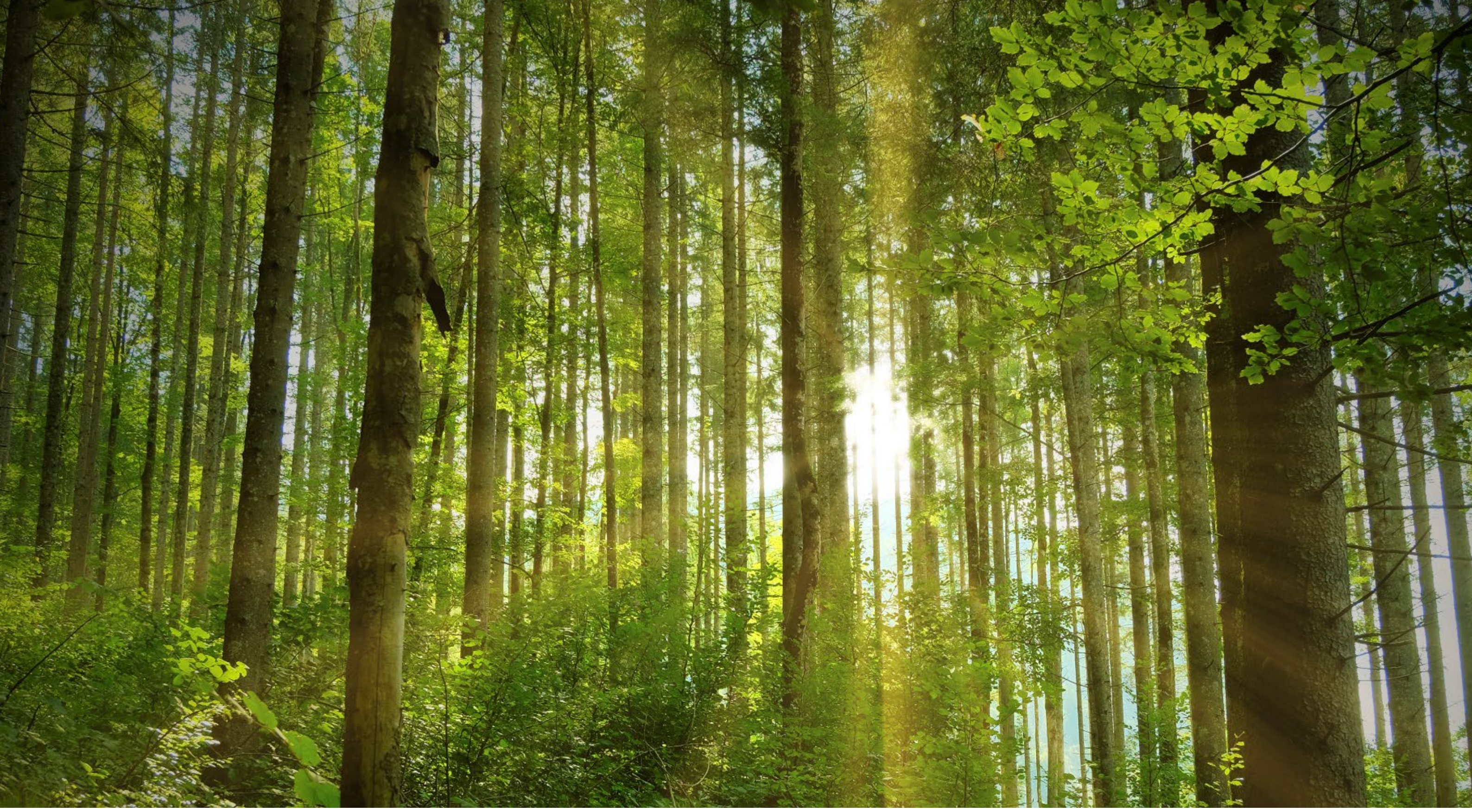


Australasian Health Infrastructure Alliance (AHIA)

Key Sustainability Guidance

Climate Resilience and Adaptation Guide

July 2024

Copyright and Disclaimer

Copyright

Australasian Health Facility Guidelines

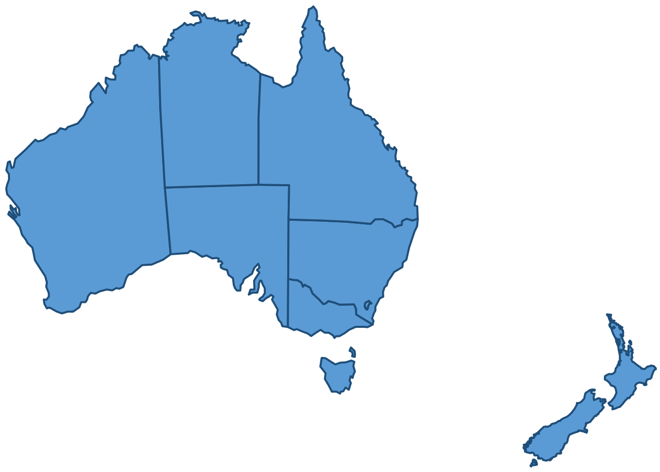
Website: http://www.healthfacilityguidelines.com.au
Email: HI-AusHFGteam@health.nsw.gov.au

The AusHFG are an initiative of the Australasian Health Infrastructure Alliance (AHIA). AHIA membership is comprised of representatives from government health infrastructure planning and delivery entities in all jurisdictions in Australia and New Zealand.

Disclaimer

Cultural Acknowledgement

The Australasian Health Facility Guidelines (AusHFG) are developed in collaboration with stakeholders across Australia and Aotearoa, New Zealand.



Acknowledgement of Country

We acknowledge the Aboriginal people as the traditional owners and continuing custodians of the land throughout Australia and the Torres Strait Islander people as the traditional owners and continuing custodians of the land throughout the Torres Strait Islands.

We acknowledge their connection to land, sea and community and pay respects to Elders past, present and emerging.

Acknowledgement of Te Tiriti o Waitangi

We acknowledge Māori as tangata whenua in Aotearoa New Zealand.

Te Tiriti o Waitangi obligations have been considered in developing these resources.

Contents

Glossary

Definitions and key terms

TERM	DEFINITION
Adaptive capacity	The ability of a system to evolve to accommodate climate changes or to expand the range of variability with which it can cope (IPCC, 2021a).
Climate adaptation	In human systems, the process of adjustment to actual or expected climate and its effects, to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects (IPCC, 2022).
Climate change	A change in the state of the climate that persists for an extended period, typically decades or longer (IPCC, 2022).
Climate projections	Simulated response of the climate system (including variables such as temperature, precipitation, wind, solar radiation, sea level) to a scenario of future emissions or concentrations of greenhouse gases and changes in land use, generally derived using climate models. Climate projections depend on an emission scenario, in turn based on assumptions concerning factors such as future socioeconomic and technological developments that may or may not be realised (IPCC, 2022).
Climate resilience	The ability of a system to survive an immediate shock, adapt to ongoing consequences, and thrive in a changed long-term landscape.
Climate risk	The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from the potential impacts of climate change as well as human responses to climate change. Physical climate risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards.
Climate variables	Factors that determine and govern the climate. Main factors include rainfall, atmospheric pressure, wind speed, wind direction, humidity and average and maximum temperature (PIARC, 2015). Changes in climate variables (such as temperature) can lead to changes in climate hazards (such as heatwaves).
Consequence	Outcome of an event affecting objectives. A consequence can be certain or uncertain and can have positive or negative direct or indirect effects on objectives. Any consequence can escalate through cascading and cumulative effects (ISO, 2019).
Exposure	The presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social or cultural assets in places that could be adversely affected (IPCC, 2022).
Extreme weather event	An event that is rare at a particular place and time of year. The characteristics of what is called extreme weather may vary from place to place (IPCC, 2022).
Hazard (climate hazard)	The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources (IPCC, 2022).
Likelihood	The chance of something happening (ISO, 2019).
Representative concentration pathways (RCPs)	Scenarios that include a time series of emissions and concentrations of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover. The word 'representative' signifies that each RCP provides only one of many possible scenarios. The term 'pathway' emphasises the fact that not

TERM	DEFINITION
	only the long-term concentration levels but also the trajectory taken over time to reach that outcome are of interest (IPCC, 2022).
Scenario	Climate change scenarios refer to a coherent, plausible and simple description of the possible future state of the climate, which forms the basis of climate change projections.
Transition risk	The potential consequences from a changing climate as well as the transition to a net zero carbon economy (IPCC, 2022).
Vulnerability	The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC, 2022).

Abbreviations

ABBREVIATION	DEFINITION
AASB	Australian Accounting Standards Board
CSIRO	Commonwealth Scientific and Industrial Research Organisation
HHS	hospital and health services
HVAC	heating, ventilation and air conditioning
IFRS	International Financial Reporting Standards
IPCC	Intergovernmental Panel on Climate Change
IS	Infrastructure Sustainability
ISO	International Organisation for Standardisation
ISSB	International Sustainability Standards Board
RCP	representative concentration pathway

1. Introduction

1.1 Purpose

Health infrastructure and services vary across Australia and New Zealand, but all share common features in their key functions and objectives. This *Climate resilience and adaptation guide* addresses climate-related risks for health infrastructure and supports planners and designers of health facilities throughout Australia and New Zealand to apply best practice approaches for enhancing resilience through climate adaptation.

Climate resilience is the ability of a system to survive an immediate shock, adapt to ongoing consequences and thrive in a changed long-term landscape. Adaptation is the mechanism to achieve this and refers to the process of adjusting to actual or expected climate and its effects to moderate harm or exploit beneficial opportunities (IPCC, 2022).

This guide presents a replicable and scalable approach for undertaking climate risk assessment and adaptation planning for health infrastructure assets. It provides a catalogue of climate-related risks and practical adaptation strategies to consider when planning and designing new and existing facilities. The methodology is aligned with local and international risk management and climate adaptation standards as well as state, regional and national policies and strategies in Australia and New Zealand.

The focus of this guide is on physical climate risks for infrastructure assets that can be addressed during the planning, design, construction and maintenance phases of new and existing assets. In addition to physical risks to assets covered in this guide, decision-makers should also consider physical risks to operations and supply chains and climate-related transition risks at the enterprise scale.

1.2 Audience

This guide targets various stakeholder groups engaged throughout the entire project lifecycle of health infrastructure capital projects, from project planning and design to post-occupancy evaluation. For existing health facilities, the guidance is directed at facility managers, hospital engineers and asset management teams. For new health facilities, the intended audience extends to planners and wider design teams.

The intended readership includes both technical and non-technical staff. This document is designed to be a valuable resource for designers, engineers, consultants and facility managers, offering guidance to ensure the successful implementation of climate adaptation and resilience measures.

1.3 Overview of the climate risk assessment and adaptation planning process

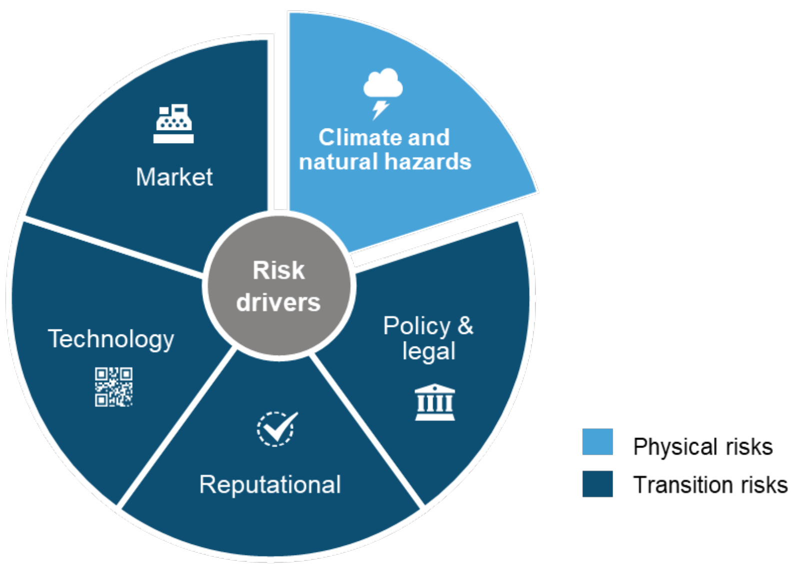
Types of climate risk

The future climate is highly uncertain and largely depends on the pace of global decarbonisation and the effectiveness of climate action. Both high-emissions scenarios and aggressive-mitigation pathways carry distinct risks. Physical risks are driven by climate and natural hazards, which vary under different climate change scenarios and are exacerbated under higher emissions scenarios. Transition risks arise from the processes and changes needed to transition to a low-carbon economy, specifically market shifts, regulatory changes, reputational impacts and policy and legal developments (Table 1 and Figure 1).

Table 1: Definitions of physical and transition risks

PHYSICAL RISKS	TRANSITION RISKS
Physical risks refer to the potential for adverse impacts on natural systems, the built environment and human health and safety as a result of increasing exposure to climate hazards such as flooding, bushfires, heatwaves, cyclones and rising sea levels. Physical risks can be acute shocks or chronic stresses, and may be compounding, cascading or isolated. For health infrastructure assets, physical risks can be addressed through effective planning and resilient design of assets in addition to operational and maintenance measures. Adaptation planning for physical risks may be undertaken at individual asset scale or at portfolio, enterprise, sector or national scales.	Transition risks encompass the uncertain changes in policy and regulation, technology, market trends and expectations associated with transitioning to a low-carbon economy. Depending on the nature, speed and focus of these changes, transition risks may pose varying levels of financial and reputational risk to organisations (TCFD, 2017). Transition risks can be addressed through design, programmatic or responsible business planning measures. Transition risks and their respective management responses exist at the enterprise scale and beyond and are therefore not addressed in this guide.

Figure 1: Drivers of climate-related physical and transition risks

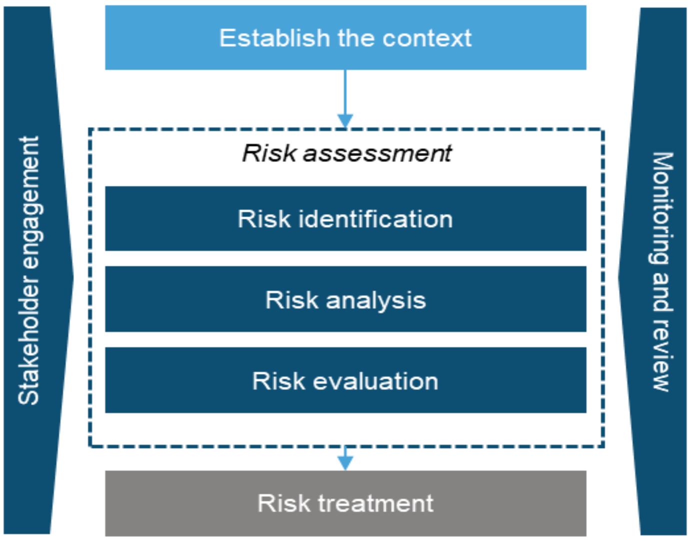


Physical climate risk assessment and adaptation planning process

At the asset and portfolio scale, improving climate resilience involves undertaking a physical climate risk assessment and adaptation planning process.

The following checklist provides an overview of this process including the key stages, tasks and activities needed to develop new and enhancing existing climate-resilient health infrastructure assets. The stages align with those specified in *AS3554:2013 Climate change adaptation for settlements and infrastructure – A risk-based approach,* summarised in Figure 2.

Figure 2: Summary of stages set out in AS5334:2013



It is important to note that climate risk assessment and adaptation planning processes are iterative and should be continually monitored and reviewed to respond to evolving conditions and emerging information. Stakeholder engagement through the process is also essential to ensuring context-specific risks and existing adaptive capacity are well understood.

Checklist of required activities for new and existing health infrastructure assets

Figure 3 provides a checklist of required activities for new and existing health infrastructure assets.

Figure 3: Physical climate risk assessment and adaptation planning process for health infrastructure

Guide section	Stage	Task	Required activities
SECTION 3: PLANNING FOR ADAPTATION AND RESILIENCE	1. Establish the context	Scoping and project context	❑ Define asset boundary (inclusions) and location ❑ Identify key stakeholders for engagement ❑ Select relevant time horizon for assessment and adaptation planning
		Climate hazard analysis	❑ Identify relevant hazards and climate variables ❑ Analyse current and future hazard exposure based on available data ❑ Conduct additional hazard modelling as required
		Vulnerability assessment	❑ Assess the criticality of health infrastructure assets ❑ Consider the vulnerability of assets to relevant hazards
	2. Risk assessment	Risk identification	❑ Identify relevant physical climate risk impacts based on context
		Risk analysis	❑ Assess the significance of existing assets and appropriate detail for the risk assessment ❑ Analyse current and future risk levels through an assessment of likelihood and consequence of identified risk impacts
		Risk evaluation	❑ Consider existing controls and adaptive capacity ❑ Identify priority physical risks based on asset criticality, and risk likelihood and consequence levels
SECTION 4: TECHNICAL CONSIDERATIONS	3. Risk treatment	Adaptation strategies for new and existing assets	❑ ***For existing assets***, identify appropriate adaptation design strategies to reduce/mitigate priority risks that relate to normal operations (maintenance) or defined upgrade/retrofit works ❑ ***For new assets***, identify appropriate design adaptation strategies to reduce/mitigate priority risks
		Prioritisation and implementation of adaptation strategies	❑ Prioritise adaptation strategies for implementation using appropriate support tools such as cost-benefit analysis, multi-criteria analysis and stakeholder engagement ❑ Evaluate and accept residual risks ❑ Implement appropriate strategies and monitor their impact of over time

Planning for adaptation and resilience

Planning for adaptation and resilience (detailed in section 3 of this guide) comprises 2 key stages. The first stage involves establishing the context including documenting the scope, objectives, asset boundary and location, stakeholders, climate hazard context and baseline vulnerability of the health infrastructure asset.

This informs the second stage during which specific climate-related physical risks to the asset(s) are identified, analysed and prioritised based on the project-specific context. In this second stage, risk impacts are assessed and prioritised in terms of the probability of the occurrence (or likelihood) of a hazard and the severity (or consequence) of its impact with consideration of existing controls, adaptive capacity and asset criticality. Consequence may be characterised and assessed using various criteria, determined by stakeholders (for example, financial, economic, social, safety, environmental, cultural and heritage and/or reputational impacts).

Technical considerations

Once risks are well understood, appropriate adaptation measures are identified and prioritised to reduce and/or mitigate risks (detailed in section 4 of this guide). Adaptation measures should be prioritised based on criteria such as risk reduction efficacy, cost, sustainability performance (for example, embodied carbon), constructability and timing. There are different options available for new and existing health infrastructure during this stage of the climate risk assessment and adaptation planning process. This guide focuses on design adaptation strategies, but decision-makers may also implement operational measures to address priority risks.

Stakeholder engagement and continuous improvement

Due to the project-specific nature of climate risk assessment and adaptation planning, stakeholder engagement is a key part of every stage. This ensures project-specific risks and opportunities can be defined and implementation responsibilities can be appropriately assigned. Stakeholder engagement is also important for leveraging existing asset and risk management systems to promote embeddedness of climate resilience and alleviate dispersed governance of the functions and roles of climate risk management.

Monitoring and evaluation play an important role in ongoing adaptive risk management to ensure adequate levels of resilience are maintained over the infrastructure operating life. In the context of climate risk, monitoring and evaluation activities serve multiple purposes:

- monitor and evaluate the adequacy and performance of adaptation measures under current climatic conditions and immediately before and/or after climate hazard events occur
- monitor and evaluate changing risk levels in response to ongoing and projected changes in climatic conditions and/or exceedance of identified climate hazard thresholds (for example, sea level rise extent)
- review and modify/confirm risk levels and adaptation measures based on contemporary climate change data as it becomes available.

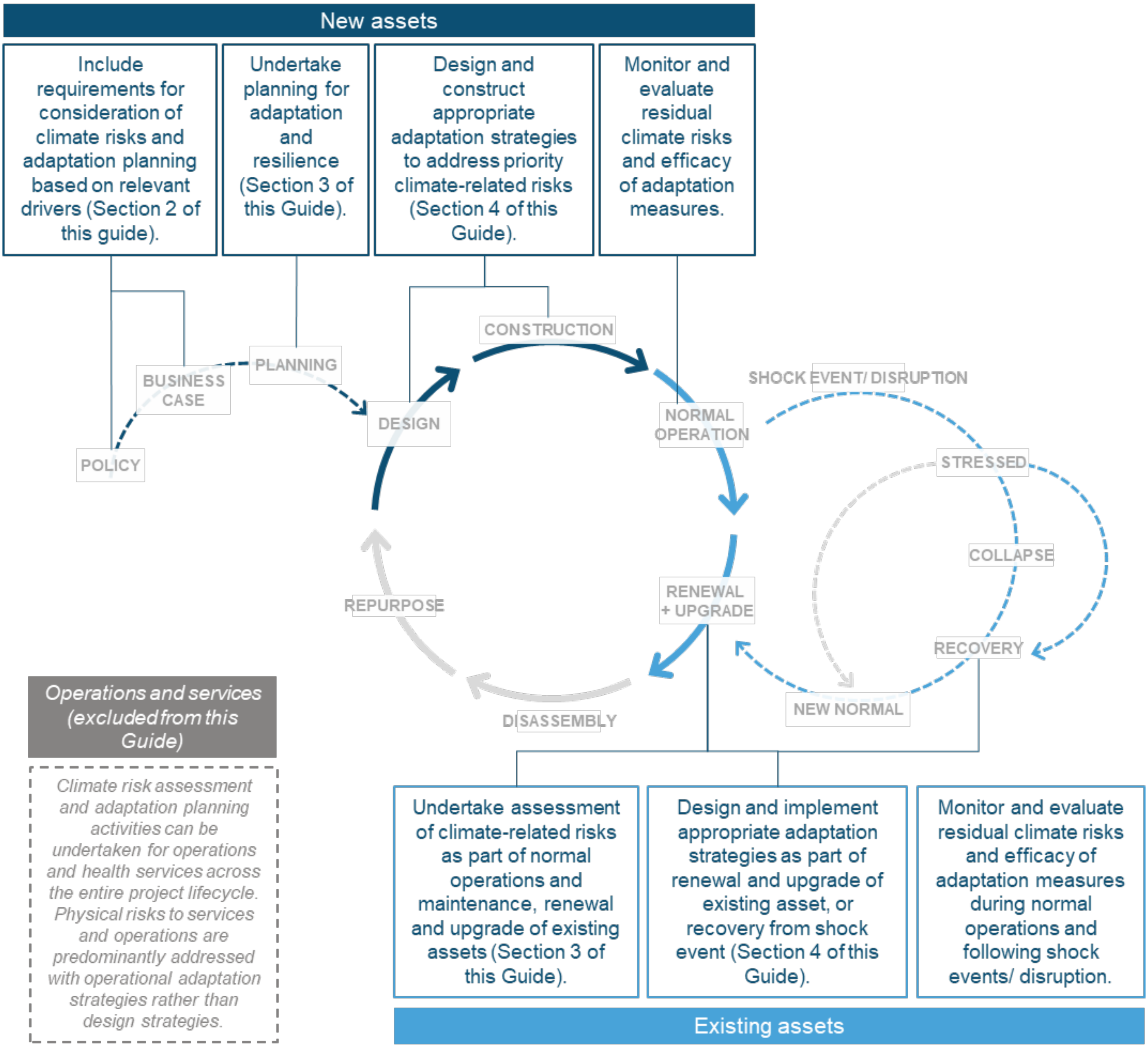
1.4 When to use this guide

For both new and existing health infrastructure assets, climate risk assessment and adaptation planning should be incorporated as soon as possible in the project lifecycle. It should be maintained through all operational phases as part of ongoing risk management and asset management processes.

Figure 4 illustrates climate risk assessment and adaptation planning activities across the asset lifecycle for new and existing health infrastructure assets.

Physical climate risks affecting health services, demand and operational activities may be considered during the operational phases of the project lifecycle and are often managed via operational measures.

Figure 4: When to undertake climate risk assessment and adaptation planning in the project lifecycle for new and existing assets



1.5 Exclusions and limitations

This *Climate resilience and adaptation guide* includes the following limitations and exclusions:

- Sections 3 and 4 of this guide focus on physical climate-related risks for health infrastructure assets. Physical risks to health services, supply chains, community health and demand have not been included in the scope of this guide. Also, transition risks primarily sit at the enterprise level and beyond and have therefore been excluded from this guide.
- Adaptation strategies presented in this guide for new and existing health infrastructure assets are planning and design measures only. In addition to planning and design adaptation measures, climate-related risks can be managed/mitigated through implementing operational measures. These have not been considered as part of this guide.
- Securing funding and financing for climate resilience and adaptation investments was identified as a key barrier to implementation during stakeholder engagement activities as part of developing this guide. This has been excluded from the scope of this guide but is an important consideration during the policy and business case phases of the project lifecycle.
- This guide focuses on climate resilience and adaptation only. Resilience to wider shocks and stresses, including population growth, economic shocks and pandemic diseases, are excluded from this guide.

2. Reasons for climate resilience and adaptation

2.1 Drivers and benefits

Climate change risk assessments and adaptation planning should be undertaken for all new and existing assets, however individual assets may be subject to specific internal and/or external drivers. Understanding the relevant drivers for undertaking a climate risk assessment for new or existing health infrastructure assets can inform the assessment scope and time horizon, relevant stakeholders and reporting requirements.

The primary motivations for undertaking climate risk assessment and adaptation planning include:

- **Legislative and policy drivers:** Health infrastructure projects are often governed by a multitude of legislative and policy frameworks at the national, state and sector-specific levels. These projects may need to comply with a range of international and local standards to ensure safety, sustainability and resilience. Key standards may include AS5334: 2013 *Climate change adaptation for settlements and infrastructure – A risk-based approach*, ISO14090 and ISO14091 series, ISO31000: 2018 *Risk management.* Legislative drivers across Australia and New Zealand are summarised in Appendix 1.
- **Market trend drivers:** In response to growing environmental concerns and market demands, major health infrastructure projects increasingly aim for certification against recognised sustainability rating schemes including Green Star Buildings and Communities and Infrastructure Sustainability (IS) Rating Scheme or are subject to internal sustainability requirements.
- **Emerging disclosure reporting:** Health infrastructure projects are increasingly required to align with emerging reporting and disclosure standards. These standards ensure transparency, accountability and sustainability in project development and operations. Key standards include International Sustainability Standards Board (ISSB) Sustainability Disclosure Standards, Australian Accounting Standards Board (AASB) Australian Sustainability Reporting Standards, and Aotearoa New Zealand Climate Standards (NZ CS1-3).
- **Increasing frequency and severity of climate-related hazards:** Health infrastructure projects must account for the growing frequency and severity of climate-related hazards. These hazards pose significant risks to the resilience and functionality of infrastructure, which may result in:
  - impacts on the integrity of infrastructure and therefore maintenance and repairs
  - service disruption
  - health and safety risks
  - cascading impacts across interdependent infrastructure and systems.
- **High cost of inaction:** Failing to address the increasing frequency and severity of climate-related hazards in health infrastructure projects can lead to significant financial, operational and societal costs. These include:
  - increased incidence and cost of damage and repair over the long term
  - operational downtime and disruption to service delivery
  - increased operational and maintenance costs including financial loss form supply chain disruption.
- **Health, safety and wellbeing:** The health, safety and wellbeing of patients, staff and the broader community are paramount considerations in health infrastructure projects in the context of a changing climate. Key drivers include:
  - ensuring health facilities are designed and built to withstand climate-related hazards to protect the physical safety of patients and staff
  - ensuring the service continuity and accessibility of health services during and after climate-related events
  - recognising increased hospital admissions associated with extreme weather events

- impacts on human health creating increased demand for existing services and demand for new services.

3. Planning for adaptation and resilience

3.1 Scoping and context

Defining the asset scope and boundary

Defining the asset scope and assessment boundary should take place at the outset of climate risk assessment and adaptation planning for new and existing infrastructure assets. This helps to determine the climate resilience objectives for the asset, identify the physical site asset components to be assessed, consider asset interdependencies and establish appropriate time horizons and climate change scenarios for assessment.

A climate risk assessment should account for risks over time, so time horizons should reflect the design lives of the infrastructure asset components. Typically, this will include a short-term horizon to cover the construction period and assets with shorter operating lives, along with a longer-term horizon (for example, 2070 or 2090) to guide the design of 'fixed' asset components with longer operating lives.

Key questions for defining the scope and boundary

Define climate resilience objectives

- What are the drivers for undertaking this climate risk assessment and adaptation planning process?
- What are the minimum performance requirements that must be met for the asset? Is there an established risk appetite for the asset?
- Has the (existing) asset already been impacted by the effects of climate change? How has this been managed to date?
- How can the asset support broader climate resilience in the surrounding community and interdependent systems?

Identify asset location, asset components and interdependencies

- What is the physical location of the new/existing asset?
- What are the asset components within the asset boundary? What is excluded?
  Example asset components are included in Appendix 2. A more detailed list of components is available on the AusHFG website.
- What is the expected life (in years) of each asset component?
- What are the key interdependencies with infrastructure systems outside of the asset boundary, such as energy, communications, transport, waste and water infrastructure?

Determine time horizons and climate change scenarios

- What time horizons will be used in the risk assessment?
  As a minimum, this should include a short-term time horizon and a medium or long-term time horizon which covers the longest expected life of defined asset components. For example, if the longest asset life is 50 years, 2070 or 2090 should be adopted as long-term time horizons.
- Which climate change scenarios will be adopted?
  For high-level assessment, it is recommended to consider the future climate change with greatest plausible change (for example, RCP8.5 or SSP5-8.5). Best available climate data should be used for each jurisdiction.

Identifying relevant stakeholders

Engaging internal and external stakeholders is a crucial aspect of identifying, prioritising and addressing climate risks for health infrastructure assets to understand context-specific vulnerabilities, validate priority risks, and generate buy-in for the implementation and management of adaptation measures. Stakeholder identification should consider the diversity of perspectives and experience (for example, staff, patients and community, local governments, asset management), representativeness, technical expertise, level of influence and proximity/vulnerability to potential risks.

Stakeholder engagement should occur at every stage of the climate change risk assessment process. However, when setting timeframes, it is essential to assess the capacity of partners and stakeholders to effectively participate in the engagement process. Also, maintaining flexibility in timeframes is vital to accommodate unexpected circumstances.

Table 2 outlines several prompts to support planning of stakeholder engagement activities.

Table 2: Prompts to support planning of stakeholder engagement activities

CONSIDERATION	PROMPTS
Purpose	• *Define the overarching objectives of stakeholder engagement*: What is the purpose of the engagement?

CONSIDERATION	PROMPTS
	• *Clarify how stakeholder input will inform decision-making processes*: How will stakeholder perspectives be integrated into planning and implementation strategies? • *Identify key areas where stakeholder engagement is essential*: Which aspects of the project need input from diverse stakeholders?
People	• *Identify relevant stakeholders*: Who are the people or groups that have a vested interest in or will be affected by the project? • *Determine the roles and responsibilities of stakeholders*: What specific contributions are expected from each stakeholder group? • *Establish communication channels*: How will stakeholders be engaged and kept informed throughout the process?
Timing	• *Determine the appropriate timing for stakeholder engagement activities*: When will stakeholder engagement activities take place in the project? • *Consider the duration and frequency of engagement activities:* How often should stakeholders be consulted or involved in the process? Will engagement be ongoing? • *Anticipate potential challenges or constraints related to timing*: Are there any external factors or deadlines that may influence the timing of engagement activities?

3.2 Climate hazard analysis

Identifying hazards

For each health infrastructure asset, conduct a hazard screening to determine relevant climate-related hazards to include in the risk assessment.

Common hazard screening questions include:

- Is the project located in a cyclone zone?
- Is the project located in or adjacent to a bushfire-prone zone?
- Is the project located in or adjacent to a flood-prone zone?
- Is the project located at or adjacent to a coastline or a tidally influenced waterway?
- Is the project located in an area that experiences extreme heat?
- What climatic hazards have occurred in the past in your project area?

Figure 5 provides a high-level overview of the climate-related hazards relevant for each jurisdiction in Australia and New Zealand. Most regions are already facing existing climate-related hazards. The impacts of these may be intensified and exacerbated by climate change. The hazard screening will help in choosing the most relevant climate variables for your risk assessment, which are summarised in Table 3.

Figure 5: Climate hazards for each jurisdiction across Australia and New Zealand

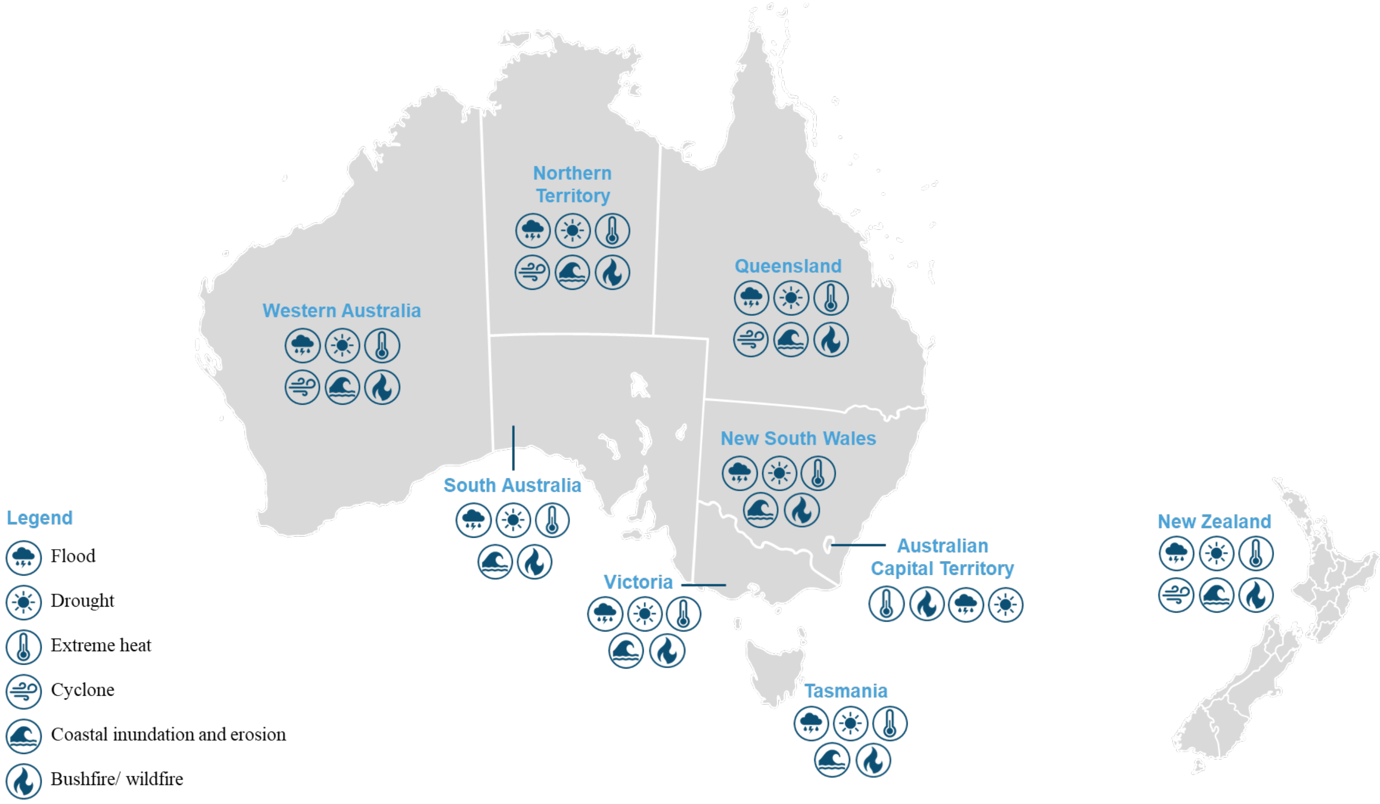


Table 3: Summary of climatic hazards and associated climate variables

CLIMATIC HAZARDS	CLIMATE VARIABLE
Flood	Rainfall intensity
Drought	Average annual rainfall, soil moisture, evapotranspiration
Extreme heat, extreme cold	Mean temperature, number of hot days, number of cold days, solar radiation, heatwaves – number, duration, amplitude, cumulative days
Cyclone	Wind speed
Coastal inundation and erosion	Sea level
Bushfire	Temperature, rainfall, wind speed, humidity

A climate risk assessment may be combined with a natural hazard risk assessment to include other geophysical hazards such as landslides, earthquakes and tsunamis.

Understanding baseline and future climate hazard exposure

To understand baseline and future exposure to climate hazards, it is useful to collate best available data on historical climate and climate change projections for relevant climate variables from Table 3. This will further clarify which hazards are most relevant for the project site and may inform site selection and land acquisition.

Historical data provides a baseline against which change can be measured, and should be collated from:

- nearby weather stations with long-term meteorological records
- satellite observations.

When identifying historical weather and climate hazards, be specific about hazard thresholds associated with impacts such as temperatures over 45ºC or wind gusts above 30 m/s. Average and extreme values should be considered for all hazards, where available. To identify relevant hazard thresholds, it may be useful to engage/consult a climate risk specialist.

Climate change projections provide an understanding of how the climate may change in the future. Quantitative data and qualitative insights should be collated for relevant climate variables to describe potential changes in climate hazards over the asset life. Understanding the historical impacts of climate variables (for example, temperature, precipitation, sea level) and projected changes (decrease, increase or no change) over the selected time horizons (for example, near- to mid-term, long term) helps to inform the most relevant hazards for consideration in adaptation planning.

Understanding climate change projections

Climate change projections illustrate plausible future climate conditions under different levels of greenhouse gas emissions and help us to understand potential changes in climate variables such as average annual rainfall or number of days of extreme heat.

The Intergovernmental Panel on Climate Change (IPCC), a leading authority on climate science, has created several sets of these scenarios. For example, in their *Fifth assessment report*, they used scenarios called representative concentration pathways (RCPs). Each RCP is named after the amount of extra energy (or radiative forcing) trapped in the Earth's atmosphere by 2100, measured in watts per square metre (W/m^2). For instance, RCP8.5 represents a scenario where the extra energy is 8.5 W/m^2 by 2100, indicating a high level of emissions and significant global warming. These scenarios were based on the Coupled Model Intercomparison Project Phase 5 (CMIP5).

In their more recent Sixth Assessment Report, the IPCC introduced a new set of scenarios called shared socioeconomic pathways. These new scenarios are based on updated climate models (CMIP6) and consider different socioeconomic futures. Climate change projections for these new scenarios have not yet been downscaled for all states, territories and regions in Australia and New Zealand.

A range of emissions scenarios and climate models should be used to assess climate-related risks and must at least include the worst-case scenario of RCP8.5.

A hazard exposure assessment should be undertaken to identify the extent to which assets are exposed to each climate hazard across selected time horizons. This should be based on available hazard maps and modelling from local government authorities – for example, flood data and maps and bushfire hazard mapping. Any existing hazard mapping/modelling should be reviewed to confirm whether it represents a baseline or future exposure based on climate change projections. Where existing maps are unavailable, additional hazard and exposure mapping should be undertaken for priority climate hazards.

Useful sources to inform a hazard exposure assessment include:

- Bureau of Meteorology Climate Data Online portal and State of the Climate report
- CSIRO Climate Change in Australia and National Institute of Water and Atmospheric Research climate change projections
- Geosciences Australia specialist data sources – for example, Tropical Cyclone Risk Model, ShakeMap.
- CoastAdapt or Coastal Risk Australia for coastal-related hazards
- Climate Council Climate Risk Map of Australia
- State-level sources – for example, AdaptNSW, Queensland Future Climate Dashboard, Victoria Future Climate Tool

- Previous natural hazard or disaster risk studies for locality, including regional/local climate adaptation plans.

Links to information sources and support tools are provided in section 4.3 of this guide.

Picture for illustrative purposes only

Case study: Embedding climate risk into property acquisition

The Victorian Health Building Authority (VHBA) follows a 3-stage process for property acquisition, involving identification, investigation and acquisition. VHBA undertook a project to embed climate risk into the investigation stage to systematically assess long-term climate risks that could potentially affect the asset to be built. The major climate risks that were prioritised for assessment were bushfire, flooding, extreme heat, sea level rise and coastal erosion where relevant.

This case study is detailed in Appendix 3.

3.3 Vulnerability assessment

Criticality and vulnerability of health infrastructure assets

Asset/component criticality and vulnerability are important considerations in prioritising climate-related risks and adaptation strategies for health infrastructure. Both concepts lead to a better understanding of the potential consequences that a climate-related failure may cause, encompassing both physical impacts on assets/components and broader impacts on service delivery and asset users.

Criticality refers to the degree of significance that an asset/component has within a wider system due to the type and scale of services or functionality it provides (Barandiarán, et al, 2019). The following questions may help to determine the level of criticality of an asset or system component:

- How vital is the asset/component to ongoing health infrastructure operations?
- If the asset/component fails, is there a potential for loss of life?
- Are there any backup systems or redundancy measures in place if the asset/component fails?
- If the asset fails, what is the cost of replacement? What is the potential duration of downtime associated with this failure?
- Are there any regulatory standards or compliance requirements specific to this asset/component?
- Does the asset/component support critical interdependent infrastructure systems?

Vulnerability refers to the degree to which a component or system is susceptible to, or unable to cope with, adverse effects of climate change hazards (IPCC, 2021). The following questions should be considered to assess vulnerability:

- Has the asset/component been affected by a climate hazard in the past? If so, what were the associated costs of damage and downtime?
- What dependencies does this asset/component have on other systems or infrastructure?
- What is the age and condition of the asset/component?

Assets/components with high criticality and vulnerability should be prioritised in a climate risk assessment for effective risk treatment via adaptation planning.

3.4 Risk identification

Climate change presents diverse physical risks for health infrastructure assets. Table 4 presents a range of risk impacts for new and existing health infrastructure assets, organised by climate hazards and area of impact. These impacts will be site-specific and may not be relevant to every jurisdiction or asset. It is important that these risks are reviewed with multidisciplinary stakeholder input to ensure relevant risks are identified for further assessment.

User notes

Table 4 can be filtered from left to right, based on relevant climate hazards identified during the hazard exposure assessment then areas of impact within the defined project scope and boundary. Areas of impact containing assets/components with high vulnerability and/or criticality must be included.

Table 4: Climate-related physical risks for health infrastructure assets

CLIMATE HAZARD	AREA OF IMPACT	CLIMATE-RELATED PHYSICAL RISK IMPACT
Changes in temperature including extreme heat	External building structure	• Greater instances of superficial peeling, cracking and corrosion to facades including glazing and cladding, structures and surfaces • Greater instances of material degradation to facades, structures and surfaces
	Internal assets (mechanical, electric)	• Increased energy and water demand across the site • Higher frequency heating, ventilation and air conditioning (HVAC) system replacement requirements • Increased need to cool buildings or work sites • Increased stress on vital equipment and services (for example, elevators and plant) leading to greater response demands
	Interdependent infrastructure	• Deterioration of utilities (such as telecommunications and energy network) or increased incidence of blackouts/brownouts due to heat • Need for increased waste disposal or storage due to risk of pest, disease or nuisance risk with warmer conditions • Impact to quality of water supply, with increased contamination and algae blooms • Impacts on landscaping and plantings, including loss of biodiversity and ecosystem function • Higher evaporation rates of water storage sites • Greater failure of transport infrastructure, making it difficult for staff and patients to access services
	Building users and occupants	• Impacts on the thermal performance levels of buildings leading to reduced comfort levels for building occupants (patients, staff, visitors) • Unsafe working conditions due to extreme heat, with increased heat stress • An exacerbation of urban heat island effects affecting comfort and amenity • Health outcomes for vulnerable patients (for example, cardiovascular and respiratory conditions) compromised by exposure to hotter conditions • Increase in respiratory-related illnesses due to increased pollution (for example, dust in dry conditions) • Increased occupancy or load on services with extreme events • Staff unable to travel to work due to failure of support services – for example, road closures and transportation failure • Increased incidence of complaints and/or antisocial behaviour • Increased demand for outdoor respite and refuge areas resulting in insufficient capacity • Increased demand on the building as a potential area of respite

CLIMATE HAZARD	AREA OF IMPACT	CLIMATE-RELATED PHYSICAL RISK IMPACT
		• Reduced accessibility to external wellness and recovery spaces
Bushfire	External building structure	• An accumulation of ash in roof drainage • Full or partial fire damage to buildings and public spaces
	Internal assets (mechanical, electric)	• Reduced air quality within internal areas • Smoke and embers affecting the ventilation and air-conditioning systems • Internal smoke damage as a result of unsealed areas
	Interdependent infrastructure	• Damage to infrastructure and assets that deliver public services (for example, buildings, telecommunications) • Impacts on landscaping and plantings, including loss of biodiversity and ecosystem function • Higher evaporation rates of water storage sites • Greater failure of transport infrastructure, making it difficult for staff and patients to access services • Higher levels of water contamination (for example, ash or fire retardant entering waterways) • Interrupted access to site due to road closures
	Building users and occupants	• Health outcomes for vulnerable patients (for example, heart and respiratory conditions) compromised by exposure to hotter conditions • Increase in respiratory related illnesses due to increased pollution (for example, increased smoke from bushfires) • Increased occupancy or load on services with extreme events • Staff unable to travel to work due to failure of support services – for example, road closures and transportation failure • Increased demand on the building as a designated 'safer place' or evacuation centre • Increased demand on emergency services and health services, including increased hospital presentations • Patient clinical needs not met
Flooding	External building structure	• Full or partial flood damage to buildings and public spaces • Increased levels of rain/moisture penetration in the building and facades affecting durability and functionality • Greater strain on drainage systems • Floodwater intrusion increasing degradation of building materials (for example, foundations)
	Internal assets (mechanical, electric)	• Higher frequency HVAC system repair/replacement requirements • Internal flood damage as a result of unsealed areas • Damage to underground services (for example, plant machinery, car parking) during flooding requires more frequent repair or replacement

CLIMATE HAZARD	AREA OF IMPACT	CLIMATE-RELATED PHYSICAL RISK IMPACT
		• Damage to ground floor services (for example, plant machinery) during flooding requires more frequent repair or replacement
	Interdependent infrastructure	• Damage to infrastructure and assets (for example, buildings, telecommunications) • Impact to water quality and water supply with contamination • Greater failure of transport infrastructure, making it difficult for staff and patients to access services • Sewerage services can be disrupted if sewerage pipes are compromised during flooding (for example, sewerage back flow) • Interrupted access to site due to road closures
	Building users and occupants	• Increased occupancy or load on services with extreme events • Ponding of water can increase disease risks, particularly from vector-borne diseases and impact on vulnerable building users • Staff unable to travel to work due to failure of support services – for example, road closures and transportation failure • Increased demand on the building as a designated 'safer place' or evacuation centre • Increased demand on emergency services and health services, including increased hospital presentations • Patient clinical needs not met
Drought	External building structure	• Degraded building foundations and other below-ground infrastructure (for example, wiring) as a result of decreased soil moisture
	Internal assets (mechanical, electric)	• Degraded integrity of building materials (for example, adhesives, wiring) as a result of warmer and drier conditions
	Interdependent infrastructure	• Damage to infrastructure and assets (for example, buildings, telecommunications) • Reduced access to water leading to potential restrictions, particularly affecting irrigation • Higher levels of water contamination and algae
	Building users and occupants	• Increased occupancy or load on services with extreme events
Extreme storms and cyclones (including dust and sand)	External building structure	• Increased storm and hail damage to building structure and facade • Increased levels of rain/moisture penetration • Structural damage due to greater wind load being exerted on assets • Greater strain or loss on building fixtures, fittings and fastenings • Damage from unsecured debris

CLIMATE HAZARD	AREA OF IMPACT	CLIMATE-RELATED PHYSICAL RISK IMPACT
	Internal assets (mechanical, electric)	• Increased levels of rain/moisture penetration into buildings and assets • Reduced air quality within internal areas • Dust and sand affecting ventilation and air-conditioning systems • Internal wind/rain/dust/sand damage as a result of unsealed areas
	Interdependent infrastructure	• Impact to water quality and water supply • Interruption to power supply and communications • Impacts on the transport network reducing accessibility • Sewerage services can be disrupted if sewerage pipes are compromised during flooding
	Building users and occupants	• Increased occupancy or load on services with extreme events • Staff unable to travel to work due to failure of support services – for example, road closures and transportation failure • Impacts on the spread of water-borne diseases and distribution of pest species affecting vulnerable users • Increased incidence of hospital presentations including mental health and emergency department presentations • Increased safety issues for patients, visitors and staff (including operations and maintenance staff) • Increased demand on the building as a place of refuge and/or as a designated evacuation centre
Humidity	External building structure	• Accelerated carbonation of concrete structures, which decreases the durability of concrete structures • Greater instances of material degradation to facades, structures, and surfaces
	Internal assets (mechanical, electric)	• Build-up of mould and condensation leading to increased operations and maintenance requirements and costs • Increased energy demand across the site • Internal moisture damage as a result of unsealed areas and air leaks
	Interdependent infrastructure	• Interruption to power supply and communications • Impacts on the transport network reducing accessibility to buildings
	Building users and occupants	• Increased occupancy or load on services with extreme events • Changes in relative humidity resulting in decreasing thermal comfort resulting in health impacts or decreased productivity • Impacts on the spread of water-borne diseases and distribution of pest species affecting vulnerable users
	External building structure	• Drainage capacity issues for buildings and hard landscaping

CLIMATE HAZARD	AREA OF IMPACT	CLIMATE-RELATED PHYSICAL RISK IMPACT
Coastal inundation and erosion		• Corrosion of exterior infrastructure from salt spray (for example, concrete) • Saltwater intrusion, contaminating water sources, increasing degradation of building materials (for example, foundations) • More frequent and higher storm surges, including localised flooding causing damage to assets and higher maintenance costs • Increased coastal erosion impacting on building foundations • Drainage capacity issues for buildings and hard landscaping
	Internal assets (mechanical, electric)	• Internal water damage as a result of unsealed areas • Increased levels of moisture penetration • Higher frequency HVAC system repair/replacement requirements
	Interdependent infrastructure	• Damage to infrastructure and assets (for example, buildings, telecommunications) • Sewerage services can be disrupted if sewerage pipes are compromised during coastal inundation • Impact to water quality and water supply with contamination of salt water • Greater failure of transport infrastructure, making it difficult for staff and patients to access services
	Building users and occupants	• Increased occupancy or load on services with extreme events • Staff unable to travel to work due to failure of support services – for example, road closures and transportation failure • Increased demand on the building as a designated 'safer place' or evacuation centre • Patient clinical needs not met

3.5 Risk analysis

Qualitative risk assessment

Once risks have been identified based on the relevant hazards and asset components, risks analysis is conducted to qualitatively assess the likelihood and consequence levels for each risk impact. This produces a qualitative risk level based on a risk rating matrix. This assessment can be done in line with established criteria matrices such as those provided in AS5334:2013 (refer to Figures 6, 7 and 8) or can be harmonised with existing risk management frameworks (organisational or jurisdictional).

Figure 6: Example risk rating matrix from AS5334:2013

EXAMPLE OF A RISK RATING MATRIX

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	L	M	H	E	E
Likely	L	M	M	H	E
Moderate	L	L	M	H	E
Unlikely	L	L	M	M	H
Very unlikely	L	L	L	M	M

LEGEND:

E = Extreme risk, requiring immediate action.

H = High risk issue requiring detailed research and planning at senior management level.

M = Moderate risk issue requiring change to design standards and maintenance of assets.

L = Low risk issue requiring action through routine maintenance of assets.

Figure 7: Example likelihood criteria matrix from AS5334:2013

EXAMPLE OF QUALITATIVE MEASURES OF LIKELIHOOD

Rating	Descriptor	Recurrent or event risks	Long term risks
Almost certain	Could occur several times per year	Has happened several times in the past year and in each of the previous 5 years *or* Could occur several times per year	Has a greater than 90% chance of occurring in the identified time period if the risk is not mitigated
Likely	May arise about once per year	Has happened at least once in the past year and in each of the previous 5 years *or* May arise about once per year	Has a 60–90% chance of occurring in the identified time period if the risk is not mitigated
Possible	Maybe a couple of times in a generation	Has happened during the past 5 years but not in every year *or* May arise once in 25 years	Has a 40–60% chance of occurring in the identified time period if the risk is not mitigated
Unlikely	Maybe once in a generation	May have occurred once in the last 5 years *or* May arise once in 25 to 50 years	Has a 10–30% chance of occurring in the future if the risk is not mitigated
Rare	Maybe once in a lifetime	Has not occurred in the past 5 years *or* Unlikely during the next 50 years	May occur in exceptional circumstances, i.e. less than 10% chance of occurring in the identified time period if the risk is not mitigated

Figure 8: Example consequence criteria matrix from AS5334:2013

Consequence descriptor	Adaptive capacity	Infrastructure, service	Social/cultural	Governance	Financial	Environmental	Economy
Insignificant	No change to the adaptive capacity	No infrastructure damage, little change to service	No adverse human health effects	No changes to management required	Little financial loss or increase in operating expenses	No adverse effects on natural environment	No effects on the broader economy
Minor	Minor decrease to the adaptive capacity of the asset. Capacity easily restored	Localized infrastructure service disruption No permanent damage. Some minor restoration work required Early renewal of infrastructure by 10–20% Need for new/modified ancillary equipment	Short-term disruption to employees, customers or neighbours Slight adverse human health effects or general amenity issues	General concern raised by regulators requiring response action	Additional operational costs Financial loss small, <10%	Minimal effects on the natural environment	Minor effect on the broader economy due to disruption of service provided by the asset
Moderate	Some change in adaptive capacity. Renewal or repair may need new design to improve adaptive capacity	Limited infrastructure damage and loss of service Damage recoverable by maintenance and minor repair Early renewal of infrastructure by 20–50%	Frequent disruptions to employees, customers or neighbours. Adverse human health effects	Investigation by regulators Changes to management actions required	Moderate financial loss 10–50%	Some damage to the environment, including local ecosystems. Some remedial action may be required	High impact on the local economy, with some effect on the wider economy
Major	Major loss in adaptive capacity. Renewal or repair would need new design to improve adaptive capacity	Extensive infrastructure damage requiring major repair Major loss of infrastructure service Early renewal of infrastructure by 50–90%	Permanent physical injuries and fatalities may occur Severe disruptions to employees, customers or neighbors	Notices issued by regulators for corrective actions Changes required in management. Senior management responsibility questionable	Major financial loss 50–90%	Significant effect on the environment and local ecosystems. Remedial action likely to be required	Serious effect on the local economy spreading to the wider economy
Catastrophic	Capacity destroyed, redesign required when repairing or renewing asset	Significant permanent damage and/or complete loss of the infrastructure and the infrastructure service	Severe adverse human health effects, leading to multiple events of total disability or fatalities	Major policy shifts Change to legislative requirements Full change of management control	Extreme financial loss >90%	Very significant loss to the environment. May include localized loss of species, habitats or ecosystems	Major effect on the local, regional and state economies
		Loss of infrastructure support and translocation of service to other sites Early renewal of infrastructure by >90%	Total disruptions to employees, customers or neighbours Emergency response at a major level			Extensive remedial action essential to prevent further degradation. Restoration likely to be required	


Picture for illustrative purposes only

Case study: Climate risk assessment of existing hospitals

The Victorian Department of Health assessed climate hazard risks to 6 regional hospitals across Victoria. The project analysed their exposure to flooding, extreme heat, grassfire and bushfire.

The climate risk assessment was informed by desktop analysis, engagement with key stakeholders and site visits to identify and validate risks and opportunities. This informed adaptation planning to increase the resilience of infrastructure and services.

This case study is detailed in Appendix 3.

Quantitative risk assessment

More complex quantitative analysis and modelling may be needed to inform a cost-benefit analysis and to support decision-makers to prioritise adaptation investments. These assessments involve estimating the direct risks in terms of financial loss from asset damage, downtime and/or life safety risk, in addition to indirect risks such as economic costs of downtime and community impacts. Quantitative risk assessments should be conducted by suitably qualified climate risk professionals.

3.6 Risk evaluation

Risk evaluation is based on the outcomes of the risk analysis stage and involves comparing the determined risk levels with established risk criteria to prioritise risks for treatment. Risk criteria (typically established at the enterprise level in a risk appetite statement or per industry standards) defines acceptability levels – that is, what levels of risk are acceptable, tolerable or unacceptable. Acceptability levels may relate to overall risk levels (for example, medium, high) or consequence levels across different areas of impact (for example, moderate human health consequence, major financial consequence). High-priority risks are those that exceed the acceptable risk threshold and require treatment via adaptation planning.

Stakeholder engagement is crucial to confirm the outcomes of the risk analysis (risk levels based on assessment of consequence and likelihood) and the priority risks for treatment in line with established risk criteria and the organisation's risk appetite.

4. Technical considerations

4.1 Adaptation measures for new and existing assets

Once risks have been identified and assessed for new and existing health infrastructure assets, risk treatments can be selected to reduce overall levels of hazard exposure or asset/system vulnerability. Risk treatments, known as adaptation measures, may be design interventions or operational controls. These can be implemented across the asset lifecycle from early site planning to design and construction, to operations and maintenance. This guide focuses on design strategies for health infrastructure assets.

Table 5 gives an overview of adaptation measures for site planning, landscape design, resilient utilities and building asset design for existing and new health infrastructure assets. These are organised by climate hazard to build on risks identified in section 3 of this guide.

The applicability and relevance of each of these adaptation measures will depend on site-specific factors such as climate context, building age, level of required service, surrounding infrastructure and community profile. It is expected that design of these adaptation measures will be underpinned by site-specific hazard modelling including hydrological studies, wind modelling and urban heat island studies, where relevant based on hazard exposure assessment.

Furthermore, given that a number of variables (for example, site location, hazard exposure, asset/component vulnerability) will determine the level of adaptation needed for each site, specific adaptation measures have not been included in Table 5. It should not be considered an exhaustive list. Instead, it provides suggestive ideas and different levels of risk treatments, such as avoid, reduce, or transfer, that should be considered in the adaptation process.

Table 5: Design adaptation measures for new and existing health infrastructure assets

CLIMATE HAZARD	AREA OF IMPACT	ADAPTATION MEASURES (NEW AND EXISTING ASSETS)	ADDITIONAL ADAPTATION MEASURES (NEW ASSETS ONLY)
Changes in temperature including extreme heat	Site planning	• Consider developing havens within the hospital that have optimised air filtration, cooling and building services for the most at-risk patients. Identify cooler 'refuge' rooms if needed. • Develop adequate facilities and arrangements such as onsite accommodation for staff during climatic events to increase staff availability. • Consider extra storage and reuse of runoff to use stormwater during dry periods.	• Orientate building for passive design.
	Landscape design	• Plant bushfire-protective vegetation around the hospital building to provide shade and reduce temperatures on external facades. • Provide for natural shade through landscape design. • Incorporate blue and green infrastructure to ameliorate urban heat island effects including green walls and roofs, trees and water elements. • Include areas of respite including drinking fountains and connections to blue and green infrastructure.	
	Resilient utilities	• Install alternative energy sources (for example, solar panels) to provide backup and cost savings (via micro-grid/island mode). • Install supplementary power generation (and battery storage capability) that can be used as backup or primary supply where there is enough power for export. • Review telecommunications and consider if alternative channels are needed as backup during outages. • Introduce internal electrical load shedding capability in the building management system to turn off non-essential equipment when needed to ration power to critical equipment.	

CLIMATE HAZARD	AREA OF IMPACT	ADAPTATION MEASURES (NEW AND EXISTING ASSETS)	ADDITIONAL ADAPTATION MEASURES (NEW ASSETS ONLY)
	Building asset design (structures, mechanical and electrical components)	• Design the materiality of outdoor areas and facades to reduce ambient air temperatures. • Relocate HVAC systems into optimal spaces for efficiency (for example, well-ventilated shaded areas or within buildings). • Increase the efficiency or capacity of HVAC systems to align with future temperature profiles and demand control ventilation per AS1668.2. • Include strategies to reduce operational energy such as installing a building management system for efficient control of energy.	• Select roof, wall and floors materials for increased durability to extreme temperatures (for example, UV-stable materials). • Integrate passive design for maintaining comfortable temperatures by including thermal insulation in the walls and ceilings, double glazing of all windows, shade windows, reflective surfaces and sealing of building cracks. • Increase passive or natural ventilation where possible.
Bushfire	Site planning	• Maintain fire protection zones as per fire authority defensible space guidelines. • Allow for extra onsite water storage and treatment. • Consider developing havens within the hospital that have optimised air filtration and building services for the most at-risk patients. • Install a fire sprinkler system to provide active fire protection for the building. • Develop adequate facilities and arrangements such as onsite accommodation for staff during climatic events to increase staff availability. • Consider extra storage and reuse of runoff to use stormwater during dry periods.	• Avoid proximity to bushfire-prone areas. • Orient buildings to minimise exposure to prevailing winds and potential fire spread.
	Landscape design	• Use fire-resistant landscaping around buildings, including gravel or stone mulch, and low-flammability plants. • Create defensible space by maintaining a buffer zone.	
	Resilient utilities	• Install supplementary power generation (and battery storage capability) that can be used as backup or primary supply where there is enough power for export. • Review telecommunications and consider if alternative channels are needed as backup during outages.	• Incorporate underground cabling where possible including power and communications. • Ensure external gas pipes and fittings above ground are of steel or copper construction having a minimum wall thickness in line with gas regulations or 0.9 mm, whichever is the greater. The metal pipe

CLIMATE HAZARD	AREA OF IMPACT	ADAPTATION MEASURES (NEW AND EXISTING ASSETS)	ADDITIONAL ADAPTATION MEASURES (NEW ASSETS ONLY)
		• Introduce internal electrical load shedding capability in the building management system to turn off non-essential equipment when needed to ration power to critical equipment.	should extend a minimum of 400 mm within the building and 100 mm below ground. • Introduce onsite tertiary water treatment or filtration capabilities.
	Building asset design (structures, materials, mechanical and electrical components)	• Seal gaps and openings to prevent ember entry into the building, including around doors, windows, vents and eaves. • Install tempered or double-pane windows with metal frames to improve resistance to radiant heat. • Use fire-rated doors and shutters to protect openings and prevent fire penetration. • Consider ember protection, such as installing roof sprinklers, to protect from ember attack or sparking on the roof. This should include ember guards on any roof ventilation. • Progressively replace external timber features and shade structures (eaves, fascia, panels, verandas, decking) with non-combustible materials when assets are renewed. • Install gutters and valley gutters or leaf guards of a non-combustible material. • Review the HVAC design to develop optimum means of recirculating and cleansing air to avoid bringing particulates in from outdoors. • Promote natural ventilation with a mechanism to adjust for smoke levels.	• Design for a non-combustible facade (balance facade measures with building performance, commensurate with fire risk). Use fire-resistant materials for exterior walls, roofs and decking such as concrete, brick, metal and fire-rated timber. Avoid flammable materials. • Include spatial provision for temporary high-efficiency filters during bushfire events.
Flooding	Site planning	• Upgrade existing drainage systems (wastewater, stormwater) to account for future increases in rainfall intensity. • Increase the capacity of stormwater management systems by adopting water-sensitive urban design principles such as developing onsite stormwater detention. • Where possible design-built land surfaces to be permeable. • Develop a drainage strategy, considering the implications for surrounding communities and access to the site.	• Avoid proximity to high-risk flood zones adjacent to a floodplain, waterway or coast. • If locating in flood-prone areas is unavoidable, elevate new buildings, infrastructure and equipment above future flood levels to minimise the risk of inundation. • Plan for raised development sites in the future. For example, ensure future additions or replacement structures can be installed above flooding or inundation levels.

CLIMATE HAZARD	AREA OF IMPACT	ADAPTATION MEASURES (NEW AND EXISTING ASSETS)	ADDITIONAL ADAPTATION MEASURES (NEW ASSETS ONLY)
			• Identify any contaminated sites in areas at future flood risk and establish clean-up procedures or implement options that reduce the potential for leakage during flood events. • Develop adequate facilities and arrangements such as onsite accommodation for staff during climatic events to increase staff availability. • Develop an asset-wide drainage strategy with consideration of the implications for neighbouring communities.
	Landscape design	• Build bunds or levies to protect external assets or building structures. • Incorporate water-sensitive urban design infrastructure including porous paving/surface, rainwater tanks, desalination basins and swales. • Optimise green and blue infrastructure elements to enhance stormwater management.	
	Resilient utilities	• Install supplementary power generation (and battery storage capability) that can be used as backup or primary supply where there is enough power for export. • Review telecommunications and consider if alternative channels are needed as backup during outages. • Introduce internal electrical load shedding capability in the building management system to turn off non-essential equipment when needed to ration power to critical equipment. • Introduce onsite tertiary water treatment or filtration capabilities.	• Raise (essential) external services including sewage pumping stations and associated electricity supply to levels above future flood levels, accounting for climate change amplification over the life of the service (100 years +).
	Building asset design (structures, mechanical and electrical components)	• Investigate underground trenching, waterproofing of cables, terminations/connections. • Relocate and raise external switchboards. Location should ensure safe access during intense rainfall events. • Elevate internal power sockets on the ground level.	• Include climate change allowance in flood modelling and design (design for 1% annual exceedance probability + climate change allowance prescribed by Australian Runoff and Rainfall guidelines). • Raise at-risk assets and critical services above future flood levels.

CLIMATE HAZARD	AREA OF IMPACT	ADAPTATION MEASURES (NEW AND EXISTING ASSETS)	ADDITIONAL ADAPTATION MEASURES (NEW ASSETS ONLY)
		• Elevate mechanical and electrical systems, such as HVAC units and electrical panels, to prevent damage from floodwaters.	• Use waterproof materials and sealants in building construction to prevent water infiltration during flooding. • Use durable and flood-resistant building materials in lower floors, such as concrete, brick and metal, that can withstand exposure to water and moisture. • Design structural elements, such as foundations and walls, to resist hydrostatic pressure and buoyancy forces exerted by floodwaters.
Drought	Site planning		• Screen new builds and new build areas for long-term stability. • Ensure foundations are designed to withstand changes in soil moisture content during drought conditions. Use deep foundations or pile systems to reach stable soil layers unaffected by drought-induced subsidence. • Install moisture barriers beneath concrete slabs and foundations to prevent excessive moisture loss and soil shrinkage during drought periods. • Consider extra storage and reuse of runoff, to use stormwater during dry periods – potential grey water and purple pipe systems.
	Landscape design	• Use drought-tolerant plants and landscaping techniques that require minimal irrigation and maintenance. • Design outdoor spaces with permeable paving and rain gardens to capture and infiltrate rainfall, reducing runoff and water demand. • Install rainwater harvesting systems to capture and store rainwater for non-potable uses such as landscape irrigation, toilet flushing and cooling systems.	
	Resilient utilities	• Implement greywater recycling systems to treat and reuse wastewater from sinks, showers and laundry facilities for non-potable purposes. • Increase onsite water treatment and storage capacities.	• Design infrastructure components, such as plumbing systems and water storage facilities, to be resilient to fluctuations in water availability and demand during droughts.

CLIMATE HAZARD	AREA OF IMPACT	ADAPTATION MEASURES (NEW AND EXISTING ASSETS)	ADDITIONAL ADAPTATION MEASURES (NEW ASSETS ONLY)
	Building asset design (structures, mechanical and electrical components)	• Increase water efficiency of fittings, fixtures and services.	
Extreme storms and cyclones	Site planning	• Develop an asset-wide drainage strategy, considering the implications for neighbouring communities. • Where possible, design-built land surfaces to be permeable.	• Choose elevated sites away from coastal zones vulnerable to storm surge. • Optimise site layout and orientate buildings to minimise exposure to prevailing winds. • Develop adequate facilities and arrangements such as onsite accommodation for staff during climatic events to increase staff availability.
	Landscape design	• Secure signage and fixtures to resist extreme storm events. • Choose native or climate-appropriate plants (for example, deep-rooted trees) that are resilient to extreme weather conditions including strong winds, heavy rainfall and salt spray in coastal areas.	• Design landscaping layouts that promote natural windbreaks and shelter belts to reduce wind speed and protect buildings from wind damage. • Use strategic placement of trees and shrubs to create buffer zones and minimise the impact of windborne debris on structures.
	Resilient utilities	• Install supplementary power generation (and battery storage capability) that can be used as backup or primary supply where there is enough power for export. • Review telecommunications and consider if alternative channels are needed as backup during outages. • Introduce internal electrical load shedding capability in the building management system to turn off non-essential equipment when needed to ration power to critical equipment. • Introduce onsite tertiary water treatment or filtration capabilities.	
	Building asset design (structures, mechanical and electrical components)	• Anchor roof structures securely to the building frame to prevent uplift and structural failure during extreme storms, including solar panels. • Seal openings around windows and doors to prevent water infiltration and wind-driven rain.	• Design buildings to meet or exceed local building codes and standards for wind and storm resistance. • Use reinforced concrete or steel frame construction to provide structural integrity and resistance to high winds.

CLIMATE HAZARD	AREA OF IMPACT	ADAPTATION MEASURES (NEW AND EXISTING ASSETS)	ADDITIONAL ADAPTATION MEASURES (NEW ASSETS ONLY)
		• Secure signage and fixtures to resist extreme storm events.	• Select impact-resistant glazing and exterior cladding materials to protect against windborne debris and projectiles. • Include spatial provision for temporary high efficiency filters during dust- and sand-storm events. • Promote natural ventilation with a mechanism to adjust for air-quality levels.
Humidity	Site planning		• Incorporate atriums, courtyards and green spaces to enhance natural ventilation and create inviting and comfortable environments. • Ensure proper grading and drainage around the healthcare facility to prevent water pooling and stagnation, which can contribute to increased humidity levels.
	Landscape design	• Avoid planting dense vegetation close to buildings because it can obstruct airflow and trap moisture against exterior walls, leading to increased humidity levels and potential moisture damage.	
	Building asset design (structures, mechanical and electrical components)	• Ensure proper sealing of windows, doors and penetrations to prevent air leaks and moisture ingress. • Implement zoned HVAC systems to allow for localised temperature and humidity control in different areas of the facility. • Maintain proper grading and drainage around the building to prevent water accumulation and seepage into the foundation. • Application of a protective anti-carbonation coating system to prevent carbonation of concrete.	• Use moisture-resistant materials in the construction of walls, floors and roofs to prevent moisture infiltration from outside. • Install vapor barriers and waterproof membranes to protect building elements from moisture intrusion. • Use insulation materials with low moisture-absorption properties, such as closed-cell foam or mineral wool, to minimise the risk of mould growth and structural damage. • Design HVAC systems with adequate ventilation rates and humidity controls to maintain indoor air quality and comfort.
Coastal inundation and erosion	Site planning	• Implement flood barriers such as levees or seawalls.	• Avoid proximity to coastal flood zones, considering future sea level rise and storm surge. • Raise the build level above projected flood and coastal inundation levels using natural topography or

CLIMATE HAZARD	AREA OF IMPACT	ADAPTATION MEASURES (NEW AND EXISTING ASSETS)	ADDITIONAL ADAPTATION MEASURES (NEW ASSETS ONLY)
			artificial elevation techniques including fill and berms. • Develop adequate facilities and arrangements such as onsite accommodation for staff during climatic events to increase staff availability.
	Landscape design	• Select salt-tolerant plant species for landscaping.	• Use permeable paving materials and green infrastructure features, such as rain gardens and bioswales, to reduce surface runoff and enhance water infiltration during heavy rainfall and storm events.
	Resilient utilities	• Install redundant utility systems, including backup power generators, water storage tanks and communication networks, to ensure continuity of essential services during coastal inundation and power outages. • Elevate critical utility infrastructure, such as electrical substations, generators and water treatment facilities, above projected flood levels to prevent inundation and maintain functionality during coastal flooding events. • Introduce internal electrical load shedding capability in the building management system to turn off non-essential equipment when needed to ration power to critical equipment. • Install supplementary power generation (and battery storage capability) that can be used as backup or primary supply where there is enough power for export.	
	Building asset design (structures, mechanical and electrical components)	• Investigate underground trenching, waterproofing of cables and terminations/connections. • Raise at-risk assets and critical services above future flood levels. • Relocate and raise external switchboards. Location should ensure safe access during intense rainfall events. • Elevate internal power sockets on the ground level.	• Use waterproof materials and sealants in building construction to prevent water infiltration during flooding. • Use durable and flood-resistant building materials, such as concrete, brick and metal, that can withstand exposure to water and moisture. • Design structural elements, such as foundations and walls, to resist hydrostatic pressure and buoyancy forces exerted by floodwaters.

CLIMATE HAZARD	AREA OF IMPACT	ADAPTATION MEASURES (NEW AND EXISTING ASSETS)	ADDITIONAL ADAPTATION MEASURES (NEW ASSETS ONLY)
		• Elevate mechanical and electrical systems, such as HVAC units, electrical panels and generators, to prevent damage from floodwaters.	

4.2 Prioritising and implementing strategies

It is important that adaptation measures are prioritised and adopted based on organisational risk appetite, project-specific objectives and constraints, and consideration of broader sustainability ambitions including decarbonisation, enhancing biodiversity and improving social value for the surrounding communities. Equally, adaptation measures should be prioritised to avoid maladaptation and unintended consequences.

The prioritisation process should be conducted with multidisciplinary stakeholder input, such as in a collaborative workshop environment, and may use decision-support tools such as a multi-criteria analysis or cost-benefit analysis.

Assessing and accepting residual risks

Once priority adaptation measures are identified, undertake a residual risk assessment to determine the efficacy of the measure. This is conducted using the same criteria matrices employed during the initial risk assessment. Multiple adaptation measures may be needed to achieve a tolerable risk level, subject to enterprise risk management frameworks. If residual risks exceed the tolerance level, different organisations may have established processes for communicating and accepting any residual risks. Risk owners and budgets must be identified for all adaptation strategies for implementation.

Monitoring and evaluation

Due to the inherent uncertainty in predicting future climate patterns and human behaviour, the impacts of climate change are likely to vary over time. Therefore, effective monitoring and evaluation are critical components of climate adaptation planning to ensure ongoing relevance and effectiveness in addressing climate change risks. A monitoring and evaluation process should be established to outline activities, performance review and reporting requirements at 6-month, 1-year and 3-year increments.

4.3 Support tools and planning resources

Below is a list of tools, templates, checklists and information to support climate risk assessment and adaptation planning for health infrastructure projects.

Climate data

- National Institute of Water and Atmospheric Research, *Climate change scenarios for New Zealand* <https://niwa.co.nz/our-science/climate/information-and-resources/clivar/scenarios>
- Ministry for the Environment, *Climate change projections for New Zealand* <http://www.mfe.govt.nz/publications/climate-change/climate-change-projections-new-zealand>
- Ministry for the Environment, *Environment Aotearoa 2022* <https://environment.govt.nz/assets/publications/>
- CSIRO, *Projections tools* <https://www.climatechangeinaustralia.gov.au/en/projections-tools/>
- CSIRO & Bureau of Meteorology, *Victorian climate projections 2019* <https://www.climatechangeinaustralia.gov.au>
- Bureau of Meteorology, *State of the climate 2022* <http://www.bom.gov.au/state-of-the-climate/2022/>
- Bureau of Meteorology, *Climate data online* <http://www.bom.gov.au/climate/data/>
- Geoscience Australia, *Community safety data and products* <https://www.community-safety.ga.gov.au/data-and-products>
- CoastAdapt, *CoastAdapt datasets* <https://coastadapt.com.au/tools/coastadapt-datasets>

- New South Wales Government, *Climate Data Portal* <https://climatedata-beta.environment.nsw.gov.au/>
- Queensland Government, *Future Climate Dashboard* <https://www.longpaddock.qld.gov.au/qld-future-climate/dashboard/>
- Victorian Government, *Future climate tool* <https://vicfutureclimatetool.indraweb.io/>
- Government of South Australia, *Climate projections viewer* <https://www.environment.sa.gov.au/climate-viewer/>
- Government of Western Australia, *Western Australian climate projections* <https://www.environment.sa.gov.au/climate-viewer/>
- Climate Council, *Climate risk map of Australia* <https://www.climatecouncil.org.au/resources/climate-risk-map/>

Risk assessments

- Victorian Government, *Guidelines for sustainability in health care capital works* <https://www.vhba.vic.gov.au/sites/default/files/2021-10/Sustainability-guidelines-for-capital-works-VHBA-Revised-October-2021.pdf>
- New South Wales Government, *Climate risk assessment tool* <https://www.climatechange.environment.nsw.gov.au/sites/default/files/2021-11/Appendix%20C_Climate%20Risk%20Assessment%20Tool_2021.xlsx>
- New South Wales Government, *Climate risk ready NSW guide* <https://www.climatechange.environment.nsw.gov.au/sites/default/files/2021-06/NSW%20Climate%20risk%20ready%20guide.pdf>
- Government of Western Australia, *Climate change risk management guide* <https://www.wa.gov.au/system/files/2022-06/WA-climate-change-risk-management-guide.pdf>
- Queensland Health, *Climate change adaptation planning guidance guidelines* <https://www.health.qld.gov.au/__data/assets/pdf_file/0026/1125962/climate-change-guideline.pdf>
- Government of South Australia, *Climate change adaptation guideline* <https://www.dit.sa.gov.au/__data/assets/pdf_file/0010/165943/DIT_Climate_Change_Adaptation_Guideline.pdf>
- Royal Australasian College of Physicians, *Climate change and Australia's healthcare systems* <https://www.racp.edu.au/docs/default-source/advocacy-library/climate-change-and-australias-healthcare-systems-a-review-of-literature-policy-and-practice.pdf?sfvrsn=efe8c61a_4>
- World Health Organization, *Operational framework for building climate resilient and low carbon health systems* <https://iris.who.int/bitstream/handle/10665/373837/9789240081888-eng.pdf?sequence=1>
- Health New Zealand, *Heat health plans guidelines* <https://www.tewhatuora.govt.nz/assets/Publications/Environmental-health/Heat-Health-Plans-Guidelines.pdf>
- New Zealand Government, *A framework for the national climate change risk assessment for Aotearoa New Zealand* https://environment.govt.nz/assets/Publications/Files/arotakenga-huringa-ahuarangi-framework-for-national-climate-change-risk-assessment-for-aotearoa-FINAL.pdf

Case study: Climate risk assessment tools for end user training

In 2019, the Queensland Health and the National Climate Change Adaptation Research Facility co-designed 3 resources to aimed at assisting hospital and health service staff to identify and manage current and future climate change-related risks across key operational areas of the health system.

This case study is detailed in Appendix 3.

Appendix 1: Legislation, policies and procedures

Legislation and strategies

POLICY/STRATEGY	JURISDICTION	YEAR(S)	FUNCTION AND RELEVANCE
Climate Change Response (Zero Carbon) Amendment Act	New Zealand	2019	A framework for climate change policies, including new emission reduction targets, that requires developing climate change adaptation and mitigation policies and establishing the Climate Change Commission (Ministry for the Environment, 2021).
National climate change risk assessment (NCCRA)	New Zealand	2020	The risk assessment evaluates risks in 5 value domains (natural environment, human, economy, built environment and governance) and identifies 43 priority risks, 10 of which are considered to be the most significant. This forms the basis of prioritisation of action and links with the *National adaptation plan* through the risks identified (Ministry for the Environment, 2020).
National adaptation plan (NAP)	New Zealand	2022–2028	The NAP provides a framework of how New Zealand will adapt to climate change and increase climate resilience. The plan requires the health sector to assess their climate risk and resilience and build adaptation implementation plans (Ministry for the Environment, 2022).
Climate Change Adaptation Act (CCA)	New Zealand	Proposed	NAP includes action to pass legislation for retreat and adaptation. The Act is currently proposed and is one of 3 Acts to replace the Resource Management Act 1991 (Taituara, 2022).
Te Pae Tata interim New Zealand health plan 2022	New Zealand	2022–2024	The plan states commitments to prioritising action on climate change including implementing a climate sustainability and response plan across the health sector (Health New Zealand, 2022).
National climate resilience and adaptation strategy	Australia	2021–2025	The strategy sets out how the Australian Government will assist in anticipating, managing and adapting to the impacts of climate change. This strategy is addresses 4 domains: natural, built, social and economic to drive adaptation. This includes increased investment for resilience and adaptation and better access to climate information that health infrastructure will be able to access (DAWE, 2021).
National climate risk assessment	Australia	Under development	Part of the National Climate Adaptation and Risk Program. This risk assessment will give an understanding of the national level risks and impacts from climate change and will be a framework to respond to risks (DCCEEW, n.d.).
National adaptation plan	Australia	Under development	Part of the National Climate Adaptation and Risk Program. This plan will be a framework to drive adaptation actions and build national resilience to climate impacts (DCCEEW, n.d.).

POLICY/STRATEGY	JURISDICTION	YEAR(S)	FUNCTION AND RELEVANCE
National health and climate strategy	Australia	2023–2028	Outlines priorities for the next 5 years to address the health and wellbeing impacts of climate change. One of the core objectives it to build health system resilience to protect from the impacts of climate change (DoHAC, 2023).
NSW climate change policy framework	New South Wales, Australia	2016	A key objective is to make New South Wales more resilient to a changing climate and reduce climate change impacts on health and wellbeing (OEH, 2016).
NSW climate change adaptation strategy	New South Wales, Australia	2022	This strategy provides a framework for approaching climate change adaptation and outlines key decision-making principles and objectives. This includes a strategy for completing a climate change risk assessment and developing adaptation action plans (NSW Government, 2022).
Building Victoria's climate resilience	Victoria, Australia	2022	Building on *Victoria's climate change strategy* released in 2021, this strategy outlines actions that Victoria is undertaking to adapt and build resilience to climate change. Includes Adaptation Action Plans for 7 systems in Victoria that are vulnerable to climate impacts including health services and the built environment (DELWP, 2022).
Health and Human Services climate change adaptation action plan	Victoria, Australia	2022–2026	One of the action plans under the *Building Victoria's climate resilience strategy*, which will be updated every 5 years. This plan was developed to help achieve the long-term goal of ensuring the health and human services system is resilient to climate change and ecologically sustainable. The plan focuses on climate-resilient infrastructure and engagement with community on climate and health issues (DH and DFFH, 2022-2026).
Prospering in changing climate: a climate change adaptation framework for South Australia	South Australia, Australia	2012	Framework to develop actions and adaptation plans for the impacts of climate change. Intended to guide action for the government and community (Department of Environment, Water and Natural Resources, 2012).
South Australian Government: Climate change action plan	South Australia, Australia	2021–2025	Based on the *Climate change adaptation framework* and provides actions to be implemented within the next 5 years to drive progress towards longer term adaptation objectives (Department for Environment and Water, 2021).
State public health plan	South Australia, Australia	2019–2024	Includes a key pillar of protecting against public and environmental health risks and responding to climate change (SA Health, 2019).
Queensland Health climate risk strategy 2021–2026	Queensland, Australia	2021–2026	Strategy for fostering a public health system that is resilient and adaptive to climate threats. The strategy includes actions to address impacts of climate change and to adapt for the health system. It embeds climate risk management into Queensland Health's management and decision-making processes (Queensland Health, 2021).

POLICY/STRATEGY	JURISDICTION	YEAR(S)	FUNCTION AND RELEVANCE
Queensland Health climate change adaptation guidelines	Queensland, Australia	2019	Includes a risk management framework to develop a climate change risk management plan (Queensland Health, 2019).
Climate adaptation strategy	Western Australia, Australia	2023	Builds on the *Climate resilient WA: Directions for the state's climate adaptation strategy* and sets out 4 directions to support climate adaptation including publishing credible climate information and building public sector climate capability (DWER, 2023).
Health impacts of climate change: adaptation strategies for Western Australia	Western Australia, Australia	2007	In partnership with the World Health Organization's Collaborating Centre of Environmental Health Impact Assessment at Curtin University, this strategy considered the potential health impacts from climate change and potential adaptation strategies (Department of Health, 2008).
Tasmania's climate change action plan 2023–25	Tasmania, Australia	2023–2025	Action plan developed in response to the *Climate Change (State Action) Act 2008*. A new climate change action plan will be released in 2025 to align with the risk assessment and emission reduction and resilience plans (Climate Change Office, 2023).
Statewide climate change risk assessment	Tasmania, Australia	Ongoing – predicted 2024	Currently under development but will be used to prioritise actions for adapting to climate change impacts. The risk assessment will identify physical climate-related risks and opportunities as well as climate-related transition risks and opportunities (Department of State Growth, 2023).
ACT climate change adaptation strategy	Australian Capital Territory, Australia	2016	This strategy was developed to identify the potential risks and impacts of climate change and the potential adaptation measures to reduce vulnerability. It identifies key adaptation policy challenges and sectors for action including Sector 2 Community health and wellbeing, and Sector 3 Settlements and infrastructure (ACT Government, 2016).
Northern Territory climate change response: towards 2050	Northern Territory, Australia	2020	This strategy outlines a climate response policy framework and actions that can be undertaken (NT Government, 2020).
Weathering the storm: adapting Victoria's infrastructure to climate change	Victoria, Australia	2024	This report outlines 7 recommendations to support the Victorian Government (as well as other agencies and organisations) to better assess and prepare infrastructure for the impacts of climate change. It shows how to assess the risks from extreme weather and prepare different solutions to better protect infrastructure assets (Infrastructure Victoria, 2024).

Design standards

STANDARD	DESCRIPTION AND RELEVANCE
AS 5334:2013 Climate change adaptation for settlements and infrastructure – a risk-based approach	Australian standard that provides a framework and guidelines for assessing risks to infrastructure and settlements from climate change. It provides a structure and approach to planning and adaptation based on the risk management process in ISO 31000 (Standards Australia, 2013).
ISO 14090:2019 Adaptation to climate change: principles, requirements and guidelines	International standard that outlines guidelines and requirements for adapting to climate change. It is a non-linear approach so organisations can implement the principles at different stages. Organisations can use it to inform decisions and to better understand the impacts of climate change (ISO, 2019).
ISO 14091:2021 Adaptation to climate change: guidelines on vulnerability, impacts and risk assessments	International standard that outlines the process for assessing risks related to the impacts of climate change. It provides guidance on understanding vulnerability and developing a risk assessment for the impacts of climate change. Also, while giving understanding of vulnerabilities, it gives structure to preventing or mitigating the impacts while also considering the opportunities (ISO, 2021).
ISO 31000:2018 Risk management: guidelines	International standard that provides structure and guidelines for risk management. It includes guidance on implementing risk management practices, criteria for monitoring and improvement of risk management, and integration into an organisation (ISO, 2018).

Rating schemes

Green Star and Infrastructure Sustainability (IS) Rating Schemes are widespread sustainability rating accreditations that incorporate climate resilience into their criteria.

Green Star

Green Star is a sustainability rating and certification system that sets standards for design, construction and operation to create healthy, resilient and positive buildings and places. The 2 main tools are Green Star Buildings, used to certify the design and construction of a building, and Green Star Communities, which certifies plans and delivery for precinct-scale developments. The rating schemes have mandatory minimum standards as well as extra points for meeting credit achievement criteria. The scheme has a 'resilient' category, with the main relevant credit being the Climate Change Resilience credit, which requires a pre-screening checklist for climate change and, for extra credit, a climate change risk and adaptation assessment. This also interconnects and interplays with the other resilient category criteria: Operations Resilience, Community Resilience, Heat Resilience, Grid Resilience and Drought Resilience (GBCA, 2023) (GBCA, 2024).

Infrastructure Sustainability Rating Scheme

The IS Rating Scheme is a system to evaluate the economic, social and environmental performance of infrastructure across the development, design and operation of major infrastructure assets. Within the IS rating there is a Governance Theme of Resilience to ensure infrastructure is resilient and responsive to the needs of communities. There are 2 relevant credits: Res-1 Climate and Natural Hazards credit, which considers adaptation and impacts from natural hazards; and Res-2 Resilience Planning, which considers how to improve an asset's resilience and the wider interdependencies with communities (ISCA, 2021).

Financial disclosures

International Sustainability Standards Board

ISSB was created in November 2021 (at COP26) by the International Financial Reporting Standards (IFRS) Foundation and aligns with the International Accounting Standards Board. The ISSB released its standards IFRS S1 (General Requirements for Disclosure of Sustainability-related Financial Information) and IFRS S2 (Climate-related disclosures) in June 2023, which are based on a consolidation of different global standards. These standards are mainly for providing financial information to investors and providers of financial capital to be able to make easy comparisons when making investment assessments. The standards include disclosures on sustainability-related risks and opportunities and climate-related issues disclosures but also encompass social and governance factors such as workforce, relationship with local communities and natural resources (IFRS, 2023)

Australian Accounting Standards Board

The Australian Government committed to establishing a climate-related reporting framework that aligns with the ISSB standards and in October 2023 they released their draft consultation. The Exposure Draft ED SR1 Australian Sustainability Reporting Standards includes 3 proposed Australian Sustainability Reporting Standards (ASRS):

- ASRS 1 General Requirements for Disclosure of Climate-related Financial Information (based on IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information)
- ASRS 2 Climate-related Financial Disclosures (based on IFRS S2 Climate-related disclosures)
- ASRS 101 References in Australian Sustainability Reporting Standards – a draft service standard to list the relevant versions of any non-legislative documents published in Australia and foreign documents that are referenced in ASRS standards.

The standards align strongly to the ISSB standards but are more limited to solely climate-related financial disclosures and adapted to the Australian context and relevant regulations. The standards are still being finalised (AASB, 2024).

Aotearoa New Zealand Climate Standards

New Zealand introduced the Financial Sector (Climate-related Disclosures and Other Matters) Amendment Act (2021), which instituted the climate-related disclosure framework in New Zealand. In 2022 XRB (External Reporting Board) established the Aotearoa New Zealand Climate Standards (XRB, 2023):

- NZ CS 1 – provides a framework for entities to consider climate-related risk and opportunities
- NZ CS 2 – outlines a limited number of adoption provisions
- NZ CS 3 – establishes principles and general requirements.

Appendix 2: Example asset components

Table 6: Example of systems and sub-systems within hospital and health services that may be affected by climate change

MAJOR SYSTEM	SUB-SYSTEM
Structural System	Materials and structural systems used in the building
Existing Service Systems	Electrical system Telecommunication system Water supply and disposal system Waste management system Fuel storage facility Medical gases storage and distribution system Heating, ventilation and air-conditioning (HVAC) system Transport and access to hospital Office, storeroom furnishings, and equipment (fixed and movable) including computers, printers etc. Medical / laboratory equipment and supplies used for diagnosis and treatment
Planning Systems	Human resource such as staff and volunteers Demand planning Policy and procedure development Capability and service planning Energy planning Water planning Hospital disaster committee and emergency operations centre Availability of medicines, supplies, instruments, and other equipment

Source: Queensland Health, 2019 Climate change adaptation planning guidance: Guidelines. Brisbane: State of Queensland

Appendix 3: Case studies

Case study 1: Embedding climate risk into property acquisition

The Victorian Health Building Authority (VHBA) follows a 3-stage process for property acquisition involving identification, investigation and acquisition. The VHBA undertook a project to embed climate risk into the investigation stage to systematically assess long-term climate risks that could potentially affect the asset to be built. The major climate risks prioritised for assessment were bushfire, flooding, extreme heat, sea level rise and coastal erosion where relevant.

The key modifications to the investigation phase included:

- a new criterion in the evaluation matrix to assess the climate-related zoning and overlays of the surrounding area of the proposed site, with weighting of the criteria increasing incrementally based on the asset lifecycle
- modification of several existing criteria to consider longer term climate risks – for example, bonus points if a site has continued access during extreme climate events, or it is near a community refuge
- climate-related risks being specifically highlighted in the site evaluation report to provide visibility of climate risks over the life of the asset to decision-makers.

This project identified several publicly available tools to help evaluate climate risks. Templates used during the property acquisition process, such as consultant specifications, evaluation matrices and site evaluation reports, were updated to reflect the changes made to assess climate risk.

The key challenge in assessing climate risk is considering how the risks change over the life of the proposed asset, and how climate risks could affect access and utilities outside of the property boundary.

Challenges

- The accuracy and currency of data to assess climate risks at the property level
- Data to assess climate risks over a 50-year period
- Capability of due diligence consultants to assess climate risk

Successes

- Identification of climate risks before property acquisition
- Working with the property team to embed into existing processes
- Piloting the changes to test proposed changes

Lessons learned

- Need to assess climate risks outside the site boundary
- Public tools and databases are a useful resource
- The lifecycle of the proposed asset needs to be considered when assessing climate risks

Case study 2: Climate risk assessment of existing hospitals

The Victorian Department of Health assessed climate hazard risks to 6 regional hospitals across Victoria. The project analysed their exposure to flooding, extreme heat, grassfire and bushfire. The project included 3 phases:

- Desktop analysis of historic weather patterns for each of the regions surrounding the hospitals and map these to projected trends to provide site-specific climatic projections.
- Engage with key stakeholders in water, planning and emergency services to source data and to better identify local risks and existing actions to mitigate and respond to these risks.
- Visit each hospital to assess the infrastructure, meet with hospital staff and workshop the challenges and opportunities the hospital faces in adapting to projected future climate hazards.

While climate risk is specific to the type of asset and its location, several themes emerged across the health services in the study:

- It was generally found that the centralised location of hospitals in towns largely protected assets from the direct impacts of severe weather events.
- Hospital services are at greater risk than health infrastructure during climate-related events.
- Aged care facilities are more exposed to severe weather events given aged care patients are broadly more susceptible to climate extremes and the inherent risks associated with evacuation.

The study proposed adaptation options to increase the resilience of infrastructure and services. Options included relocating critical assets, upgrading building components to better manage extreme heat, reviewing emergency management protocols to address site-specific risks, installing backup communications and strengthening supply chains through stress-testing arrangements and backup options.

Challenges

- Managing risks outside the hospital boundary
- Budget to implement recommendations
- Sourcing site-specific data to assess climate risks

Successes

- Site-specific risk assessments and adaptation responses
- Identification of common risks across hospital types
- Facilitated workshops ensured health service engagement

Lessons learned

- Assess infrastructure risk and service risk concurrently
- Relationships are key to managing climate risks
- Managing risks outside the hospital boundary is key to managing resilience

Case study 3: Climate risk assessment tools for end user training

In 2019, the Queensland Health and the National Climate Change Adaptation Research Facility co-designed 3 resources to aimed at assisting hospital and health service (HHS) staff to identify and manage current and future climate-related risks across key operational areas of the health system.

The initial resources comprised 2 templates to help develop climate risk management plans: the Scan Cycle template (first-pass risk assessment) and the Detailed Cycle template, which focused on assessing significant risks necessitating immediate attention. A guideline was created to step users through the template completion process, as well as an almanac that contained the Queensland-specific climate forecasts and related data. Together, these components form the 'HHS toolkit', providing a comprehensive set of tools to empower HHSs in addressing climate-related risks and in developing climate risk management plans.

After developing the resources, a series of training workshops were carried out across Queensland, taking staff from all HHS sectors through the templates and providing the opportunity for in-depth discussion of their risks. The HHS toolkit and corresponding training created a solid foundation from which Queensland HHSs can progress to effectively address their risks from climate change.

Challenges

- Difficulty in identifying the primary contact within the HHS for discussions and planning
- Limited understanding of climate risk and adaptation
- No legislative mandate for climate risk assessment, which contributed to low uptake or interest
- Insufficient staffing and financial resources to progress beyond the training phase

Successes

- The HHS toolkit proved beneficial to participants, while the user training deemed informative
- Around 80% of the HHSs participated in the training during its initial rollout
- The HHS toolkit provides the foundation for developing national climate risk assessment and adaptation guidelines under the *National health and climate strategy*

Lessons learned

- Although the HHS toolkit and the training were considered useful, extra support, whether staffing or finances, is necessary to assist the HHS in completing their climate risk assessment and/or developing their management plan
- A significant level of engagement from the HHS is essential to generate interest in or raise awareness about the utility of the toolkit

References

AASB. (2024). *Climate-related Financial Disclosure.* Canberra: Australian Government: Australian Accounting Standards Board. Retrieved from https://aasb.gov.au/media/ukbp1lmn/ps_climate_02-24.pdf

ACT Government. (2016). *ACT Climate Change Adaptation Strategy.* Canberra: ACT Government: Environment and Planning Directorate. Retrieved from https://www.environment.act.gov.au/__data/assets/pdf_file/0004/912478/ACT-Climate-Change-Adaptation-Strategy.pdf

Barandiarán, M., Esquivel, M., Lacambra, S., Suárez, G., & Zuloaga, D. (2019). *Disaster and Climate Change Risk Assessment Methodology for IDB Projects.* Inter-American Development Bank.

Climate Change Office. (2023). *Tasmania's Climate Change Action Plan 2023-2025.* Tasmanian Government: Department of State Growth. Retrieved from https://recfit.tas.gov.au/__data/assets/pdf_file/0007/439684/Tasmanias_Climate_Change_Action_Plan_2023-25_Plain_Language_Version_Accessible.pdf

DAWE. (2021). *National Climate Resilience and Adaptation Strategy 2021 to 2025: Positioning Australia to better anticipate, management and adapt to our changing climate.* Canberra: Department of Agriculture, Water and the Environment .

DCCEEW. (n.d.). *Assessing and adapting to Australia's climate risks*. Retrieved from Australian Government: Department of Cliamte Change, Energy, the Environment and Water: https://www.dcceew.gov.au/climate-change/policy/adaptation/ncra

DELWP. (2022). *Building Victoria's Climate Resilience.* The State of Victoria Department of Environment, Land, Water and Planning.

Department for Environment and Water. (2021). *South Australian Government: Climate Change Action Plan 2021-2025.* Government of South Australia.

Department for Infrastructure and Transport. (2015). *Climate Change Adaptation Guideline.* Government of South Australia.

Department of Environment, Water and Natural Resources. (2012). *Propsering in a Changing Climate: A Climate Change Adaptation Framework for South Australia.* Government of South Australia: Department of Environment, Water and Natural Resources.

Department of Health. (2008). *Health impacts of climate change: Adaptation strategies for Western Australia.* Government of Western Australia: Department of Health.

Department of State Growth. (2023). *Statewide climte change risk assessment*. Retrieved from Tasmania Government: Department of State Growth: https://recfit.tas.gov.au/statewide_climate_change_risk_assessment

DH and DFFH. (2022-2026). *Health and Human Services Climate Change Adaptation Action Plan.* The State of Victoria Department of Health and the Department of Families, Fairness and Housing. Retrieved from https://www.health.vic.gov.au/sites/default/files/2022-02/health-human-services-climate-change-adaptation-action-plan-2022-2026_0.pdf

DoHAC. (2023). *National Health and Climate Strategy.* Canberra: Australian Government: Department of Health and Aged Care. Retrieved from https://www.health.gov.au/sites/default/files/2023-12/national-health-and-climate-strategy.pdf

DWER. (2023). *Climate Adaptation Strategy: Bulding WA's climate resilient future.* The Government of Western Australia: Department of Water and Environmental Regulation.

GBCA. (2023). *Green Star Buildings: Submission Guidelines.* Green Star Building Council Australia.

GBCA. (2024). *Green Star Communities consultation*. Retrieved from Green Building Council Australia: https://new.gbca.org.au/green-star/evolution/communities-consultation/

Health New Zealand. (2022). *Te Pae Tata - Interim New Zealand Health.* Wellington: Te Whatu Ora.

IFRS. (2023). *ISSB issues inaugural global sustainability disclosure standards*. Retrieved from IFRS: https://www.ifrs.org/news-and-events/news/2023/06/issb-issues-ifrs-s1-ifrs-s2/

Infrastructure Victoria. (2024). *Weathering the storm: adapting Victoria's infrastructure to climate change.* Melbourne: Infrastructure Victoria.

IPCC. (2021). Annex VII: Glossary [Matthews, J.B.R., V. Möller, R. van Diemen, J.S. Fuglestvedt, V. Masson-Delmotte, C. Méndez, S. Semenov, A. Reisinger (eds.)]. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen,*, 2215–2256. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. doi:10.1017/9781009157896.022.

IPCC. (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

IPCC. (2022). Annex II: Glossary. In IPCC, & V. R. Möller (Ed.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to* (pp. 2897–2930). Cambridge, UK and New York, NY, USA: Cambridge University Press. doi:10.1017/9781009325844.029

ISCA. (2021). *Technical Manual: Design & As-Built version 2.1.* Sydney: Infrastructure Sustainability Council of Australia (ISCA).

ISO. (2018). *ISO 31000:2018 Risk Management.* Geneva: International Organization for Standardization. Retrieved from https://www.iso.org/standard/65694.html

ISO. (2019). *ISO 14090:2019 Adaptation to climate change.* Geneva: International Organization for Standardization. Retrieved from https://www.iso.org/standard/68507.html

ISO. (2021). *ISO 14091:2021 Adaptation to climate change.* Geneva: International Organization for Standardization. Retrieved from https://www.iso.org/standard/68508.html

Ministry for the Environment. (2020). *National Climate Change Risk Assessment for Aotearoa New Zealand: Main Report - Arotakenga Tūraru mō te Huringa Āhuarangi o Āotearoa: Pūrongo whakatōpū.* Wellington: Ministry for Environment. Retrieved from https://environment.govt.nz/publications/national-climate-change-risk-assessment-for-new-zealand-main-report/

Ministry for the Environment. (2021). *Climate Change Response (Zero Carbon) Amendment Act 2019*. Retrieved from Ministry for the Environment: https://environment.govt.nz/acts-and-regulations/acts/climate-change-response-amendment-act-2019/

Ministry for the Environment. (2022). *Aotearoa New Zealand's first national adaptation plan.* Wellington: Ministry for the Environment.

NSW Government. (2022). *NSW Climate Change Adaptation Strategy.* NSW Government. Retrieved from https://www.climatechange.environment.nsw.gov.au/sites/default/files/2022-09/NSW%20climate%20change%20adaptation%20strategy_.pdf

NT Government. (2020). *Northern Territory Climate Change Response: Towards 2050.* Northern Territory Government: Office of Climate Change, Department of Environment and Natural Resources.

Retrieved from https://depws.nt.gov.au/__data/assets/pdf_file/0005/904775/northern-territory-climate-change-response-towards-2050.pdf

OEH. (2016). *NSW Climate Change Policy Framework.* The State of NSW and Office of Environment and Heritage. Retrieved from https://www.energy.nsw.gov.au/sites/default/files/2022-08/nsw-climate-change-policy-framework-160618.pdfhttps://www.energy.nsw.gov.au/sites/default/files/2022-08/nsw-climate-change-policy-framework-160618.pdf Retrieved from https://www.energy.nsw.gov.au/sites/default/files/2022-08/nsw-climate-change-policy-framework-160618.pdf

OEH. (2016). *NSW Climate Change Policy Framework.* The State of NSW and Office of Environment and Heritage. Retrieved from https://www.energy.nsw.gov.au/sites/default/files/2022-08/nsw-climate-change-policy-framework-160618.pdf

PIARC (2015) Toplis, C., Kidnie, M., Marchese, A., Marunta, C., Murphy, H., Sebille, R., Thompson, S. (2015). International Climate Change Adaptation Framework for Road Infrastructure. PIARC. Retrieved from https://www.piarc.org/en/order-library/23517-en-International%20climate%20change%20adaptation%20framework%20for%20road%20infrastructure

Queensland Health. (2019). *Climate change adaptation planning guidance: Guidelines.* Brisbane: State of Queensland.

Queensland Health. (2021). *Queensland Health: Climate Risk Strategy 2021-2026.* State of Queensland: Queensland Health.

SA Health. (2019). *State Public Health Plan.* Government of South Australia: SA Health.

Standards Australia. (2013). *AS 5334:2013.* Standards Australia. Retrieved from https://www.standards.org.au/standards-catalogue/standard-details?designation=as-5334-2013

Taituara. (2022). *Updates on cliamte change work at the Ministry for the Environment*. Retrieved from Taituara: https://taituara.org.nz/Story?Action=View&Story_id=347

TCFD. (2017). *Recommendations of the Taskforce on Climate-related Financial Disclosures.* Taskforce on Climate-related Financial Disclosures.

World Health Organisation. (2023). *Operational framework for building climate-resilient and low carbon health systems.* Geneva. Retrieved from Climate Change and Health.

XRB. (2023). *Aotearoa New Zealand Climate Standards*. Retrieved from XRB: External Reporting Board: https://www.xrb.govt.nz/standards/climate-related-disclosures/aotearoa-new-zealand-climate-standards