers also commented on the performance of the market, including that:

- The general public do not know or understand what their flood risk is, or what resilience measures are required to identify these.
- The demand side of the market does not adequately respond to flood risk, due to lack of information about flood risk.
- Governments have a duty of care to disseminate information about flood risks, including in land use planning and building standards.

ABCB Response

The insurers' advocacy of property protection is noted; however this is outside of the NCC and ABCB Objectives.

It should be noted that insurance groups acknowledged that some Local Government flood maps are flawed, however, it is assumed that Geo-science Australia's database would be sourced directly from Local Governments.

The application of the proposed Standard in regards to building repairs will be a matter for consideration by the State and Territory administrations, as is building restrictions in high hazard areas.

Depth of flooding varies from region to region. It is best estimated by each local council when the council prescribes the minimum height of the habitable floor for buildings in flood hazard areas.

Comments on the performance of the market are noted.

Housing Industry Association

HIA are generally critical of the methodology used to undertake the Consultation RIS.

Concern was expressed regarding the cost implications of both options including on-going insurance premiums, cost of compliance with the proposed Standard and potential land value increase.

HIA suggest that it is unreasonable to assume that Victoria's share of new buildings in each building class can be applied to other jurisdictions and suggest that data for other jurisdictions is available and should be used.

HIA also suggest there is no foundation to assume that the risk profile of new residential land is likely to reflect the broader dwelling stock and State Government development plans should have been considered.

HIA contend that the assumption that the number of new buildings in flood affected areas can be deduced from past data on 1:100 year floods is flawed, because it does not take into account the potential impacts of sea level rise and storm surge.

HIA suggest it is inappropriate that the Consultation RIS uses residential buildings to represent all classes of buildings and given the extent of flooding in the Brisbane CBD, it would be prudent that the proposed Standard be considered for other classes of buildings other than residential buildings only.

HIA also challenge a building can be "flood proofed" by the proposed Standard and propose the objective should be to reduce the severity of flood impacts.

It is also observed that the Deemed-to-Satisfy Provisions give no guidance on "how to construct".

HIA conclude to recommend that if the Standard is to be adopted, Option 1a is preferred. This being cited, they argue that that the cost-benefit analysis presented in the Consultation RIS contains inadequate information to make an assessment of its validity.

ABCB Response

Victoria has published detailed data of the number of new buildings by BCA Class of building. The ABCB is unaware of a similar data set in any other jurisdiction. The HIA have not indicated where such data could be found.

The composition of the population living in flood hazard areas would be similar to that of the broader community; hence the composition of new housing would also be similar to the broader housing stock.

Local councils already identify flood prone areas so there should be no change in perceptions about values of existing homes or land. Residents will incur costs under the proposed Standard and they will also benefit by the safeguarding from illness, injury and loss of amenity during a flood event. If insurers were relied on to pay higher claims instead, then premiums payable by residents would also rise.

The impacts of rising sea levels and storm surge were not taken into consideration as it is outside of the scope of the proposed Standard.

The Consultation RIS includes all classes of buildings suitable for residents: Classes 1, 2, 3, 4 (caretakers' rooms), 9a and 9c buildings. Costs are calculated for each building Class.

The Standard contains requirements for wet flood proofing; the water is allowed to enter the building to reduce the built-up of hydrostatic pressure between the flood water and the inside of the building. The structural materials used below the DFL must therefore be water resistant to minimise the resulting damage.

Provided the proposed building falls within the scope of the Standard, current Deemed-to-Satisfy building solutions comply.

Plumbing Industry Commission

PIC provided detailed responses in regards to the implications of the Standard to plumbing and drainage installation with particular regard to backflow. They suggest that the Consultation RIS does not adequately consider plumbing and drainage and in particular the potential for conflict between the proposed Standard and requirements specified in Australian Standard 3500.

ABCB Response

The plumbing and drainage requirements contained within Australian Standard 3500 are noted. Consequently, plumbing provisions relating to the prevention of backflow have been removed from the Standard.

Floodplain Management Association

The Floodplain Management Association (FMA) consists of councils, Catchment Management Authorities, consultants, businesses and individuals involved in floodplain risk management.

The FMA supports a national approach to floodplain risk management. They suggest ideally national floodplain risk management policies and standards would be of such a level of competency that if properly applied they would result in consistent best practice Australia wide.

The FMA recommends that fundamental consideration be given to the limitations in the scope and are concerned about the Standard being restricted to residential buildings and the limitation to structural stability rather than including property protection.

They recommend that the Standard be modified to rely on external guidelines and standards for the setting of specific flood plain risk management performance requirements for buildings in specific locations of specific floodplains where development is appropriate. It is also suggested the requirements cover management of risk to life considerations as well as building resilience to the consequence of flooding and all types of rain induced floods would be covered for the full range of potential flood events.

There were concerns regarding the current definition of flood hazard areas and suggest that there are many parameters that need to be taken into consideration when determining such an area. They recommend that these parameters be acknowledged within the definition.

The FMA highlight that there can be more than one defined flood event and the Standard should not restrict use of the upper bound defined flood event for determining appropriate levels for flood refuges.

Furthermore, it was suggested that consideration should be given to retrofitting as this is a current demand area.

The conclusion from the FMA suggests an alternative approach to the options provided being:

- The floodplain risk management context and planning be recognised, but be delegated as outside the scope of the Building Code Standard. It would be left to these external floodplain risk management processes to set where development should be located, what type of development, and the primary performance requirements for buildings in terms of overall management of the flood plain. The full range of floods up to and including the probable maximum flood would be incorporated in these external processes. The present development of National Floodplain risk management best practice guidelines would seem to be the obvious choice of a national approach to this.
- The national building Standards for buildings in flood affected areas not be restricted to only certain types of buildings.
- The national building Standards for flood affected areas only provide technical guidance on the building design matters to achieve flood management objectives which would be set for the specific circumstances and locations by external processes. These objectives would include building stability and resilience to post

flood recovery. The objectives would not necessarily be pegged to a single defined flood event.

ABCB Response

If adopted, the Standard will be supported by relevant Performance Requirements contained within the NCC. The Performance Requirements will give direction as to what is required to satisfy the NCC provisions and the Standard will provide a Deemed-to-Satisfy solution.

It is noted that certain areas may be subject to more than one defined flood event. It is at the discretion of the authority having jurisdiction to decide which flood event is to be designed to.

Flood hazard area is the commonly used term in the planning area which is typically responsible for mapping the hazard. It will be the responsibility of the authority having jurisdiction to determining the flood hazard areas depending on the multiple factors described.

The scope of the NCC is limited to new construction work and as such it will be the responsibility of State and Territory building administrations to determine its application in regards to retrofitting of existing buildings.

Comments from individuals

One submission was received from a Victorian builder who suggested an alternative construction method should be acknowledged within the proposed Standard. He believes that amphibious construction technology provides a viable alternative to traditional construction techniques in flood hazard areas and provides examples of its potential application.

ABCB Response

Whilst the concept of amphibious construction technology is an interesting one, its application in Australia in relation to specific terrain and environmental conditions would need further investigation. Despite this in circumstances appropriate, it is acknowledged that the construction method may meet an Alternative Solution.

9 Implementation and Review

If the Board decided to adopt Option 1, the new Standard would be proposed for introduction in the NCC 2013, which is scheduled for adoption on 1 May 2013. As a matter of policy, proposed changes to the NCC are released in advance of implementation to allow time for familiarisation and education and for industry to modify its practices to accommodate the changes.

It is expected that building control administrations and industry organisations, in association with the ABCB, would conduct information training seminars on the new measures prior to their introduction into the NCC.

There is no fixed schedule for reviewing provisions of the NCC and the referenced Standards. However, the ABCB maintains regular and extensive consultative relationships with a wide range of stakeholders. It relies on this process to identify emerging concerns.

10 Conclusion

Floods are a prominent natural hazard in Australia. The problem is that many home owners are unaware that they live in a flood hazard area until the flood is upon them. Others tend to assume that a new residential building has been constructed with survivability measures. The demand side of the market does not respond adequately to flood risks due to a lack of information about floods. On the supply side, builders who may be aware of flood risks will not voluntarily add flood survivability measures to their designs because their quotations will be uncompetitive in a price conscious market, where these measures are not expected to be valued by consumers.

Flood risks are managed under State and Territory planning regulations, as administered by local governments, where:

- approvals for new residential buildings are discouraged / disallowed in high risk areas – usually where the flood risk is higher than 1% Annual Exceedance Probability; and
- approvals for new residential buildings in other flood hazard areas are permitted where the minimum floor height of the habitable rooms is higher than the expected flood level.

The problem is that these planning actions by local governments – that do help in addressing flood risks – are insufficient to prevent buildings being structurally damaged during a flood event or to ensure the survival of utilities. Consequently residents still face life safety risks and a lack of amenity when they return to their homes.

The objective is to support health, safety and amenity outcomes for residents during a flood event, by addressing the structural robustness of buildings and the survival of utilities.

Four alternative choices are suggested to the ABCB Board:

- **Status Quo** – this is the default choice for decision makers if other options would impose a net cost on society.
- **Option 1a** - new NCC provisions to apply in flood hazard areas, as designated by each local government.
- **Option 1b** – new NCC provisions to apply in flood hazard areas, identified on a national flood map.
- **Option 2** – a handbook providing guidance on constructing residential buildings in flood hazard areas (as designated by each local government).

Option 1a would increase construction costs by $216 million (present value over 10 years), but the benefits of ensuring structural integrity and survival of amenities was estimated to be $352 million (present value over 10 years); a net benefit to society.

Option 1b would result in the same cost and benefits plus the additional cost in the first year of preparing a national flood map. An initial estimate for this is $11 million, although clearly this is a minimum and the actual cost could be much higher.

An alternative approach, suggested by stakeholders, notes that Geoscience Australia is developing an internet portal for local governments and other organisations to upload existing flood hazard information, which could be used as a national data source very much like a national map. However this approach does not deliver superior information than is already known by local governments – the flood hazard areas in the database would be the same flood hazard areas designated by each local government.

The principal intangible and indirect benefits of Option 1 would be: the avoidance of injuries and fatalities during a flood event; the avoidance of damage to other resident's dwellings by preventing parts of the building washing away; reduced emotional and physiological effects, household disruption and loss of memorabilia; enhanced resilience of the community after a flood event for residents and business; the benefit to insurers when national building provisions reduce risks of flood damage and more clearly define these risks; and a reduction in Government disaster relief payments after a flood event.

Option 1 would also have distributional impacts. While all residents in new buildings would incur costs to ensure structural robustness and the survival of utilities, only some residents would benefit from these measures – during a flood event within the 40 year physical life of the building. For many residents in flood hazard areas a flood event will not have occurred during this 40 year period, and hence these residents will not directly benefit from the flood protection measures. These distributional impacts are only observable in retrospect, after 40 years. From the perspective of today, looking to the future over the next 40 years, it is impossible to determine where the incidence of floods will occur. It is impossible to determine where residents need not bother with more robust structures, and where they should. However all residents will have the comfort of knowing that, should a predictable flood event occur, their homes will be sufficiently robust to withstand it.

Option 2 would deliver a similar ratio of benefits to costs as Option 1a, but at a much reduced scale. As an example (and purely as an example) if the handbook was applied to 10% of new residential buildings, the present value of costs would be $22 million and $35 million for benefits. In circumstances where Options 1a and 1b would result in very high costs, with a benefit cost ratio close to unity, Option 2 could appear an attractive and low cost option for decision makers.

Stakeholders generally supported the proposed NCC provisions and were evenly divided in their preferences between Options 1a and 1b. Two stakeholders, one from government and one from industry, were critical of the material presented in the Consultation RIS; see NSW and HIA sections in the Consultation chapter for stakeholder comments and ABCB responses.

Option 1b introduces a degree of complexity and uncertainty, in that a national flood map currently does not exist and would have to be developed de novo. There is no guarantee that this could be accomplished in a timely or cost-effective manner. Given these uncertainties concerning Option 1b, and the outcomes of the impact analysis where Option 1a would result in the highest net benefit to society, Option 1a is preferred.

Recommendation

It is recommended that the Board agree to adopt new NCC provisions to address the risk of floods to residential buildings, as described in Option 1a, from May 2013.

A Summary of Existing Requirements

The existing requirements of the States and Territories are summarised below.

State	Flood related building and planning provisions
Northern Territory	• Part 10 of the NT *Building Regulations*, under the *Building Act* state the regulation surrounding buildings in flood prone areas. • The flood level used for a flood prone area is the 1 in 100 year flood level. • Buildings constructed in a flood prone area must adhere to the following specifications: a) The height of the lowest floor level, of lowest part of the floor level, of a habitable room shall not be less than 300 mm above the flood level; b) The structural design of the building shall be adequate to withstand flooding giving consideration to: i. The site, size and shape of the building; ii. The effect of buoyancy on the sub-structure of the building; and iii. The stresses that the depth and velocity of water and the impact of water borne debris may have on the structure. • Local Governments cannot develop their own building or planning requirements to control the construction of buildings in flood prone areas.
Australian Capital Territory	• There are no “flood prone areas” in ACT’s main urbanised area - greater Canberra. The government has the responsibility to ensure that land is not released for construction in flood prone areas.
Western Australia	• Section 23 of the Town Planning (Buildings) Uniform General By-laws 1989, under the *Planning and Development Act 2005*, states that “a building shall not be constructed on land defined by the council as being liable to flooding or inundation.” • Local governments that face the risk of flooding incorporate provisions into their individual Town Planning Schemes (TPS) to deal with the risk. Common ways the risk is dealt with include: a) the requirement for developments to receive planning approvals; b) providing councils with the power to not issue approvals in flood risk areas; c) ability for councils to consult other government departments; and d) giving councils the responsibility to determine the finished floor level (FFL).
Victoria	• Under the *Planning and Environment Act 1987*, land can be identified in a planning scheme as an area liable to flooding. • The *Building Regulations 2006* states when land is considered to be liable to flooding. • If an area is deemed to be liable to flooding, generally, the report and consent of the relevant council must be obtained. In its report, the relevant council must specify a level at least 300mm above any flood levels declared under the *Water Act 1989* or otherwise determined by the floodplain management authority, unless the authority consents to a lower floor level.
Queensland	• The *Sustainable Planning Act 2009* states that a planning scheme must not

State	Flood related building and planning provisions
	include provisions about building work, to the extent the building work is regulated under the assessment provisions, unless permitted under the *Building Act 1975*. • Section 31 of the *Building Act 1975* provides local governments authority to include building provisions in a planning scheme if permitted by a regulation. • Section 13 of the *Building Regulations 2006* states that local government may, in a planning scheme or by a temporary local planning instrument under the *Planning Act* or a resolution - a) Designate part of its areas as a natural hazard management area (flood); and b) Declare the level to which the floor levels of habitable rooms as defined under the NCC of buildings on the land must be built.
New South Wales	• Local councils are responsible for managing flood risk. To do this, they are encouraged to map flood prone land and define areas such as floodway, flood storage areas, flood planning areas, and flood prone land • Section 117 of the *Environmental Planning and Assessment Act 1979* includes Ministerial Direction No. 4.3 Flood Prone Land, which sets out flood related planning requirements for local councils. Councils are expected to develop flood prone land in a way that is consistent with the NSW Government's Flood Prone Land Policy.
South Australia	• Councils in South Australia are in the process of converting to the 'Better Development Plans' policy system. This represents the base policy of councils, to which more detailed planning policies that relate to council specific circumstances can be added. • Typically, South Australian planning policy states that plans should be designed to withstand a 1 in 100 year average flood event. • Building design requirements are not prescriptive with regard to mitigating floods. Instead, the applicant is required to show how the building is designed to prevent an entry of floodwaters of a 1 in 100 year average flood event.
Tasmania	• The *Building Act 2000* and *Building Regulations 2004* state that the floor level of habitable rooms must be 300mm above the prescribed designated flood level. The designated flood level is described in the *Building Regulations 2004*. • Ten floodplains that are subject to flooding have been identified. • A new Statewide (Planning) Code is under consideration as part of a Planning Directive. The Planning Directive will assist in uniformity across the State. • Local Government cannot have its own building related controls.

B Detailed Calculations & Assumptions

This analysis estimates the impact at a State / Territory and national level using a combination of data sourced from the Victorian Building Commission and the Australian Bureau of Statistics (ABS), and the analysis undertaken by specialist engineers and quantity surveyors. A description of the specific steps and assumptions involved in estimating the impact of the proposed changes at a State / Territory and national level is provided below.

To calculate the costs and benefits of the proposed changes, an Excel-based model was used. A description of the specific steps and assumptions involved in estimating the impact of the proposed changes is provided in the subsequent sections.

B.1 Victoria Building Commission Data

Table B-1 and Table B-2 below provide a summary of the total number of permits for new buildings and the corresponding value of approved building work across BCA building Classes 1, 2, 3, 4, 9a and 9c in Victoria. The data was obtained from the Victorian Building Commission for the five years from FY2006-07 to FY2010-11 (inclusive).

Table B-1: Number of permits and value of building work, Victoria total, new buildings, all uses, FY2007-11[2]

Building Class	No. of permits	Value of building work
1	194,004	$44,532,710,496
2	1,473	$2,003,996,905
Adjusted Class 2	*4,157*	*$5,655,543,200*
3	507	$479,219,935
4	198	$85,016,601
9a	239	$390,704,766
9c	131	$340,297,621
Total FY2007-11	**200,709**	**$53,487,489,524**
Adjusted total	**199,236**	**$51,483,492,619**

Note, the adjustment made to the number of Class 2 permits and the value of construction in that category. This adjustment has been made to better reflect an accepted ratio of residential construction (as advised by the ABCB), which suggests a 70:30 split between Class 1 buildings and the number of residences within Class 2 buildings. Assuming an average of 20 units per Class 2 building, this would imply an increase in the recorded volume from 1,473 to 4,157. The value associated with this additional activity is assumed to increase in the same proportion as the original data (i.e. the same average cost has been assumed).

The total values over the 5 years from FY2006-07 to FY2010-11 were then divided by the number of years to arrive at the yearly average.

[2] Unpublished data sourced through a specific data request to the Victorian Building Commission.

Table B-2: Number of permits and value of building work, Victoria total, new buildings, all uses, yearly average[3]

Building Class	No. of permits	Value of building work
1	38,801	$8,906,542,099
2	831	$1,131,108,640
3	101	$95,843,987
4	40	$17,003,320
9a	48	$78,140,953
9c	26	$68,059,524
Total FY2007-11	**39,847**	**$10,296,698,523**

B.2 Australian Bureau of Statistics (ABS) Data

Table B-3 and Table B-4 below outline the monthly averages of the value and number of building approvals across Australia.

Table B-3: Value of Total Building Approved per Month ($'000)

$ value approved	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
10 year average (Aug01 – Jul11)	1,383,085	**1,511,660**	1,242,744	308,411	688,909	81,121	58,860	130,861
As a percentage of VIC	91.5%	**100.0%**	82.2%	20.4%	45.6%	5.4%	3.9%	8.7%

Table B-4: Total Number of Dwelling Units Approved per Month

Number approved	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
10 year average (Aug01 – Jul11)	3,133	**3,869**	3,139	968	1,922	234	102	259
As a percentage of VIC	81.0%	**100.0%**	81.1%	25.0%	49.7%	6.1%	2.6%	6.7%

The values for all States and Territories were expressed as a percentage of the Victorian data. This percentage was then applied to the more detailed Victorian Building Commission data (refer B.1 above) to approximate the corresponding values in other jurisdictions (refer B.3 below).

B.3 Estimating Building Activity for Other Jurisdictions

Table B-5 and Table B-6 below provide the estimated building activity by BCA Class for each jurisdiction, which has been calculated based on the Victorian figures and the percentages estimated in B.2 above. This approach assumes that the distribution of new building work by BCA Class in Victoria is reasonably similar to the corresponding distributions in other jurisdictions.

[3] Unpublished data sourced through a specific data request to the Victorian Building Commission.

Table B-5: Estimated value of building permits, per annum, all jurisdictions

Building Class	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
1	$8,148,992,636	$8,906,542,099	$7,322,120,641	$1,817,126,427	$4,058,977,677	$477,958,451	$346,795,899	$771,018,338
2	$1,034,901,747	$1,131,108,640	$929,891,065	$230,770,526	$515,480,045	$60,699,532	$44,042,214	$97,917,407
3	$87,691,939	$95,843,987	$78,793,905	$19,554,238	$43,678,972	$5,143,348	$3,731,897	$8,296,988
4	$15,557,096	$17,003,320	$13,978,530	$3,469,044	$7,748,922	$912,462	$662,062	$1,471,937
9a	$71,494,643	$78,140,953	$64,240,137	$15,942,438	$35,611,170	$4,193,337	$3,042,591	$6,764,478
9c	$62,270,694	$68,059,524	$55,952,135	$13,885,609	$31,016,761	$3,652,329	$2,650,048	$5,891,752
Total	**$9,420,908,756**	**$10,296,698,524**	**$8,464,976,414**	**$2,100,748,281**	**$4,692,513,546**	**$552,559,458**	**$400,924,711**	**$891,360,900**
% of VIC	91.5%	**100.0%**	82.2%	20.4%	45.6%	5.4%	3.9%	8.7%

Table B-6: Estimated number of building permits, per annum, all jurisdictions

Building Class	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
1	31,420	38,801	31,483	9,711	19,273	2,352	1,025	2,593
2	673	831	675	208	413	50	22	56
3	82	101	82	25	50	6	3	7
4	32	40	32	10	20	2	1	3
9a	39	48	39	12	24	3	1	3
9c	21	26	21	7	13	2	1	2
Total	**32,267**	**39,847**	**32,332**	**9,972**	**19,792**	**2,415**	**1,053**	**2,663**
% of VIC	81.0%	**100.0%**	81.1%	25.0%	49.7%	6.1%	2.6%	6.7%

B.4 *Estimating Residential Building Activity within Flood Hazard Areas*

Data obtained from Risk Frontiers (sourced from the National Flood Insurance Database (NFID)) provided a basis to estimate the proportion of addresses within flood hazard areas, by jurisdiction. Table B-7 summarises this data.

Table B-7: Proportion of addresses within flood hazard areas, by jurisdiction

No. addresses	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
Total addresses	3,756,602	3,040,068	2,558,675	927,395	1,304,569	287,884	85,755	189,615
Addresses within flood hazard areas	111,769	41,175	46,486	12,440	8,557	206	0	0
% addresses within flood hazard areas	**3.0%**	**1.4%**	**1.8%**	**1.3%**	**0.7%**	**0.1%**	**0.0%**	**0.0%**

While the NFID data represents the most complete flood risk dataset available (for the 100 year Annual Recurrence Interval or ARI), it is subject to ongoing work and refinement. In particular, this version of the NFID (version 2.5) reflects the analysis of only 42 per cent of all Australian addresses for flood risk. While this might appear a relatively low percentage, the analysis to date has focused on known flood risk areas, which means the actual number of addresses within the ARI 100 year riverine flood zone is unlikely to vary significantly from the above figures.

Furthermore, neither the ACT nor the NT have yet been incorporated in the database. However, these regions represent only approximately 1.6 per cent and 0.7 per cent of total Australian addresses, which combined with the current ACT planning restrictions (i.e. no construction in flood risk areas) means the number of addresses in flood hazard areas in these jurisdiction is likely to be minimal. For the purposes of this analysis, it has been assumed there will be no new construction in flood hazard areas in the ACT, and construction in the NT would be in the same proportion as other jurisdictions.

These percentages were then multiplied with the building activity estimates from the previous step to arrive at an estimate of building activity within flood hazard areas. Tables B-8 and B-9 show the results of this multiplication.

Table B-8: Value of building permits per annum, all jurisdictions, within flood hazard areas

Building Class	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Total
1	$242,454,420	$120,631,141	$133,028,267	$24,374,784	$26,623,867	$342,011	$6,443,232	$0	**$553,897,721**
2	$30,791,107	$15,319,854	$16,894,258	$3,095,537	$3,381,165	$43,435	$818,274	$0	**$70,343,630**
3	$2,609,071	$1,298,121	$1,431,527	$262,299	$286,501	$3,680	$69,336	$0	**$5,960,536**
4	$462,865	$230,295	$253,962	$46,533	$50,827	$653	$12,301	$0	**$1,057,436**
9a	$2,127,158	$1,058,349	$1,167,115	$213,851	$233,583	$3,001	$56,529	$0	**$4,859,585**
9c	$1,852,720	$921,805	$1,016,538	$186,260	$203,447	$2,613	$49,236	$0	**$4,232,621**
Total	**$280,297,341**	**$139,459,565**	**$153,791,667**	**$28,179,264**	**$30,779,390**	**$395,393**	**$7,448,908**	**$0**	**$640,351,528**

Table B-9: Number of permits, per annum, all jurisdictions, within flood hazard areas

Building Class	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Total
1	935	526	572	130	126	2	19	0	**2,310**
2	20	11	12	3	3	0	0	0	**49**
3	2	1	1	0	0	0	0	0	**4**
4	1	1	1	0	0	0	0	0	**3**
9a	1	1	1	0	0	0	0	0	**3**
9c	1	0	0	0	0	0	0	0	**1**
Total	**960**	**540**	**587**	**133**	**129**	**2**	**19**	**0**	**2,372**

B.5 Estimating Additional Costs of New Buildings in Flood Hazard Areas

Costing analysis provided by Turner & Townsend (based on engineering advice) provided estimates of the additional costs due to the proposed changes (refer Table B-10 below).

Table B-10: Additional costs under proposed Standard, per building

Building Class		Base cost	Cost impact ($)	Cost impact (%)
1	Design (A)	$497,904	$14,895	3.0%
1	Design (B)	$546,480	$28,103	5.1%
1	Design (C)	$451,757	$27,404	6.1%
1	Design (D)	$689,779	$30,202	4.4%
Average		*$546,480*	*$25,151*	*4.6%*
2		$427,469	$14,926	3.5%
3		$306,029	$20,757	6.8%
4*		$434,000	$19,974	4.6%
9a*		$1,653,000	$76,077	4.6%
9c*		$2,617,000	$120,444	4.6%

*Note: Cost impacts for these classes were assumed to be equal to the weighted average percentage change identified for Class 1-3 buildings. The base costs for these buildings were approximated as the average value per approval in each BCA Class.

It is important to note that as the vast majority of future construction activity is expected to be focused on the residential sector, the focus of the costing work has been to evaluate the impact of the proposed Standard on the construction of BCA Class 1 buildings, and to a lesser extent Class 2 and Class 3 buildings. The specific designs used are included as Appendix C to this RIS.

For each chosen design, the plans and specifications were used to determine the impact of the proposed Standard on construction practices in each jurisdiction. This work was undertaken by Northrop Consulting Engineers, with the assumed construction implications then provided to Turner and Townsend to estimate the cost implications of these changes for each building.

Due to minimal construction activity being projected for Class 4, 9a and 9c buildings in flood hazard areas, a more high level approach was adopted for the cost analysis for construction in these categories. Specifically, the average percentage cost increase quantified for other building types was applied to the construction in these categories, with areas of potential variation identified and described qualitatively

The analysis first identified the *cost impact* of the proposed Standard for each BCA Class, which represented the additional costs compared to a base case of no regulation (i.e. not taking into account existing State / Territory requirements).

Table B-11: Additional costs under proposed Standard, present values, all jurisdictions

Building Class	NSW	VIC	QLD	SA	WA	TAS	NT	Total
1	$83,807,223	$41,697,573	$45,982,785	$8,425,431	$9,202,853	$118,220	$2,227,179	$191,461,264
2	$8,079,953	$4,020,112	$4,433,255	$812,306	$887,258	$11,398	$214,725	$18,459,006
3	$1,329,908	$661,684	$729,685	$133,700	$146,037	$1,876	$35,342	$3,038,232
4	$159,995	$79,604	$87,785	$16,085	$17,569	$226	$4,252	$365,515
9a	$735,277	$365,831	$403,427	$73,920	$80,741	$1,037	$19,540	$1,679,773
9c	$640,415	$318,633	$351,378	$64,383	$70,324	$903	$17,019	$1,463,055
Total	**$94,752,770**	**$47,143,437**	**$51,988,315**	**$9,525,825**	**$10,404,781**	**$133,660**	**$2,518,057**	**$216,466,845**

B.6 Estimating Additional Costs over the next 10 Years

Table B-12 shows the assumed discount and inflation rates, which were used to estimate the additional costs arising from the proposed NCC changes over the next 10 years.

Table B-12: Assumed discount rate and dwelling growth rate

Item	Value	Explanation
Discount rate (p.a.)	7%	Factor to account for the time value of money. Monetary values in future periods are discounted to the present period. Selected discount rate reflects OBPR advice and COAG guidelines.
Inflation adjustment	n/a	All costs and benefits are presented in real terms (2011 dollars).
Timeframe	10 years	Assumed life of the regulation

Based on the estimated values in the preceding analysis and the assumed discount rate, a Net Present Value was calculated for each building type over the lifetime of the regulations.

Table B-13: Additional costs of new buildings under proposed Standard, by building Class (NPV)

Year	Class 1	Class 2	Class 3	Class 4	Class 9a	Class 9c
1	$25,476,427	$2,456,212	$404,277	$48,637	$223,516	$194,679
2	$23,809,745	$2,295,526	$377,829	$45,455	$208,893	$181,943
3	$22,252,098	$2,145,351	$353,111	$42,481	$195,227	$170,040
4	$20,796,353	$2,005,001	$330,010	$39,702	$182,455	$158,916
5	$19,435,844	$1,873,833	$308,421	$37,105	$170,519	$148,519
6	$18,164,340	$1,751,245	$288,244	$34,677	$159,364	$138,803
7	$16,976,019	$1,636,678	$269,387	$32,409	$148,938	$129,723
8	$15,865,438	$1,529,606	$251,763	$30,288	$139,194	$121,236
9	$14,827,512	$1,429,538	$235,293	$28,307	$130,088	$113,305
10	$13,857,488	$1,336,017	$219,900	$26,455	$121,578	$105,892
Total	$191,461,264	$18,459,006	$3,038,232	$365,515	$1,679,773	$1,463,055
NPV	**$216,466,845**					

Table B-14: Additional costs of new buildings under proposed Standard, by jurisdiction (NPV)

Year	NSW	VIC	QLD	SA	WA	TAS	NT
1	$12,608,096	$6,273,051	$6,917,726	$1,267,536	$1,384,492	$17,785	$335,060
2	$11,783,267	$5,862,665	$6,465,164	$1,184,613	$1,293,918	$16,622	$313,141
3	$11,012,399	$5,479,126	$6,042,210	$1,107,115	$1,209,269	$15,534	$292,655
4	$10,291,962	$5,120,678	$5,646,925	$1,034,687	$1,130,158	$14,518	$273,509
5	$9,618,656	$4,785,681	$5,277,500	$966,997	$1,056,223	$13,568	$255,616
6	$8,989,398	$4,472,599	$4,932,243	$903,735	$987,124	$12,681	$238,893
7	$8,401,307	$4,179,999	$4,609,573	$844,613	$922,546	$11,851	$223,265
8	$7,851,689	$3,906,541	$4,308,012	$789,357	$862,192	$11,076	$208,659
9	$7,338,027	$3,650,973	$4,026,179	$737,717	$805,787	$10,351	$195,008
10	$6,857,969	$3,412,124	$3,762,784	$689,455	$753,072	$9,674	$182,251
Total	**$94,752,770**	**$47,143,437**	**$51,988,315**	**$9,525,825**	**$10,404,781**	**$133,660**	**$2,518,057**
NPV				**$216,466,845**			

B.7 Estimating the Quantitative Benefits

The benefits arising from the proposed NCC changes were estimated in terms of the expected value of avoided flood structural repair costs due to introduction the proposed Standard. This approach required an estimate of expected annual flood structural repair costs for different types of buildings, and an assumption around the likely effectiveness of the proposed Standard in contributing to a reduction in these costs.

Calculating average annual flood damage

The quantitative analysis of the benefits associated with the proposed Standard is based on a costing exercise undertaken by Turner and Townsend (quantity surveyors). This analysis sought to estimate the repair costs for flood damages resulting from a flood level of one metre for each of the sample buildings used in the cost analysis (refer table below).

Table B-15: Estimated structural repair costs for a flood of one metre (2011 dollars)

Building type	Estimated structural repair costs (one metre)
BCA Class 1 (Design A)	$28,085
BCA Class 1 (Design B)	$223,644
BCA Class 1 (Design C)	$201,522
BCA Class 1 (Design D)	$201,158
BCA Class 2	$134,673
BCA Class 3	$200,212

As the above estimates relate only to the damage repair costs for a one metre flood level, they require adjustment to reflect varying flood levels experienced by properties affected by a 100 year flood event, and the level of protection already provided by State / Territory requirements for construction in those areas. This provided an estimate of the expected annual cost of flood damage for properties located in each jurisdiction. The analysis excluded the costs associated with more frequent flood events (i.e. 10% AEP, 2% AEP) as it was assumed that no new buildings would be constructed in these areas.

Table B-16 summarises the adjustments made to arrive at the estimated annual damage costs for each building type. The following assumptions / data sources were used to complete this analysis:

- *Proportion of properties* – i.e. the proportion of total properties within the 1% AEP flood level affected by different flood levels (high-level estimate provided by Risk Frontiers based on the NFID);
- *Damage factor* – i.e. the factor used to calculate the variation in the estimated repair costs associated with different flood levels (based on damage estimates provided in Middlemann et al (2000) for different flood levels);
- *AEP 1% cost impact* – i.e. the estimates of repair costs for a one metre flood event for different building types (refer Table B-16) have been extrapolated to other flood depths based on the assumed 'damage factor' and the assumed proportion of affected properties; and
- *Expected annual cost* – i.e. the cost a household would reasonably expect to incur in a given year, and estimated as 1% of the estimated damage costs for each building.

Table B-16: Expected annual structural repair costs by BCA Class (2011 dollars)

Flood depth		**Proportion of properties**	**Damage factor**	**Design (A)**	**Design (B)**	**Design (C)**	**Design (D)**	**Class 2**	**Class 3**
AEP 1%	0m-0.5m	35%	57%	$16,049	$127,797	$115,155	$114,947	$76,956	$114,407
	0.5m-1.0m	30%	100%	$28,085	$223,644	$201,521	$201,158	$134,673	$200,212
	1.0m-1.5m	10%	138%	$38,717	$308,309	$277,811	$277,311	$185,656	$276,006
	>1.5m	25%	176%	$49,349	$392,974	$354,101	$353,463	$236,639	$351,800
	Total	100%	Total cost	$30,253	$240,896	$217,067	$216,676	$145,062	$215,656
	Expected annual cost			*$303*	*$2,409*	*$2,171*	*$2,167*	*$1,451 (0.3%)*	*$2,157 (0.7%)*
	Average annual cost			*$1,762 (0.3%)*					

The table below summarises the key assumptions applied for the benefits modelling, which reflect the above estimates and information from other sources.

Table B-17: Assumptions to estimate benefits

Item	Value	Explanation
Useful dwelling life	30 years	Previous advice received from the OBPR in relation to similar analyses.
Class 1 – expected annual cost	$1,762	Refer Table B-16 above.
Class 2 – expected annual cost	$1,451	Refer Table B-16 above.
Class 3 – expected annual cost	$2,157	Refer Table B-16 above.
Class 4 – expected annual cost	$1,399	Estimated base construction costs (based on Building Commission data) multiplied by average annual damage percentage from Table B-16 above.
Class 9a – expected annual cost	$5,327	
Class 9c – expected annual cost	$8,434	
Percentage of flood damage costs avoided by new NCC requirements	90%	Reflects building performance following implementation of cyclone protection measures (as advised by ABCB)

Table B-18 below summarises the outputs of the benefits modelling conducted in accordance with the above assumptions. Note that due to the assumed useful dwelling life of 30 years, benefits had to be considered for the time up to 40 years after the base year (i.e. benefits associated with houses constructed in year 10 will still be being realised in year 40). To calculate the NPV the same assumed discount rate was used as in the cost analysis.

Table B-18: Maximum avoided costs of new buildings in flood hazard areas

Year	Aggregate avoided costs ($)
1	$3,777,181
2	$7,554,361
3	$11,331,542
4	$15,108,722
5	$18,885,903
6	$22,663,083
7	$26,440,264
8	$30,217,444
9	$33,994,625
10	$37,771,805
11	$37,771,805
12	$37,771,805
(…)	
29	$37,771,805
30	$37,771,805
31	$33,994,625
32	$30,217,444
33	$26,440,264
34	$22,663,083

Year	Aggregate avoided costs ($)
35	$18,885,903
36	$15,108,722
37	$11,331,542
38	$7,554,361
39	$3,777,181
40	$0
Total	**$1,133,154,150**
NPV	**$352,247,867**

B.8 Overall Assessment

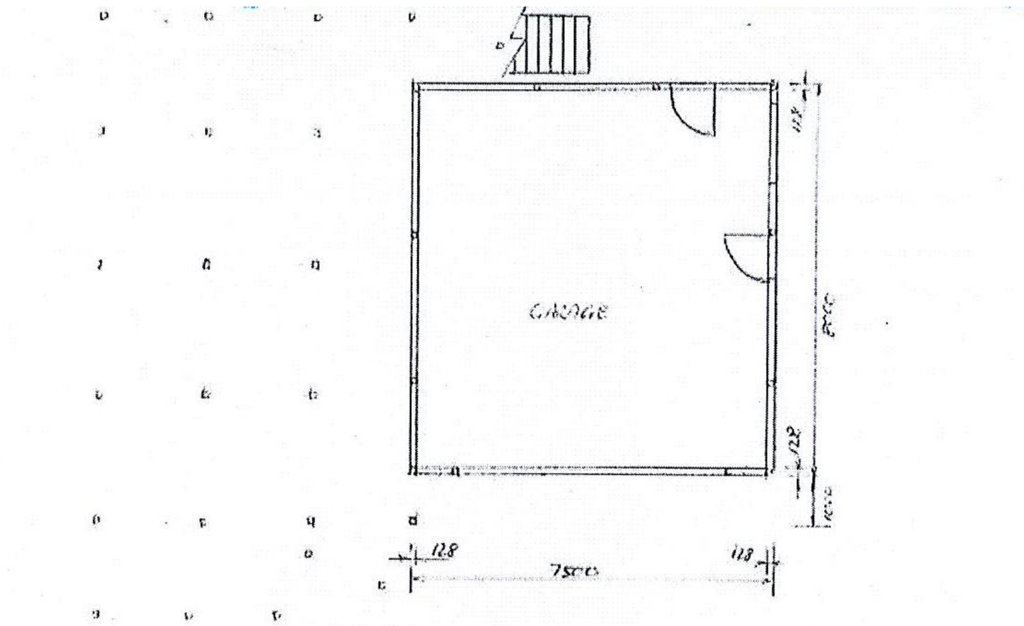
The final step involved a comparison of the NPV of the total gross cost impact to the NPV of the total gross benefit impact.

Table B-19: Overall assessment of the proposed Standard (NPV, 2011 dollars)

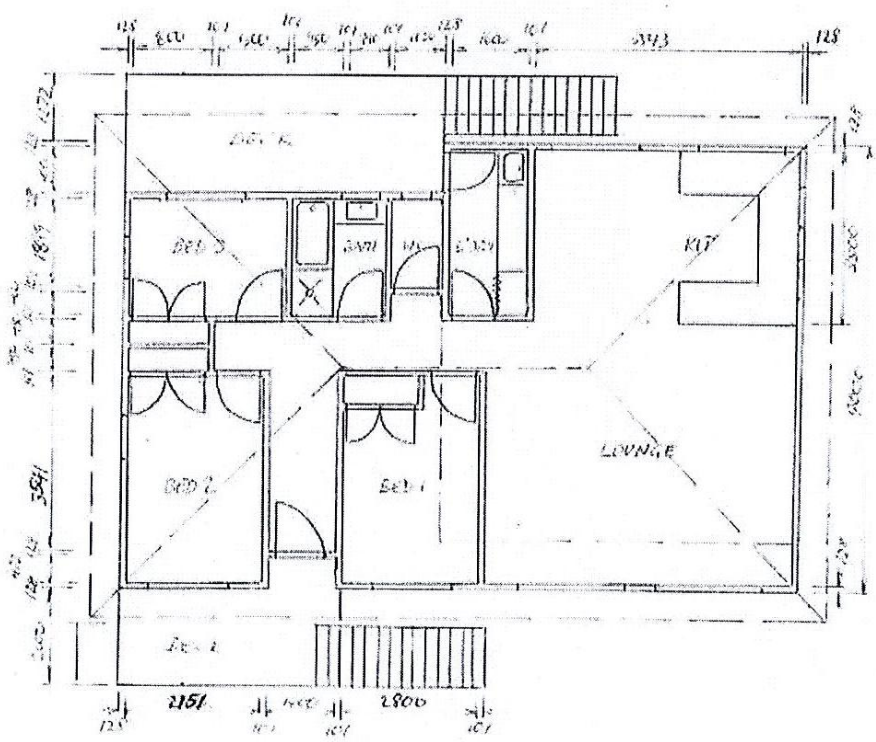
Impact	NPV (discount rate of 7%)
Estimated cost impact (NPV)	$216,466,845
Estimated benefit impact (NPV)	$352,247,867
Overall impact (NPV)	**$135,781,021**
Benefit Cost Ratio (BCR)	**1.63**

C Sample Designs

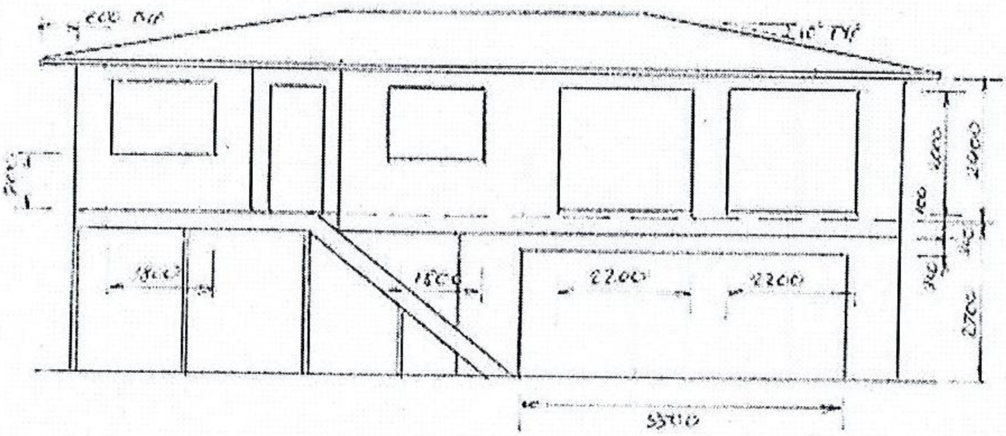
A.1 BCA Class 1 – Design A



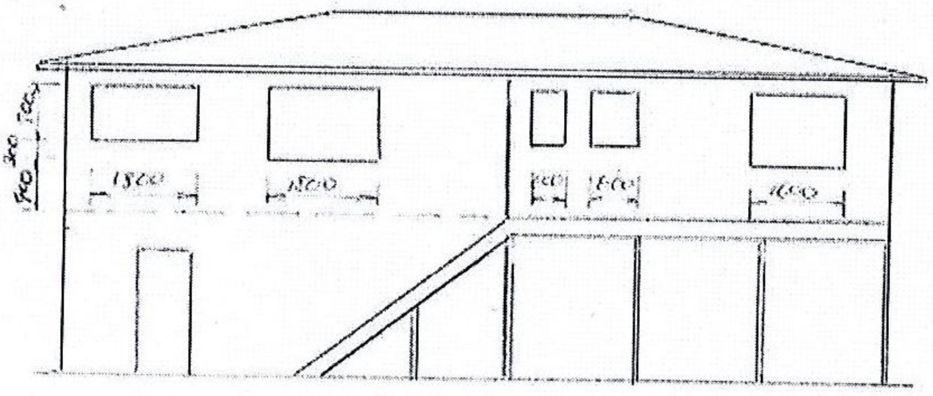
FCM5 Lower floor plan



FCM5 Upper floor plan

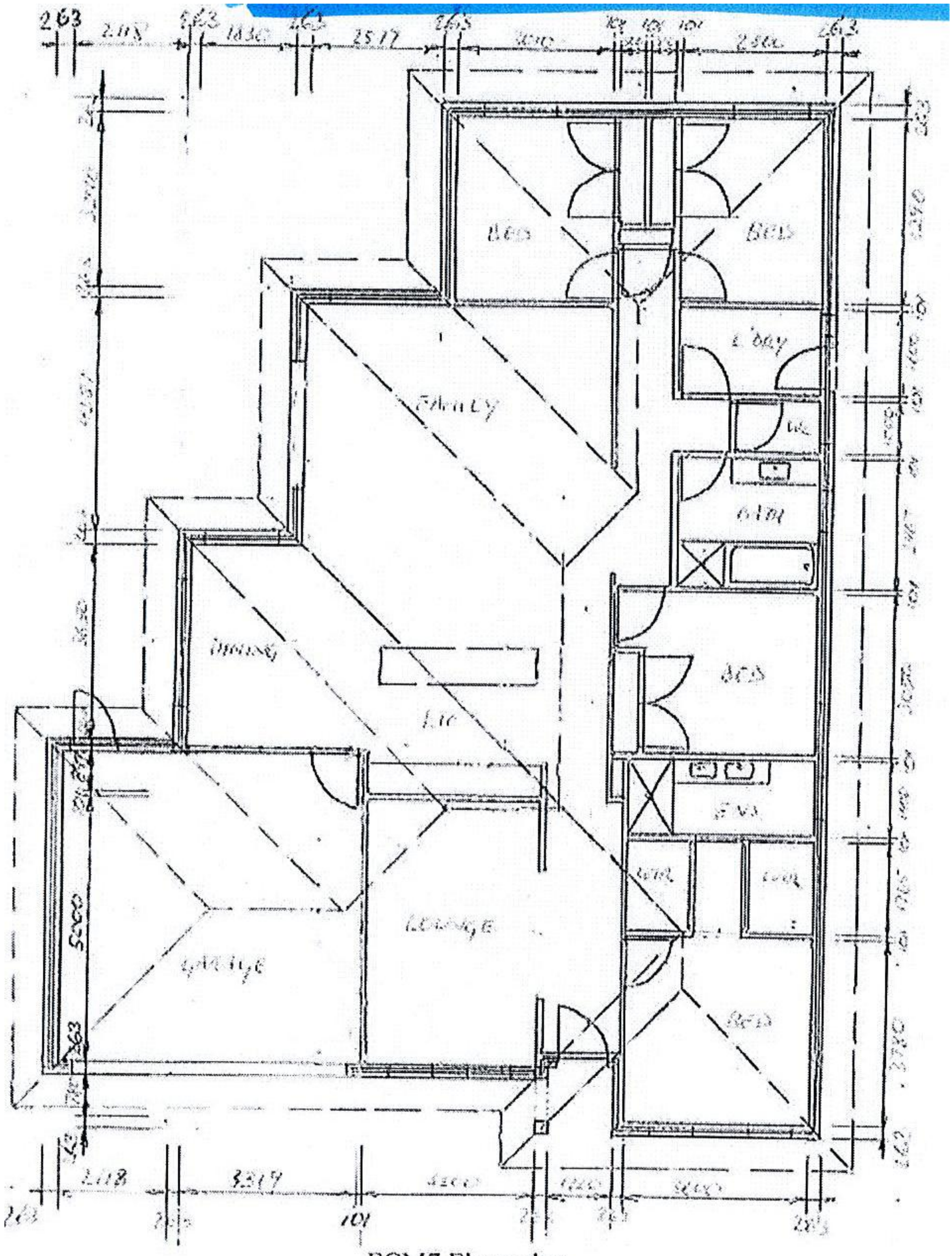


FCM5 South elevation

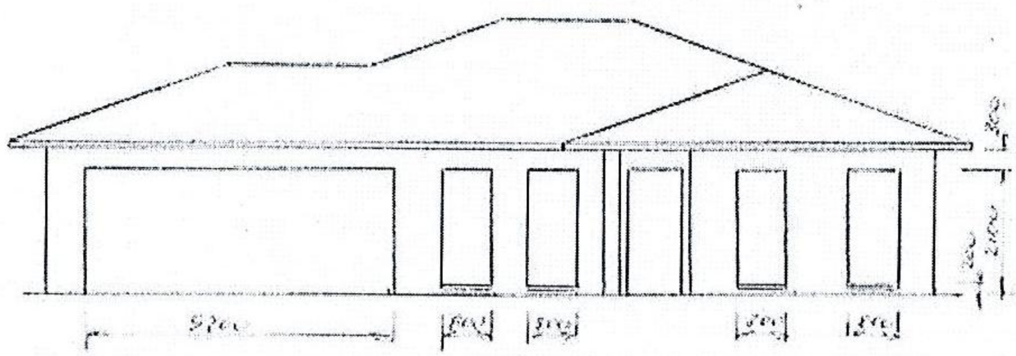


FCM5 North elevation

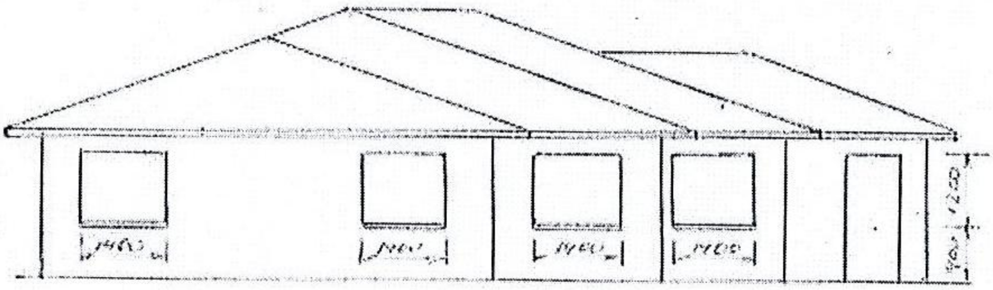
A.2 BCA Class 1 – Design B



FCM7 Floor plan

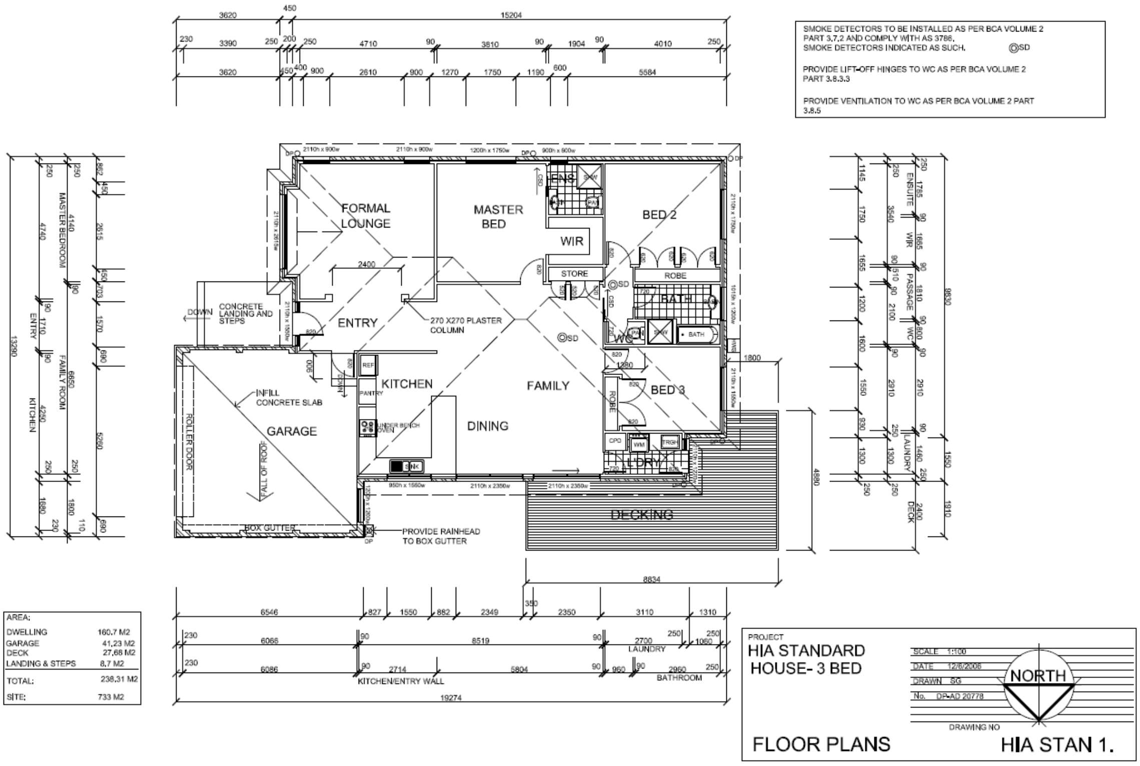


FCM7 South elevation



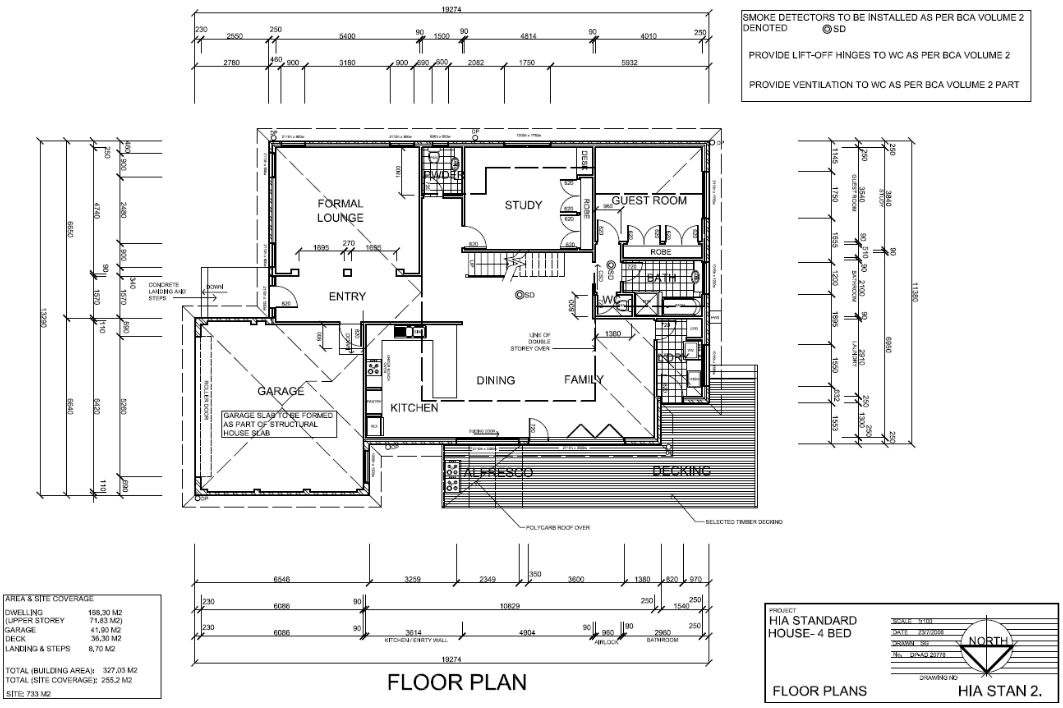
FCM7 North elevation

A.3 BCA Class 1 – Design C

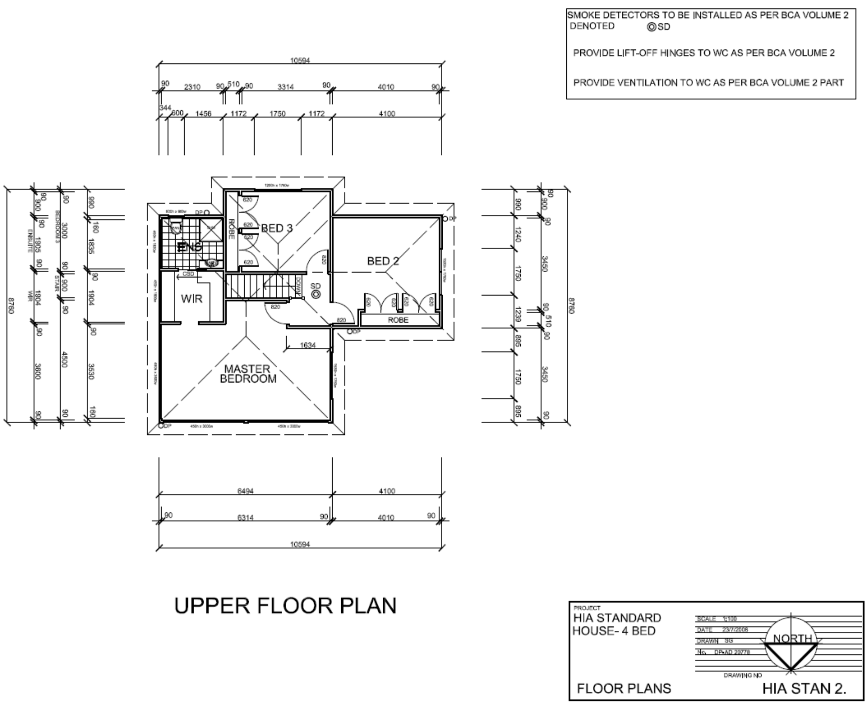


A.4 BCA Class 1 – Design D

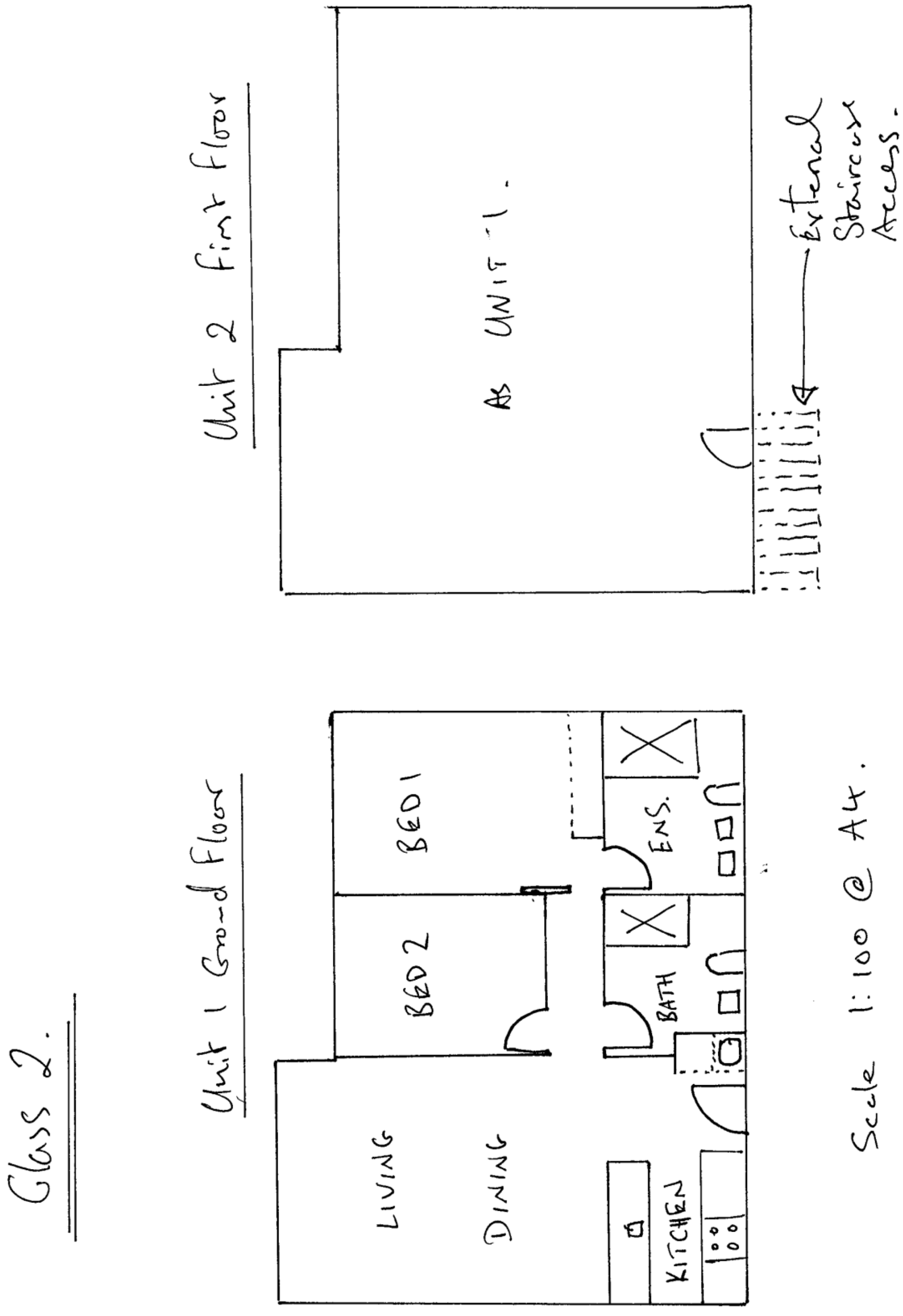
Ground floor plan



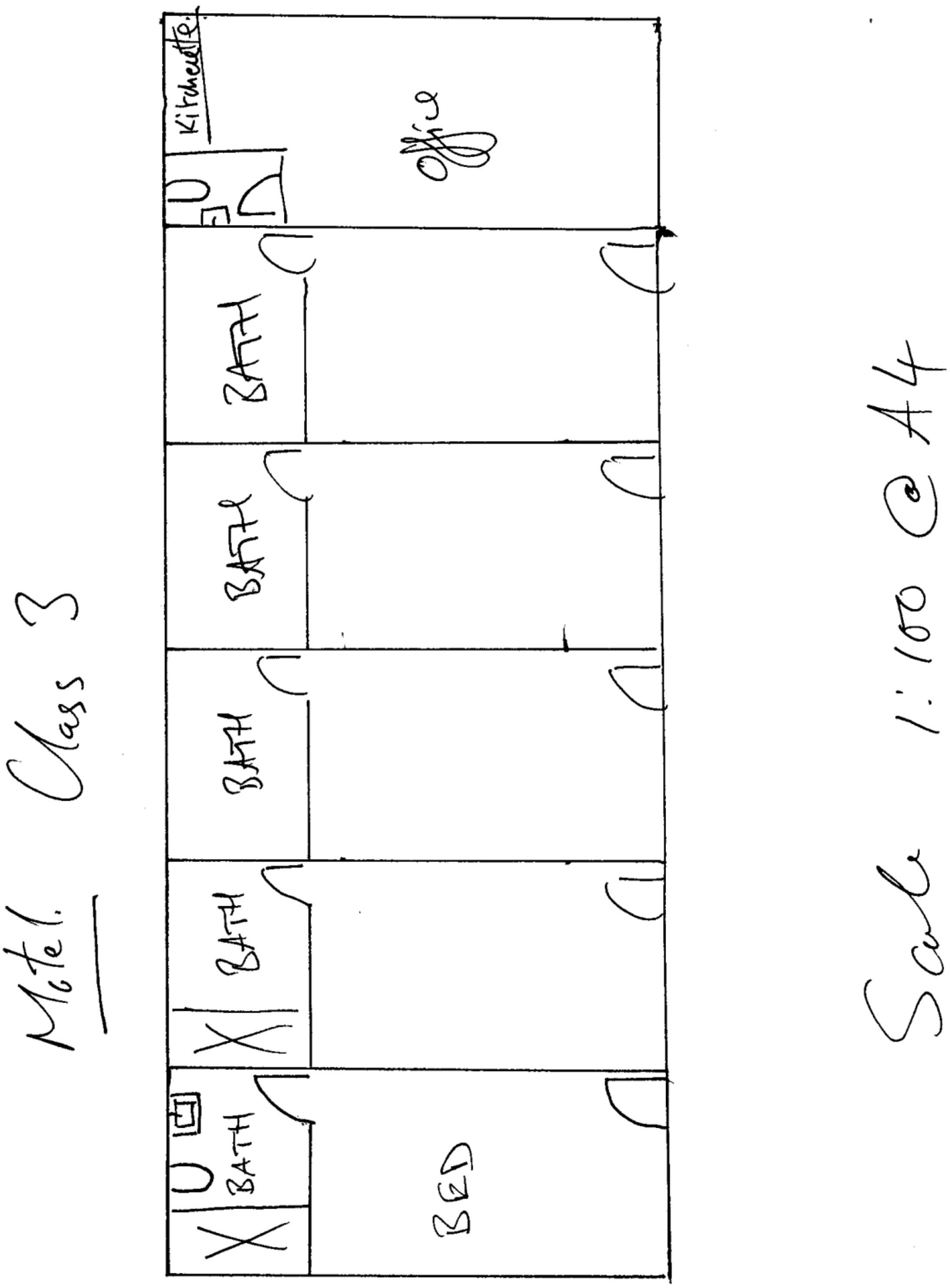
Upper floor plan



A.5 BCA Class 2



A.6 BCA Class 3



D Proposed NCC Provisions

ABCB

CONSTRUCTION OF BUILDINGS IN FLOOD HAZARD AREAS

Preface

The Australian Government and State and Territory Government Building Ministers responsible for building regulatory matters directed the ABCB to develop a standard for the design and construction of certain new buildings *in flood hazard areas* (the Standard). The Standard aims to reduce the risk of death or injury of building occupants as a result of buildings subjected to certain flood events.

The Standard is not a stand-alone solution to mitigating life safety risk due to flooding. Reducing life safety risk due to flooding requires a comprehensive set of measures that consider flood hazard and function and aim to reduce risk to a manageable level. This may be achieved by limiting development within both hazardous areas and areas (such as floodways) where it may impact on flood behaviour for other developments. Within areas allowable for development, development controls or protection works may be used to reduce risk. This requires a suite of measures which generally involve a combination of effective land use planning considering flood hazard, flood mitigation measures, flood warning and emergency response strategies for flooding, and building standards. The balance of these measures will vary from new development areas to infill or redevelopment areas. Sufficient awareness of the flood risk and the safety measures required by the occupants and those assisting them during a flood emergency are essential pre-requisites.

Therefore, with the application of this Standard within *flood hazard areas*, in the absence of supporting measures, it is not possible to guarantee that a building constructed in accordance with the Standard will eliminate the risk of serious injury or fatality even in the *defined flood event* (*DFE*).

In addition, larger floods than the *DFE* can occur and even floods of the scale of the *DFE* can vary in behaviour and could exceed the design parameters and limitations of this Standard. Availability of assistance from emergency services or other avenues are important considerations not dealt with in this Standard.

Note: terms in *italics* are defined in Clause 1.7 of this Standard.

Acknowledgements

The ABCB acknowledges the contribution of members of an expert Reference Group that assisted the development of the Standard.

The following organisations were represented on the Reference Group –

- Australian Government Attorney-General's Department
- Brisbane City Council
- Bureau of Meteorology
- Geoscience Australia
- Gold Coast City Council
- Hawkesbury City Council
- Housing Industry Association
- Insurance Australia Group
- Master Builders Australia
- NSW Department of Planning and Infrastructure
- NSW Office of Environment and Heritage
- Queensland Department of Local Government and Planning
- Risk Frontiers
- Tasmania Department of Justice

Table of Contents

1 Scope and General

1.1 General

The National Construction Code (NCC) Series is an initiative of the Council of Australian Governments (COAG) developed to incorporate all on-site construction requirements into a single code. The NCC comprises the Building Code of Australia (BCA), Volume One and Two; and the Plumbing Code of Australia (PCA), as Volume Three.

The BCA is produced and maintained by the ABCB on behalf of the Australian Government and each State and Territory Government.

The BCA is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia whilst allowing for variations in climate and geological or geographic conditions.

The BCA contains requirements to ensure new buildings and structures and, subject to State and Territory legislation, alterations and additions to existing buildings located in *flood hazard areas* do not collapse during a flood when subjected to flood actions resulting from the *defined flood event*.

The Standard provides additional requirements for buildings *in flood hazard areas* consistent with the objectives of the BCA which primarily aim to protect the lives of occupants of those buildings in events up to and including the *defined flood event*. *Flood hazard areas* are identified by the relevant State/Territory or Local Government authority ie the *appropriate authority*.

Section 2 of the Standard contains basic design requirements for the construction of buildings *in flood hazard areas*.

Section 2 also contains provisions for the design of buildings *in flood hazard areas*. These provisions only apply if certain limits such as maximum flow velocity and depth of submersion, are not exceeded. This does not mean that buildings cannot be constructed if they fall outside these limits if it is permissible under a planning scheme or planning instrument to do so. It means that such a proposal would need to be considered as an Alternative Solution under the relevant Performance Requirements and must be assessed accordingly.

The Standard also does not contain provisions that specify particular materials or design solutions which comply with the relevant BCA Performance Requirement. Therefore, in all instances, designers are required to use professional judgment in order to develop designs intended to comply with the BCA Performance Requirement.

It must also be emphasised that the Standard is not a stand-alone solution to mitigating life safety risk due to flooding. Mitigating risk to life in flooding requires a comprehensive set of measures that consider flood hazard and aim to reduce residual flood risk to a manageable level. This set of measures generally involves a combination of effective land use planning considering flood hazard, flood mitigation measures, emergency response strategies for flooding, and building standards.

Therefore, with application of this Standard within *flood hazard areas,* in the absence of supporting measures, it is not possible to guarantee that a building constructed in accordance with the Standard will eliminate the risk of serious injury or fatality even in the *DFE.*

In addition, larger floods than the *DFE* can occur and even floods of the scale of the *DFE* can be unpredictable and could exceed the design parameters and limitations in this Standard. Also, assistance from emergency services or other avenues may not be available to individual properties.

It is important to understand that flood is a local hazard whose parameters, including depth and velocity, vary significantly within the flood hazard area. Modelling of flood hazard generally provides information on average velocities across an area for an event rather than velocities at all points across a location. It is possible to have strong local flow velocities not being shown by such modelling.

In addition, there are significant variations in the information available on flooding between areas within a local authority and between local authorities within Australia. This may result from the age of studies, the type of modelling undertaken, the information available to understand flood behaviour, or the reliance of historical flood information or estimates used to provide an understanding of flood risk. This will mean that the information available is not uniform.

Flood investigations may have also resulted in mitigation works which may alter flood behaviour. These are local by nature and their benefits would generally be considered in studies on flooding for the area and considered by the local authority in determining the *flood hazard area*.

Existing development in more active flow areas, including floodways, is more likely to be subjected to higher velocities of flow than provided for in the Standard and is also more likely to impact upon flood behaviour elsewhere. Any additional development or redevelopment in these areas is also likely to be exposed to more hazardous conditions and therefore would require careful consideration and assessment. Also note that the flow velocities could also be expected to exceed those specified in this Standard in many areas subject to local overland flooding.

The local authority may need to rely upon its own judgement upon where the Standard applies or request specific information from the proponent. This may limit the application of the Standard by the local authority to *backwater and inactive flow areas* in the *DFE* where it is less likely the velocity nominated in the Standard would be exceeded.

In many cases detailed information on the depth of inundation at the development in question will rely upon the provision of survey advice from the proponent relative to flood level information determined in the *DFE*.

In some cases the local authority may require the proponent to engage a suitably qualified professional to determine the *DFE* and/or to gain a more detailed understanding of flood behaviour at the location. This may include ascertaining the specific design criteria necessary to enable consideration of the development in relation to the Standard and meeting other requirements established by the local authority.

1.2 Scope

The Standard specifies requirements for flood-resistant design and construction of buildings that are subject to the BCA requirements and that are located, in whole or in part, in *flood hazard areas*.

The ABCB has also prepared an Information Handbook which provides additional information relating to the construction of buildings in *flood hazard areas*. The Handbook is available on the ABCB website www.abcb.gov.au.

1.3 Application

1.3.1 Identification of applicable *flood hazard areas*

A *flood hazard area* is an area subject to flooding during the *DFE* as determined by the *appropriate authority*, or where this information is not available, by the proponent in accordance with standards set, or referred to, by the *appropriate authority*.

This Standard does not apply to parts of *flood hazard areas* with the following characteristics:

(a) The part of the *flood hazard areas* is subject to mudslide or landslide during periods of rainfall and runoff.

(b) The part of the *flood hazard areas* is subject to storm surge or coastal wave action.

1.3.2 Identification of applicable buildings

This Standard only applies to new Class 1, 2, 3, 9a health care and 9c buildings and Class 4 parts of buildings and, subject to State and Territory legislation, alterations and additions to existing buildings of these classifications.

1.4 Limitations

The Standard is not intended to –

(a) override or replace any legal rights, responsibilities or requirements; or

(b) override any land use planning controls imposed by the *appropriate authority*; or

(c) address administrative requirements for construction of buildings *in flood hazard areas*.

1.5 Normative References

The following documents are referred to in this Standard:

(a) AS/NZS 1170.0.

(b) AS/NZS 1170.1.

(c) AS/NZS 1170.2.

1.6 Units

Except where specifically noted, this Standard uses the SI units of kilograms, metres, seconds, Pascals and Newtons (kg, m, s, Pa, N).

1.7 Definitions

Defined terms used within the text of the Standard are printed in italics. For the purposes of the Standard the following definitions apply:

Appropriate authority: the relevant authority with the statutory responsibility to determine the particular matter.

Defined flood level (DFL): the flood level associated with a *defined flood event (DFE)* relative to a specified datum. The *DFL* plus the *freeboard* determines the extent of the *flood hazard area*.

Defined flood event (DFE): the flood event selected for the management of flood hazard for the location of specific development as determined by the *appropriate authority*.

Finished floor level: the uppermost surface of the finished floor, not including any floor covering such as carpet, tiles and the like.

Flood hazard area: the area (whether or not mapped) encompassing land lower than the *flood hazard level* which has been determined by the *appropriate authority.* The area relates to that part of the allotment on which a building stands or is to be erected.

Flood hazard level (FHL)*:* the flood level used to determine the height of floors in a building and represents the *defined flood level* (*DFL)* plus the *freeboard*.

Freeboard: the height above the *defined flood level* (*DFL)* as determined by the *appropriate authority,* typically used to compensate for effects such as wave action and localised hydraulic behaviour.

Habitable room: a room used for normal domestic activities, and-

(a) includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom; but

(b) excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes-drying room, vehicle parking area, storage area and other spaces of a specialised nature occupied neither frequently nor for extended periods.

Hydrodynamic action: the action caused by a fluid in motion.

Hydrostatic action: the pressure exerted by a fluid at equilibrium due to the force of gravity.

Inactive flow or backwater area: the part of the *flood hazard area* where the maximum flow velocity is not greater than 1.5 m/s. The area does not include areas within or directly adjacent to a river, stream or floodway, where the maximum flow velocity is likely to exceed 1.5 m/s.

Wet flood proofing: includes permanent or contingent measures applied to a building that prevent or provide resistance to damage from flooding while allowing floodwaters to enter and leave the building.

1.8 Notation

The following letters and symbols have the following meanings:

G	permanent action (dead load) (AS/NZS1170.1
Q	imposed action (live load) (AS/NZS 1170.1)
F_l	flood action, resulting from the *DFE*
W_u	ultimate wind action (AS/NZS 1170.2)
Ψ_c	combination factor for imposed action (AS/NZS 1170.0)
D_e	equivalent surcharge depth in metres
C	shape factor
V	velocity of moving water in m/s
g	gravitational acceleration in m/s^2
Pa	Pascal
N	Newton
m	metre
s	second
kg	kilogram

1.9 Performance-Based Standards

The Standard is part of the NCC performance-based regime. Buildings to be constructed in *flood hazard areas* must be designed to comply with the NCC Performance Requirements in –

(a) BCA Volume One, BP1.4; or

(b) BCA Volume Two, P2.2.

The Performance Requirements lists various provisions that must be met during the design process.

The Performance Requirement enables the design of a building to be constructed in *flood hazard areas* to be developed from first principles to maximise its potential to meet specific occupant needs for a specific site.

1.10 Design Pathways

The Standard provides two pathways for compliance as follows:

(a) Compliance with Clauses 2.3 to 2.10 of this Standard.

(b) Formulating an Alternative Solution which complies with the NCC Performance Requirements. This involves the application of engineering practice from first principles in combination with appropriate design considerations as an alternative to the requirements of Clauses 2.3 to 2.10 of this Standard. An Alternative Solution requires designers to apply professional judgment on all design issues.

2 Basic Design Requirements

Limitations:

This standard only applies to-

(a) **Class 1, 2, 3, 9a health care and 9c buildings, and Class 4 parts of buildings; and**

(b) **areas that are not subject to landslip, mudslide, storm surge or coastal wave action.**

2.1 Compliance with this Standard

A Building Solution must comply with either –

(a) Clauses 2.3 to 2.10 of this Standard; or

(b) BCA Volume One, BP1.4 or BCA Volume Two, P2.2 as appropriate.

2.2 Application

(a) Clauses 2.3 to 2.10 of this Standard only apply to *flood hazard areas* where the maximum flow velocity is not greater than 1.5 m/s.

(b) Where the *appropriate authority* is not able to determine whether the maximum flow velocity is not greater than 1.5 m/s, the Deemed-to-Satisfy Provisions of this Standard can only apply to *inactive flow or backwater areas*.

2.3 Flood Actions

2.3.1 General

(a) Values of flood actions for use in design must be established that are appropriate for the type of structure or structural element, its intended use and exposure to flood action.

(b) The flood actions must include, but not limited to, the following as appropriate: *hydrostatic actions*, *hydrodynamic actions*, debris actions, wave actions, erosion and scour.

(c) The flood actions must be based on the *DFE*.

2.3.2 Hydrostatic Actions

(a) *Hydrostatic actions* caused by a depth of water to the level of the *DFL* must be applied to all surfaces, both above and below ground level. These actions include lateral pressures, and uplift pressures or buoyancy effects.

(b) Reduced uplift and lateral actions on surfaces of enclosed spaces below the *DFL* must apply only if provisions are made for entry and exit of flood water.

2.3.3 Hydrodynamic Actions

(a) Dynamic effects of moving water must be determined by a detailed analysis based on the principles of fluid mechanics.

(b) Where water velocities do not exceed 1.5 m/s, the hydrodynamic actions can be approximated into equivalent hydrostatic actions by increasing the *DFL* by an equivalent surcharge depth D_e, equal to

$$D_e = (C\ V^2)/2g$$

Where

V = velocity of moving water in m/s

g = gravitational acceleration (9.8 m/s^2)

C = shape factor (1.25)

(c) This surcharge depth must be added to the *DFL* and applied to the vertical projected area of the building or structure that is perpendicular and upflow to the flow. Surfaces parallel to the flow or downflow will be subjected to the *DFL* hydrostatic pressures only.

2.3.4 Debris Actions

Where required, impact actions caused by objects transported by flood waters striking against buildings and structures must be determined using engineering principles as concentrated loads acting horizontally at the most critical location at or below the *DFL*.

2.3.5 Wave Actions

Where required, wave actions caused by water waves propagating over the water and striking a building or other structure must be determined using engineering principles. Wave actions include wash and wind generated waves. The Standard does not cover coastal waves.

2.3.6 Erosion and Scour

The effects of erosion and scour must be included in the calculation of actions on building foundations and other structures *in flood hazard areas*. The Standard does not cover coastal erosion.

2.3.7 Combinations of Actions

In addition to the combinations specified in AS/NZS 1170.0, the following combinations must be considered for structures located in a *flood hazard area*-

(a) $[1.2G, \psi_c Q, Y_F F_l]$; and

(b) $[0.9G, 0.5W_u, Y_F F_l]$.

Where F_l represents the flood related actions for the *DFE*, including hydrostatic (including buoyancy), hydrodynamic, wave and debris actions as appropriate; and

Y_F is the flood load factor as given in Table 2.3.7.

Table 2.3.7

Defined Flood Event (DFE)	**Flood load factor Y_F**
DFE based on annual probability of exceedance of not more than-	
1:100	1.0
1:50	1.2
1:25	1.4
DFE based on maximum recorded flood with record length of not less than-	
100 years	1.1
50 years	1.3
25 years	1.5

2.4 Floor Height Requirements

Unless otherwise specified by the *appropriate authority-*

(a) the *finished floor level* of *habitable rooms* must be above the *FHL;* and .

(b) the *finished floor level* of enclosed non-*habitable rooms* must be no more than 1.0 m below the *DFL*.

2.5 Footing System Requirements

2.5.1 General

The footing system of a structure must provide the required support to prevent flotation, collapse or significant permanent movement resulting from the flood actions specified in Section 2.3.

2.5.2 Geotechnical Considerations

The footing system design must account for instability and decrease in structural capacity associated with soil properties when wet, erosion and scour, liquefaction, and subsidence resulting from the flood actions specified in Section 2.3, depending on the geotechnical characteristics of the site.

2.5.3 Footing System Depth

The footing system depth must be adequate to provide the support required in 2.5.1 taking into account the geotechnical considerations of 2.5.2.

2.5.4 Piers, Posts, Columns and Piles

Piers, posts, columns and piles used to elevate buildings to the required elevation must take account of-

(a) the potential erosion action due to flood; and

(b) the potential debris actions.

2.5.5 Use of Fill

Fill providing support to the footing system must be designed to maintain that support under conditions of flooding, including rapid rise and draw-down of flood waters, prolonged inundation, erosion and scour, without exceeding the maximum design differential movement of the footing system as specified in AS 2870 as appropriate.

2.5.6 Use of Slabs

Slabs must comply with the following-

(a) the slab must be installed on fill in accordance with 2.5.5, or on undisturbed soil of adequate bearing capacity; and

(b) the slab must have adequate strength to resist the design actions even if the supporting soil under the slab is undermined by erosion; and

(c) the bottom of the slab edge (usually the edge beam or edge footing) must be at or below the depth of expected scour.

2.6 Requirements for Enclosures Below the Flood Hazard Level (FHL)

Any enclosure below the *FHL* must have openings to allow for automatic entry and exit of floodwater for all floods up to the *FHL*.

2.7 Requirements for Structural Attachments

(a) Erosion control structures that are attached to the foundation or superstructure of the building must be structurally adequate and not reduce the structural capacity of the building during the *DFE*.

(b) Decks, patios, stairways, ramps and the like below the *FHL* that are attached to the building must be structurally adequate and not reduce the structural capacity of the building during the *DFE*.

2.8 Material Requirements

(a) Materials used for structural purposes and located below the *FHL* must be capable of resisting damage, deterioration, corrosion or decay taking into account the likely time the material would be in contact with flood water and the likely time it would take for the material to subsequently dry out.

(b) For the purposes of (a), materials used for structural purposes include loadbearing columns, bracing members, structural connections, fasteners, wall framing members and the like.

2.9 Requirements for Utilities

2.9.1 General

(a) Utilities and related equipment, other than an electrical meter for the building, must not be placed below the *FHL* unless they have been designed specifically to cope with flood water inundation.

(b) Buried systems must be placed at a depth sufficient to prevent damage due to scour and erosion during the *DFE*.

(c) Exposed systems must be designed to withstand the flood related actions (buoyancy, flow, debris and wave) as appropriate.

2.9.2 Electrical

Unless the electrical supply authority determines otherwise-

(a) Electrical switches must be placed above the *FHL*.

(b) Electrical conduits and cables installed below the *FHL* must be waterproofed or placed in waterproofed enclosures.

2.9.3 Mechanical and HVAC systems, tanks and the like

Ductwork, tanks, gas storage cylinders and the like shall be placed above the *FHL* or designed, constructed, installed and anchored to resist all flood-related actions and other actions during the *DFE* with appropriate load factors as given in 2.3.7. Potential buoyancy and other flood related actions on the empty tank during the *DFE* condition shall be considered.

2.10 Requirements for Egress

Egress from a balcony, verandah, deck, door, window or the like must be available to allow a person in the building to be rescued by emergency services personnel, if rescue during a flood event up to the *DFE* may be required.

2.11 Additional State or Territory requirements

State or Territory agencies may have a range of requirements for the location, construction and use of buildings to be constructed *in flood hazard areas*. It is also necessary to determine whether legislation requires –

(a) approval for construction; or

(b) conditions of approval: or

(c) limitations on use.

The ABCB Information Handbook presents an outline of requirements in each State and Territory.

3 References

Australian Building Codes Board, Information Handbook, *Construction of Buildings in Flood Hazard Areas*, www.abcb.gov.au, 2011.

Standards Australia/Standards New Zealand, 2002, *Structural design actions, Part 0 General principles*, Australia/New Zealand Standard AS/NZS 1170.0: 2002.

Standards Australia/Standards New Zealand, 2002, *Structural design actions, Part 1 Permanent, imposed and other actions*, Australia/New Zealand Standard AS/NZS 1170.1: 2002.

Standards Australia/Standards New Zealand, 2002, *Structural design actions, Part 2 Wind actions*, Australia/New Zealand Standard AS/NZS 1170.2: 2002.

4 Bibliography

AEM Series Document No. 19, Managing the Floodplain, www.ema.gov.au, 2009

AEM Series Document No. 20, Flood Preparedness, www.ema.gov.au, 2009

Agriculture and Resource Management Council of Australia and New Zealand, SCARM Report 73, *Floodplain Management in Australia: best practice principles and guidelines*, CSIRO, 2000.

Hawkesbury-Nepean Floodplain Management Steering Committee, 2006, *Reducing Vulnerability of Buildings to Flood Damage: Guidance on Building in Flood Prone Areas*, Parramatta, June 2006.