NSW GOVERNMENT | Resilience NSW

Critcal Infrastructure Resilience Strategy: Infrastructure Planning Guide

Resilience NSW
GPO Box 5434
SYDNEY NSW 2001
(02) 9212 9200

Authors: Stephen Timms (Meridian Urban) and Chris Quin (Resilient Projects)

Acknowledgements: The contributions made by all the stakeholders involved in the planning, workshops, and development of the NSW Critical Infrastructure Resilience Strategy 2018 are acknowledged.

Table of contents

Overview

This infrastructure planning guide is designed to provide some tools to help those planning for new critical infrastructure and maintaining existing critical infrastructure to ensure decision making processes are taken through a resilience lens.

Thinking about and planning for resilience and how to mitigate disasters before they happen provides the potential to significantly reduce the cost of disasters. Further investment in disaster resilience is essential, and this includes physical measures, such as resilient critical infrastructure, and community measures, such as awareness and preparedness programs[1].

Almost all infrastructure is a multi-decade investment and most infrastructure will be exposed to many hazards during its life. On average, reconstruction costs due to natural disasters cost NSW $3.6bn per year with a predicted rise to $10.6bn per year by the year 2050 if we do not incorporate resilience.[1]

Over the next four years (2017-18 to 2020-21) it is expected that around $79.2bn dollars will be spent on infrastructure investment.[2] This record level of investment includes $72.7bn from state government and around $7.2bn through financial contributions, capital grants to non-government bodies and local councils. This level of spending is expected to continue for the foreseeable future. Across Australia around $1.1 trillion will be spent on infrastructure between now and 2050[1], with a significant amount of this expected to be in NSW.

The growing population of New South Wales and tightening fiscal positions make it imperative that we get the most from our current infrastructure stock and that investment in new infrastructure is targeted effectively to meet and shape demand. Aligning infrastructure investment with strategic land use planning is critical to maximising the effectiveness and efficiency of both new and existing infrastructure. Figure 1 shows the cost of the 2019-2020 bushfires in NSW with losses of $899 million in infrastructure alone.

[1] Resilience NSW. 2020. *NSW bushfire recovery: Supporting NSW communities following the 2019–2020 bushfires.*

[2] State of New South Wales through NSW Treasury. 2018. Budget 2018-19 Budget Paper No. 2 – Infrastructure Statement

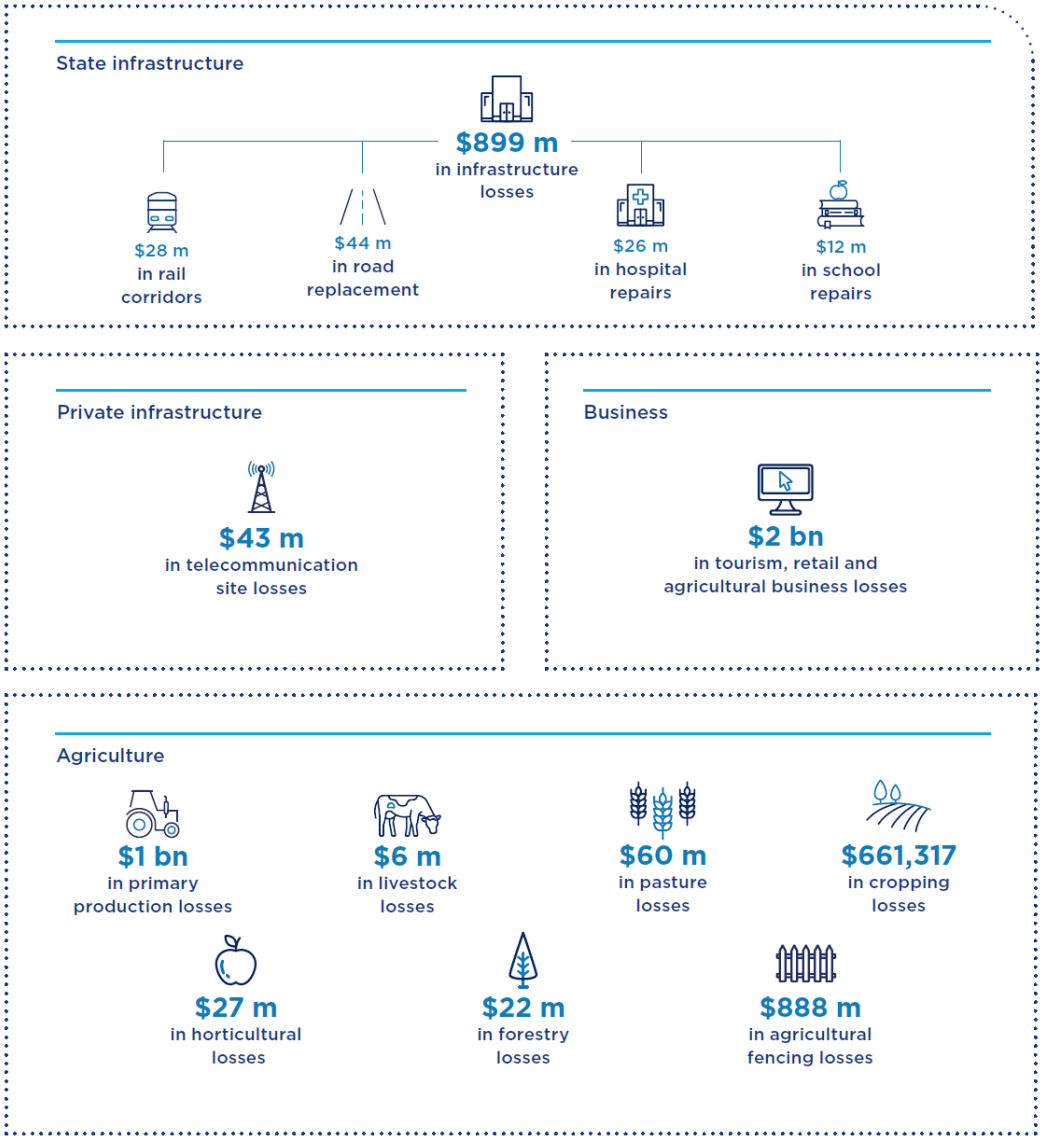


Figure 1 – The cost of the 2019-2020 bushfires in NSW[2].

The Critical Infrastructure Resilience (CIR) Strategy 2018 complements recommendations within the 2017 State Level Emergency Risk Assessment and the NSW State Infrastructure Strategy 2018-2038. It builds on previous work including the Commonwealth's 2015 Critical Infrastructure Resilience Strategy and COAG's National Strategy for Disaster Resilience.

The Sendai Framework for Disaster Risk Reduction 2015-2030 calls for a people centred, multi-hazard, multi-sectoral approach to disaster risk reduction. The UN Sustainable Development Goals include a call to develop quality, reliable, sustainable and resilient infrastructure and to improve resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, holistic disaster risk management at all levels in line with the Sendai Framework.

Importance of planning

The 2017 State Level Emergency Risk Assessment identifies enhancing land use planning as a priority to mitigate natural disaster impacts and improve the state's approach to emergency

management. The State Infrastructure Strategy states that an attractive environment, supported by urban infrastructure, is fundamental to NSW's continued economic success.

The CIR Strategy 2018 reinforces the importance of integration between planning and investment to improve infrastructure resilience in the first instance. Co-ordinated regional planning such as in the Greater Sydney Regional Plan demonstrates the benefits of collaborative planning for infrastructure.

The importance of planning for a more resilient future has also been reinforced by the Australian Business Roundtable, the Planning Insitute of Australia and Infrastructure Australia. The Productivity Commission Report on Natural Disaster Funding Arrangements in 2015 stated that:

> *Land use planning is perhaps the most potent policy lever for influencing the level of future disaster risk.*

The National Strategy for Disaster Resilience also states that the strategic planning system is particularly important in contributing to the creation of safer and sustainable communities:

> *Locating new or expanding existing settlements and infrastructure in areas exposed to unreasonable risk is irresponsible.*

The insurance industry has raised the the importance of planning for resilience in various forums, including submissions to the *Parliamentary Inquiry in to The Future Impacts of Climate Change on Housing, Buildings and Infrastructure*:

> *Infrastructure, planning and zoning requirements do not reflect the level of risk communities will face in the future… Current land planning and zoning requirements are misaligned with insurance risk, this dynamic in particular creates an affordability challenge for insurance and will only worsen as the risk increases with climate change*[3]*."*

Those involved in planning and designing critical infrastructure will need to place a greater emphasis on resilience. We need to ensure that decision-makers are provided the best information to make informed decisions with particular regard to resilience and the full life cycle of critical infrastructure (CI).

Considering critical infrastructure resilience at the earliest possible opportunity is necessary to get the best outcomes. Identifying infrastructure requirements before zoning land provides new or changing communities and provides with many benefits, including reduced cost and increased resilience to threats and hazards throughout the lifetime of the infrastructure, as outlined in the figure below.

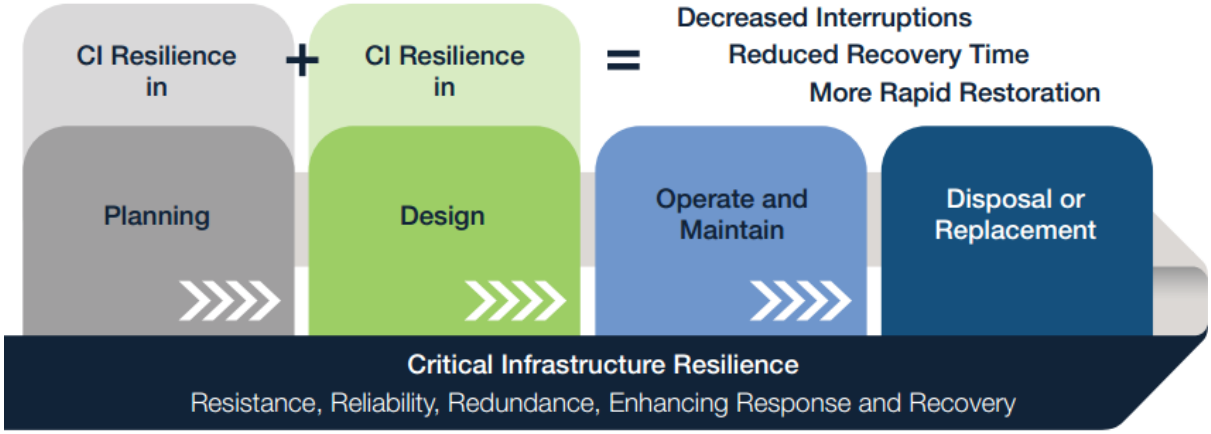


Figure 2: Embedding resilience in the planning and design of services pays back in operation and maintenance services

This guide is designed to assist infrastructure planners to build resilience. In addition, the website will provide the best possible information, including case studies and where to find more information. It will be updated on a regular and on-going basis.

The professions involved in planning for critical infrastructure, and the community that relies on them, will need to work together so

- resilience planning becomes 'mainstream'
- all conversations in the planning and design stage of critical infrastructure include resilience; and
- that a collaborative approach and shared responsibility is a normal way of working together.

The roles for those involved in planning and designing critical infrastructure and integrating land use planning are:

Partner: mainstream resilience in to planning

Prepare: enhance risk management processes

Provide: plan to enhance recovery and build back better

Figure 3: The key role for planners in planning for resilience

Addressing current challenges

This guide has been designed to aid in understanding the considerations to plan for and design more resilient critical infrastructure. Some of the current challenges in this space include:

- lack of mature policy environment / policy uncertainty
- limited/unclear funding streams
- limited capacity and capability
- limited leadership, support and trust
- education and knowledge base of built environment professionals
- more focus on resilience within and across organisations needed
- lack of community engagement on resilience measures; and

- lack of coordination amongst the many different actors and decision makers.

By tackling each of these challenges at the local level, communities, local government and the private sector can work together to make critical infrastructure more resilient. It will take time but given the level of investment in infrastructure and expected population growth in NSW now is the time to do this.

The challenges are like those faced by the environmental movement in the past. Over recent decades, ecologically sustainable development has been ‘normalised’, not only in the strategic planning and decision-making process for development and infrastructure but in day to day the management of our cities and lifestyle.

Together, we’re exploring ways to accelerate the level of understanding of resilience among professionals and the community, and to make sure that the infrastructure we are building today withstands the threats and hazards it is likely to experience across its life.

Resilience Priority 1: Partner

The NSW Critical Infrastructure Resilience Strategy promotes the need to **partner** as one of the three priorities for improving critical infrastructure resilience. We must partner in shared responsibility for critical infrastructure resilience.

A collaborative multi-agency and cross disciplinary approach to mapping out, talking about and addressing weak links in critical infrastructure and potential hazards in a local community has a wide range of benefits. This recognises the diverse perspectives and shared skills that all parties bring to increasing resilience. Partnering early can identify how to improve resilience of existing or proposed critical infrastructure.

Following large scale disasters, such as severe storms, floods, earthquakes, or during a drought crisis, a collaborative approach is a natural reaction to a common threat. The NSW Critical Infrastructure Resilience Strategy aims to make that business as usual, so that shared responsibility for resilience is well understood and acted on prior to emergencies. This approach recognises that the best time to have friends is before you need them. International literature, and experience in NSW, points to the many benefits of strong relationships between agencies, the private sector and the community in speeding up and more efficiently recovering from or reducing the risk of disaster.

The resilience of critical infrastructure and the involvement of all relevant stakeholders in planning for resilience can be integrated in the Prevent, Prepare, Respond, Recover (PPRR) cycle.

Planning is not just the role of planners and engineers, it should be a shared responsibility. For example, first responders and emergency services will know what the implications of a major event (say flooding) may be on critical infrastructure (roads, hospitals etc.). Knowledge from previous experience in a local community, or from exercises or other sources should be utilised when planning for critical infrastructure, and the emergency services (SES, RFS, Police etc.) should be consulted when planning for critical infrastructure.

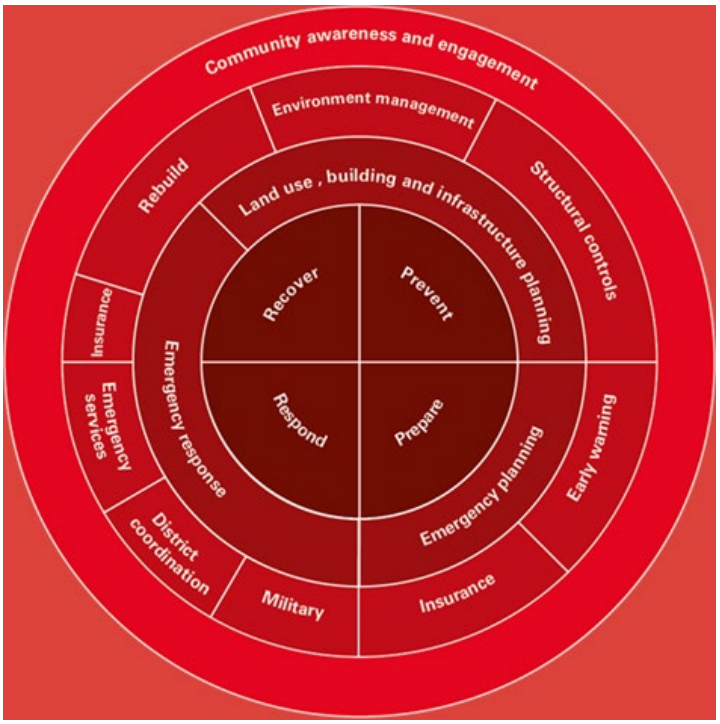


Figure 4: Technical disciplines and the interface with the PPRR cycle (Planning Institute of Australia)

Opportunities for co-location of different services may arise through the planning phases, through new communication channels across different levels of government.

A collaborative 'co-design process' with the local community, emergency services, local council (including all relevant professionals, particularly town planners, engineers and asset operators), and private sector providers and operators would help deliver on the principles set out in the Critical Infrastructure Resilience Strategy to **Partner, Prepare** and **Provide** for resilient infrastructure.

In practice, co-design of critical infrastructure is achieved via collaboration. For local-government-owned infrastructure, this process might be led by town planning or the Local Emergency Management Officer (LEMO). Ultimately, it is up to the infrastructure provider to plan collaboratively, consider all risks to infrastructure, and engage widely with decision-makers across engineering, planning, asset management, emergency services, and other disciplines. The process of partnering in shared responsibility allows all affected parties to have input and improve the resilience of the proposed infrastructure. Further advice is provided in the CIR Strategy Local Government Guide and the CIR Strategy Organisational Resilience Guide available on the opengov website.

Enhancing community information and partnerships

The NSW Critical Infrastructure Resilience Strategy encourages closer working relationships between government and infrastructure providers. Involving the community and a wide range of stakeholders, infrastructure owners and agencies in planning for critical infrastructure can have a wide range of benefits, including:

- providing local knowledge to help 'experts' and decision makers
- identifying weak links in the critical infrastructure network of interdependencies
- helps to improve community awareness of risks and how to respond in a disaster
- de-risks the decision-making process and gain community/political support
- builds trust between government, the community and private sector
- helps create a sense of 'ownership' or respect for the assets
- ensures critical infrastructure provides wider benefits for the community, environment and economy; and
- may identify additional uses for infrastructure (e.g. parkland or easements that can be used as green space for flood mitigation)

While additional consultation may seem time consuming, meaningful early engagement with the community helps avoid delays at later stages, particularly challenges to the decision-making process. Engagement should develop rapport on the premise of shared solutions to common problems, with a wide range of tangible and indirect benefits for critical infrastructure and the community.

The IAP2 Spectrum of Public Participation (inform, consult, involve, collaborate and empower) is designed to assist with the selection of the level of participation that defines the public's role in any community engagement program, and is particularly useful for new infrastructure projects and significant upgrades. Lessons from disaster recovery processes and planning exercises have been captured in the summary below of what works and what doesn't work. This is derived from the National Land Use Planning Guidelines for Disaster Resilient Communities by the Planning Institute of Australia.

What works

1. Knowing your obligations and responsibilities as a planner or other built environment professional to respond to natural hazard risk
2. Knowing the risks yourself, and then communicating them to your community as part of the plan-making process
3. Getting involved - working collaboratively across technical disciplines
4. Including the community – taking them on the same journey you are on
5. Improving your technical skills – knowing what planning and urban design can achieve, but also knowing what it can't, and knowing the balance between planning and building responses
6. Seeking assistance when required

What doesn't work

1. Doing nothing – inaction simply increases vulnerability over time, making a currently hazardous situation even worse
2. Expecting others to drive risk reduction in the built environment and avoiding hard decisions
3. Sole reliance on engineering or disaster management solutions to address risks
4. Working in silos
5. Avoiding community involvement in resilience planning
6. Not implementing policy – maintaining enthusiasm for resilience objectives across programs and projects

Figure 5 – What works and what does not when planning for resilience[4]

Resilience Priority 2: Prepare

The NSW Critical Infrastructure Resilience Strategy states that we must prepare for all threats and hazards, not just the ones we can foresee.

There can be an assumption in the community and some organisations that land use planning, building codes and standards provide adequate protection against the worst case scenario. Yet, for at least some assets, it is highly likely to be cost-effective to build to a higher level of resilience than standards mandate. When the community costs and full asset life cycle are considered, it becomes obvious that enhanced infrastrcuture resilience is cost effective.

The Critical Infrastructure Resilience Strategy is about aiming for best practice, and takes a non-regulatory approach. The process of planning for more resilient critical infrastructure is about going beyond mandatory minimum standards and integrating resilience into all thinking as a business as usual approach.

Although regulation can change and sometimes improve the way things are done, this can take years to develop and there is no guarantee that it will be implemented as intended, without a wide range of other policy tools. A non-regulatory approach is considered to be the best way to help change culture, improve understanding, and aim high for best-practice resilience. If we learn from each other, work collaboratively and are open to new ideas, this will achieve better outcomes than adhering to minimum regulatory standards.

A broader view of resilience

Increasing resilience for critical infrastructure is not simply about additional dollars on engineering design and strengthening infrastructure to withstand natural hazards. Preparing communities and regions for long-term resilience is a complex process requiring vision, setting of priorities, co-operation, and action sustained over a long period. It requires close collaboration across the public, private, and non-profit sectors. It requires data, analysis, and continuous innovation and refinement. Most especially, it requires public leadership and public support.

The social impacts of natural disasters, including those on health and wellbeing, education, employment and community networks are significant. The social costs of natural disasters equal the more traditionally defined economic costs – and are sometimes even higher. A greater effort must be invested in the preparedness of individuals, in particular long-term psycho-social recovery. Further advice on building community resilience as part of this strategy is provided in the CIR Strategy Community Resilience Guide.

The Australian Business Roundtable have stated that further investment in disaster resilience is essential to lessen the forecast increase in costs. This includes physical measures, such as resilient infrastructure, and community measures, such as preparedness programs.

Investment in disaster resilience yields a double dividend. First, in the avoided impacts of disasters when they occur; and second, in the broader benefits that arise even in the absence of a disaster. For infrastructure investments, for example, broader benefits may include employment opportunities, improved service reliability, greater business confidence, incentives for innovation, and decreased insurance premiums and operating costs. Such benefits support economic growth and social cohesion in Australian communities.

Improved understanding

When planning and designing critical infrastructure it is important to consider all hazards and all threats in order to prepare for, respond to and recover from events. Gathering perfect knowledge of known hazards, and unforeseen ones, is not always possible, but by working across disciplines and with all stakeholders, an agreed approach to avoid or mitigate possible risks can be developed.

Flooding

The NSW Floodplain Development Manual provides a mature model for how to deal with flood risk. It follows a logical process for the consideration and management of flood risk for local government, built on the foundation of a solid evidence base and cross sectoral understanding of known and unknown risks. The process follows basic steps of:

- establishing a floodplain risk management committee
- data collection
- flood study
- floodplain risk management study
- flood plain risk management plan
- plan implementation
- funding for management measures

These steps provide one logical example for considering other hazards and threats to critical infrastructure in a local area. The NSW Floodplain Development Manual poses 4 key questions as shown in Figure 6 below:

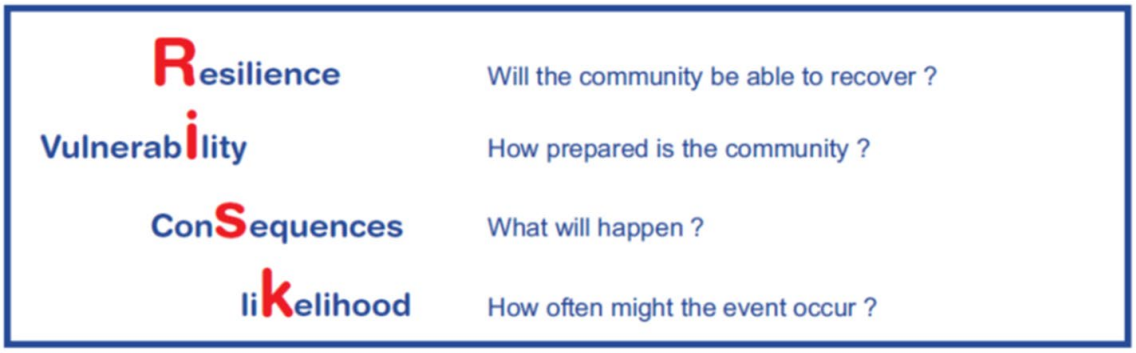


Figure 6: Risk management questions from the NSW Floodplain Development Manual

Further work is needed in NSW to ensure that the full range of flood impacts are considered in decision-making, up to the probable maximum flood. Over the past 35 years it has become accepted practice to adopt the 1% annual exceedence probability (AEP), to derive a flood planning level (minimum floor level control), particularly for residential development in urban areas. The application of the Guideline for Residential Development on Low Flood Risk Land issued in 2007 as part of a Ministerial Direction has resulted in a focus on the 1% (AEP)plus freeboard for land use planning and infrastructure.. A more resilient approach would see consideration of different flood probabilities, evacuation and other risks guiding the location of more vulnerable uses, critical infrastructure and intense urban development to areas not as susceptible to flooding. Clearer consideration of evacuation planning, social and economic impacts of flooding, insurance premiums, land values and making room for the rivers natural processes could provide a more resilient outcome.

The Hawkesbury-Nepean Valley Floodplain Management Working Party, co-ordinated by Infrastructure NSW, has considered these issues in more detail in Resilient Valley, Resilient

Communities: the Hawkesbury-Nepean Valley Flood Risk Management Strategy (the Flood Strategy). The Flood Strategy sets out actions to make the Hawkebsury-Nepean Valley more resilient, with particular regard to flooding. A project is underway looking at all critical infrastructure, including evacuation routes by road, rail and other transport, resilience of the electricity network, wastewater, bridges, the Warragamba dam and other critical infrastructure in the catchment. This is an all of government risk-based planning approach, involving relevant state agencies and local government pays homage to the discipline of risk management. Whilst it is not the only input to decision-making, risk management provides a framework and foundation that considers the organisation's objectives and seeks to identify the opportunities and threats that might exist to enhance or hinder the organisation in achieving those objectives.Further detail about risk management is provided in the organisation resilience guide on the NSW Critical Infrastructure Resilience website.

Bushfire

After the 2001 Black Christmas fires in Sydney, which destroyed 109 homes and burnt more than 750,000 hectares, a Joint Parliamentary Inquiry was established. The resulting report endorsed the release of a document which contained specifications for building on land identified as bush fire prone. As a result *Planning for Bush Fire Protection 2006* was produced and implemented across NSW.

A review has recently been conducted of Planning for Bush Fire Protection 2006, which included periods of targeted and full public consultation. The NSW RFS has worked extensively with representatives from the NSW Department of Planning and Environment (DPE) and stakeholders to prepare a pre-release version of the document.

It is anticipated that the Planning for Bushfire Protection 2018 (PBP 2018) will become legislated by mid – 2019, to coincide with the enactment of the National Construction Code 2019. Until then, PBP 2018 is in a 'pre-release' stage, also known as the transitionary period.

Until PBP 2018 becomes legislated, PBP 2006 will remain the legally referenced document and PBP 2018 can be used on a performance basis in consultation with NSW RFS only.

The updated guide states that the most important objective for strategic planning is to identify whether new development is appropriate subject to identified bush fire risk on a landscape scale. An assessment of a development impact on existing infrastructure is also a key element of the strategic planning process in bushfire prone areas. Land use planning policies can be introduced to limit the number of people exposed to unacceptable risk (that should also include the risks associated with loss of service or failure of critical infrastrucutre as a result of bush fire.

Services and infrastructure that facilitate effective suppresssion of bush fires also need to be provided for at the earliest stages of planning for new development and critical infrastructure. Considerations must include life safety risks associated with fire and proximity to high voltage power lines, natural gas supply lines and options for evacuation. This includes looking at the capacity of existing infrastructure (such as roads and utilities) to handle the increase in demand during emergencies. Other issues to consider at the early stages include on-going land management and fire fighting operations including reticulated water supply to deal with a major bush fire event. Careful consideration must be given to other critical infrastructure development, such as power generating works and telecommunications structures in bush fire prone areas.

Even though state significant projects are exempt from the requirement for a bush fire strategic assessment (BFSA) the guidance provided by the RFS and the planning for bush fire protection documents are strongly encouraged and sometimes utilised.

Further reading and guidance is provided here: Planning for Bush Fire Protection.

Lessons from previous disasters

The spate of significant natural hazard events across Australia, and globally, has precipitated a number of reviews into governance and practice in relation to the management of natural hazard risks and planning for settlements and critical infrastructure. Central to this has been a focus on disaster resilience education and advancements in the way land use planning contributes to preparing communities to be disaster resilient. Recent inquiries have included:

- 2011 Queensland Floods Commission of Inquiry
- 2011 Perth Hills and Margaret River Bushfires Inquiries
- 2009 Victorian Bushfires Royal Commission
- 2012 Canterbury Earthquakes Royal Commission; and
- 2013 Tasmanian Bushfires Inquiry

The Queensland Floods Commission of Inquiry and the Victorian Bushfires Royal Commission include substantial review and commentary of the planning systems in their respective states and the role of planning in improving risk and resilience outcomes. However, an analysis by Deloittes Access Economics of nine recent disaster reviews (2011-2014) indicates that of the 124 recommendations relating to resilience, just 13 have been implemented and 26 are in progress but with no clearly defined timeframe for completion. Some have not been actioned at all[5].

The Canterbury Earthquake Royal Commission found there was a need to clarify roles & responsibilities to improve land use planning. The NZ Government have since amended Section 6 of the Resource Management Act to ensure that decision making regarding land use provides explicit reference to: “the management of significant risks from natural hazards.”

Lessons from recovery

These lessons are a summary of those captured through the recovery process and developing the Land Use Recovery Plan, Lyttelton Port Recovery Plan and other recovery activities in Christchurch. Further information is available here: www.eqrecoverylearning.org/

1. **Walk around the neighbourhood** – understanding the interpendency of critical infrastructure and shared responsibility requires an understanding of the local area and the community.
2. **Well organised / coordinated consultation is critical** – in times of recovery multiple engagement exercises can confuse and dilute the important messages that need to be conveyed
3. **‘Test’ early iterations of plans** – running different possible scenarios or proposals through the policy or planning framework will indicate if the intended outcomes will eventuate, or if unintended consequences arise from poor planning. This can be referred to as 'wargaming', exercises or scenario testing depending on your profession. Doing this exercise together with multiple stakeholders is of most value.
4. **Planning is inherently political and resilience planning is emotive for many stakeholders** – communication and persuasion skills are crucial, and understanding

the bigger picture is necessary to win funds, gain approval and deliver the best outcomes for communities. A few key decision makers can make a huge difference.

5. **Need a 'champion' and very clear governance and decision-making processes** – having an advocate for resilience with a high level of influence in an organisation is important.
6. **Collaboration requires strong relationships** – it takes time and effort to build good working relationships, but this pays dividends in multiple different ways, particularly on future critical infrastrcuture projects.
7. **Happy team equals productive team** – the process of making critical infrastructure more resilient should, overall, be a hugely positive and enjoyable experience. Sharing responsibility for creating more resilient communities, and being involved in projects that will stand the test of time is challenging, but if the leaders and those involved are committed and working together this will produce much better results for everyone, saving time, money and stress in the long run.

Insurance

Planning and design for more resilient critical infrastructure will save money in the long run, especially in the event of a shock or stresses on the system. The recent Senate Inquiry (Environment and Communications References Committee) by the Australian government into *the current and future impacts of climate change on housing, buildings and infrastructure*, noted the important role that insurance plays in the resilience of critical infrastructure.

The costs of insurance on small business, local communities and local authorities place stresses on the viability of some operations and hard choices are sometimes made to reduce premiums, which result in an unacceptable exposure if and when a disaster strikes. The ability to secure affordable insurance cover for residential, commercial and other assets which adequately covers all eventualities is important for resilience. This is critical to provide confidence to homeowners, mortgage lenders, business and the community, and to encourage investment and economic prosperity. Insurance is also critical for response and recovery from any disaster.

Research from the US and other floods indicates that around 30% of business can fail after a major natural disaster. This would impact on the local economy and wider community. Uninsured or underinsured business in the Lismore CBD following flooding from ex tropical cyclone Debbie in early 2017 has impacted on the recovery of business in the CBD. Likewise, delays resolving insurance arrangements post earthquake in Christchurch, NZ, has impacted on the on recovery of the CBD and individual small business throghout the city. This impacts significantly on individual owners, their suppliers, customers, family and community, along with the economic vitality of the CBD. Under insurance is also arisk to the government, who will be expected to step in and assist those impacted by a natural disaster.

Critical infrastructure can both avoid the worst impacts of shocks and stresses through good planning (for example not locating a hospital in a flood zone) and help to mitigate the impacts of disasters on communities (resilient electricity network or flood levees, for example).

By avoiding and mitigating the risks of sudden shocks and long term stresses on critical infrastructure, the improved resilience should be reflected in insurance premiums over the life of the critical infrastructure. A section on Insurance Management can be found in the CIR Strategy Organisational Resilience Guide.

Maintenance

Investing a relatively small amount of capital and design expertise up front in order to ensure the resilience of critical infrastructure has the potential to minimise ongoing maintenance costs through the life cycle of the asset. Most critical infrastructure is already designed to withstand predictable or known shocks and stresses with a long design life. However, in addition to thinking about the longevity, safety and resilience of the individual piece of infrastructure, the interconnectedness and interdependency of infrastructure in a local area, across the state and the country needs to be considered. For example, ensuring a hospital building can physically withstand a flood or earthquake is only of benefit to the community if access roads remain open or can be utilised immediately following an event and fixtures within the hospital building are not damaged.

Critical infrastructure should be able to be upgraded as technology and society changes. Telecommunications towers are often designed with high spigots, but so high that it is not possible to get a crane to the top when it needs upgrading or maintaining. By planning for whole of life cycle and on-going maintenance these types of issue can be avoided. Further guidance and case studies to help inform decision making is provided in the CIR Strategy Design, Operations and Maintenance Guide.

Resilience Priority 3: Provide

The CIR Strategy states that we must provide critical infrastructure services with minimal interruptions. The cost of interuptions to critical infrastructure, such as electricity and telecommunications, is measured in the millions or multi millions of dollars[6]. Ensuring that critical infrastructure provides the expected levels of service for the community is essential to a well functioning 21st century society. The community's tolerance for critical infrastructure that does not meet expectations is continually decreasing. Along with the risks to health and safety, there are signficant economic impacts of service interuption.

The best time to embed resilient infrastructure services is in the early stages, during planning and design. Over the lifetime of a building, for example a hospital or a school, the additional up-front project costs to embed resilience are unlikely to be more than 3% of the total costs, but the operating costs will often constitute 85% of the total. On the same scale, the design costs are likely to be 0.3-0.5% of the whole life cycle costs, and yet it is through the design process that the largest impact can be made on operating costs[7]. This is without quantifying the costs or benefits of social and environmental factors.

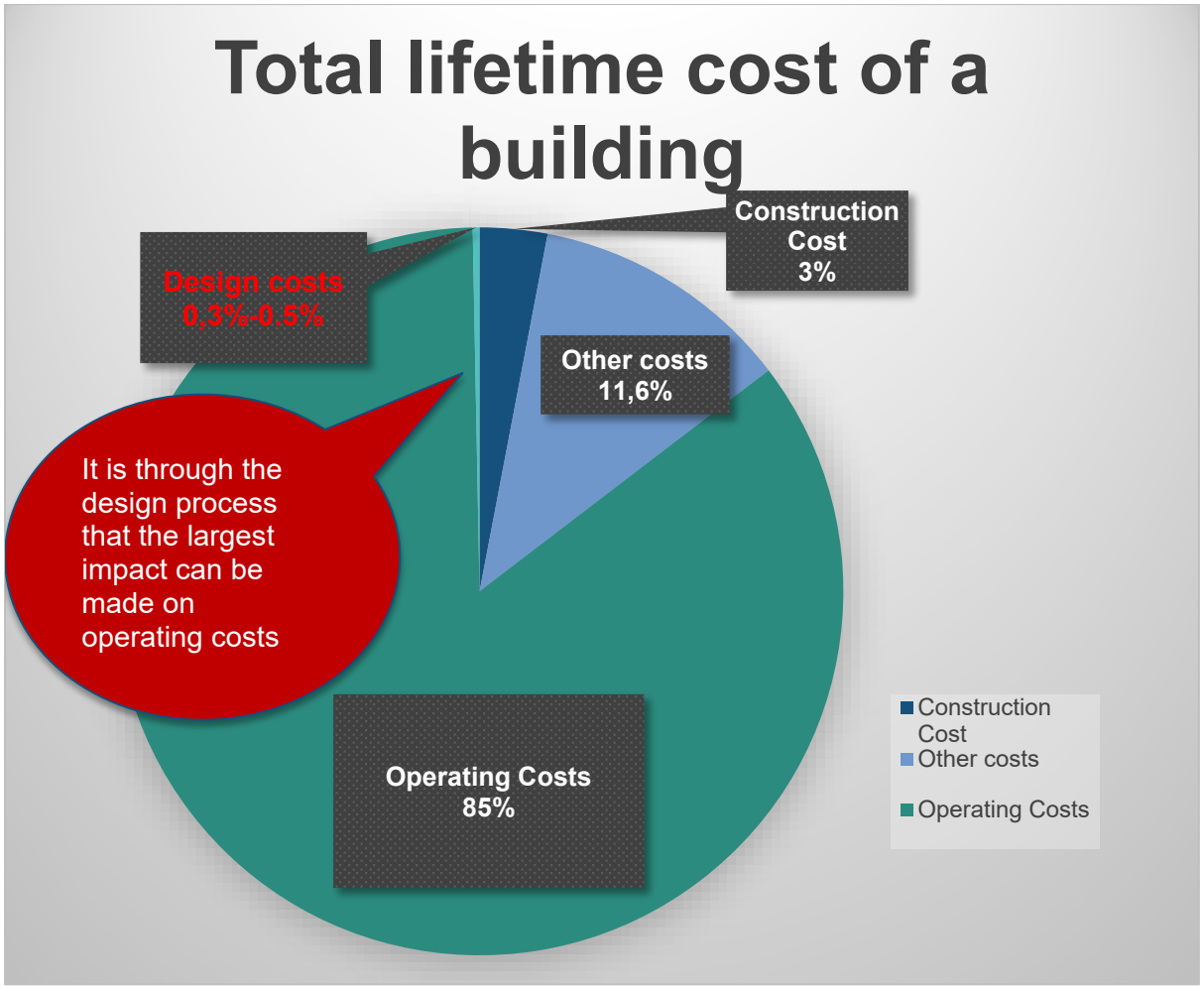


Figure 7 – The value of good design[8]

To help practitioners, the Australian Business Roundtable have provided some practical guidance for decision makers. This is built on the premise that moving towards a system in which resilience is integrated in the deccision-making process for new infrastructure will be a long term process requiring commitment from both industry and government. They identify a key opportunity to improve resilience at the strategic planning phase of new infrastructure projects, including the cost-benefit analysis process used to assess the cost-effectiveness of options. A set of five principles to help decision-makers systematically include disaster resilience in infrastructure planning approval processes is provided. These are :

1. identify disaster risks
2. apply robust methodologies for cost benefit analyses (cba)
3. coordinate, centralise and make available critical data and information
4. strengthen approval processes; and
5. embed ongoing monitoring of resilience.

Taking this a step further, Infrastructure Australia have recently released an extensive assessment process process for large scale infrastructrure projects. At 184 pages this won't be applicable to all projects, but the principles suggested above are applicable at all scales. Robust, transparent and accountable decision making should be the starting point to planning for resilient critical infrastructure.

Legislation

While the focus of the CIR Stratetgy is on a non-regulatory approach, there is existing legislation and guidance that provides a range of requirements and responsibilities. Public and private organisations need to provide critical infrastructure that best meets the communities needs, now and in the future. This means providing services for the community to ensure the lights stay on, roads stay open and phones keep working. Providing for minimal disruption requires thinking about these issues at the outset.

While the existing planning and design legislation doesn't always use the word resilience specifically, as discussed in the Introduction(hyperlink) the definition of resilience is broad and requirements on infrastructure providers include the need to provide sustainable outcomes and ensure levels of service for the community.

The Environmental Planning and Assessment Act, 1979 and the *Local Government Act 1993* in particular, guides the planning of critical infrastructure and decision making in NSW. The overall intent of both acts is clearly aimed at ensuring efficient and sustainable outcomes that will most benefit the community. This should include considerations of resilience.

The objects of the *Environmental Planning and Assessment Act 1979*, (EP&A Act) when read together and implemented as intended will help to provide for more resilient communities. The Objects of the EP&A Act include: *the need to promote the social and economic welfare of the community*; *to promote the orderly and economic use and development of land*; *the sharing of the responsibility for environmental planning and assessment*; and *to provide increased opportunity for community participation in environmental planning and assessment*. A wide range of regulations, state environmental planning policies, circulars and guidelines sit under the act. Those most relevant to critical infrastructure resilience are listed for further reading below.

The Local Government Act 1993 includes requirements of councils to: *consider and plan for their communities in a manner that would also make them more resilient*. The guiding principles of the act include: *the need for councils to have regard to achieving intergenerational equity and to ensure policy decisions are made after considering their financial effects on future generations*; *Councils should work co-operatively with other councils and the state government to achieve desired outcomes for the local community*; *councils should manage lands and other assets so that current and future local community needs can be met in an affordable way*; and, *councils should invest in responsible and sustainable infrastructure for the benefit of the local community*.

Investment in resilience

International research points towards the minimal additional investment (around 1% of infrastructure costs) to achieve significant benefits through mitigation for better resilience. Various case studies demonstrate the benefits of investing in additional mitigation measures to ensure the resilience of infrastructure and communities.

It is sometimes hard to prove the benefits of avoiding the worst impacts of natural disasters through work before they happen, given the low likelihood but high consequence of natural disasters, some decision makers understanding or appetite for risk, and the perceived costs of mitigating the worst possible impacts of shocks and stresses.

By adapting existing infrastructure cost-benefit analysis to include resilience, these issues can be properly included in decision making processes. The Australian Business Roundtable have developed an adapted and simplified cost-beneft analysis process as set out in the table below. Three additional steps for practitioners to integrate disaster resilience in to cost benefit analyses have been highlighted.

Table 1 - Adapting infrastructure CBA processes[9]

Steps	Description
1. Profile Infrastructure requirements	Predetermined objectives and scope of the proposed infrastructure project (e.g. function, location, estimated budget and timing)
2. Specify a base case	Usually a business-as-usual option
3. Assess disaster hazards	**Determine the potential disaster hazards and their probability of occurrence**
4. Identify project options	Develop a series of options for infrastructure
4a. Identify resilient project options	**Include options for infrastructure with greater resilience to natural disasters**
5. Estimate the costs and benefits of each option	Estimate the costs and benefits of each project in present value terms
5a. Estimate resilience benefits	**Include 'avoided disaster costs' as a measure of resilience benefits**
6. Identify preferred option	Compare costs and benefits to identify a preferred option

The decision-making process for building new infrastructure is often complex, requiring trade-offs between objectives within budget constraints. Cost benefit analysis is a key factor in the decision making process and is used to prioritise options with the greatest net benefits.

Infrastructure Australia has developed an Assessment Framework to provide information about what Infrastructure Australia does and how initiatives and projects are assessed for inclusion on the Infrastructure Priority List (IPL). What is clear is that the earlier in the process that resilience is thought about, the more benefit will be gained.

Integrating land use planning and critical infrastructure

The integration of land use and infrastructure planning has long been talked about as essential to create sustainable and liveable communities. Planning for critical infrastructure generally has a long lead time and it is essential that land use planners and infrastructure providers work together across government with local communities and for new communities.

The CIR Strategy demonstrates the need for planning and design to include infrastructure at the outset. The land rezoning process is used as one example, and this is illustrated in the case study. The case study illustrates that at the same time as new urban growth areas for new subdivision and housing are being planned, supporting infrastructure should be planned concurrently. Ensuring that critical infrastructure is planned at the same time as housing, commercial or other urban uses will mean that adequate land is available, that the best outcomes are delivered and that supporting infrastructure can be planned, designed, and built efficiently and effectively.

Green infrastructure

Green Infrastructure is the network of natural systems, semi-natural systems and open spaces including parks, rivers, bushland, wetlands, dune systems and even private land that can be strategically planned, designed and managed to support communities. Green Infrastructure is as crucial to a city as transport, communications and other critical infrastructure. It delivers a range of benefits including:

- mitigating flooding
- improving air and water quality
- cooling the urban environment
- encouraging walking and cycling
- healthy living
- enhancing bio-diversity and ecological resilience
- absorbing and transforming waste

The NSW government has recently released 'Greener Places' a draft policy for discussion on the importance of 'green infrastructure'. The four principles are:

Integration – combine green Infrastructure with urban development and grey infrastructure

Connectivity – create an interconnected network of open space

Multifunctionality – deliver multiple ecosystem services simultaneously

Participation – involve stakeholders in development and implementation

Infrastructure design that is ecologically sensitive and uses natural processes, such as wetlands for the storage and treatment of stormwater, integration with recreation and open space and appropriate planting, provides a greater range and degree of benefits for the community than 'hard' or 'grey' infrastructure design alternatives. By working within the natural systems and understanding natural processes infrastructure can be planned to be more resilient, through land use decision making, design, or operation. There are many case studies about the multifunctionality of green infrastructure and the role that greener places and spaces can play in an integrated resilience solution. These case studies demonstrate how green infrastructure can help mitigating the effects of climate change, manage stormwater, improve access to open space and make critical infrastructure more resilient. Figure 8 below illustrates the wide ranging beneficiaries of green infrastructure.

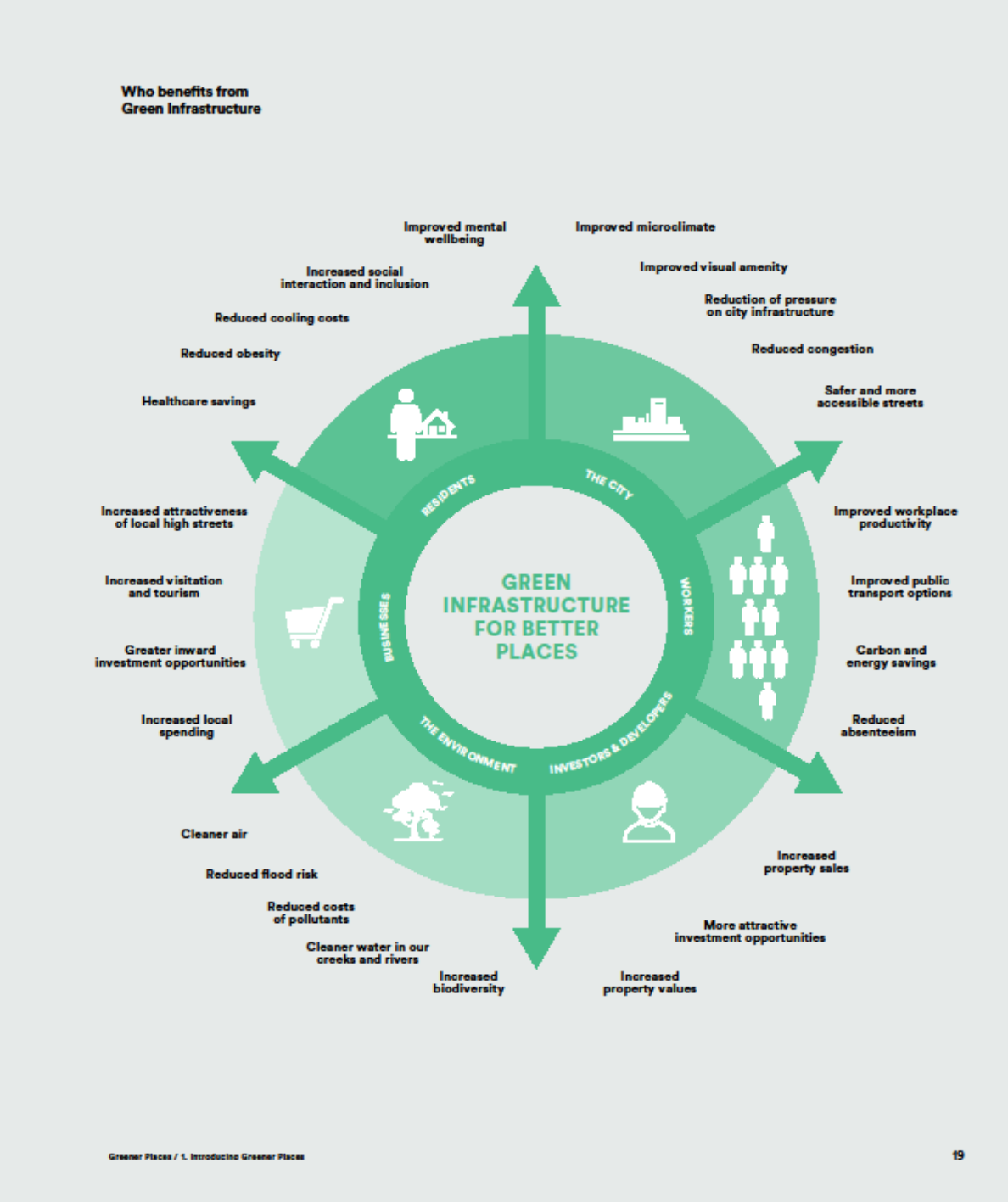


Figure 8 Who benefits from green infrastructure[10]

Access to nature has been demonstrated to improve health and wellbeing, speed up recovery in patients and increase vitality in the elderly, improve cognitive ability in children and therefore improve overall resilience. Incorporating natural elements in to critical infrastructure like hospitals, schools and airports will have a wide range of benefits.

Planning and design should be considered through a resilience lens, and with a partnered approach to working with the community, end users, and other agencies. The natural elements can have economic benefits through reducing energy consumption, avoiding natural hazards, improving accessibility and productivity benefits. Social, cultural, environmental and economic benefits can be maximised by considering these issues at the

outset, through thinking holistically about the interconnectedness of critical infrastructure and how to make the *system* more resilient, not just an individual asset.

Building momentum

The State Infrastructure Strategy 2018-2038 Building Momentum sets six cross-sectoral strategic directions to achieve 'more with less' from the state's large infrastructure program and asset base, this includes:

1. continuously improve the integration of land and infrastructure planning
2. plan, prioritise and deliver an infrastructure program that represents the best possible investment and use of public funds.
3. optimise the management, performance and use of the state's assets
4. ensure NSW's existing and future infrastructure is resilient to natural hazards and anthropogenic threats
5. improve state-wide connectivity and realise the benefits of technology; and
6. drive high quality consumer-centric services and expand innovative service delivery models in infrastructure sectors.

The resilience of vital state assets will be improved by better coordination between agencies, sharing of information and infrastructure-specific risk assessment tools and guidance. Resilience considerations will be embedded into project business cases, capital asset planning and assurance processes, and agencies will be required to undertake rolling, periodic assessments of the vulnerability of their assets to natural disasters and human related threats.

Appendix A: Sample resilience audit

When planning and designing new infrastructure, or maintenance and improvements of existing assets, it is important to ensure that resilience is a key consideration. One of the key priorities of the State Infrastructure Strategy 2018-2038 is to ensure NSW's existing and future infrastructure is resilient to natural hazards and malicious threats.

To help prompt the consideration of resilience when planning for critical infrastructure a sample audit has been developed that can be used to support reporting and decision-making processes.

This could be attached to or referenced in council or board meeting reports for decision and could be used to start the conversation about resilience at the outset of planning for critical infrastructure.

It is important that this should only be used as a starting point and shouldn't be used only as a 'tick the box' exercise. Critical thinking about each of the issues should be undertaken with a cross section of the organisations or even better multi-agency and recorded and able to be demonstrated if needed.

This audit has been developed after considering the 'safe growth' audit utilised in the US, the Planning Institute of Australia the Clarence Valley Councils Sustainability Initiative and the ISCA Infrastructure Sustainability Rating Tool. The Infrastructure Sustainability Council of Australia (ISCA) have developed a rating scheme for evaluating sustainability across planning, design, construction and operation of infrastructure. There are a lot of parallels with resilience.

Planning for Critical Infrastructure – A sample checklist	Yes	No
Before you plan:		
□ Are hazard models/maps up to date and have you checked the Emergency Information Co-ordination Unit (EICU)?		
□ Is there a recently completed natural hazard management plan (such as a bush fire Risk Management Plan or a Flood Risk Management Plan) available to help guide your planning?		
□ Are you aware of other critical infrastructure that will benefit or could be reliant on the planned infrastructure project? Have you mapped critical infrastructure for the local area/region/state with the community and other stakeholders to understand interdependencies?		
□ Are you aware of progress on the implementation of a natural hazard management plan or resilience strategy that might be underway? Some projects like levees or other structural controls can have land use implications (both positive and negative) that should be incorporated into the planning process		
□ Have you identified ways in which you can contribute to resilience plans for your area?		
□ Could you do more to go beyond the minimum requirements that might be in place via State planning requirements? Does anything prevent best practice?		

While you are planning:		
□ Are you just addressing natural hazards as a 'side issue' rather than a fundamental part of strategic planning for your area/region?		
□ Are all relevant disciplines and experts involved, and is there a resilience focus/perspective informing decision making?		
□ How do plans for housing, town centres and associated infrastructure interface with known natural hazards? Are you placing or reinforcing investment in infrastructure and economic and employment areas in known hazard areas?		
□ Are there any existing settlement areas and supporting infrastructure that are of concern to you? Do you need to consider specific land use policy approaches in these areas that can address the risks?		
□ Is there an identified issue with infrastructure/utility vulnerability that could be magnified or lead to failure subject to natural hazard activity? Have new infrastructure items/sites been considered against the relevant natural hazard context?		
□ Have you specifically identified any vulnerable communities, infrastructure at risk or activities that require planning considerations and a need to improve resilience?		
□ Are natural hazard considerations being frontloaded within strategic plans for land use and critical infrastructure in a manner which seeks to minimise deferral of issues to the development assessment or later decision-making phase?		
□ Have you engaged with other valuable professionals such as natural hazard managers or local emergency/disaster management officers to contribute additional expertise to urban planning and infrastructure resilience?		
While you are implementing:		
□ Is development assessment and investment decision making being made in accordance with best practice? Is strategic/policy advice sought for risk/resilience issues on occasions where out-of-sequence or other development not planned for is proposed, during the assessment process?		
□ Is feedback on risk treatment via plan implementation being provided back to natural hazard managers?		
□ Are emergency/disaster managers engaged in assessment processes for development sites and infrastructure in higher risk locations?		

Appendix B: Case studies

Case study: Integrating infrastructure resilience into planning processes: The Emilie Serisier Bridge

Flooding of a state highway bridge that crosses the Macquarie River in regional NSW has caused six major traffic disruptions since its construction in 1987, estimated to have cost about $17 million. The cost of future disruption events is estimated at $75 million, totalling about $92 million (in present value terms) over the projected life of the asset.

When the Emile Serisier Bridge is inundated, traffic must be diverted to the LH Ford Bridge, which can withstand a one-in-50-year flood. During a 2010 flood, it took more than two hours to cross the river – a trip that typically takes 10 minutes. The increased travel time impacts other services supplied via this infrastructure, including health, emergency services, and education. There are increased costs to affected business, especially tourism, and additional social costs to the community. As the river crossing is a significant trade route, this had wider ranging impacts to regional and interstate commerce.

The NSW Government is planning for a new bridge over the Macquarie River in Dubbo and has identified a preferred route. [11] Should the new bridge cost less than $92 million this new investment will provide a net benefit to NSW CIR.

Whatever the cost of the new bridge, it is likely to cost more than the 1987 cost to integrate flood resilience into the initial bridge-building project. Flood risk and infrastructure resilience is better understood today than it was in 1987, and part of the work of the CIR Strategy is to highlight the benefits of integrating resilience early to avoid reconstruction and replacement costs, and to foster the ability to gather improved data and partner in planning for resilient infrastructure.

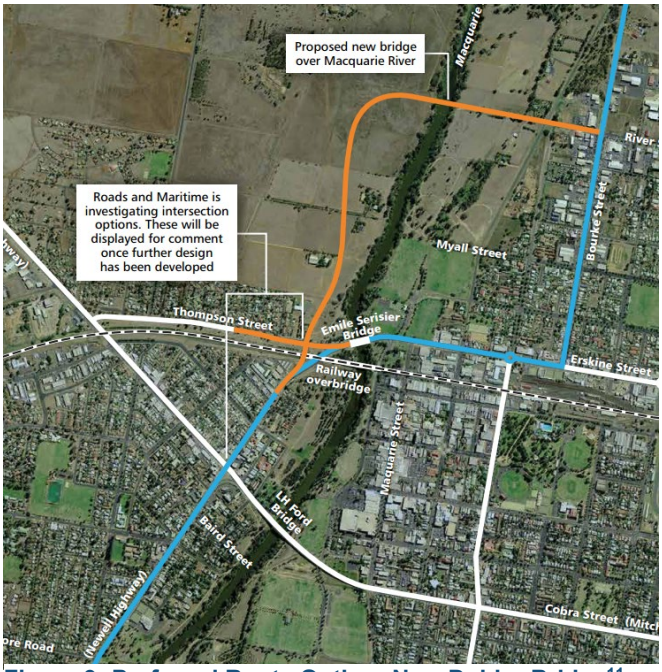


Figure 9: Preferred Route Option: New Dubbo Bridge[11]

Figure 10: Dubbo, looking east over Emile Serisier Bridge[11]

Case study: Partnering and planning for infrastructure resilience: The Clarence – Coffs water supply project

The $180 million Regional Water Supply Scheme involves linking the Clarence Valley and Coffs Harbour bulk water supplies to meet the demand for water in the region up to and beyond 2046.

Two key elements make up the Regional Water Supply Scheme - A 'non-build' Water Efficiency Program and a $180 million 'build' Project which includes:

- a 30,000ML off-stream storage dam at Shannon Creek, west of Grafton; and
- 87km of underground pipeline distribution system linking the Nymboida River and three water storage areas.

Coupled with the new infrastructure is the regional water efficiency strategic plan, which aims to reduce unnecessary water use extend the operational life of the scheme. Reduced costs and deferred or avoided future capital investment were also key drivers.

The efficiency plan comprises:

- processes that identify and minimise water losses from leakage and overflows
- water restrictions and pricing policies to discourage inappropriate use of water and optimise the efficiency of supply operations
- incentives to adopt water efficient practices such as re-bates for dual flush toilets, water efficient shower roses and rainwater tanks
- education of communities in environmentally sound water usage; and
- both councils have implemented permanent level 1 water restrictions.

The community were kept informed and engaged from the outset, to help ensure that environmental risks were managed, and that additional assets were part of the project such as view-points, tour bus areas, walking tracks, picnics and conservation areas are included.

The construction has been planned and designed to both withstand and avoid shocks (floods and other hazards) and long term stresses (like drought and increasing population). The new dam provides a secure, sustainable and resilient water supply for both Clarence Valley and Coffs Harbour local government areas, which has significant benefits for other interdependent critical infrastructure that relies on water, such as hospitals, food and grocery, and wastewater.

The dam foundations were constructed to allow further construction up to 75,000ML if required in the future, but by managing demand the cost of increasing the size of the dam wall should be deferred for many years.

The ‘off stream’ dam design reduces the likelihood of natural hazards such as large floods, but also minimises environmental impacts as water is only allowed to be taken when flow in the Nymboida River is either not too high or not too low. The recent run of dry weather in mid-2018 had minimal impact on the availability of water in the dam. This project has won a number of awards for its benefits to the community, the environment and engineering excellence.

Case study: Re-building resilience in Christchurch's horizontal infrastructure

The 2010-11 Canterbury Earthquakes had a devastating impact on the people and infrastructure of Christchurch and surrounds. The Stronger Christchurch Infrastructure Rebuild Team (SoemT) was a virtual organisation created in 2011 to rebuild Christchurch's earthquake damaged horizontal infrastructure. SCIRT's job was to provide a cost-effective and efficient vehicle to quickly get the city's civil infrastructure back on its feet.

SCIRT's $2.2 billion five-and-a-half year programme was funded by the New Zealand Government and Christchurch City Council. It involved more than 700 individual projects across the city repairing and rebuilding underground sewage, storm water and fresh water infrastructure networks, as well as roads, bridges and retaining walls. SCIRT's design team included individuals from more than 20 consultancies who worked collaboratively across a remarkable range of projects to ensure a high level of service and outstanding outcomes.

Before the earthquakes, 1,700km of gravity fed sewerage pipes carried over 160 million litres of wastewater a day to the wastewater treatment plant. Post-earthquake, up to 60million litres of wastewater a day was leaking in to backyards, waterways and the ocean.

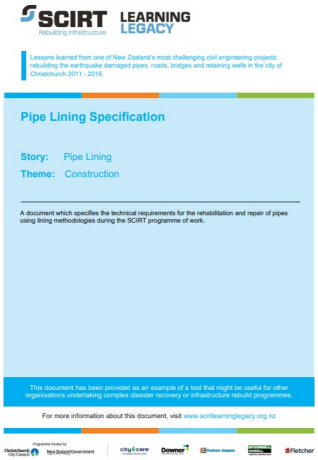
An innovative multi-parameter pipe defect assessment tool was developed to more rapidly inspect the damage. This allowed SCIRT to get on with repairs and replace older, less durable pipes with more resilient materials like polyethylene.

Hard decisions had to be made based on budget constraints, and where 5-10-15 years of useful life was still in an asset, replacement was delayed to concentrate on other parts of the network. Other techniques such as pipe lining were also used to speed up service restoration.

While there was significant disruption to streets across Christchurch, a joined up approach between all critical infrastructure owners aimed to minimise streets being dug up multiple times to repair the network of telecommunications, water, wastewater, electricity and road and bridge repairs needed.

Many lessons have been learnt from the Christchurch infrastructure rebuild experience, including:

- the need for a design guideline for post disaster repairs to ease the rebuild pain for asset owners; and
- up-to-date asset registers to help discern between disaster-related faults and general network wear and tear.



These lessons are even more useful in relation to the new Disaster Relief and Funding Arrangements (DRFA) in Australia.

Further information is provided on the SCIRT Rebuilding Infrastructure *Learning Legacy website*, and the government's earthquake recovery learning centre.

EQ Recovery Learning | Shared insights from the Canterbury earthquakes

Case study: Queensland Reconstruction Authority implementing *Resilient Queensland*

The Queensland Reconstruction Authority (QRA) is leading the Implementation of Resilient Queensland 2018-21. Resilient Queensland is an engagement and implementation plan to ensure outcomes are delivered against the objectives of the Queensland Strategy for Disaster Resilience.

As part of the wider program, the QRA is the lead agency for several pilot projects which seek to test various approaches, pathways and methodologies to develop resilience strategies, including one now in implementation phase for the Burnett River Catchment. The Wide Bay Burnett Regional Organisation of Councils Inc, as the pilot steering committee, recently won the Qld 2018 Resilient Australia Government Award for this pilot project.

In recent years, repeated and severe flooding has impacted the properties and livelihoods of those living and working in the Burnett River catchment. Households, communities and governments have worked together to recover well from these events. However, the region is not immune to future floods of a similar, or possibly larger scale than that of recent years. Therefore, it has been critical to investigate ways to better prepare for the future by coordinating efforts, sharing knowledge and capability, and setting a proactive agenda for improving resilience over time across the catchment. The Burnett Catchment Flood Resilience Strategy (the Strategy) guides how government, the community and all stakeholders work together to proactively reduce flood risk and increase resilience throughout the catchment.

One innovative tool the QRA has adopted to identify risks to critical infrastructure and the community is a very large mapping activity to assist and encourage participation. These maps have been up to 10metres square, spread out in large meeting rooms to facilitate discussion and identify hazards, risks, topical issues, areas for development, funding needs and infrastructure, particularly weak links in critical infrastructure as a result of natural hazards. The multi-disciplinary nature of these discussions enabled those not traditionally engaged in flood resilience to provide their own lens, skills and experience to the common challenges across the catchment, to help drive shared solutions.

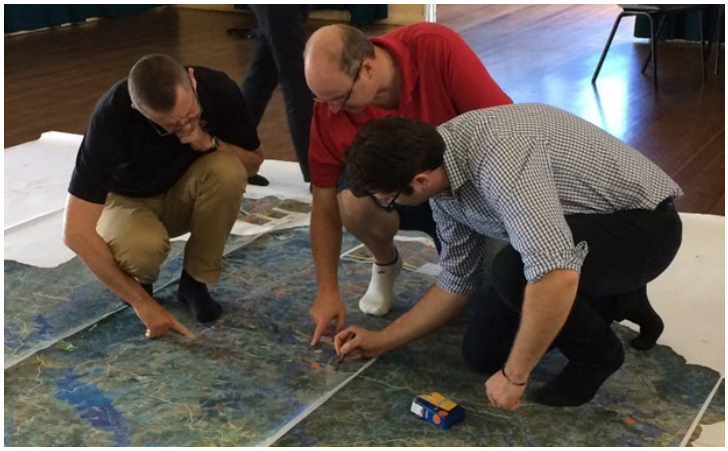


Figure 5: Using a large map for community engagement

The consultation takes a locally led, regionally co-ordinated and state facilitated approach to community engagement.

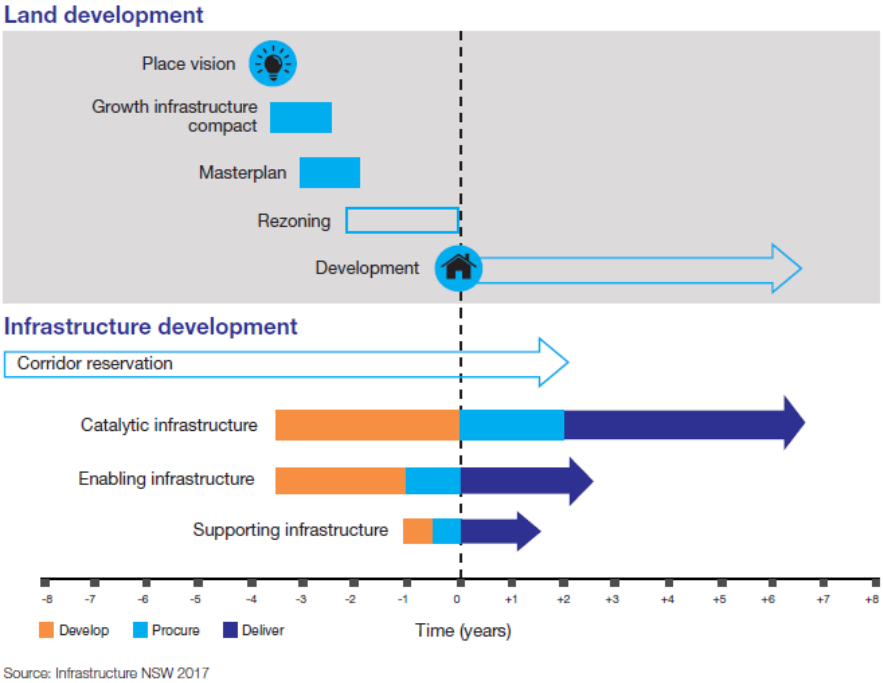
Case study 6: Planning for growth - Integrating infrastructure and land use planning

The Greater Sydney Commission has designed the growth infrastructure compact (GIC) to assess the local and regional infrastructure needed to support long-term housing and jobs growth on an area-by-area basis. The Greater Sydney Commission is leading a pilot GIC for the Greater Parramatta to the Olympic Peninsula area, to be completed by the end of 2018. If successful, the pilot will evaluate where the GIC can be applied in other areas of Greater Sydney.

The GIC process should culminate in the production of a place-based strategic business case, which addresses each location's needs in terms of development feasibility, service and infrastructure costs. The place-based strategic business case can then inform investment decisions where significant state capital investment is required. This will allow an upfront assessment of the best approaches to using existing assets and services, the optimal combination of new infrastructure investments to support future housing and jobs growth, and the most cost-effective sequencing and delivery of infrastructure investment at each location.

The place-based strategic business case can also provide agencies with the guidance and investment parameters they need to coordinate their investment priorities geographically. There appears to be merit in preparing place-based strategic business cases to inform future updates to regional plans and district plans. The inclusion of critical infrastructure in that discussion and decision-making process is also essential.

Infrastructure and the associated costs should be factored in to decisions about whether and where to release or rezone land. This will ensure that the government understands the full cost of rezoning decisions. It may also result in a more integrated response to population growth if opportunities for the co-location of different services can be identified. Indicative infrastructure and land development lead times are outlined in Figure 12 below, which demonstrates the advantages of beginning infrastructure planning well ahead of rezoning.



Source: Infrastructure NSW 2017

Figure 12 – Timing of infrastructure and development

Appendix C: Abbreviations and glossary

Abbreviation	Meaning
All Hazards	An approach to manage the uncertain nature of emergency risk by building resilience to all or multiple hazards
CI	Critical Infrastructure
CIP	Critical Infrastructure Protection (protection against terrorism specifically)
CIR	Critical Infrastructure Resilience (protection against all hazards)
Dependency	When a critical infrastructure relies on another critical infrastructure, good or service for continued service provision
Disaster	When a hazard or threat intersects with a vulnerability, and the ability of local resources or business as usual to cope is overwhelmed
EMDRR	NSW Emergency Management and Disaster Resilience Review
Hazard	A threat, usually natural, that unintentionally disrupts critical infrastructure service provision
Infrastructure Provider	An organisation responsible for providing an infrastructure service at a state, regional or local level, whether publicly or privately owned
Interdependency	When multiple critical infrastructures rely on each other for continued service provision
Mitigation	Measures taken in advance to reduce the likelihood or consequence of a hazard or threat.
Sector	An industry or service group identified within the NSW CIR Strategy
SEMC	State Emergency Management Committee
SCADA	Supervisory Control and Data Acquisition (SCADA) systems are used for remote monitoring and control in the delivery of critical services such as electricity, gas, water, waste and transportation.
SLERA	NSW State Level Emergency Risk Assessment
Threat	A hazard, usually man-made, that deliberately disrupts critical infrastructure service provision
TISN	Trusted Information Sharing Network (information sharing network co-ordinated by Commonwealth Home Affairs Department)
Vulnerability	The conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of an individual, a community, assets, or systems to the impacts of hazards. (Source: NDRRF Glossary)

Appendix D: References

[1] Australian Business Roundtable for Disaster Resilience & Safer Communities, 2016. *Building Resilient Infrastructure* Available at: australianbusinessroundtable.com.au/our-research/resilient-infrastructure-report
[2] Australian Business Roundtable for Disaster Resilience & Safer Communities Building resilience in our states and territories australianbusinessroundtable.com.au/2017-facts
[3] IAG submission to the *current and future impacts of climate change on housing, buildings and infrastructure* Environment and Communications References Committee for inquiry and report.
[4] Derived from the National Land Use Planning Guidelines for Disaster Resilient Communities
[5] Australian Business Roundtable website australianbusinessroundtable.com.au/
[6] Ibid
[7] Commission for Architecture and the Built Environment (CABE) UK
[8] Ibid
[9] ABR Report *Building Resilient Infrastructure pg 72*
[10] *Greener Places – draft for discussion – establishing an urban green infrastructure policy for NSW*
[11] State of New South Wales through Roads and Maritime Services. 2017. *New Dubbo Bridge: Preferred Route Option*. Available: www.rms.nsw.gov.au/projects/western-nsw/dubbo-bridge/index.html