ABCB

# CONSULTATION REGULATION IMPACT STATEMENT (RIS 2010- 02)

## Proposal to amend the Building Code of Australia to include mitigation against the effects of saline soils

**July 2010**

The Australian Building Codes Board (ABCB) has commissioned The Centre for International Economics to prepare this Consultation Regulation Impact Statement (RIS) in accordance with the requirements of *Best Practice Regulation: A Guide for Ministerial Councils and National Standard Setting Bodies,* endorsed by the Council of Australian Governments in 2007. Its purpose is to inform interested parties regarding a proposal to amend existing regulatory requirements for protection from saline soils. Comments are invited by 10 September 2010. Please title *"Salinity RIS Public Comment"* and forward by email to: Consultationris@abcb.gov.au

The General Manager
Australian Building Codes Board
PO Box 9839, Canberra City, 2601

Or by email: abcb.office@abcb.gov.au

www.TheCIE.com.au

# Proposal to amend the Building Code of Australia to include mitigation against the effects of saline soils

## Consultation Regulation Impact Statement

Prepared for

Australian Building Codes Board

Centre for International Economics
Canberra & Sydney

June 2010

This report has been prepared by the Centre for International Economics on behalf of the Australian Building Codes Board.

# *Contents*

**Boxes, charts and tables**

# *Glossary*

| | |
|---|---|
| ABCB | Australian Building Codes Board |
| ABS | Australian Bureau of Statistics |
| ACP | Acceptable Construction Practice |
| ANRA | Australian Natural Resources Atlas |
| AS | Australian Standard |
| BCA | Building Code of Australia |
| BCC | Building Codes Committee |
| CIE | Centre for International Economics |
| COAG | Council of Australian Governments |
| DECC | Department of Environment and Climate Change (NSW) |
| DIPNR | Department of Infrastructure Planning and Natural Resources (NSW) |
| DtS | Deemed-to-Satisfy |
| HIA | Housing Industry Association |
| IPWEA | Institute of Public Works Engineering Australia |
| NPV | Net Present Value |
| NLWRA | National Land and Water Resources Audit |
| OBPR | Office of Best Practice Regulation |
| RIS | Regulation Impact Statement |

# *Executive summary*

Salinity is a serious and worsening problem affecting rural and urban areas Australia wide. Increasing salinity in soils is an issue of concern to the building industry due to the potential for salt attacks on buildings to weaken structures, increasing the risk of failure. In 2000, it was estimated that 68 Australian towns were affected by urban salinity, with this figure projected to increase to approximately 125 by 2020 and 219 by 2050[1]. These towns were located across New South Wales, Western Australia, South Australia and Victoria.

While there are a number of avenues through which salinity may affect a building structure, including rising damp, falling damp and condensation, this Consultation Regulation Impact Statement (RIS) is directed at possible regulatory and non-regulatory options to mitigate against the effects of saline soils. Moisture is absorbed into the building structure through direct contact with soils. Where this moisture is heavily laden with salts (saline soils), a direct physical attack from the mobilised salts occurs when the structure is first wetted and then allowed to dry. When this process is repeated, the formation and dissolving of salt crystals in the bricks and building structure weakens and eventually causes the bricks and structure to deteriorate[2]. Such deterioration also extends to building concrete and reinforcement elements that are susceptible to corrosion and loss of strength due to salt attacks.

## *Salinity damage costs*

The costs of salinity are highly dependent on issues such as the extent of the saline intrusion, as well as the nature of the building products used and prevention measures taken by building owners. Studies that have considered the costs of salinity have been rather disjointed in nature with widely varying results. These studies have reported average costs of saline effects, across both residential and commercial buildings, depending on the severity of the salt attack.

---

[1] National Land and Water Resources Audit (2000) Australian dryland salinity assessment 2000.

[2] DECC NSW (2008) Building in a saline environment.

In general, the costs of salinity may be divided into three categories:

1. initial repair costs;
2. on going repair and maintenance costs; and
3. reduced building life span.

The analysis in this Consultation RIS assumes that damage costs of $8000, recurring every 10 years, will be incurred from the first onset of salt attack, through the lifetime of the dwelling.

Currently, provisions to manage rising damp — and through rising damp, salinity — are explicitly covered in both the Building Code of Australia (BCA) and referenced standards. However, with concerns that the risks of urban and rural salinity are likely to increase over time with the associated increased potential for damage to building structures as well as information issues for consumers, the Australian Building Codes Board (ABCB) is proposing to broaden provisions in the BCA addressing the effects of saline soils. This Consultation RIS evaluates the impact from a proposed expansion of current variations to the BCA in South Australia for protecting against salt attacks.

## *Proposed amendments*

The preliminary Deemed-to-Satisfy (DtS) and Acceptable Construction Practice (ACP) changes to both Volumes and the implications for practitioners and builders are:

1. a limitation on types of materials deemed acceptable for use as damp proof courses, resulting in a possible reduction in choice of acceptable materials from the current BCA. Materials are potentially limited to:
   a) black polyethylene; or
   b) polyethylene coated aluminium; or
   c) bitumen impregnated material not less than 2.5mm minimum thickness (in accordance with clause 7.5 of Australian Standard AS 2904).
2. an increase in impact resistance requirements for vapour barriers (or 'damp proofing membranes') used under slabs from 'medium impact' to 'high impact' membranes in accordance with AS 2870(1996) Residential Slabs and Footings – Construction.

Further variations to Volume Two provision 3.2.3.1 are implemented in SA, increasing the requirements for concrete slab construction to maximise its strength in order to resist mechanical, termite and salt damage. The variations are inserted after 3.2.3.1 (d) and include the requirements that:

e) concrete in slabs must be adequately compacted, and slab surfaces, including edges, moist cured for 7 days;

f) after vertical surfaces are stripped of formwork, slab edges must be finished prior to curing;

g) loading of concrete slabs with stacked materials or building plant must not occur for a minimum of 7 days after pouring although construction of wall frames and setting out brick work may be undertaken during this period.

The objectives of the proposed amendments are to provide a three fold increase in protection against salt attack for newly constructed dwellings.

- Increasing the impact resistance of the membrane product, from medium to high, reduces the potential for unintended damage during the construction process.
- The proposed amendments that restrict materials for damp proof courses mean that materials susceptible to salt attack cannot be used in constructing a damp proof course, increasing protection from moisture rising through the walls of a dwelling.
- Increased requirements for curing and compaction work to reduce the permeability of the dwelling slab, reducing the potential for moisture and salts to enter the building structure.

The estimated additional construction costs due to the proposed amendments were published in a consultation paper on salinity, commissioned by ABCB in 2007. Overall, an additional $285 per house, for a 200msq slab on ground construction is estimated. These costs are made up of approximately $60 due to the high impact damp proof membrane and $225 due to curing and compaction of the slab. It is estimated that there will be no additional costs associated with the provisions for damp proof courses.

### *Implementation options*

There have been four alternative options identified with respect to implementing the proposed regulatory changes.

- Maintain the status quo.
- Application of South Australian variations to all areas in Australia, irrespective of the risk of a salt attack (national roll out).
- Application of South Australian variations to all areas in Australia considered at risk of a salt attack in which areas at risk of salt attack would need to be identified (national mapping exercise).
- Requirement that the variations be met unless there is proven to be no possibility of salt attack in the area (selective mapping exercise).

There are a number of difficulties that have been noted with selective proposals to expand salinity provisions within the BCA. These include the inability to precisely determine the locations in which increased urban salinity will result, as well as a level of uncertainty surrounding the rate at which dryland salinity may spread and affect constructions.

It should also be noted that where implementation is based on mapping studies, the quality of the mapping exercises will have an impact on the estimated benefits and costs. Where a low resolution study is undertaken, there will be both areas of low salinity risk that are incorrectly mapped as high risk and inefficiently required to meet the proposed amendments, as well as potentially areas of medium to high salinity risk that will be incorrectly assessed as low risk and therefore not be required to meet the proposed amendments. The assumptions of mapping accuracy used in this RIS are:

- national mapping exercise: 70 per cent of areas at risk are identified correctly and 90 per cent of low risk areas are correctly identified.
- selective mapping exercise: 90 per cent of areas at risk are identified correctly and 95 per cent of low risk areas are correctly identified.

These rates of accuracy assume that:

- it is easier to accurately identify low risk areas than it is to accurately identify high risk areas; and,
- selective mapping exercises are likely to be individually more costly than a national mapping exercise, while also being individually more accurate, and requiring less areas to be mapped.

## *Benefits of the proposed amendments*

The rate of salinity damage is an important element when estimating the net benefits of the proposed amendments. A single house would require an additional $285 of construction costs aimed at removing a net present value of $7200 worth of damage[3]. In this case, the probability of salt attack would need to be greater than 4 per cent for a positive net benefit to be achieved. For a house that is assured of salt attack, this additional $285 of up front construction costs will be considered to be a good insurance investment.

However, as a national average, a required 4 per cent risk of salinity damage is quite high. Within the worst affected areas of Australia, such as

3 Note that $7200 is an over estimate of the average net present value of avoided salinity damage. This figure assumes that all houses will be damaged within the first 10 years. In reality, there will be some houses not affected for 15-20 years. Accounting for these factors lowers the average damage costs, further increasing the required probability of salt attack.

Wagga Wagga, it has been estimated that only approximately 8-10 per cent of the current building stock is at risk of being affected by salinity.

Table 1 presents the results of the three implementation options, including the net present value of the costs and benefits compared to the status quo option, and the estimated benefit cost ratio. Overall, all three implementation options are estimated to return a net cost to the economy, with the highest benefit cost ratio, 0.54, estimated for the highly accurate mapping exercise. The national roll out option yields the lowest net return to the Australian economy due to the additional costs potentially imposed on those dwellings not considered to be at risk of salt attack. Increasing the accuracy of the implementation option more than doubles the benefit cost ratio, also reducing the net costs by over 85 per cent.

### 1 Modelling results — alternative implementation options

| | *NPV costs* | *NPV benefits* | *BCR* | *NPV net benefits* |
|---|---|---|---|---|
| National roll out | 214 903 000 | 48 686 441 | 0.23 | -166 216 559 |
| National mapping | 52 247 886 | 22 121 702 | 0.42 | -30 126 184 |
| Selective mapping | 50 151 730 | 26 876 154 | 0.54 | -23 275 576 |

*Source: TheCIE estimates.*

However, it is recognised that these estimates are based on uncertain assumptions of damage costs, incidence rates of salinity damage as well as the accuracy of mapping exercises. Various sensitivity analyses have been undertaken, including a threshold analysis on salinity damage costs which is presented in table 2.

### 2 Sensitivity analysis — required damage costs for BCR of 1

| *Modelling framework* | *Implementation scenario* | *Central case damage costs* | *Required damage costs for benefit cost ratio of 1* | *Proportional increase over central case* |
|---|---|---|---|---|
| Regional | National roll out | $8 000 recurring | $35 000 recurring | 4.375 |
| | National mapping | $8 000 recurring | $19 000 recurring | 2.375 |
| | Selective mapping | $8 000 recurring | $15 000 recurring | 1.875 |

*Source: TheCIE estimates.*

Across the three implementation options, to achieve a benefit cost ratio of 1, the required level of average salinity damage costs range from $35 000 recurring every 10 years under a national rollout to $15 000 recurring every 10 years under a more selective rollout. Information gathered through the public consultation period will be used to clarify the level of average damage costs expected to be observed per salt attack.

Further sensitivity analyses have also been undertaken to investigate the potential impacts on the estimated net benefits from dividing the proposed amendments, and excluding the provisions for concrete curing and compaction. Difficulties with these estimates include the inability to categorically determine the level of protection afforded by each element of the proposed amendments. For example, a correctly laid and unbreached damp proof membrane (or even vapour proof barrier) will be able to provide sufficient protection against salt attack. However, where the membrane is incorrectly laid or breached in the construction process, the permeability of the slab becomes a critical element of building protection. The results of the sensitivity analysis are presented in table 3, where 3 alternate divisions of protection are tested.

### 3 Sensitivity analysis — removal of concrete curing requirements

| *Proportion of benefits concrete curing versus damp proof membrane* | *BCR — National roll out* | *BCR — National mapping* | *BCR — Selective mapping* |
|---|---:|---:|---:|
| 30:70 | 0.76 | 0.82 | 1.02 |
| 50:50 | 0.54 | 0.59 | 0.73 |
| 70:30 | 0.33 | 0.36 | 0.44 |

*Source: TheCIE estimates.*

Firstly, 30 per cent of protection from the proposed amendments is assumed to be derived from correctly cured concrete, and 70 per cent from the use of damp proof membranes. In this case, removal of the requirements for concrete curing would reduce costs by almost 80 per cent, but only reduce the estimated benefits by approximately 30 per cent. Under a selective mapping implementation option, a benefit cost ratio of 1.02 is estimated. As with all other scenarios, the more accurate selective mapping exercises return the highest benefit cost ratios.

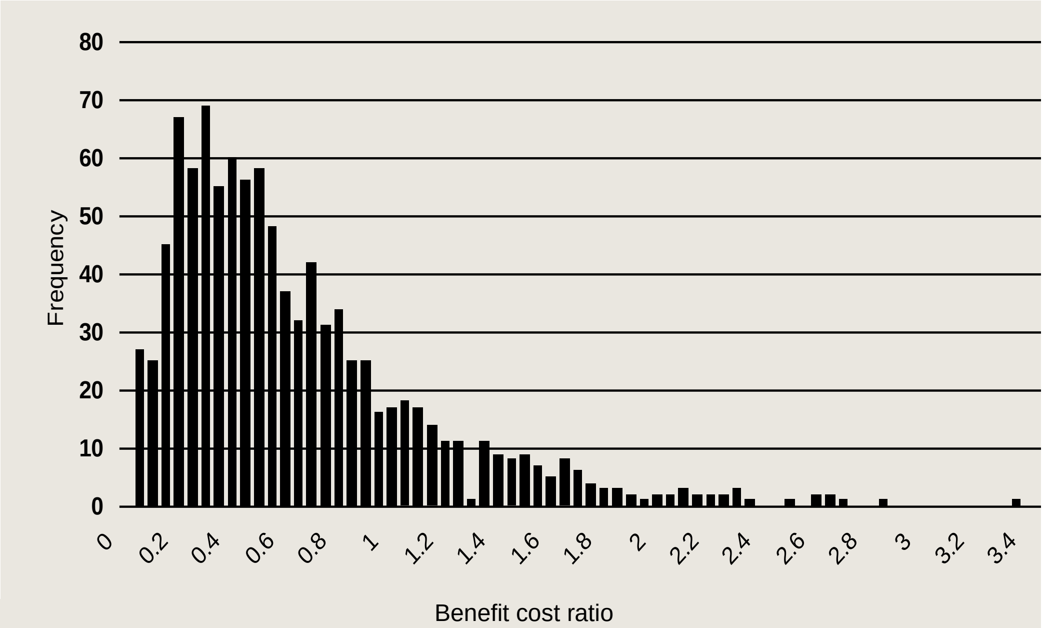
Finally, a Monte Carlo based sensitivity analysis was also undertaken, allowing for defined levels of uncertainty in variables such as the level of salinity damage, the discount rate, the rate of salinity risk, the accuracy of the mapping exercises and the additional construction costs. These results are presented in table 4 and chart 5.

### 4 Monte Carlo simulation — mapping based roll out

| *Variable* | *Value* |
|---|---:|
| Minimum | 0 |
| Maximum | 3.33 |
| Average | 0.62 |
| 5th percentile | 0.1 |
| 95th percentile | 1.61 |

*Source: TheCIE estimates.*

**5 Histogram — mapping based roll out Monte Carlo analysis**




*Data source: TheCIE estimates.*

Across the simulation, the average estimated benefit cost ratio is 0.62. In addition, 95 per cent of observations have a benefit cost ratio of below 1.61 (that is, the 95th percentile). Overall, there are 17.3 per cent of the simulations (173) that return a positive benefit cost ratio. These positive results are being driven through the generous assumptions on damage costs, as well as the potentially high accuracy of the mapping exercises allowed for within the simulations.

## *Results and consultation*

Preliminary results drawn out in this Consultation RIS indicate that while there will be significant benefits accruing to dwellings with a risk of salt attack above 4 per cent, under a national roll out and most mapping options, a net cost will be imposed on the Australian economy. This result is driven by the large numbers of dwellings, particularly in capital cities, that are not considered to be at risk of salt attack.[4]

However it is also noted that the introduction of mapping options, where the proposed amendments are only implemented in areas that are considered to be at risk, greatly increases the estimated benefit cost ratios of the proposals. Under all simulations, the most accurate mapping implementation option (termed selective mapping exercise, with accuracy

[4] This has been inferred from NLWRA reports and maps that indicate a greater prevalence of dryland salinity in rural and regional areas that maintain higher levels of agricultural production.

rates of 90 per cent in high risk areas and 95 per cent in low risk areas) returns the greatest net benefit to the Australian economy. The size of this net benefit depends heavily on the assumptions used. For example, in the central case, a Benefit to Cost Ratio (BCR) of 0.54 is returned under the selective mapping exercise, but where concrete curing requirements are excluded, and are assumed to account for only 30 per cent of the building protection benefits, a BCR of 1.02 is returned.

It should be noted that where there is a negative net benefit estimated (a figure less than 1.0), there is the potential for a regulatory failure. That is, greater costs imposed through regulation than allowing a market failure to persist, should the proposed changes be implemented.

To facilitate the development of this Consultation RIS, TheCIE completed a selected consultation program with members of the ABCB's Building Codes Committee (BCC). The BCC membership is made up of representatives of both government and industry and are responsible for providing advice to the Board of the ABCB on technical matters. This consultation was used to gather information on various issues, including experience with salinity across the Australian building industry and State and Territory Governments, as well as information on the costs of salinity damage and the potential for the proposed amendments to provide protection against salinity damage. Information on current industry practice was also drawn out.

Following this preliminary consultation process, there still remains uncertainty surrounding key variables. These key variables include the average damage costs of salinity and the level of protection afforded by the different elements of the proposed amendments and means that there is a large amount of uncertainty in these Consultation RIS results. A Monte Carlo simulation notes that while the average benefit cost ratio is below 1, where the level of mapping accuracy is high, when combined with high average damage costs, benefit cost ratios in excess of 2, may be achieved. Noting however, that the Monte Carol analysis only identified a 17.3 per cent probability of achieving a benefit cost ratio above 1.

Therefore, through the public consultation period, information is sought to further clarify these key areas of uncertainty. The following questions are included to guide this consultation period.

- **Understanding salinity issues**
- In what urban areas (cities, towns, or state regions) is salinity currently an issue for the building industry?
- Is there information on the urban areas that are likely to be at increased risk in the future?

- How do planning authorities include consideration of salinity issues in the planning process?

## Costs of salinity

- What are the on-going annual costs of building maintenance in a saline affected area?

## Proposed changes to the BCA

- Are the cost estimates of the proposed changes presented here (additional $285 for a 200m sq slab on ground house) an accurate representation of additional per house construction costs, or could they be updated?
- How should the protection benefits be divided across the different elements of the proposed amendments (that is, across damp proof membranes, courses and slab curing and compaction)?
- To what extent are the SA provisions, or other similar requirements (such as those found in AS 2870) for designing and constructing for saline protection, already being used in other States and Territories (and therefore, increasing the stringency would not impose any additional construction costs)?
  - That is, what is the current application of ‘high impact’ resistant damp-proofing membranes, outside of SA and NSW when ‘medium impact’ would suffice?
  - To what extent are curing and compaction currently being undertaken to either mitigate saline soils or for other reasons such as structural adequacy?
- What will be the implications of reducing the choice of acceptable materials used for damp-proof courses, such as currently applies in SA?
- Are the estimated costs of the salinity mapping exercises appropriate?

# 1 Introduction

Salinity has been identified as a growing problem in the Australian landscape, affecting a wide range of land areas, and land uses. Urban salinity, in which saline intrusion is observed in the soils of urban areas, particularly has the potential to damage most forms of infrastructure such as buildings and roads, as well as to reduce amenity and use values of land and infrastructure. The objective of this Consultation Regulation Impact Statement is to consider the options for expanding the current Building Code of Australia provisions for saline soils.

This chapter provides an overview of the policy context in which regulatory options are being considered to provide mitigation options against the effects of saline soils in the Australian building industry.

## Current legislative framework

The Building Code of Australia (BCA) contains the required technical standards for building construction in Australia. The goal of the BCA is to achieve the minimum necessary standards that are nationally consistent to ensure health, safety (including structural safety and safety from fire), amenity and sustainability objectives are met.

Where building and construction regulations are the authority of the State and Territory governments in Australia, the BCA is given power to cover technical aspects of building construction through individual State and Territory enacting legislation. These pieces of legislation generally cover a range of issues involving the construction and building industry including:

- Issuance of building permits;
- Inspections both during and after construction;
- Issuance of occupancy or compliance certificates; and
- Accreditation or approval of materials or components.

As a performance based code, the BCA requires that the construction industry is able to provide practical, safe and enduring buildings that are fit for their desired purposes. Within this framework, the BCA has performance requirements ensuring that buildings are not unduly susceptible to environmental elements, such as soil moisture and salinity. It is through these performance requirements that the BCA ensures there are adequate means to maintain structural protection against soil moisture and salinity damage.

## *Compliance path ways under the BCA*

For each element of the BCA, there are defined Performance Requirements for buildings constructed in Australia. These Performance Requirements mandate for example, requirements on the strength and durability of construction materials, desired outcomes for energy efficiency requirements as well as the generation and maintenance of safe and habitable living environments for residents.

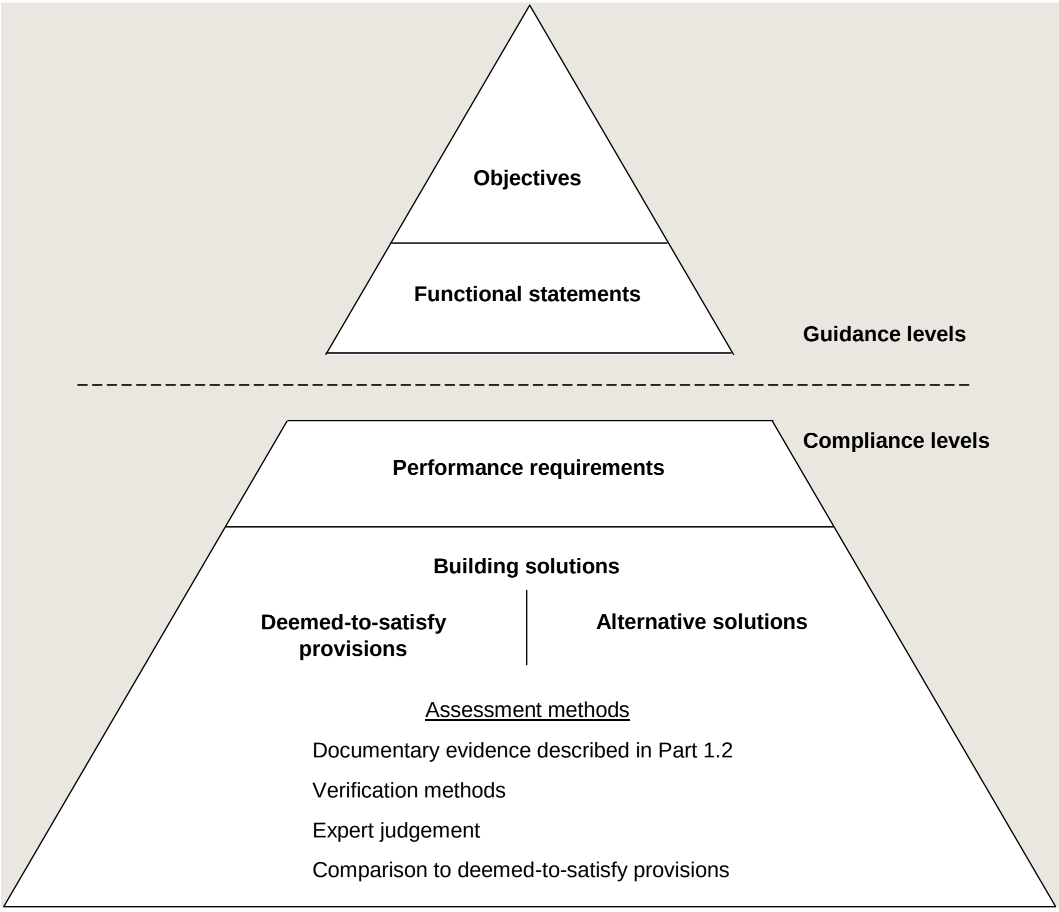
To achieve compliance with the BCA performance requirements, two alternate methods may be used. Firstly, Deemed-to-Satisfy (DtS) provisions are included in the BCA, identifying construction practices and references to Australian Standards that, when followed and adhered to, are considered sufficient to achieve the required Performance Requirements. The second option available is to propose an Alternative Solution, providing evidence that these alternative construction methods or materials are still able to achieve the required Performance Requirements.

These two options provide flexibility within the Australian construction industry to ensure that both safe and enduring buildings are constructed and that innovation in design and construction are facilitated.

Chart 1.1 provides an illustration of the BCA hierarchy and compliance pathways. The apex of the pyramid identifies the high level, overarching Objectives of the BCA. This is followed by Functional Statements referencing the issues that must be addressed to ensure that the Objectives mentioned above are achieved. Finally, the Performance Requirements are outlined, stating the required performance of the element or design through which objectives may be achieved — where the Performance Requirements may be met either by meeting DtS Provisions, or Alternative Solutions which achieve an equivalent level of performance.

A significant proportion of the DtS Provisions in the BCA, particularly with respect to salinity and moisture resistance, refer to different Australian Standards for both construction materials and practices. References to these associated standards are included to ensure that the Performance Requirements are met, and allow for Deemed to Satisfy methods to be used.

### 1.1 **The BCA Hierarchy**




*Data source: Figure 1.0.3 of BCA Volume Two, Guidance on compliance with the BCA.*

## *Current BCA provisions to protect against saline intrusion*

Buildings may be protected from the effects of saline soils and saline intrusion through physical barriers between the building construction and the affected soils, as well as the use of saline resistant building materials that either prevent or reduce damage from saline soils.

Provisions to protect buildings from the effects of saline intrusion and saline soils in the BCA are incorporated in the provisions for ‘Damp and Wetherproofing’ in Volume One and ‘Concrete and Reinforcing’ & ‘Weatherproofing of Masonry’ in Volume Two. These provisions ensure that buildings are protected from rising moisture in soils, as well as ensuring that concrete footings and brickwork are sufficiently resistant to degradation from environmental moisture effects.

The predominant method through which a building is protected from soil moisture and hence saline intrusion is the inclusion of a vapour barrier or damp proof membrane under the slab on ground, providing a physical barrier between the affected soil and the building. Additionally a damp proof course included in the construction of the walls may also be used to provide a barrier against moisture rising through the structure of the building.

- BCA Volume One (Class 2-9 buildings) provisions related to salinity[5]:
  - Performance Requirements BP1.1 requiring that buildings remain stable by resisting action to which it may be subjected to, including ground water action and FP1.5 requiring that moisture from the ground be prevented from causing undue dampness or deterioration of building elements and unhealthy or dangerous conditions, or loss of amenity for occupants;
  - DtS provisions F1.9 outlining requirements for buildings to be constructed to prevent damage from moisture, and F1.10 which requires that a vapour barrier be laid under the slab on ground or in infill.
- BCA Volume Two (Class 1 &10 building) provisions related to salinity[6]:
  - Performance requirement P2.2.3 which requires restriction of moisture from the ground from causing unhealthy or dangerous conditions, or loss of amenity for occupants; and undue dampness or deterioration of building elements.
  - DtS provisions are incorporated in sections 3.1, 3.2 and 3.3 of BCA Volume Two, covering issues such as:
    - 3.1.2.3 – water drainage away from Class 1 buildings;
    - 3.1.2.3 – minimum height of concrete slab above finished external surfaces as well as directional and drainage requirements to prevent water pooling;
    - 3.2.2.6 – requirements for vapour barriers to be in place below slab on ground construction;
    - 3.3.4.4 and 3.3.4.5 – outlining requirements for damp proof courses;
    - 3.3.1.5 – specifications for masonry located below a damp proof course, requiring Exposure Class materials where walls are expected to be exposed to salt attack or salt damp;
    - 3.3.1.6 providing specifications for mortar mixes.

As previously discussed, DtS provisions also make reference to Australian Standards, considered to achieve the Performance Requirements of the BCA. The standards referred to in terms of salinity management in the BCA include[7]:

---

[5] ABCB (2007) Salinity consultation paper.

[6] Ibid.

[7] Ibid.

- AS 2159/1995 (& 2009) Piling — durability requirements for concrete and steel piles that are dependent on the amount of sulphates and chlorides present in the soils, as well as the pH level of the soils;
- AS 3600/2001 Concrete structures — specifying requirements for concrete strength, reinforcing and curing requirements in high exposure locations;
- AS 2870/1996 Residential slabs and footings — providing requirements for vapour barriers and damp proof membranes, as well as detailing of damp proof courses and concrete vibration and curing in salt affected areas;
- AS 3700/2001 Masonry structures — specifications for salt attack resistant masonry and mortar requirements (Exposure Class).

### *Variations in South Australia and New South Wales*

As the State and Territory governments have jurisdiction over the building and construction industry, there is also State and Territory based jurisdiction over the implementation and application of the BCA within each State and Territory. To this end, State and Territory governments have the ability to introduce variations to the BCA, applicable only to construction undertaken within the jurisdiction. Such variations may range from either an increase in stringency or relaxation of existing BCA requirements, to a jurisdiction choosing not to implement proposed amendments to the BCA.

In the context of salinity issues, both South Australia and New South Wales have implemented variations to the BCA to provide additional protection from salt attack. These variations have been introduced due to a combination of i) expected greater prevalence and severity of salinity issues in these States, as well as ii) consideration that the BCA provisions are not strong enough to protect against salt attack in these higher risk areas.

The South Australian BCA variations and their predecessors addressing salinity have been in place since 1978 and include both an increase in the required impact resistance of the damp proof membrane being installed, as well as a reduction in the types of materials that may be used to construct a damp proof course. In addition, the South Australian variations also include greater stringency of requirements on the curing and compaction of concrete slabs.

The New South Wales variations are both more recent and less stringent than the South Australian variations. Implemented in 2004, the New South Wales variations replicate the South Australian variations on the impact resistance of the damp proof membranes, but not the required materials for damp proof courses or concrete curing requirements.

Underlying the national concerns for protecting buildings against the effects of saline soils, there is also a push for increased consistency in the BCA across States and Territories in Australia. Therefore, included in this Consultation RIS are both regionalised and nationally applied solutions.

## *Policy context*

The Australian construction industry has been considering issues of urban salinity for many years, with progressive policy assessment frameworks and research and consultation assessments already having been developed. These frameworks have been developed at all levels of government — Commonwealth, State and Local — as well as by environmental groups such as catchment management authorities. Given the highly localised effects of urban salinity, the depth of research and implementation of activities vary widely across Australia, see box 1.2.

Critical to the assessment in this Consultation RIS is that the majority of the research questions and evaluation studies of salinity issues in Australia have considered the potential to reduce the occurrence of salinity, through for example, targeting water table levels and vegetation policies. In addition, the majority of mapping exercises have been undertaken to estimate the broad extent of salinity, and in particular dryland salinity, affecting agricultural lands.

Therefore, while issues of urban salinity and its effects on the building industry have been recognised for many years (since the late 1970s in South Australia), there has been limited coordinated research into the extent of the effects across urban areas in Australia. There have also only been limited projections made of the estimated costs of urban salinity in Australia.

Across the building industry at a national level, consideration of urban salinity and its impacts on buildings has progressed since 2001 when an Australian Building Codes Board (ABCB) National Technical Summit (NTS) was held. The conclusion of the NTS was that urban salinity was a growing issue, damaging buildings in certain areas of Australia. A number of options to expand the provisions in the BCA were suggested, including both regionally specific and across the board (National) changes to the BCA. A further option that was opened for consideration was to allow local

## 1.2 State government policies to address urban salinity

### South Australia

Variations made to the BCA predecessor in 1978 and carried through to the BCA. The variations require additional stringency on damp proof courses and membranes, as well as additional requirements for slab compaction and curing.

### New South Wales

Variations made to the BCA in 2004, requiring additional stringency on damp proof membranes. Further to State wide variations, the local councils of Junee, Fairfield and Camden also require that the South Australian variations to the BCA be met for all new constructions. Further localised policies are also in force in high salt risk areas such as Dubbo and Wagga Wagga.

### Western Australia

Highly localised salinity programs have been set up across south eastern Western Australia. These include information services, as well as physical solutions to urban salinity such as ground water pumping.

### Victoria

Where urban salinity is considered to be a risk in Victoria, power is transferred to local councils to manage land use planning. In general, development is limited in salinity prone areas in an attempt to minimise the extent of infrastructure damage.

### Queensland

Salinity is not considered to be a current issue in urban areas in Queensland, and so limited policy responses have been enacted. The current provisions of the BCA are considered to be sufficient to protect against the limited observances of urban salinity.

### Northern Territory

As dryland salinity is not considered to be an issue in the Northern Territory, there are no specific policies addressing urban salinity.

### Tasmania

While mapping exercises have been undertaken, with limited urban salinity reported, no specific policies have been introduced in Tasmania.

### Australian Capital Territory

With no drlyand salinity issues present, there are no urban salinity policies in the Australian Capital Territory.

councils to develop provisions and guidelines external to the BCA[8].

Further to these proposed direct amendments to the BCA, in November 2005, the ABCB wrote to Standards Australia to request that issues surrounding building in saline environments be included in the relevant standards. As the BCA references these associated standards, this was a first step in increasing requirements for building protections against salt attacks.

To date, there has been no change to the BCA to address salinity issues directly. However where salinity is considered to be a significant issue, State and Territory governments are addressing these local issues at a regional level, see box 1.2.

## *Purpose of the report*

Given the regulatory nature of the BCA and the fact that it is jointly produced by the Australian Government and the State and Territory Governments, the expansion of saline provisions in the BCA is subject to a RIS. In light of this, the ABCB has commissioned the Centre for International Economics (TheCIE) to develop a Consultation RIS that assesses the costs and benefits of proposed changes to the stringency of requirements (damp proofing) for saline soils in the BCA.

The proposed changes being assessed within this Consultation RIS are various methods of expanding the current South Australian variations to mitigate against the effects of saline soils.

This report is aimed at assisting a wide range of built environment related stakeholders in providing feedback to the ABCB on the proposed changes to the BCA. Dependent on the outcomes of this Consultation RIS and following public consultation, a decision will be made as to whether a Final RIS will be developed.

## *Regulatory review process*

Depending on the level of government jurisdiction, new regulations must adhere to either the Australian Government or the Council of Australian Governments (COAG) requirements for best practice regulation requirements. All changes to the BCA are required to meet the COAG principles of best practice regulation. These are that:

---

[8] As will be discussed, this option is problematic with States conferring different levels of authority to local planning agencies with respect to technical construction standards.

1. a case for action be established before addressing a problem;
2. a range of feasible policy options must be considered, including self-regulatory, co-regulatory and non-regulatory approaches, and their benefits and costs assessed;
3. the option that generates the greatest net benefit for the community be adopted;
4. in accordance with the Competition Principles Agreement, legislation should not restrict competition unless it can be demonstrated that:
   a) the benefits of the restrictions to the community as a whole outweigh the costs, and
   b) the objectives of the regulation can only be achieved by restricting competition
5. effective guidance is provided to relevant regulators and regulated parties in order to ensure that the policy intent and expected compliance requirements of the regulation are clear;
6. the regulation remains relevant and effective over time;
7. effective consultation is continued with affected key stakeholders at all stages of the regulatory cycle; and
8. government action should be effective and proportional to the issue being addressed.

This report acts as the Consultation RIS, documenting the changes under consideration and detailing their expected costs and benefits.

The RIS has been developed in accordance with the COAG regulatory principles set out in Best Practice Regulation: A Guide for Ministerial Councils and National Standard Setting Bodies (COAG Guidelines).

The RIS process is aimed at ensuring that the preferred government action is both ‘warranted’ and ‘justified’ (OBPR 2007). As such, a RIS should present any available evidence on benefits and costs. The process of developing a RIS is intended to enhance the transparency of the regulatory process (and thereby promote public scrutiny and debate) to provide comprehensive treatment of the anticipated (and unintended) consequences of the proposed changes.

## *Scope of the RIS*

While the proposed regulatory options are designed to address the effects of saline intrusion in all new buildings, they are predominantly targeted at residential dwellings, either detached or semi-detached. A general summary of building classifications in the BCA is provided in table 1.3.

Quantitative assessments in this RIS will focus predominantly on class 1a and 1b buildings. This is due to the site and building specific measures that may be taken for larger scale commercial buildings which preclude an 'average building' based analysis from being undertaken.

## 1.3 Classifications of buildings and structures used in the BCA

| *Class* | *Description* |
|---|---|
| Class 1a | A single detached house or one or more attached dwellings, each being a building, separated by a fire-resisting wall, including a row house, terrace house, town house or villa unit. |
| Class 1b | A boarding house, guest house, hostel or the like with a total floor area not exceeding 300 m2 and in which not more than 12 persons would ordinarily be resident, which is not located above or below another dwelling or another Class of building other than a private garage. |
| Class 2 | A building containing 2 or more sole-occupancy units each being a separate dwelling. |
| Class 3 | A residential building, other than a Class 1 or 2 building, which is a common place of long term or transient living for a number of unrelated persons. Example: boarding house, hostel, backpacker's accommodation or residential part of a hotel, motel, school or detention centre. |
| Class 4 | A single dwelling in a Class 5, 6, 7, 8 or 9 building. |
| Class 5 | An office building used for professional or commercial purposes, excluding buildings of Class 6, 7, 8 or 9. |
| Class 6 | A shop or other building for the sale of goods by retail or the supply of services direct to the public, including:<br>(a) an eating room, cafe, restaurant, milk or soft-drink bar; or<br>(b) a dining room, bar, shop or kiosk part of a hotel or motel; or<br>(c) a hairdresser's or barber's shop, public laundry, or undertaker's establishment; or<br>(d) market or sale room, showroom, or service station. |
| Class 7a | A building which is a carpark. |
| Class 7b | A building which is for storage, or display of goods or produce for sale by wholesale. |
| Class 8 | A laboratory, or a building in which a handicraft or process for the production, assembling, altering, repairing, packing, finishing, or cleaning of goods or produce is carried on for trade, sale, or gain. |
| Class 9a | A health-care building; including those parts of the building set aside as a laboratory; or |
| Class 9b | An assembly building, including a trade workshop, laboratory or the like in a primary or secondary school, but excluding any other parts of the building that are of another Class. |
| Class 9c | An aged care facility. |
| Class 10a | A non-habitable building being a private garage, carport, shed, or the like. |
| Class 10b | A structure being a fence, mast, antenna, retaining or free-standing wall, swimming pool, or the like. |

*Source: Building Code of Australia.*

# 2 Nature and extent of the problem

This section considers the need for government action, the physical drivers of salinity as well as the distribution of both dryland salinity and urban salinity across Australia.

## Role of government and salinity based market failures

There is a suggested need for government intervention driven by a need to resolve uncertainty surrounding building longevity and performance in light of changing regional risks of salt attack, and the difficulties markets have had in responding appropriately.

The role of the Australian Government, through the ABCB and the BCA, is to observe the operations and interactions within the Australian building industry and ensure that market failures are minimised, without introducing regulatory failure (that is, imposing greater costs through regulation than would be imposed by allowing the market failure to continue).

In the context of urban salinity, a regulatory failure would be introduced if the changes made to the BCA introduced greater costs to the Australian construction industry than would have otherwise been faced if no changes were made. The analysis in this Consultation RIS will estimate the relative costs of action compared to the status quo of maintaining current building requirements. Where there is a negative net benefit estimated, there is the potential for a regulatory failure to be introduced should the proposed changes be implemented.

As noted above, it is the resolution of uncertainty and information issues with respect to building longevity and performance that is the key driver concerning urban salinity and the proposed changes to the BCA. While the uncertainty surrounding the physical processes of salinity may not be resolved, the performance of a building subject to salt attack will be.

Where urban and dryland salinity are plagued by a number of levels of uncertainty they are primarily based around the geography and hydrology of a given catchment. These factors determine the depth of the water table in a given area, flow rates of ground water through the catchment, and recharge and discharge regions. The uncertainty at this level of the salinity problem means that it is very difficult to assess the impact of actions by any parties in both the immediate area, or in surrounding or distant areas.

Further timing issues complicate potential mapping exercises since activities undertaken in a given location could take anywhere between a few years to a few decades to manifest in a salinity issue in another, more removed location.

And finally, once salinity effects have manifested in a given region, there are many different hydrological and topographical effects working to make specific sites more or less susceptible to salinity effects than others.

Without complete information on the physical science of a catchment, as well as knowledge of activities that have either been undertaken in the past, or being currently undertaken in the catchment, it is very difficult and almost impossible to be able to identify individual sites at high risk of salt attack.

However, without this information markets cannot efficiently respond to minimise potential impacts of urban salinity on buildings and dwellings. Firstly, buyers and sellers may not be aware of the existence of the potential problem or the risks associated with it. Further, mitigation technologies may not be easily verified or detected once they are buried beneath a slab.

In addition to these information issues, builders and first home owners may not face clear incentives to attempt to mitigate against the threat of salinity damage given: the uncertainty of the problem; the delayed nature of the effects; and, the relatively short period of first home ownership. To builders and first home owners the cheapest strategy may be to ignore mitigation technologies.

The effect of hidden actions such as ignoring mitigation technologies is to generate additional costs for subsequent owners who may be forced to foot the bill. More widely, neighbourhood costs may also be imposed if subsequent salinity attacks create uncertainty among neighbouring properties.

Government intervention that specifies efficient mitigating technologies and can verify their use may overcome these problems. Whether it pays to do so is an empirical question.

In general, where a region is considered to be at high risk of urban salinity, there will always be some houses that suffer greatly while others are able to avoid the effects entirely. This extreme level of uncertainty introduces an information uncertainty into the housing construction market. To address this missing information, without introducing a regulatory failure, it should be assessed whether it is more cost effective to provide insurance against the possibility of damage for all buildings, or alternatively to pay the upfront costs of establishing the missing information, without introducing regulatory failure. These two options reflect the implementation options that will be considered in section 3 — firstly the national roll out implementation option (insurance), and secondly the mapping exercises (establishing the missing information).

## *The salinity process*

Salts are naturally present in both the soils and groundwater systems of Australia. Environmental issues associated with saline soils arise when the concentration of these salts is increased and they are mobilised, through increasingly high water tables, for example. In these instances, rising water tables lift the salts to the surface, where the ground water then evaporates and leaves salt deposits.

At a simplified level, salinity issues arise when the hydrological balance is disrupted, through either an increase in water application (for example, through irrigation) or a reduction in ground water use (for example, through vegetation clearing). Therefore, land use change and urban development are two key factors contributing to the expanding salinity issues being observed in areas around Australia.

Difficulties associated with the study, tracking and management of all forms of salinity arise due to the dynamic nature of the problem. Driven by hydrological and geographic elements such as water table levels and ground water flows, as well as soil types and regional topography, areas that are affected by salinity may not be located in close vicinity to the activities that are causing it. This is particularly the case with regional recharge areas where, for example, land clearing for agricultural purposes that may both increase the level of water application, and reduce the rate of water use in a given area, may generate a rise in the ground water level a number of kilometres away. In these regional recharge areas, that cover a large hydrological system, not only may cause and effect be separated by large distances, symptoms of salinity may take up to 50 years to be observed. In these cases, effective treatment of the issue will also include a significant time delay to rectify the hydrological balance.

However, some systems are highly localised, with the time taken for symptoms to present themselves being much shorter, perhaps from 2-10 years. In such localised systems, actions taken within the local region are directly affecting the local salinity outcomes. Actions by residents and local authorities have the potential to exacerbate local urban salinity problems through, for example, over watering of gardens and public open spaces, poorly maintained and leaking infrastructure, and town layouts impeding water flow and creating drainage problems.[9] Wagga Wagga and catchments across Western Sydney are considered to be localised systems.[10]

Further issues that are beginning to come to light with the development of sustainable cities are the effects of water reuse systems. When located in urban areas already facing some risk of urban salinity there is a risk that the increased salt load of re-used water applied to gardens and outdoor areas may be great enough to either generate or exacerbate salinity issues in the region. The potential for this effect to be observed is of particular concern in areas of rapid urbanisation already affected by saline soils, for example the western Sydney region, where sustainable cities are being promoted.

## *Nature of salinity risk on buildings*

Increasing salinity in soils is an issue of concern to the building industry due to the potential for salt attacks on buildings to weaken structures, increasing the risk of failure. Buildings and infrastructure are considered to be at risk of damage when the water table is less than 2m from the ground surface.[11] In 2000, it was estimated that 68 Australian towns were affected by urban salinity, with this figure projected to increase to approximately 125 by 2020 and 219 by 2050.[12] These towns were located across New South Wales, Western Australia, South Australia and Victoria.

While there are a number of avenues through which salinity may affect a building structure, including rising damp, falling damp and condensation, this RIS is directed at possible regulatory and non-regulatory options to mitigate against the effects of rising damp from saline soils. In this situation, saline soil moisture is absorbed into the building structure through direct contact with saline soils. Where this moisture is heavily laden with salts, a direct physical attack from the mobilised salts occurs when the structure is first wetted and then allowed to dry. When this process is repeated, the formation and dissolving of salt crystals in the bricks and building structure weakens and eventually causes the bricks

[9] IPWEA (2002) Local Government Salinity Management Handbook: A resource guide for the public works professional.

[10] Hayward, S. (2000) Urban Salinity – the ultimate constraint to development, Department of Land and Water Conservation, Sydney South Coast Region.

[11] IPWEA (2002) Local Government Salinity Management Handbook: A resource guide for the public works professional.

[12] National Land and Water Resources Audit (2000) Australian dryland salinity assessment 2000

and structure to deteriorate.[13] Such deterioration also extends to building concrete and reinforcement elements that are susceptible to corrosion and loss of strength due to salt attacks.

There are four elements that are required for salinity effects to be observed in a building:

- presence of salt in the soil;
- moisture in the surrounding soil to mobilise the salts;
- permeability of the slab, and / or damp proof membrane; and
- evaporation of moisture, leaving salts within the structure.

Currently, provisions to manage rising damp — and through these, salinity — are explicitly covered in both the BCA and referred standards. However, with concerns that the risks of urban and rural salinity are likely to increase over time, and the increased potential for damage to building structures, the ABCB is proposing to broaden provisions in the BCA to specifically target the effects of saline soils.

Due to the nature of salinity issues there are a number of difficulties associated with such a proposal to expand salinity provisions within the BCA. These include the inability to precisely determine the locations in which increased urban salinity will result, as well as a level of uncertainty surrounding the rate at which dryland salinity may spread and affect constructions. The costs and benefits of such a proposal are highly dependent on issues such as the costs that will be faced if the current framework is maintained, as well as the costs of imposing changes on new building constructions, and the level of damage that may be avoided by such an imposition. All of these issues are regionally specific and are determined through the State and regional distribution of salinity impacts as well as the nature of salinity problems experienced across Australia.

## *Extent of salinity effects across Australia*

As previously discussed, the majority of studies into salinity in Australia have considered dryland salinity, targeted predominantly at agricultural lands. However, this information, when provided at a national level can be utilised to assess those areas that are at potentially increased risk of urban salinity in the future. Most figures and findings in this section have been drawn from the National Land and Water Resources Audit (NLWRA 2000).

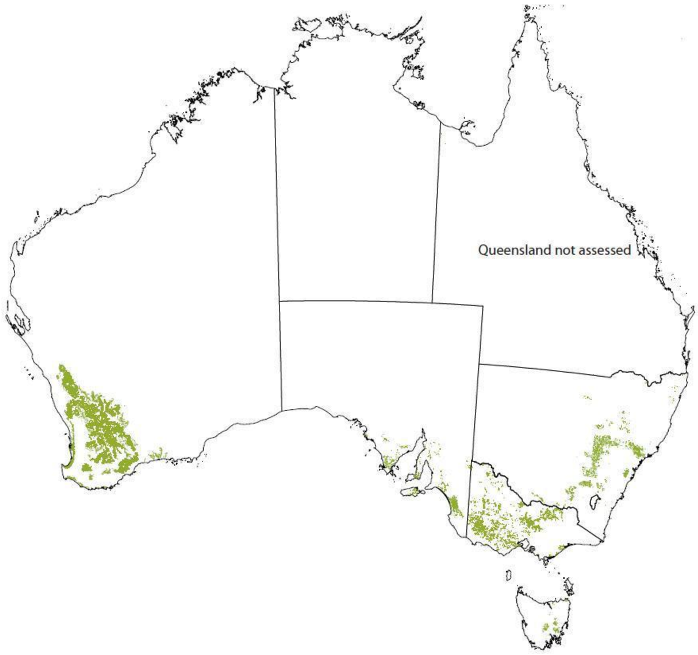
Charts 2.1 and 2.2 provide an indication of the spread in dryland salinity projected over the period 2000-2050. Where salinity has been reported to

---

[13] DECC NSW (2008) Building in a saline environment.

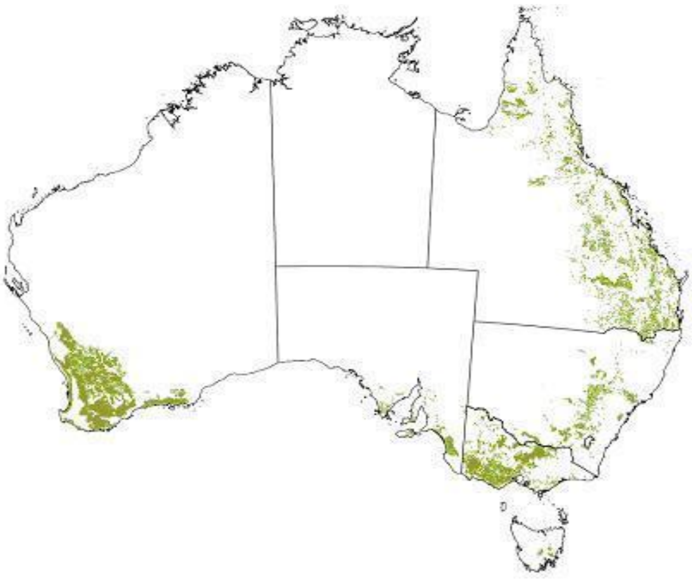
be affecting towns and cities in South Australia, New South Wales, Victoria and Western Australia, projections of the rate and location of dryland salinity growth have indicated that this spread will affect more than 200 towns across Australia by 2050.

### 2.1 **Areas at high hazard or risk of dryland salinity in 2000**




*Data source: Australian Natural Resources Atlas.*

### 2.2 **Areas forecast to contain land of high hazard or risk of dryland salinity in 2050**



*Data source: Australian Natural Resources Atlas.*

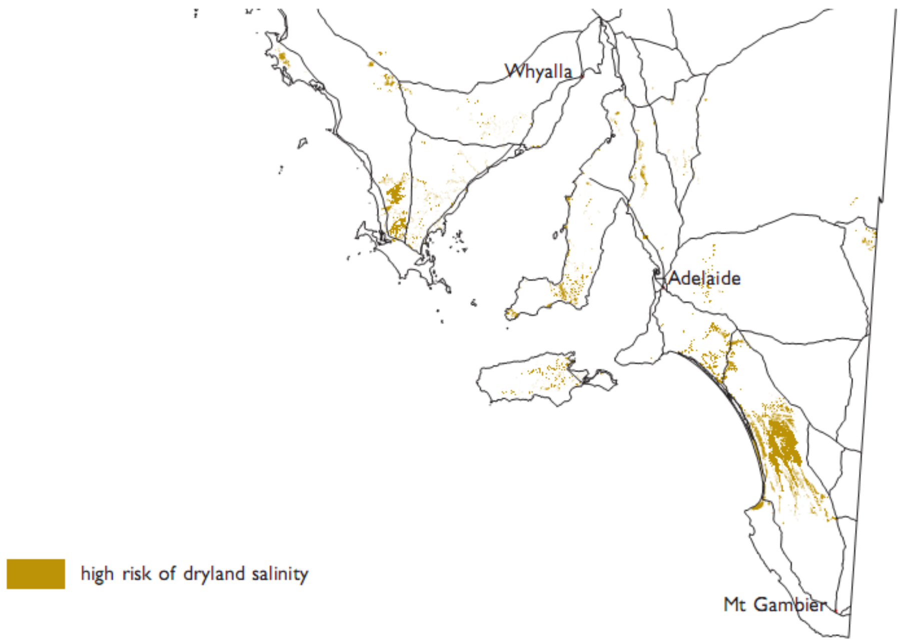
## *South Australia*

The upper south east region was reportedly the most heavily salt affected region of SA, according to the NLWRA. With approximately 326,000 ha of salt affected land in South Australia in 2000, this figure is projected to increase by up to 60 per cent, to 521,000 ha by 2050 as represented in charts 2.3 and 2.4.

There is however, some discrepancy between South Australian State Government reports of the effects of salinity and results from the NLWRA. In 2000, the NLWRA reported that there were no towns at risk of dryland salinity in SA, and by 2050, there were only 2 towns (Tintinara and Commandook) projected to be at risk of dryland salinity effects. Annual building maintenance costs due to salinity were estimated to grow from approximately $1.1m per year in 2000, to $1.4m per year in 2020, to $1.9m per year in 2050[14].

However, reports from the South Australian State Government indicate that urban salinity is a widespread issue in South Australia, having required increased stringency in building requirements since 1978. One possible explanation for this discrepancy includes the targeting of agricultural dryland salinity in the NLWRA report, or alternatively where the additional building requirements are considered to provide sufficient protection to most urban areas.

2.3 **South Australian areas at risk of salinity, 2000**

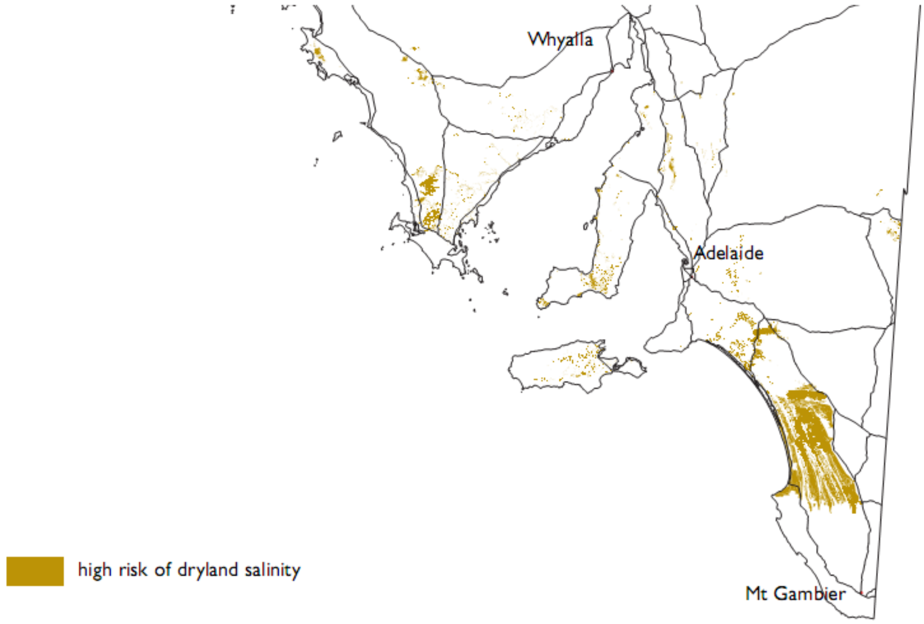



*Data source: NLWRA (2000).*

---

14 NLWRA (2000).

2.4 **South Australian areas at risk of salinity, 2050**




*Data source: NLWRA (2000).*

## ***New South Wales***

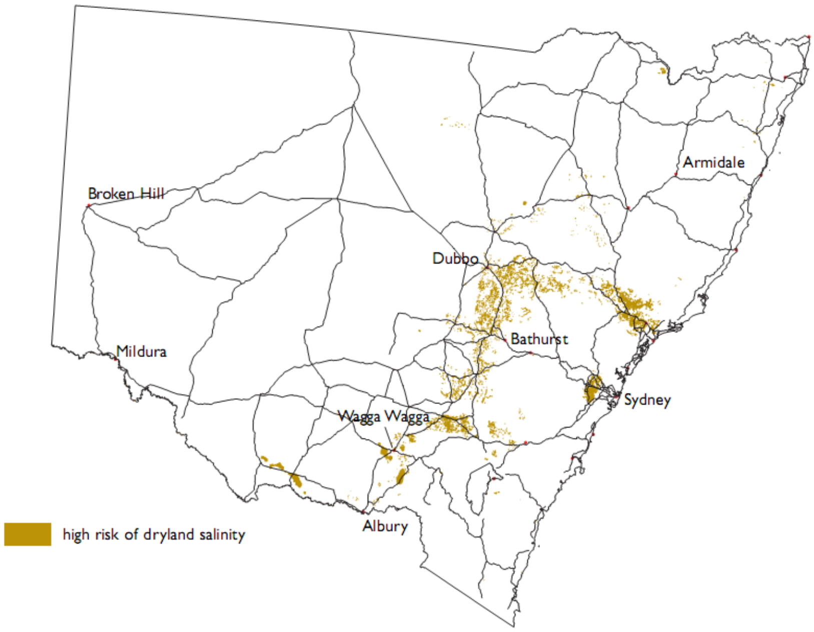
Salinity issues in New South Wales are concentrated in five catchments, generally in the eastern areas of the Murray Darling Basin:

- Murray;
- Murrumbidgee;
- Lachlan;
- Macquarie; and
- Hunter.

A more than eight fold increase in New South Wales Murray Darling basin land area affected by dryland salinity is projected over 2000 to 2050. This growth is represented in charts 2.5 and 2.6.

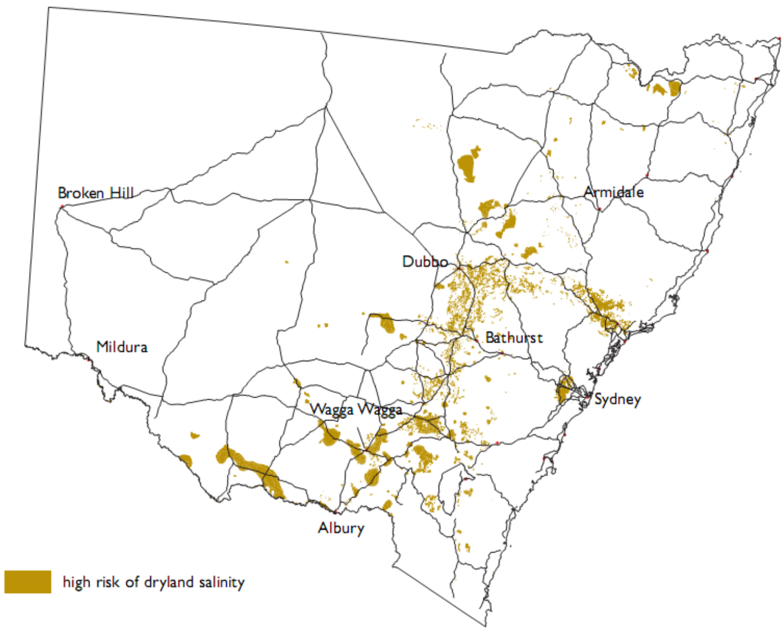
The fastest rates of growth in dryland salinity are projected to occur in the inland catchments, including the Bogan, the Macquarie and the Namoi. Dryland salinity is also expected to intensify in the western Sydney region.

## 2.5 **New South Wales areas affected by salinity, 2000**




*Data source: NLWRA (2000).*

## 2.6 **New South Wales areas affected by salinity, 2050**




*Data source: NLWRA (2000).*

In 2000, there were estimated to be 954 hectares of developed land in New South Wales affected by salinity. This figure is projected to increase to over 3600 hectares by 2050. This growth in developed land affected by salinity drives the rapid growth in the number of towns projected to be affected by salinity in the near future.

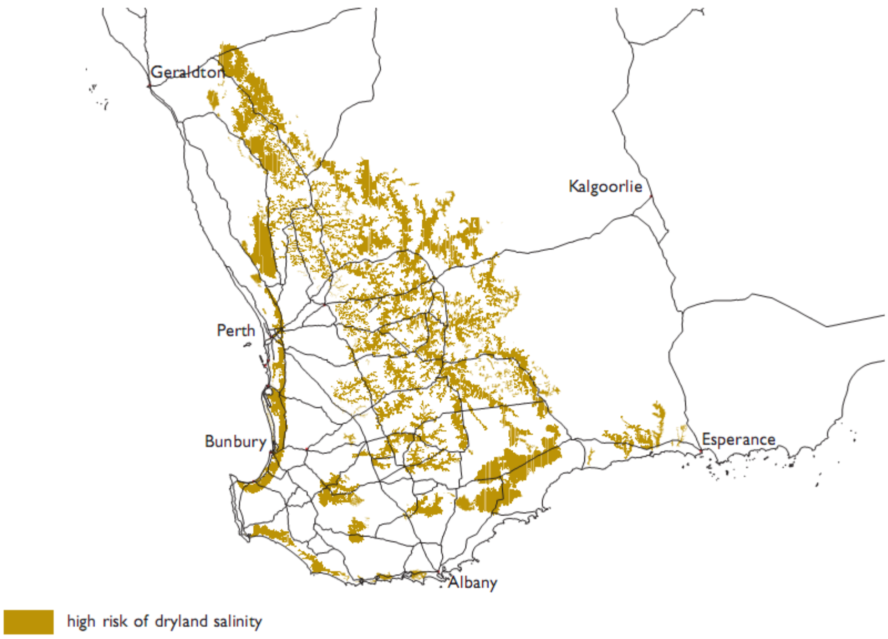
In 2000, there were 38 New South Wales towns estimated to be affected by dryland salinity and high water tables. By 2020, this figure is projected to rise to 82, and by 2050, there are projected to be 125 New South Wales towns at risk from salinity and high water tables.

## *Western Australia*

While Western Australia currently has the largest area of land affected by dryland salinity of any State in Australia, this is predominantly (81 per cent) located in the agricultural areas of south west Western Australia. In total, 4.3 million hectares of land was estimated to be affected by dryland salinity in 2000, with this figure projected to rise to 8.8 million hectares by 2050.

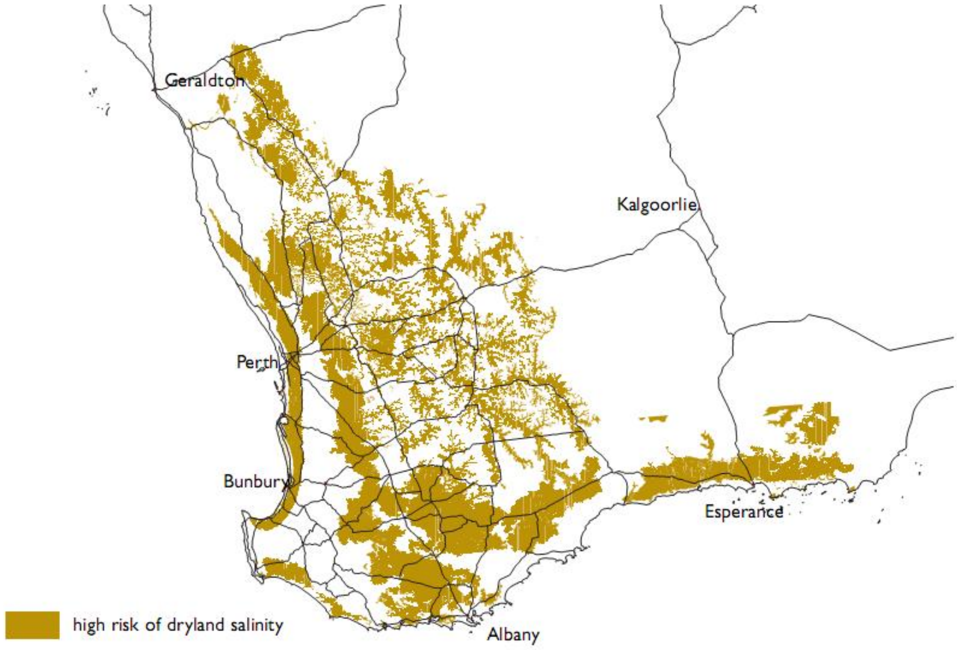
There were estimated to be 20 towns affected by salinity in 2000, with this projected to increase to 29 towns by 2050. The costs associated with this expanding urban salinity in Western Australia is estimated at approximately $5 million per year over 50 years, but could be in the range of $2-16 million per year depending on the severity of expansion rates.

2.7 **Western Australian areas affected by salinity, 2020**




*Data source: NLWRA (2000).*

### 2.8 **Western Australian areas affected by salinity, 2050**




*Data source: NLWRA (2000).*

Through the Western Australia rural salinity program, the salinity risk of towns across south west Western Australia was assessed. The results are presented in table 2.9, which includes projections of the risk assessment. These 27 towns do not represent the full risk of urban salinity in Western Australia.

### 2.9 **Towns considered at risk of salinity in Western Australia**

| Town | Risk 2020 | Risk 2050 | Town | Risk 2020 | Risk 2050 |
|---|---|---|---|---|---|
| Harvey | H | H | Brookton | H | H |
| Three Springs | M | H | Carnamah | H | H |
| Gnowangerup | M | H | Coorow | H | H |
| Jerramungup | H | H | Calingiri | H | H |
| Cranbrook | H | H | Wagin | H | H |
| Boyup Brook | H | H | Williams | H | H |
| Darkan | H | H | Beacon | H | H |
| Boddington | M | H | Kellerberrin | H | H |
| Walpole | H | H | Koorda | H | H |
| Mt. Barker | M | H | Merredin | H | H |
| Northam | M | H | Mukinbudin | H | H |
| Moora | H | H | Narembeen | H | H |
| Katanning | M | H | Kondinin | H | H |
| | | | Perenjori | H | H |

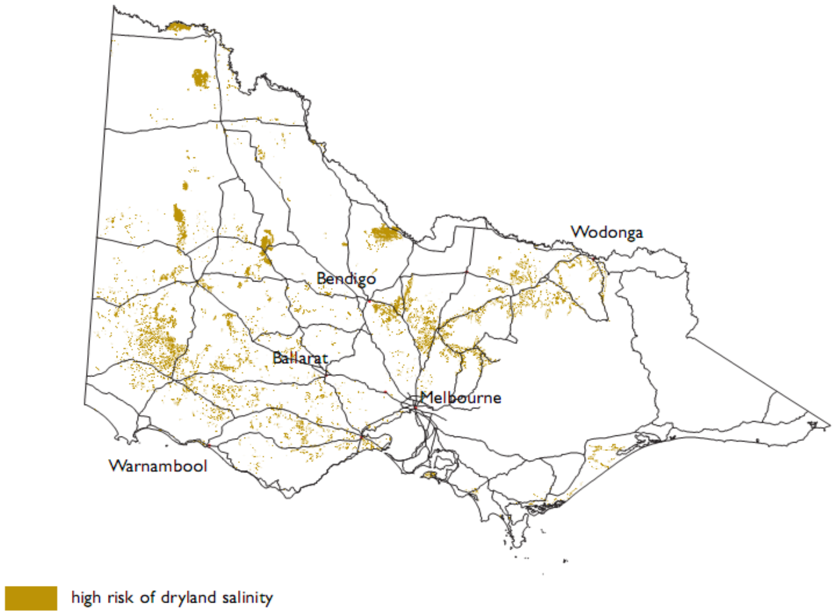
*Source: West Australian Salinity Strategy.*

## *Victoria*

Across Victoria, the land area affected by dryland salinity is projected to increase from 670 000 hectares in 2000 to over 3 million hectares by

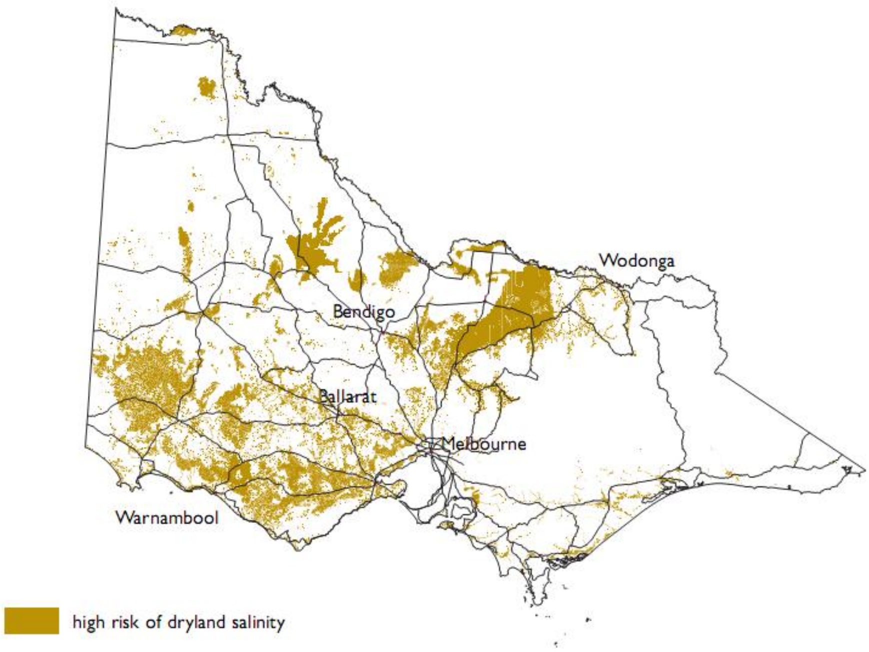
2050. The highest risk areas are located in the north of the State, however, by 2050, the risk is expected to expand significantly in the south west region as well. Charts 2.10 and 2.11 illustrate this expansion in salinity risk.

### 2.10 **Victorian areas at risk of salinity, 2000**




*Data source: NLWRA (2000).*

### 2.11 **Victorian areas at risk of salinity, 2050**




*Data source: NLWRA (2000).*

Victoria has one of the fastest rates of growth in the number of towns considered to be at risk from salinity over 2000-2050. In 2000, 10 towns were estimated to be at risk of high watertables and dryland salinity, increasing to 21 by 2020, and then tripling by 2050 to approximately 63 towns. Specific towns that have been identified as being at risk, by both population size and location are presented in table 2.12. Note that these lists are not exhaustive and limited to towns of less than 20 000 people.

2.12 **Towns and populations at risk of salinity in Victoria**

| **Towns with 500-1000 people** | **Towns with 1000-5000 people** | | **Towns with 5000-10 000 people** | **Towns with 10000-20000 people** |
|---|---|---|---|---|
| Apollo Bay | Anglesea | Gisborne | Benalla | Colac |
| Avenal | Ballan | Heathcote | Clifton Springs | Horsham |
| Bannockburn | Beaufort | Koo-Wee-Rup | Hastings | Portland |
| Eildon | Broadford | Lancefield | Lara | Sale |
| Indented Head | Casterton | Lorne | | |
| Timboon | Charlton | Myrtleford | | |
| Violet Town | Cobram | Nagambie | | |
| Winchelsea | Dromana | Numurkah | | |
| Wycheproof | Drysdale | Paynesville | | |
| Yea | Euroa | Port Fairy | | |
| | Torquay | Romsey | | |
| | Yarrawonga | Rushworth | | |
| | | Terang | | |

*Source: http://www.anra.gov.au/topics/salinity/impacts/vic.html#infrastructure.*

## *Queensland*

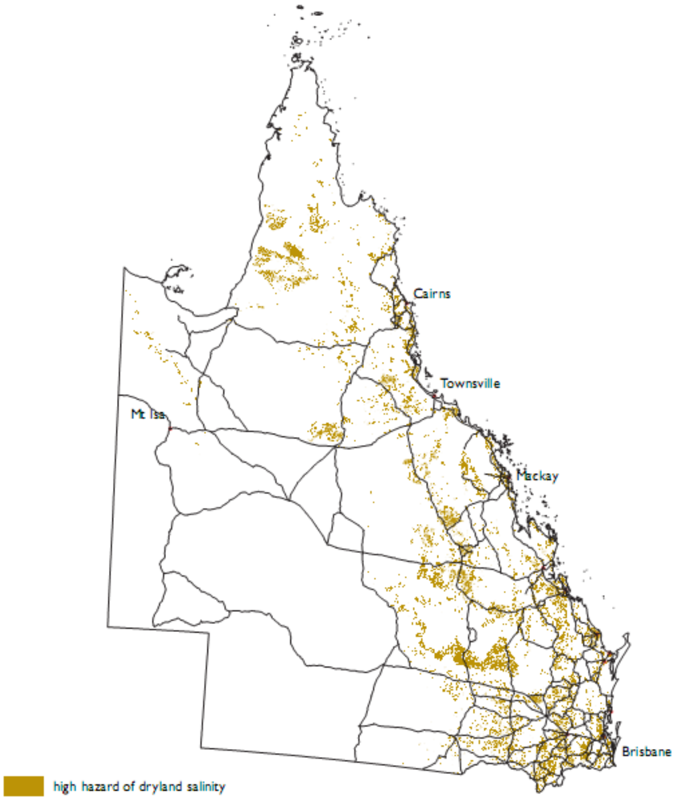
Due to limited data availability, salinity was not mapped across Queensland for 2000. However, projections of the amount of land affected by salinity in 2050 were determined using a number of data sources covering the Atlas of Australian soils, elevation maps and expected land use change.

Overall, urban salinity was not noted as a major problem in Queensland, and this was supported by discussions with the Queensland government. There have been no studies into the costs of salinity in Queensland due to outbreaks tending to be small and localised, with limited effect on either towns or agricultural lands.

Within the Queensland Murray-Darling Basin area[15], there were estimated to be approximately $40 000 per year of total repair and maintenance costs to urban households of which, $10 000 per year (not including the effects of saline water supply) was due to the effects of high saline water tables.

[15] http://lwa.gov.au/files/products/national-dryland-salinity-program/ef010662/ef010662.pdf

2.13 **QLD areas at risk of salinity 2050**




*Data source: NLWRA (2000).*

### *Northern Territory*

Where salinity risk has been investigated in the Northern Territory in the mid to late 1990s there were no areas considered to be at high risk of dryland salinity. Only 6 per cent of the land area was considered to be a moderate salt hazard, 34 per cent low hazard and 60 per cent very low. Moderate salinity risk is concentrated in the Sturt Plateau region.

### *Tasmania*

Salinity effects were mapped and found to be concentrated in the central agricultural areas of Tasmania, the midlands, as well as some observance in northern Tasmania and King and Flinders Islands. There was no evidence of damage to infrastructure from salinity reported in the NLWRA (2000).

## *Costs of salinity in Australia*

Following the difficulties that are associated with tracking and projecting movements of salinity across Australia, there are also difficulties and uncertainties associated with assessing the costs of urban salinity. While an area or town may be considered to be at risk of salinity, and buildings susceptible to salt attack, it is not guaranteed that these effects will eventuate.

Observance of the salt attacks on buildings and houses is reported to be patchy and considerably random. Based on a number of factors including topography of the surrounding land as well as site specific topography, urban salinity may affect only one or two houses in a street, or it may affect a whole row of houses in a street.

In addition to the uncertainty associated with a salt attack occurring, the costs of salinity are also highly variable. Costs depend on issues such as:

- the extent of the saline intrusion, and the location of the damage in the house structure (for example, above or below the damp proof course, bricks and/or mortar);
- the choice of repair work to be undertaken (for example, replacement of bricks, or use of chemical damp proof course); and,
- the nature of the building products used and prevention measures taken by building owners.

## *Repair and maintenance of salinity affected buildings*

There are a large array of options available to address salinity impact on buildings, ranging from directly repairing or replacing parts of the building structure that are damaged, to the use of chemical damp proof courses and physical drainage of the site to maintain ground water flows.

All of these options will vary not only in their direct costs, but also in their longer term ability to address the salinity issue.

Options that involve addressing the impacts of salinity identified by the New South Wales government include.[16]

- decreasing soil moisture;
- application of protective surface coatings;
- increased internal and external ventilation to limit height and thus area of wall affected; and
- installation of false internal walls to remove the damage from view.

These options do not directly attempt to rectify the damage caused to the building structure, instead attempting to limit further damage and the spread of salinity effects.

---

[16] DIPNR (2007) Repairing and maintaining salinity affected houses, Local Government Salinity Initiative, booklet no. 12.

Alternatively, repair options that have also been presented by the New South Wales government include:

- the use of salt resistant materials either at the point of construction, or at the point of repair[17];
- introduction of barriers to salt and water, again either at time of construction or at the time of repair; and
- removing the salts where specially designed poultices or renders may be able to draw salts away from the building structure.

These options require physical repair work to be undertaken to the building structure, with the first two options requiring parts of the building structure to be removed.

### *Per building costs of salinity*

Studies that have considered the costs of salinity have been rather disjointed in nature with widely varying results. These studies have reported average costs of saline effects, across both residential and commercial buildings, depending on the severity of the salt attack.

In general, the costs of salinity may be divided into three categories:

- initial repair costs;
- on going repair and maintenance costs; and
- reduced building life span.

In general, the most observable, and quantifiable costs will be associated with initial and ongoing repairs.

The New South Wales government has been involved in producing and commissioning a number of studies into the costs of urban salinity. These studies have taken a number of different approaches to estimating costs, and have also covered a range of different costs, some of which are not relevant to this RIS.

The following cost estimates have been drawn from a New South Wales Government Department of Infrastructure, Planning and Natural Resources report and a study by Wilson Land Management Services Pty

[17] Discussion with industry representatives indicates that it is potentially problematic to use materials with a higher resistance to salt in a repair job as it will result in a redirection of the salt attack and further issues appearing across other areas of the building structure in the future. The implication is that where the salt issues are localised, maintaining a single weakness will allow the issue to be monitored over time.

and Ivey ATP in 2003.[18] The results estimate on going costs of salinity for households at between $75 and $2135 annually and for commercial buildings between $450 and $6000 annually.

### 2.14 Sample cost functions for various stakeholders and levels of salinity impact

| Building type | | Very slight impact | Slight impact | Moderate impact | Severe impact |
|---|---|---|---|---|---|
| Households | *$/household/ year* | $75 | Not reported | $250 | $2 135 |
| Industrial/ commercial/ retail buildings | *$/building/ year* | $450 | $1 500 | $3 750 | $6 000 |

*Source: DIPNR (2005) Costs of urban salinity, local government salinity inititative, booklet no. 10*

A 1998 report, by the New South Wales Department of Land and Water Conservation, considered the costs of urban salinity in Wagga Wagga and estimated that once off remedial works on houses experiencing severe effects of rising saline ground water were approximately $10 000 per house.

Considering that the average lifespan of a residential dwelling is approximately 40 years, these two estimates roughly coincide with $250 average per year costs, equating to approximately $10 000 per affected house.

It should be noted that these studies of New South Wales locations were conducted prior to the implementation of the current New South Wales variations to the BCA. Therefore, they provide indicative information on the costs of repair to buildings built under the current BCA requirements, and not under the New South Wales variations.

A more recent study commissioned by the Western Australian Department of Agriculture in 2000, made distinctions across the depths of water tables when considering repair costs. The report found that these costs were dependent on both the depth of water tables as well as the type of building materials used within the building structure.

- Water tables at a depth of greater than 1.5m did not impose repair costs.

[18] Wilson, S.M. (2003) Determining the full costs of dryland salinity across the Murray-Darling Basin: Final Project Report, a Wilson Land Management Services report to the Murray Darling Basin Commission and National Dryland Salinity Program. Referenced in DIPNR (2005) Costs of Salinity, Local Government Salinity Initiative, booklet no. 10

- Water tables less than 0.5m below the surface of a brick house, on ground, would require initial repair costs of $2000 and a further $6000 in three years' time.
- Water tables less than 0.5m below the surface of a house elevated on stumps would require $1000 of repairs every five years.

The required repairs that were referenced in the report included:

- Repair of brick work and crumbling mortar which were assumed to be once off expenditures which would not be required again after the subsequent repairs undertaken in the third year.
- These third year repairs consisted of constructing perimeter drains to physically protect the site from ground water effects.
- For houses on stumps, the repairs included jacking and restumping required each year when the water table reached 0.5 m.

These figures, while at a total cost of close to $10 000, are in line with the New South Wales figures. It should be noted that the major expense is reported as the installation of perimeter drains, while the New South Wales reports have not identified the specific repair costs components.

Discussions with industry associations across Australia have provided in principle support for the repair and costs estimates in these published reports, with estimates of repair costs of between $2000 and $7000 per house, depending on the extent of the salt attack, and the amount of private labour used in the repair job.

Finally, a local government based study, by SGS Economics and Planning considered the reduced life span as well as the increased repair and maintenance costs for a general class of buildings due to salinity effects. The results are presented in table 2.18. Placing a value on these reductions requires building specific information on the value of activities undertaken as well as indications of the value of replacement buildings.

### 2.15 **Building cost effects from salinity**

| | ***Total life span*** | ***Increased maintenance costs*** |
|---|---|---|
| | Years | Per cent |
| Unaffected/low impacts | 50-100 | 5 |
| Moderate | 40-80 | 10 |
| Severe | 25-50 | 15 |

*Source: DIPNR (2005) Costs Of Urban Salinity, Local Government Salinity Initiative, Booklet No. 10*

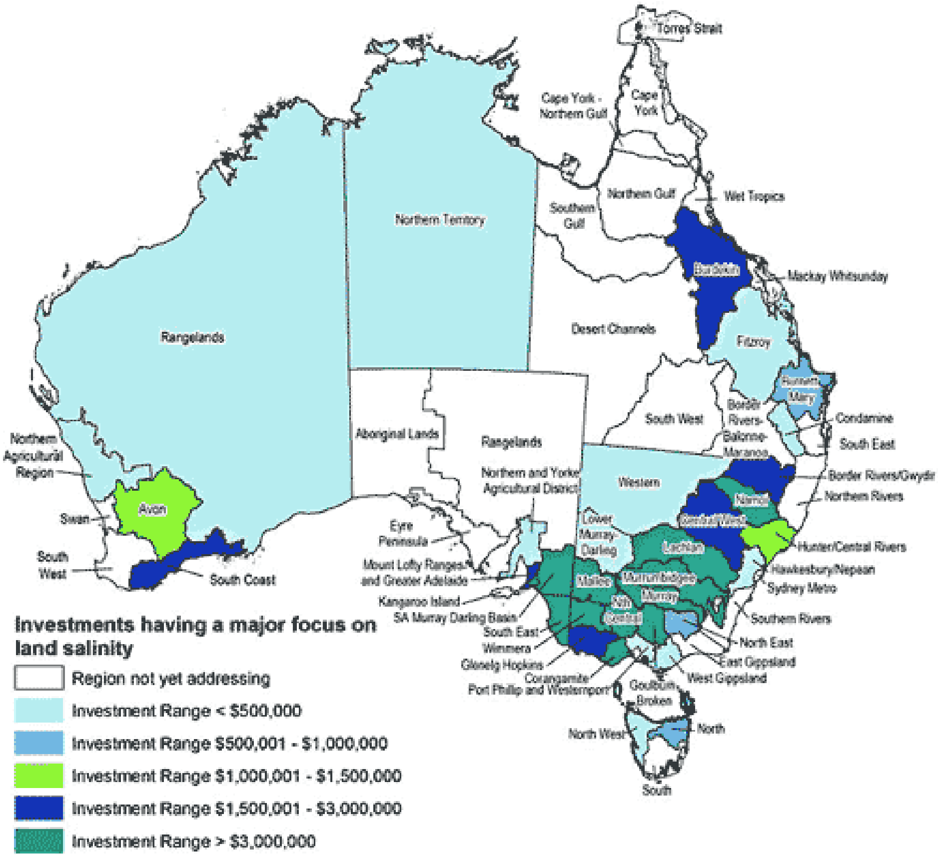
### *Regional cost estimates of urban salinity*

There have been a number of studies conducted estimating the costs of salinity in general to Australia. Total regional investment in salinity mitigation systems may be used as a proxy to determine the relative intensity of salinity issues across Australia. Such investment patterns for 2003-04 were assessed through joint expenditure under the National Action Plan for Salinity and Water Quality and Natural Heritage Trust program values. As illustrated in chart 2.16, the value of investments for the year 2003-04 varied greatly by region, with predominant effects being located through the southern regions of the Murray Darling Basin, northern areas of Queensland, and in south west Western Australia.

However, these figures consider the broader impacts of salinity to agricultural areas, as well as environmental effects. Even assessing specific studies targeting the costs of urban salinity requires care as they usually also include costs associated with infrastructure damage and repairs to heritage buildings and public open spaces as well as the effects of saline water supplies. Therefore, such aggregated studies should be utilised as reference points for the potential scale of salinity impacts in an urban region, but should be treated with care to ensure that the costs of salinity that are assessed in this consultation RIS are only associated with damage to buildings. In general, damage costs due to rising saline water tables causing damage to building structures accounts for approximately 20 per cent of total urban salinity costs.[19]

[19] Wilson, SM. and Laurie, I. (2001) Assessing the Full Impacts and Costs of Dryland Salinity, report prepared for the Salinity Economics Workshop, 22-23 August 2001, Orange.

## 2.16 **Regional investment in salinity**




*Data source: Source: Regional Programs Report 2005, National Action Plan for Salinity and Water Quality and Natural Heritage Trust Regional Programs Report 2003-04, viewed 31 May 2006, http://www.nrm.gov.au/publications/regional-report/03-04/index.html.*

A report considering the total costs of urban salinity, by category, in the Central West Region of New South Wales as reported by Ivey ATP and Wilson are presented in table 2.17.

## 2.17 **Value of damage from high saline water tables Central West NSW**

| ***Building type*** | ***Annual costs($ per year)*** |
|---|---:|
| Rural households | 492 220 |
| Urban households | 4 563 070 |
| Commercial/ retail buildings | 1 499 100 |
| Industrial buildings | 634 950 |

*Source: Wilson S. and Laurie, I (n.d.) Dryland salinity in the Central West Region, what is it costing you? Factsheet.*

A disaggregated cost assessment for urban salinity in the town of Wagga Wagga, identified total costs of up to $95 million over 30 years if no action taken:

- Road repairs: $56 million;
- Houses: $19 million;

- Sewerage pipes: $8 million;
- Gas pipes: $6 million; and,
- Agriculture: $4 million.

Therefore in Wagga Wagga, a town of approximately 60 000 people, with a conservative assessment of approximately 23 000 dwellings, damage to houses was estimated to account for approximately one fifth of the total urban salinity damage, representing an average of approximately $826 per house.

If considering that a house that is struck by salinity is expected to face approximately $10 000 of damage, this would alternatively equate to 1900 affected houses, or 8 per cent of the residential building stock.[20]

The Western Australian salinity strategy in 2000, estimated the urban salinity cost to be approximately $68 million Net Present Value (NPV) for 60 townships affected by salinity over the period 2000-2050.[21] However, this figure includes damage to roads and other forms of infrastructure, as well as the effects of saline town water supplies. If approximately 20 per cent of the total costs are imposed on households, this figure is approximately $13 million over 50 years, and predominantly covers the existing building stock.

---

[20] Again, it should be noted that this study was undertaken prior to the implementation of the NSW variations.

[21] http://www.anra.gov.au/topics/salinity/impacts/wa.html.

# 3 Objectives of government action and proposed amendments

This chapter outlines the objectives of government action, discusses the objectives of the proposed BCA amendments, provides a brief description of the regulatory proposal, and considers alternative policy approaches.

## Objectives of government action

There is a suggested need for government intervention driven by a need to resolve uncertainty surrounding building longevity and performance in light of changing regional risks of salt attack, and the difficulties markets have had in responding appropriately.

The primary goal of government action is to allow for efficient management of risks associated with a building being damaged due to salt attack.

## Role of the Building Code of Australia

The Building Code of Australia (BCA) is a uniform set of technical provisions for the design and construction of buildings throughout Australia. The goal of the BCA is to achieve the minimum necessary standards that are nationally consistent to ensure health, safety (including structural safety and safety from fire), amenity and sustainability objectives are met.

The use of the BCA as a minimum standard for construction firstly makes certain that the market is aware of the required technical aspects of building safety and operation. That is, it operates as a central information source on required features to be included to ensure that occupants are able to use the buildings for their intended purposes – for example, structural reliability and protection from environmental elements. Such information gathering and compilation forms a public good, whereby a single, government supported source is the most efficient mechanism.

Secondly, the BCA provides a minimum standard against which consumers may be assured of building quality and performance. This provision of a minimum standard works to lower transaction costs in the building and construction market, firstly between owners and builders, and secondly between first and subsequent owners. The first owners of a building are assured of a minimum standard of construction, allowing efficient investment decisions to be undertaken, without a full review of the technical specifications of the construction. However, the process does allow for increased specification of building features, providing only a minimum threshold. Further, subsequent owners who have not necessarily been involved in the construction process and therefore not privy to tradeoffs in design, quality and cost that were made through the construction process are again assured of a minimum standard.

## *Description of regulatory proposal*

Primarily, the objective of the proposed amendments to the BCA is to resolve information issues associated with building longevity and performance in light of regional risks of salt attack.

Currently, provisions to manage rising damp and salinity are explicitly covered in both the BCA and referred standards. However, with concerns that the risks of urban and rural salinity are likely to increase over time, with increased potential for damage to building structures, the ABCB is proposing to broaden provisions in the BCA to more adequately target the effects of saline soils.

The regulatory proposal being assessed in this Consultation RIS is to expand the current South Australian based variations to the BCA regarding damp proof courses (permitted materials) as well as the impact resistance of damp proof membranes and requirements for concrete slab curing and compaction. Two alternate implementation options are considered — general expansion across all State and Territories, and application only to those areas considered as being at risk.

The sections of the BCA that are affected by the proposed changes are:

1. Volume One:
   a) Performance Requirement FP1.5; and
   b) Deemed-to-Satisfy (DtS) provisions F1.9 and F1.10[22].
2. Volume Two:
   c) Performance Requirement P2.2.3; and
   d) Acceptable construction practice (ACP) provisions 3.2.2.6, 3.3.2.1, 3.3.4.4, 3.3.4.5 and 3.3.4.6[23].

---

[22] These provisions rely largely on BCA referenced Australian Standard AS 2870 *Residential slabs and footings* and Australian/New Zealand Standard AS/NZS 2904 *Damp proof courses and flashings*.

The preliminary DtS/ACP changes to both Volumes has implications for practitioners and builders including a limitation on types of materials deemed acceptable for use as damp proof courses, resulting in a possible reduction in choice of acceptable materials from the current BCA. Materials are potentially limited to:

a) black polyethylene; or

b) polyethylene coated aluminium; or

c) bitumen impregnated material not less than 2.5mm minimum thickness (in accordance with clause 7.5 of AS 2904).

d) An increase in impact resistance requirements for vapour barriers (or 'damp proofing membranes') used under slabs from 'medium impact' to 'high impact' membranes in accordance with AS 2870.

Given the increased risk of salt attacks across both South Australia and New South Wales, and the assessment that BCA provisions are not effective enough to ensure reasonable protection in these salt affected areas, variations to the BCA provisions already exist in both South Australia and New South Wales. South Australia currently applies both the limitations to types of materials as well as the required increase in impact resistance for vapour barriers, where New South Wales only applies the impact resistance provisions. The remainder of Australian States and Territories apply current BCA provisions. The costs and benefits of applying South Australian provisions across all of Australia are being assessed in this consultation RIS.

As well as the proposed variations to provisions for damp proof membranes and courses, extension of South Australia variations to concrete slab constructions are also being evaluated.

Further variations to provision 3.2.3.1 are implemented in South Australia, increasing the requirements for concrete slab construction to maximise its strength in order to resist mechanical, termite and salt damage. The variations are inserted after 3.2.3.1 (d) and include the requirements that:

e) concrete in slabs must be adequately compacted, and slab surfaces, including edges, moist cured for 7 days;

f) after vertical surfaces are stripped of formwork, slab edges must be finished prior to curing;

---

[23] ABCB (2007) Salinity consultation paper

g) loading of concrete slabs with stacked materials or building plant must not occur for a minimum of 7 days after pouring although construction of wall frames and setting out brick work may be undertaken during this period.

## *Objectives of the variations*

Damp proof membranes provide a physical barrier between the surrounding earth and the concrete slab. This protection reduces the potential for moisture to be carried from the surrounding earth and damage the concrete slab. It is through providing a barrier against soil moisture, that damp proof membranes protect the slab from saline intrusion as well.

It should be noted that the differences between the currently required vapour barriers and the proposed high impact damp proof membranes is additional strength in the membrane product to avoid unintended damage during the construction process. In the event that a lower strength vapour barrier is laid without breach, for example a puncture, it is considered to be able to protect the slab from saline intrusion. Difficulties arise when an undetected breach in the barrier is introduced, the effects of which will not be observable for many years. The proposed amendments are aimed at reducing the likelihood that the vapour barrier will be breached during the construction process, providing additional protection to the house structure.

A damp proof course provides protection to the walls of a house, blocking the upward movement of moisture through the structure. Within the current BCA, the DtS provisions allow the use of materials in damp proof courses which comply with AS 2904 -1995 (Damp-proof courses and flashings). There are five groups of materials in current use: metals, bitumen-coated metals, polyethylene coated metals, bitumen-impregnated materials, and polyethylene. However, to account for where the building's structure is subject to salt attack, the South Australian variation limits the use of materials which can be used for damp proof courses by removing the reference to "a material that complies with AS/NZS 2904, and provides a more definitive list of materials not susceptible to salt attack. The effect is to preclude the use of materials susceptible to salt attack.

Finally, concrete permeability is an important factor in determining the extent of damage in the event the slab is subject to salt and moisture attack. Highly permeable concrete products will allow water and salts to be readily transported through the slab. However, more impermeable concrete will limit its movement, and therefore the amount of damage that may result. The proposed amendments to the BCA are aimed at reducing the permeability of slabs, which is most heavily influenced through the water-cement ratio of the product, as well as the amount of time a slab is cured for[24].

It is expected, and early consultation with industry has indicated, that through implementing the complete set of proposed variations – damp proof courses, membranes and concrete curing – will provide an extremely high, and effectively total, level of protection against salt attack.

### *Implementation options being considered*

There have been four alternative options identified with respect to implementing the proposed regulatory changes.

- Maintenance of the current provisions in the BCA, which would not require any additional considerations for damp proofing across new buildings in Australia.
  - This is referred to as the status quo.
- Application of South Australian variations to all areas in Australia, irrespective of the risk of a salt attack. This would attempt to both harness benefits of a nationally consistent approach to the BCA, as well as potentially protect areas which, due to information issues, may be overlooked in the regional application option.
  - This is referred to as the national roll out implementation option.
- Application of South Australian variations to all areas in Australia considered to be at risk of a salt attack. This would require areas at risk of salt attack to be identified. Increased stringency of damp proofing of new buildings would only be required in these at risk areas.
  - This is referred to as the national mapping exercise implementation option.
- Requirement that the variations be met unless there is proven to be no possibility of salt attack in the area.
  - This is referred to as the selective mapping exercise implementation option.

All three latter options are modelled in this Consultation RIS (status quo is modelled implicitly) with estimated net benefits being reported.

These implementation options have been presented to address particular difficulties that have been noted with a proposal to expand salinity provisions within the BCA. These include the inability to precisely determine the locations in which increased urban salinity will result, as well

[24] Lume, E. and Sirivivatnanon V. (n.d.) Building with concrete in saline soils, Cement Concrete and Aggregates Australia.

as a level of uncertainty surrounding the rate at which dryland salinity may spread and affect constructions. The costs and benefits of such a proposal are highly dependent on issues such as the costs that will be faced if the current framework is maintained, as well as the costs of imposing changes on new building constructions, and the level of damage that may be avoided by such an imposition.

While these three latter implementation options are evaluated based on a complete acceptance of the proposed variations, there is the potential for the variations to be divided into damp proof courses and membranes, separate from the concrete curing variations. The potential impacts of such a division are considered in the sensitivity analysis, where the results depend heavily on the proportion of benefits that may be attributed across either damp proof membranes or concrete curing.

### *Targeting the symptom rather than the cause*

The issues of urban salinity are generally not the result of actions undertaken purely by the Australian building industry. Salinity in urban areas is considered to be a joint product of land clearing, for both urban and agricultural uses, as well as inappropriate land use practices. Therefore, from an Australian Government perspective it should be noted, that the proposed regulations are not targeted at solving the issues of urban salinity, but at minimising the impact of the problem on the Australian building industry.

Taking a further step back from the problem, there is the potential for environmentally based policies and programs to reduce the observance and spread of dryland and urban salinity in Australia. Such progress at an environmental level could potentially negate the need for increased stringency in the BCA through addressing the source problem of spreading urban salinity.

Difficulties with such environmental based policy solutions include the long lead times required. That is, any remedial works will likely take a significant amount of time before they are effective. Therefore, where it is not possible to treat the cause of the problem, the building industry, as well as all other affected industries must adapt in the meantime.

Further, such policy options are outside of the jurisdiction of the BCA, and as such are outside of the scope of this Consultation RIS. The current assessment and analysis takes as given the environmental and policy factors influencing urban salinity in Australia through published projections of salinity effects across Australia.

## Alternative policy approaches

### Voluntary opt-out approach

A further option for managing the risk of salinity damage to buildings that has been suggested through initial discussions is a voluntary opt-out scheme. Under such a proposal, the increased protection measures for salinity damage would be included in the BCA, however, individual owners and builders would be given the choice to voluntarily opt-out of applying the measures[25].

This system is very similar in nature to the selective mapping exercise that has been proposed, except that the choice to opt-out or to meet the salinity protection measures is made at the individual level, rather than the state or local government level.

There are a number of reasons that such an individual based proposal could be considered to be advantageous, not least of which is that it allows for private assessment of the relative costs and benefits of the protection measures. Such a scheme is thought to be able to publicly signal the benefits of the protection measures without imposing the requirements on new dwelling constructions, thereby disproportionately reducing the costs, with hopefully limited effects on the benefits.

However, when considered in contrast to the selective mapping exercise, there are a number of strengths in allowing the decision to be made at a local or state government level, rather than by individuals.

- Gathering information on salinity patterns and projected growth is a highly specialised exercise, requiring a large number of resources that are generally only available at the National and State level, and also at the local government level in areas of high current risk. It is unlikely that individuals would be able to collect this information more efficiently than local and regional authorities.
- The average turnover of home ownership in Australia is approximately 7.5 years across Australia[26]. As such, there will be a significant number of initial home owners/builders that will not be living in the house when the first round of salinity damage is likely to be observed, and even less through the subsequent attacks. Without a comprehensive administrative tracking system to identify houses that were or were not opted out of the salinity protection measures, it will be extremely difficult

25 Note that this is in contrast to the operation of the remainder of the BCA in which only State based variations are permitted (or local councils depending on delegated authority), at which point the legislation always forms a minimum requirement.

26 www.rpdata.com

for subsequent owners to verify the protection measures, and for initial owners to capitalise on them.

Opting out may also be an attractive scenario if individuals were able to privately implement alternate mitigation strategies to limit the risk of salt attack. However, salinity is a hydro-geological risk and therefore, individual home owners do not have access to alternate options that would significantly mitigate their private risk of being affected by saline soils. As such, mitigation measures may only be implemented at a more regional level, with extended time horizons.

While this voluntary opt-out scenario is not considered formally within the benefit cost analysis of this Consultation RIS comments on it are welcomed through the public consultation period. This includes comments on both the benefits and difficulties of taking such an approach, especially compared to a more regional level opt out approach as with the selective mapping scenario.

### *Other forms of regulation*

In addition to direct government based regulation, there are some alternate forms of regulation that may be considered.

- Self-regulation — generally characterized by industry formulating rules, standards and codes of conduct, with industry solely responsible for enforcement. In some cases, government may be involved in a limited way, for example, by providing advisory information.
- Quasi-regulation — which includes a wide range of rules or arrangements where governments influence businesses to comply, but which do not involve government regulation. Some examples of quasi-regulation include industry codes of practice developed with government involvement and guidance notes or industry-government partnership agreements and accreditation schemes.
- Co-regulation — referring to the situation where industry develops and administers its own arrangements to demonstrate the level of protection against saline soils, but government provides the legislative backing to enable the arrangements to be enforced. This is also known as the 'underpinning' (through legislation) of codes, standards and other forms of legality verification schemes.

There are a number of reasons for which these alternate forms of regulation are not appropriate for addressing urban salinity issues in the Australian building industry.

- These forms of regulation typically work best in situations where actions are observable, and there is recourse to correct actions that do not meet the regulated requirements. In the case of urban salinity and building measures to protect building structures, there is limited ability of both consumers and industry groups to verify procedures after construction.

- Given the information based market failures that are driving the requirement for some form of regulation, provision of non-binding regulation options are not likely to be able to provide the required level of protection for consumers.
- Recognizing that the BCA is the main reference for building and construction requirements in Australia, using it as a central source for addressing urban salinity issues provides some degree of cost and administration savings to the industry.

### *Non-regulatory intervention*

In certain circumstances, there is the potential for non-regulatory intervention to be able to achieve a given policy objective (in this case, reduced risk of damage from salt attack) at a lower cost than regulatory based intervention. This cost reduction is achieved through potentially greater flexibility being introduced, allowing individuals involved to identify alternative least cost methods, as well as reducing oversight and administration costs. In general, the non-regulatory methods of intervention that are considered include:

- information based assistance;
- voluntary standards; and,
- market based incentives.

Similar arguments against the introduction of non-regulatory intervention hold as with the alternate forms of regulation. While the provision of information will go some way to addressing the information based market failures, there is still an externality introduced for second and third owners of a house who were not privy to construction decisions and may not be able to verify construction practices. Further, market based incentives are not appropriate methods of addressing urban salinity, as these would be directed at the source of the dryland salinity problem, that is, at the point of land clearing or irrigation, for example.

### *Associated regulation*

A number of Australian states have chosen to manage construction practices addressing urban salinity through local planning policies. These policies target urban salinity through two main avenues:

1. attempting to reduce the number of buildings constructed in what is considered to be an ‘at risk’ area, and through this avenue, reducing the expected costs of salinity in urban areas; and
2. increasing the construction requirements for a given local government area in which urban salinity is considered to be a serious threat.

When considering the ability of land use restrictions and zoning practices to limit the damage caused by urban salinity, it is unlikely that expansion of restrictive planning and development provisions (such as zoning) across Australia would be more efficient than the proposed changes to the BCA.

A simple thought experiment can illustrate the potential inefficiencies of such planning restrictions. Where the planning and development provisions are imposed, development in a particular area will be reduced based solely on the potential risk of saline intrusion in the future. Such reductions will be observed irrespective of the expected net value of the development that may have occurred, even when the additional costs for protection measures are included. Therefore, where there is no flexibility for developers and builders to increase structural protection to balance against the saline risk, it is possible that development may be inefficiently constrained.

The more market based method of mediating the risk of saline intrusion allows building developers to balance the costs of construction and protection from saline intrusion against the expected value of the development. In this case, where the additional costs of protection do not reduce the net benefits of development below zero, additional construction requirements will not impede development, where management through planning and zoning restrictions would have.

The additional construction requirements, as introduced in some local government areas in New South Wales, allow for this flexibility. Where there is an acknowledgement that salinity is a real risk in the area, and builders are able to balance the additional construction costs against the value of the developments, only efficient developments proceed.

However, the difficulties with transferring responsibility for construction based salinity protection measures to local governments more broadly lies in the costs of information as well as the access to expertise and experience at the local government level. Due to the localised nature of salinity issues, where local governments have the resources and the information, it may be more effective for councils to assume responsibility for assessing the risks and required construction practices. However, not all councils will be so well equipped. This issue will be considered qualitatively when evaluating the implementation option of compliance unless an area is proven not to be affected by salinity.

A further issue associated with such a decentralised implementation option is the differentiated approach to local planning laws across States. For example, where New South Wales local governments are given the authority to alter construction requirements from those in the BCA, in other States, such as Queensland, local governments do not have jurisdiction over construction practices, as these are covered by the State government.

# 4 Cost impacts of the proposal

## Per dwelling construction costs

Some preliminary estimates of increased construction costs have been modelled for a 200m sq single storey slab-on-ground house and are presented in table 4.1. The estimated additional construction costs for expanding the South Australian provisions are $285 per house.

4.1 **Estimated cost increases from proposed provisions on a 200m$^2$ house**

| *Provision* | *Current BCA requirement* | *Possible new BCA requirement* | *Cost increase* |
|---|---|---|---|
| Vapour/moisture barrier under concrete slab | 0.2mm polyethylene vapour barrier (4mx50m roll, $115) | High impact resistant 0.2mm thick polyethylene moisture barrier (4mx50m roll, $145) | $60 (for 2 rolls) |
| Slab compaction | Not mandatory | Mandatory | Concrete vibrator hire: $75 |
| Slab curing (surfaces and edges) | Not mandatory | Moist cured for 7 days | $100 approx |
| Finishing slab edges | Not mandatory | After vertical surface stripped of formwork, slab edges finished prior to curing | $50 approx |
| Loading of slabs | No requirement | Must not load slabs with stacked materials or building plant within 7 days of pouring slab | - |
| Damp proof courses and flashings used as DPCs | Comply with AS/NZS 2904 or embossed black polyethylene film, or polyethylene coated aluminium or bitumen impregnated material not less than 2.5mm thick, or termite shields | Embossed black polyethylene film, or polyethylene coated aluminium or bitumen impregnated material not less than 2.5mm thick | - |
| Total | | | Approximately $285 |

*Source: ABCB Salinity consultation paper.*

These figures were estimated as part of study commissioned by ABCB in 2007.

Drawing on construction projections, as reported in TheCIE (2009), State and Territory based costs estimates of the proposed variations to the BCA for 10 years worth of new dwelling constructions are reported in table 4.2.

4.2 **Projected costs of national rollout of proposed changes**

| *State* | *Newly constructed dwellings* | *Total construction costs $* |
|---|---|---|
| Australian Capital Territory | 17 341 | 3 119 038 |
| New South Wales | 373 373 | 51 365 785 |
| Northern Territory | 12 784 | 2 264 534 |
| Queensland | 403 260 | 71 227 858 |
| Tasmania | 11 832 | 2 303 571 |
| Victoria | 290 136 | 52 727 083 |
| Western Australia | 168 037 | 31 895 130 |
| Total for Australia | 1 276 763 | 214 903 000 |

*Source: TheCIE estimates.*

In total, the net present value of total costs of a national rollout of the proposed changes to the BCA is estimated at approximately $215 million. This figure reflects 10 years worth of construction (the assumed life of the regulations), evaluated with a 7 per cent discount rate.

## *National mapping exercise*

The costs of a national mapping exercise will depend on a number of factors — predominately on the extent of the area that is to be covered, and the resolution at which the results are required.

Overall, it is assumed that any regional implementation of the proposed amendments to the BCA would not be finer than local government areas, as this is generally the finest level at which most planning policies are implemented. Therefore, resolution would not necessarily be required at a resolution less than a few thousand square kilometres.

It is presumed that there are a number of options available to minimise the total costs of the mapping exercise to the building industry. For example, the results of the mapping exercise could also be used by other government agencies — allowing for cost sharing — or alternatively the maps could be obtained from already existing sources — noting that such a method would include outdated information that is also not necessarily correctly targeted at the urban salinity information sought. Both of these options would have the effect of reducing the total cost of the mapping exercise to the Australian building industry directly. It should be noted however, that TheCIE is not considering issues of revenue raising or delineation of responsibility to undertake the mapping.

To estimate the costs of the mapping exercises, in 2004 a technical report was prepared that outlined various mapping techniques as well as a review of the extent, accuracy and costs associated with a number of maps generated across the different States in Australia.[27]

- Over 1998-2001 salinity maps were generated for the south-west agricultural area of Western Australia. The project cost was approximately $7 million, and covered 240 000 $km^2$ with a fine resolution of <0.1ha. It was noted that since this project, costs have reduced considerably.
- In Riverland, Murray Basin, South Australia, a 1650 $km^2$ study was conducted at a total cost of approximately $470 000.
- In Tintinara, Murray Basin, South Australia, a 590 $km^2$ mapping exercise cost approximately $250 000.
- Across the Liverpool Plains, maps across almost 16,000 $km^2$ at a resolution of 1:100 000 cost approximately $1.3 million.

For the purposes of this Consultation RIS, it is assumed that a national mapping exercise would cost approximately $10 million. This figure is a best estimate given the limited published data on the cost of conducting such a large scale assessment. Further, this figure assumes that there would be issues with quality, as well as cost sharing arrangements entered into with other government agencies. This mapping cost represents approximately 4.5 per cent of the construction costs associated with a national roll out of the proposed amendments.

It should be noted that the quality of the mapping exercise will have an impact on the estimated benefits of the implementation options. Where a low resolution study is undertaken, there will be both areas of low salinity that are incorrectly mapped as high risk and therefore required to meet the proposed amendments, as well as potentially areas of medium to high salinity risk that will be incorrectly assessed as low risk and therefore not be required to meet the proposed amendments. The central case will assume:

- 70 per cent of areas at high risk are identified correctly; and
- 90 per cent of low risk areas are identified correctly.

Implicit in these assumptions is that it is easier to accurately identify low risk areas than it is to accurately identify high risk areas.

---

[27] Spies, B. and Woodgate, P. (2004) Technical Report: Salinity mapping methods in the Australian context. Prepared for the Programs Committee, of the Natural Resource Management Ministerial Council through Land and Water Australia and the National Dryland Salinity Program.

### *Selective mapping exercises*

Under this implementation scenario, all construction in Australia would be required to meet the South Australian variations unless it could be proven that there is limited risk of salinity damage to buildings constructed in the given area.

As with the national mapping exercise, TheCIE will not consider the level of government that will be responsible for the revenue raising or the undertaking of the mapping exercise.

However, it could be assumed that selective mapping exercises are likely to be individually more costly than a national mapping exercise, albeit, they are also likely to be more accurate. For the purposes of this Consultation RIS, it is therefore also assumed that a selective mapping exercise would collectively cost $10 million. This is based on an assertion that the majority of the $10 million for a national mapping exercise would be incurred in those regions with a higher prevalence of dryland salinity to begin with, that is, in New South Wales, Victoria and Western Australia, increasing the accuracy of salinity identification in higher risk areas. As with the national mapping exercise, this cost is an estimate and further information is sought on its accuracy through the public consultation phase.

Therefore, for the purposes of this Consultation RIS, it is assumed that a selective mapping exercise will also have a total cost of $10 million, however, the higher quality indicators that will be used for the central case will be:

- 90 per cent of high risk areas are correctly identified;
- 95 per cent of low risk areas are correctly identified.

Again, this assumes that it is easier to accurately project low risk areas than high risk areas.

# 5 Benefits of the proposal

This section provides information on the estimated benefits of the alternative implementation options. Two alternative modelling methodologies are presented to illustrate the differences between a simplified per house methodology using a constant salinity risk factor and a simple damage cost function, compared to a more complex regionally based modelling approach utilising assumed differential rates of salinity risk across statistical divisions in Australia. The per house methodology is presented first to provide a point of reference for the regionally based bottom up methodology.

As discussed within the framework presented in Appendix A, the estimated costs of urban salinity damage to houses is approximately $8000 per house, with repairs assumed to last 10 years, at which point they will need to be redone. Therefore, on a per house basis, the benefits of the proposed amendments are $8000 every 10 years, for those houses that would otherwise have been affected by salinity.

South Australia is excluded from the analysis as the proposal will not affect construction in the State. In addition, those areas of New South Wales that currently require South Australian variations to be met have also been excluded as accurately as possible (due to local government areas being smaller in size than statistical divisions, this level of exclusion is estimated). A reduced cost function is also applied for New South Wales, to account for current NSW variations.

A further note regarding the analysis is that the status quo is developed around the current provisions and variations in the BCA. However, as with the current South Australian and New South Wales variations, it is possible for individual States (and depending on planning authority, local councils) to further amend construction requirements in the jurisdiction to cover salinity. Should this occur over time, the status quo scenario would include both a lower level of benefits and a lower level of costs, attributing net benefits only to the proposed amendments to the BCA, in isolation of these independent variations. While the potential for such changes to be made may be speculated upon, it is not possible to definitively identify likely candidate States and local councils. Therefore, this analysis does not take into consideration these staggered State and local variations, providing an overall assessment of the costs and benefits of moving from the current arrangements to a centrally driven amendment to the BCA.

## Per house assessment

### National roll out implementation option

If salinity is not expected to be observed within the first 8–10 years of a house being constructed, an average amount of damage may be estimated. Consider a house is struck by salinity damage in year 10, which would therefore require a total of $24 000 of repairs over the next 30 years. In net present value terms, at the time of construction, this equates to $7200 worth of repairs over the life of the building. Over the entire building stock, those houses struck within the first 10 years after construction will face the highest total repair costs due to the discounting of damage costs faced later in time. Therefore, applying this figure across the newly constructed building stock will ensure a generous estimate of a national salinity risk rate is reported.

The rate of salinity damage is an important element of the net benefits calculation. Consider a single house that is required to meet the proposed amendments which would raise construction costs by $285. These costs would be aimed at avoiding approximately $7200 worth of damage. In this case, a probability of salt attack would need to be greater than 4 per cent for a positive net benefit to be achieved. For a house that is assured of salt attack, this additional $285 of up front construction costs will be considered to be a good insurance investment.

However, in the case of a national roll out of the proposed amendments, every newly constructed house in Australia would require at least a 4 per cent chance of being affected by salinity.[28]

As a national rate of salinity incidence, this is extremely high. Within the worst affected areas of Australia, such as Wagga Wagga, it has been estimated that only approximately 8–10 per cent of the current building stock is affected by salinity (see early calculations on page 47). To illustrate the difficulties of reaching a national risk of salinity of 4 per cent, the following example is presented.

[28] Note that $7200 is an over estimate of the average net present value of avoided salinity damage. This figure assumes that all houses will be damaged within the first 10 years. In reality, there will be some houses not affected for 15-20 years. Accounting for these factors lowers the average damage costs, further increasing the required probability of salt attack.

In general, urban salinity issues have been reported to be more prevalent in non-metropolitan areas, removed from capital cities[29]. This includes the capital cities of Brisbane, Hobart, Darwin and Canberra being considered to have a very low risk, close to zero. By 2050, it is possible that dryland salinity areas will begin to approach the eastern sides of Perth, but not encroach into the metropolitan area. Where the city of Melbourne is also considered to be of low risk, by 2050 there are expected to be higher risk areas arising along the western edge of Port Philip Bay. In Sydney, the western areas are expected to face a continuing high risk of salinity damage, but this is not projected to spread east into the central areas of the city[30]. In addition, measures for dwelling protection are already being undertaken in these western Sydney areas and so cannot be included in this analysis.

Therefore, at a broad level, if all new constructions located in non-metropolitan statistical divisions are considered to have an 8 per cent probability of being affected by salinity (a very high risk rate), there would still remain some States in which a net cost would be imposed from an across the board roll out. The risk of salt attack by State in this case (all non-metropolitan construction facing an 8 per cent probability of salt attack) is presented in table 5.1.

### 5.1 **State and National salinity risk if all regional dwellings are at 8 per cent risk**

| ***State or Territory*** | ***Risk*** |
|---|---|
| New South Wales | 3.27 per cent |
| Victoria | 2.39 per cent |
| Queensland | 4.53 per cent |
| Western Australia | 2.19 per cent |
| Northern Territory | 3.18 per cent |
| Tasmania | 4.71 per cent |
| Australian Capital Territory | 0.01 per cent |
| Australian total | 3.32 per cent |

*Source: TheCIE estimates.*

These estimates should be interpreted in the following way.

For Victoria for example, if all houses constructed outside of Melbourne faced an 8 per cent probability of salt attack, this would imply that across the State, all newly constructed dwelling would face on average a 2.39 per cent probability of salt attack. As this probability is below the required 4 per cent probability for a single house to justify the additional construction

29 This has been inferred from NLWRA reports and maps that indicate a greater prevalence of dryland salinity in rural and regional areas that maintain higher levels of agricultural production.

30 Reference: http:\\www.anra.gov.au\mapmaker

costs, a net cost would be imposed if all constructions in Victoria were required to meet the proposed amendments.

In contrast, for Queensland, if all houses constructed outside of Brisbane faced an 8 per cent probability of salt attack, this would imply that across the State, all newly constructed dwellings faced on average a 4.53 per cent probability of salt attack. As this probability is above the required 4 per cent probability for a single house to justify the additional construction costs, a net benefit would be conferred on Queensland should the proposed amendments be rolled out across the State.

At a national level, the results may be interpreted in the same way. That is, should all houses constructed outside of capital city areas face an 8 per cent probability of salt attack, then nationally, the new housing stock would face a 3.32 per cent probability of salt attack. As this figure is below the required 4 per cent probability, even if the entire non-metropolitan based housing stock was to face an extremely high 8 per cent probability of salt attack, there would still be a net cost imposed on the Australian economy from the proposal to roll out the amendments nationally.

This final result provides some insight into the required level of risk across high risk areas needed to generate a net benefit from the implementation option of a national roll out of the proposed amendments.

### *National mapping exercise*

Were a national mapping exercise be used to identify areas of medium to high risk of salt attack, it is assumed that an additional $10 million cost will be applied. Further to the additional costs, it is also assumed that only 70 per cent of high risk areas would be assessed correctly as being at high risk and only 90 per cent of low risk areas would be assessed as being low risk.

Areas that will, for the purposes of this exercise, be considered to be low risk are based on discussions with State and Territory governments and include:

- all metropolitan areas; and
- all areas of the Northern Territory, Tasmania, Queensland and the Australian Capital Territory.

A dwelling in a high risk area will be assumed to face a 4 per cent probability of salt attack (a 1 in 25 chance) and a dwelling in a low risk area will be assumed to face a 0.1 per cent probability of salt attack (a 1 in 1 000 chance). It should be noted that these estimates of risk are still quite high.

The results of the analysis are presented in table 6.2. Here, while the results have been presented at a State and Territory level, they are constructs of the accuracy and risk assumptions that have been stated above, which are themselves estimated averages. Therefore, while the risk and accuracy factors for each State and Territory may differ, the national average result is indicative.

Overall, States and Territories that are considered to be at low risk of salinity attack still receive a net cost from the proposed amendments, under the assumption that 10 per cent of dwellings are incorrectly identified as being at high risk and therefore included in the proposed amendments. These dwellings are assumed to have an underlying risk factor of 0.1 per cent.

The results are presented in table 5.2, with nationally, a $41.8 million net cost estimated returning a benefit cost ratio of 0.3.

5.2 **Results of national mapping exercise, per house modelling ($)**

| | *NPV costs* | *Benefits* | *BCR* | *Net benefits* |
|---|---|---|---|---|
| Australian Capital Territory | 311 904 | 5,380 | 0.02 | -306 524 |
| New South Wales | 18 690 044 | 6,616,916 | 0.35 | -12 073 129 |
| Northern Territory | 226 453 | 3,953 | 0.02 | -222 501 |
| Queensland | 7 122 786 | 123,793 | 0.02 | -6 998 993 |
| Tasmania | 230 357 | 3,836 | 0.02 | -226 521 |
| Victoria | 15 131 271 | 7,559,935 | 0.50 | -7 571 337 |
| Western Australia | 8 494 293 | 4,006,018 | 0.47 | -4 488 275 |
| Australia | 60 207 109 | 18,319,829 | 0.30 | -41 887 280 |

*Note: Australian total costs have had the $10m mapping costs applied. State and Territory totals cannot be considered individually achievable.*

*Source: TheCIE estimates.*

These results are based on the assumptions that:

- all houses are subjected to a net present value of $7200 worth of repairs over their lifetime; and
- the probability of salt attack in high risk areas is 4 per cent, and the probability of salt attack in low risk areas is 0.1 per cent.

Maintaining these probabilities of salt attack, the net present value of per house damage costs would be required to be approximately $23 000 to return a benefit cost ratio of 1. This equates to recurring damage costs of approximately $26 000 every 10 years.

Alternatively, should the estimated NPV of $7200 in damage costs be maintained, a risk factor of just over 13 per cent would be required for all non-metropolitan areas in New South Wales, Victoria and Western Australia, to generate a benefit cost ratio of 1.

The selective mapping exercise considered below estimates the net benefits to the Australian economy from undertaking a more targeted approach to salinity management through the BCA.

## *Selective mapping exercise*

Under the implementation option of a selective mapping exercise to identify at risk areas, it is assumed that an additional $10 million cost is applied. In addition, only 90 per cent of high risk areas are assessed correctly as being at high risk and only 95 per cent of low risk areas are correctly assessed as being low risk.

For the purposes of comparison, areas considered to be at high and low risk as well as the associated probabilities of salt attack across these regions are the same as those in the national mapping exercise.

Under a more targeted mapping exercise, an increased rate of accuracy is assumed, with similar mapping costs. Implied within this assumption is that regions that are known to be unaffected by salinity, due to position, hydrological data and land use patterns will not necessarily require detailed mapping to be undertaken. At the same time, those areas considered to be at some level of risk will undertake more accurate mapping exercises.

The results of this analysis are presented in table 5.3. Nationally, a net cost of $38.1m is estimated, with a benefit cost ratio of 0.38.

As with the national mapping exercise, these results are based on the assumptions that:

- all houses are subjected to NPV of $7 200 worth of repairs over their lifetime; and,
- the probability of salt attack in high risk areas is 4 per cent, and the probability of salt attack in low risk areas is 0.1 per cent.

5.3 **Results of selective mapping exercise, per house modelling ($)**

| | *NPV costs* | *Benefits* | *BCR* | *Net benefits* |
|---|---|---|---|---|
| Australian Capital Territory | 155 952 | 2 690 | 0.02 | -153 262 |
| New South Wales | 21 769 033 | 8 480 695 | 0.39 | -13 288 337 |
| Northern Territory | 113 227 | 1 976 | 0.02 | -111 250 |
| Queensland | 3 561 393 | 61 897 | 0.02 | -3 499 496 |
| Tasmania | 115 179 | 1 918 | 0.02 | -113 261 |
| Victoria | 16 602 652 | 9 670 621 | 0.58 | -6 932 031 |
| Western Australia | 9 109 862 | 5 121 024 | 0.56 | -3 988 837 |
| Australia | 61 427 296 | 23 340 821 | 0.38 | -38 086 475 |

*Note: Australian total costs have had the $10m mapping costs applied. State and Territory totals cannot be considered individually achievable.*

*Source: TheCIE estimates.*

Maintaining these probabilities of salt attack, NPV of per house damage costs of just under $19 000 would return a benefit cost ratio of 1. This would require recurring damage costs of $21 000 every 10 years.

Alternatively, should the estimated NPV of $7200 in damage costs be maintained, a risk factor of 10 per cent would be required in all non-metropolitan areas in New South Wales, Victoria and Western Australia to return a benefit cost ratio of 1.

## *Regionally based modelling*

The regional modelling methodology utilises information gathered through discussions with State and Territory governments, as well as through the National Land and Water Resources Audit (NLWRA) to estimate the probability of salt attack across Australian statistical divisions.

Statistical division based risk factors were estimated through:

- current total building stock measures (sourced from the ABS and local council information sheets); and,
- town by town identifications of high risk locations (sourced predominantly from State governments and the NLWRA).

Where towns were reported to be observing damage from urban salinity, a generous 10 per cent risk factor was applied. These figures formed the base of the current risk profile for each statistical division. Projections of growth in risk factors were based on maps of projected salinity risk across Australian States in 2050. That is, through the model, the annual risk of salinity is estimated to be increasing.

Again, the regulations were assumed to be in place for 10 years, with each house having an expected useful life of 40 years. The first observance of salt attack in the newly constructed building stock was assumed to occur 7 years after construction. Note that this 10 year lag is applied to each building cohort individually, and therefore, those buildings constructed in the first year will be first affected in year 7, but those built in year 7 will only be first affected in year 14. Repair costs of $8000 every 10 years were assumed.

## *National roll out implementation option*

Across Australia, high risk areas for urban salinity have been reported to be concentrated in New South Wales (both in Western Sydney and the Central West region), as well as Victoria and Western Australia[31]. The remainder of Australia has been reported to be at low risk of urban salinity, although in many areas, this risk is projected to be steadily increasing over time. The risk factors used in the model, estimated by statistical division estimated at 2020 and 2050, are presented in table 5.4. A linear growth factor over time is applied to the annual risk of salinity over 2020 to 2050. Note that these are TheCIE estimates only and are not considered to be definitive risk factors. Further, they are averages only and do not necessarily represent the risk level to each town located in the statistical divisions. In general, these are generous estimations of risk factors.

Note that there are only 17 of 49 statistical divisions across Australia with the estimated required risk factor of above 4 per cent by 2050.

5.4 **Per cent risk factors, over time, by statistical division**

| **State and statistical division** | **2020** | **2050** | **State and statistical division** | **2020** | **2050** |
|---|---|---|---|---|---|
| *New South Wales* | | | *Western Australia* | | |
| Sydney | 1 | 7 | Perth | 0 | 0 |
| Hunter | 2 | 5 | South West | 1 | 1.5 |
| Mid-North Coast | 0 | 0 | Lower Great Southern | 4 | 8 |
| Richmond-Tweed | 0 | 0 | Upper Great Southern | 4 | 8 |
| Illawarra | 0 | 0 | Midlands | 4 | 8 |
| Northern | 0 | 2 | South Eastern | 4 | 8 |
| North Western | 5 | 10 | Central | 1 | 2 |
| Central West | 5 | 8 | Pilbara | 0 | 0 |
| South Eastern | 1 | 5 | Kimberley | 0 | 0 |
| Murrumbidgee | 5 | 10 | | | |
| Murray | 0 | 5 | *Victoria* | | |
| Far West | 0 | 0 | Melbourne | 0.5 | 0.8 |
| | | | Barwon | 1 | 2 |
| *Queensland* | | | Western District | 2 | 4 |
| Brisbane | 0 | 0 | Central Highlands | 2 | 4 |
| Gold Coast | 0 | 0 | Wimmera | 8 | 12 |
| Sunshine Coast | 0 | 0 | Mallee | 2 | 4 |
| West Moreton | 0 | 1 | Loddon | 2 | 5 |
| *Queensland* | | | | | |

[31] National Land and Water Resources Audit (2000) Australian dryland salinity assessment 2000

| | | | | | |
|---|---|---|---|---|---|
| Wide Bay-Burnett | 0 | 1 | Goulburn | 2 | 5 |
| Darling Downs | 0 | 1 | Ovens-Murray | 2 | 3 |
| South West | 0 | 0 | East Gippsland | 2 | 3 |
| Fitzroy | 0 | 1 | Gippsland | 0 | 0 |
| Central West | 0 | 0 | | | |
| Mackay | 0 | 1 | Tasmania | | |
| Northern | 0 | 1 | Greater Hobart | 0 | 0 |
| Far North | 0 | 1 | Southern | 0 | 1 |
| North West | 0 | 0 | Northern | 0 | 0 |

*Note: While the assumed rate of salinity risk is quite high, this is based on the assumption that the majority of Sydney's residential growth will be located in western regions. These dwellings are also covered by current NSW variations.*

*Source: TheCIE estimates.*

A national roll out of the proposed amendments, based on the risk factors presented in table 5.4, is estimated to have a benefit cost ratio of 0.23. Across Australia, a total of just over 10 000 new dwellings are projected to be affected by salinity damage, or a national risk factor of 0.8 per cent for these newly constructed dwellings. The results, disaggregated across State and Territories are presented in table 5.5.

### 5.5 Results of national roll out, regional modelling

| | *NPV costs* | *Benefits* | *BCR* | *Net benefits* |
|---|---|---|---|---|
| Australian Capital Territory | 3 119 038 | - | 0.00 | -3 119 037 |
| New South Wales | 51 365 785 | 20 585 909 | 0.40 | -30 779 876 |
| Northern Territory | 2 264 534 | - | 0.00 | -2 264 534 |
| Queensland | 71 227 858 | 944 333 | 0.01 | -70 283 525 |
| Tasmania | 2 303 571 | 6 850 | 0.00 | -2 296 721 |
| Victoria | 52 727 083 | 19 829 117 | 0.38 | -32 897 965 |
| Western Australia | 31 895 130 | 7 320 232 | 0.23 | -24 574 898 |
| Australia | 214 903 000 | 48 686 441 | 0.23 | -166 216 559 |

*Source: TheCIE estimates.*

The estimated net present value of the costs of the proposed national roll out is $214 million, with only $48.6 million worth of salinity damage being avoided. Note that this figure implies a net present value of per house damage of approximately $4900. This figure is well below the $7200 as utilised in the per house assessment, as it more accurately reflects the impacts of discounting benefits, as well as accurately considering the housing cohorts affected by salinity (this is, accounting for year of construction as well as year in which salinity damage is first observed).

These figures are based on assumed recurring damage costs of $8000 every 10 years. To return a benefit cost ratio of 1, this figure would be required to increase to approximately $35 000.

## *National mapping exercise*

Under the implementation scenario requiring a national mapping of salinity risk, an additional $10 million cost is imposed, resulting in 90 per cent of low risk areas being excluded from the proposed amendments, and 70 per cent of high risk areas being covered. The list of high and low risk locations are slightly altered from the list used in the per house model, to more closely reflect the information presented in table 5.4. Statistical divisions with an estimated zero probability of salt attack by 2050 are reclassified as low risk regions. The underlying probability of salt attack for each region used in the analysis is that reported in table 5.4.

Increasing the focus of the proposed amendments does have the effect of raising the estimated benefit cost ratio to 0.42, still returning net costs to the Australian economy. The results are presented in table 5.6.

5.6 **Results of national mapping exercise, regional modelling**

| | *NPV costs* | *Benefits* | *BCR* | *Net benefits* |
|---|---|---|---|---|
| Australian Capital Territory | 311 904 | 0 | 0.00 | -311 904 |
| New South Wales | 12 641 159 | 7 557 840 | 0.60 | -5 083 319 |
| Northern Territory | 226 453 | 0 | 0.00 | -226 453 |
| Queensland | 7 122 786 | 94 433 | 0.01 | -7 028 353 |
| Tasmania | 230 357 | 685 | 0.00 | -229 672 |
| Victoria | 13 803 763 | 9 344 582 | 0.68 | -4 459 181 |
| Western Australia | 7 911 464 | 5 124 162 | 0.65 | -2 787 302 |
| Australia | 52 247 886 | 22 121 702 | 0.42 | -30 126 184 |

*Note: Australian total costs have had the $10m mapping costs applied. State and Territory totals cannot be considered individually achievable.*

*Source: TheCIE estimates.*

Total construction costs are $52 million, slightly lower than with the per house methodology, as a greater number of regions are assumed to have a low risk factor. Further, due to the specific risk factors applied in the regional model, total benefits in terms of avoided salinity damage are only $22.1 million. This lower result reflects both the lower incidence of salinity as well as the lower level of assumed accuracy of the mapping techniques.

These figures are based on assumed recurring damage costs of $8000 every 10 years. To return a benefit cost ratio of 1, this figure would be required to increase to approximately $19 000.

## *Selective mapping exercise*

The selective mapping exercise utilises the same high and low risk regional profiles as in the national mapping exercise presented above, as well as the specific risk factors for each statistical division. However, a greater rate of accuracy on the mapping techniques is assumed, with 90 per cent of high risk areas being classified as such, and 95 per cent of low risk areas being classified as such.

The results of the analysis are presented in table 5.7. Nationally, a net cost of $23m is estimated, with a benefit cost ratio of 0.54.

### 5.7 **Results of selective mapping exercise, regional modelling**

| | *NPV costs* | *Benefits* | *BCR* | *Net benefits* |
|---|---|---|---|---|
| Australian Capital Territory | 155 952 | 0 | 0.00 | -155 952 |
| New South Wales | 13 199 778 | 8 819 898 | 0.67 | -4 379 880 |
| Northern Territory | 113 227 | 0 | 0.00 | -113 227 |
| Queensland | 3 561 393 | 47 217 | 0.01 | -3 514 176 |
| Tasmania | 115 179 | 343 | 0.00 | -114 836 |
| Victoria | 14 722 014 | 11 420 489 | 0.78 | -3 301 526 |
| Western Australia | 8 284 188 | 6 588 208 | 0.80 | -1 695 979 |
| Australia | 50 151 730 | 26 876 154 | 0.54 | -23 275 576 |

*Note: Australian total costs have had the $10m mapping costs applied. State and Territory totals cannot be considered individually achievable.*

*Source: TheCIE estimates.*

These figures are based on assumed recurring damage costs of $8000 every 10 years. To return a benefit cost ratio of 1, this figure would be required to increase to approximately $15 000.

## *Groups impacted by the proposal*

### *Individuals*

It is assumed that builders will pass on the additional construction costs to owners. This is an efficient solution as it will be the owners that will reap the benefits of the proposed amendments in the form of reduced damage costs and repair bills. Therefore, home owners will face the majority, if not all of the additional costs, as well as the benefits of the proposed amendments.

### *Businesses*

Individual builders will be required to become familiar with the proposed amendments, including the additional construction requirements, as well as the justification for their introduction. This would potentially require additional education services offered through building associations.

Further, the proposed reduction in allowable building materials for damp proof courses has been reported by industry groups as having the potential to disrupt the operations of suppliers and builders for approximately 6–12 months. This time frame was estimated as sufficient to allow both suppliers and builders to be able to work through their current inventory levels, and ensure that new orders and deliveries are able to meet the new requirements. This cost could possibly be alleviated through a delay in implementation, or early notification of the proposed amendments coming into force.

Quantification of this cost, should notice not be given to suppliers and builders of the proposed amendments would heavily depend on current inventory stocks, as well as the potential to return unused products.

### *Government*

Who bears responsibility of the mapping exercise is an important question. To undertake such a large scale national mapping exercise, highly specialised personnel and equipment is required. The difficulty of the task is reflected in the slow frequency with which such reports are generated.

# 6 Sensitivity analysis

Throughout the discussion of the analysis framework, as well as the presentation of the modelling results, areas of uncertainty in the models have been discussed. This section provides information on the likely effect of these uncertainties on the modelling results.

## Scenario based sensitivity analysis

A scenario based sensitivity analysis considers each area of uncertainty in turn, outlining the level of change required in selected variables to return a benefit cost ratio of 1.

### Costs of salinity damage

The level of damage costs in each implementation scenario required to return a benefit cost ratio of 1 was presented along with the results of the modelling exercises. The central cases of the models assume a net present value of damage costs of approximately $7200 for the per house model, and $8000 recurring every 10 years in the regionally based bottom up model. The proportional increase in these estimated costs required for a break even result are presented in table 7.1. In general, the damage costs of salinity are required to be approximately 2–4 times greater than those in the central case to return a benefit cost ratio of 1.

6.1 **Sensitivity analysis — salinity damage costs**

| ***Modelling framework*** | ***Implementation scenario*** | ***Central case damage costs*** | ***Required damage costs for benefit cost ratio of 1*** | ***Proportional increase over central case*** |
|---:|---:|---:|---:|---:|
| Per house | National mapping | $7 200 NPV | $26 000 NPV | 3.61 |
| | Selective mapping | $7 200 NPV | $21 000 NPV | 2.92 |
| Regional | National roll out | $8 000 recurring | $35 000 recurring | 4.375 |
| | National mapping | $8 000 recurring | $19 000 recurring | 2.375 |
| | Selective mapping | $8 000 recurring | $15 000 recurring | 1.875 |

*Source: TheCIE estimates.*

## *Probability of salt attack*

For the per house model, to achieve a benefit cost ratio of 1, the required risk of salt attack in high risk areas was presented in the benefits section. A risk factor of 13 per cent is required for high risk areas if a national mapping option was undertaken, and 10 per cent risk factor for high risk areas is required for a more selective mapping option. These figures represent a significantly greater level of salt attack than are currently estimated for the highest risk areas of Australia.

Considering the regionally specific risk factors that were presented in table 5.4, a significant proportional increase would be required across all statistical divisions to return a benefit cost ratio of 1. A continuous 16 fold increase in regional probabilities of salt attack would be required to return a break even net benefit from a national roll out of the proposed amendments. Note that these probabilities are well beyond the realms of possibility.

## *Discount rate*

A 7 per cent discount rate is used in both of the models. However, due to the lag between the additional construction costs and the benefits of the proposed amendments, changes to the discount rate will have a discernable effect on the model results.

Considering the regionally based modelling results, the effects of alternate discount rates on the benefit cost ratio are presented in table 6.2.

6.2 **Sensitivity analysis — discount rates**

| *Implementation option* | *3 per cent* | *7 per cent (central case)* | *11 per cent* |
|---:|---:|---:|---:|
| National roll out | 0.39 | 0.23 | 0.15 |
| National mapping | 0.75 | 0.42 | 0.26 |
| Selective mapping | 0.95 | 0.52 | 0.33 |

*Source: TheCIE estimates.*

A reduction in the assumed discount rate has the effect of increasing the implicit value of repair costs that are incurred in the future. Therefore, under a lower 3 per cent discount rate, the estimated benefit cost ratio increases for all implementation options. Under the selective mapping exercise, a benefit cost ratio of 0.95 is estimated under a 3 per cent discount rate.

Conversely, where a higher discount rate is assumed, any repair costs incurred in the future are heavily discounted, implying a much lower net present value. This is seen through the results of an assumed 11 per cent discount rate. In this case, the estimated benefit cost ratios of all implementation scenarios are lowered compared to the central case.

## *New South Wales variations*

Through the regionally based bottom up model, it is assumed that 20 per cent of the costs of the proposed variations are already being met in New South Wales due to the current requirements of high impact damp proof membranes to be used in all New South Wales dwelling constructions. In addition, 50 per cent of the benefits from the proposed amendments are assumed to be drawn from the use of a high impact damp proof membrane.

The effects of altering this benefit assumption are presented in table 6.3.

6.3 **Sensitivity analysis — benefits of New South Wales variations**

| *Implementation scenario* / *Proportion of benefits from damp proof membrane* | *30 per cent* | *50 per cent — central case* | *70 per cent* |
|---|---|---|---|
| National roll out | 0.26 | 0.23 | 0.19 |
| National mapping | 0.48 | 0.42 | 0.37 |
| Selective mapping | 0.61 | 0.54 | 0.47 |

*Source: TheCIE estimates.*

An increase in the proportion of benefits derived from the damp proof membrane has the effect of reducing the estimated benefit cost ratio of all implementation options. This is because where the New South Wales variations are assumed to already be generating these benefits in New South Wales they cannot be double counted in the estimated benefits of the proposed amendments. Under a selective mapping exercise, with 70 per cent of the estimated benefits being derived from the damp proof membrane, a benefit cost ratio of 0.47 is estimated.

Alternatively, should the benefits of the damp proof membrane be lower than assumed in the central case, for example, accounting for only 30 per cent of the estimated benefits, then the benefit cost ratio will increase for all implementation options. Under the selective mapping implementation option, these lower benefits of the damp proof membrane would result in a national benefit cost ratio of approximately 0.61.

## *Current levels of compliance*

Due to data limitations, the central case presented in the Consultation RIS assumes that there are no areas voluntarily implementing the proposed amendments to the BCA (note that this discussion surrounds voluntary implementation, and is in addition to the New South Wales variations, and those areas of New South Wales requiring South Australian variations to be met).

Evidence provided from industry associations is mixed with regards to the current level of voluntary compliance across Australia, with some reports that the proposed amendments are good building practice, and therefore are already being implemented, with other reports noting that vapour barriers of any description are not always included.

Where voluntary compliance levels are constant across Australia, for example, 10 per cent of all new constructions voluntarily meet the proposed amendments, there will be no change in the benefit cost ratio. This is because there will be an equally proportional reduction in both the costs and benefits. Only where voluntary compliance is not constant across Australia will there be an impact on the estimated benefit costs ratio.

Information on the current levels of compliance, by State and region, across Australia will be sought through the consultation period.

### *Concrete curing requirements*

The majority of the estimated costs of the proposed amendments to the BCA are derived from the additional requirements for concrete curing — $225 of $285 total costs. Should the amendments be restricted to only including the provisions for damp proof membranes and courses, there will be a significant drop in the estimated per house construction costs, as well as an associated drop in the realised benefits from the proposed amendments.

As previously discussed, concrete strength and permeability are key factors in determining the susceptibility of the slab to moisture damage and salt attack. This is particularly the case where the damp proof membrane is breached through the construction process, including through puncture or incorrect installation.

Incorrect installation of damp proof courses is a significant quality issue that has been raised in a number of forums, including published reports, discussions with industry associations, as well as reviews of training materials.[32] Within the BCA, it is a mandatory requirement that damp proof membranes be finished to ground or finished surface levels. However, reports by Cement Concrete and Aggregates Australia, as well as discussions with industry groups reveal that this is not common practice.

---

[32] Lume, E. and Sirivivatnanon V. (n.d.) Building with concrete in saline soils, Cement Concrete and Aggregates Australia.

For these reasons, a number of potential benefits scenarios are considered against the option of removing the proposed concrete curing amendments. The results are presented in table 6.4. Three alternate ratios of protection are considered. Firstly, 30 per cent of protection from the proposed amendments is assumed to be derived from correctly cured concrete, and 70 per cent from the use of damp proof membranes. In this case, removal of the requirements for concrete curing would reduce costs by almost 80 per cent, but only reduce the estimated benefits by approximately 30 per cent. Under a selective mapping implementation option, a benefit cost ratio of 1.02 is estimated.

A potentially more realistic division of benefits at 50:50 (the central case assumed for the New South Wales variations) reduces the estimated benefit cost ratio of a selective mapping exercise to 0.73. In this case, costs are still reduced by almost 80 per cent, with the estimated benefits reduced by 50 per cent.

The final scenario assumes that the proportions of benefits are more closely aligned with the proportions of costs. That is, 70 per cent of the benefits being derived from concrete curing, and 30 per cent from the use of damp proof membranes. At benefit cost ratio of 0.44 is estimated in this case under a selective mapping exercise.

6.4 **Sensitivity analysis – removal of concrete curing requirements**

| *Proportion of benefits concrete curing versus damp proof membrane* | *BCR — National roll out* | *BCR — National mapping* | *BCR — Selective mapping* |
|---|---|---|---|
| 30:70 | 0.76 | 0.82 | 1.02 |
| 50:50 | 0.54 | 0.59 | 0.73 |
| 70:30 | 0.33 | 0.36 | 0.44 |

*Source: TheCIE estimates.*

Information on the division of protection benefits across the elements of the proposed amendments will be sought through the consultation period.

## *Monte Carlo simulation*

Where the previous sensitivity analyses have provided discrete estimation of single parameter changes within the results, the following Monte Carlo simulation allows for testing of the combined effects of changing the underlying assumptions. These variations in key assumptions are presented in table 7.5, and reflect the uncertainties considered throughout the report.

A highly variable normal distribution of salinity damage costs was used in the simulations, a mean of $8000 per 10 years, with a standard deviation of $5000. This means that 36 per cent of the simulated salinity damage costs are within the range of $8000 and $13 000 (one standard deviation above the average). This relatively high standard deviation reflects the large increase in damage costs required for a positive benefit cost ratio, but also reflects highly variable damage costs as reported by the the NSW State Government (See Table 2.14).

The risk of salt attack premium allows for variation in the regional probabilities of salt attack as reported in table 6.5. Where a premium is applied, it is constant across all regions, applying a proportional upwards or downwards shift in all probabilities.

6.5 **Monte Carlo simulation variables**

| *Variable* | *Central case value* | *Monte Carlo distribution* |
|---|---|---|
| Average salinity damage costs – regional methodology | $8 000 every 10 years | Truncated normal (8 000, 5 000) [a] |
| Additional construction costs | $285 per house | Discrete uniform (200, 285, 370) |
| NSW variation proportion of benefits already accrued | 50 per cent | Uniform (0.3,0.9) |
| Cost of mapping exercises | $10 million | Uniform (8million, 12 million) |
| Accuracy of mapping exercises | National 70% high risk<br>90% low risk<br>Selective 90% high risk<br>95% low risk | Uniform (60%, 100%) high risk<br>Uniform (80%, 100%) low risk |
| Risk of salt attack premium | 1[b] | Normal (1,0.5) |
| Discount rate | 7 per cent | Discrete uniform (3, 7, 11) |

*a Distribution truncated at 0 to reflect minimum bound of damage costs.*
*b A premium of 1 indicates risk figures in table 7.4 utilised.*

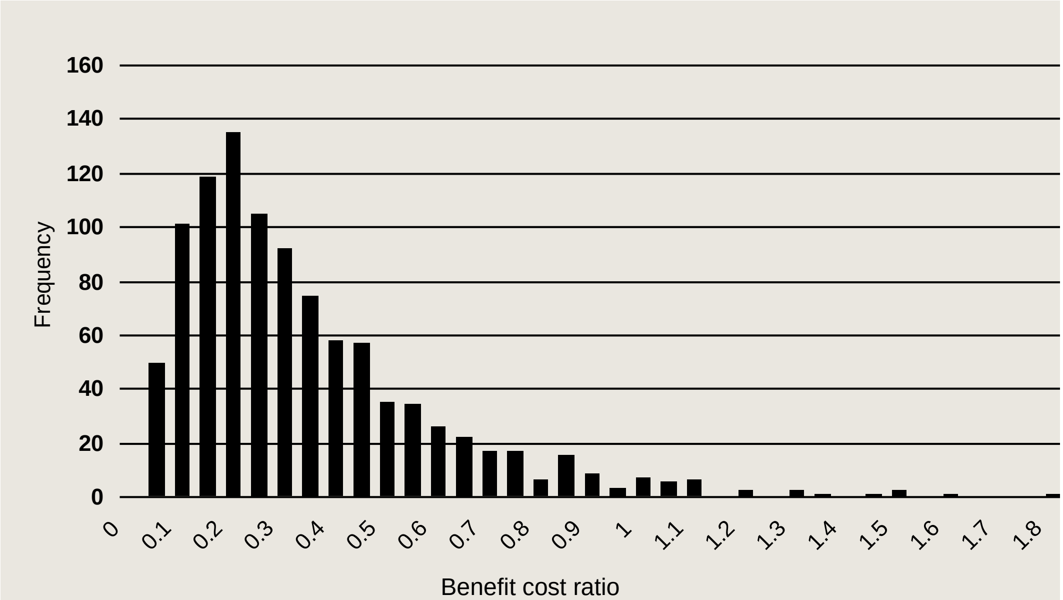
*Source: TheCIE.*

A Monte Carlo analysis is employed to test the sensitivity of the central case to all key parameters employed. The Monte Carlo analysis varies all key parameters as outlined and recalculates the benefits and costs to explore the effect of their potential interactions on the results. One thousand Monte Carlo simulations have been conducted for each exercise. Due to the nature of the implementation options, a separate simulation has been run for both the national implementation option as well as the mapping exercises (which were simulated jointly). The simulations were only run for the regional based modelling approach.

## *National rollout implementation*

The results of the Monte Carlo simulation for the national roll out exercise are presented in chart 6.6 and table 6.7. Chart 6.6 presents a histogram of the results, indicating the relative frequencies of the estimated benefit cost ratios. Table 6.7 is a summary of these results.

### 6.6 **Histogram — national roll out Monte Carlo analysis**




*Data source: TheCIE estimates.*

### 6.7 **Monte Carlo simulation — national roll out**

| ***Variable*** | ***Value*** |
|---|---|
| Minimum | 0.0 |
| Maximum | 1.77 |
| Average | 0.31 |
| 5th percentile | 0.05 |
| 95th percentile | 0.81 |

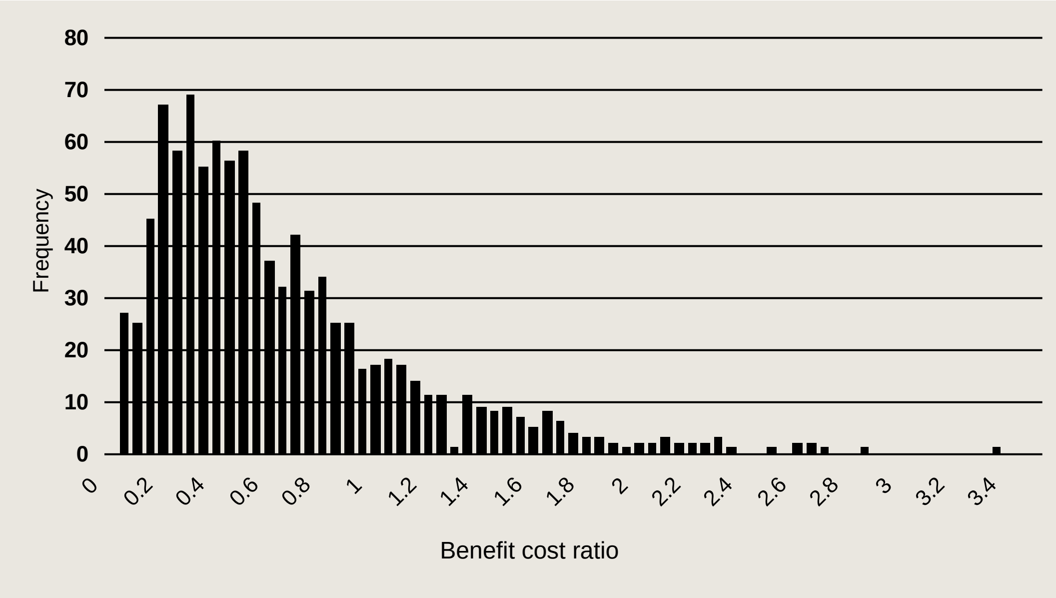
*Source: TheCIE estimates.*

Across the simulation, the average estimated benefit cost ratio is 0.31. In addition, 95 per cent of observations have a benefit cost ratio of below 0.81 (that is, the 95th percentile). Overall, there are only 2 per cent of the simulations that return a positive benefit cost ratio. This is of note even with the generous variability allowed for in the salinity damage distribution.

## *Mapping exercises*

Due to the nature of the models, the mapping exercises were simulated together, allowing for a combined distribution of mapping accuracy. As shown in chart 6.8 and table 6.9, the simulations allowed for a uniform distribution of high risk area accuracies across 60 per cent to 100 per cent — that is, allowing for between 60 and 100 per cent of high risk areas to be correctly identified. A uniform distribution of accuracy across low risk areas was also included, between 80 and 100 per cent.

## 6.8 **Histogram — mapping based roll out Monte Carlo analysis**




*Data source: TheCIE estimates.*

## 6.9 **Monte Carlo simulation — mapping based roll out**

| *Variable* | *Value* |
|---:|---:|
| Minimum | 0 |
| Maximum | 3.33 |
| Average | 0.62 |
| 5$^{th}$ percentile | 0.1 |
| 95$^{th}$ percentile | 1.61 |

*Source: TheCIE estimates.*

Across the simulation, the average estimated benefit cost ratio is 0.62. In addition, 95 per cent of observations have a benefit cost ratio of below 1.61 (that is, the 95$^{th}$ percentile). Overall, there are 17.3 per cent of the simulations (173) that return a positive benefit cost ratio. These positive results are being driven through the generous assumptions on damage costs, as well as the potentially high accuracy of the mapping exercises allowed for within the simulations.

# 7 Implementation issues

## Enforcement issues

Anecdotal evidence has been received that in some areas across Australia the necessary education courses and training services are not reaching the construction industry as well as they should. The result of this being that current requirements of the BCA are not necessarily always being followed, increasing the risk of damage to houses.

Common elements of non-compliance that have been raised include that vapour barriers or damp proof membranes are not being installed, or where they are, they may not be extended up to the finished ground level. A damp proof membrane that is not extended to the finished ground level is likely to be breached by moisture, leaving the building vulnerable.

BCA compliance issues are the jurisdiction of States and Territories, and therefore beyond the scope of this consultation RIS. However, compliance issues should be considered very carefully by the relevant authorities as they have the ability to affect the results as reported here, both lowering the expected benefits, and the costs of the proposed changes[33].

## Business compliance costs

There are not expected to be any significant business compliance costs imposed due to the proposed amendments. There will be transitional costs associated with a turn over of inventory; however, according to discussions with industry associations, and following experience with NSW variations in 2004, this is not expected to last more than 12 months.

There is the potential for significant business compliance costs to be imposed through education services and ensuring that the proposed amendments are adhered to. These costs however, should not be attributed to the proposed amendments presented in this Consultation RIS as they reflect a wider need for education, training and information through the construction industry.

---

33 Where current BCA requirements are not being met, with the expectation that the proposed BCA changes will not be met, there will be a nil effect due to the proposed changes.

## Competition effects

The principles of best practice regulation outlined in COAG (2007) set out specific requirements with regards to regulatory process undertaken by all governments. In particular, Principle 4 of Best Practice Regulation states that:

> In accordance with the Competition Principles Agreement, legislation should not restrict competition unless it can be demonstrated that:
>
> a. the benefits of the restrictions to the community as a whole outweigh the costs; and
>
> b. the objectives of the regulation can only be achieved by restricting competition.

As such, COAG requires that all RISs include evidence that:

- the proposed regulatory changes do not restrict competition; or
- the changes can potentially restrict competition but the public benefits of the proposed change outweigh the costs and the objectives of the changes can only be achieved by restricting competition.

Potential impacts on competition will predominantly be associated with the ability of builders and construction companies to flexibly adjust to the increased stringency of building materials. This flexibility will be determined through a combination of the implementation scenario that is utilised, as well as the national or regional coverage of builders and suppliers.

Under the selective implementation options, there is the potential for highly localised builders and suppliers of building materials to be adversely affected by the proposed amendments. This effect will be a result of limited flexibility to divert building materials (for example medium impact damp proof membranes and vapour barriers) to areas that are not required to meet the proposed amendments. However, as previously discussed, this disruption in supplies is only expected to last for between 6–12 months before both suppliers and builders will be able to manage inventory levels and sources.

Alternatively, under a national roll out of the proposed amendments, there will be limited flexibility for any national construction companies to shift construction supplies across State and regional borders to dispose of current inventories. This limitation would lessen the competitive effects of the transition period to some degree, but again, is only expected to last for between 6–12 months after implementation.

# 8 Consultation

## ABCB consultation protocol

The ABCB is committed to regularly review the BCA and to amend and update it to ensure that it meets changing community standards. To facilitate this, the ABCB maintains regular and extensive consultative relationships with a wide range of stakeholders. In particular, a continuous feedback mechanism exists and is maintained through State and Territory building control administrations and industry, through the Building Codes Committee. These mechanisms ensure that opportunities for regulatory reform are identified and assessed for implementation in a timely manner.

All ABCB regulatory proposals are developed in a consultative framework in accordance with the Inter-Government Agreement. Key stakeholders are identified and approached for inclusion in relevant project specific committees and working groups. Thus, all proposals have widespread industry and government involvement.

The ABCB has also developed a Consultation Protocol, which includes provisions for a consultation process and consultation forums. [34] The Protocol explains the ABCB's philosophy of engaging constructively with the community and industry in key issues affecting buildings and describes the various consultation mechanisms available to ABCB stakeholders.

The ABCB’s consultation processes include a range of programs that allow the ABCB to consult widely with stakeholders via:

- the proposal for change process;
- the release of BCA amendments for comments;
- regulatory impact assessments;
- impact assessment protocol;
- research consultations;
- ABCB approval that reports directly to ministers responsible for building; and

34 Available on http://www.abcb.gov.au/index.cfm?objectid=49960DC7-BD3E-5920-745CE09F1334889C.

- international collaboration.

The Protocol also ensures that the ABCB engages with their stakeholders via a range of events and information series through:

- the Building Codes Committee with representatives from a broad cross section of building professions and all levels of government;
- its consultation committees;
- public information seminars;
- its biennial National Conference;
- its technical magazine, the Australian Building Regulation Bulletin (ABRB);
- its online technical update, ABR Online;
- its free 1300 service advisory line which provides information for BCA subscribers to clarify BCA technical matters and access technical advice about provisions; and
- the ABCB website.

## *Preliminary consultation*

To assist in the development of this Consultation RIS, a preliminary round of consultation has been undertaken by TheCIE. Targeted stakeholders – members of the Building Codes Committee – were approached and asked to comment on the Consultation RIS assumptions as well as current experiences with salinity damage, costs and industry practice.

## *Public consultation period*

Key areas of uncertainty have been presented in the sensitivity analysis, along with the estimated impacts of these uncertainties. Through the public consultation period, the ABCB is looking to gather information that will help to resolve these reported issues of uncertainty.

- Understanding salinity issues
  - In what urban areas (cities, towns, or state regions) is salinity currently an issue for the building industry?
  - Is there information on the urban areas that are likely to be at increased risk in the future?
  - How do planning authorities include consideration of salinity issues in the planning process?
- Costs of salinity

  - What are the on-going annual costs of maintenance in a saline affected area?
- Proposed changes to the BCA
  - Are the cost estimates of the proposed changes presented here (additional $285 for a 200m sq slab on ground house) an accurate representation of additional per house construction costs, or could they be updated?
  - How should the protection benefits be divided across the different elements of the proposed amendments (that is, across damp proof membranes, courses and slab curing and compaction)?
  - To what extent are the SA provisions, or other similar requirements (such as those found in AS 2870) for designing and constructing for saline protection, already being used in other States and Territories (and therefore increasing the stringency would not impose any additional construction costs)?
    - That is, what is the current application of ‘high impact’ resistant damp-proofing membranes, outside of SA and NSW when ‘medium impact’ would suffice?
  - What will be the implications of reducing the choice of acceptable materials used for damp-proof courses, such as currently applies in SA?
  - To what extent are curing and compaction currently undertaken to either mitigate saline soils or for other reasons such as structural adequacy?
- Are the estimated costs of the salinity mapping exercises appropriate?

# 9 Conclusion

Increasing salinity in soils is an issue of concern to the building industry due to the potential for salt attacks on buildings to weaken structures, increasing the risk of failure. Buildings and infrastructure are considered to be at risk of damage when the water table is less than 2m from the ground surface.[35] In 2000, it was estimated that 68 Australian towns were affected by urban salinity, with this figure projected to increase to approximately 125 by 2020 and 219 by 2050.[36] These towns were located across New South Wales, Western Australia, South Australia and Victoria.

Currently, provisions to manage rising damp — and through rising damp, salinity — are explicitly covered in both the BCA and referenced standards. However, with concerns that the risks of urban and rural salinity are likely to increase over time and with increased potential for damage to building structures and information issues across consumers, the ABCB is proposing to broaden provisions in the BCA addressing the effects of saline soils. This Consultation RIS evaluates the impacts of the proposed national expansion of current South Australian variations, to the BCA in order to protect against salt attack.

The proposed amendments are estimated to provide a net benefit for all new dwellings facing a greater than 4 per cent risk of salt attack. Across high risk areas, this would be considered to be a good insurance investment, where the rate of salt attack can be up to 8–10 per cent across the region.

However, as a national average, 4 per cent is an extremely high risk target. This is because the majority of dwellings across Australia are not considered to be at risk of salt attack, especially in capital city areas. The regionally based bottom up model utilised in the Consultation RIS estimates the national rate of salinity risk at approximately 0.5 per cent.

In addition to this low national risk level, areas that are considered to be at high risk of salt attack predominantly already have significant provisions in

---

[35] IPWEA (2002) Local Government Salinity Management Handbook: A resource guide for the public works professional.

[36] National Land and Water Resources Audit (2000) Australian dryland salinity assessment 2000.

place to protect dwellings. Examples of these provisions include New South Wales local councils of Fairfield, Camden and Junee that already require the South Australian variations to be met. Such provisions, in known high risk areas, have already achieved the net benefits of protection and they therefore cannot be attributed to the proposed amendments considered in this Consultation RIS.

Table 9.1 presents the estimated results of the three implementation options, including the net present value of the costs and benefits compared to the status quo option, and the estimated benefit cost ratio. Overall, all three implementation options are estimated to return a net cost to the economy, with the highest benefit cost ratio, 0.54, estimated for the highly accurate mapping exercise. The national roll out option yields the lowest net return to the Australian economy due to the additional costs imposed on those dwellings not considered to be at risk of salt attack. Increasing the accuracy of the implementation option more than doubles the benefit cost ratio, also reducing the net costs by over 85 per cent.

### 9.1 **Modelling results — alternative implementation options**

| | *NPV costs* | *NPV benefits* | *BCR* | *NPV net benefits* |
|---|---|---|---|---|
| National roll out | 214,903,000 | 48,686,441 | 0.23 | -166,216,559 |
| National mapping | 52,247,886 | 22,121,702 | 0.42 | -30,126,184 |
| Selective mapping | 50,151,730 | 26,876,154 | 0.54 | -23,275,576 |

However, it is recognised that these estimates are based on uncertain assumptions of damage costs, incidence rates of salinity damage as well as the accuracy of mapping exercises.

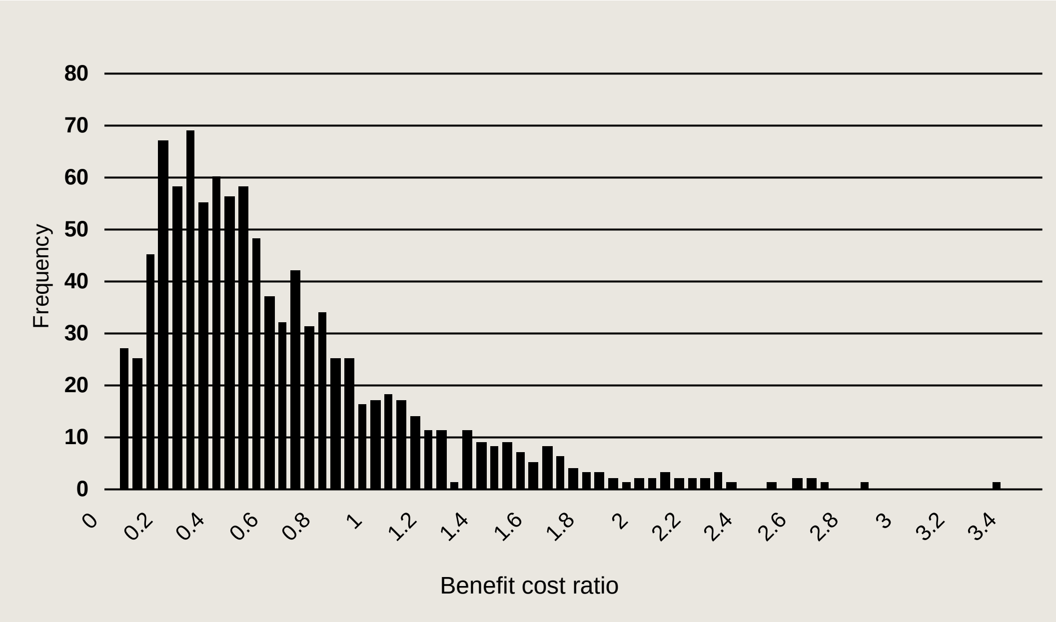
A Monte Carlo analysis has highlighted both the level of uncertainty in the model variables, as well as the uncertainty in the final modelling results. The results, allowing for defined levels of uncertainty in variables such as the level of salinity damage, the discount rate, the rate of salinity risk, the accuracy of the mapping exercises and the additional construction costs, are presented in table 9.2 and chart 9.3.

### 9.2 **Monte Carlo simulation — mapping based roll out**

| *Variable* | *Value* |
|---|---|
| Minimum | 0 |
| Maximum | 3.33 |
| Average | 0.62 |
| 5th percentile | 0.1 |
| 95th percentile | 1.61 |

*Source: TheCIE estimates.*

### 9.3 **Histogram — mapping based roll out Monte Carlo analysis**




*Data source: TheCIE estimates.*

Across the simulations, the average estimated benefit cost ratio is 0.62. In addition, 95 per cent of observations have a benefit cost ratio of below 1.61 (that is, the 95$^{th}$ percentile). Overall, there are 17.3 per cent of the simulations (173) that return a positive benefit cost ratio. These positive results are being driven through the generous assumptions on damage costs, as well as the potentially high accuracy of the mapping exercises allowed for within the simulations.

Various sensitivity analyses have been undertaken, including a threshold analysis on salinity damage costs which is presented in table 9.4.

### 9.4 **Sensitivity analysis — required damage costs for BCR of 1**

| *Modelling framework* | *Implementation scenario* | *Central case damage costs* | *Required damage costs for benefit cost ratio of 1* | *Proportional increase over central case* |
|---|---|---|---|---|
| Regional | National roll out | $8 000 recurring | $35 000 recurring | 4.375 |
| | National mapping | $8 000 recurring | $19 000 recurring | 2.375 |
| | Selective mapping | $8 000 recurring | $15 000 recurring | 1.875 |

*Source: TheCIE estimates.*

Across the three implementation options, to achieve a benefit cost ratio of 1, the required level of average salinity damage costs range from $35 000 recurring every 10 years under a national rollout to $15 000 under a selective mapping scenario. Information gathered through the public consultation period will be used to clarify the level of average damage costs expected to be observed per salt attack.

The key results of this Consultation RIS are that the use of mapping options, where the proposed amendments are only implemented in areas that are considered to be at risk, provides a relative improvement to a national implementation option. Under all simulations, the most accurate mapping implementation option (termed selective mapping exercise, with accuracy rates of 90 per cent in high risk areas and 95 per cent in low risk areas) returns the greatest net benefit to the Australian economy. The size of this net benefit depends heavily on the assumptions used. For example, in the central case, a BCR of 0.54 is returned under the selective mapping exercise, but where concrete curing requirements are excluded, and are assumed to account for only 30 per cent of the building protection benefits, a BCR of 1.02 is returned.

Where key areas of uncertainty have been presented in the sensitivity analysis, along with the estimated impacts of these uncertainties the ABCB is looking to gather information that will help to resolve these reported issues of uncertainty through the public consultation period.

# References


ABCB (2007) Salinity consultation paper

Australian Natural Resources Atlas — www.anra.gov.au

DECC NSW (2008) Building in a saline environment

DIPNR (2005) Costs of Salinity, Local Government Salinity Initiative, Booklet No. 10

DIPNR (2007) Repairing and maintaining salinity affected houses, Local Government Salinity Initiative, booklet no. 12

Hayward, S. (2000) Urban Salinity — the ultimate constraint to development, Department of Land and Water Conservation, Sydney South Coast Region

IPWEA (2002) Local Government Salinity Management Handbook: A resource guide for the public works professional

Lume, E. and Sirivivatnanon V. (n.d.) Building with concrete in saline soils, Cement Concrete and Aggregates Australia

National Land and Water Resources Audit (2000) Australian dryland salinity assessment 2000

Regional Programs Report 2005, National Action Plan for Salinity and Water Quality and Natural Heritage Trust Regional Programs Report 2003-04, viewed 31 May 2006, http://www.nrm.gov.au/publications/regional-report/03-04/index.html

Spies, B. and Woodgate, P. (2004) Technical Report: Salinity mapping methods in the Australian context. Prepared for the Programs Committee, of the Natural Resource Management Ministerial Council through Land and Water Australia and the National Dryland Salinity Program

TheCIE (2009) *Economic evaluation of energy efficiency standards in the Building Code of Australia, Standardising the cost-benefit analysis*, prepared for the Department of the Environment, Water, Heritage and the Arts, January

Wilson S. and Laurie, I (n.d.) Dryland salinity in the Central West Region, what is it costing you? Factsheet

Wilson, S.M. and Laurie, I. (2001) Assessing the full impacts and costs of dryland salinity, report prepared for the Salinity Economics Workshop, 22-23 August 2001, Orange

Wilson, S.M. (2003) Determining the full costs of dryland salinity across the Murray-Darling Basin: Final Project Report, a Wilson Land Management Services report to the Murray Darling Basin Commission and National Dryland Salinity Program. Referenced in DIPNR (2005) Costs of Salinity, Local Government Salinity Initiative, Booklet no. 10

APPENDIX

# Model development

# A Analysis framework

It is important that the impact analysis be conducted within the bounds of a consistent and coherent framework. This chapter outlines the framework of analysis, highlighting both its scope and the key methodological tacts employed.

This section will set up the discussion on:

- the number of houses to be constructed in each area across Australia;
- current levels of compliance with the South Australian variations (that is all of South Australia and the majority of New South Wales);
- probability of salt attack across different regions of Australia; and
- alternative methodologies.

## Regional construction projections

The proposed amendments will only affect buildings constructed in the 10 years after the BCA 2011 implementation. Therefore, construction projections across Australia are required over the period 2011-2021. These projections are required to be disaggregated at both the State and regional level to ensure that a targeted assessment of the proposed implementation options may be made.

State and Territory level construction figures were drawn from TheCIE (2009), which in turn draws on Australian Bureau of Statistics (ABS) construction figures. The report TheCIE (2009) transfers the ABS figures into the specific categories of 'flat, town house and house', allowing the analysis to closely follow building classifications within the BCA. These State and Territory level construction projections were then allocated across ABS statistical division, based on the 2006 ABS Census figures. Construction was assumed to remain proportional across the statistical divisions over time. Overall, the residential housing stock is projected to increase by approximately 130 000 dwellings annually over the coming 10 years.

Assumptions underpinning the analysis include that the proposed amendments will be in effect for 10 years, and that each building has a useful life of 40 years.

## *Current levels of compliance*

The proposed amendments to the BCA will only have an impact in those areas that are not currently meeting the South Australian variations. Therefore, the analysis will not include assessment of effects in South Australia, as there will be nil impact.

In addition, a number of local government areas in New South Wales will also have a nil impact where the local government already requires South Australian variations to be met. Local government areas of Camden, Junee and Fairfield all require that new constructions meet South Australian requirements. These variations were introduced due to the higher risk of salinity impacts within the region.

Further differentiation of cost and benefit impacts are utilised across New South Wales where the status quo situation does not reflect the current BCA provisions. That is, the assessment is only required to estimate the additional costs and benefits that would be accrued by moving from the current New South Wales variations on damp proof membranes to include the South Australian variations of damp proof courses and concrete curing.

In the central case, it is assumed that 20 per cent of the estimated cost impact is already being met in New South Wales due to the current variations, with 50 per cent of the benefits also already being achieved.

## *Per house costs of salinity*

The benefits of the proposed amendments to the BCA are measured in terms of their ability to remove requirements for repair and maintenance work on building structures damaged by salinity. Therefore, the average cost of salinity damage is an important variable within the model.

The estimated costs of salinity at a per house level have been presented in section 2. These costs vary on a site by site basis, and depend on the extent of the salinity damage when it is observed and treated, the materials affected, the part of the structure that is affected, as well as the repair option chosen.

Estimates of per house costs to repair salinity damage ranged from $2000 where owners undertook the labour themselves, to upwards of $10 000 for a commercial repair and to full-rebuild costs in the case of extensive damage.

For the central case of this Consultation RIS, average upfront construction costs are estimated at approximately $8000, with such repairs lasting for

10 years. This figure was suggested by industry associations, and is supported by New South Wales State government estimates.

## *Probability of salt attack*

The benefits of the proposed amendments are also determined by the probability that a house will be subject to a salt attack. This probability is based on a number of factors including:

- the regional probability of saline soils being observed in the area;
- site characteristics that may reduce or increase the risk of salt attack above the average in a given area (for example, a house located on lower ground is more susceptible to salt attack than those on higher ground); and
- the probability that the vapour barrier (installed to current BCA requirements) is breached in the construction process (at which point the permeability of the slab is the protecting feature of construction).

Estimates of regional probabilities of salt attack have been developed for the purposes of the model. The probabilities are estimated at the ABS statistical division level, and are based on the risk profile maps published by the Natural Heritage Trust, through the National Land and Water Resources Audit (NLWRA), 2000.

Where a town has been reported to be affected by salinity, for example, through the NLWRA process, or through State and local government reports, it is assumed that approximately 10 per cent of the building stock will be subjected to salt attack. While this figure may not be representative of each individual location, it does provide an average estimate of house risk across Australia.

Through this model, an estimate of the proportion of a given State’s building stock that may be at risk from salt attack is estimated. In general, a building will not be affected by saline soils for a number of years after construction. While there have been reports of effects being observed within 2–3 years of construction, on average, it takes between 5–10 years before impacts are observed. The model takes this delay factor into account, through the use of a lagged growth rate in the probability of salt attack. This growth rate is as region specific as possible, and is based on projected increases in the physical observance of salinity in a given region.

The first observance of salt attack is assumed to occur no earlier than 7 years after construction.

## *Modelling methodologies*

There are two models used to evaluate the impacts of the proposed changes to the BCA.

The first model uses a per house based risk assessment. The per house methodology considers the ongoing per house repair costs that would be faced in the event of salt attack as well as the required up front additional construction costs for each house. These figures are used to estimate the national rate of salinity risk that would be required to return a break even benefit to the Australian economy from a national roll out. That is, a benefit cost ratio of 1. While this rate of salinity risk is an estimate, it does provide some guidance on the high level of national salinity risk that would be required to justify a national roll out of the proposed changes to the BCA.

Following this national risk assessment, the two mapping implementation options are also considered. In these cases, an assumed distribution of high and low risk areas is applied (based on observed salinity issues as reported in section 2). In addition, approximate levels of risk of salt attack are also applied across these high and low risk areas.

The second model uses a regionally based bottom up approach, considering the costs of the proposed changes, as well as estimated probabilities of a salt attack by statistical division across Australia. Conservative assumptions are made in both cases that the proposed amendments will be able to fully protect against salinity damage.

# B Quantitative model description

The model used to assess the net present value of the proposed changes to the BCA, is an excel spreadsheet based model. Impacts are disaggregated to the ABS statistical division (SD) level, identifying the number of annual house constructions by SD, annual probability of salt attack by SD, costs of salinity per Australian dwelling and additional construction costs per Australian dwelling.

Maps of ABS SDs are presented in Appendix C.

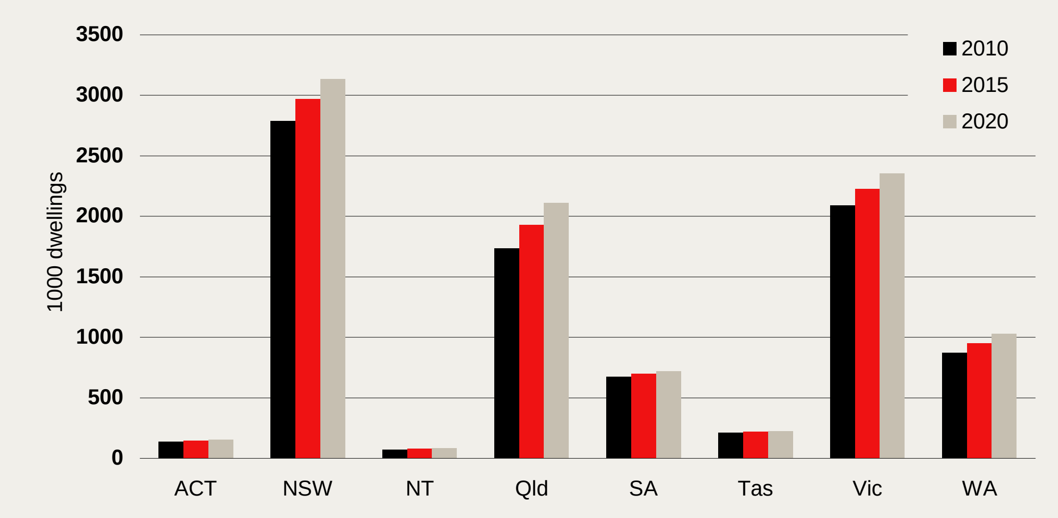
## Housing stock projections

Projections of the housing stock are taken directly from CIE (2009), which in turn are based on forecasts provided by the ABS through the report ‘Household and Family Projections, Australia, 2001-2026’. The ABS forms these projections based on long term trends observed for:

- population growth;
- household size;
- social and demographic factors; and
- construction trends.

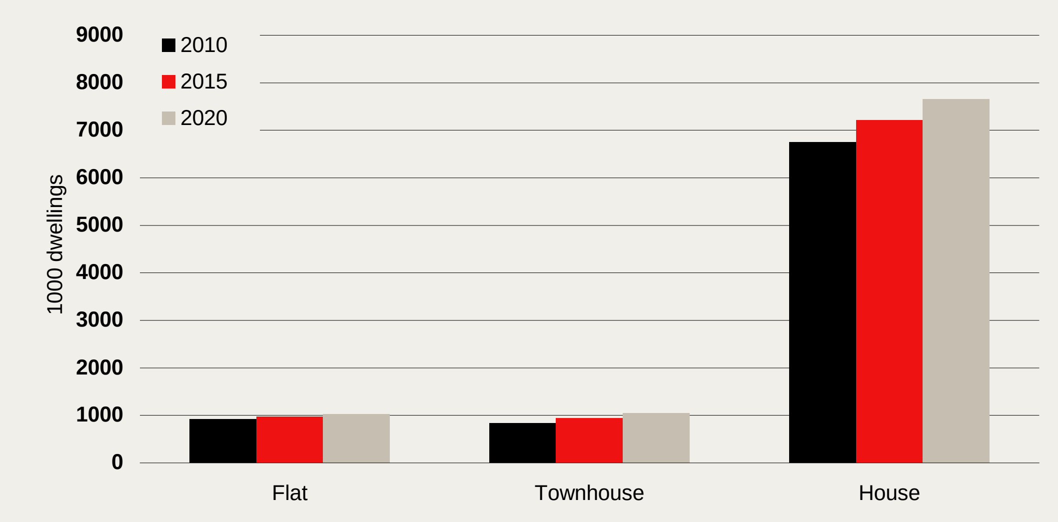
Charts B.1 and B.2 respectively report the total housing stock by State and dwelling type for the decade beginning 2010. In total, the housing stock is expected to be some 14 per cent greater by 2020 than in 2010. The fastest growing state is Queensland, followed by Western Australia with New South Wales and Victoria maintaining the largest number of dwellings. On average, the building stock is forecast to grow by 1.3 per cent per annum over the period.

### B.1 **Total housing stock by State and Territory**




*Data source: Extrapolated from CIE (2009).*

### B.2 **Total housing stock by dwelling type**

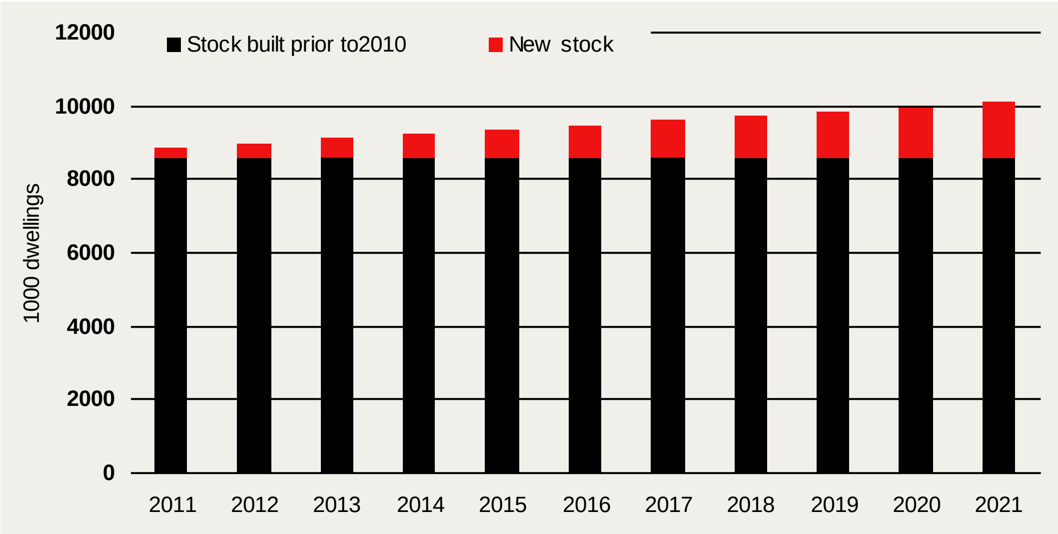



*Data source: Extrapolated from CIE (2009).*

Note that growth across the stock of dwelling types is relatively evenly spread. This is the largely the result of limited information regarding forecasts of dwelling structures specifically.

An important factor in the model development is that the proposed amendments to the BCA will only impact new residential buildings and not the stock in total. Table B.4 therefore reports in detail the number of new dwellings projected to be constructed over the period, by State and Territory and by dwelling type. Again these forecasts have been taken from CIE (2009a) and reflect trends projected by the ABS[37]. In any one year an average of 130 000 new dwellings will be constructed — most of which are houses. Chart B.3 shows the increasing share of new stock over the coming decade. Initially the share of new buildings is very low, but by 2020, approximately 4 per cent of all residential buildings will have been constructed under the proposed provisions.

B.3 **New residential dwellings**




*Data source: Extrapolated from CIE (2009).*

37 The numbers reported in B.4 may differ from actual planned development. In some years table A.4 may overestimate development, and underestimate development in others. On *average* however, the table is consistent with the long term trend over the period.

B.4 **New household constructions**

| | *2011* | *2012* | *2013* | *2014* | *2015* | *2016* | *2017* | *2018* | *2019* | *2020* | *2021* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Flat*** | | | | | | | | | | | |
| ACT | 197 | 186 | 175 | 186 | 175 | 186 | 164 | 164 | 153 | 164 | 154 |
| NSW | 5616 | 5433 | 5326 | 5342 | 5372 | 5342 | 5097 | 5006 | 4975 | 4945 | 4858 |
| NT | 161 | 148 | 148 | 148 | 148 | 136 | 148 | 148 | 124 | 136 | 131 |
| Qld | 4511 | 4384 | 4384 | 4407 | 4453 | 4453 | 4280 | 4234 | 4234 | 4234 | 4202 |
| SA | 296 | 266 | 256 | 256 | 261 | 245 | 210 | 210 | 194 | 199 | 181 |
| TAS | 117 | 89 | 89 | 89 | 89 | 82 | 62 | 48 | 62 | 48 | 41 |
| Vic | 2614 | 2504 | 2486 | 2495 | 2486 | 2477 | 2367 | 2321 | 2302 | 2284 | 2247 |
| WA | 648 | 617 | 617 | 617 | 621 | 613 | 582 | 578 | 578 | 570 | 561 |
| ***Town-house*** | | | | | | | | | | | |
| ACT | 248 | 234 | 220 | 234 | 220 | 234 | 206 | 206 | 193 | 206 | 193 |
| NSW | 3177 | 3073 | 3013 | 3021 | 3039 | 3021 | 2883 | 2832 | 2814 | 2797 | 2748 |
| NT | 146 | 135 | 135 | 135 | 135 | 124 | 135 | 135 | 113 | 124 | 120 |
| Qld | 3012 | 2927 | 2927 | 2943 | 2974 | 2974 | 2858 | 2827 | 2827 | 2827 | 2806 |
| SA | 729 | 653 | 628 | 628 | 641 | 603 | 515 | 515 | 477 | 490 | 444 |
| TAS | 159 | 121 | 121 | 121 | 121 | 112 | 84 | 65 | 84 | 65 | 55 |
| Vic | 2934 | 2811 | 2790 | 2801 | 2790 | 2780 | 2656 | 2605 | 2584 | 2564 | 2522 |
| WA | 2271 | 2162 | 2162 | 2162 | 2176 | 2148 | 2039 | 2025 | 2025 | 1998 | 1967 |
| ***House*** | | | | | | | | | | | |
| ACT | 1348 | 1274 | 1199 | 1274 | 1199 | 1274 | 1124 | 1124 | 1049 | 1124 | 1054 |
| NSW | 27 795 | 26 889 | 26 360 | 26 436 | 26 587 | 26 436 | 25 227 | 24 774 | 24 623 | 24 472 | 24 044 |
| NT | 995 | 919 | 919 | 919 | 919 | 842 | 919 | 919 | 766 | 842 | 812 |
| Qld | 30 555 | 29 693 | 29 693 | 29 850 | 30 163 | 30 163 | 28 988 | 28 674 | 28 674 | 28 674 | 28 455 |
| SA | 4757 | 4265 | 4101 | 4101 | 4183 | 3937 | 3363 | 3363 | 3117 | 3 199 | 2 898 |
| TAS | 1416 | 1083 | 1083 | 1083 | 1083 | 1000 | 750 | 583 | 750 | 583 | 494 |
| Vic | 22 985 | 22 017 | 21 856 | 21 937 | 21 856 | 21 775 | 20 807 | 20 404 | 20 243 | 20 082 | 19 754 |
| WA | 13 579 | 12 924 | 12 924 | 12 924 | 13 006 | 12 843 | 12 188 | 12 106 | 12 106 | 11 943 | 11 757 |

*Source: Extrapolated from CIE (2009a).*

## *Dwelling construction across ABS statistical divisions*

The model has been developed to assess risk of salt attack at the ABS SD level across Australia, and as such, requires State and Territory projections of dwelling constructions to be disaggregated to the SD level. This disaggregation was achieved through ABS census 2006 figures reporting the number of dwellings by SD, by respondents' location on census night.

Within the ABS dataset, 12 dwelling categories were reported:

- Separate house;
- Semi-detached, row or terrace house, townhouse etc with one storey;
- Semi-detached, row or terrace house, townhouse etc with two or more storeys;
- Flat, unit or apartment in a one or two storey block;

- Flat, unit or apartment in a three storey block;
- Flat, unit or apartment in a four or more storey block;
- Flat, unit or apartment attached to a house;
- Caravan, cabin, houseboat;
- Improvised home, tent, sleepers out;
- House or flat attached to a shop, office, etc;
- Not stated; and
- Not applicable.

To form the modeling dataset, a flat was defined as the four categories referencing 'flat' in the census dataset, a town-house was represented by the two categories of 'semi-detached' dwellings and a house was represented by the category of a 'separate house'.

The ABS census dataset represents a point in time estimate of the distribution of dwellings across each State and Territory, allocated by SD, and identified by dwelling type. To allow for projections of salinity impacts by dwelling type and by SD, the modeling assumes that the proportion of State and Territory dwellings in each SD remain constant over time, as do the proportion of dwelling types. This simplifying assumption is not expected to have a significant impact on the modeling results, and is imposed due to data constraints.

Table B.5 reports the proportion of State and Territory constructions allocated to each SD, by dwelling type. For example, in the NSW SD of 'Hunter', 4.2 per cent of NSW flats, 7.6 per cent of NSW town-houses and 11.1 per cent of NSW houses are located in the SD.

B.5 ***Dwellings across ABS statistical divisions***

| ***State and statistical division*** | ***Flat*** | ***Town-house*** | ***House*** | ***State and statistical division*** | ***Flat*** | ***Town-house*** | ***House*** |
|---|---|---|---|---|---|---|---|
| *New South Wales* | | | | *Western Australia* | | | |
| Sydney | 81.6 | 73.3 | 53.0 | Perth | 83.8 | 82.9 | 70.4 |
| Hunter | 4.2 | 7.6 | 11.1 | South West | 6.2 | 7.5 | 12.6 |
| Mid-North Coast | 2.4 | 3.8 | 5.4 | Lower Great Southern | 1.5 | 1.0 | 3.3 |
| Richmond-Tweed | 2.0 | 4.1 | 3.8 | Upper Great Southern | 0.3 | 0.2 | 1.2 |
| Illawarra | 3.6 | 5.2 | 7.4 | Midlands | 0.7 | 1.0 | 3.7 |
| Northern | 1.1 | 0.6 | 3.5 | South Eastern | 1.9 | 1.9 | 2.8 |
| North Western | 0.5 | 0.6 | 2.3 | Central | 3.0 | 1.8 | 3.1 |
| Central West | 0.8 | 1.1 | 3.5 | Pilbara | 1.8 | 2.3 | 1.8 |
| South Eastern | 1.6 | 2.2 | 4.2 | Kimberley | 0.8 | 1.4 | 1.1 |
| Murrumbidgee | 1.0 | 0.7 | 2.9 | | | | |
| Murray | 1.0 | 0.8 | 2.2 | | | | |
| Far West | 0.1 | 0.1 | 0.5 | | | | |
| *Queensland* | | | | *South Australia* | | | |
| Brisbane | 40.1 | 41.5 | 44.0 | Adelaide | 86.7 | 83.7 | 67.6 |
| Gold Coast | 24.5 | 28.4 | 10.2 | Outer Adelaide | 3.1 | 2.3 | 10.1 |
| Sunshine Coast | 10.9 | 10.5 | 7.3 | Yorke and Lower North | 1.0 | 1.0 | 4.5 |
| West Moreton | 0.3 | 0.5 | 2.1 | Murray Lands | 2.3 | 1.9 | 5.3 |
| Wide Bay-Burnett | 2.9 | 3.3 | 7.8 | South East | 3.1 | 1.9 | 4.7 |
| Darling Downs | 3.0 | 2.9 | 6.2 | Eyre | 1.6 | 1.1 | 2.6 |
| South West | 0.2 | 0.1 | 0.9 | Northern | 2.2 | 8.1 | 5.1 |
| Fitzroy | 2.5 | 1.7 | 5.3 | | | | |
| Central West | 0.1 | 0.2 | 0.4 | *Tasmania* | | | |
| Mackay | 2.9 | 2.5 | 3.9 | Greater Hobart | 52.1 | 60.9 | 38.0 |
| Northern | 4.5 | 2.4 | 5.2 | Southern | 1.5 | 1.5 | 10.5 |
| Far North | 7.3 | 5.5 | 5.9 | Northern | 26.5 | 21.4 | 28.9 |
| North West | 0.7 | 0.5 | 0.7 | Mersey-Lyell | 19.9 | 16.2 | 22.5 |
| *Victoria* | | | | *ACT* | | | |
| Melbourne | 85.9 | 88.1 | 66.0 | Canberra | 100 | 100 | 99.9 |
| Barwon | 3.3 | 3.5 | 6.6 | Australian Capital Territory - Bal | 0.0 | 0.0 | 0.1 |
| Western District | 0.9 | 0.8 | 2.5 | | | | |
| Central Highlands | 1.6 | 1.0 | 3.5 | *Northern Territory* | | | |
| Wimmera | 0.4 | 0.3 | 1.3 | Darwin | 77.3 | 62.0 | 57.2 |
| Mallee | 1.0 | 0.9 | 2.0 | Northern Territory - Bal | 22.7 | 38.0 | 42.8 |
| Loddon | 1.2 | 1.4 | 4.1 | | | | |
| Goulburn | 2.1 | 1.4 | 4.8 | | | | |
| Ovens-Murray | 1.1 | 1.0 | 2.2 | | | | |
| East Gippsland | 0.8 | 0.6 | 2.3 | | | | |
| Gippsland | 1.7 | 1.1 | 4.7 | | | | |

*Source:* ABS census (2006) CDataOnline.

## Probability of salt attack

To incorporate both the spatial and regional elements of urban salinity, the model incorporates a region and time specific matrix of probabilities of salt attack. That is, individual salt attack probabilities for each SD are reported, for each year.

Based on the information sourced from the Australian Natural Resources Atlas, an estimate of the area of each statistical division at risk from salt attack has been reported. An annual percentage increment in risk factor is applied, gradually increasing the risk of salt attack for these SDs, estimating the projected spread of urban salinity.

## Number of salt affected dwellings

The number of houses affected by urban salinity in any one year is a function of:

- The number of houses that were considered to be affected by salinity in the previous year;
- The number of new houses constructed in the given year;
- The number of houses built not previously affected by salinity; and
- The regional probability of a given building being subject to a salt attack in the given year.

Therefore, the model allows for not only newly constructed houses to be considered at risk of a new salt attack, but also includes the probability that a proportion of those houses previously unaffected by salinity, may now be affected.

## Costs of salinity

The model makes the simplifying assumption that the cost of damage to a house from salinity will be constant, irrespective of the location of the house. That is, the cost of salinity to a house in the NSW SD of Illawarra will be the same as the costs of salinity to a house in the Western Australia SD of South West. Should evidence refuting this be presented through the public consultation process, the assumption may be relaxed, allowing for a regional based cost of salinity estimate to be included.

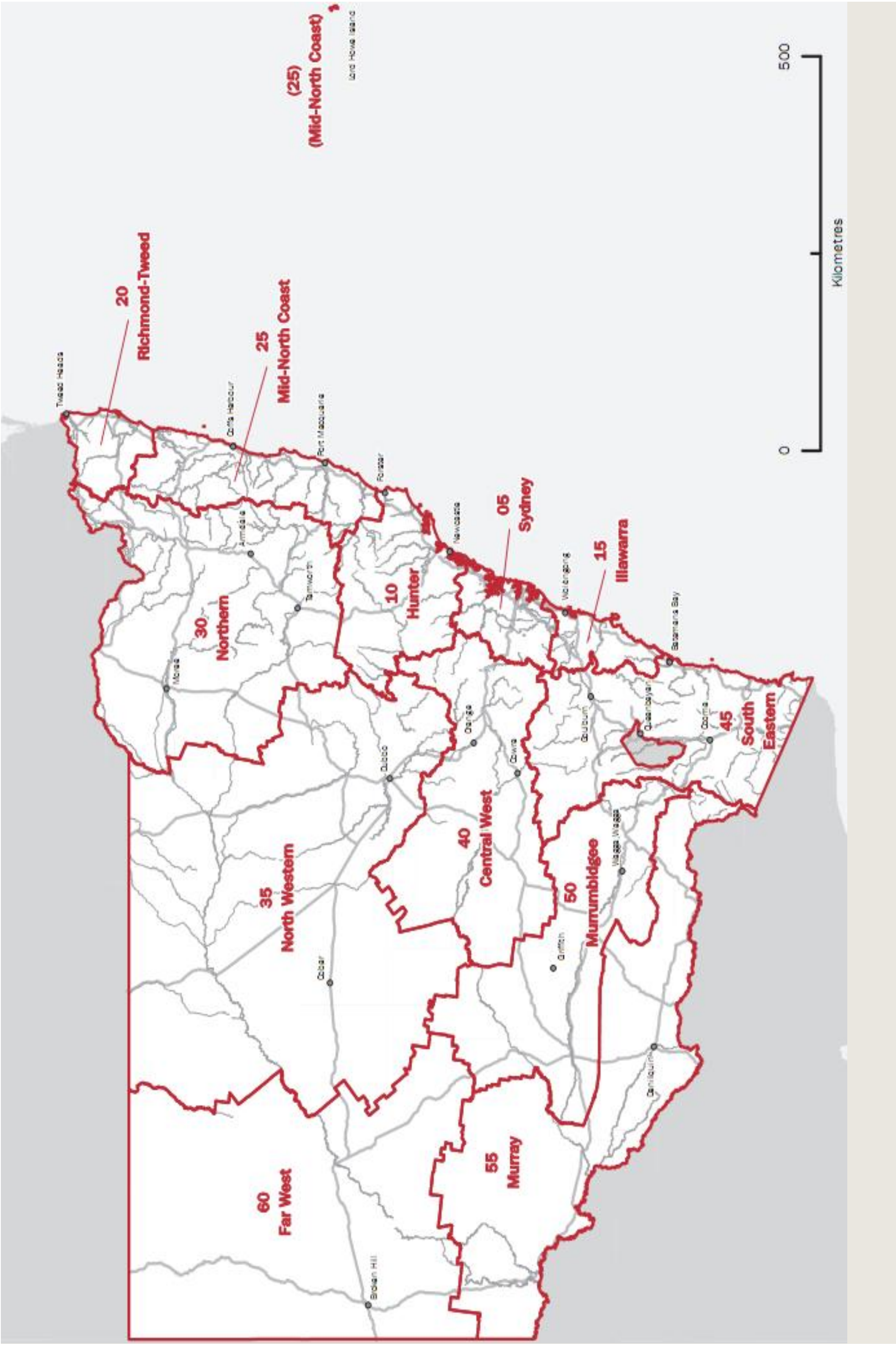
The costs of salinity are based on an initial repair cost being payable the first year that a dwelling is exposed to a salt attack. This costs is assumed to be a once off up front cost of repairing the initial damage and putting in place measure to minimise the spread of damage. Following the initial repair costs, there is assumed to be an ongoing maintenance cost, which is applied annually in the model, but may actually be payable every 10 years (this is achieved by annualising the amount that would otherwise be payable every 10 years).

For the purposes of cost estimations, a town house was assumed to be similar in nature to a house, and a flat was considered to face one sixth of the damage costs faced by a house.

# *C Maps of ABS statistical divisions*

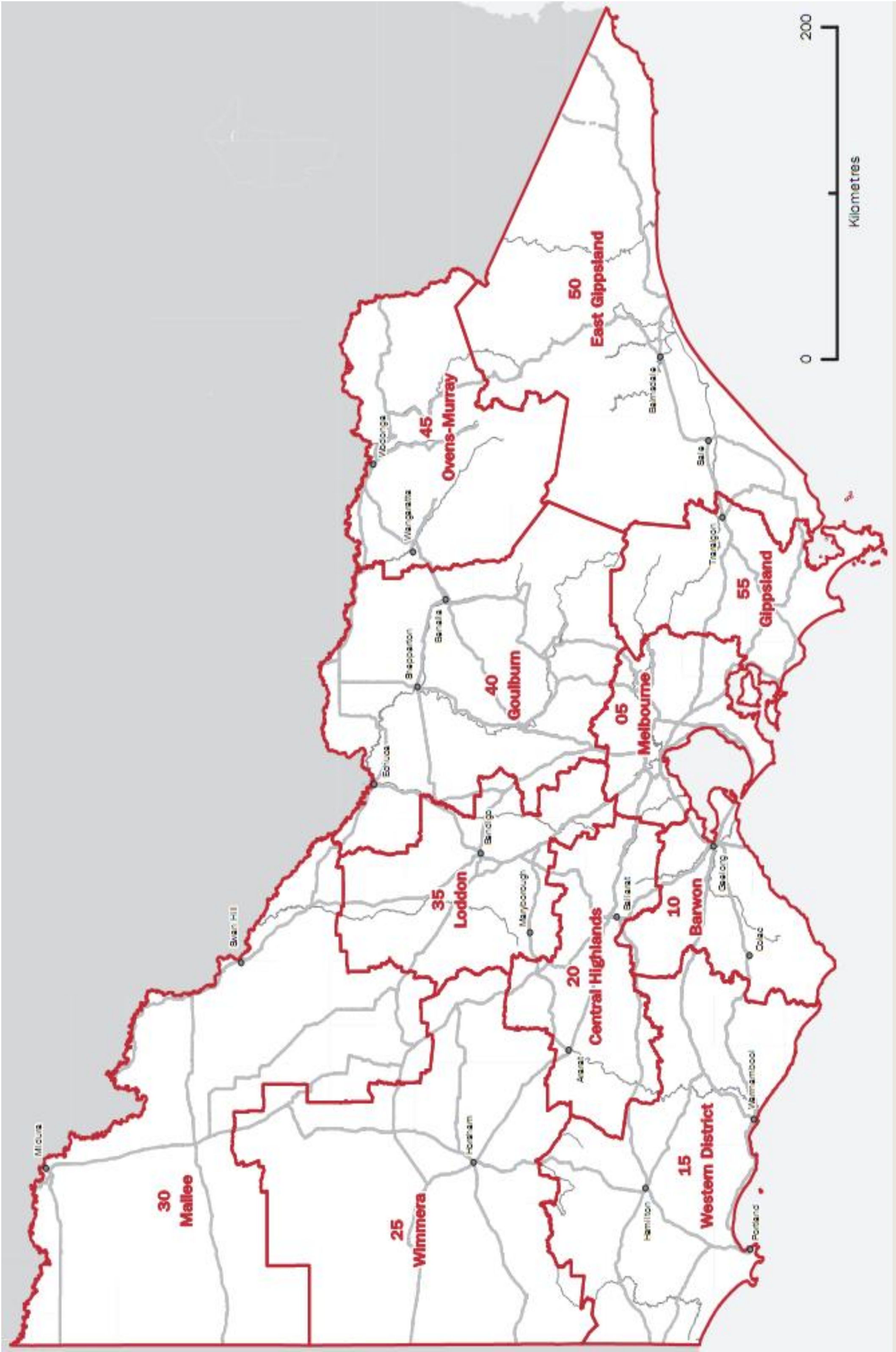
The following charts outline the statistical divisions of all Australian States and Territories.

## C.1 **Statistical divisions of New South Wales**



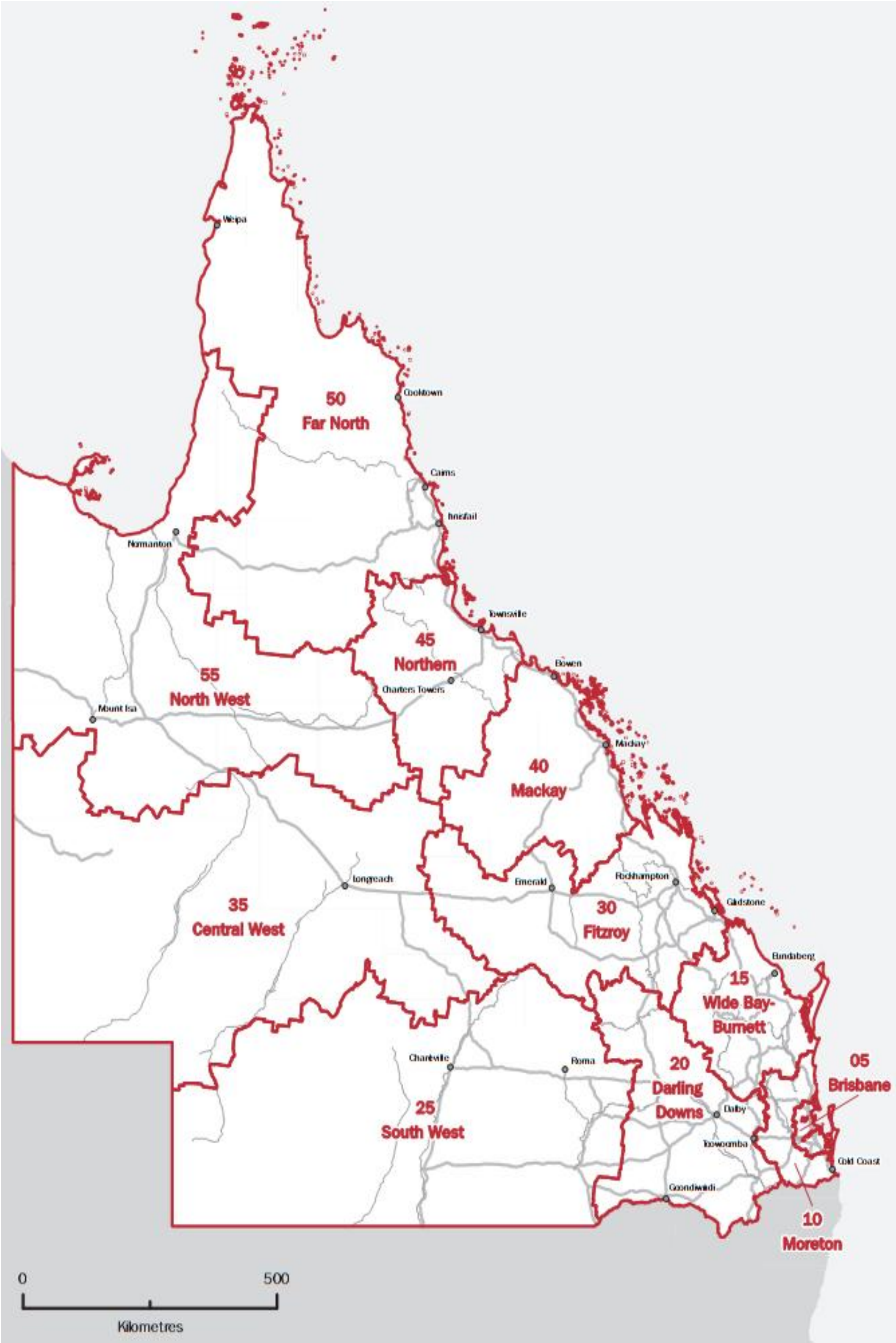

*Source: ABS (2001) Statistical geography Volume 1, Australian Standard Geographical Classification (ASGC).*

## C.2 **Statistical divisions of Victoria**



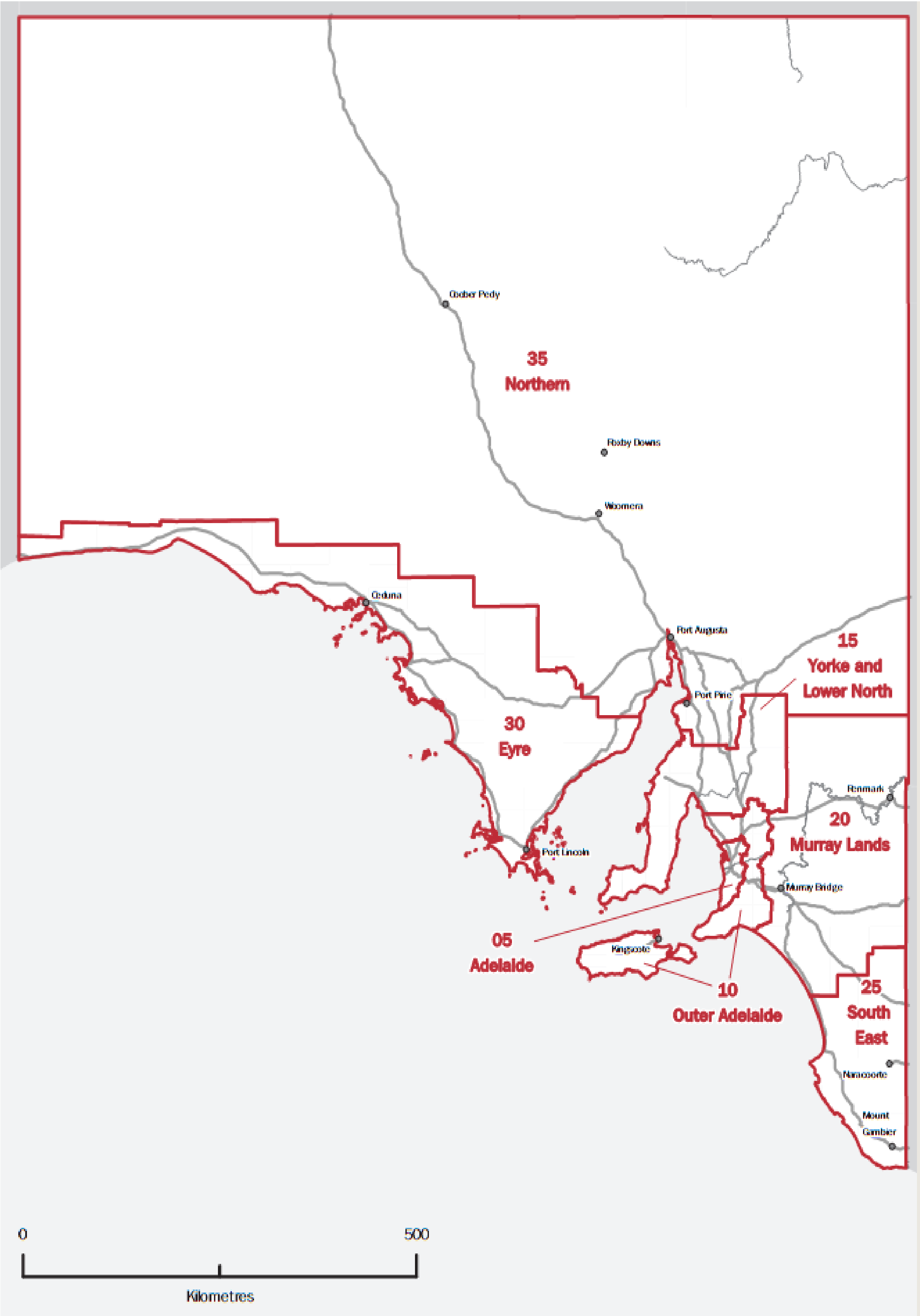

*Data source: ABS (2001) Statistical geography Volume 1, Australian Standard Geographical Classification (ASGC)*

## C.3 **Statistical divisions of Queensland**



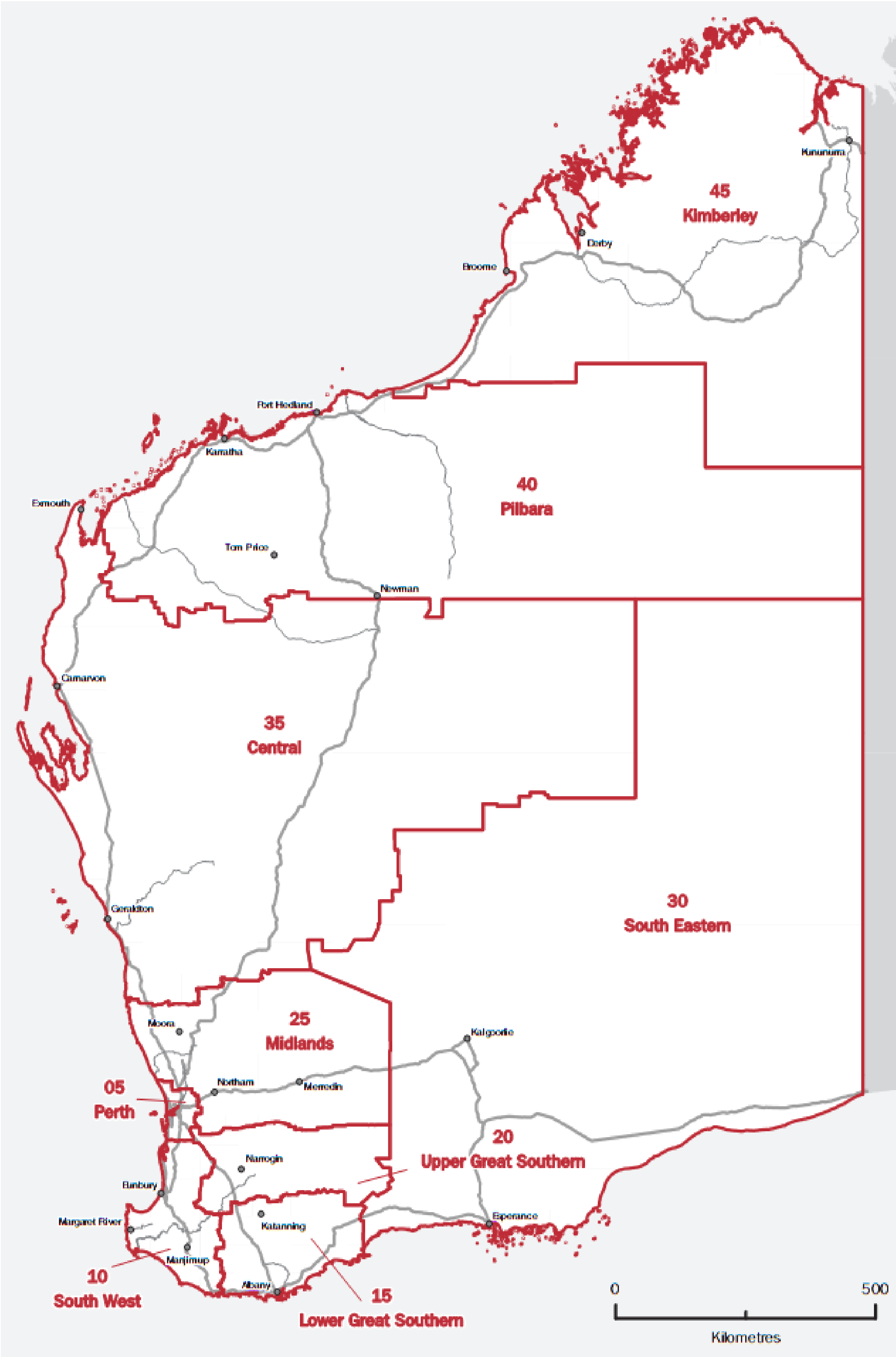

*Source: ABS (2001) Statistical geography Volume 1, Australian Standard Geographical Classification (ASGC).*

## C.4 **Statistical divisions of South Australia**




*Source: ABS (2001) Statistical geography Volume 1, Australian Standard Geographical Classification (ASGC).*

## C.5 **Statistical divisions of Western Australia**

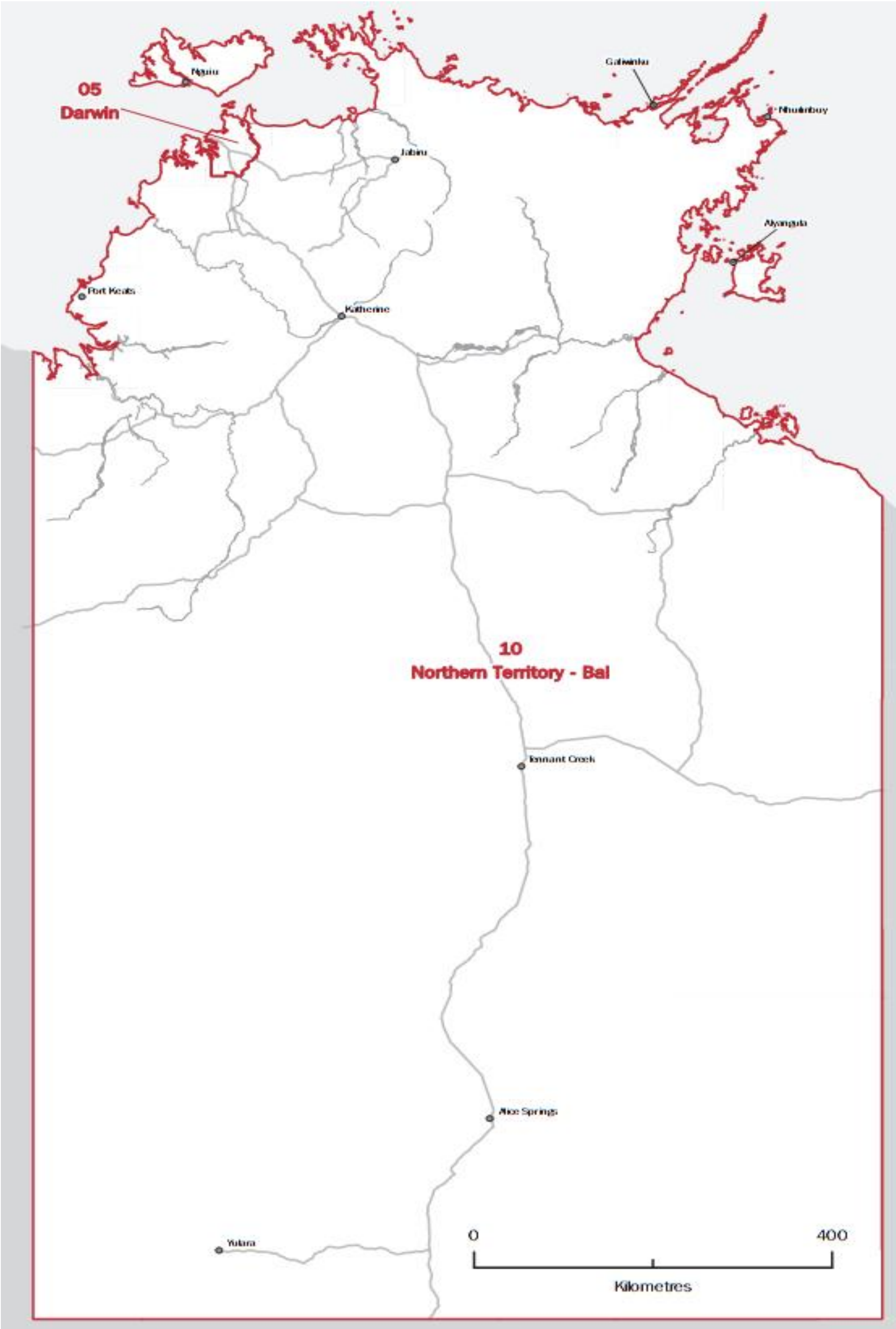



*Source: ABS (2001) Statistical geography Volume 1, Australian Standard Geographical Classification (ASGC).*

C.6 **Statistical divisions of Tasmania**

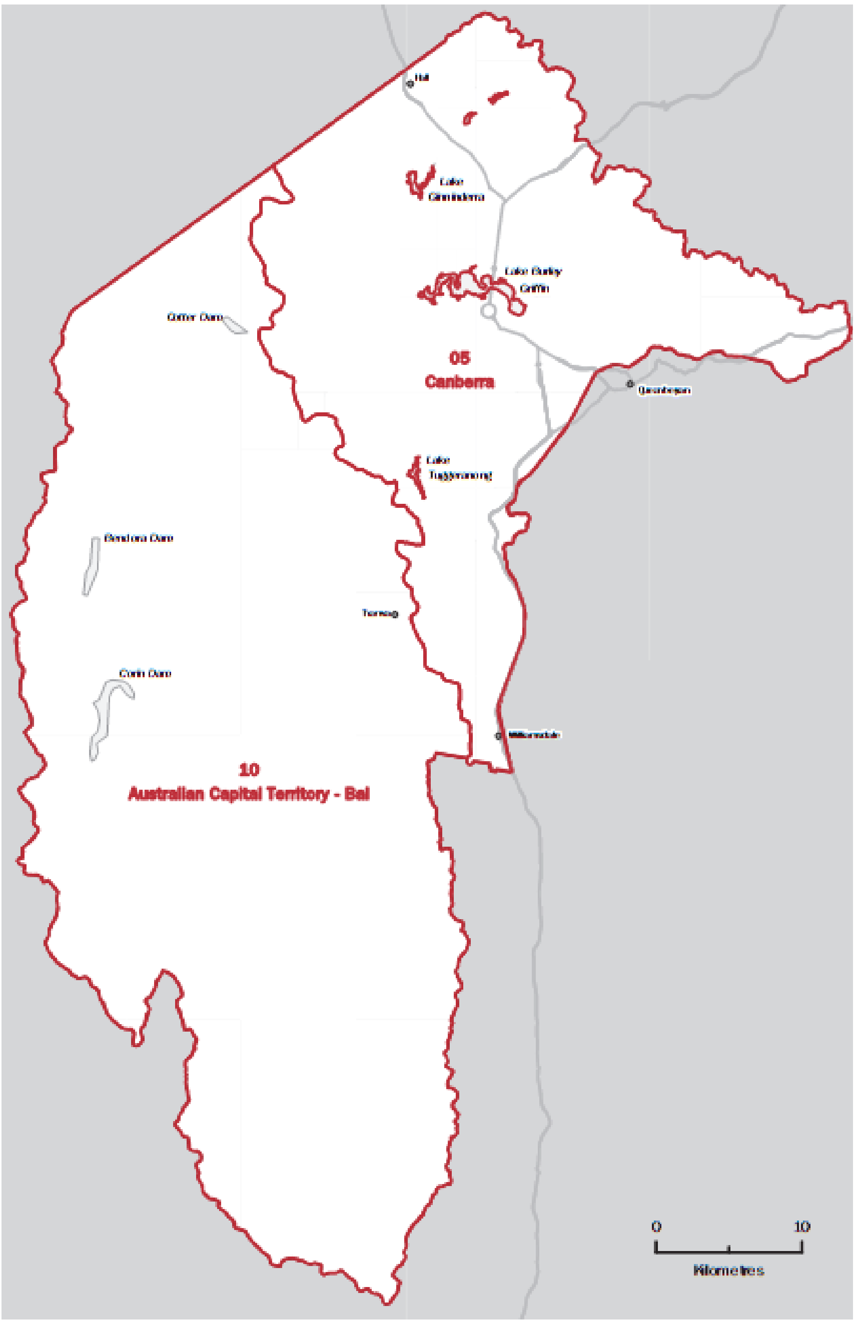

*Source: ABS (2001) Statistical geography Volume 1, Australian Standard Geographical Classification (ASGC).*

## C.7 **Statistical divisions of the Northern Territory**




*Source: ABS (2001) Statistical geography Volume 1, Australian Standard Geographical Classification (ASGC).*

## C.8 **Statistical divisions of the Australian Capital Territory**




*Source: ABS (2001) Statistical geography Volume 1, Australian Standard Geographical Classification (ASGC)*