



*Draft for Consultation*

## **Cost benefit analysis**

**Proposed changes to Clause E2 of the New Zealand Building Code and Approved Documents B2/AS1, E2/AS1 & E2/VM1**

**Report to the Building Industry Authority**

**June 2003**



## Executive Summary

This document summarises the initial results from a cost benefit analysis of proposed changes relating to clauses B2 (relating to durability of framing timber) and E2 (resistance to external moisture) of the Building Code. Findings are guided by information gathered from previous reports and discussions with the BIA, BRANZ, and selected stakeholders in the timber supply and residential construction sectors. They are also heavily influenced by some key assumptions made in the modelling.

**This analysis should be viewed as interim only.** It will be finalised following a period of public consultation, taking into account any additional information received.

This summary:

- Provides the highlights of our indicative results in relation to the proposed changes; and
- Summarises the key impacts of the proposed changes on different stakeholder groups.

### Highlights of results

The cost benefit analysis, in spreadsheet form, generates year by year costs and benefits for each change or feasible combination of changes to the Code. These are set out in detail in the Section 7 of the report.

Main findings to date are:

- The estimated net effects in each year are small percentages of the value of construction in each year.
- They are very sensitive to assumptions about the projected 'base case' (construction and materials standards in the absence of the proposed changes), for example, the proportion of treated timber and the standard of treatment in framing, the projected incidence of failure; and the average cost of repair in the event of failure.
- Because the analysis only applies to the future new dwelling stock, costs are incurred year by year in proportion to new dwelling construction activity; benefits (reduced incidence and cost of failure) rise as the stock of new dwelling grows. Hence, the higher the discount rate used, the lower the net benefit estimated.

The discount rate used is 5%, reflecting the 'social time preference rate' deemed appropriate for analyses of this type.

Summary results, in aggregate form, are set out here.

All analyses were performed over a 25 year period assuming that a certain percentage of building stock would experience problems, the percentage depending on the combination of options for change in the requirements for B2 and E2 as proposed by BIA.

Over the 25 year period, some 500,000 dwellings are assumed to be built with an aggregate value of approximately NZ\$70 billion (in 2003 prices). Estimated benefits and disbenefits should be viewed in that context.

The first table shows the net present value of benefits (i.e. reduction in expected repair costs), comparing across code combinations. E2 + B2 Option 1 results in the highest figure, and E2 alone in the lowest figure, across the three scenarios.

The 'high case' scenario indicates a weathertightness failure rate for monolithic claddings of 5% per annum, which we regard as an extreme upper boundary.

**Table 1: NPV of benefits - over 25 year analysis period**

**Benefits**

NPV of benefits over entire period, discounted at 5%

\$ millions

*Medium scenario 1 failure rates are 20% of high case*

*Medium scenario 2 failure rates are 50% of high case*

	E2 Alone	E2 + B2 Option 1	E2 + B2 Option 2	B2 Option 1 only	B2 Option 2 only
High scenario	1,729	2,706	2,562	2,345	1,996
Medium scenario 1	346	541	512	469	399
Medium scenario 2	865	1,353	1,281	1,172	998

The next table shows the NPV of benefits less costs. With the exception of E2 alone, there is very little difference between the options.

**Table 2: NPV of benefits less costs - over 25 year period**

**Net benefits**

NPV of benefits less costs over entire period, discounted at 5%

\$ millions

*Medium scenario 1 failure rates are 20% of high case*

*Medium scenario 2 failure rates are 50% of high case*

	E2 Alone	E2 + B2 Option 1	E2 + B2 Option 2	B2 Option 1 only	B2 Option 2 only
High scenario	1,310	1,828	1,860	1,886	1,714
Medium scenario 1	-74	-337	-189	10	117
Medium scenario 2	445	475	579	714	716

The next table shows summary benefit:cost ratios using the same discount of 5%. All of the code changes generate significant B/C ratios, but in this case the E2 + B2 Option 1 figure is the lowest in all scenarios.

**Table 3: Benefit cost ratios – over 25 year period**

Benefit to cost ratios

NPV of benefits divided by NPV of costs over entire period, both discounted at 5%  
\$ millions*Medium scenario 1 failure rates are 20% of high case**Medium scenario 2 failure rates are 50% of high case*

	E2 Alone	E2 + B2 Option 1	E2 + B2 Option 2	B2 Option 1 only	B2 Option 2 only
High scenario	4.1	3.1	3.7	5.1	7.1
Medium scenario 1	0.8	0.6	0.7	1.0	1.4
Medium scenario 2	2.1	1.5	1.8	2.6	3.5

The message from these benefit cost ratios is that on the assumption used, increased use of treated timber alone (addressed by B2) is a relatively efficient way of achieving reduced cost of failure in dwellings, even though the initial cause of failure is often problems of weathertightness (addressed by E2). An important influence on these results, amongst others, is the assumption that in the event of a leak, repair costs with extensive use of treated timber framing to the standards proposed will drop to about 30% of costs that would result with untreated timber. And this applies to all cladding systems.

For further details refer Section 7 of the Report.

### *Impact on homeowners*

To a large extent the impacts of the proposed changes, both costs and benefits, are likely to ultimately fall on those individuals that purchase new dwellings

We would expect the incremental costs from the proposed changes to be passed through to consumers, in the form of an increase in new house prices. Based on our analysis, the impact on the cost of an 'average' new house would be in the order of \$4,000 to \$5,000 (see Table 4) depending on the cladding type.<sup>1</sup>

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<sup>1</sup> Incremental costs effects on brick veneer dwellings are significantly lower, because, for example they already include cavities.

**Table 4: Indicative impact on house construction cost**

Dollars

	Stand alone	Multi-unit apartment
E2 plus B2 Option 1	\$4,000 to \$5,000	\$2,000-\$2,500
E2 plus B2 Option 2	\$3,500 to \$4,000	\$1,800-\$2,300

Notes: (1) Estimates based on impact of preferred option on an exemplar house, construction cost \$170,000-\$180,000, and a multi-unit apartment costing about \$100,000 to build.  
 (2) Results are sensitive to key assumptions (see below)  
 (3) Brick veneer dwellings largely unaffected by E2.

Source: NZIER

The above estimates are indicative only. The actual incremental impact on dwelling construction costs may be lower or higher. For example, there is anecdotal evidence that some industry participants are changing their behaviour anyway in response to the weathertightness issue. For example we understand some councils are requiring treated timber and/or wall cavities in new dwellings. Although it is not possible to assess the extent or permanence of such changes, they may reduce the incremental effect of the proposed changes to B2 and E2.

In return for this additional cost, new house purchasers would benefit from a reduced risk of weathertightness problems and thus:

- **Reduced financial risk:** The financial cost (repair cost and impact on property value) of damage from leaks and fungal decay can be high.
- **Reduced health risks:** Weathertightness problems can lead to particular types of rot, such as *stachybotris chartrum*, that can damage the health of the dwelling's occupants. (Refer Table 6).
- **Reduced stress / enhanced 'peace of mind':** For many people, their house is their most valuable asset. The discovery of weathertightness problems, and the financial, health and 'quality of life' implications this can have, can cause significant stress for affected house owners.

**No attempt has been made in this analysis to quantify and value any of these benefit categories, except the repair costs.**

The impact of the proposed changes is analogous to the impact of house insurance. House owners pay a premium in return for a reduction in the financial harm they would experience should some (uncertain) event, such as a house fire, occur. Most homeowners pay the premium – only a proportion 'benefit' in the sense of actual compensation i.e. those that have to claim. The main difference is that buying insurance is voluntary, but the

proposed changes in the building code would to some extent be ‘imposed’ on owners of new dwellings.

### *Aggregate impact*

Relative to the overall value of construction activity over the period in question the costs and benefits and the net effects are not large. However, within that overall picture there are concentrations of costs and benefits.

### Costs

In addition to the monetised costs, the changes may have the following, unquantified impacts:

- ***Environmental impacts:*** The proposed B2 changes may impose some incremental environmental impact, due to solvent emissions and the release of preservative chemicals. The magnitude of this impact will depend on the extent to which environmental regulation at the local government level, and businesses’ internal processes, are effective in mitigating the environmental effects from an increase in timber treatment. These will impose some costs on timber producers and the distribution chain which will be passed through into construction costs.
- ***Health impacts:*** Employees may suffer negative health effects from increased exposure to solvent and preservatives. This effect may ‘spillover’ to the wider community through costs to the public health system and reduced productivity. Again, the magnitude of this impact will depend on the effectiveness of business processes and occupational safety and health regulation in addressing this risk.
- ***Douglas Fir:*** Suppliers of Douglas Fir will experience reduced demand for their product. Douglas Fir will need to be diverted to alternative, potentially lower value, uses. We would expect this to reduce the value of existing investments in Douglas Fir plantations.
- ***Export impacts:*** Some timber suppliers claim that future exports of untreated kiln dried *Pinus radiata* to developing markets may be compromised by the proposed changes, as they would undermine confidence in this timber.

We do not envisage E2 having significant effects in these categories.

**No attempt has been made in this analysis to quantify and monetise these costs.**

### Benefits

The aggregate benefit from the proposed changes is the total value of the resulting reduction in risk to new house purchasers. It is difficult to quantify the size of this benefit, as:

- Good data on the probability of problems occurring under the *status quo* are not available;

- There is better data, based on recent experience, on the expected cost of repair, where problems do occur. There is still uncertainty about the representative range; and
- Some elements of the benefit, such as the value of 'peace of mind', depend on individuals' own preferences and priorities.

**Table 5: Impact of preferred options on stakeholders**

Stakeholder group	Proposed B2 changes	Proposed E2 changes
Timber suppliers	<p>Some increase in production cost, storage, handling and compliance costs, but these would be passed on in prices.</p> <p>Substitution away from Douglas Fir to other timbers for wall framing would reduce volumes and revenues for Douglas Fir suppliers. (Primarily a transfer between market participants; the cost to the economy is likely to be negligible.)</p> <p>Possibly some reduction in future export revenues (?)</p>	Not applicable
Timber treatment suppliers	Increased sales. No/negligible cost impact (increase in production costs would be passed on in prices).	Not applicable
Frame and truss manufacturers	Possibly some increase in indirect / compliance costs, but these would be passed on in prices.	Not applicable
Timber merchants	Net cost impact negligible. Some increase in storage, handling and compliance costs, but these would be passed on in prices.	Not applicable

Cladding suppliers	Not applicable	Possibly some substitution away from remaining proprietary cladding systems to systems covered by the new Acceptable Solution. (Primarily a transfer between market participants; the cost to the economy is likely to be negligible.)
Designers / Architects	Net cost impact negligible. (Possibly some increase in compliance costs, but not likely to be substantial, and in any case likely to be passed on to house purchasers.)	Net cost impact negligible. Some increase in compliance costs (expected to be passed on to house purchasers)
Construction firms / Builders	Net cost impact negligible. Some increase in storage, handling and compliance costs, but these would be passed on to house purchasers.	Net cost impact negligible. Additional cost of wall cavities would be passed on to house purchasers. Some increase in compliance costs (expected to be passed on to house purchasers)
Local government	Net cost impact negligible. Possibly some increase in costs from processing alternative solutions, likely to be recovered in fees (and ultimately borne by house purchasers). Possibly some increase in cost of administering discharge consents (Regional Councils) and land use consents (TAs), but likely to be negligible (and recovered through fees).	Net cost impact negligible. Some increase in cost of processing building consents / alternative solutions, likely to be recovered in fees (and ultimately borne by house purchasers).
House purchasers	Increase in the cost of a new house (small relative to total house cost)  Reduced risk of structural damage from leaks	Increase in the cost of a new house (small relative to total house cost)  Reduced risk of weathertightness problems, and associated structural damage / health impacts

Employees	Some increased risk of health impacts from contact with solvents and preservatives (primarily employees of timber treatment suppliers, possibly employees further downstream).	Not applicable
Wider community	Some incremental environmental damage possible. Spillover impacts possible if employees' health affected.	Not applicable

Notes: (1) These results are indicative only, and are subject to reassessment following public consultation.

Source: NZIER

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# 1. Introduction

The Building Industry Authority (BIA) is proposing changes to:

- B2/AS, the Acceptable Solution for meeting Clause B2 Durability of the New Zealand Building Code (NZBC) relating to durability of timber framing in residential dwellings;
- Clause E2 External Moisture of the NZBC, relating to external moisture; and
- Approved Documents associated with Clause E2 External Moisture, namely Approved Documents Verification Method E2/VM1 and Acceptable Solution E2/AS1

As part of its process, the BIA sought input from NZIER on the economic impacts of the above proposals. This input includes an economic cost benefit analysis (CBA) of the proposed changes and other options, relative to the status quo.

This draft report sets out the initial results of our cost benefit analysis. This is based on information gathered from previous reports and discussions with the BIA, BRANZ, and selected stakeholders in the timber supply and residential construction sectors.

*This analysis should be viewed as interim only.* Our analysis will be finalised taking into account any additional information received during the course of public consultation on the BIA's proposed changes. We have included questions throughout this document to highlight particular areas in which we are seeking further input. These questions are summarised for convenient reference in Appendix A.

The BIA has prepared draft Regulatory Impact Statements as separate documents, drawing on the analysis in this report. Those documents have been published along with the BIA's discussion documents.

## 1.1 Background

The Building Act framework contains a number of mechanisms to manage the risks discussed above. These include:

- **Building Code:** The New Zealand Building Code, which is monitored by the BIA and administered by territorial authorities (TAs), sets minimum requirements for New Zealand buildings based on keeping the occupants safe and healthy. Buildings must have an acceptably low risk of structural collapse over their intended life being not less than 50 years (apart from specific short life situations). The Clauses of the Building Code with which we are concerned here cover durability (Clause B2 Durability) and the entry of moisture from external sources (Clause E2 External moisture).
- **Building Code Approved Documents:** The Building Code is supported by a range of Approved Documents developed by the BIA to assist compliance with the required standards. Acceptable Solutions set out design solutions which people can use to comply with the Building Code. Verification Methods provide calculations / tests that can be used to demonstrate compliance with the Building Code.

- ***Building consent / certification process:*** Day-to-day compliance with the Building Code is administered by territorial authorities (TAs). Building consents from the local TA are required for new buildings and for alterations to existing buildings. The consent process is intended to confirm that proposed buildings will satisfy code provisions. This includes reviews of building designs, proposed components and on-site inspections of the construction process at key intervals. Building certifiers are approved by the BIA. Building certifiers are the private-sector equivalent of territorial authorities in respect of ensuring compliance with the New Zealand Building Code.

An increasing number of reports emerged in the late 1990s of leaks and subsequent rotting of timber framing in relatively new houses. These reports often involved houses of less than ten years of age with so-called 'monolithic' cladding systems.<sup>1</sup> The extent of damage in relatively new houses, and the cost of repairs have in some cases been very substantial. In response to 'weathertightness' concerns, the BIA commissioned an independent investigation into the weathertightness problem in 2002. The report of this investigation (commonly known as the Hunn Report) found that the weathertightness problem was systemic and that a wide range of factors contributed to the failures, including:

- Standards of design and construction that were set at the minimum necessary to achieve Code compliance, and thus provided no margin for error in the event that either design or construction was inadequate;
- Variable performance by those involved in design and construction, often reflecting a lack of information and capability;
- Inadequate review of consent applications and inspections of building work, which meant that specific problems were not identified and rectified;
- Inadequate monitoring of the building control system by the BIA, which meant that the systemic problems were not identified until the weathertightness problem arose.

The Hunn report called for issues of weathertightness to be addressed, and made recommendations addressing a range of areas. These recommendations included revising the Approved Documents to include more details on how to achieve weathertightness.

The Government Administration Committee subsequently held an inquiry into weathertightness and produced a wide range of recommendations - many similar to those in the Hunn report. A common underlying theme in both reports was for more consumer protection and increased robustness in buildings.

Changes are being made across the building industry in response to weathertightness concerns. These include recently announced changes to the Building Act. The specific changes addressed in this report are concerned with Clauses B2 Durability and E2 Weathertightness of the NZBC (see Section 4 for a summary of the key features of the options).

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<sup>1</sup> 'Monolithic' cladding systems are those utilising sheet material with an applied coating to give the appearance of a seamless cladding, often imitating concrete or masonry.

## **1.2 Reducing risk to house purchasers**

In general, we expect that the impacts of the proposed changes, in terms of both costs and benefits, would fall largely on purchasers of new houses. On the cost side, we would expect increases in production costs resulting from the changes to be passed through in prices, and ultimately to result in an increase in the cost of a new home. At the same time, the proposed changes should reduce the magnitude of risk faced by house purchasers.

The proposed changes can be viewed as essentially analogous to involuntary house insurance. New home owners would face a small increase in costs upfront, and but in return both the likelihood and the potential extent of damage from leaks and fungal decay will be reduced.

At first sight it is not obvious why insurance should be provided by government intervention in this case, but not with respect to general risks and losses from home ownership. The rationale is based on information asymmetries – consumers (purchasers of houses or apartments) are not able to judge the quality of construction, so some imposition of standards can be socially beneficial in reducing the likelihood of building failure, claims and disputes.

We discuss the risk context in Section 3.1, and impacts of the proposed changes on the purchaser of a typical new house in Section 5.

## **1.3 Outline of this report**

The remainder of this document is structured as follows. In the next section we outline our conceptual framework, based on principles of risk management, and outline our methodology for assessing the costs and benefits of proposed changes. We then go on to briefly discuss the nature and extent of the problem being addressed in Section 3. In Section 4 we summarise the key features of the status quo and of the options under consideration. We then go on to identify the impacts of proposed changes, relative to the status quo. In Section 5 we examine the impacts on the purchaser of a typical new house. In Section 6 we look at the nature and incidence of the impacts in more detail - who will bear the immediate impacts of the proposed changes and to what extent will they be passed through to final consumers? Finally, in Section 7 we present our quantitative analysis of the proposals.

## 2. Approach

### 2.1 Cost benefit analysis

We outline our methodology in this sub-section. In summary cost benefit analysis involves estimating and, to the extent possible, quantifying the costs and the benefits of a proposal relative to an assumed 'base case'. This enables us to estimate the net cost (or net benefit) of the proposal. Where more than one option is being evaluated (as in this case), CBA allows us to assess their relative merits to determine which option is preferred.

The basic question here is whether the addition to timber treatment, handling, and distribution costs, which flows into construction costs nationally, following implementation of the new code, would be offset by the benefit in terms of future building damage avoided/deferred, and maybe other benefits (e.g. health).

Drawing on the conceptual framework outlined above, our cost benefit analysis assesses:

- The monetary and other costs of the changes with respect to B2 and E2; and
- The benefit from the reduction in the risk of mould and fungal growth, and therefore the reduced risk of structural failure and negative health outcomes.

CBA involves the following basic steps:

1. Identifying relevant impacts (e.g. on costs of framing timber production, construction costs, building performance) relative to a realistic 'base case' (i.e. the setting in the absence of the proposed changes to the Code.)
2. Quantifying impacts (e.g. the number of dwelling affected by the change)
3. Monetising impacts (based on the projected value of dwelling construction activity; benefits in terms of costs avoided through better performance of new buildings)
4. Discounting for time and risk
5. Choosing among alternatives.

The analytical challenges arise in the detail, in particular in this context:

1. Assumptions made about industry responses to the change in standards for timber.
2. Other changes in building practice as a result of heightened awareness of past or potential problems, and their implication for performance.
3. Secondary market effects via changes in consumer demand patterns, partly influenced through increased product awareness.
4. Other effects on supplier industries e.g. timber production and export, manufacturers of prefabricated framing.

These aspects are discussed below.

### **2.1.1 Industry response**

If a *mandatory code* were contemplated then it would be adopted in all new dwelling construction, and this would simplify the CBA to a degree. It would be reasonable, in that case, to assume a fair degree of uniformity of effects across all new dwelling. The new standard *may* be adopted as a rule, although legally it will not be mandatory.

In practice, TAs have considerable discretion as to building standards in their jurisdictions, so there could be considerable divergence across New Zealand in the extent to which, and how, the new standard is reflected in building practice. Construction industry assessment of compliance costs and options will be the primary influence.

For example, some larger construction firms may have the scale to adopt changes in building design or practices, which precludes the need for them to use the more durable timber, or at least limits the range of uses. But for small construction businesses, the lowest cost of compliance may be achieved by simply treating the new standard as mandatory, and passing on increased costs to customers.

### **2.1.2 Building practice**

The weathertightness issue has been attributed to a combination of factors including:

- Building design trends
- Lack of consumer awareness of risks inherent in some practices
- New materials including cladding systems
- Timber treatment standards
- Inadequate skills/knowledge in some parts of the construction sector and unsatisfactory practices
- Ineffective certification procedures.

The government, industry, and consumers have already reacted to this and these reactions will be on-going although perhaps to a falling magnitude as time goes on.

This has a bearing on the 'base case' that we assume in terms of the performance of dwelling structures hereon, and on the degree to which improved performance (the benefit of this intervention) is attributable to the performance standard of framing timber alone. For example, we may be in a transition phase in which a combination of changed behaviour in the construction industry, TAs and certifiers, is raising the general standard of construction and reducing the risk of failures.

### **2.1.3 Secondary market effects**

Raising standards (and costs) as contemplated here could have several market effects in addition to those already set in train by the weathertightness issue. The magnitude of these effects will depend on the (estimated) additional costs resulting from the standard but would include:

- Some effect on the rate of new construction or refurbishment

- Changes in building practice e.g. towards non-timber framing systems or other approaches which reduce the cost impost of higher framing timber standards.

The standards may have some effect on the resale value of dwellings built to the new code, relative to comparable dwellings built under the existing code. But we would see these asset value effects as being minor (relative to value changes that have occurred as a result of building failures and associated publicity in the last year), and with no overall efficiency effects i.e. this is a transfer amongst successive owners of the various building cohorts.

#### **2.1.4 Effects on suppliers**

If adopted, the proposed changes could have serious implications for the timber production industry, offsite fabricators of framing, and on local competitors. Effects on the timber industry would include:

- Requirements for more costly production methods including (under the option to treat only external wall framing and bottom plates) an increased product range and short production runs
- Adverse effects in export markets on perceptions of untreated New Zealand timber, and on the competitiveness of timber as a framing material .

These have potential implications for profits of the timber and related industries, depending on the extent to which higher production costs can be passed through to final consumers.

#### **2.1.5 Key questions for analysis**

For both the proposed B2 and E2 changes, the crucial economic issues are how will the proposals affect the cost and hence use of the building materials and practices affected by the change; and what effect will this have on likelihood of building failure? Questions that need to be addressed are:

- How significant is the cost impost on timber resulting from the changes?
- How are these additional costs passed on to builders and consumers? Welfare theory leads us to expect that if the demand is inelastic (as is often the case for derived demands for intermediate inputs) all the cost will be borne by timber users i.e. ultimately home-owners, but if there is elastic demand suppliers bear part of the imposition because demand drops through substitution to other products.
- What are the substitution possibilities that might arise in materials use or building practices as a result of the proposed changes?
- Allowing for market responses to the leaky building crisis, and likely responses to the changes in the code, what is the proportion of new buildings receiving protection from the proposed code changes?

#### **2.1.6 Timespan for analysis**

We are concerned here with the performance of fixed assets (i.e. dwellings) that are designed to last 50 years or more. Theoretically, the CBA could reach out that far. But given the difficulties in projecting the relevant data, and the effect of discounting on the later part of such a long period, and the probability that buildings are renewed or

substantially altered for functional reasons within their technical life-span, it is impractical to take such a long timeframe. We have limited the CBA to 25 years i.e. 2003 to 2028.

### 3. Problem definition

The weathertightness problem is essentially about the management of risk, in this case the risks associated with leaks in residential buildings. In this section we discuss problems of risk management in general terms, discuss the nature of the specific risks that the proposals assessed in this report seek to address and review the available data on the size of the problem. We then go on to identify specific factors and trends that appear to be contributing to the problem.

#### 3.1 General principles of risk management

People face and deal with risks in all their daily activities.<sup>2</sup> Often individuals are best placed to manage the risks that affect them, as each individual places a different value on the costs, risks and benefits of their actions. However, this may not always be the case, for example in the presence of:

- **Information problems** – where consumers may not have sufficient information or knowledge to assess the nature and magnitude of risks associated with a particular building, due to factors such as the design and type of building components used, or to assess the skills of builders.
- **Spillovers** - where individuals are affected by a transaction to which they are not a party. For example, if the incidence of buildings with weathertightness problems affected the value of the wider housing stock (including houses with no such problems), this would be an externality. Conversely, if a potential home-owner chooses to reduce the risk of substantial rot in their home by using timber treated to a high standard, they may not take into account the cost of adverse environmental impacts associated with the treatment process. To the extent that such ‘spillover’ effects are not taken into account in decisions made by individuals, the outcome may not be in the overall interest of society as a whole.

Where risk exists the question is not whether all risks should be completely eliminated, but what level of risk individuals are willing to accept given the cost of risk mitigation, and whether individuals are able to make those trade-offs themselves. Efficient risk management means that the response is proportionate to the magnitude of that risk (as distinct from risk minimisation). If the cost of reducing an identified risk is too high (i.e. greater than the value of the risk reduction), the social outcome may be worse than if there was no intervention.

#### 3.2 Risk and weathertightness

Weathertightness concerns relate to the potential for decay of timber in the presence of water from leaks through the external envelope of buildings. Where mould and decay occur on timber framing, insulation, and/or interior linings and fittings this not only raises concerns about the integrity of the structure but can also cause health problems for occupants.

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<sup>2</sup> Risk is the probability of an event occurring multiplied by the impact of the event.

Leaks in buildings are not new. Concern over the weathertightness of buildings has been heightened in recent times for two main reasons. There is an apparent recent trend for weathertightness problems to occur in relatively new houses (e.g. 1-5 years old). Where such problems have occurred, the extent of the resultant damage has in some cases been severe.

Weathertightness is not the same as 'waterproof'. The concept of weathertightness incorporates the objective of keeping liquid water out, but also accepts that most buildings will leak at some point during their lives. Weathertightness therefore requires mechanisms to manage the risk of damage should a leak occur, for example through:

- The use of water management principles to reduce the severity of any leaks that occur, by allowing any moisture that may penetrate the wall cladding to escape; and
- Treating timber to reduce the extent of damage should it become wet for any sustained period.

Ultimately, weathertightness in buildings addresses two sets of risk:

- Risks to the structural integrity of the dwelling from mould and fungal growth; and
- Risks to the health / amenity of the dwelling's occupants from dampness or from particular types of rot, such as such as *stachybotris chartrum*.

Figure 1 (on page 11) provides a simplified illustration of these risks, and the various factors that influence them. The risk that a given building will suffer structural failure is affected by the risk of mould and fungal growth, as well as other risk factors (such as the possibility of insect infestations). The risk of mould and fungal growth is in turn affected by:

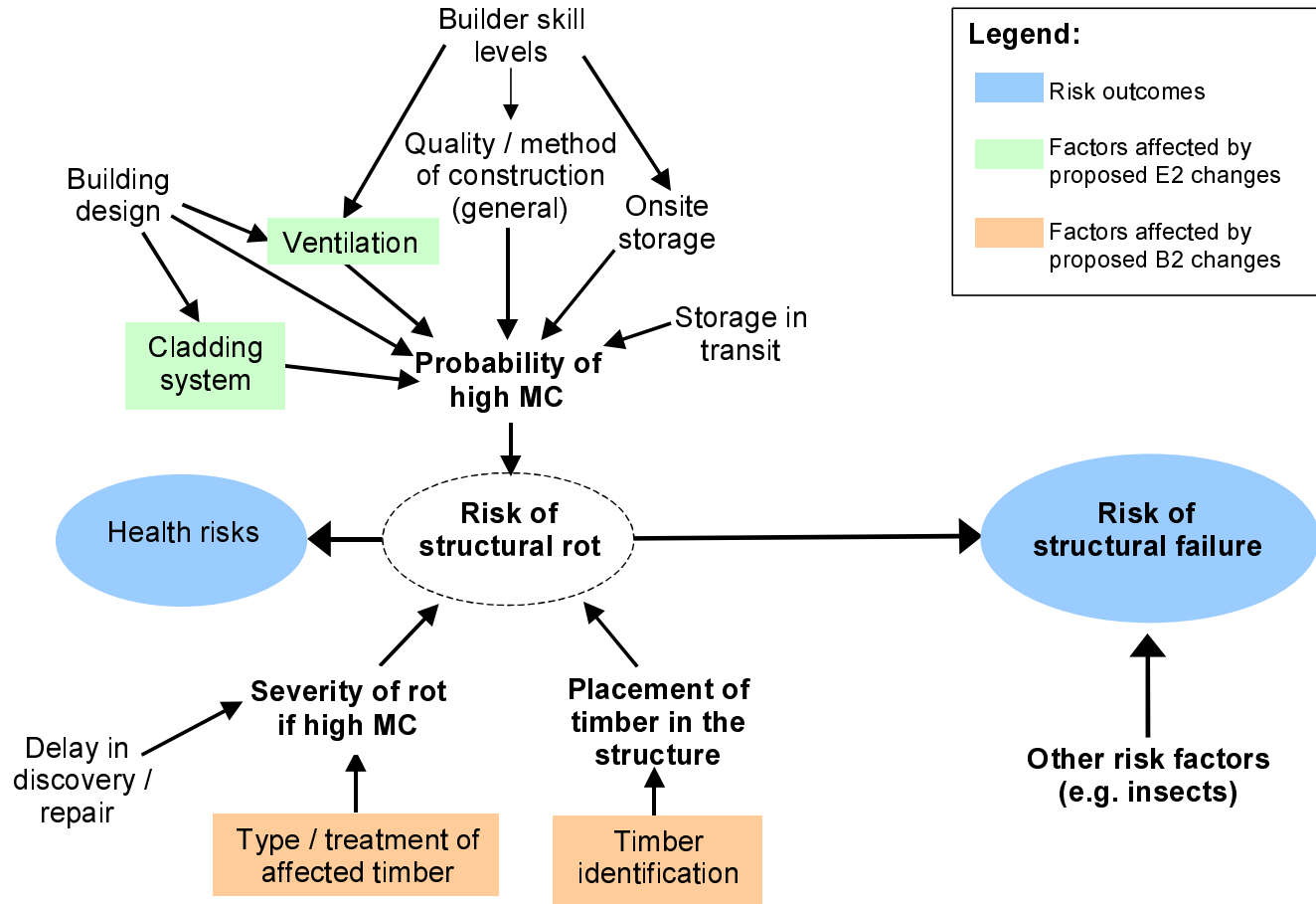
- The probability of a high moisture content (MC) occurring. (We define a 'high' MC as being a MC greater than 30 percent for a sustained period, as this is the level of MC that will generally trigger rot in untreated kiln dried *Pinus radiata*); and
- The extent of rot that will occur given a high MC. This is determined by the type of timber used (including whether it has been treated and to what standard), and the length of any delay before the damage is discovered and repaired.

As Figure 1 shows, both of these factors are affected by the various inputs to the construction of a new dwelling. Residential dwellings are produced from a multitude of inputs (products and services). On the services side, a range of distinct specialist trades people may be involved in a single building project, such as designers/architects, engineers, draughtspeople and builders. On the products side, the final building comprises a number of components including timber frames and trusses, cladding, guttering and drainage, window frames and so on. The quality of the final product, including whether it is weathertight, is not just determined by the quality of the individual components, but by whether the right combination of components is used and the way in which they are assembled.

This degree of complexity gives rise to a clear information problem. In the case of new houses (with which we are concerned here) consumers generally do not have the knowledge or expertise to be able to determine the quality of a given building design or of the various inputs that go into the building. As a result, consumers are generally not

well placed to be able to judge whether a new house is likely to be weathertight or not. In the case of mould and fungal growth in dwellings, this risk is magnified by the fact that wall framing is hidden, and there may be a significant delay before a rot problem is discovered and repaired (by which time the damage may be severe).

**Figure 1: Building Risk Factors and Proposed Changes**



Source: NZIER

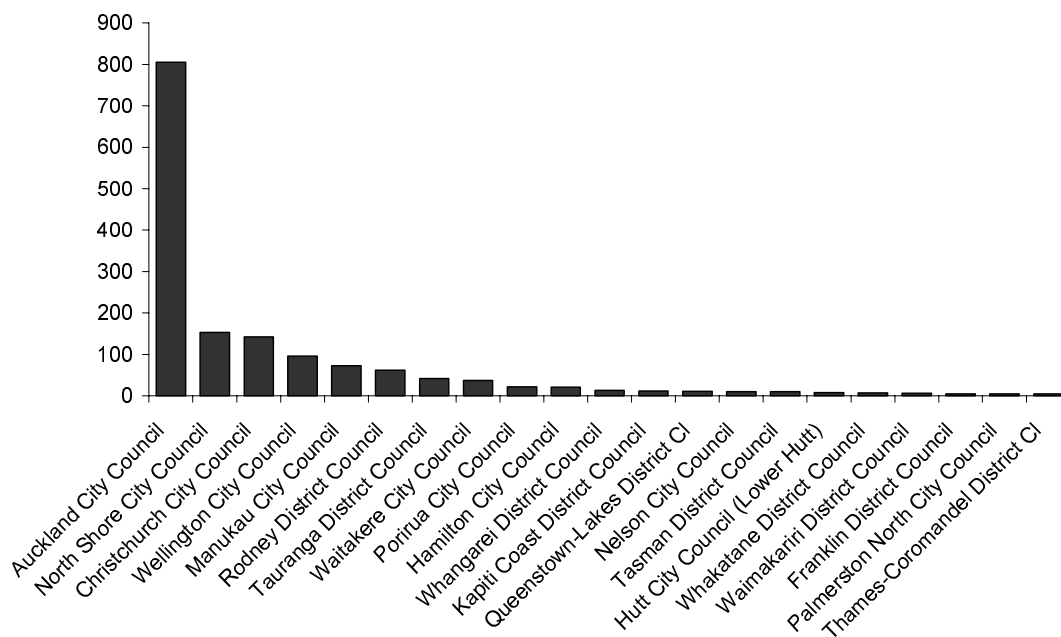
### 3.3 Size of the problem

The number of buildings suffering from weathertightness problems is not clearly known. Estimates of the total number of dwellings affected range from a small number say several hundred to perhaps 20,000. Estimates from industry sources of the potential costs incurred by New Zealand from potential repairs to leaking buildings range from tens of millions to \$3-4 billion.

Anecdotal information is available in relation to cases that have been publicly notified, and where dwelling owners have made applications for dispute resolution under the newly established Weathertight Homes Resolution Service. However, the actual number of dwellings affected may be considerably larger. Rot and fungal decay due to weathertightness problems is often hidden from sight, in the wall framing. Therefore it is possible that many more cases of substantial damage exist but have not yet been discovered. Further, home owners may decide not to apply for dispute resolution to avoid publicity (and the possibility of a negative impact on the value of their house).

Applications received to date by the Weathertight Homes Resolution Service cover a total of 1599 dwellings.<sup>1</sup> Figure 2 shows the distribution of problems by local authority area.

**Figure 2: Dwellings by TA**



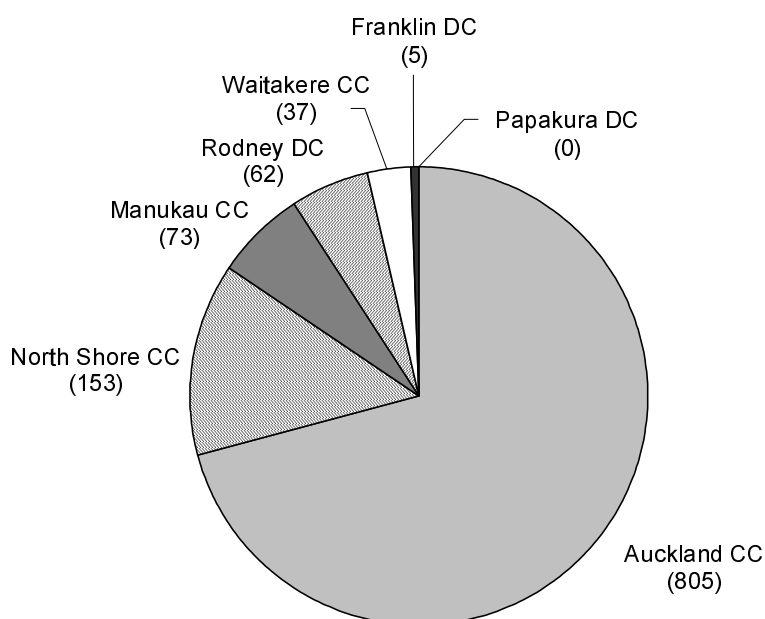
Source: [www.weathertightness.govt.nz](http://www.weathertightness.govt.nz)

By far the majority of dwellings affected by weathertightness problems are located in the Auckland region. 1,135 dwellings covered by applications to the dispute resolution

<sup>1</sup> Source: [www.weathertightness.govt.nz](http://www.weathertightness.govt.nz), updated as at 22 May 2003.

service (or 71% of the total) are in or around Auckland. Figure 3 shows the number of dwellings with weathertightness problems in the Auckland region, broken down by TA.

**Figure 3: Dwellings in the Auckland region by TA**



Source: [www.weathertightness.govt.nz](http://www.weathertightness.govt.nz)

### 3.4 Contributing factors

The recent increase in the incidence of severe weathertightness problems has been attributed to a range of systemic failures. The proposals we are concerned with here deal with a subset of these factors, specifically with cladding systems and timber treatment. The specific problems that have been identified in these areas are:

- With respect to **wall cladding**:
  - Changes in the use of wall cladding systems. In particular, there has been a substantial increase in the use of ‘monolithic’ cladding systems such as fibre cement and EIFS (coated polystyrene). According to BRANZ, monolithic cladding systems are used in almost 50 percent of new stand alone dwellings and 36 percent of multi-units.<sup>2</sup> Based on available data, monolithic cladding systems are strongly associated with weathertightness problems.
  - The current acceptable solution E2/AS1 only covers brick veneer, stucco and weatherboard systems. These are used in 52 percent of new stand-alone dwellings and a third of new multi-units.<sup>3</sup> The Acceptable Solution does not cover fibre cement and EIFS cladding solutions.
  - This is combined with trends over the past ten years or so towards building designs that do not effectively manage water (e.g. designs with inadequate or no

<sup>2</sup> Source: BRANZ building materials survey, five year average over the period 1998-2002.

<sup>3</sup> Ibid.

eaves, little or no ventilation, and so on), and more complex designs which further increase the probability of weathertightness problems.

- With respect to timber durability (particularly in relation to wall framing):
  - The increased incidence of weathertightness problems, due in part to the changes described above, has meant that in affected dwellings timber framing has been subjected to high moisture content for sustained periods of time.
  - While any timber will rot if wet for long enough, the extent of damage, and time the rot or fungal decay takes to develop, vary depending on the type and treatment of the timber (see Table 6 below). [ Question marks signify that the percentage shown are ‘guesstimates’ only.]

**Table 6: Estimated risk of damage and timber/treatment**

<b>Timber/treatment</b>	<b>Wet for 4 weeks then maintained 25-28% MC</b>	<b>Maintained at 30-40% MC</b>	<b>Maintained at +40% MC</b>
Untreated KD <i>Pinus radiata</i>	Probability of brown rots starting and continuing 80%? Potential for extensive decay over 1-2 years	Probability of brown and wet rots starting and continuing 95%? Potential for extensive decay over 0.5-2 years	Probability of wet rots and soft rots starting and continuing 100%? Potential for extensive decay over 0.5-2 years
Douglas fir	Probability of brown rots starting and continuing 20%? Potential for moderate decay over 1-2 years	Probability of wet rots starting and continuing 75%? Potential for extensive decay over 1-2 years	Probability of wet rots and soft rots starting and continuing 90%? Potential for extensive decay over 1-2 years
H1.1 Boron	Probability of brown rots starting and continuing 10%? Limited decay over 3 years. But localized to affected areas.	Probability of wet rots starting and continuing 40%? Potential for moderate decay over 3 years	Probability of wet rots and soft rots starting and continuing 50%? Potential for extensive decay over 5 years
H1.1 LOSP	Probability of brown rots starting and continuing 50%? Potential for extensive decay over 1-2 years	Probability of wet rots starting and continuing 90%? Potential for extensive decay over 1-2 years	Probability of wet rots and soft rots starting and continuing 100%? Potential for extensive decay over 1-2 years
H1.2 Boron	Probability of brown rots starting and continuing 5%  Limited decay over 5 years but very localised	Probability of wet rots starting and continuing 10%? Potential for moderate decay over 5 years  but very localised	Probability of wet rots and soft rots starting and continuing 50%? Potential for moderate decay over 5 years but very localised
H1.2 LOSP	Probability of brown rots starting and continuing 5%? Limited decay over 3 years.	Probability of wet rots starting and continuing 10%? Potential for moderate decay over 3 years	Probability of wet rots and soft rots starting and continuing 65%? Potential for moderate decay over 5 years
H3.1 (TBTO or TBTN)	Probability of brown rots starting and continuing 0%?	Probability of wet rots starting and continuing 7.5%? Potential for moderate decay over 5 years	Probability of wet rots and soft rots starting and continuing 25%? Potential for moderate decay over 5 years
H3.2 (CCA, ACQ, CuAz, CuN)	Probability of brown rots starting and continuing 0%?	Probability of wet rots starting and continuing 3%? Potential for minor decay over 5 years	Probability of wet rots and soft rots starting and continuing 10%? Potential for limited decay over 5 years

Source: BIA

- Kiln dried untreated *Pinus radiata* has been used extensively in residential construction since the mid-1990s. Kiln dried untreated *Pinus radiata* was incorporated into the New Zealand Standard NZS3602 as acceptable for wall framing in areas where the moisture content would be retained at no greater than 18 percent. In 1998, the Acceptable Solution for Clause B2 (Durability) was amended to accept kiln dried untreated *Pinus radiata* in residential wall frames on the same basis. In those cases where extensive rotting of untreated *Pinus radiata* wall framing has occurred, the moisture content of the timber has generally been substantially greater than 18 percent for sustained periods.
- As untreated *Pinus radiata* has no fungicidal protection, once rot and fungicidal decay has occurred the probability of repeat problems is relatively high even following repair.
- Often problems have been left undetected for some time, further magnifying the severity of the damage.

## 4. Options

In this section we briefly summarise the status quo with respect to B2 Durability (timber treatment and timber identification) and E2 External Moisture (wall cladding). Our analysis considers the status quo and the BIA's preferred options, and other options canvassed in the BIA's consultation documents. (See the *Glossary of terms* in Appendix B for a description of the technical terms used in this section.)

### 4.1 The status quo

#### 4.1.1 B2 Durability

##### a) Timber treatment

There are several levels of timber treatment currently available in New Zealand to deal with varying situations of exposure to moisture. Principally these are:

- Untreated - chemical-free and kiln dried
- H1 Treatment – to achieve resistance to insect attack only, although some formulations provide some resistance to fungal growth and decay. (The level of chemicals required for this has decreased over the years for various reasons)
- H3 Treatment – protected from insect attack, and from decay when exposed to moisture.
- H4 and H5 Treatment – protected from insect attack, and from decay when exposed to moisture and ground contact
- H6 Treatment – protected from insect attack and from decay when exposed to marine conditions

Within some classes of treatment there are now alternative treatment methods and chemicals that achieve different levels of resistance to decay. The current treatment grades do not recognise this.

The level of treatment expected for key building components, to achieve compliance with the NZBC, is set out in the Acceptable Solution, B2/AS1, by reference to the relevant New Zealand Standard. The Acceptable Solution provides for the following:<sup>4</sup>

- Wall framing when kept at 20% moisture content or less is to be H1 treated Radiata and Corsican pine, H1 treated sapwood Rimu, H1 treated sapwood Matai; untreated heart Rimu and heart Matai, Douglas fir and Larch.
- Wall framing when kept at less than 18% moisture content, may be untreated kiln dried and planer gauged Pinus radiata

Under the status quo, untreated kiln dried timber is, in many cases, being used in situations where actual moisture content is much higher than the required minimum (e.g. in exterior walls and balconies where there is a likelihood of cladding systems failing and leaks occurring). This has led to extensive fungal decay problems in some

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<sup>4</sup> As discussed in Section 1.1, the Acceptable Solution is not mandatory, but rather provides a benchmark for what is required in order to comply with the relevant part of the NZBC.

cases. This makes the status quo unacceptable, as it fails to achieve compliance with the standard of durability required under the NZBC.

#### ***b) Timber identification***

Treated timber must be branded with the plant number or trade name of the plant responsible for the preservative treatment and the hazard class. This brand must be placed on one end of each piece, on a broad face 150 millimetres from an end, or repeatedly along one face at regular intervals (the last approach is currently not used very often).

In practice, branded information is often lost, for example when squaring off the ends or cutting timber to length, making it difficult to identify the type and treatment of timber on site. This has led to timber being used in applications not suited to its treatment level.

### **4.1.2 E2 External Moisture**

The current NZBC Clause E2.3 requires that buildings be constructed to avoid the entry and accumulation of water that could cause damage to the structure. An Acceptable Solution and Verification Method are available to assist industry in establishing compliance where the parties do not wish to pursue an alternative solution. The current Acceptable Solution provides for the following cladding solutions:

- Brick veneer (with cavities);
- Stucco; and
- Weatherboard.

As a result of increasing reliance on proprietary cladding solutions over recent years, particularly monolithic solutions such as fibre cement and polystyrene systems, the systems covered by the current Acceptable Solution account for approximately 55 percent [check] of new buildings. In theory, compliance with the NZBC with respect to all other new dwellings is provided through the Alternative Solution process. However, in practice, this has not provided for effective compliance in many cases. The evidence suggests a relatively high incidence of weathertightness problems in buildings with fibre cement and polystyrene systems.

## **4.2 Other options**

### **4.2.1 B2 Durability**

#### ***a) Timber treatment***

With respect to timber treatment the following is proposed:

- Split the existing Hazard Class H1 into two classes, H1.1 and H1.2. H1.1 would provide protection against insect attack, while H1.2 would also protect against decay when timber is exposed to dampness for a period of two to five years (the length of time it is likely for a home occupier to discover a leak and have it fixed);
- Split the H3 Hazard Class into two classes, H3.1 and H3.2. H3.1 would contain H3 LOSP and H3.2 would contain H3 CCA, ACQ, copper naphthenate and copper azole.

H3.1 treated timber would no longer be acceptable in the construction of the structure or decking of exposed timber members, including beams and joists for timber decks and pergolas, and timber decking;

- Require all joists, framing and supporting framing for enclosed balconies and parapets to be treated to a minimum level of H3 (either H3.1 or H3.2); and

***Either***

- ***Treat only external wall framing and bottom plates to H1.2:*** Require H1.2 as the minimum level of treatment for all exterior wall framing and all bottom plates in housing designed within the scope of NZS3604 and up to three storeys high. Under this option, kiln dried untreated *Pinus radiata* and Douglas Fir may be used for interior wall framing and roof trusses. The use of untreated *Pinus radiata* (or other timbers less durable than H1.2 treated *Pinus radiata*, such as Douglas fir) in exterior walls or bottom plates would require a specific approval by a Territorial Authority or Building Certifier as an Alternative Solution;

***Or***

- ***Treat all wall framing and bottom plates to H1.2:*** Require H1.2 as the minimum level of treatment for all framing including exterior walls, roof frames and trusses, ceiling joists and inter-storey joists, and interior walls in housing designed within the scope of NZS3604 and up to three storeys high. Again, the use of untreated *Pinus radiata* (or other timbers less durable than H1.2 treated *Pinus radiata* such as Douglas fir) for these building components would require a specific approval by a TA or Building Certifier as an Alternative Solution. or

***b) Timber identification***

Treated timber would be required to be:

- Branded with the plant number or trade name of the plant responsible for the preservative treatment, the hazard class and type of treatment. This brand would be placed on one end of each piece or on a broad face 150 mm from an end (as is the common practice currently), or placed repetitively along the length at 600 mm centres. In the case of H1.1 and H3.1 repetitive branding only would be required.
- Coloured by a dye or pigment specific to the hazard class and treatment as set out in Table 7 below.

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**Table 7: Proposed colours for dye identification of treated framing timber**

Hazard Class	Preservative	Colour <sup>(1)</sup>
H1.1	Boron, permethrin	Clear <sup>(3)</sup>
H1.2	TBTO, TBTN or IPBC / permethrin	Blue <sup>(2)</sup>
	Boron	Pink
H3.1	TBTO or TBTN	Clear <sup>(3)</sup>
H3.2	CCA, ACQ, CuAz, CuN	Natural copper colour

Notes: (1) These colours would not be permitted to be used for any preservative types/hazard classes other than those specified.  
(2) The blue colour would be required to be a red blue in order that it does not turn green with the natural yellow of timber.  
(3) As noted above, H1.1 and H3.1 framing would be required to be branded along the timber's face or edge.

Source: BIA

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#### 4.2.2 E2 External Moisture

The proposed option would involve the following:

- Amend Clause E2 External Moisture to
  - Clarify that it covers fungal growth
  - Introduce an additional requirement that due allowance be made for the consequences of failure and the effects of various uncertainties (new clause E2.3.7)
- Replace the current Verification Method (E2/VM1) to:
  - Clarify the use of the SIROWET test as specified in AS/NZS 4284.
  - Restrict the use of AS/NZS 4284 to claddings installed over cavities (with details defined in E2/AS1).
  - Specify the sample configuration and modify the test procedure specified in AS/NZS 4284, and define the pass/fail criterion that is only loosely set in AS/NZS 4284.
- Replace Acceptable Solution E2/AS1 with a new version that:
  - Gives specific details on claddings and weatherproofing for a range of common claddings restricted to buildings 3 storeys or less and applies mainly to residential and apartment style buildings

- In relation to roofing, Provides prescriptive details for:
  - Metal long run and pressed tile roofing
  - Concrete and clay tile
  - Butyl and EPDM membrane
- In relation to walls, provides prescriptive details for:
  - Clay and concrete brick veneer
  - Weatherboards (timber and fibre cement)
  - Fibre cement
  - EIFS
  - Stucco (cavity option only).
  - Horizontal corrugate profile metal cladding (cavity option only)
- Requires wall cladding situations that are identified as ‘high risk’ to have drained ventilated cavities behind all claddings.
- Introduce additional requirements for the use of DPM materials in sub-floors where ventilation is compromised.

## 5. What is the impact on a typical new house?

The proposals assessed in this report are essentially concerned with reducing risk to new house purchasers by:

- Reducing the probability that a weathertightness problem will occur; and
- Reducing the likely extent of damage (i.e. the extent of rot, mould or fungal growth) that will result in the event that a weathertightness problem does develop.

We therefore expect that new house purchasers would benefit from these proposals through:

- Reduced financial risk. The discovery of extensive damage from leaks and fungal decay can have serious consequences. The financial impact can be significant. Depending on the extent of damage, repair costs can be substantial. In addition, weathertightness problems can undermine the value of a property. Anecdotally, we understand that the discovery of weathertightness problems in a \$400,000 house could lead to a drop in the market value of the house by as much as \$80,000.
- Reduced health risks. Weathertightness problems can lead to particular types of rot, such as *stachybotris chartrum*, that can damage the health of the dwelling's occupants.
- Reduced stress / enhanced 'peace of mind'. For many people, their house is their most valuable asset. The discovery of weathertightness problems, and the financial, health and 'quality of life' implications this can have, can cause significant stress for affected house owners. It seems reasonable to expect that the proposed changes will lead to increased 'peace of mind' for new house purchasers that may be concerned about weathertightness issues (analogous to conventional house insurance).

On the cost side, it seems likely that the additional costs from the proposed changes will be ultimately met by new house purchasers in the form of a slight increase in house prices. The Table provides an indication of the potential impact of proposed changes on the price of a typical new stand alone or multi-unit dwelling, based on the results of our initial cost benefit assessment.

**Table 8: Indicative impact on house construction cost**

Dollars

	Stand alone	Multi-unit apartment
E2 plus B2 Option 1	\$4,000 to \$5,000	\$2,000-\$2,500
E2 plus B2 Option 2	\$3,500 to \$4,000	\$1,800-\$2,300

Notes: (1) Estimates based on impact of preferred option on an exemplar house, costing \$180,000 to build, and an apartment costing \$100,000 to build.

(2) Excludes brick veneer dwellings. E2 proposals have minimal cost implications for them.

Source: NZIER

## 6. Impacts identification

In this section we identify the nature of the likely impacts under the options identified in Section 4, and where they fall. In Section 7 below, we provide quantitative estimates of those impacts that are quantifiable. We separate the discussion into consideration of likely impacts under the proposals with respect to durability (Clause B2) and weathertightness (Clause E2).

### 6.1 Durability (Clause B2) - Timber treatment

#### 6.1.1 Summary of impacts

##### a) Benefits

Both options would reduce risk to house purchasers from mould and fungal growth relative to the status quo. While mould / fungal growth will still occur where there is a moisture problem, problems would take longer to develop and the extent of damage would be less for many house purchasers than under the status quo.

The option of treating all wall framing and bottom plates to H1.2 would provide an additional reduction in risk for house purchasers, by reducing the potential for damage to internal wall framing as a result of either insect attack or moisture problems.

##### b) Costs

Overall the effect of both options would be to:

- Reduce demand for:
  - Untreated kiln dried *Pinus radiata*, untreated Douglas Fir and H1.1 treated timber (permethrin LOSP or boron 0.1% BAE m/m), for use in the construction of residential dwellings; and
  - *Pinus radiata*, untreated Douglas Fir and H1.1 timber (permethrin LOSP or boron 0.1% BAE m/m) and H3.1 timber (tin based LOSP) for use in the construction of balconies and parapets in residential dwellings; and
- Increase demand for:
  - H1.2 treated timber (boron 0.4% BAE m/m, LOSP tributyltin or IPBC) for use in wall framing and bottom plates in residential dwellings; and
  - H3.2 treated timber (CCA, ACQ and copper azole preservatives) for use in the construction of balconies and parapets in residential dwellings.

The major difference between the two options in terms of costs is the magnitude of the substitution from untreated kiln dried *Pinus radiata*, untreated Douglas Fir and H1.1 treated timber to H1.2 treated timber.

We understand that balconies and parapets account for a very small proportion of timber used for residential construction. We would therefore expect the impacts in respect of timber for use in the construction of balconies and parapets to be relatively small.

Given that the Acceptable Solution B2/AS1 is not mandatory, untreated kiln dried *Pinus radiata*, untreated Douglas Fir and H1.1 timber (or H3.1 timber in respect of balconies and parapets) may still be used for framing in specific projects where they are accepted as part of an alternative solution. In principle this may offset the shift in demand to some extent. In general, however, we would expect the number of new dwellings affected to be relatively small. (In quantifying the impacts of these options in Section 7, we assume that the proportion of new dwellings that comply with the Acceptable Solution in respect of timber treatment for framing will be high.

We summarise the likely cost impacts from the two timber treatment options below. As a general comment, we understand anecdotally that some TAs are now requiring the use of treated timber in new dwellings, in response to the leaky buildings crisis. To the extent that this is the case, any additional costs from either option will be correspondingly lower.

### **Monetary costs**

Monetary costs include:

- The direct impact on production, storage and handling costs for industry participants;
- Indirect costs, such as increased transaction costs; and
- Compliance costs, such as training yardsmen and other affected staff, obtaining expert advice on compliance, increased interactions with regulatory authorities such as the BIA or TAs.

These costs will initially fall on the upstream timber production sector - timber suppliers, preservative suppliers, frame and truss manufacturers, timber merchants and residential construction firms / builders. However, in practice we would expect the majority of these monetary costs to be passed through in prices, and ultimately borne by house purchasers. In theory, the impact of the treatment requirement on prices to end users could cause users to choose cheaper substitutes. However, in practice we understand that the alternatives are too expensive or have other disadvantages such that the potential for such substitution is low. As a result, we would expect the increased production costs of timber supply industry to ultimately be borne by the end consumer (in this case house purchasers).

We attempt to quantify the relative monetary costs of the two options in Section 7.

### **Environmental costs**

The proposed options will increase the use of boron 0.4% BAE m/m, tributyltin LOSP and IPBC. These chemicals all have potential adverse environmental impacts, for example:

- Boron has very low toxicity to mammals, but can have serious detrimental impacts on the health of waterways;
- Tributyltin LOSP is toxic to some marine life. For example it has been banned from marine paints because of its toxicity to shellfish.

In the medium term, we understand that LOSP is likely to be the most common form of H1.2 timber treatment. H1 LOSP is already in fairly wide usage, and so treatment plant is already in place. (We understand that around 40 to 45 percent of timber used in residential framing is currently treated, predominantly with H1 LOSP.) In addition, treatment technologies currently using boron are 'wet' processes. This has disadvantages from both the producer's and user's point of view, as boron treated timber requires a relatively long period of time to dry. We understand that in the past, problems have been experienced with boron treated wall frames, as the dimensions of the wood can change over the early life of the building, as the wood continues to dry. While a 'dry' boron process is under development, this is as yet unproven.

The nature of environmental impacts and their incidence (i.e. where they fall) will depend on the extent to which they are addressed through environmental regulation and business practice. These impacts will fall on either:

- The timber and construction industry, in the form of costs associated with resource management consents and processes implemented to mitigate environmental impacts; or
- The wider community, to the extent that the environmental impacts of treatment are not adequately mitigated through the consenting process.

(Or some mix of the two.) There may also be some increase in the cost to Regional Councils and TAs of administering discharge consents and land use consents, although in general we would expect these to be passed through to firms through cost-recovery fees.

We note that:

- a) Consenting regulation already imposes costs on industry to cover environmental externalities;
- b) The incremental impact of the new code may be 'internalised' by these in part or in full;
- c) We have insufficient information to quantify the incremental impact.

### **Health costs**

The health impacts of H1.2 timber treatments vary across the type of treatment. As we noted above, boron has a low toxicity for mammals and so does not raise substantial health concerns. However, tributyltin LOSP, which is likely to be the most common H1.2 treatment at least in the short to medium term, does raise health concerns.

Firstly, LOSP uses organic solvent to convey the preservative treatment through the timber. The solvent then evaporates off the timber over the course of (at least) two weeks. Exposure to the solvent fumes can have negative health impacts. In addition the preservative required for treatment to H1.2 LOSP, tributyltin, is toxic to humans. The alternative (IPBC) is also toxic, although to a lesser extent than tributyltin.

As was the case with respect to environmental impacts, the health impacts of the increased demand for treated timber will either fall on individuals to the extent that they

suffer negative health outcomes from contact with treatment chemicals,<sup>5</sup> or on the health regulation increase as a result. Where individuals' health is negatively affected, there may be wider 'spillover' impacts on society such as the cost of publicly funded healthcare or reduced productivity.

## 6.1.2 Impacts of the options on stakeholders

### a) Timber treatment options

The impacts of the two options on affected parties are summarised in Table 9. We make the following additional comments:

- **Initial incidence of treatment costs:** We understand that currently timber treatment is in most cases provided by separate, specialised firms not by the timber suppliers themselves. Where a customer demands treated timber either the timber supplier or the customer arranges for the timber to be treated once it has left the supplier and before it is delivered to the customer. The proposed changes may increase demand for treated timber to the extent that it is more economic for timber suppliers to arrange for timber to be treated prior to sale, either by treating it themselves or by outsourcing treatment. Where the cost falls initially will clearly depend on the extent of this effect (in any case we would expect this cost to be passed on to house purchasers).
- **Douglas fir:** The proposed changes reduce demand for Douglas Fir, for use in residential framing. It is technically not possible to treat Douglas Fir. As a result this timber will no longer be acceptable for use in wall framing and bottom plates in residential dwellings. Therefore the changes will lead to an absolute reduction in demand for Douglas Fir. This may be mitigated to the extent that this timber can be put to alternative uses in domestic markets, or exported. We understand that untreated Douglas Fir heart timber can be used for lintels, structural beams, and in some flooring applications. Otherwise, the only alternative use of which we are aware is in the manufacture of pallets and packaging.
- **Additional product line under option to treat only external wall frames and bottom plates:** This option would allow different types of timber to be used for internal and external wall frames. As a result, we would expect an increase in the number of product lines in use under this option, with a consequent increase in handling costs. In practice, we would expect users of timber – namely designers, builders and frame and truss manufacturers – to weigh up the additional cost of using H1.2 treated timber in internal walls on the one hand, and the additional handling costs from working with two product lines (say, untreated timber and H1.2 treated timber) on the other. It is not possible for us to determine on the basis of the available data the extent to which H1.2 treated timber would be used for internal wall frames under this option.
- **Export impacts:** Some timber suppliers claim that future exports of untreated kiln dried *Pinus radiata* to developing markets may be compromised by the proposed changes, as they would undermine confidence in this timber.

This effect is somewhat speculative, as timber exports to the markets of concern (in particular China) are still developing. It is therefore not appropriate to include this

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<sup>5</sup> This will generally be employees of timber suppliers, treatment providers, merchants or construction firms.

cost in a formal cost benefit analysis, as the stream of export revenues that would be affected has not yet been realised.

Even if the proposed changes impact on perceptions in export markets, the cost to timber suppliers would be no more than the difference in revenues (net of costs) from exporting kiln dried untreated *Pinus radiata* and the next highest value market opportunity. This might be exporting treated *Pinus radiata*, selling untreated timber for alternative uses, or selling untreated timber for residential construction to an alternative destination.

**Table 9: Impacts of timber treatment options on stakeholders**

	All wall framing and bottom plates	External wall framing and bottom plates only	Initial incidence	Final incidence
<b>Costs</b>				
<i>Production costs:</i>				
<ul style="list-style-type: none"> <li>Direct cost of treating timber: cost of preservative chemicals (and solvent where LOSP treatment is used); cost of the treatment process; capital cost if capacity expansion required.</li> </ul>	✓	✓	Preservative suppliers, timber suppliers, frame & truss manufacturers, timber merchants (where they arrange for the timber to be treated).	Possibly House purchasers
<ul style="list-style-type: none"> <li>Storage and handling costs. LOSP treated timber must be stored for two weeks following treatment to allow solvent to operate.</li> </ul>	✓	✓	Frame & truss manufacturers, timber merchants. Possibly timber suppliers and construction firms / builders.	House purchasers?
<ul style="list-style-type: none"> <li>Increased handling costs from a greater number of product lines</li> </ul>	X	✓	Frame & truss manufacturers, timber merchants.	House purchasers?
<ul style="list-style-type: none"> <li>Where treatment is outsourced or provided off-site, the cost of transport to and from the treatment plant.</li> </ul>	✓	✓	Timber suppliers, frame & truss manufacturers, timber merchants.	House purchasers?

*Impacts on markets:*

- Reduced demand for Douglas Fir for residential wall framing  
No longer acceptable for wall framing      Acceptable for internal framing only.      Douglas Fir producers      Douglas Fir producers
- Potential export impacts – timber suppliers claim that withdrawing regulatory recognition of kiln dried *Pinus radiata* will have a negative impact on exports of kiln dried *Pinus radiata* for residential framing, by undermining confidence of regulators and market participants in export markets (e.g. China).      ✓      ?      Timber exporters      Timber exporters

*Information and process costs*

- Provision of information on the changes to customers - in particular what type of timber is accepted in for various uses. This may require changes to information publications and marketing materials, and, we would expect an increase in the time spent with individual customers explaining requirements.      ✓      ✓      Timber suppliers, timber merchants.      ?
- Increased time / resource for applications for approval of alternative solutions      ✓      ✓      Possibly timber suppliers, construction firms / builders      House purchasers
- Familiarisation with the new requirements and training for key staff such as yardsmen. (In practice likely to be relatively low as many industry participants already familiar with proposals, plus industry organisations, e.g. the Building Industry Federation and the New Zealand Forest Industries Council, may assist.)      ✓      ✓      Timber suppliers, preservative suppliers, frame and truss manufacturers, timber merchants, designers/architects, construction firms/builders      ?

*Costs arising from health and environmental impacts*

<ul style="list-style-type: none"> <li>Expert advice on RMA and OSH compliance implications</li> </ul>	✓	✓	Preservative suppliers. Possibly timber suppliers, frame and truss manufacturers, timber merchants, construction firms/builders	
<ul style="list-style-type: none"> <li>Potentially increased RMA compliance costs, e.g. if the increased treatment / handling of treated timber causes the supplier to breach discharge or land use consents</li> </ul>	✓	✓	Preservative suppliers. Possibly timber suppliers, frame and truss manufacturers, timber merchants, construction firms/builders (?)	
<ul style="list-style-type: none"> <li>Potentially increased OSH compliance costs as a result of the increased health risks from treatment / handling of treated timber</li> </ul>	✓	✓	Preservative suppliers. Possibly timber suppliers, frame and truss manufacturers, timber merchants, construction firms/builders (?)	
<ul style="list-style-type: none"> <li>Increased risk of negative health impacts</li> </ul>	✓	✓	Employees (preservative suppliers)	Employees (preservative suppliers)
<ul style="list-style-type: none"> <li>Increased risk of negative environmental impacts</li> </ul>	✓	✓	Whole community	Whole community
<i>Administrative costs</i>				
<ul style="list-style-type: none"> <li>Potentially an increase in the cost of processing alternative solutions (from a rise in the number of applications).</li> </ul>	✓	✓	Territorial Authorities	House purchasers
<ul style="list-style-type: none"> <li>Increased cost of monitoring compliance with existing discharge consents and land use consents / processing applications for new or amended consents.</li> </ul>	✓	✓	Regional Councils, Authorities	Territorial House purchasers

*Other impacts*

- |  |   |   |                               |  |
|--|---|---|-------------------------------|--|
| <ul style="list-style-type: none"> <li>• Reduced ability to burn timber off-cuts. In particular, we understand some timber processors use (untreated) timber off-cuts as a source of fuel, e.g. for power generation. The proposed changes may reduce the availability of timber off-cuts that can be used for this purpose (treated timber is unsuitable due to health and environmental risks).</li> </ul> | ✓ | ✓ | Timber suppliers / processors | Timber suppliers / processors. Timber users to the extent the increased fuel cost is passed through. |
|--|---|---|-------------------------------|--|

**Benefits**

- |  |   |   |                  |                  |
|--|---|---|------------------|------------------|
| <ul style="list-style-type: none"> <li>• Reduced risk from fungal decay</li> </ul> | ✓ | ✓ | House purchasers | House purchasers |
|--|---|---|------------------|------------------|

**Other impacts**

- |  |   |   |                        |     |
|--|---|---|------------------------|-----|
| <ul style="list-style-type: none"> <li>• Increased demand for treated timber would increase volumes for preservative suppliers. This is in effect a transfer from house purchasers and producers of other timbers to preservative suppliers</li> </ul> | ✓ | ✓ | Preservative suppliers | N/A |
|--|---|---|------------------------|-----|

Source: NZIER

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**b) Timber identification**

Overall, we would expect the increased cost from the proposed change to timber identification requirements to be small. Indeed, we understand that some timber is already being dyed in accordance with the proposed colour coding system, which would reduce the incremental costs of this proposal to some extent. The key benefit of this change is a reduction in the risk to house purchasers of incorrectly treated timber being used in key building components (and consequently a reduction in the risk of problems associated with mould and fungal growth). This proposal may also enable some reduction in storage and handling costs, as industry participants will be able to identify different categories of timber more easily than is currently the case.

The impacts of this option for key stakeholder groups are summarised below

**Timber suppliers**

Timber suppliers are already required to brand timber with the plant number or trade name of the plant responsible for the preservative treatment, the hazard class and type of treatment. The most common practice currently is for this brand to be placed on one end of each piece of timber, or on a broad face 150 mm from an end. The proposed requirement for repetitive branding along the side of timber treated to H1.1 and H3.1 would involve a small additional processing cost for timber suppliers, which we would expect this cost to be passed through in prices to end users.

**Preservative suppliers**

Preservative suppliers would incur the incremental cost of adding a dye or pigment to the chemicals used to treat timber to H1.2 or H3.2. We understand that this is a relatively simple process. The major source of cost will be the cost of the dye, which is likely to be small (and in any case will be passed on in prices).

**Frame and truss manufacturers / Timber merchants / Builders and construction firms**

The proposed change would make it easier to determine the type of timber which and, in principle, should reduce on-site storage and handling costs. There may be some initial cost to familiarising staff with the colour coding system, but this is not likely to be substantial.

**Building designers / architects**

This issue does not directly affect building designers / architects, although they will need to be sufficiently familiar with the new provisions to be able to ascertain whether the correct treatment is being used on site for key building components.

**Consumers**

To the extent that this change reduced the potential for human error leading to unacceptable timber being used in key structural components of new dwellings, this option will reduce risk to house purchasers. While we would expect the cost associated

with the proposed change to ultimately be passed through to house purchasers, in practice the impact on house prices appears likely to be negligible.

### **Government**

This option would have no impact on central government, but will make it easier for local government (specifically building inspectors) to ascertain whether the correct treatment is being used on site for various building components.

### **c) Proposed changes to clause E2 External moisture**

The proposed changes essentially have three key elements:

- Extension of the Acceptable Solution and Verification Method to cover commonly used monolithic cladding systems, particularly fibre cement and polystyrene systems;
- Greater detail on what is required to comply with the Acceptable Solution; and
- The introduction of a requirement for drained ventilated wall cavities in wall cladding situations. This all claddings on buildings exposed to high risk of leaking.

In principle, the third element is the only substantial source of a cost increase under the proposed change, as the first two elements set out in detail what should already be required in order to comply with Clause E2 of the Building Code. It may be that in practice the increased detail and coverage of the Acceptable Solution and Verification Method will cause costs to increase in some cases, where appropriate practices have not been used in the past. However, as we do not have information on the extent to which this is the case, we are not able to quantify this effect. That said, we would expect the increased level of prescription in the Acceptable Solution and Verification Method to affect compliance costs, specifically it:

- May impact on compliance costs associated with the building consent process; and
- Is likely to increase the cost of applications for approval of alternative solutions.

As a general comment, we understand anecdotally that some TAs are now requiring greater detail and in some cases the use of wall cavities in wall claddings, in response to the leaky buildings crisis. To the extent that this is the case, any additional costs from this change will be correspondingly lower.

### **Cladding system suppliers**

Suppliers of those additional cladding systems being brought under the Acceptable Solution, namely fibre cement sheet claddings, EIFS (plastered polystyrene claddings), fibre cement weatherboards, plywood and horizontal corrugated steel will benefit from increased regulatory certainty under this option. The expanded Acceptable Solution will provide greater detail on what is required for these systems to comply with Clause E2 of the Building Code.

Currently, a relatively large proportion of cladding systems in use are not covered by the Acceptable Solution. Therefore, whether a system is covered or not is unlikely to have a substantial impact on its perceived desirability in the market; a substantial proportion of the claddings systems in use must be covered by an approved alternative solution.

Under the proposed change, however, only a small percentage of cladding systems will fall outside the Acceptable Solution (approximately 10 percent of the market by value). This 10 percent of cladding systems will need to approval as an alternative solution in to be used in any new residential dwelling. It is possible that this shift will have the effect of reducing the perceived desirability of these ‘proprietary’ solutions in the eyes of consumers.<sup>1</sup>

Suppliers of proprietary cladding solutions may seek to obtain accreditation of their systems, in order to retain their market position relative to those systems covered by the proposed new Acceptable Solution. We understand that the cost of obtaining accreditation ranges from around \$20,000 to \$100,000, depending on the type of product and the initial development work required.

### ***Building designers / architects***

While the owner of a new building is legally responsible for obtaining the building consent, in practice this task will either fall to the building designer / architect or to the builder. Under the proposed changes, building consent applications will need to provide greater detail on the proposed design and materials, to allow TAs to check the application against the (more detailed) Acceptable Solution. This will lead to an increase in the up-front cost of preparing building consent applications, primarily due to the increased time taken to collate the required information (as the designer / architect should already have access to the required information). This increase may be offset by a reduction in the extent to which TAs require further information to be provided to support the application. The net effect on compliance costs is unclear, but may not be substantial.

The increased coverage of the Acceptable Solution under this option should mean it covers a significantly greater proportion of new projects than is currently the case. As a result, the proportion of projects requiring approval of an alternative solution will reduce substantially, with a consequent reduction in compliance costs. This reduction will affect the majority of dwellings that are designed by building designers, say around 70 percent of new residential dwellings. We understand that the approximately 10 percent of new dwellings that are architect designed are unlikely to be affected. Architect designed dwellings generally have a number of features that will require approval of an alternative solution in any case.

For those projects that do require an alternative solution, the cost of the approval process is likely to be somewhat higher under this option than is currently the case, due to the increased level of detail that will be required.

In addition to the above, at least initially, designers and architects will incur some additional compliance costs from the need to familiarise themselves with the new Acceptable Solution and Verification Method.

We would expect the net compliance cost impact to be passed through to house-purchasers, in the fee for service.

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<sup>1</sup> By ‘proprietary’ solution, we mean those cladding solutions that would fall outside the proposed new Acceptable Solution.

### **Construction firms / builders**

The key direct cost impact on builders will be the requirement to include wall cavities in cladding situations that are classified as 'high risk'. This cost is likely to be passed directly through to house-purchasers in the prices.

As we noted above, in practice the task of applying for and obtaining building consent falls either to the building designer / architect or to the builder. In those cases where the builder manages the building consent process, the costs of doing so will be affected along the same lines that we discussed in the previous sub-section.

In addition to the above, at least initially, construction firms / builders will incur some additional compliance costs from the need to familiarise themselves with the new Acceptable Solution and Verification Method. In practice this is likely to occur through interaction with TAs in relation to specific projects, and so is likely to be felt as a further increase in the time needed to process building consents over some transitional period.

### **Consumers**

We expect that the increased costs of complying with the Acceptable Solution and Verification Method, and the cost of cavities where required, will ultimately flow through to house purchasers. Those that are likely to be affected the most are:

- Consumers purchasing dwellings that fall are classified as having 'high risk' cladding situations, who will bear the additional cost of wall cavities under the proposed changes.
- Consumers purchasing dwellings that require an alternative solution.

All consumers will face increased costs to the extent that the costs of the building consent process increase. However, as we noted above, it is not clear that there will be any substantial net impact on building consent costs.

### **Government / local government**

The main impact of the proposed change is on TAs with respect to:

- Processing building consents: As we noted above, building consent applications are likely to contain more detail that is generally the case now, and so will require more time to process. This will be offset by a probable reduction in the extent to which the processing authority needs to interact with the applicant to obtain additional information to support an application; and
- Processing applications for alternative solution approvals: Alternative solutions will need to contain more detail, and again may require more time to process.

We would expect these costs to be passed back to the applicants (ultimately the house purchaser) through fees, as TAs operate these functions on a full-cost recovery basis.

## 7. Quantification and monetisation of impacts

### 7.1 Overview

This section reports on the approach, assumptions, and sources, used in undertaking the quantitative part of the CBA, and sets out results in summary form.

The underlying approach is conventional. We project a ‘base’ case (in this case dwelling construction in value and volume terms over 25 years), that is, dwelling construction in the absence of the proposed regulatory change. We then estimate (in monetary terms) the extent and timing of the costs and benefits attributed to the regulatory change, and discount these back to present value terms in order to compare costs and benefits on a consistent basis. In doing so we need to differentiate between the various potential combinations of changes to the Code, and the varying implications across external cladding types.

The practice of discounting is, in general, well-accepted within the economics profession. Various considerations underly the use of discounting, and the choice of a particular discount rate:

- the most fundamental reason for discounting is that society has a preference for current over future consumption. This is usually explained with reference to the fact that the degree of uncertainty attached to costs and benefits increases as the timespan before they are realised increases, and as a result less importance should be attached to more distant costs and benefits. There is also an argument that future generations will have a wider range of technological options (and thus a broader production possibility frontier) than we do at present, and so will be able to obtain higher utility levels. The social time preference rate (STPR) encapsulates this time preference, and is generally thought to be in the range of 2% to 5% per annum.
- the real opportunity cost of capital is above zero. If money is invested in alternative uses to the project (e.g. deposited in a bank) then it will earn some return over and above that which is required to offset the effect of inflation. Conceptually, this is also known as the social opportunity cost (SOC), and is generally thought to be higher than the STPR. In New Zealand at present, the real risk-free rate of return on capital (as measured by the government bond rate less the inflation rate) is around 5%. It has been higher in the recent past, but historically lower than this.

In general, the discount rate used should be a weighted average of the STPR and the SOC, with the weight accorded the former equal to the proportion of the required cost which would otherwise (in the counterfactual situation) be used for consumption, and the weight accorded the latter equal to the proportion which would be used for private sector investment. In this analysis we have used 5% as the discount rate for the results presented.

Readers should note the following principal caveats in assessing this analysis:

- To keep the estimation and reporting task manageable, we have had to work with the concept of standardised dwellings for example, size and general design and construction. We do distinguish between standalone dwellings and apartments. But, in general the analysis does not reflect the full extent of the diversity across the

current and future dwelling stock, and hence does not reflect the variability in the absolute and relative size of costs and benefits that could result from the Code changes.

- For similar reasons, the analysis is at a national level. Costs and benefits of the proposed changes are likely to vary across regions, but the primary focus here is on their net effect for New Zealand as a whole.
- The analysis requires the attribution of benefits to the proposed Code, these benefits being in the form of reduced incidence or average cost of structural failure. This involves oversimplification of complex relationships between cause and effects.
- There is very little comprehensive information on the incidence, cost, and primary cause of failure in the dwelling stock. This adds to the uncertainties in projecting the benefits of the Code changes, and to the degree of reliance on assumptions that cannot be easily tested.
- Again for simplicity, we assume a stable base case in terms of building practice, for example, in terms of the proportion of treated timber in the various components of new dwellings, and the market shares of the various types of cladding. In fact, and regardless of the proposed changes to the code, these elements may be subject to significant changes over the short to medium term.

## 7.2 Projected base case

The (projected) base case is defined by the following parameters:

1. Projected total dwelling construction activity defined e.g. by number and value (in constant dollar terms) of new dwellings.
2. Disaggregation into freestanding and multi-unit residential, and into additions and alterations.
3. Assumed proportions by external cladding group (based on BRANZ classifications and 5 year averages).
4. Current and projected construction costs.
5. Representative data on ongoing failure rates e.g. in terms of number or proportion of dwellings affected, costs of repairs etc.

We need to consider the possibility that the weathertightness issue may have transmitted a 'shock' to the building environment that may reverberate for some years. There were several contributing factors at work (e.g. building design, materials used, building practices, ineffective certification processes).

The market (i.e. consumers of dwelling construction services) and the industry will have reacted/be reacting to this information, and taking precautionary measures. So, for example, regardless of the BIA's proposed changes to the code, the style of dwellings, construction techniques, materials used over the next few years may differ significantly

from the mix over the last (say) five years, and failure rates should drop significantly (although this difference might not be so apparent within the next 5 years).

We should also consider the extent to which the base case (looking forward say 25 years) includes some long-term trends in building technology which, for example, are contributing to a relative reduction in the importance of materials as a component of construction costs.

In summary, we need to be wary of using construction quality over recent years as the base case for evaluating the effects of the propose code changes. A more realistic comparator quality wise, might be building over recent months and over the forthcoming year.

NZIER's summary projections (which do not differ greatly from the BRANZ figures) although ours are based on a lower net migration assumption) are set out below. Note that, consistent with BRANZ, the projections incorporate a rising proportion of multi-unit dwellings as a proportion of the total, and for most of the period, a gradual decline in the total number of new dwellings constructed.

**Table 10: Dwelling construction projections**

	Number of new dwellings, NZIER projections	Number of new apartments	Number of new stand alone houses
2002	20,065	2,891	17,175
2003	26,970	5,539	21,431
2004	25,706	5,377	20,330
2005	22,483	4,787	17,695
2006	20,398	4,421	15,977
2007	20,951	4,620	16,331
2008	20,718	4,647	16,071
2009	20,683	4,717	15,965
2010	20,566	4,769	15,798
2011	20,571	4,848	15,724
2012	20,577	4,927	15,650
2013	20,706	5,036	15,670
2014	20,838	5,147	15,691
2015	20,930	5,249	15,681
2016	21,066	5,363	15,703
2017	21,245	5,489	15,756
2018	21,386	5,606	15,779
2019	21,485	5,714	15,772
2020	21,587	5,822	15,764
2021	21,647	5,920	15,726
2022	21,665	6,007	15,657
2023	21,596	6,070	15,526
2024	21,527	6,132	15,395
2025	21,369	6,168	15,201
2026	21,122	6,177	14,945
2027	20,916	6,196	14,720
2028	20,618	6,185	14,433

## 7.3 Economic costs

### 7.3.1 B2 - Durability

The principal direct cost effect of the B2 changes is through more extensive use of treated timber, and higher minimum standards for treated timber used in certain parts of dwelling structures.

For these purposes, we are estimating the effects of the Code on the overall cost of a new structure. But this cost reflects a range of 'upstream' compliance, production and distribution costs, which we assume are borne by the ultimate consumer – whoever pays for the new dwelling.

Our estimates of aggregate costs are based on the following components:

1. Projected volume of new construction.
2. The volume of timber in the applications affected by the Code changes. This differs as between Option 1 and Option 2, and between standalone dwellings and apartments.
3. The percentage increase in timber costs under the two Options.

We have adopted the approach to costing of B2 changes set out below. Costing elements are as follows:

1. BRANZ construction costings for exemplar house and multi-unit dwelling under existing rules.<sup>2</sup> These costs are the same in dollar terms for each of the four cladding groups (weatherboard etc, claybrick, fibre-cement, EIFS/50% stucco, but differ as a proportion of total construction costs.
2. Assumptions about the proportion of treated timber (in the various framing applications) in the base case. We are working on the assumption that without the new Code, the proportion of treated timber would rise from 40% to 50%.<sup>3</sup> Under E2/B2 Option 1, the proportion will rise from 50% to 80%.<sup>4</sup> Under E2/ Option 2, we are assuming the proportion will stay at about 50% but with H1.2 or H3 replacing H1.<sup>5</sup>
3. Current breakdown of structural framing. Industry sources report that the average new home (180 m<sup>2</sup>)<sup>6</sup> contains 13 - 16m<sup>3</sup> of structural framing as follows:
  - Trusses – 2-3m<sup>3</sup>
  - Battens (Ceiling and roof) – 2-3m<sup>3</sup>
  - Interior frames – 4-6m<sup>3</sup>

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<sup>2</sup> Refer PriceWaterHouseCoopers report May 2003 for Ministry of Economic Development - *Social and Economic Impact Study of Changes to Building Regulation*. Pp.83-86.

<sup>3</sup> Industry advice is that the current make-up is 35% H1 (treated against borer hazard), 5% H1.2 (new treatment – decay resistant); 10% H3.

<sup>4</sup> Advice from BRANZ.

<sup>5</sup> Some industry observers think that if E 2 were accepted, the proportion of treated timber would fall to below 20%. However, B2 Option 1 alone would result in 100% treated timber being used. B2 Option 2 would result in about a 30% of all timber being treated to at least H1.2 level.

<sup>6</sup> Note that this is larger than the 'Exemplar' house used by BRANZ which is 149 m<sup>2</sup>.

- Exterior frame - 4m<sup>3</sup>
4. Incremental cost estimates provided by various parts of the timber industry.

These are summarised in the table below. Note that this is an indicative range, and there will be examples of homes in which the incremental costs would be well outside it.<sup>7</sup>

**Table 11: B2 - Estimated incremental cost per dwelling**

	Option 1	Option 2
Standalone	\$1,200 - \$2,000	\$800 - \$1,100
Apartments	\$700 - \$1,200	\$500 - \$900

5. These are then multiplied by the projected number of new dwellings constructed to estimate aggregate additional construction costs year by year over the 25 year period.

### 7.3.2 E2 – Weathertightness

The main direct cost effect from E2 results from the increase in the number of dwelling structures where a cavity<sup>8</sup> will be required for compliance with the Acceptable Solution.<sup>9</sup> But there are also significant additional costs arising from requirements for wall flashings and window details.

**Table 12: E2 – Additional costs of providing:**

Houses	Cavities	Wall flashings	Window details	Total
Brick				
All excl. Brick	\$1500	\$380	\$620	\$2,500
Apartments	Cavities	Wall flashings	Window details	Total
Brick				
All excl. Brick	\$1140	\$50	\$130	\$1320

Source: BRANZ estimates

### 7.3.3 Total costs per dwelling - B2 plus E2

Adding together these two sets of estimates results in the following costs ranges per dwelling.

**Table 13: Total costs per dwelling**

	B2 Option 1 + E2	B2 Option 2 + E2
Houses: Non - brick	\$3,700-\$4,500	\$3,300-\$3,600
Houses: Brick veneer	\$1,200 - \$2,000	\$800 - \$1,100
Apts: Non – brick	\$2,020 - \$2,520	\$1,820 - \$2,220
Apts: Brick veneer	\$700-\$1,200	\$500 - \$900

<sup>7</sup> Some industry costings are much higher than these, partly because the full handling and storage costs of a major increase in timber treated to H1.2 or above (as would result from B2 Option 1) is yet to flow through.

<sup>8</sup> Some single storey house will be built with soffits to avoid the need for cavities.

<sup>9</sup> Brick veneer houses are unaffected by this change, the exception being double storey houses with a different cladding form in the second storey.

## 7.4 Economic benefits

The value of benefits is estimated on the basis of a simple model of the effects of the proposed Code changes on the incidence and costs of failure. (Since the changes can only affect dwellings built in the future, the existing building stock does not enter in to the calculations.)

Key considerations are:

1. The relationship between building failure and the performance factors addressed by the code.
2. The influence of external cladding systems, and other design features, on the likelihood of failure (E2).
3. The influence of the type/treatment of timber on the speed and extent of damage, where a failure occurs (B2)
4. Timing factors such as the relationship between failure costs and for example, age of dwelling, time since construction, time lags between initial failure, detection, and repair.

In estimating benefits, we need to distinguish between the effects of E2 (weathertightness) and B2 (durability, Options 1 and Option 2). This is because the benefit from higher standards for timber framing is dependent on the weathertightness of the building envelope. We thus need to model effects of the Code changes as follows:

1. Benefits of E2 changes alone.
2. Benefits of B2 changes conditional on E2 changes.
3. Benefits of B2 changes alone.

Note that no attempt has been made to quantify intangible benefits such as effects on market value, health risks or peace of mind. Nor has any attempt been made to quantify costs due to effects on environment, export industry, health effects or impacts on the producers of Douglas Fir.

Key elements of our calculations are as follows:

1. Estimate the stock of dwellings built under the new code. This grows over the period covered by our projections i.e. about 20,000 by the end of the first year, 40,000 by the end of the second years etc.

Assume incidence of failure in the base case which varies by cladding type. This is expressed in percentage terms<sup>10</sup> and applies to the stock of dwellings that exists in each year.<sup>11</sup> [ The stock assumed to be affected in any year is restricted to that built

<sup>10</sup> We have found it very difficult to find sources that present 'incidence' factors that can guide this assumption. The % in fact conflates incidence in terms of failures in the year of construction and lagged failure of dwellings built in previous years – within the stock under examination.. Table 1 of a BRANZ draft report (Bassett *et al*) was one such source. Industry views on current and prospective failure rates vary widely.

<sup>11</sup> These reflect some industry observations to date but views vary widely on the realistic base case as to costs and incidence of failure. These focus in particular, on the combination of complex designs for some multi-unit apartments and – depending on cladding materials and detailing – perceived significantly heightened risk of weather tightness problems.

<sup>12</sup> Dwellings are assumed to drop out of the stock at risk and thus these calculations after 10 years.

in the preceding 10 years. It was considered that after 10 years, all significant problems with weathertightness will have been detected and dealt with.]

2. Assume variance in the incidence of failure according to the code changes or combination of changes.
3. Assume average dollar cost of repairs per failure. This is assumed to be lower the greater the proportion of treated timber used in construction. For houses we have started with a repair cost range of \$60,000 in the base case, and for apartments \$40,000 per apartment.<sup>13</sup>
4. We have further assumed that with B2 option 1, repair costs will fall to about 30% of the base case. With B2, Option 2, the repair costs are assumed to drop to about 40% of the base case.
5. Estimate failure costs under each proposed change or set of changes.
6. Deduct these from the base case failure cost to estimate year by year benefits.

The incidence parameters are derived as follows:

**Table 14: Derivation of incidence parameters – medium scenario 1**

E2 Case		Chance of Leak			
	W'board	Clay Brick	Fib Cem	EIFS Stucco	
Status Quo	0.20%	0.10%	1.00%	1.00%	
E2 Changes	0.10%	0.10%	0.20%	0.20%	
B2 Case		Chance of Damage - Assuming Leak Occurs			
	W'board	Clay Brick	Fib Cem	EIFS Stucco	
Status Quo	35%	20%	95%	95%	
Option 1	20%	5%	65%	65%	
Option 2	25%	10%	75%	75%	
Case	Overall Chance of Failure				Ave Cost of Failure
	W'board	Clay Brick	Fib Cem	EIFS Stucco	\$
Status Quo	0.070%	0.020%	0.950%	0.950%	60,000
B2 Option 1 only	0.040%	0.005%	0.650%	0.650%	20,000
B2 Option 2 only	0.050%	0.010%	0.750%	0.750%	25,000
E2 only	0.035%	0.020%	0.190%	0.190%	60,000
E2 + B2 Option 1	0.020%	0.005%	0.130%	0.130%	20,000
E2 + B2 Option 2	0.025%	0.010%	0.150%	0.150%	25,000

*Note: These are failure rates per annum per unit of housing stock existing in any one year*

<sup>13</sup> These might understate total costs of failure. Legal and other such costs of claim have not been explicitly incorporated.

## 7.5 Summary results

Summary results, in aggregate form, are set out here. The first table shows the net present value of benefits (i.e. reduction in expected repair costs), comparing across code combinations. E2 + B2 Option 1 results in the highest figure, and E2 alone in the lowest figure.

**Table 15: NPV of benefits**

Benefits  
NPV of benefits over entire period, discounted at 5%  
\$ millions

*Medium scenario 1 failure rates are 20% of high case  
Medium scenario 2 failure rates are 50% of high case*

	E2 Alone	E2 + B2 Option 1	E2 + B2 Option 2	B2 Option 1 only	B2 Option 2 only
High scenario	1,729	2,706	2,562	2,345	1,996
Medium scenario 1	346	541	512	469	399
Medium scenario 2	865	1,353	1,281	1,172	998

The next table shows the NPV of benefits less costs. With the exception of E2 alone, there is very little difference between the options.

**Table 16: NPV of benefits less costs**

Net benefits  
NPV of benefits less costs over entire period, discounted at 5%  
\$ millions

*Medium scenario 1 failure rates are 20% of high case  
Medium scenario 2 failure rates are 50% of high case*

	E2 Alone	E2 + B2 Option 1	E2 + B2 Option 2	B2 Option 1 only	B2 Option 2 only
High scenario	1,310	1,828	1,860	1,886	1,714
Medium scenario 1	-74	-337	-189	10	117
Medium scenario 2	445	475	579	714	716

The next table shows summary benefit:cost ratios using the same discount of 5%. All of the code changes generate significant B/C ratios, but in this case the E2 + B2 Option 1 figure is the lowest in all scenarios.

**Table 17: Benefit cost ratios**

Benefit to cost ratios  
NPV of benefits divided by NPV of costs over entire period, both discounted at 5%  
\$ millions

*Medium scenario 1 failure rates are 20% of high case  
Medium scenario 2 failure rates are 50% of high case*

	E2 Alone	E2 + B2 Option 1	E2 + B2 Option 2	B2 Option 1 only	B2 Option 2 only
High scenario	4.1	3.1	3.7	5.1	7.1
Medium scenario 1	0.8	0.6	0.7	1.0	1.4
Medium scenario 2	2.1	1.5	1.8	2.6	3.5

The message from these benefit cost ratios is that on the assumption used, increased use of treated timber alone (addressed by B2) is a relatively efficient way of achieving reduced cost of failure in dwellings, even though the initial cause of failure is often problems of weathertightness (addressed by E2). An important influence on these results is the assumption that in the event of a leak, repair costs with extensive use of

treated timber framing to the standards proposed will drop to about 30% of costs that would result with untreated timber. And this applies to all cladding systems.

## Sources

Bennett, A (2002) *Leaking or Weathertight Buildings – the implications for timber framing*, paper presented at FIEA Wood Technology Clinics, Rotorua, 14-15<sup>th</sup> March 2002.

Building Industry Authority (2003) 'Building Code Clause B2 Durability: Proposed Changes to Acceptable Solution B2/AS1.' April.

Ministry of Economic Development (2003) *Better Regulation of the Building Industry in New Zealand*. March.

Standards New Zealand Draft Number DZ 3602/V8 "The Use of Timber and Wood Based Products".

## Appendix A: Glossary of terms

Term	Definition
Acceptable Solution	A prescriptive design solution approved by the BIA as a way of complying with the Building Code. Acceptable Solutions are published in the Approved Documents and often quote other documents such as New Zealand Standards.
Accreditation	A certificate of accreditation issued by the BIA states that a specific product, system or method if used under certain conditions meets nominated provisions of the Building Code.
ACQ	Alkaline Copper Quaternary. A timber preservative.
Alternative Solution	A design solution which differs totally or partially from solutions given in the Approved Documents yet complies with the Building Code. These are stand alone solutions considered and approved on their individual merits by a Territorial Authority or building certifier.
Appraisal	A certificate or report issued by a person or organisation stating an opinion that a product, system or method is suitable for some purpose.
Approved Documents	Issued by the BIA, they comprise Acceptable Solutions and Verification Methods that provide methods of compliance with the Building Code. The methods describe one way of complying and it is not mandatory that they be followed.
Authority	The Building Industry Authority (BIA). An independent Crown entity whose fundamental purpose is to manage New Zealand's building legislation.
Boron	A timber preservative chemical.
Building Act	An Act of Parliament which commenced on 15 February 1992 and came into full force on 1 January 1993. It provides for necessary controls relating to building work and the use of buildings, and for ensuring that buildings are safe, sanitary and have means of escape from fire.

Building Code	The First Schedule of the Building Regulations 1992. The Building Code prescribes the functional requirements for buildings and the performance criteria with which new building work must comply in performing those functional requirements. Compliance with the Building Code is mandatory.
Building Consent	A consent for building work to begin in accordance with the approved plans and specifications. Building consents are issued by Territorial Authorities and include plumbing and drainage work.
Building Wrap	A building paper or underlay placed behind cladding systems to assist the control of moisture by ensuring any condensation or moisture behind the cladding system is directed to the exterior of the building.
Cantilevered Balcony	A balcony reliant on the extension of framing members from the face of a building for its structural stability, i.e. no support is provided at the outer extremities of the balcony.
CCA	Copper Chrome Arsenate. A timber preservative.
Code Compliance Certificate (CCC)	A certificate issued by a TA or Building Certifier at the completion of building work, confirming that the building work under the building consent complies with the relevant provisions of the Building Code.
CuAz	Copper Azole. A timber preservative.
CuN	Copper Napthenate. A timber preservative.
DZ	A draft New Zealand Standard.
Drainage Plane (drained and ventilated cavity)	The plane, generally formed by a cavity, immediately behind a cladding system. This allows water which penetrates the cladding system to drain to the exterior of the building.
Eaves	That part of the underside of a roof that extends beyond the external walls of a building. Also known as a soffit.
ERMA	Environmental Risk Management Authority.
Face Sealed Cladding System	A cladding system that relies on a protective coating applied to the face of the cladding to seal and prevent the penetration of water.

Functional Requirement	Used in the Building Code to describe what is required of the building work so that the Objectives of the particular Building Code Clause will be met.
H1.1	A hazard class for protection against insect attack. To achieve H1.1, timber can be treated with either “LOSP” Permethrin, or “Boron” at 0.1% boron. (See Standards New Zealand Draft Number DZ 3602/V8 “The Use of Timber and Wood Based Products”.)
H1.2	Also known as H1+. A hazard class for protection against insect attack and against decay when exposed to dampness for 2 to 5 years. To achieve H1.2, timber can be treated with either “LOSP” with Permethrin plus 0.6 % tributyltin, or “Boron” at 0.4% boron. (See Standards New Zealand Draft Number DZ 3602/V8 “The Use of Timber and Wood Based Products”.)
H3.2	[specify]
Hazard Class	A system of hazard classes rated 1 to 6 determined by the New Zealand Timber Preservation Council. 1 is low risk, 6 is very high risk.
LOSP	Light Organic Solvent Preservative. A commonly used timber preservative.
Monolithic Cladding	A cladding of sheet material with an applied coating to give the appearance of a seamless cladding, often imitating concrete or masonry.
NZS	New Zealand Standard.
OSH	Occupational safety and health. Safety in the work place in New Zealand is covered by the Health and Safety in Employment Act 1992 and administered by the Occupational Safety and Health Service in the Department of Labour.
Parapet	The extension of a wall above the roofline or the floor of a balcony. A parapet has its top and both sides exposed to the weather.
RMA	Resource Management Act. Under the RMA consents are required for various activities that impact on the environment (e.g. land use, discharges). These are administered by Regional Councils and TAs.
SNZ	Standards New Zealand.

TBTN	Tri-n-butyltin naphthenate. A chemical used in LOSP timber preservative.
TBTO	Tri-n-butyltin oxide. A chemical used in LOSP timber preservative.
Territorial Authority (TA)	A City or District Council. The TA enforces the Building Act and Building Regulations in its territory.
Verification Method	A prescriptive calculation or test procedure approved by the BIA as a way of complying with the Building Code. Verification Methods are published in the Approved Documents.
Weathertightness	The term used to describe the resistance of a building to the weather. Weathertightness is not necessarily waterproofing, but rather ensuring against undue dampness inside buildings and damage to building elements.

## Authorship

This report has been prepared at NZIER by Ian Duncan, Anna McKinlay and John Ballingall and reviewed by Peter Clough. The assistance of the timber industry, construction industry, building consultants, TAs, and materials manufacturers, who provided us with detailed advice and data on likely effects of the proposed changes, is gratefully acknowledged.

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